EXPLORING POPULATION DISPERSION IN SPAIN AS A SPENDING NEEDS DRIVER

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Abstract

The objective of this paper is to present our results regarding population dispersion in Spain´s regions. It follows an exploratory work aimed at providing a methodological framework previously published. It aims at providing a tool for policy decision-making concerning the Welfare State´s fundamental public services: health, social services and education. Population dispersion is a driver of the expenditure on the mentioned services not yet explored in Spain as much as others have been; such as population ageing, with which it has clear interaction. The ultimate goal is to contribute with an improved decision-making tool to the fiscal sustainability of public spending on fundamental public services that, in Spain, requires the territorial administrations to maintain the full exercise of their autonomy within a framework of budgetary stability.

Keywords: Budgetary stability; fiscal decentralisation; population dispersion; indicators methodology.

JEL Codes: C43, H53, H60, H72, R14.

CONTENT

1. INTRODUCTION

Population dispersion is one of the drivers of spending in the Welfare State´s fundamental public services: health, social services and education (FPS), and thus is a factor of sustainability of public finances. It is a driver of the mentioned expenditure not yet explored in Spain as much as others have been; such as population ageing, with which it interacts.

Due to sustainability reasons, population dispersion is a factor that should be considered in the decision-making process regarding the budgeting and planning of fundamental public services. Geographic areas with high population dispersion would need to offer services at higher rates of intensity of resources to ensure equality of access.

Considering the *de facto* federal structure of Spain, the sustainability of fundamental public services at the national level is determined by the sub-national government´s ability to comply with fiscal stability requirements. Indeed, according to Delgado, M. et al. (2016), "*a larger share of regions' spending on said fundamental public services limits regions' ability to adjust and comply with fiscal targets once their revenue-raising capacity is taken into account*." Over the last four decades, regional governments have become accountable for delivering more than ⅔ of essential services. Thus, in Spain, addressing the sustainability of public spending in fundamental public services concerns the decision-making process in territorial administration, which requires them to be able to maintain the full exercise of their autonomy within a framework of budgetary stability.

We have developed this work in the context of the analysis of budgetary stability in Spain. Specifically, connected to the identification and measurement of drivers of public spending needs on fundamental public services. There is vast literature on the subject. Nonetheless, population dispersion has not been as widely addressed as other factors, such as population ageing. In the European Union, the analyses of the drivers of public spending needs on fundamental public services have been typically focused on population ageing. A driver in itself, it interacts with other expenditure drivers. This is the case regarding population dispersion. By way of example, ageing is interacting with the progressive depopulation we are witnessing in rural areas (the "*emptied Spain*"), which in turn is associated with the evolution of dispersion.

The first step in addressing the integration of population dispersion into the decision-making process would be to ensure the availability of sound indicators, for it to be evidence-based. We approached this issue in two working papers: D-2021-01 where we set the methodological framework for formulating dispersion indicators, and this one (D-2021-02). Building on the first working paper, the objective now is to present our results from quantifying the indicators on population dispersion in Spain´s regions. Ultimately, the aim is to provide a tool for policy decision-making concerning the expenditure on health, social services and education at the national and the regional level.

To this end, we applied our methodological framework to quantify population dispersion. According to the methodological framework we have designed, population dispersion is a multidimensional concept. We have defined it as a specific pattern of land use by the population for residential purposes that is represented by low values in one or more of six distinct dimensions: proximity, centrality, nuclearity, density, concentration and continuity. Thus, we have selected a set of indicators to gauge each of these different dimensions and quantified them for Spain's territories. Then, we created a composite indicator that synthesises the different dimensions of population dispersion. Finally, we looked into the association of this indicator to per capita expenditure in health, social services and education with a view to deriving some policy implications.

We have framed dispersion indicators taking into account two leading vectors: the territorial vector and the population vector. In addition, we have calculated the indicators for each year of the period 2003 to 2017, with 2016 being the base year.

As for the territorial vector, our work takes Spain´s singular population entities (SE) and municipalities (MUN) as the basic territorial cells for the measurement of dispersion. Then we worked with a bottom-up approach. We used singular entities (alternatively, municipalities) and their population to measure the indicators on dispersion's dimensions at provincial level. The province is our geographical unit of analysis. We then aggregated the indicators at regional and the national level. Where possible, we have focused our calculations on indicators based on SE. However, we have verified that when needed, it is possible to work with indicators based on municipalities instead of singular entities, without great loss of generality.

Regarding the population vector, we distinguished two approaches for population dispersion: one is that of the people and the other one is that of the locations where the people inhabit. This distinction raises relevant issues from the perspective of the fundamental public services organization. On one hand, less population dispersion would promote economies of scale regarding the offer of fundamental public services (including Reference Services, especially when centrality is high). On the other hand, even when the population dispersion is lower than the geographical dispersion, the need to guarantee universal access to fundamental public services would imply the need to offer services at different ratios per inhabitant, depending on the province's zone, with possible losses of economies of scale. Thus, regarding decision-making, even if efficiency reasons would advise focusing on the population dispersion, both population and geographical dispersions should be jointly considered as fundamental public services needs drivers to take into account equality of access considerations.

This paper is organised as follows. After this introduction, in point two, we present our calculations for indicators on proximity, centrality, nuclearity, density, concentration and continuity. In point three, present the main features of dispersion dimensions. In point four, we explore the association between population dispersion and ageing. Then, in point five, we develop a composite indicator for population dispersion. Point six looks into the association of the indicators to per capita expenditure in FPS. Point seven summarises our conclusions. Following point seven, we include some annexes to further support our analyses, as well as some references at the end.

2. INDICATORS ON DISPERSION’S DIMENSIONS

The methodological framework that we applied in this paper is described in Blanco, A. et al. (2021), including nomenclature, definitions, indicators’ formulation and interpretation, and some basics on the indicators´ primary components.

We have selected a set of ninety-four indicators for Spain´s regions grouped in six dimensions (proximity, centrality, nuclearity, density, concentration and continuity) and two categories, depending on whether the indicator definition is based on singular entities (SE) or municipalities (MUN).

In Box 1 below, we present the list of indicators on dispersion by dimension and category juxtaposing the SE-based indicators to their counterpart MUN-based. The selected indicators are candidates for exploring the association between population dispersion and the cost of fundamental public services.

The indicators based on SE would capture dispersion's dimensions to a greater degree than those based on municipalities since the network of singular entities provides greater granularity. Therefore, where available, we have focused our analysis on the former. The exceptions are:

- Indicators involving areas in their formulation have to be based on municipalities, as we lack area data referred to SE.
- Some indicators involving distances between land uses require such extensive calculation resources that, given the available ones, it is not feasible to work with SE.

However, we have verified that, when needed, it is possible to work with indicators based on municipalities within a province, instead of singular entities, without great loss of generality.

Indeed, we have analysed the association between SE-based and their homologous MUN-based indicators, when there is such correspondence. This is the case for thirty-one indicators concerning proximity, centrality, nuclearity and concentration. We present this analysis in Annex I. Except for four indicators,[1] we have found a strong linear correlation between SE-based and MUN-based. Excluding the exceptions, correlations are very high, varying from 0.88 to 1.00 for proximity; from 0.90 to 1.00 for centrality; from 0.93 to 1.00 for nuclearity; and from 0.93 to 1.00 for concentration (*Annex I. Table 0*). Regarding the exceptions, the correlations are intermediate-low: 0.41 (regarding $PROXN_{SE1j}$ and $PROXN_{MUN2j}$); or even intermediate to high: 0.64 (regarding $PROXN_{SE1k}$ and $PROXN_{MUN2k}$); 0.70 (regarding $CBDdN_{SE1j}$ and $CBDdN_{MUN1j}$) and 0.78 (regarding $CBDdN_{SE1k}$ and $CBDdN_{MUN1k}$).

[1] Relative to standardised locations proximity and centrality:

- Normalised proximity - simple average of straight-line distances between SE ($PROXN_{SE1j}$)
- Normalised proximity - simple average of travel distances between SE ($PROXN_{SE1k}$)
- Normalised centrality - simple average of straight-line distances from SE to CBD ($CBDdN_{SE1j}$)
- Normalised centrality - simple average of travel distances from SE to CBD ($CBDdN_{SE1k}$).

Box 1. List of indicators by dimension and category ***(It continues)***

DIMENSION	TYPE	CATEGORY: SE – TEXT	CATEGORY: SE – ACRONISM SE	CATEGORY: MUN – ACRONISM MUN	CATEGORY: MUN – TEXT
PROXIMITY	*ABSOLUTE*	*1. Inverse of the simple average of straight-line distances between SE*	*PROXSSE1a*	*PROXSMUN2a*	*14. Inverse of the simple average of straight-line distances between municipalities*
PROXIMITY	*ABSOLUTE*	*2. Inverse of the simple average of travel distances between SE*	*PROXSSE1b*	*PROXSMUN2b*	*15. Inverse of the simple average of travel distances between municipalities*
PROXIMITY	*ABSOLUTE*	*3. Inverse of the simple average of travel durations between SE*	*PROXSSE1c*	*PROXSMUN2c*	*16. Inverse of the simple average of travel durations between municipalities*
PROXIMITY	*ABSOLUTE*	*4. Inverse of the weighted average of straight-line distances between SE*	*PROXWSE1d*	*PROXWMUN2d*	*17. Inverse of the weighted average of straight-line distances between municipalities*
PROXIMITY	*ABSOLUTE*	*5. Inverse of the weighted average of travel distances between SE*	*PROXWSE1e*	*PROXWMUN2e*	*18. Inverse of the weighted average of travel distances between municipalities*
PROXIMITY	*ABSOLUTE*	*6. Inverse of the weighted average of travel durations between SE*	*PROXWSE1f*	*PROXWMUN2f*	*19. Inverse of the weighted average of travel durations between municipalities*
PROXIMITY	*RELATIVE*	*7. Ratio population proximity to geographical proximity (SE & straight-line distance)*	*PROXRSE1g*	*PROXRMUN2g*	*20. Ratio population proximity to geographical proximity (MUN & straight-line distance)*
PROXIMITY	*RELATIVE*	*8. Ratio population proximity to geographical proximity (SE & travel distance)*	*PROXRSE1h*	*PROXRMUN2h*	*21. Ratio population proximity to geographical proximity (MUN & travel distance)*
PROXIMITY	*RELATIVE*	*9. Ratio population proximity to geographical proximity (SE & travel duration)*	*PROXRSE1i*	*PROXRMUN2i*	*22. Ratio population proximity to geographical proximity (MUN & travel duration)*
PROXIMITY	*STANDARDISED*	*10. Normalised geographical proximity (SE & straight-line distance)*	*PROXNSE1j*	*PROXNMUN2j*	*23. Normalised geographical proximity (MUN & straight-line distance)*
PROXIMITY	*STANDARDISED*	*11. Normalised geographical proximity (SE & travel distance)*	*PROXNSE1k*	*PROXNMUN2k*	*24. Normalised geographical proximity (MUN & travel distance)*
PROXIMITY	*STANDARDISED*	*12. Normalised population proximity (SE & straight-line distance)*	*PROXNSE1l*	*PROXNMUN2l*	*25. Normalised population proximity (MUN & straight-line distance)*
PROXIMITY	*STANDARDISED*	*13. Normalised population proximity (SE travel distance)*	*PROXNSE1m*	*PROXNMUN2m*	*26. Normalised population proximity (MUN travel distance)*
PROXIMITY	*STANDARDISED*			*PROXVMUN2n*	*27. Standardised Proximity Index (SPI) based on straight-line distance*
PROXIMITY	*STANDARDISED*			*PROXVMUN2o*	*28. Standardised Proximity Index (SPI) based on travel distance*
PROXIMITY	*STANDARDISED*			*PROXVMUN2p*	*29. Standardised Proximity Index (SPI) based on travel duration*

DIMENSION	TYPE	CATEGORY: SE – TEXT	CATEGORY: SE – ACRONISM SE	CATEGORY: MUN – ACRONISM MUN	CATEGORY: MUN – TEXT
CENTRALITY	*ABSOLUTE*	*30. Inverse of the simple average of straight-line distances from SE to CBD*	*CBDdSSE3a*	*CBDdSMUN4a*	*43. Inverse of the simple average of straight-line distances from municipalities to CBD*
CENTRALITY	*ABSOLUTE*	*31. Inverse of the simple average of travel distances from SE to CBD*	*CBDdSSE3b*	*CBDdSMUN4b*	*44. Inverse of the simple average of travel distances from SE municipalities to CBD*
CENTRALITY	*ABSOLUTE*	*32. Inverse of the simple average of travel durations from SE to CBD*	*CBDdSSE3c*	*CBDdSMUN4c*	*45. Inverse of the simple average of travel durations from municipalities to CBD*
CENTRALITY	*ABSOLUTE*	*33. Inverse of the weighted average of straight-line distances from SE to CBD*	*CBDdWSE3d*	*CBDdWMUN4d*	*46. Inverse of the weighted average of straight-line distances from municipalities to CBD*
CENTRALITY	*ABSOLUTE*	*34. Inverse of the weighted average of travel distances from SE to CBD*	*CBDdWSE3e*	*CBDdWMUN4e*	*47. Inverse of the weighted average of travel distances from municipalities to CBD*
CENTRALITY	*ABSOLUTE*	*35. Inverse of the weighted average of travel durations from SE to CBD*	*CBDdWSE3f*	*CBDdWMUN4f*	*48. Inverse of the weighted average of travel durations from municipalities to CBD*
CENTRALITY	*RELATIVE*	*36. Ratio population centrality to geographical centrality (SE & straight-line distance)*	*CBDdRSE3g*	*CBDdRMUN4g*	*49. Ratio population centrality to geographical centrality (MUN & straight-line distance)*
CENTRALITY	*RELATIVE*	*37. Ratio population centrality to geographical centrality (SE & travel distance)*	*CBDdRSE3h*	*CBDdRMUN4h*	*50. Ratio population centrality to geographical centrality (MUN & travel distance)*
CENTRALITY	*RELATIVE*	*38. Ratio population centrality to geographical centrality (SE & travel duration)*	*CBDdRSE3i*	*CBDdRMUN4i*	*51. Ratio population centrality to geographical centrality (MUN & travel duration)*
CENTRALITY	*STANDARDISED*	*39. Normalised geographical centrality (SE & straight-line distance)*	*CBDdNSE3j*	*CBDdNMUN4j*	*52. Normalised geographical centrality (MUN & straight-line distance)*
CENTRALITY	*STANDARDISED*	*40. Normalised geographical centrality (SE & travel distance)*	*CBDdNSE3k*	*CBDdNMUN4k*	*53. Normalised geographical centrality (MUN & travel distance)*
CENTRALITY	*STANDARDISED*	*41. Normalised population centrality (SE & straight-line distance)*	*CBDdNSE3l*	*CBDdNMUN4l*	*54. Normalised population centrality (MUN & straight-line distance)*
CENTRALITY	*STANDARDISED*	*42. Normalised population centrality (SE travel distance)*	*CBDdNSE3m*	*CBDdNMUN4m*	*55. Normalised population centrality (MUN travel distance)*
CENTRALITY	*STANDARDISED*			*CBDdCRMUN4n*	*56. Centralisation Ratio*
CENTRALITY	*STANDARDISED*			*CBDdACIMUN4o*	*57. Centralisation Index*

DIMENSION	TYPE	CATEGORY: SE – TEXT	CATEGORY: SE – ACRONISM SE	CATEGORY: MUN – ACRONISM MUN	CATEGORY: MUN – TEXT
NUCLEARITY	*na*	*58. Inverse of the number of nuclei per province*	*NUNoNSE5a*	*NUNoNMUN6a*	*60. Inverse of the number of nuclei*
NUCLEARITY	*na*	*59. Share of the population in the CBD over the population in nuclei within a province*	*NUSoPSE5b*	*NUSoPMUN6b*	*61. Share of the population in the CBD over the population in nuclei within a province*

Box 1. List of indicators by dimension and category **(It concludes)**

DIMENSION	TYPE	CATEGORY: MUN	
		TEXT	ACRONISM MUN
DENSITY	*na*	*62. Population-weighted density based on total land*	*DEPWDMUN7a*
DENSITY	*na*	*63. Population-weighted density based on urban land*	*DEPWDMUN7b*
DENSITY	*na*	*64. Population-weighted density based on built-up land*	*DEPWDMUN7c*
DENSITY	*na*	*65. Maximum density based on total land*	*DENMAXMUN7d*
DENSITY	*na*	*66. Maximum density based on urban land*	*DENMAXMUN7e*
DENSITY	*na*	*67. Maximum density based on built-up land*	*DENMAXMUN7f*
DENSITY	*na*	*68. Minimum density based on total land*	*DENMINMUN7g*
DENSITY	*na*	*69. Minimum density based on urban land*	*DENMINMUN7h*
DENSITY	*na*	*70. Minimum density based on built-up land*	*DENMINMUN7i*
DENSITY	*na*	*71. Share of the population living in high-density municipalities based on total land*	*DENHIGHMUN7j*
DENSITY	*na*	*72. Share of the population living in high-density municipalities based on urban land*	*DENHIGHMUN7k*
DENSITY	*na*	*73. Share of the population living in high-density municipalities based on built-up land*	*DENHIGHMUN7l*
DENSITY	*na*	*74. Density of land use in the CBM based on total land*	*DENCBDMUN7m*
DENSITY	*na*	*75. Density of land use in the CBM based on urban land*	*DENCBDMUN7n*
DENSITY	*na*	*76. Density of land use in the CBM based on built-up land*	*DENCBDMUN7o*

DIMENSION	TYPE	CATEGORY: SE		CATEGORY: MUN	
		TEXT	ACRONISM SE	ACRONISM MUN	TEXT
CONCENTRATION	*na*			$CNDCV_{MUN9a}$	*80. Coefficient of variation of densities*
CONCENTRATION	*na*			$CNHGD_{MUN9b}$	*73. Share of the population living in high-density municipalities based on built-up*
CONCENTRATION	*na*			$CNPDG_{MUN9c}$	*81. Population density gradient*
CONCENTRATION	*na*	*77. Gini index for SE*	$CNGINI_{SE8a}$	$CNGINI_{MUN9d}$	*82. Gini index for MUN based on population*
CONCENTRATION	*na*			$CNGINI_{MUN9e}$	*83. Gini index for MUN based on land areas*
CONCENTRATION	*na*	*78. Standardised Theil entropy index (SE)*	$CNSTHEI_{SE8b}$	$CNSTHEI_{MUN9f}$	*84. Standardised Theil entropy index (MUN)*
CONCENTRATION	*na*			$CNTHI_{MUN9g}$	*85. Theil index*
CONCENTRATION	*na*	*79. Standardised Herfindahl index (SE)*	$CNSHHI_{SE8c}$	$CNSHHI_{MUN9h}$	*86. Standardised Herfindahl index (MUN)*
CONCENTRATION	*na*			$CNRGCI_{MUN9i}$	*87. Raw geographical concentration index*
CONCENTRATION	*na*			$CNEG_{MUN9j}$	*88. Ellison and Glaesser*
CONCENTRATION	*na*			$CNDI_{MUN9k}$	*89. Delta index (also Hoover index)*
CONCENTRATION	*na*			$CNMDDI_{MUN9l}$	*90. Massey and Denton dissimilarity index for urban land [1]*
CONCENTRATION	*na*			$CNMDDI_{MUN9m}$	*91. Massey and Denton dissimilarity index for built-up-up land [2]*

DIMENSION	TYPE	CATEGORY: MUN	
		TEXT	ACRONYM MUN
CONTINUITY	*na*	*92. Ratio urban land area to total land area*	$CNTRUT_{MUN10a}$
CONTINUITY	*na*	*93. Ratio urban land area to total land area*	$CNTRBT_{MUN10b}$
CONTINUITY	*na*	*94. R-square of the exponential density function*	$CNTR2_{MUN10c}$

Proximity

The set of indicators that we used captures proximity within province i through the spatial separation between land uses: SE and municipalities within the province. We used three types of distances to measure spatial separation: straight-line, travel distance and travel duration.[2] We aggregated distances via simple averages and population weighted averages. Simple average-based indicators reflect the proximity of the locations where the population inhabits[3] ("geographical proximity") rather than the proximity of the people themselves ("population proximity"). On the contrary, weighted average-based indicators reflect the population proximity rather than the geographical proximity.

This distinction between population and geographical proximities raises two relevant issues from the perspective of the FPS organization. On one hand, a higher proximity of the population would promote economies of scale regarding the offer of FPS. On the other hand, even when the population proximity is higher than that of the settlements, the need to guarantee universal access to those population entities that are far away and less populated would imply the need to offer services at different ratios per inhabitant, depending on the province's zone, with possible losses of economies of scale.

Thus, regarding decision-making, even if efficiency reasons would advise focusing on population proximity, both types of proximity should be jointly considered as FPS needs drivers to take into account equality of access considerations.

According to the methodology developed by Blanco, A. et al. (2021), we worked with three types of proximity indicators:

- Absolute:
  - *Inverse of the simple average of straight-line distances between SE* ($\mathbf{PROXS}_{SE1a}$).
  - *Inverse of the simple average of travel distances between SE* ($\mathbf{PROXS}_{SE1b}$).
  - *Inverse of the simple average of travel durations between SE* ($\mathbf{PROXS}_{SE1c}$).

[2] Please, notice that we always refer to distances between any two land uses within the same province: No distance between two SE or municipalities of different provinces is involved in the calculations.

[3] Please remember that SE with 0 inhabitants have been excluded from our analysis.

- *Inverse of the weighted[4] average of straight-line distances between SE (**$PROXW_{SE1d}$**).*
- *Inverse of the weighted average of travel distances between SE (**$PROXW_{SE1e}$**).*
- *Inverse of the weighted average of travel durations between SE (**$PROXW_{SE1f}$**).*

- Relative:
  - *Ratio population proximity to geographical proximity (SE & straight-line distance) (**$PROXR_{SE1g}$**).*
  - *Ratio population proximity to geographical proximity (SE & travel distance) (**$PROXR_{SE1h}$**).*
  - *Ratio population proximity to geographical proximity (SE & travel duration) (**$PROXR_{SE1i}$**).*

- Standardised:
  - *Normalised geographical proximity (SE & straight-line distance) (**$PROXN_{SE1j}$**).*
  - *Normalised geographical proximity (SE & travel distance) (**$PROXN_{SE1k}$**).*
  - *Normalised population proximity (SE & straight-line distance) (**$PROXN_{SE1l}$**).*
  - *Normalised population proximity (SE & travel distance) (**$PROXN_{SE1m}$**).*
  - *Standardised Proximity Index (SPI) based on straight-line distance (**$PROXV_{MUN2n}$**).*
  - *Standardised Proximity Index (SPI) based on travel distance (**$PROXV_{MUN2o}$**).*
  - *Standardised Proximity Index (SPI) based on travel duration (**$PROXV_{MUN2p}$**).*

As a rule, we will focus on SE-based indicators and present the associated MUN-based indicators in Annex I. Correlation between SE and MUN-based proximity indicators, excluding the normalised geographical proximity indicators based on straight-line distance, ranges from 0.64 to 1.00 (Annex I. Table 0).

Absolute proximity

Nationwide, the ***simple average of straight-line distances between SE*** locations within the same province is 51.82 Km; for travel distances it is 80.72 Km; and for travel durations 70.52 minutes (1.18 hours). (Table 1.1).

The ***population-weighted average of straight-line distances between SE*** within the same province is 32.41 Km; for travel distances, it is 48.49 Km; and for travel durations 43.96 minutes (0.73 hours).

Maximum average distances within a province occur in the islands, normally in Canarias.[5] Regarding location distances (simple averages), in Illes Balears, we calculated an average

[4] We weight the distance between two different Singular Entities of province i by the product of their respective populations, using a proper weights system: rescaled to add one.

[5] Please, notice that we measure distances within the same province. In the islands territories, a province includes several island. Thus, distances are influenced by the inter-islands distances. For further details, please refer to Blanco, A. et al. (2021).

straight-line distance of 83.80 Km, the highest in Spain; in Canarias, the average travel distance is 129.85 Km, the highest in Spain; and, also in Canarias, the average travel duration of 237.76 minutes (3.96 hours) is the maximum one. Regarding population distances (weighted averages), maximum values correspond to Illes Balears for straight-line distance (74.00 Km), Canarias for travel distance (111.09 Km) and Canarias as well for travel duration (204.04 minutes —3.40 hours) (Table 1.2).

Minimum average distances within a province occur always in País Vasco, except for travel duration that registers its minimum values in Madrid when distances are population weighted. Regarding simple averages, in País Vasco, we calculated an average straight-line distance of 27.31 Km; an average travel distance of 43.26 Km; and an average travel duration of 42.14 minutes (0.70 hours), the lowest in Spain. Regarding weighted averages, País Vasco registers the minimum average for straight-line distance (19.59 Km) and for travel distance (32.03 Km), and Madrid for travel duration (29.48 minutes —0.49 hours) (Table 1.2).

Inter-region variability of the average distances between SE within the same province is high, with coefficients of variation (CV) over 21%. It is especially high for travel durations, with CV close to 100% (Table 1.3).

Against this backdrop, absolute proximity indicators in Spain´s regions show the following basic features (Table 2): [6]

- ***Geographical proximity*** (***absolute***) measured in terms of ***straight-line distance*** ranges from 0.0119 to 0.0366; in País Vasco (maximum value), it is 3.1 times that of Illes Balears (minimum value). Measured in terms of ***travel distance,*** it ranges from 0.0077 to 0.0231; in País Vasco (maximum value), it is 3.0 times that of Canarias (minimum value). In terms of ***travel duration,*** it ranges from 0.0042 to 0.0237; in País Vasco (maximum value), it is 5.6 times that of Canarias (minimum value).
- ***Population proximity (absolute)*** measured in terms of ***straight-line distance*** ranges from 0.0135 to 0.0510; in País Vasco (maximum value), it is 3.8 times that of Illes Balears

[6] Please remember that the unit for indicators based on straight-line or travel distances is Km^{-1} as it is the inverse of a distance measured in Km. Regarding travel durations, the unit for indicators is min^{-1} as it is the inverse of a distance measured in minutes.

(minimum value). Measured in terms of ***travel distance,*** it ranges from 0.0090 to 0.0312; in País Vasco (maximum value), it is 3.5 times that of Canarias (minimum value). In terms of ***travel duration***, it ranges from 0.0049 to 0.0333; in Madrid (maximum value), it is 6.9 times that of Canarias (minimum value).

- ***Absolute proximity*** has a significant variability among regions with inter-region coefficients of variation from 24% to 34%.
- Systematically, the minimum proximity correspond to the islands. On the opposite side, País Vasco registers the maximum one, except for population proximity based on travel duration that occurs in Madrid.
- Generally, geographical proximity is lower than population proximity proving that population tends to reside in singular entities that are closer to each other than the whole set of locations. Except for Navarra, where the geographical proximity is slightly below the population proximity. At the national level, population proximity is between 60% and 66% higher than geographical proximity depending on the type of distance used.

There are not standard references available against which benchmarking the value of our indicators. Therefore, we developed our analysis based on interregional comparisons with the national average and the distribution across regions as a reference.

We observe that absolute geographical proximity has a symmetric distribution across regions, while absolute population proximity presents a marked positive asymmetric one (Chart 1). This reflects that the share of the population in regions that present below average absolute geographical proximity is similar to that of the population living in regions with above average geographical proximity. However, the share of people in regions with low population proximity overpasses that in regions above average.

We have verified not only that the share of the population in regions that hold below average population proximity overpasses that in regions with above average values, but also the number of regions, with just four regions (Cantabria, Cataluña, Madrid and País Vasco) systematically in the right side or positive tail of the asymmetric distributions (Table 3).

Indeed, we found that Cantabria, Cataluña, Madrid and País Vasco are systematically in top positions above the national average with a high level of absolute proximity, mainly for absolute population proximity. On the contrary, Andalucía, Aragón, Illes Balears, Canarias, Castilla y León, Castilla-La Mancha and Extremadura are systematically in bottom positions below average, with low a level of absolute proximity (Table 3).

Regarding the evolution of proximity, we highlight that geographical proximity is constant as we worked with a panel of land uses that remain the same over the course of the period 2003-2017. Therefore, our analyses about the evolution of proximity (as well as for the rest of the dimensions) will focus on population-based indicators.

Population proximity is increasing since 2008. Nationwide, the indicators show that from 2003 to 2008 population proximity decreased, to initiate a rising trend as of 2008 that continued until 2017, our last analysed year (Chart 2). We observed that the fall between 2003 and 2008 regarding travel durations is greater and, unlike the rest of variables, the related proximity indicators have not recovered in 2017 the level of 2003.[7]

Our results show that over time population has moved to reside in land uses that are closer to each other, mainly in terms of travel distances. Indeed, the evolution of population proximity based on travel distances (brown and light blue lines in Chart 2) presents the highest rates of increase. In addition, these movements seem to be more intense concerning SE than municipalities (the lines in Chart 2 representing the indicators based on SE overpass those based on municipalities for the same sort of distance). One plausible explanation could be that the population has moved towards the municipalities' capitals in addition to towards municipalities that are closer to each other.

[7] Please, notice that we have only estimated the ratios straight-line to travel distance and straight-line to travel duration in 2016. Thus, we are not capturing time variations in these ratios.

Table 1.1 Average distance between singular entities within the same province by Region

Region	Singular entity-based indicators					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
	$PROXS_{SE1a}$	$PROXS_{SE1b}$	$PROXS_{SE1c}$	$PROXW_{SE1d}$	$PROXW_{SE1e}$	$PROXW_{SE1f}$
TOTAL	**51.82**	**80.72**	**70.52**	**32.41**	**48.49**	**43.96**
Andalucía	56.79	92.92	80.31	41.95	64.64	56.32
Aragón	61.92	95.88	79.73	47.67	70.88	55.66
Asturias	54.90	87.80	75.47	35.93	57.46	49.40
Illes Balears	83.80	113.52	209.22	74.00	100.24	184.76
Canarias	81.02	129.85	237.76	69.97	111.09	204.04
Cantabria	45.42	76.17	64.00	28.91	48.49	40.74
Castilla y León	60.78	89.95	75.60	45.14	65.82	55.07
Castilla-La Mancha	61.39	90.58	76.00	59.08	83.59	68.19
Cataluña	47.13	74.68	67.05	28.78	43.70	35.98
Comunidad Valenciana	52.66	79.09	64.84	37.13	54.46	42.87
Extremadura	76.16	110.32	90.01	68.30	95.08	77.69
Galicia	51.12	79.36	69.23	40.59	63.56	54.87
Madrid	48.54	70.75	58.03	24.66	35.94	29.48
Murcia	50.32	71.82	60.08	43.08	61.49	51.44
Navarra	43.43	68.89	58.07	43.74	69.38	58.49
País Vasco	27.31	43.26	42.14	19.59	32.03	31.31
La Rioja	39.42	66.77	57.70	36.44	61.71	53.33

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 1.2. Maximum and minimum values of the average distance (value and Region)

	Singular entity-based indicators					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
Max SE	83.80	129.85	237.76	74.00	111.09	204.04
Min SE	27.31	43.26	42.14	19.59	32.03	29.48
Max SE	Illes Balears	Canarias	Canarias	Illes Balears	Canarias	Canarias
Min SE	País Vasco	País Vasco	País Vasco	País Vasco	País Vasco	Madrid

Source: Author's own work based on Table 1.1. Base year = 2016.

Table 1.3. Inter-region variability of the average distance

	Singular entity-based indicators					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
Standard Deviation SE	11.15	16.90	41.86	13.51	19.64	40.29
CV SE	0.22	0.21	0.59	0.42	0.41	0.92

Source: Author's own work based on Table 1.1. Base year = 2016.

Table 2.1. Absolute proximity indicators by region

Region	Inverse of the distance from singular entities to CBD within the same province					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
	$PROXS_{SE1a}$	$PROXS_{SE1b}$	$PROXS_{SE1c}$	$PROXW_{SE1d}$	$PROXW_{SE1e}$	$PROXW_{SE1f}$
TOTAL	**0.0193**	**0.0124**	**0.0142**	**0.0309**	**0.0206**	**0.0227**
Andalucía	0.0176	0.0108	0.0125	0.0238	0.0155	0.0178
Aragón	0.0161	0.0104	0.0125	0.0210	0.0141	0.0180
Asturias	0.0182	0.0114	0.0132	0.0278	0.0174	0.0202
Illes Balears	0.0119	0.0088	0.0048	0.0135	0.0100	0.0054
Canarias	0.0123	0.0077	0.0042	0.0143	0.0090	0.0049
Cantabria	0.0220	0.0131	0.0156	0.0346	0.0206	0.0245
Castilla y León	0.0165	0.0111	0.0132	0.0222	0.0152	0.0182
Castilla-La Mancha	0.0163	0.0110	0.0132	0.0169	0.0120	0.0147
Cataluña	0.0212	0.0134	0.0149	0.0348	0.0229	0.0278
Comunidad Valenciana	0.0190	0.0126	0.0154	0.0269	0.0184	0.0233
Extremadura	0.0131	0.0091	0.0111	0.0146	0.0105	0.0129
Galicia	0.0196	0.0126	0.0144	0.0246	0.0157	0.0182
Madrid	0.0206	0.0141	0.0172	0.0406	0.0278	0.0339
Murcia	0.0199	0.0139	0.0166	0.0232	0.0163	0.0194
Navarra	0.0230	0.0145	0.0172	0.0229	0.0144	0.0171
País Vasco	0.0366	0.0231	0.0237	0.0510	0.0312	0.0319
La Rioja	0.0254	0.0150	0.0173	0.0274	0.0162	0.0188

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 2.2. Maximum and minimum values of absolute proximity indicators (value and Region)

	Inverse of the distance from singular entities to CBD within the same province					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
Max SE	0.0366	0.0231	0.0237	0.0510	0.0312	0.0339
Min SE	0.0119	0.0077	0.0042	0.0135	0.0090	0.0049
Max SE	País Vasco	País Vasco	País Vasco	País Vasco	País Vasco	Madrid
Min SE	Illes Balears	Canarias	Canarias	Illes Balears	Canarias	Canarias

Source: Author's own work based on Table 2.1. Base year = 2016.

Table 2.3. Inter-region variability of absolute proximity indicators

	Inverse of the distance from singular entities to CBD within the same province					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
Standard Deviation SE	0.0046	0.0029	0.0037	0.0096	0.0062	0.0078
CV SE	0.24	0.24	0.26	0.31	0.30	0.34

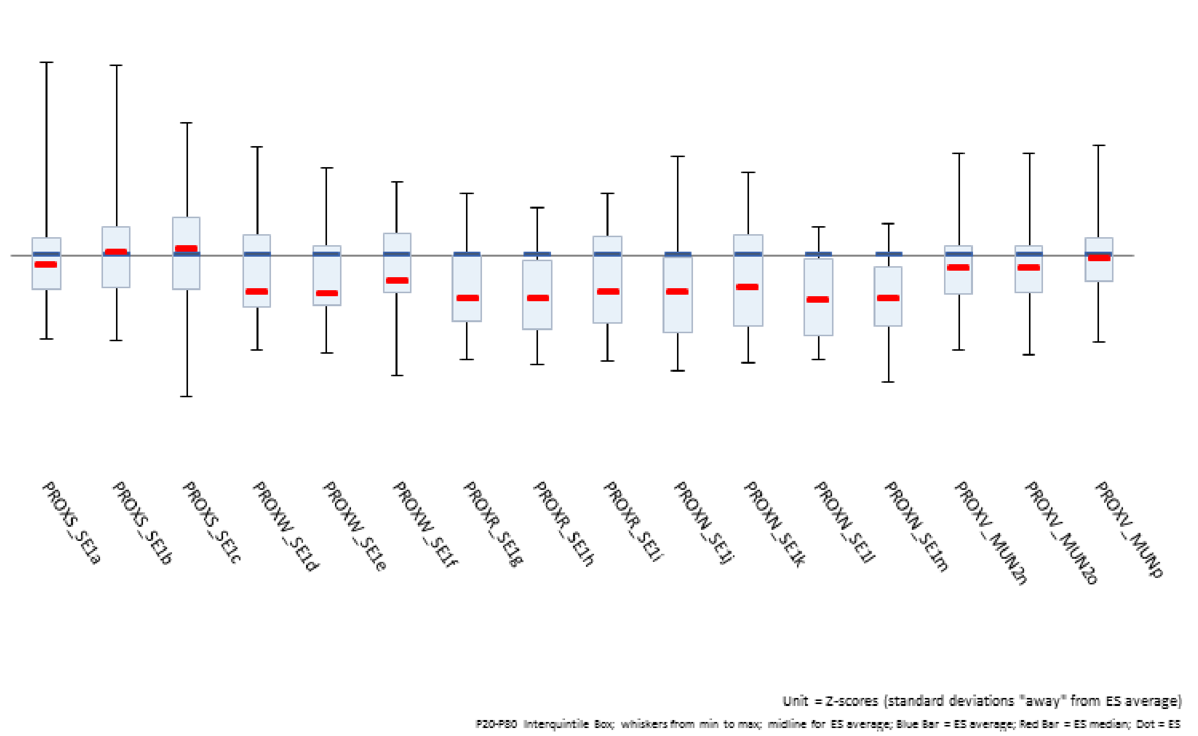
Source: Author's own work based on Table 2.1. Base year = 2016.

Table 3. Regional rankings of absolute proximity indicators—Regions in decreasing order

	Singular entity-based indicators					
	Absolute					
	Simple average /Straight-line distance	Simple average /Travel distance	Simple average /Travel duration	Weighted average /Straight-line distance	Weighted average /Travel distance	Weighted average /Travel duration
	$PROXS_{SE1a}$	$PROXS_{SE1b}$	$PROXS_{SE1c}$	$PROXW_{SE1d}$	$PROXW_{SE1e}$	$PROXW_{SE1f}$
ABOVE AVERAGE	País Vasco	País Vasco	País Vasco	País Vasco	País Vasco	Madrid
	La Rioja	La Rioja	La Rioja	Madrid	Madrid	País Vasco
	Navarra	Navarra	Madrid	Cataluña	Cataluña	Cataluña
	Cantabria	Madrid	Navarra	Cantabria	Cantabria	Cantabria
	Cataluña	Murcia	Murcia			C. Valenciana
	Madrid	Cataluña	Cantabria			
	Murcia	Cantabria	C. Valenciana			
	Galicia	C. Valenciana	Cataluña			
		Galicia	Galicia			
BELOW AVERAGE	C. Valenciana	Asturias	Asturias	Asturias	C. Valenciana	Asturias
	Asturias	Castilla y León	Castilla y León	La Rioja	Asturias	Murcia
	Andalucía	C-La Mancha	C-La Mancha	C. Valenciana	Murcia	La Rioja
	Castilla y León	Andalucía	Aragón	Galicia	La Rioja	Galicia
	C-La Mancha	Aragón	Andalucía	Andalucía	Galicia	Castilla y León
	Aragón	Extremadura	Extremadura	Murcia	Andalucía	Aragón
	Extremadura	Illes Balears	Illes Balears	Navarra	Castilla y León	Andalucía
	Canarias	Canarias	Canarias	Castilla y León	Navarra	Navarra
	Illes Balears			Aragón	Aragón	C-La Mancha
				C-La Mancha	C-La Mancha	Extremadura
				Extremadura	Extremadura	Illes Balears
				Canarias	Illes Balears	Canarias
				Illes Balears	Canarias	

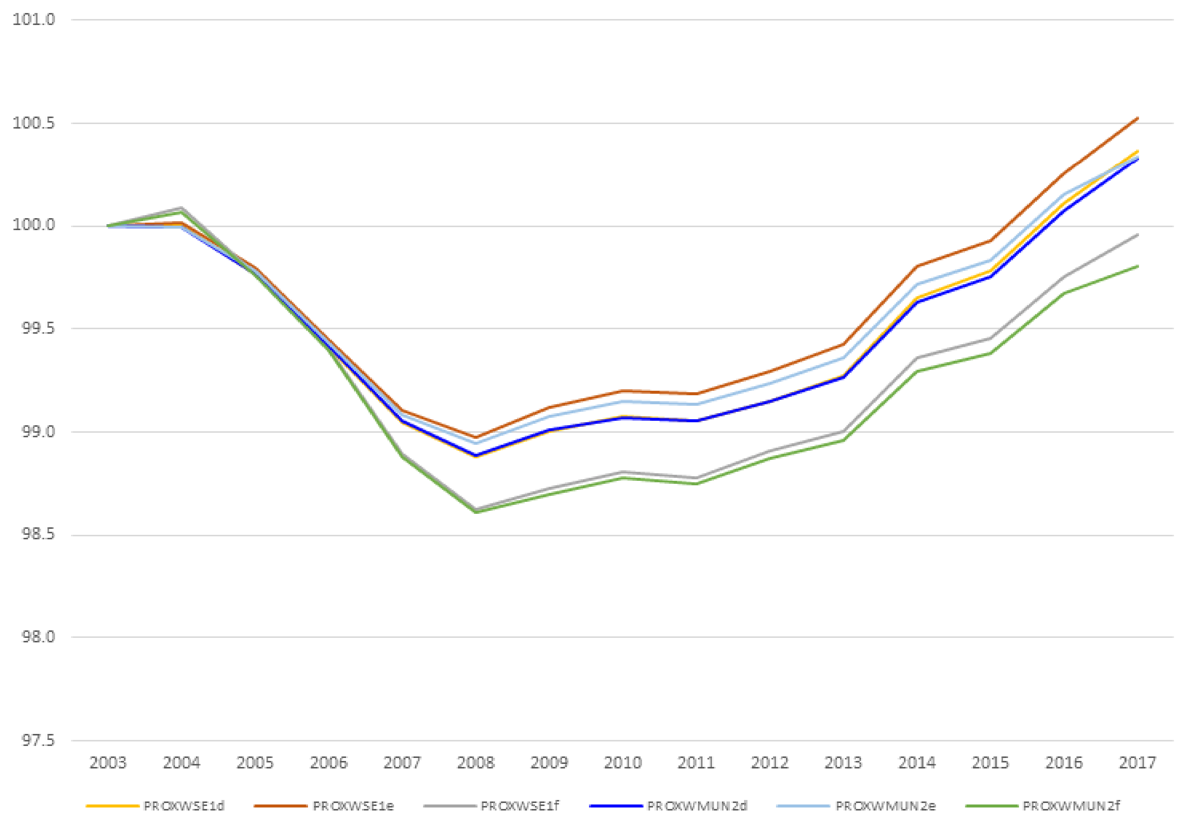
Source: Author's own work based on Table 2.1. Base year = 2016.

Chart 1. Across-region distribution of proximity indicators in Spain (ES) 2016



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 2. Evolution of absolute population proximity. 2003=100



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Relative proximity

The comparison between population and geographical proximities, where geographical proximity is the benchmark, leads to the formulation of relative proximity indicators. This sort of approach to proximity is the one used by Galster et al. (2001), one of our leading references from the literature reviewed. It estimates population proximity and captures the extent to which population tends to reside in locations that are close to each other.

Nationwide, the ***ratio of population to geographical proximity*** based on straight-line distances between SE is 1.60; for travel distances it is 1.66; and for travel durations 1.60 (Table 4.1). This points out that, on average, the *"population distance"* is around 60% to 63% of the "*location distance."* Maximum ratios occur systematically in Madrid and the minimum in Navarra (Table 4.2). Inter-region variability of relative proximity indicators is lower than that of absolute ones, with coefficients of variation of 19% (Table 4.3).

Our results show two types of findings. First, overall, population proximity is higher than geographical proximity, as already described. This is the situation in all regions except Navarra, where it seems that SE that are far from each other have higher population weights than in other regions. Overall, in Spain, the population's tendency to reside in SE closer to each other in terms of travel distances stands out.

Second, regarding regional comparisons, we observed that relative proximity presents a positive asymmetric distribution across regions, especially for straight-line and travel distances (Chart 1), pointing out that most of the population resides in territories with relative proximity below the national average. The regions that systematically show high relative proximity, above the national average, are Cataluña and Madrid. In general, Asturias, Cantabria, Cataluña, Comunidad Valenciana and Madrid hold the highest positions regarding relative proximity, showing that, in these regions, the population tends to settle in locations close to each other to a greater extent than in other regions. The bottom positions are for Illes Balears, Canarias, Castilla-La Mancha, Extremadura, Galicia, Murcia, Navarra and La Rioja (Table 5). We note that País Vasco moves from the top position in the ranking of absolute proximity indicators to an intermediate position for relative proximity.

Table 4.1. Relative proximity indicators by region

Region	Singular entity-based indicators		
	Ratio population to geographical proximity /Straight-line distance	Ratio population to geographical proximity /Travel distance	Ratio population to geographical proximity /Travel duration
	$PROXR_{SE1g}$	$PROXR_{SE1h}$	$PROXR_{SE1i}$
TOTAL	**1.5988**	**1.6647**	**1.6040**
Andalucía	1.3537	1.4376	1.4260
Aragón	1.2991	1.3527	1.4322
Asturias	1.5279	1.5279	1.5279
Illes Balears	1.1324	1.1324	1.1324
Canarias	1.1580	1.1689	1.1653
Cantabria	1.5709	1.5709	1.5709
Castilla y León	1.3464	1.3666	1.3729
Castilla-La Mancha	1.0392	1.0836	1.1146
Cataluña	1.6379	1.7089	1.8633
Comunidad Valenciana	1.4183	1.4524	1.5123
Extremadura	1.1151	1.1603	1.1586
Galicia	1.2596	1.2487	1.2618
Madrid	1.9684	1.9684	1.9684
Murcia	1.1681	1.1681	1.1681
Navarra	0.9929	0.9929	0.9929
País Vasco	1.3938	1.3644	1.3462
La Rioja	1.0819	1.0819	1.0819

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.
Note: Please notice that the extent to which population tends to reside in locations that are close to each other in terms of travel distance or travel duration is only captured by provincial differences in the corresponding ratios to straight-line distance.

Table 4.2. Maximum and minimum values of relative proximity indicators (value and Region)

	Singular entity-based indicators		
	Ratio population to geographical proximity /Straight-line distance	Ratio population to geographical proximity /Travel distance	Ratio population to geographical proximity /Travel duration
Max SE	1.97	1.97	1.97
Min SE	0.99	0.99	0.99
Max SE	Madrid	Madrid	Madrid
Min SE	Navarra	Navarra	Navarra

Source: Author's own work based on Table 4.1. Base year = 2016.

Table 4.3. Inter-region variability of relative proximity indicators

	Singular entity-based indicators		
	Ratio population to geographical proximity /Straight-line distance	Ratio population to geographical proximity /Travel distance	Ratio population to geographical proximity /Travel duration
Standard Deviation SE	0.3072	0.3236	0.3034
CV SE	0.19	0.19	0.19

Source: Author's own work based on Table 4.1. Base year = 2016.

Table 5. **Regional rankings of relative proximity indicators—Regions in decreasing order**

	Singular entity-based indicators		
	Relative		
	Ratio population to geographical proximity /Straight-line distance	Ratio population to geographical proximity /Travel distance	Ratio population to geographical proximity /Travel duration
	$PROXR_{SE1g}$	$PROXR_{SE1h}$	$PROXR_{SE1i}$
ABOVE AVERAGE	Madrid	Madrid	Madrid
	Cataluña	Cataluña	Cataluña
BELOW AVERAGE	Cantabria	Cantabria	Cantabria
	Asturias	Asturias	Asturias
	C. Valenciana	C. Valenciana	C. Valenciana
	País Vasco	Andalucía	Aragón
	Andalucía	C. y León	Andalucía
	C. y León	País Vasco	C. y León
	Aragón	Aragón	País Vasco
	Galicia	Galicia	Galicia
	Murcia	Canarias	Murcia
	Canarias	Murcia	Canarias
	Illes Balears	Extremadura	Extremadura
	Extremadura	Illes Balears	Illes Balears
	La Rioja	C-La Mancha	C-La Mancha
	C-La Mancha	La Rioja	La Rioja
	Navarra	Navarra	Navarra

Source: Author's own work based on Table 4.1. Base year = 2016.

Standardised proximity

Absolute and relative proximity indicators do not capture the extent to which locations and population spread throughout the whole province's land area. To overcome this limitation we calculated standardised indicators, via estimates of the province's breadth.[8] First, by using the province´s diagonal (***normalised proximity indicators***); second, by calculating the maximum average distance attainable between land uses when they are distributed in a way that maximises the distances between them: ***Standardised Proximity Index (SPI)***. These standardisation procedures improve the comparability of the indicators taking into account province breadth differences. Both sorts of indicators are dimensionless, easing the comparisons and interpretation: They range between 0 (minimum proximity when land uses attain the maximum distance between them) and 1 (maximum proximity when all the population locates in one land use).

In our opinion, the *Standardised Proximity Index* would be a key piece to reflect proximity within Spain's regions. By construction, we expect that it would better capture the propensity of the population to settle in locations that are close to each other given the extension of the province. Technically speaking, it uses a benchmark (the maximum attainable value of the population's separation) which is more homogeneous with the indicator we wish to normalise than the province's diagonal. On the debit side, the estimation of the mentioned attainable maximum in each province is not trivial, because it has no closed-form solution (please refer to Blanco, A. et al. (2021)). In addition, we have calculated it using municipality-based distances instead of SE-based distances because of the complexity of calculating that benchmark dealing with matrix dimensions in the range of $10^4 \times 10^4$. In this regard, we can argue that we have found a strong correlation between population proximity indicators based on SE and those based on municipalities (*Annex I. Table 0*).

In Table 6, we present our results for the normalised proximity indicators. The four first ones concern those based on the province's diagonal and the three last ones on the Venables Spatial Separation Index that we have constructed according to the methodology set in Blanco, A. et al. (2021).

[8] Please, refer to Blanco, A. et al. (2021).

Regarding ***normalised geographical proximity,*** we have observed that, at the national level, on average, the province's diagonal is 3.92 times the simple average of straight-line distances between SE within the same province; ranging from 3.22 in Castilla y León to 4.84 in Navarra.[9] In terms of travel distances, the national ratio is 2.51, ranging from 2.05 in Canarias to 3.05 in Navarra. Therefore, the normalised geographical proximity in Spain is 0.7447 for straight-line distance and 0.6023 for travel distance.[10] These two indicators have low inter-region variability, with a CV of 3% to 7% and with most of the regions placed below the national average (Table 7).

The ***normalised population proximity*** based on straight-line distance takes into account that, at the national level, on average, the province's diagonal is 6.26 times the average population distance. It ranges from 3.81 in Canarias to 7.71 in Madrid. As for travel distances the ratio is 4.19, with its minimum value in La Rioja (2.30) and the maximum in Madrid (5.29). Therefore, the normalised population proximity in Spain is 0.8403 for straight-line distance and 0.7611 for travel distances. The inter-region variability of normalised population proximity is also low (CV of 6% and 11%) with an even more asymmetric distribution than normalised geographical proximity. All regions except two are below the national average (Table 7).

Regarding the ***Standardised Proximity Index***, we estimate that the *Venables Spatial Separation Index* between municipalities (17.68 Km for straight-line distance; 26.76 Km for travel distances; and 26.01 min) is 35%, 36% and 37% of the maximum *Venables Spatial Separation Index* attainable (49.94 Km; 75.12 Km; and 69.92 min respectively). Therefore, transforming that proportion into a proximity index leads to *Standardised Proximity Indexes* of 0.6459, 0.6438 and 0.6280. Maximum values of the SPI occur always in Madrid (0.8167, regardless of the way in which separation is measured). Minimum ones are for Canarias from

[9] Please refer to Annex III Table V in Blanco, A. et al. (2021) for data referring the provinces' diagonal.

[10] The simple average of straight-line or travel distance between SE of province i ($\bar{d}(i)$ or $\bar{\bar{d}}(i)$) are rescaled and expressed as units of the province's adjusted diagonal, which is set as the standard. Then we calculate: $1-\frac{\bar{d}(i)}{D_{adj}(i)}$ and $1-\frac{\bar{\bar{d}}(i)}{D_{adj}(i)}$.

0.4815 to 0.4883. Inter-region variability for the SPI has coefficients of variation of 13%-14%. (Table 7).

Our results show that, in general, the inter-region variability of standardised proximity indicators is lower than the absolute and relative proximity ones.

Once standardised, the regions that systematically hold top geographical proximity are Aragón, Madrid, Murcia, and Navarra. Those systematically in bottom positions are Canarias, Galicia and Castilla y León. Regarding population proximity, once standardised, the regions that systematically hold top proximity are Aragón, Asturias, Cantabria, Cataluña, and Madrid. Those systematically in bottom positions are Illes Balears, Canarias, Castilla-La Mancha, Extremadura, Galicia, Murcia and Navarra (Table 7).

The distribution across regions of population proximity measured with normalised indicators based on the province's diagonal is quite positive asymmetric. Most population in Spain resides in regions with below average normalised proximity, both for locations and population. The SPI indicators seem to be more symmetric though still positive asymmetric (Chart 1, Table 6 and Table 7).

Regarding the evolution of population proximity measured with standardised indicators, our results show that, overall, it is increasing since 2008. From 2003 to 2008, we observe a decreasing trend, especially for the SPI (Chart 3). However, The SPI registers a more pronounced rise as of 2008.

Table 6.1. Standardised proximity indicators by region

Region	SE-based indicators				MUN-based indicators		
	Normalised geographical proximity /Straight – line distance	Normalised geographical proximity /Travel distance	Normalised population proximity /Straight –line distance	Normalised population proximity /Travel distance	Standardised Proximity Index (SPI) /Straight-line distance	Standardised Proximity Index (SPI) /Travel distance	Standardised Proximity Index (SPI) /Travel duration
	$PROXN_{SE1j}$	$PROXN_{SE1k}$	$PROXN_{SE1l}$	$PROXN_{SE1m}$	$PROXV_{MUN2n}$	$PROXV_{MUN2o}$	$PROXV_{MUN2p}$
TOTAL	**0.7447**	**0.6023**	**0.8403**	**0.7611**	**0.6459**	**0.6438**	**0.6280**
Andalucía	0.7235	0.5476	0.7957	0.6853	0.6255	0.6208	0.6213
Aragón	0.7527	0.6170	0.8096	0.7169	0.7458	0.7430	0.7378
Asturias	0.7439	0.5905	0.8324	0.7320	0.6956	0.6956	0.6956
Illes Balears	0.7211	0.6222	0.7537	0.6663	0.5002	0.5002	0.5002
Canarias	0.6962	0.5131	0.7376	0.5834	0.4883	0.4781	0.4815
Cantabria	0.7158	0.5234	0.8191	0.6966	0.6447	0.6447	0.6447
Castilla y León	0.6893	0.5401	0.7692	0.6635	0.6495	0.6463	0.6442
Castilla-La Mancha	0.7381	0.6136	0.7480	0.6435	0.5672	0.5689	0.5708
Cataluña	0.7406	0.5890	0.8416	0.7595	0.6755	0.6753	0.6716
Comunidad Valenciana	0.7122	0.5677	0.7971	0.7024	0.6295	0.6291	0.6283
Extremadura	0.7316	0.6113	0.7593	0.6650	0.5378	0.5378	0.5378
Galicia	0.7027	0.5385	0.7640	0.6304	0.5406	0.5439	0.5438
Madrid	0.7447	0.6279	0.8703	0.8110	0.8167	0.8167	0.8167
Murcia	0.7580	0.6545	0.7928	0.7043	0.5984	0.5984	0.5984
Navarra	0.7934	0.6722	0.7919	0.6699	0.6067	0.6067	0.6067
País Vasco	0.7388	0.5863	0.8126	0.6937	0.6228	0.6182	0.6237
La Rioja	0.7222	0.5295	0.7432	0.5651	0.6164	0.6164	0.6164

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 6.2. Maximum and minimum values of standardised proximity indicators (value and Region)

	SE-based indicators				MUN-based indicators		
	Normalised geographical proximity /Straight-line distance	Normalised geographical proximity /Travel distance	Normalised population proximity /Straight –line distance	Normalised population proximity /Travel distance	Standardised Proximity Index /Straight-line distance	Standardised Proximity Index /Travel distance	Standardised Proximity Index /Travel duration
Max	0.7934	0.6722	0.8703	0.8110	0.8167	0.8167	0.8167
Min	0.6893	0.5131	0.7376	0.5651	0.4883	0.4781	0.4815
Max	Navarra	Navarra	Madrid	Madrid	Madrid	Madrid	Madrid
Min	Castilla y	Canarias	Canarias	La Rioja	Canarias	Canarias	Canarias

Source: Author's own work based on Table 6.1. Base year = 2016.

Table 6.3. Inter-region variability of standardised proximity indicators

	SE-based indicators				MUN-based indicators		
	Normalised geographical proximity /Straight – line distance	Normalised geographical proximity /Travel distance	Normalised population proximity /Straight –line distance	Normalised population proximity /Travel distance	Standardised Proximity Index /Straight-line distance	Standardised Proximity Index /Travel distance	Standardised Proximity Index /Travel duration
Standard Deviation	0.0254	0.0436	0.0521	0.0809	0.0872	0.0879	0.0888
CV	0.03	0.07	0.06	0.11	0.13	0.14	0.14

Source: Author's own work based on Table 6.1. Base year = 2016.

PROMEMORIA Table 6
Benchmarks for standardised proximity indicators by Region.

Region	Adjusted Diagonal (Km)	Maximum attainable Venables spatial separation (Km)		
	Standardised proximity	Straight-line distance	Travel distance	Travel duration
TOTAL	**202.99**	**49.94**	**75.12**	**69.92**
Andalucía	205.39	51.53	79.74	69.54
Aragón	250.37	67.01	100.09	79.27
Asturias	214.39	53.00	84.76	72.87
Illes Balears	300.43	67.15	90.97	167.67
Canarias	266.67	62.19	96.92	179.11
Cantabria	159.83	38.25	64.14	53.89
Castilla y León	195.60	52.57	75.44	63.48
Castilla-La Mancha	234.44	60.78	87.18	72.46
Cataluña	181.70	44.92	68.57	57.83
Comunidad Valenciana	182.96	46.56	68.93	55.15
Extremadura	283.79	69.05	97.55	79.67
Galicia	171.96	41.68	66.18	57.67
Madrid	190.12	50.53	73.64	60.41
Murcia	207.91	51.64	73.70	61.66
Navarra	210.16	49.87	79.11	66.69
País Vasco	104.57	25.75	41.70	39.53
La Rioja	141.92	36.26	61.41	53.07

Venables Spatial Separation Index

Region	Straight-line distance	Travel distance	Travel duration
TOTAL	**17.68**	**26.76**	**26.01**
Andalucía	19.30	30.24	26.34
Aragón	17.03	25.72	20.78
Asturias	16.13	25.80	22.18
Illes Balears	33.56	45.47	83.80
Canarias	31.82	50.59	92.87
Cantabria	13.59	22.79	19.15
Castilla y León	18.43	26.68	22.58
Castilla-La Mancha	26.30	37.58	31.10
Cataluña	14.58	22.27	18.99
Comunidad Valenciana	17.25	25.56	20.50
Extremadura	31.92	45.09	36.83
Galicia	19.15	30.19	26.31
Madrid	9.26	13.50	11.07
Murcia	20.74	29.60	24.76
Navarra	19.62	31.12	26.23
País Vasco	9.71	15.92	14.88
La Rioja	13.91	23.56	20.36

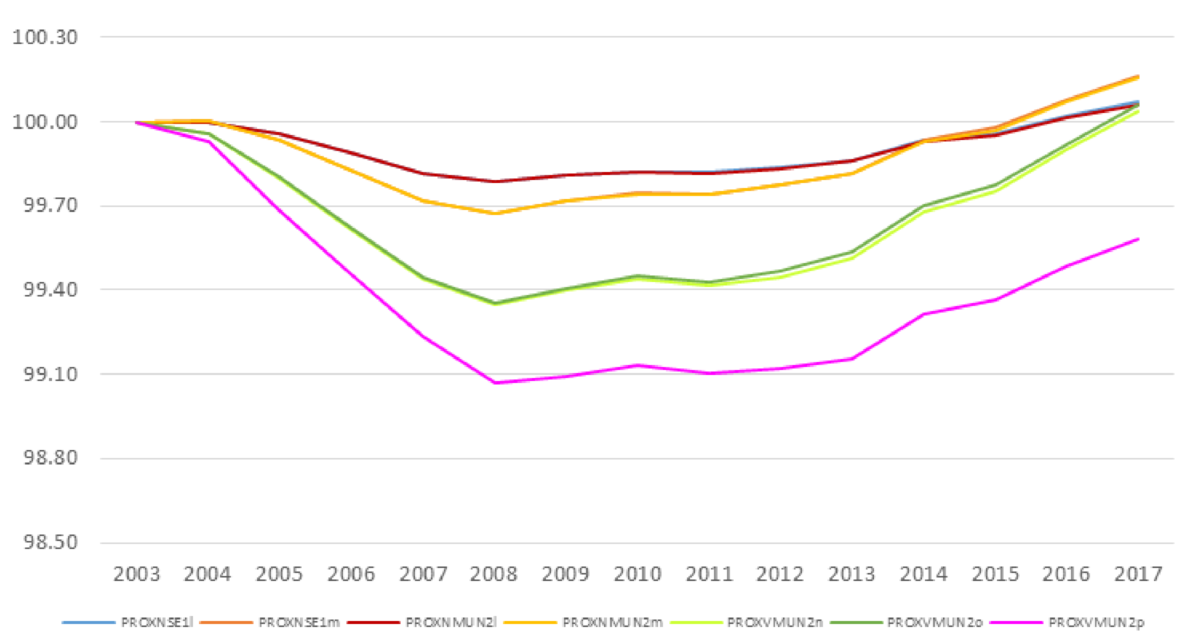
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 7. Regional rankings of standardised proximity indicators—Regions in decreasing order

	Singular entity-based indicators						
	Standardised						
	Normalised Simple average /Straight –line distance	Normalised Simple average /Travel distance	Normalised weighted average /Straight-line distance	Normalised weighted average /Travel distance	Standardised Proximity Index /Straight-line distance	Standardised Proximity Index /Travel distance	Standardised Proximity Index /Travel duration
	PROXN_SE1j	PROXN_SE1k	PROXN_SE1l	PROXN_SE1m	PROXV_MUN2n	PROXV_MUN2o	PROXV_MUN2p
ABOVE AVERAGE	Navarra	Navarra	Madrid	Madrid	Madrid	Madrid	Madrid
	Murcia	Murcia	Cataluña		Aragón	Aragón	Aragón
	Aragón	Madrid			Asturias	Asturias	Asturias
		Illes Balears			Cataluña	Cataluña	Cataluña
		Aragón			Castilla y León	Castilla y León	Cantabria
		C-La Mancha				Cantabria	Castilla y León
		Extremadura					C. Valenciana
BELOW AVERAGE	Madrid	Asturias	Asturias	Cataluña	Cantabria	C. Valenciana	País Vasco
	Asturias	Cataluña	Cantabria	Asturias	C. Valenciana	Andalucía	Andalucía
	Cataluña	País Vasco	País Vasco	Aragón	Andalucía	País Vasco	La Rioja
	País Vasco	C. Valenciana	Aragón	Murcia	País Vasco	La Rioja	Navarra
	C-La Mancha	Andalucía	C. Valenciana	C. Valenciana	La Rioja	Navarra	Murcia
	Extremadura	Castilla y León	Andalucía	Cantabria	Navarra	Murcia	C-La Mancha
	Andalucía	Galicia	Murcia	País Vasco	Murcia	C-La Mancha	Galicia
	La Rioja	La Rioja	Navarra	Andalucía	C-La Mancha	Galicia	Extremadura
	Illes Balears	Cantabria	Castilla y León	Navarra	Galicia	Extremadura	Illes Balears
	Cantabria	Canarias	Galicia	Illes Balears	Extremadura	Illes Balears	Canarias
	C. Valenciana		Extremadura	Extremadura	Illes Balears	Canarias	
	Galicia		Illes Balears	Castilla y León	Canarias		
	Canarias		C-La Mancha	C-La Mancha			
	Castilla y León		La Rioja	Galicia			
			Canarias	Canarias			
				La Rioja			

Source: Author's own work based on Table 6.1. Base year = 2016.

Chart 3. Evolution of standardised proximity indicators. 2003=100



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Some insights into proximity in Spain's regions

The analysis of the position that each Region registers regarding proximity indicators and the comparative analysis between indicators will provide some insights into proximity in Spain's regions. For the mentioned analysis, we will rely on Table 8 and Chart 4. We have built Table 8 based on the ranking position each Region has for each proximity indicator, in decreasing order. A low number in Table 8 means high proximity. On the other hand, in Chart 4, we show the distribution of all the proximity indicators for each Region and its position in that distribution. The central box encloses what we will name "*central*" values of the said distribution. The bottom whisker goes from the minimum to the first quintile of the distribution, enclosing the values that account for 20% of the distribution in the bottom positions. Regions holding such low levels of proximity are flagged with a red dot. The upper whisker goes from the fourth quintile to the maximum, enclosing the values that account for 20% of the distribution in the upper positions. Regions holding these high levels of proximity are flagged with a green dot.

It is important to keep in mind that we have calculated proximity indicators for each province and then aggregated them to the regional level. Therefore, our analysis outlines the regional panorama, which subsumes the provincial realities at the same time that it may conceal significant provincial differences within a region.

We would highlight the following features regarding proximity in Spain's regions:

- **Andalucía** has an intermediate-low level of proximity, both in absolute and standardised terms. The values of the indicators place Andalucía among the "*central"* positions of the regional distributions (between the first and the fourth quintiles). The population seems to be less separated than the locations (relative indicators have an intermediate-high position), especially when the extension of the provinces is taken into account (normalised population proximity indicators slightly upgrade the position of Andalucía in the ranking of proximity). The SPI would reinforce this finding.
- **Aragón** has a low level of absolute proximity. The values of the related indicators place Aragón among the 20% with the lowest level of proximity —red dots in Chart 4—.

Population proximity seems to be higher than geographical proximity, and yields to relative proximity levels in "*central"* positions of the respective distributions, although below average. On the contrary, when normalising by the provinces' extension, standardised proximity moves to central-high positions. Some standardised indicators place Aragón among the 20% with the highest level of proximity —green dots in Chart 4—. This would point out that a relevant part of the population tends to settle in locations close to each other (especially considering the breadth of Aragón's provinces), but there is still a part that remains in enough distant places to yield below average relative proximity and normalised population proximity. Aragon would be an example of what we have previously put forward regarding decision-making: even if efficiency reasons would advised to focus on population proximity, both population and geographical proximity should be jointly considered as FPS needs drivers to take into account equality of access considerations.

- **Asturias** presents a below average position, though in the inter-quintile range, in all the proximity indicators except for the SPI. Population proximity is sufficiently high, in comparison to geographical proximity, to place the Region in high positions regarding relative proximity. When spatial separation is normalised by the province breadth, proximity indicators hike positions in the regional distribution, especially in the case of the SPI, which overpasses the fourth quintile. This would point out that the population in Asturias has a high tendency to settle in locations that are close to each other, far from spreading throughout the territory towards the border. However, there is still a part of the population that remains in enough distant places to yield below average relative proximity.
- **Illes Balears'** proximity indicators place the Region among the lowest levels regardless of the way in which proximity is approached, except for the normalised geographical proximity indicators, in which Illes Balears records "*central*" values of proximity, mainly regarding travel distances.[11]
- **Canarias'** proximity indicators place the Region among the lowest levels regardless of the way in which proximity is approached. In all of the indicators, Canarias is among

[11] Please notice that Illes Balears has the lowest ratio travel distance to straight-line distance among Spain's provinces; in addition, it has the highest diagonal (Blanco, A. et al. 2020). This is why, when normalising travel distance-based locations proximity, the position of the Region mounts in the distribution.

the 20% with the lowest proximity; in addition, in most cases, proximity reaches the minimum value of the respective indicator.

- **Cantabria** presents intermediate to high levels of absolute proximity. Nonetheless, when normalising by the province's extension, both geographical and population proximity indicators turn down (even among the 20% with the lowest proximity). The SPI, nonetheless, remains in above but close to average positions, pointing out that the population would have a mild tendency to settle in locations that are close to each other. However, there is still a part that remains in enough distant places (especially considering the breadth of Cantabria) to yield below average relative proximity.
- **Castilla y León** registers low proximity in all indicators except for the Standardised Proximity Index that places the Region in an intermediate position above average. The SPI is emphasising the population's tendency to settle in locations that are close to each other, far from evenly expanding across the province's territory. Nonetheless, the low level of relative proximity, well below average, would suggest that a part of the population does establish in considerably distant places.
- **Castilla-La Mancha** registers very low proximity in all indicators except for the normalised geographical proximity ones that place the Region in intermediate positions (even above average). This region's indicators point to a remarkable tendency of the population to settle in distant places. This tendency remains even when normalising by the extension of each province. The low levels of the SPI would suggest that the population tends to expand through the territory towards province limits.
- **Cataluña** registers high proximity in all the indicators, especially for those referring to population proximity, even when normalising by the extension of each province.
- **Comunidad Valenciana** generally registers intermediate proximity in all indicators, normally below average, except when normalising by the extension of each province, where geographical proximity is low. There is a middle tendency of the population to settle in locations that are close to each other but it seems that a part of the population establishes in sufficiently distant places to yield intermediate-low relative proximity.
- **Extremadura** has a very low level of proximity, with the value of all the indicators among the lowest 20% of the regional distribution. Except for normalised geographical proximity indicators, which have intermediate positions, close to or even above

average. This means that there is a tendency for the population to establish in sufficiently distant places to render low proximity even after normalising by the extension of each province. Nonetheless, these extensions are large enough to smooth the low proximity of the locations when it is measured in normalised terms.

- **Galicia** has a very low level of proximity. In absolute terms, both locations and population register intermediate positions that move to very low levels when considering the provincial extensions. Our data show very low population proximity in relative and standardised terms, indicating that the population in the Region tends to spread throughout the territory together with a tendency to settle in distant places towards the border (very low SPI values).
- **Madrid** registers high proximity in all the indicators, especially for those referring to population proximity and especially when normalising by the province extension.
- **Murcia** shows intermediate absolute geographical proximity, which moves to high when normalising by the province's diagonal. On the contrary, absolute population proximity is low, with relative proximity among the lowest 20% of the regional distribution. When normalising by the province's diagonal, we observe intermediate-low population proximity, pointing out that the population is not inclined to settle in locations that are close to each other. The Standardised Proximity Index being in the lowest 20% of the regional distribution further support this fact.
- **Navarra** shows high absolute geographical proximity. However, population proximity is very low and, in relative terms, it is the lowest in Spain. When normalising by the province's extension, we observe the highest position in geographical proximity together with low population proximity. The low level of the Standardised Proximity Index could be capturing two underlying effects:
    - The marked tendency of the population to settle in distant locations, especially when normalising by the province's extension.
    - The population's tendency to spread throughout the province's territory towards the border.
- **País Vasco** registers the highest absolute proximity indicators. They move to intermediate below average positions when normalising by the extension of each province, due to their small size. Relative proximity is below average, pointing out that

the population is not prone to settle in locations that are close to each other within the provinces.

- **La Rioja** registers high levels of absolute geographical proximity and intermediate-low ones for absolute population proximity. According to the low values of the relative proximity, we infer that the propensity of the population to settle in locations that are close to each other is low. When normalising by the province's diagonal, both geographical and population proximities move to bottom positions suggesting a notable degree of spatial separation. The Standardised Proximity Index, located almost at the fourth quintile, corroborates this.

Table 8. Regional rankings of proximity indicators—Positions in decreasing order

Regions	Singular entity-based proximity indicators plus SPI (decreasing order)															
	Absolute						Relative			Standardised						
	Simple average /Straight-line distance	Simple average /Travel distance	Simple average /Travel duration	Weighted average /Straight-line distance	Weighted average /Travel distance	Weighted average /Travel duration	Ratio population to geographical proximity /Straight-line distance	Ratio population to geographical proximity /Travel distance	Ratio population to geographical proximity /Travel duration	Normalised Simple average /Straight-line distance	Normalised Simple average /Travel distance	Normalised weighted average /Straight-line distance	Normalised weighted average /Travel distance	Standardised Proximity Index /Straight-line distance	Standardised Proximity Index /Travel distance	Standardised Proximity Index /Travel duration
	PROXS_SE1a	PROXS_SE1b	PROXS_SE1c	PROXW_SE1d	PROXW_SE1e	PROXW_SE1f	PROXR_SE1g	PROXR_SE1h	PROXR_SE1i	PROXN_SE1j	PROXN_SE1k	PROXN_SE1l	PROXN_SE1m	PROXV_MUN2n	PROXV_MUN2n	PROXV_MUN2n
Andalucía	11	13	14	9	10	12	7	6	7	10	12	8	9	8	8	9
Aragón	14	14	13	13	13	11	9	9	6	3	5	6	4	2	2	2
Asturias	10	10	10	5	6	6	4	4	4	5	8	3	3	3	3	3
Illes Balears	17	16	16	17	16	16	13	14	14	12	4	14	11	16	16	16
Canarias	16	17	17	16	17	17	12	11	12	16	17	17	16	17	17	17
Cantabria	4	7	6	4	4	4	3	3	3	13	16	4	7	6	6	5
C. y León	12	11	11	12	11	10	8	7	8	17	13	11	13	5	5	6
C-La Mancha	13	12	12	14	14	14	16	15	15	8	6	15	14	13	13	13
Cataluña	5	6	8	3	3	3	2	2	2	6	9	2	2	4	4	4
C. Valenciana	9	8	7	7	5	5	5	5	5	14	11	7	6	7	7	7
Extremadura	15	15	15	15	15	15	14	13	13	9	7	13	12	15	15	15
Galicia	8	9	9	8	9	9	10	10	10	15	14	12	15	14	14	14
Madrid	6	4	3	2	2	1	1	1	1	4	3	1	1	1	1	1
Murcia	7	5	5	10	7	7	11	12	11	2	2	9	5	12	12	12
Navarra	3	3	4	11	12	13	17	17	17	1	1	10	10	11	11	11
País Vasco	1	1	1	1	1	2	6	8	9	7	10	5	8	9	9	8
La Rioja	2	2	2	6	8	8	15	16	16	11	15	16	17	10	10	10

Source: Author's own work based on Tables 2.1, 4.1 and 6.1. Base year = 2016.

Chart 4.Proximity indicators by Region 2016

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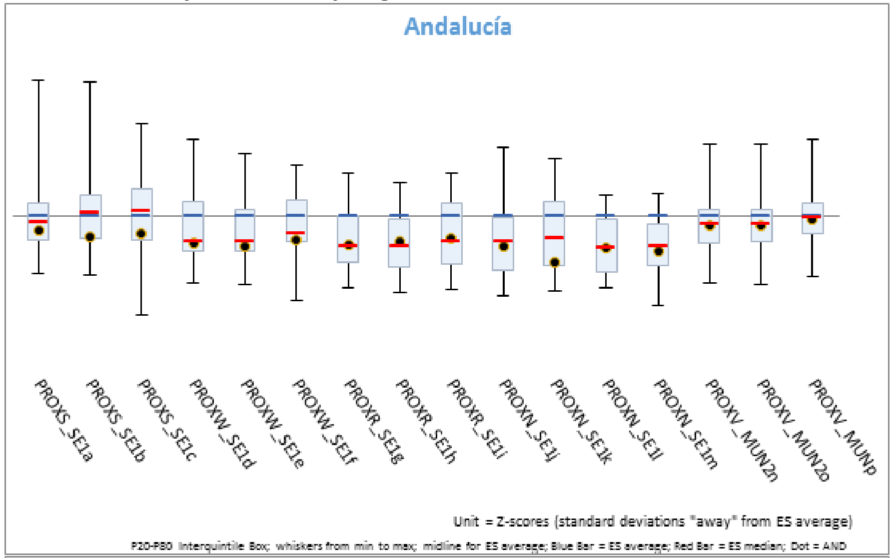
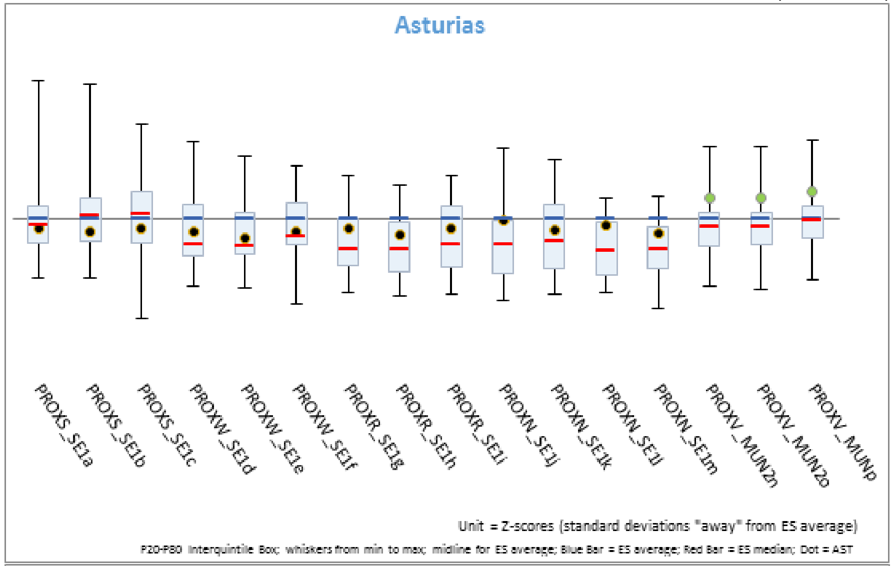
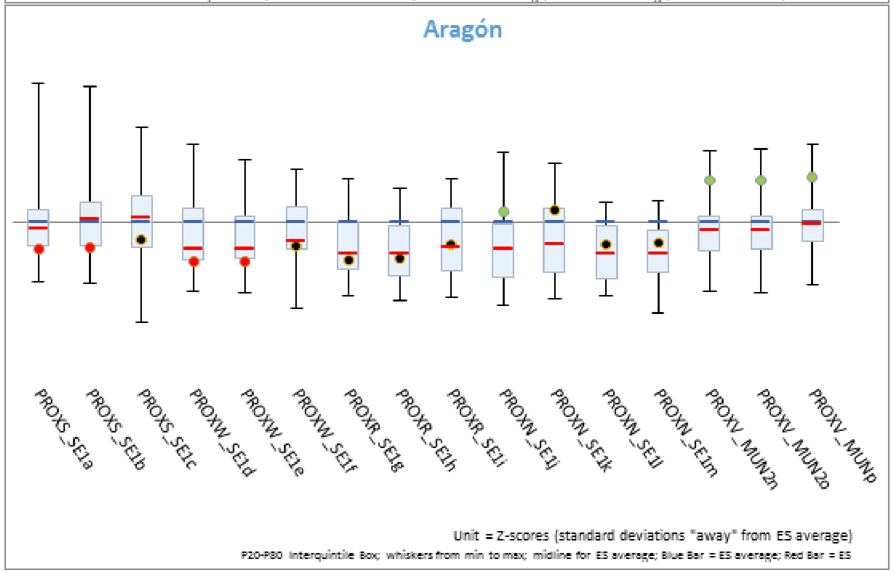
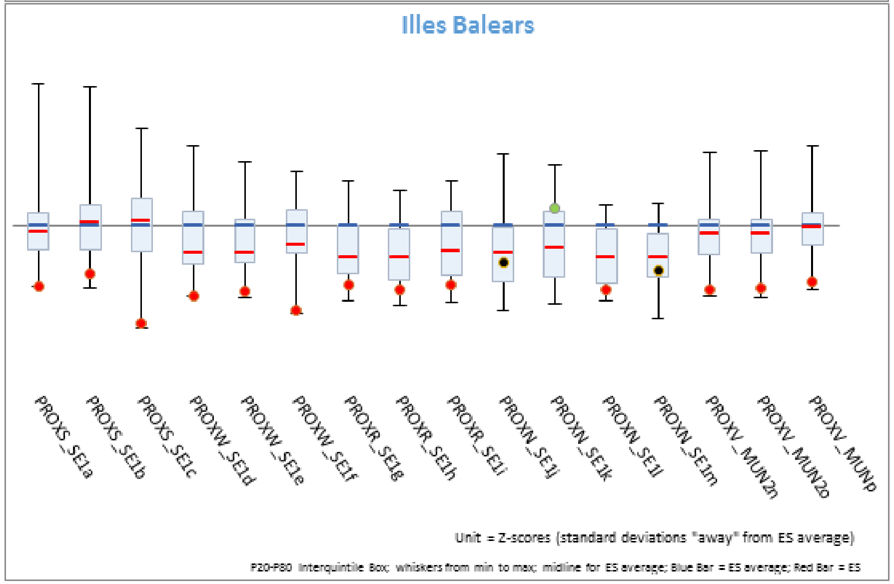




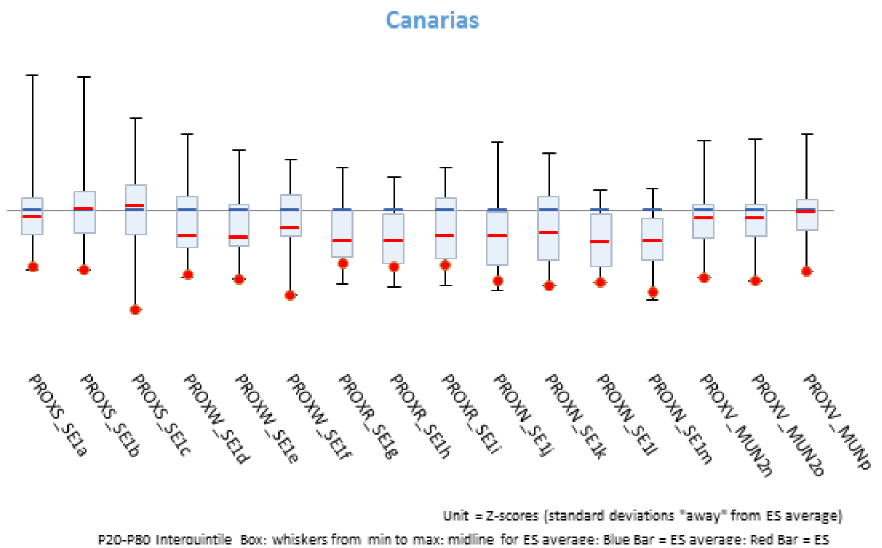


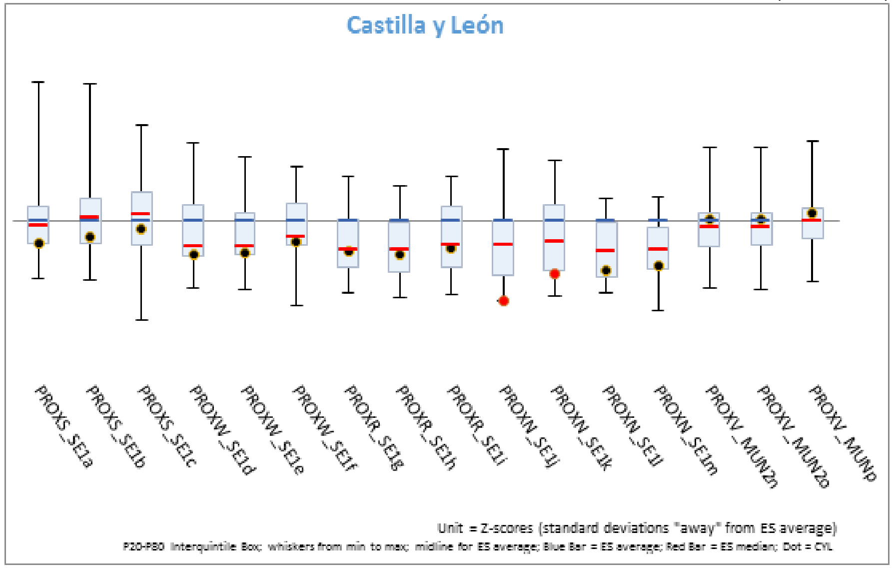


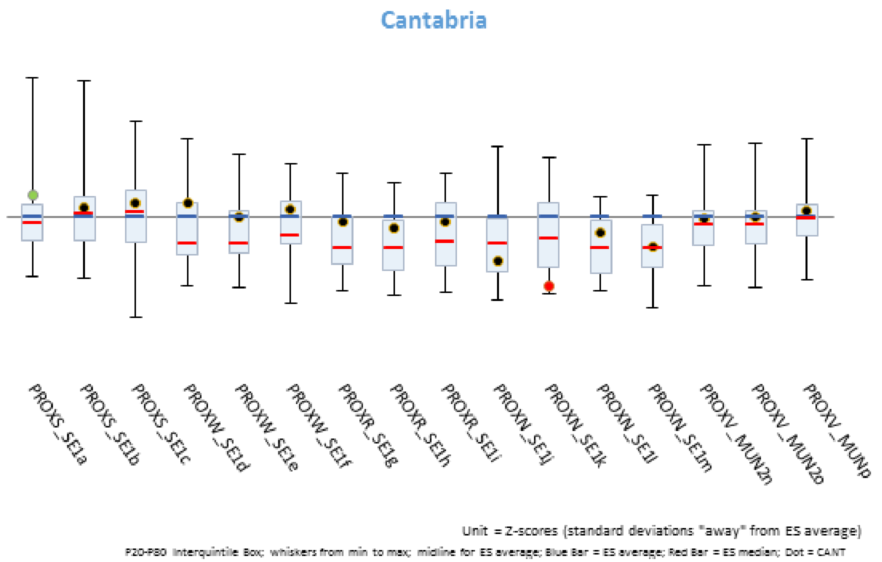
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

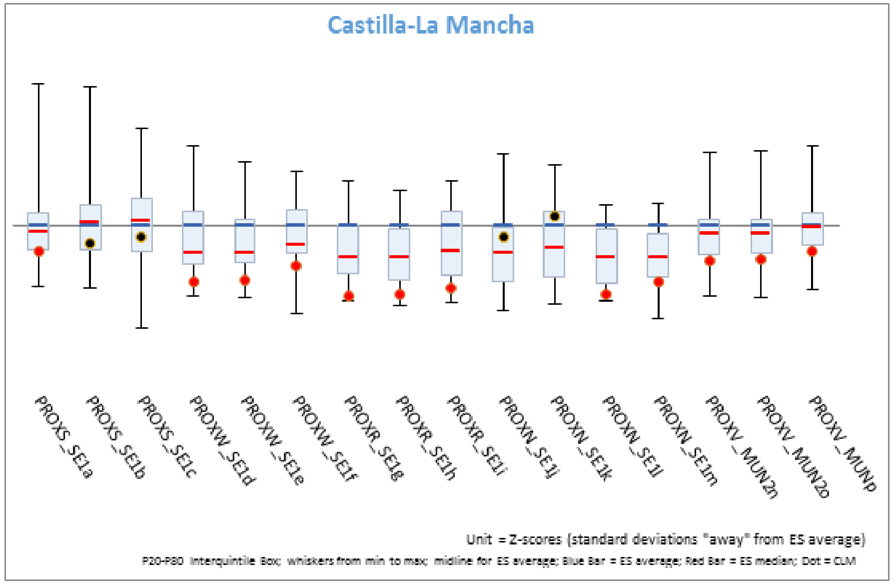
Chart 4.Proximity indicators by Region 2016

(It continues)









Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

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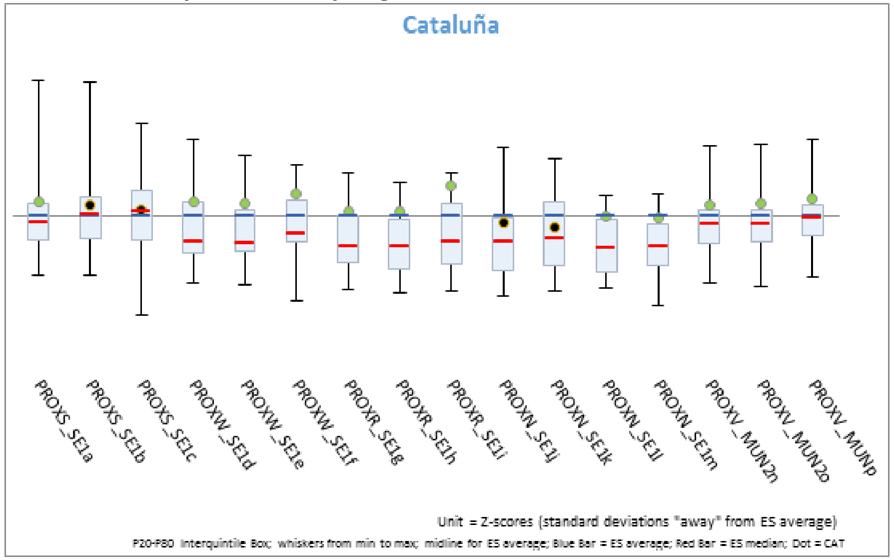
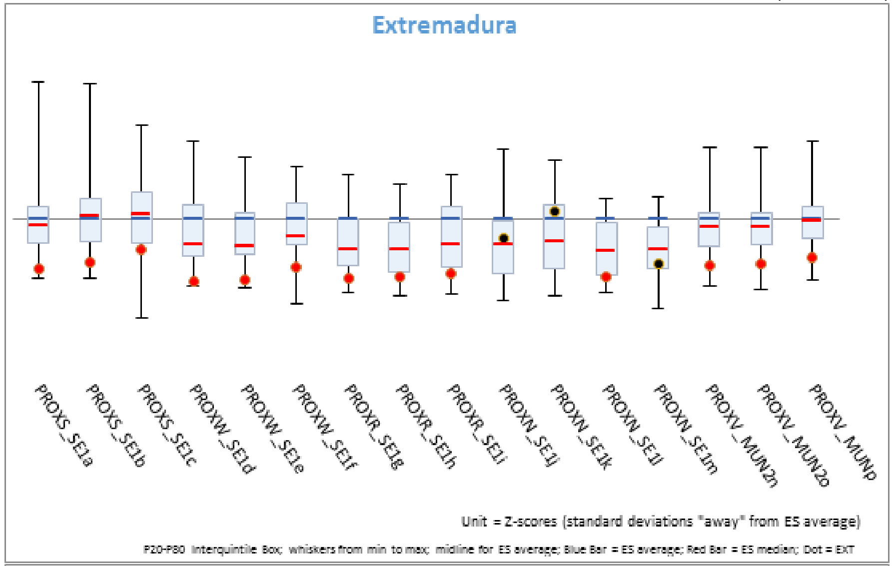
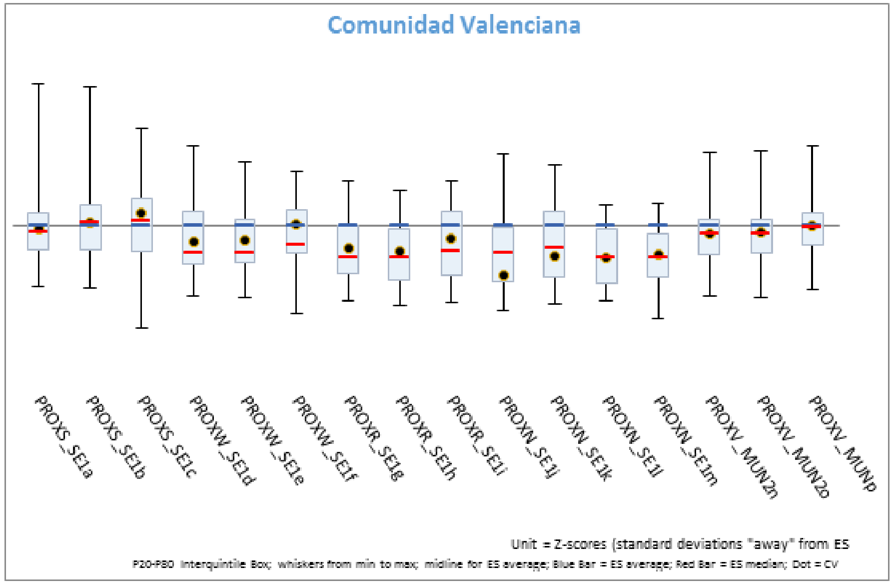
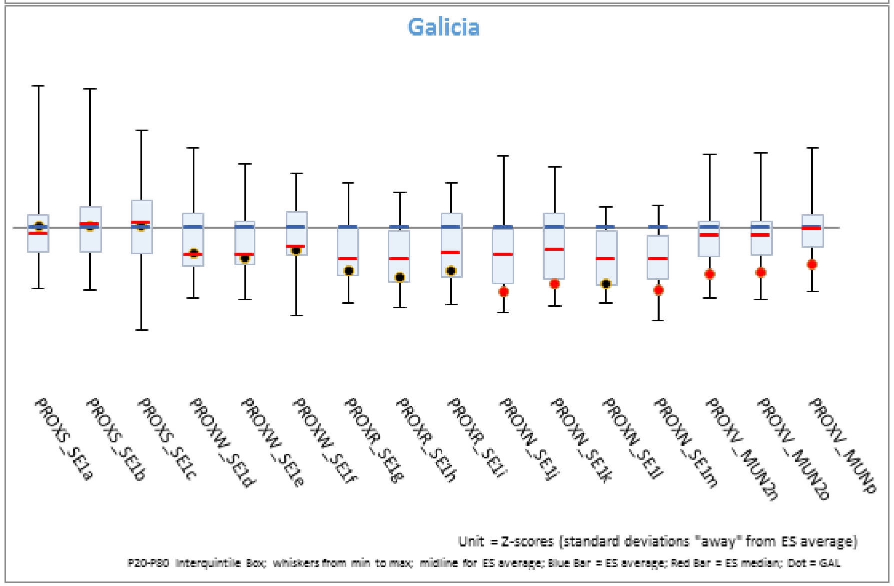
Chart 4.Proximity indicators by Region 2016





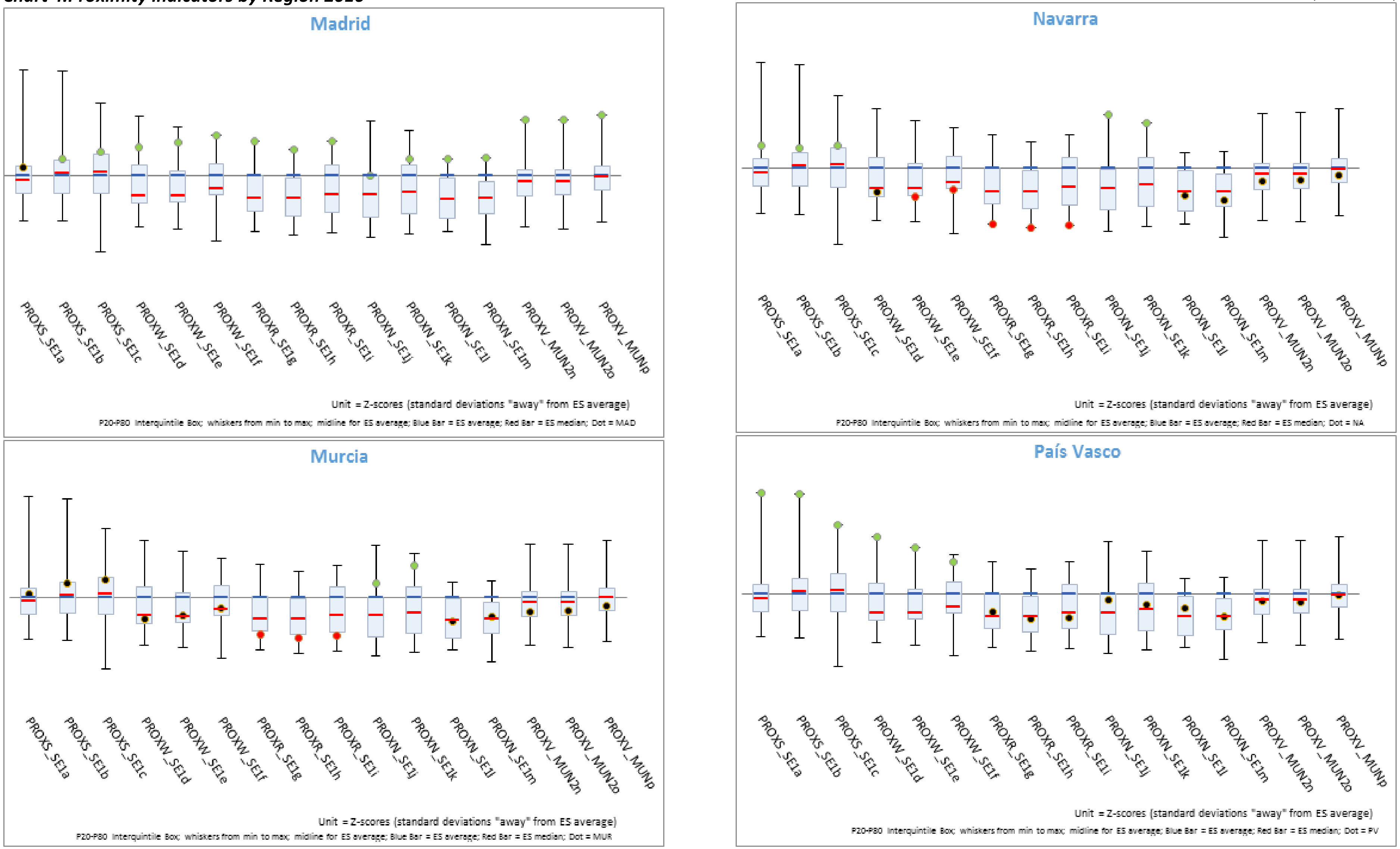




Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

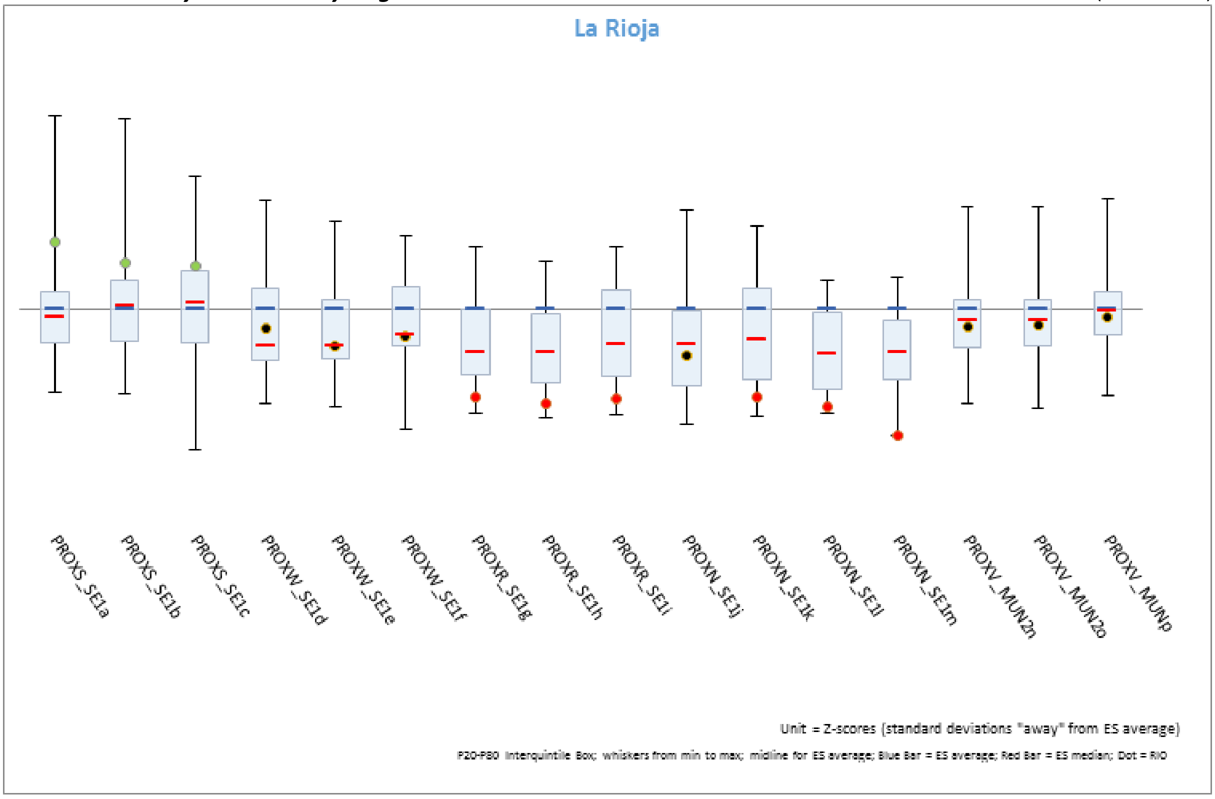
Chart 4.Proximity indicators by Region 2016

(It continues)



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 4.Proximity indicators by Region 2016 (It concludes)



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016

Population proximity has increased over the period 2003-2017 at cumulative annual rates between 0.01% and 0.04%, except for travel duration-based indicators, which have decreased at rates between -0.03% and -0.003% (Table 9). From 2003 to 2008, it decreased at cumulative annual rates between -0.03% and -0.003%. From 2008 to 2017, all proximity indicators increased at cumulative annual rates between 0.03% and 0.17%.

Table 9. Evolution of population proximity indicators at the national level 2003-2017

Proximity indicators		Δ Annual average 2008/2003 (%)	Δ Annual average 2017/2008 (%)	Δ Annual average 2017/2003 (%)
Inverse of the weighted average of straight-line distances SE	$PROXW_{SE1d}$	-0.225	0.166	0.026
Inverse of the weighted average of travel distances SE	$PROXW_{SE1e}$	-0.206	0.173	0.037
Inverse of the weighted average of travel durations SE	$PROXW_{SE1f}$	-0.277	0.150	-0.003
Ratio population to geographical proximity (SE & straight-line distance)	$PROXR_{SE1g}$	-0.225	0.166	0.026
Ratio population to geographical proximity (SE & travel distance)	$PROXR_{SE1h}$	-0.206	0.173	0.037
Ratio population to geographical proximity (SE & travel duration)	$PROXR_{SE1i}$	-0.277	0.150	-0.003
Normalised population proximity (SE & straight-line distance)	$PROXN_{SE1k}$	-0.043	0.032	0.005
Normalised population proximity (SE & travel distance)	$PROXN_{SE1m}$	-0.065	0.055	0.012
Standardise Proximity Index (SPI) straight-line distance	$PROXV_{MUN2n}$	-0.131	0.077	0.003
Standardise Proximity Index (SPI) travel distance	$PROXV_{MUN2o}$	-0.130	0.079	0.004
Standardise Proximity Index (SPI) travel duration	$PROXV_{MUN2p}$	-0.187	0.057	-0.030

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016

Concerning the dynamic of population proximity in Spain´s regions, when comparing their relative position to the national average in 2016 together with their time trend during the period 2008 to 2016 (Chart 5), we would highlight the following regional features:

- **Andalucía** has below average levels of population proximity. On the other hand, all the indicators show evolution rates in 2008-2016 moderately[12] higher than average. This dynamic would cause convergence towards the national average.
- **Aragón** has below average levels of population proximity except when measured by the SPI, which for Aragón is well above average. All the indicators show rates of change in 2008-2016 above average, among the highest within Spain's regions (moderate for the SPI). This dynamic would promote convergence towards the national average or (according to the SPI) maintaining top positions.
- **Asturias** has below average levels of population proximity except when measured by the SPI, which for Asturias is above average. All the indicators show evolution rates of change in 2008-2016 above the national average. This dynamic would cause convergence towards the national average or even advancing to/maintaining top positions.
- **Illes Balears** has systematically below average levels of population proximity regardless of the way in which it is measured. In addition, all the related indicators show below average evolution rates in 2008-2016, among the lowest within Spain's regions. These results show that the Region would be far away from converging towards the national average.
- **Canarias** has systematically below average levels of population proximity regardless of the way in which it is measured. In addition, all related indicators show below average evolution rates in 2008-2016, among the lowest within Spain's regions. These results show that the Region would be far away from converging towards the national average.
- **Cantabria** presents absolute population proximity above the national average and evolving at a rhythm that would push the Region to top positions. Regarding relative population proximity or normalised proximity based on the province's diagonal, it is at

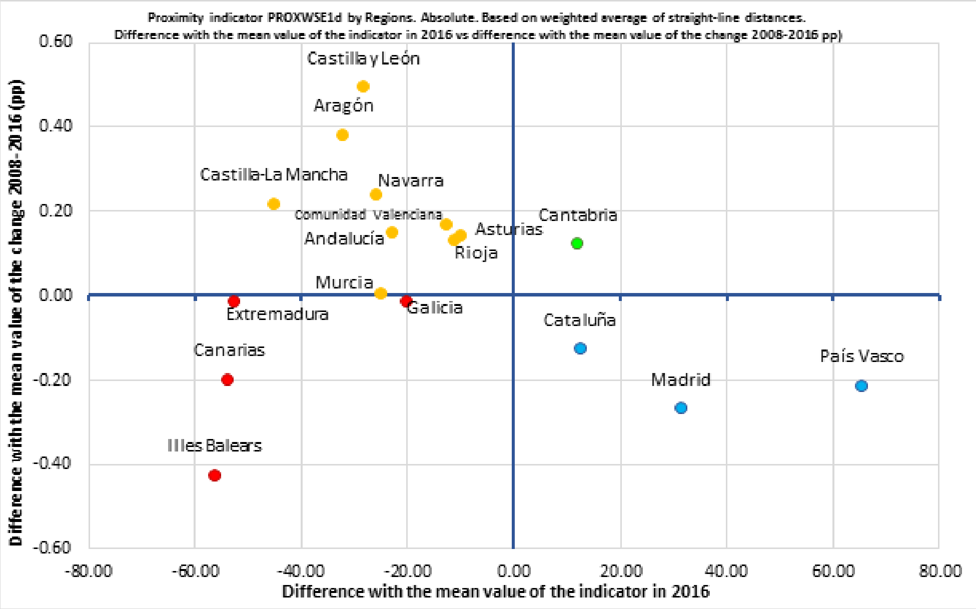
[12] Please note that the assessment statements like this one should be taken in the context of the analysed variables' range.

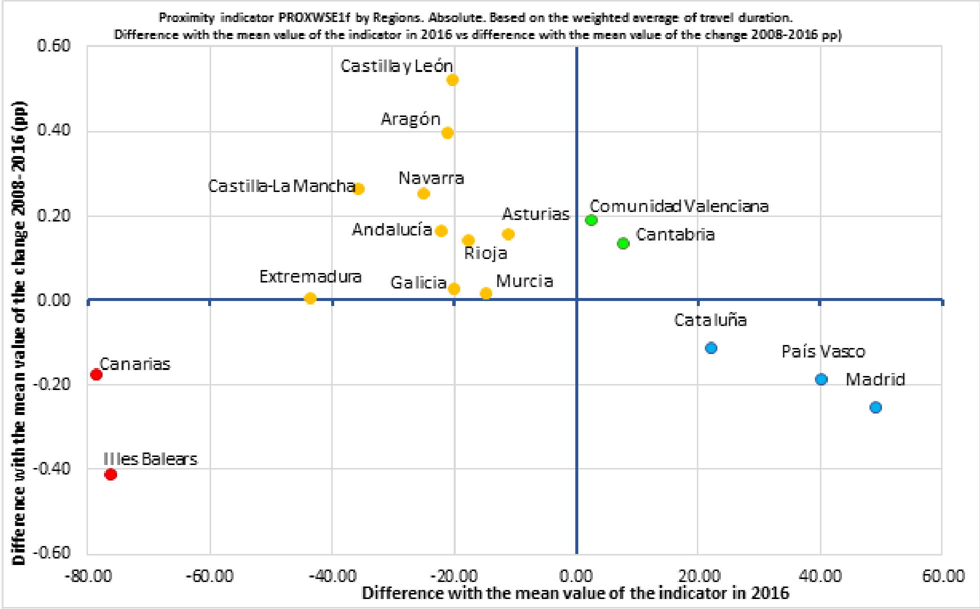
or below the national average but moving at a rhythm to converge towards the national average. Finally, the SPI is practically at the average and evolving at the average rate, thus pointing out that the Region would be stagnated.

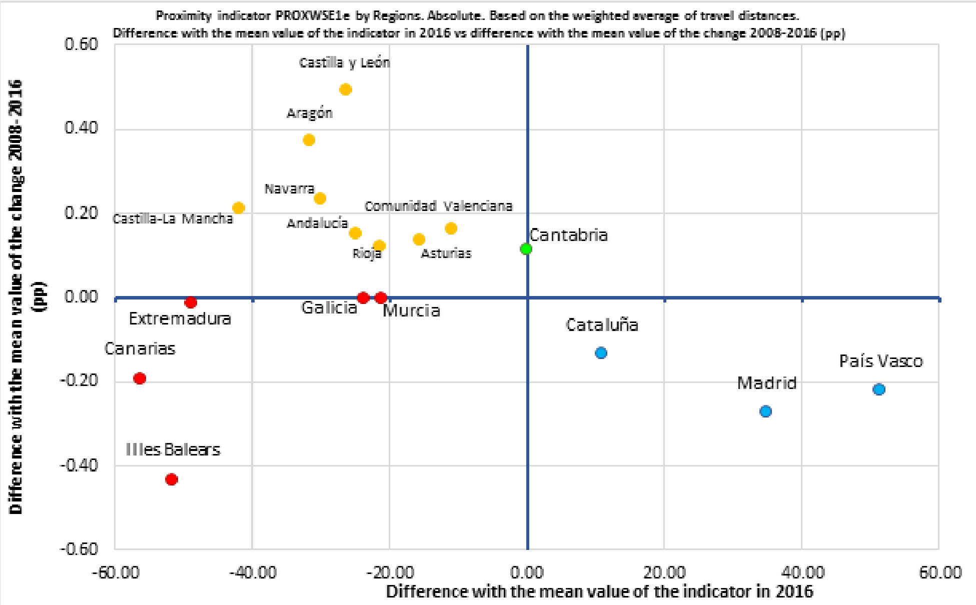
- **Castilla y León** presents population proximity levels below the national average except for the SPI, where it is slightly over the average. On the other hand, population proximity registers the highest rates of change, or among the highest ones. These results show that the Region would be on the path to converge towards the national average or even advancing to top positions.
- **Castilla-La Mancha** presents population proximity levels below the national average, regardless of the way in which proximity is approached. On the other hand, population proximity registers well above average rates of change. These results show that the Region would be on the path to converge towards the national average.
- **Cataluña** typically presents population proximity levels above the national average, regardless of the way in which proximity is approached, and all the indicators show it is stagnated in the years 2008-2016. This dynamic pattern would trigger convergence towards the national average.
- **Comunidad Valenciana's** population proximity is typically below the national average and evolving with above average rates of change. This dynamic pattern would promote convergence towards the national average or even beyond it.
- **Extremadura's** population proximity is notably below the national average and typically evolving at rates below but close to the national average. This dynamic pattern would produce stagnation of proximity in the region.
- **Galicia's** population proximity is notably below the national average and it registers mild rates of change. This dynamic pattern would produce a proximity stagnation in the region.
- **Madrid's** population proximity is always above average, in the highest or among the highest positions for all the related indicators, especially for relative and standardised population proximity indicators. Nonetheless, it is evolving below the average rate. This dynamic pattern would lead the Region to convergence towards the national average.

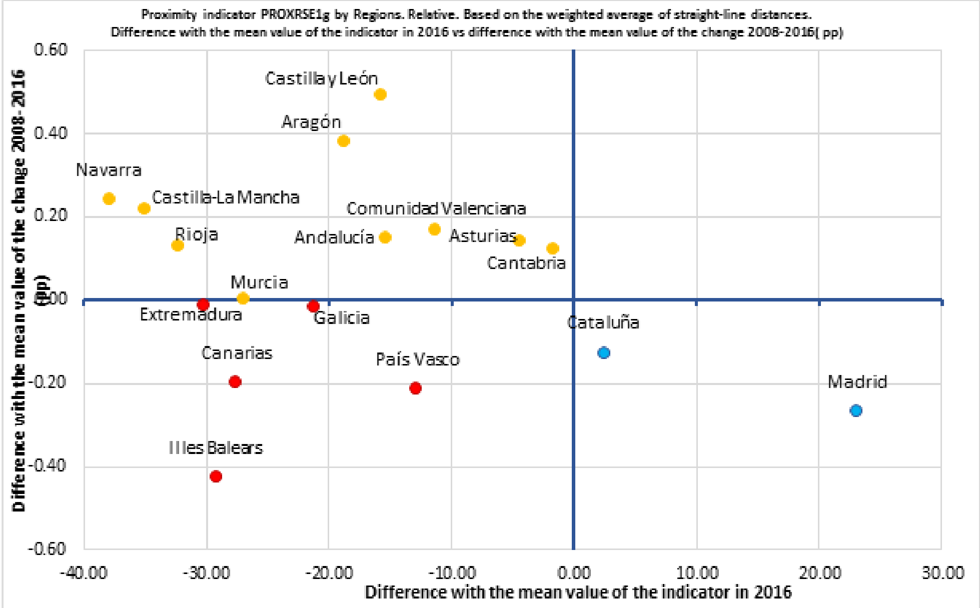
- **Murcia's** population proximity is typically below or close to the national average and with evolving rates of change at or below average. This dynamic pattern would produce a proximity stagnation in the region.
- **Navarra's** population proximity is typically below the national average but evolving notably above the average rate. This dynamic pattern would cause convergence towards the national average.
- **País Vasco's** population proximity is typically below the national average except for absolute population proximity. In all cases, population proximity is evolving below average. Absolute indicators point to a converging path, while relative and normalised indicators point to a divergent path.
- **La Rioja** presents population proximity levels below the national average, regardless of the way in which proximity is approached, except for the SPI. On the other hand, population proximity registers above average rates of change. These results show that the Region would be on the path to converge towards the national average or advancing to top positions according to the SPI.

Chart 5. The dynamic of population proximity (It continues)





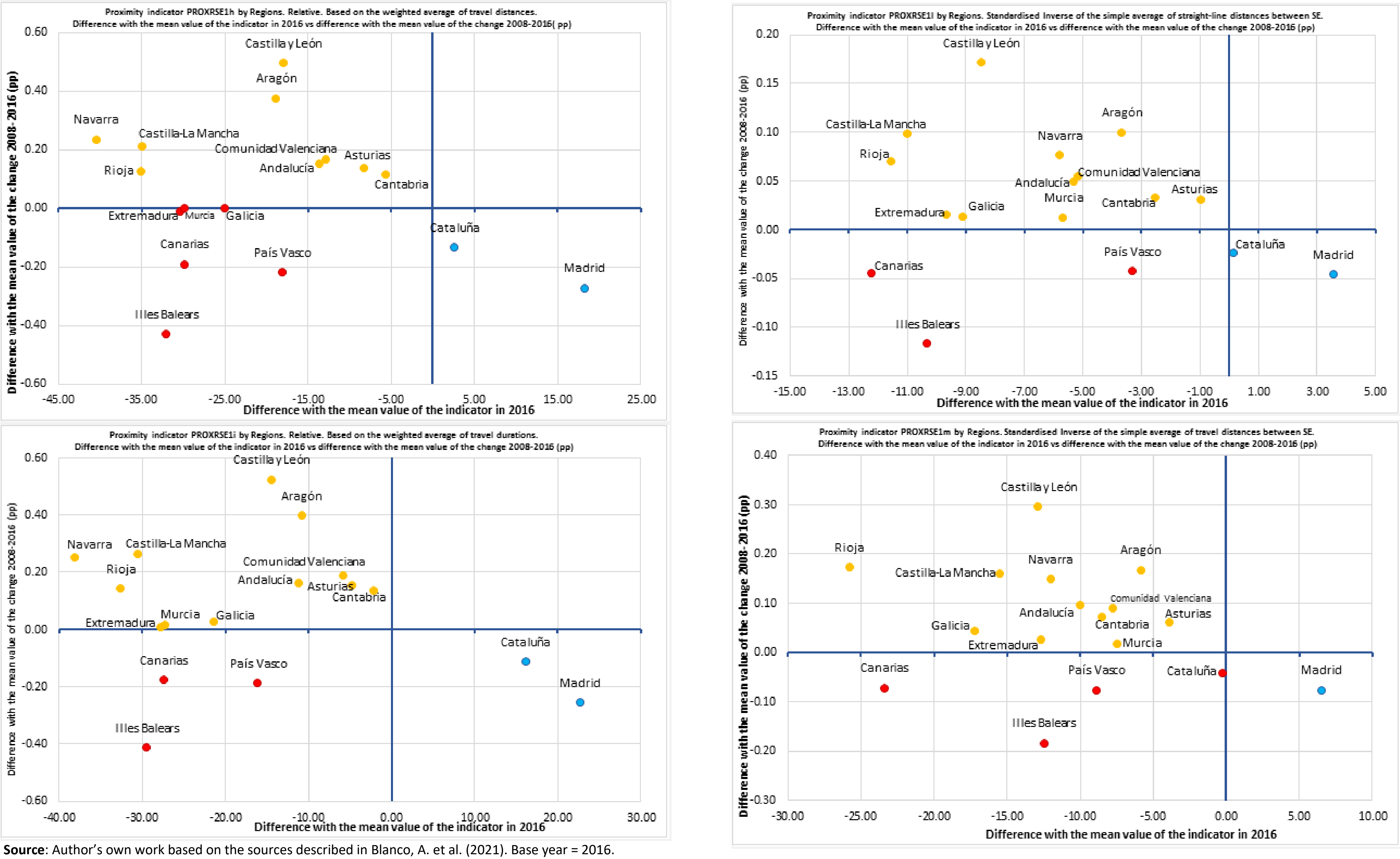




Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

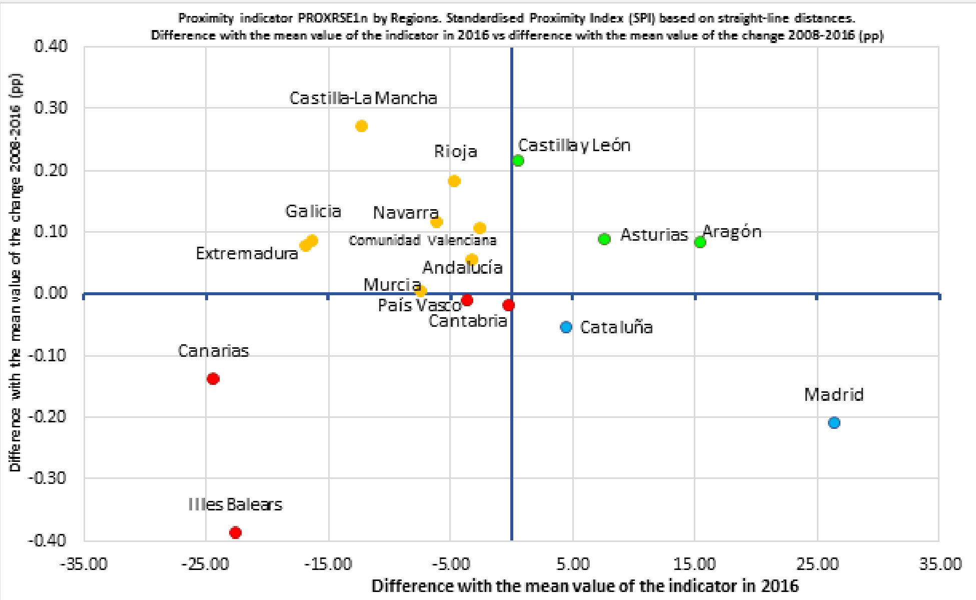
Chart 5. The dynamic of population proximity

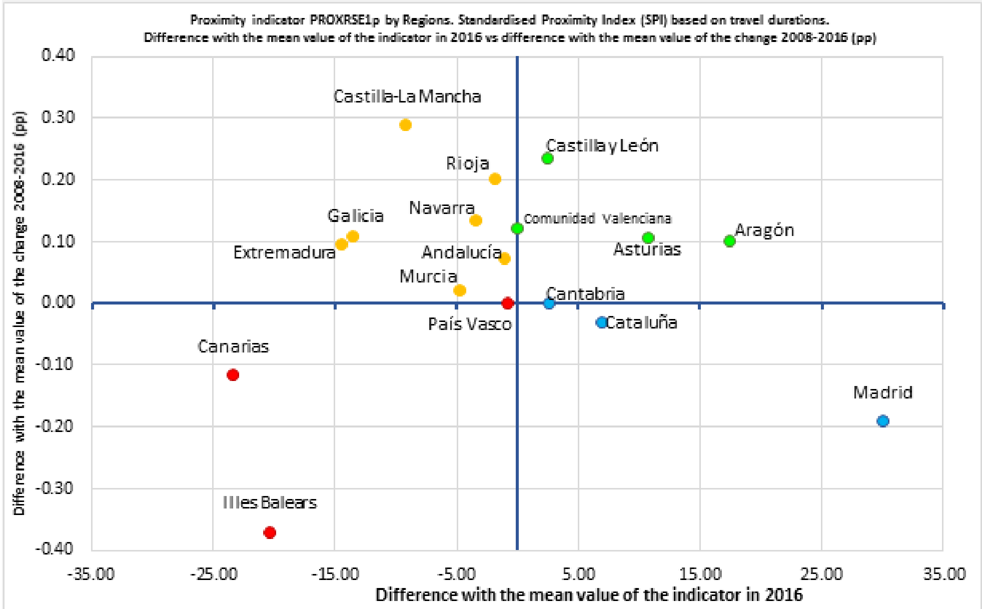
(It continues)

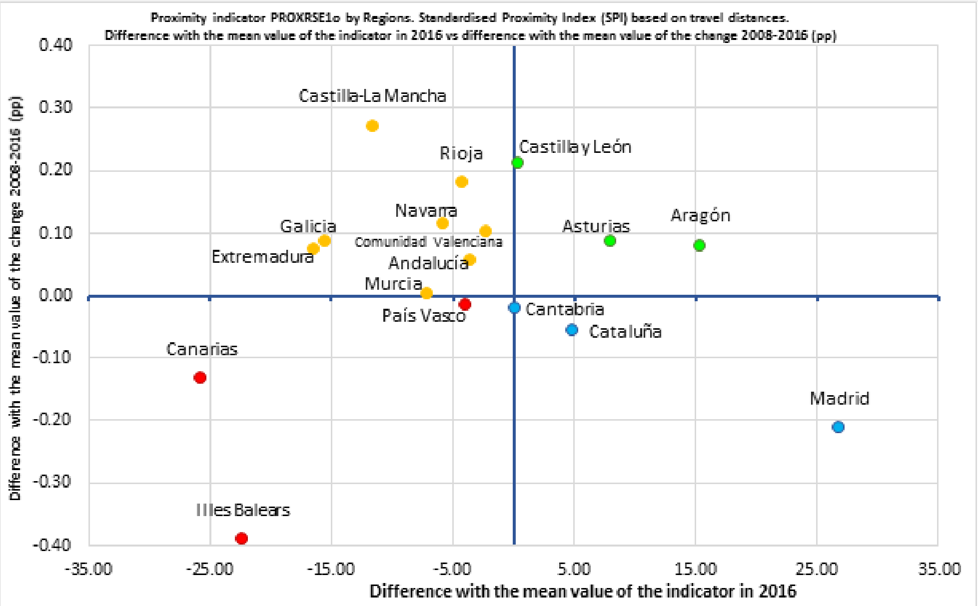


Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 5. The dynamic of population proximity (It concludes)







Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Centrality

According to the methodology developed by Blanco, A. et al. (2021), the set of indicators that we used captures centrality within province i through the distances from land uses (SE and MUN) to the Central Business District (CBD). As already detailed, we used three types of distance: straight-line, travel distance and travel duration. We aggregated distances via simple averages and population weighted averages. Simple average-based indicators reflect the centrality of the locations rather than the centrality of the population that inhabits them. On the contrary, weighted average-based indicators reflect the population´s centrality rather than the geographical centrality.

This distinction between population and geographical centralities raises one relevant issue from the perspective of the FPS organization, specifically concerning Reference Services that are typically placed in the CBD. On one hand, a higher centrality of the population would promote economies of scale regarding the offer of FPS Reference Services. On the other hand, even when the centralisation of the population is higher than that of the locations, should geographical centrality remain low, the need to guarantee universal access to those population entities that are far away and less populated would imply a relevant cost that would offset the efficiency gains from the mentioned economies of scale. Thus, regarding decision-making, even if efficiency reasons would advise focusing on population centrality, both types of centrality indicators should be jointly considered as FPS needs drivers to take into account equality of access considerations.

We worked with three types of centrality indicators:

- Absolute:
  - *Inverse of the simple average of straight-line distances from SE to the CBD (**$CBDdS_{SE3a}$**).*
  - *Inverse of the simple average of travel distances from SE to the CBD (**$CBDdS_{SE3b}$**).*
  - *Inverse of the simple average of travel durations from SE to the CBD (**$CBDdS_{SE3c}$**).*
  - *Inverse of the weighted average of straight-line distances from SE to the CBD (**$CBDdW_{SE3d}$**).*
  - *Inverse of the weighted average of travel distances from SE to the CBD (**$CBDdW_{SE3e}$**).*
  - *Inverse of the weighted average of travel durations from SE to the CBD (**$CBDdW_{SE3f}$**).*

- Relative:
  - *Ratio population centrality to geographical centrality (SE & straight-line distance) (**$CBDdR_{SE3g}$**).*
  - *Ratio population centrality to geographical centrality (SE & travel distances) (**$CBDdR_{SE3h}$**).*

- *Ratio population centrality to geographical centrality (SE & travel durations) (**$CBDdR_{SE3i}$**).*

- Standardised:
  - *Normalised geographical centrality (SE & straight-line distance) (**$CBDdN_{SE3j}$**).*
  - *Normalised geographical centrality (SE & travel distance) (**$CBDdN_{SE3k}$**).*
  - *Normalised population centrality (SE & straight-line distance) (**$CBDdN_{SE3l}$**).*
  - *Normalised population centrality (SE & travel distance) (**$CBDdN_{SE3m}$**).*
  - *Centralisation Ratio (**$CBDdCR_{MUN4n}$**).*
  - *Centralisation Index based on population accumulated (**$CBDdACI_{MUN4o}$**).*

In the same way as for proximity indicators, as a rule, we focused on SE-based indicators and present the associated MUN-based indicators in Annex I. Correlation between SE and MUN-based centrality indicators ranges from 0.70 to 1.00 (Annex I. Table 0).

Absolute centrality

Nationwide, the ***simple average of straight-line distances from SE locations to the province´s CBD*** is 42.53 Km; for travel distances it is 66.05 Km; and for travel durations, 59.81 minutes (1.00 hours). (Table 10.1).

The ***population-weighted average of straight-line distances from SE locations to the province´s CBD*** is 24.51 Km; for travel distances, it is 37.14 Km; and for travel durations, 36.10 minutes (0.60 hours).

Maximum average distances from SE locations to the province´s CBD occur normally in Canarias,[13] but also in Extremadura. Concerning simple averages (location distance), in Extremadura, we calculated an average straight-line distance to the CBD of 74.79 Km, the highest in Spain; in Canarias, the average travel distance to the CBD is 115.43 Km, the highest in Spain; and, also in Canarias, the average travel duration to the CDB of 211.06 minutes (3.52 hours) is the maximum one. Regarding weighted averages (population distances), maximum averages occur in Extremadura for straight-line distance (56.48 Km), Canarias for travel distance (81.13 Km) and Canarias as well for travel duration (148.81 minutes —2.48 hours) (Table 10.2).

[13] Please, notice that we measure distances within the same province. In the islands territories, a province includes several island. Thus, maximum distances from SE to the province's CBD are influenced by the inter-islands distances. For further details, please refer to Blanco, A. et al. (2021).

Minimum average distances to the province's CBD occur in País Vasco, except for travel distances and travel durations, which register its minimum values in Madrid when distances are population weighted. As regards simple averages (location distance), in País Vasco, we calculated an average straight-line distance to the CBD of 22.98 Km; an average travel distance of 36.63 Km; and an average travel duration of 35.05 minutes (0.58 hours), the lowest in Spain. Regarding weighted averages (population distances), País Vasco registers the minimum distance to the CBD for straight-line distance (12.41 Km), and Madrid for travel distance (18.18 Km) and travel duration (14.91 minutes — 0.25 hours) (Table 10.2).

The provincial average distance of SE to the CBD records a high inter-region variability, with coefficients of variation (CV) over 26%. It is especially high for travel durations, with CV close to 100% (Table 10.3).

Against this backdrop, absolute centrality indicators in Spain´s regions show the following basic features (Table 11):

- ***Absolute geographical centrality*** measured in terms of ***straight-line distance*** ranges from 0.0134 to 0.0435; in País Vasco (maximum value), it is 3.3 times that of Extremadura (minimum value). Measured in terms of ***travel distance,*** it ranges from 0.0087 to 0.0273; in País Vasco (maximum value), it is 3.2 times that of Canarias (minimum value). In terms of ***travel duration,*** it ranges from 0.0047 to 0.0285; in País Vasco (maximum value), it is 6.0 times that of Canarias (minimum value).
- ***Absolute population centrality*** measured in terms of ***straight-line*** distance ranges from 0.0177 to 0.0806; in País Vasco (maximum value), it is 4.6 times that of Extremadura (minimum value). Measured in terms of ***travel distance,*** it ranges from 0.0123 to 0.0550; in Madrid (maximum value), it is 4.5 times that of Canarias (minimum value). In terms of ***travel duration***, it ranges from 0.0067 to 0.0671; in Madrid (maximum value), it is 10.0 times that of Canarias (minimum value).
- ***Absolute centrality*** has a significant variability among regions with interregional coefficients of variation from 25% to 62%.

- Systematically, the minimum centrality corresponds to Canarias and Extremadura. On the opposite side, País Vasco registers the maximum one except for travel distances and travel durations, which occur in Madrid when the indicators are population-based.
- Generally, geographical centrality is lower than population centrality, showing that the population tends to reside in singular entities that are closer to the CBD than the whole set of locations. Except for Navarra, where singular entities´ geographical centrality is practically identical to population centrality. The regions where population centrality remains close to geographical centrality are mainly Illes Balears, Castilla-La Mancha, Murcia and Navarra. This would point out that, in these regions, the population tends to reside in locations that are farther away from the CBD to a greater extent than in other regions.

There are not standard references available against which benchmarking the value of our indicators. Therefore, we developed our analysis based on interregional comparisons with the national average and the distribution across regions as a reference.

We observe that absolute geographical centrality has a positive asymmetric distribution across regions, meaning that most of the population resides in regions with a low level of absolute geographical centrality. On the contrary, for population centrality, the distribution is more symmetric, especially when distances are measured in terms of travel distances; and it becomes negative asymmetric for travel durations. Thus, approximately, half of the people live in regions with below average absolute population centrality, except when it is measured via travel durations; in this case, most of the population lives in regions with above average centrality (Chart 6).

We found that Asturias, Madrid, País Vasco and La Rioja are systematically in positions above the national average, with a high level of absolute centrality. On the contrary, Illes Balears, Canarias, and Extremadura are systematically in the bottom positions below average, with a low level of absolute centrality (Table 12).

We note that Galicia, Murcia and Navarra move from positions above the national average to below it when the focus is placed on population centrality instead of geographical centrality. This would point out that in these regions the population's tendency to settle close to CBD is weaker than in the country as a whole.

Nationwide, absolute population centrality decreased from 2003 to 2008. As of 2008, it initiated a raising trend that continued until 2017, our last analysed year (Chart 7).

Our results show that over the whole period the population has moved to reside in land uses that are increasingly closer to the CBD, mainly in terms of travel distances. In addition, these movements seem to be more intense concerning municipalities than singular entities (the lines in Chart 7 representing the indicators based on municipalities overpass those based on singular entities for the same sort of distance). The evolution of absolute centrality based on travel distances of municipalities to the CBD (dark blue line in Chart 7) presents the highest rates of increase. One plausible explanation could be that the population has moved towards municipalities that are close to the capitals of each province more intensely than to towards municipality capitals. This seems to be coherent with OECD's analysis on "*Urban Spatial Structure in OECD Cities,*" showing that "*Population grew more in locations with relatively low density and close to the CD and sub-centres, but outside them. These results may suggest that people tend to prefer to locate in accessible places while maintaining a relatively low-density living environment. Polycentric structures might be the result of this type of behaviour. The latter determines a decentralisation from the densest places towards more peripheral locations, which in turn might become sub-centres over time*." (Veneri, P. (2015)).

Table 10.1. Average distances from SE to the province's CBD by Region

Region	Singular entity-based indicators					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
	$CBDdS_{SE3a}$	$CBDdS_{SE3b}$	$CBDdS_{SE3c}$	$CBDdW_{SE3d}$	$CBDdW_{SE3e}$	$CBDdW_{SE3f}$
TOTAL	**42.53**	**66.05**	**59.81**	**24.51**	**37.14**	**36.10**
Andalucía	50.50	81.52	71.00	29.51	46.40	40.40
Aragón	55.86	85.69	70.77	25.15	38.12	31.05
Asturias	39.39	63.00	54.16	22.34	35.73	30.72
Illes Balears	63.60	86.15	158.79	49.61	67.21	123.87
Canarias	71.72	115.43	211.06	50.89	81.13	148.81
Cantabria	42.32	70.98	59.64	19.97	33.49	28.14
Castilla y León	48.79	70.80	59.95	23.74	34.48	29.17
Castilla-La Mancha	52.31	76.93	64.70	42.34	60.28	49.87
Cataluña	46.76	74.48	67.50	22.55	34.44	29.39
Comunidad Valenciana	41.90	63.39	52.61	25.66	38.00	30.45
Extremadura	74.79	107.84	88.01	56.48	79.52	64.96
Galicia	38.76	60.79	53.18	28.55	45.16	39.26
Madrid	37.49	54.64	44.82	12.47	18.18	14.91
Murcia	39.81	56.82	47.53	33.21	47.40	39.66
Navarra	30.70	48.70	41.05	28.24	44.80	37.77
País Vasco	22.98	36.63	35.05	12.41	20.26	19.40
La Rioja	34.83	58.98	50.97	19.20	32.51	28.10

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 10.2. Maximum and minimum values of the average distance from SE to the province's CBD (value and Region)

	Singular entity-based indicators					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
Max SE	74.79	115.43	211.06	56.48	81.13	148.81
Min SE	22.98	36.63	35.05	12.41	18.18	14.91
Max SE	Extremadura	Canarias	Canarias	Extremadura	Canarias	Canarias
Min SE	País Vasco	País Vasco	País Vasco	País Vasco	Madrid	Madrid

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 10.3. Inter-region variability of average distances from SE to the province's CBD

	Singular entity-based indicators					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
Standard Deviation SE	11.16	17.38	37.51	11.00	16.24	29.74
CV SE	0.26	0.26	0.63	0.45	0.44	0.82

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 11.1. Absolute centrality indicators by region

Region	Inverse of the distance from singular entities to CBD within the same province					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
	$CBDdS_{SE3a}$	$CBDdS_{SE3b}$	$CBDdS_{SE3c}$	$CBDdW_{SE3d}$	$CBDdW_{SE3e}$	$CBDdW_{SE3f}$
TOTAL	**0.0235**	**0.0151**	**0.0167**	**0.0408**	**0.0269**	**0.0277**
Andalucía	0.0198	0.0123	0.0141	0.0339	0.0216	0.0248
Aragón	0.0179	0.0117	0.0141	0.0398	0.0262	0.0322
Asturias	0.0254	0.0159	0.0185	0.0448	0.0280	0.0326
Illes Balears	0.0157	0.0116	0.0063	0.0202	0.0149	0.0081
Canarias	0.0139	0.0087	0.0047	0.0196	0.0123	0.0067
Cantabria	0.0236	0.0141	0.0168	0.0501	0.0299	0.0355
Castilla y León	0.0205	0.0141	0.0167	0.0421	0.0290	0.0343
Castilla-La Mancha	0.0191	0.0130	0.0155	0.0236	0.0166	0.0201
Cataluña	0.0214	0.0134	0.0148	0.0443	0.0290	0.0340
Comunidad Valenciana	0.0239	0.0158	0.0190	0.0390	0.0263	0.0328
Extremadura	0.0134	0.0093	0.0114	0.0177	0.0126	0.0154
Galicia	0.0258	0.0165	0.0188	0.0350	0.0221	0.0255
Madrid	0.0267	0.0183	0.0223	0.0802	0.0550	0.0671
Murcia	0.0251	0.0176	0.0210	0.0301	0.0211	0.0252
Navarra	0.0326	0.0205	0.0244	0.0354	0.0223	0.0265
País Vasco	0.0435	0.0273	0.0285	0.0806	0.0494	0.0516
La Rioja	0.0287	0.0170	0.0196	0.0521	0.0308	0.0356

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 11.2. Maximum and minimum values of absolute centrality indicators (value and Region)

	Inverse of the distance from singular entities to CBD within the same province					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
Max SE	0.0435	0.0273	0.0285	0.0806	0.0550	0.0671
Min SE	0.0134	0.0087	0.0047	0.0177	0.0123	0.0067
Max SE	País Vasco	País Vasco	País Vasco	País Vasco	Madrid	Madrid
Min SE	Extremadura	Canarias	Canarias	Extremadura	Canarias	Canarias

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 11.3. Inter-region variability of absolute centrality indicators

	Inverse of the distance from singular entities to CBD within the same province					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
Standard Deviation SE	0.0060	0.0038	0.0050	0.0191	0.0129	0.0171
CV SE	0.25	0.25	0.30	0.47	0.48	0.62

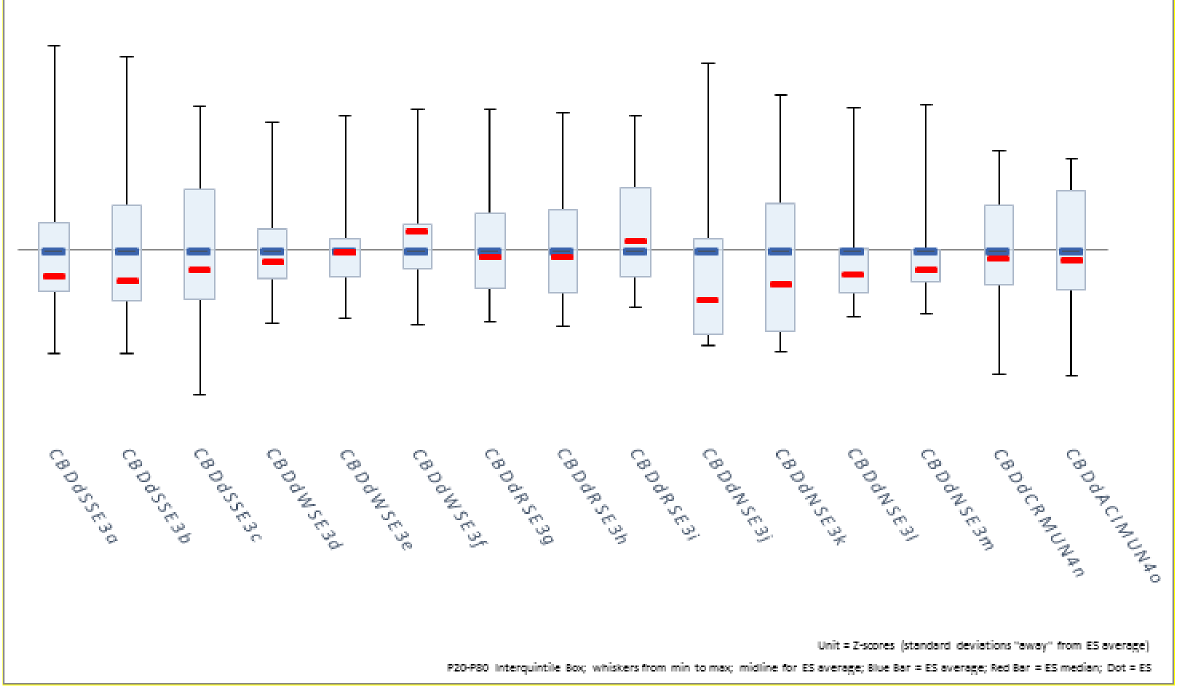
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 12. Regional rankings of absolute centrality indicators—Regions in decreasing order

	Singular entity-based indicators					
	Absolute					
	Simple average /Straight-line distance	Simple average /Travel distance	Simple average /Travel duration	Weighted average /Straight-line distance	Weighted average /Travel distance	Weighted average /Travel duration
	$CBDdS_{SE3a}$	$CBDdS_{SE3b}$	$CBDdS_{SE3c}$	$CBDdS_{SE3d}$	$CBDdS_{SE3e}$	$CBDdS_{SE3f}$
ABOVE AVERAGE	País Vasco	País Vasco	País Vasco	País Vasco	Madrid	Madrid
	Navarra	Navarra	Navarra	Madrid	País Vasco	País Vasco
	La Rioja	Madrid	Madrid	La Rioja	La Rioja	La Rioja
	Madrid	Murcia	Murcia	Cantabria	Cantabria	Cantabria
	Galicia	La Rioja	La Rioja	Asturias	Cataluña	Castilla y León
	Asturias	Galicia	C.Valenciana	Cataluña	Castilla y León	Cataluña
	Murcia	Asturias	Galicia	Castilla y León	Asturias	C. Valenciana
	C. Valenciana	C. Valenciana	Asturias			Asturias
						Aragón
BELOW AVERAGE	Cantabria	Castilla y León	Cantabria	Aragón	C.Valenciana	Navarra
	Cataluña	Cantabria	Castilla y León	C. Valenciana	Aragón	Galicia
	Castilla y León	Cataluña	C-La Mancha	Navarra	Navarra	Murcia
	Andalucía	C-La Mancha	Cataluña	Galicia	Galicia	Andalucía
	C-La Mancha	Andalucía	Aragón	Andalucía	Andalucía	C-La Mancha
	Aragón	Aragón	Andalucía	Murcia	Murcia	Extremadura
	Illes Balears	Illes Balears	Extremadura	Ca-La Mancha	C-La Mancha	Illes Balears
	Canarias	Extremadura	Illes Balears	Illes Balears	Illes Balears	Canarias
	Extremadura	Canarias	Canarias	Canarias	Extremadura	
				Extremadura	Canarias	

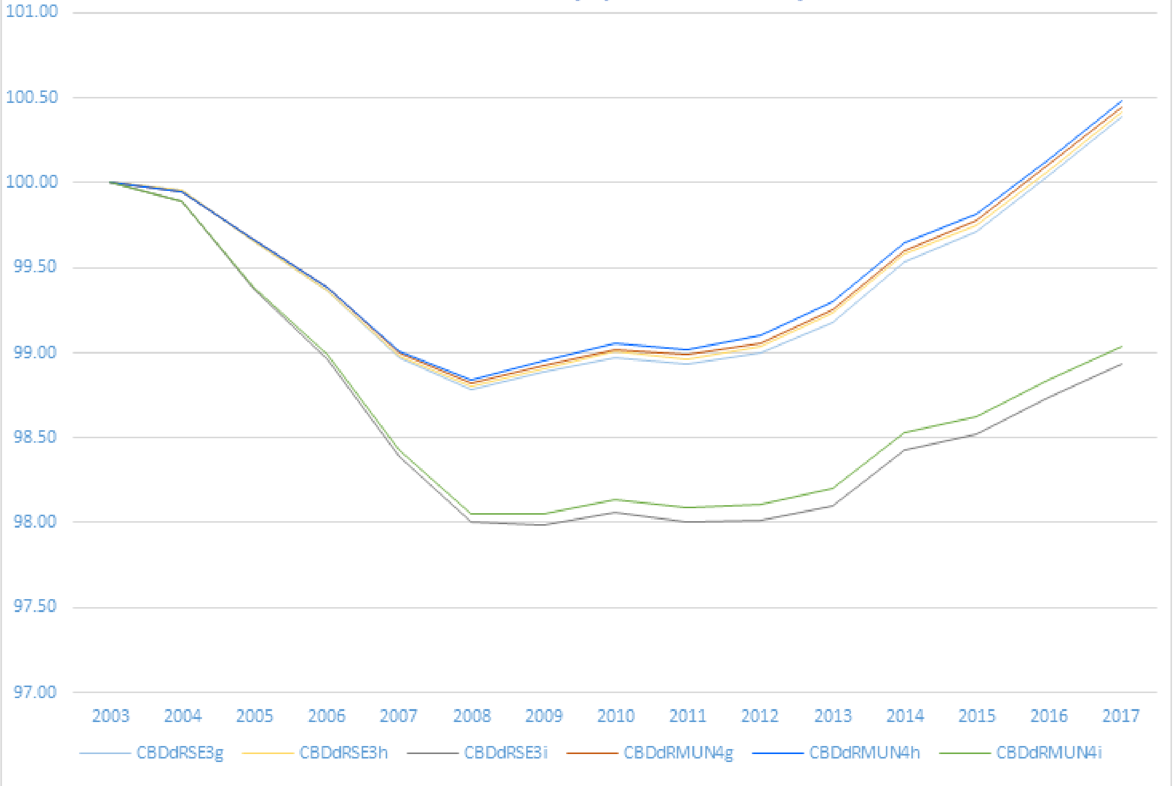
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 6. Across-region distribution of centrality indicators in Spain (ES) 2016



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 7. Evolution of absolute population centrality. 2003=100



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Relative centrality

The comparison between population and geographical centralities, where the centrality of the locations is the benchmark, leads to the formulation of relative centrality indicators.

Nationwide, the ***ratio of population to geographical centrality*** for straight-line distances from SE to the province's CBD is 1.74; for travel distances it is 1.78; and for travel durations 1.66 (Table 13.1). This points out that, on average, the population distance to the CBD ranges from 58% to 60% of the location distance. Maximum ratios occur systematically in Madrid and the minimum in Navarra (Table 13.2). Inter-region variability for relative centrality indicators is high, with coefficients of variation ranging from 31% to 37% (Table 13.3).

Our results show two types of findings. First, overall, population centrality is higher than geographical centrality, as already described (with a ratio even larger than for proximity). Nonetheless, in Navarra, both types of indicators are very similar. This would point out that Navarra's population tends to reside in locations that are farther away from the CBD than in the country as a whole, which is coherent with the previous finding, which indicated that the SE in Navarra that are more distant from the others have higher population weights than in Spain's provinces overall.

Second, regarding regional comparisons, we observe that relative centrality presents a symmetric or negative asymmetric distribution, indicating that approximately half of the population lives in regions with low relative population centrality and the other half (or more, especially when distance is based on travel duration) in regions with high relative population centrality (Chart 6). The regions that systematically hold positions above the national average are Aragón, Cantabria, Castilla y León, Cataluña, Madrid, País Vasco and La Rioja. Showing that, in these regions, the population tends to concentrate in locations close to the CBD to a greater extent than in other regions. It is worth mentioning that País Vasco moves from the top positions in the centrality ranking of absolute indicators to an intermediate position for relative centrality. Illes Balears, Canarias, Castilla-La Mancha, Extremadura, Galicia, Murcia and Navarra are systematically below the national average (Table 14). This would point out that in these regions the tendency of the population to settle in locations close to the CBD is weaker than in the country as a whole.

Table 13.1. Relative centrality indicators by region

Region	Singular entity-based indicators		
	Ratio population to geographical centrality /Straight-line distance	Ratio population to geographical centrality /Travel distance	Ratio population to geographical centrality /Travel duration
	$CBDdR_{SE3g}$ (R_n)	$CBDdR_{SE3h}$ (R_n)	$CBDdR_{SE3i}$ (R_n)
TOTAL	**1.7352**	**1.7785**	**1.6566**
Andalucía	1.7115	1.7569	1.7576
Aragón	2.2209	2.2477	2.2795
Asturias	1.7631	1.7631	1.7631
Illes Balears	1.2818	1.2818	1.2818
Canarias	1.4092	1.4228	1.4183
Cantabria	2.1193	2.1193	2.1193
Castilla y León	2.0554	2.0532	2.0554
Castilla-La Mancha	1.2356	1.2762	1.2976
Cataluña	2.0734	2.1625	2.2963
Comunidad Valenciana	1.6330	1.6681	1.7278
Extremadura	1.3241	1.3560	1.3548
Galicia	1.3576	1.3459	1.3545
Madrid	3.0056	3.0056	3.0056
Murcia	1.1986	1.1986	1.1986
Navarra	1.0871	1.0871	1.0871
País Vasco	1.8519	1.8078	1.8069
La Rioja	1.8142	1.8142	1.8142

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 13.2. Maximum and minimum values of relative centrality indicators (value and Region)

	Ratio population to geographical centrality /Straight-line distance	Ratio population to geographical centrality /Travel distance	Ratio population to geographical centrality /Travel duration
Max SE	3.01	3.01	3.01
Min SE	1.09	1.09	1.09
Max SE	Madrid	Madrid	Madrid
Min SE	Navarra	Navarra	Navarra

Source: Author's own work based on Table 13.1. Base year = 2016.

Table 13.3. Inter-region variability of relative centrality indicators

	Ratio population to geographical centrality /Straight-line distance	Ratio population to geographical centrality /Travel distance	Ratio population to geographical centrality /Travel duration
Standard Deviation SE	0.55	0.55	0.61
CV SE	0.32	0.31	0.37

Source: Author's own work based on Table 13.1. Base year = 2016.

Table 14. Regional rankings of relative centrality indicators—Regions in decreasing order

	Singular entity-based indicators		
	Relative		
	Ratio population to geographical centrality /Straight-line distance	Ratio population to geographical centrality /Travel distance	Ratio population to geographical centrality /Travel duration
	$PROXR_{SE3g}$	$PROXR_{SE3h}$	$PROXR_{SE3i}$
ABOVE AVERAGE	Madrid	Madrid	Madrid
	Aragón	Aragón	Cataluña
	Cantabria	Cataluña	Aragón
	Cataluña	Cantabria	Cantabria
	Castilla y León	Castilla y León	Castilla y León
	País Vasco	La Rioja	La Rioja
	La Rioja	País Vasco	País Vasco
	Asturias		Asturias
			Andalucía
			C. Valenciana
BELOW AVERAGE	Andalucía	Asturias	Canarias
	C. Valenciana	Andalucía	Extremadura
	Canarias	C. Valenciana	Galicia
	Galicia	Canarias	Castilla-La Mancha
	Extremadura	Extremadura	Illes Balears
	Illes Balears	Galicia	Murcia
	Castilla-La Mancha	Illes Balears	Navarra
	Murcia	Castilla-La Mancha	
	Navarra	Murcia	
		Navarra	

Source: Author's own work based on Table 13.1. Base year = 2016

Standardised centrality

Absolute and relative indicators do not capture the extent to which locations or population spread around the CBD. To overcome this limitation we calculated standardised or normalised indicators. The normalization procedures improve the comparability of the indicators by taking into account differences in province sizes.

To build standardised indicators, we first used the province breadth to normalise distance (normalised centrality indicators). In addition, we worked with the indicators described next, which are based on alternative benchmarks for the population distance. Though not strictly standardised by the province breadth, they provide some information on the extent to which population spreads around the centre, and they are independent of breadth.

We used alternative benchmarks for the population distance. These benchmarks provide some information on the extent to which population spreads around the centre and are independent of the province size. The ***Centralisation Ratio*** compares the mean distance population is located from the centre to the mean distance to the centre if the population were uniformly distributed across the province with the same density in each municipality. The ***Centralisation Index*** computes the accumulation around and from the CBD of the land uses population compared to the corresponding accumulation of surface area.

We present in Table 15 our results for the standardised centrality indicators: normalised geographical and population centralities, based both on straight-line and travel distance, as well as the Centralisation Ratio and the Centralisation Index.

Regarding ***normalised geographical centrality*** we have observed that, at the national level, on average, the province's diagonal is 4.77 times the average straight-line distance from SE locations to the province's CBD; ranging from 3.72 in Canarias to 6.85 in Navarra.[14] As for travel distances, the national average is 3.07; ranging from 2.25 in Cantabria to 4.32 in Navarra. Therefore, the normalised geographical centrality in Spain is 0.7905 for straight-

[14] Please refer to Table 6 for data referring the provinces' diagonal.

line distance and 0.6746 for travel distances.[15] These two indicators have low inter-region variability, with a CV of 4% to 9% and with most regions situated below the national average (Table 16).

As for ***normalised population centrality*** we have observed that, at the national level, on average, the province's diagonal is 8.28 times the straight-line-based average population distance from SE to the CBD It ranges from 5.02 in Extremadura to 15.24 in Madrid. Concerning travel distances the ratio is 5.47, with its minimum value in Canarias (3.29) and the maximum in Madrid (10.46). Therefore, the normalised population centrality in Spain is 0.8793 for straight-line distance (from 0.8010 in Extremadura to 0.9344 in Madrid); and 0.8171 for travel distances (from 0.6958 in Canarias to 0.9044 in Madrid). The inter-region variability of normalised population centrality is also low (CV between 4% and 9%), with an asymmetric distribution and most of the regions below the national average (Table 16).

The ***Centralisation Ratio*** presents the value of 0.5044 at the national level. Thus, the mean distance population is located from the centre is around half of the mean distance to the centre if the population were uniformly distributed across the province with the same density in each municipality. We notice that the mean distance to the centre if the population were uniformly distributed across the province with the same density in each municipality is not the maximum attainable mean distance to the centre. Indeed, the indicator might be negative if the population is more decentralised than a uniform distribution. The *Centralisation Ratio* ranges from 0.2659 in Extremadura to 0.6942 in Madrid with an interregional CV of 23%, higher than the normalised geographical and population centralities. The interregional distribution of the indicator is slightly positive asymmetric though almost symmetric (Chart 6).

The ***Centralisation Index*** presents the value of 0.5326 at the national level. It shows that, on average, the population in a province accumulates faster than land area around the CBD and is closer to it than a uniform distribution from the centre to the periphery. A 53.26% of

[15] The simple averages of straight-line or travel distances from SE to province i's CBD $(\bar{d}(i)\ or\ \bar{\bar{d}}(i))$ are rescaled and expressed as units of the province's adjusted diagonal, which is set as the standard. Then we calculate: $1-\frac{\bar{d}(i)}{D_{adj}(i)}$ and $1-\frac{\bar{\bar{d}}(i)}{D_{adj}(i)}$.

the province's population should move towards the periphery to achieve an even distribution around the CBD. The indicator ranges from 0.2615 in Extremadura to 0.7277 in Madrid and registers a notable level of interregional variability: CV of 25%. The interregional distribution of the indicator is slightly positive asymmetric though almost symmetric (Chart 6).

Our results show that the distribution across regions of standardised centrality is typically positive asymmetric or symmetric, meaning that most people reside in regions with a low level of standardised centrality. The Region that systematically exhibits high standardised centrality, above the national average, is Madrid. Asturias is also above the national average for all the indicators. On the contrary, Extremadura is systematically in a bottom position for all the indicators (Table 16).

Regarding the evolution of population centrality measured with standardised indicators, our results show that, nationwide, it is increasing since 2008. From 2003 to 2008 we observe a decreasing trend (Chart 8).

Table 15.1. Standardised centrality indicators by region

Region	Singular entity-based indicators					
	Normalised geographical centrality /Straight-line distance	Normalised geographical centrality /Travel distance	Normalised population centrality /Straight-line distance	Normalised population centrality /Travel distance	Centralisation Ratio	Centralisation Index
	$CBDdN_{SE3j}$	$CBDdN_{SE3k}$	$CBDdN_{SE3l}$	$CBDd_{SE3m}$	$CBDdCR_{MUN4n}$	$CBDdACI_{MUN4o}$
TOTAL	**0.7905**	**0.6746**	**0.8793**	**0.8171**	**0.5044**	**0.5326**
Andalucía	0.7541	0.6031	0.8563	0.7741	0.4687	0.4891
Aragón	0.7769	0.6578	0.8995	0.8477	0.5911	0.5703
Asturias	0.8163	0.7061	0.8958	0.8333	0.5311	0.5987
Illes Balears	0.7883	0.7132	0.8349	0.7763	0.2810	0.3070
Canarias	0.7311	0.5671	0.8092	0.6958	0.5269	0.4718
Cantabria	0.7352	0.5559	0.8751	0.7905	0.5826	0.6542
Castilla y León	0.7506	0.6381	0.8787	0.8237	0.4944	0.4926
C-La Mancha	0.7769	0.6718	0.8194	0.7429	0.3083	0.2968
Cataluña	0.7426	0.5901	0.8759	0.8104	0.5919	0.6639
C. Valenciana	0.7710	0.6535	0.8597	0.7923	0.4801	0.5283
Extremadura	0.7365	0.6200	0.8010	0.7198	0.2659	0.2615
Galicia	0.7746	0.6465	0.8340	0.7374	0.3095	0.3360
Madrid	0.8028	0.7126	0.9344	0.9044	0.6942	0.7277
Murcia	0.8085	0.7267	0.8402	0.7720	0.4042	0.4186
Navarra	0.8539	0.7683	0.8656	0.7868	0.3737	0.3969
País Vasco	0.7803	0.6497	0.8813	0.8062	0.4960	0.5253
La Rioja	0.7546	0.5844	0.8647	0.7709	0.5404	0.5462

Source: Author’s own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 15.2. Maximum and minimum values of standardised centrality indicators (value and Region)

	Normalised geographical centrality /Straight-line distance	Normalised geographical centrality /Travel distance	Normalised population centrality /Straight-line distance	Normalised population centrality /Travel distance	Centralisation Ratio	Centralisation Index
Max SE	0.85	0.77	0.93	0.90	0.69	0.73
Min SE	0.73	0.56	0.80	0.70	0.27	0.26
Max SE	Navarra	Navarra	Madrid	Madrid	Madrid	Madrid
Min SE	Canarias	Cantabria	Extremadura	Canarias	Extremadura	Extremadura

Source: Author’s own work based on Table 6.1. Base year = 2016.

Table 15.3. Inter-region variability of standardised centrality indicators

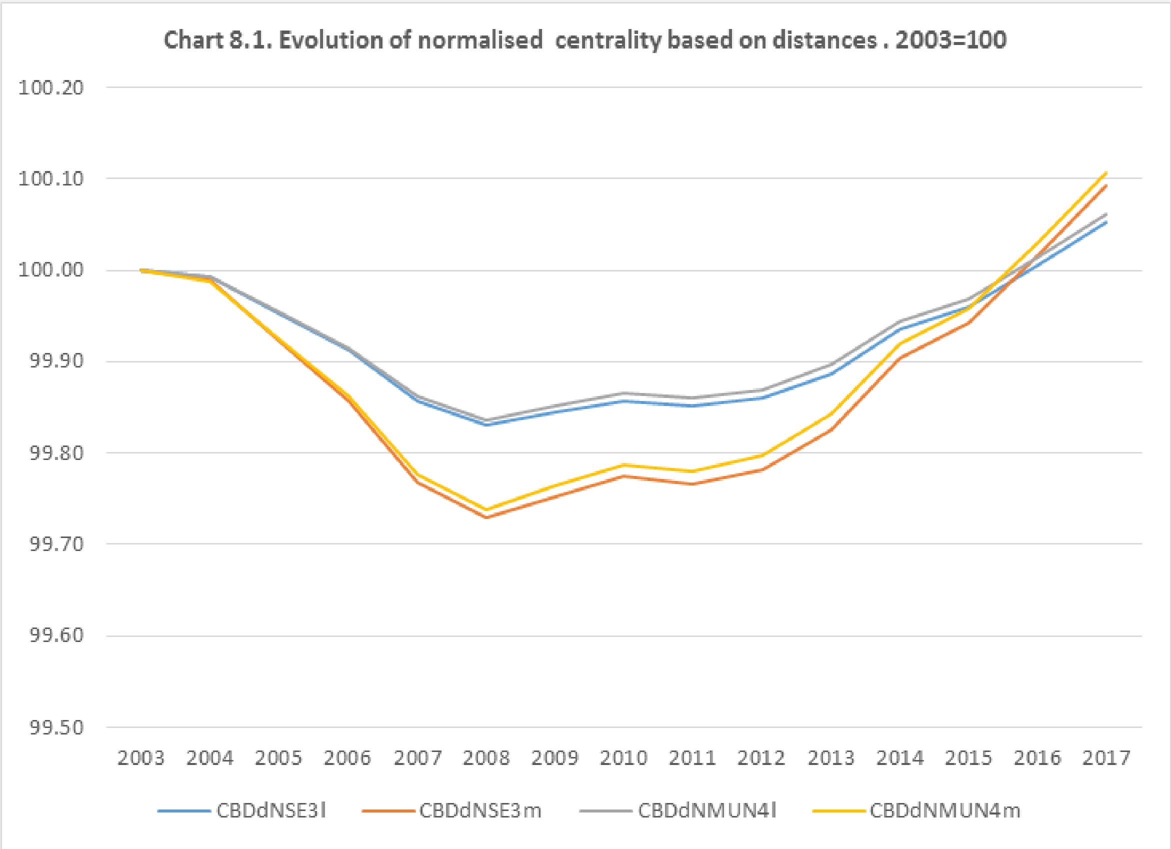
	Normalised geographical centrality /Straight-line distance	Normalised geographical centrality /Travel distance	Normalised population centrality /Straight-line distance	Normalised population centrality /Travel distance	Centralisation Ratio	Centralisation Index
Standard Deviation SE	0.03	0.06	0.04	0.06	0.12	0.13
CV SE	0.04	0.09	0.04	0.07	0.23	0.25

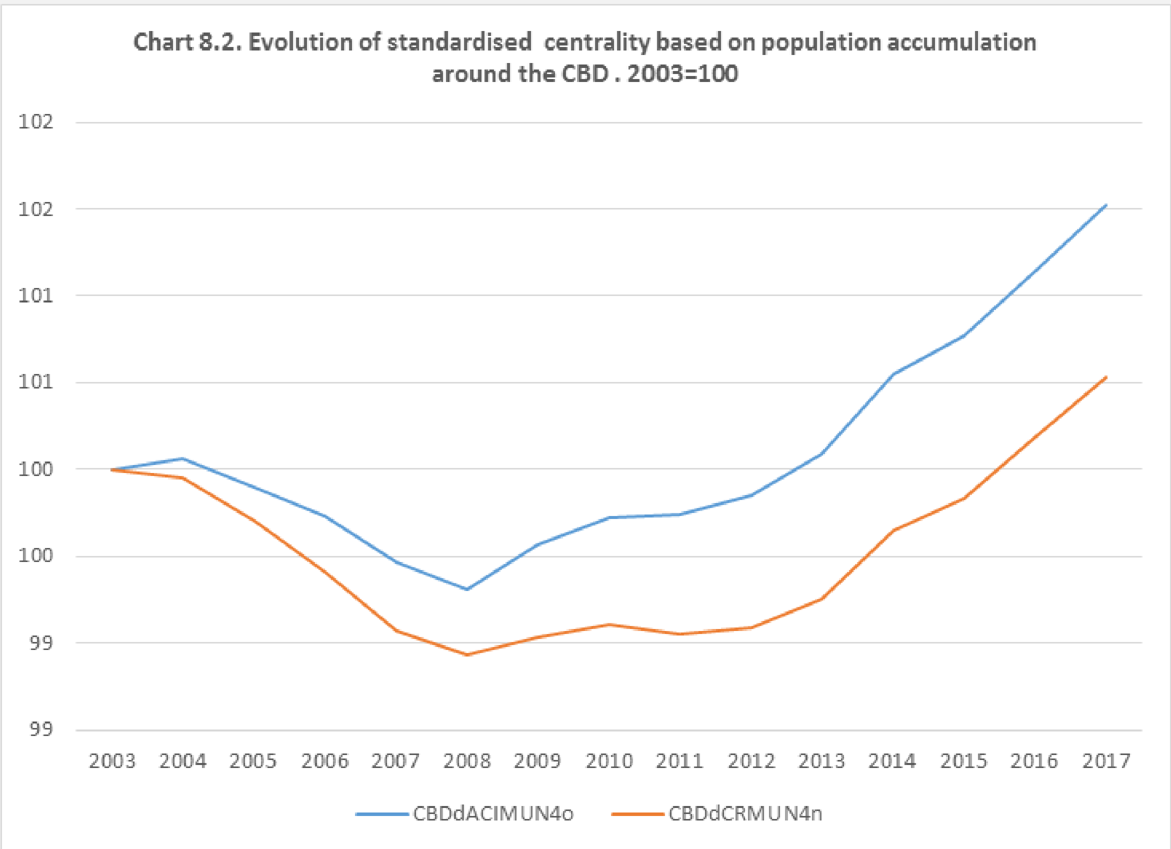
Source: Author’s own work based on Table 6.1. Base year = 2016.

Table 16. Regional rankings of standardised centrality indicators—Regions in decreasing order

	Singular entity-based indicators					
	Standardised					
	Normalised geographical centrality /Straight-line distance $CBDdN_{SE3j}$	Normalised geographical centrality /Travel distance $CBDdN_{SE3k}$	Normalised population centrality /Straight-line distance $CBDdN_{SE3l}$	Normalised population centrality /Travel distance $CBDd_{SE3m}$	Centralisation Ratio $CBDdCR_{MUN4n}$	Centralisation Index $CBDdACI_{MUN4o}$
ABOVE AVERAGE	Navarra	Navarra	Madrid	Madrid	Madrid	Madrid
	Asturias	Murcia	Aragón	Aragón	Cataluña	Cataluña
	Murcia	Illes Balears	Asturias	Asturias	Aragón	Cantabria
	Madrid	Madrid	País Vasco	Castilla y León	Cantabria	Asturias
		Asturias			La Rioja	Aragón
					Asturias	La Rioja
					Canarias	
BELOW AVERAGE	Illes Balears	C-La Mancha	Castilla y León	Cataluña	País Vasco	C.Valenciana
	País Vasco	Aragón	Cataluña	País Vasco	Castilla y León	País Vasco
	C-La Mancha	C. Valenciana	Cantabria	C. Valenciana	C. Valenciana	Castilla y León
	Aragón	País Vasco	Navarra	Cantabria	Andalucía	Andalucía
	Galicia	Galicia	La Rioja	Navarra	Murcia	Canarias
	C. Valenciana	Castilla y León	C. Valenciana	Illes Balears	Navarra	Murcia
	La Rioja	Extremadura	Andalucía	Andalucía	Galicia	Navarra
	Andalucía	Andalucía	Murcia	Murcia	C-La Mancha	Galicia
	Castilla y León	Cataluña	Illes Balears	La Rioja	Illes Balears	Illes Balears
	Cataluña	La Rioja	Galicia	C-La Mancha	Extremadura	C-La Mancha
	Extremadura	Canarias	C-La Mancha	Galicia		Extremadura
	Cantabria	Cantabria	Canarias	Extremadura		
	Canarias		Extremadura	Canarias		

Source: Author’s own work based on Table 15.





Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Some insights into centrality in Spain's regions

The analysis of the position that each Region registers regarding centrality indicators and the comparative analysis between indicators will provide some insights into centrality in Spain's regions. For the mentioned analysis, we will rely on Table 17 and Chart 9. We have built Table 17 based on the ranking position that each Region has for each centrality indicator, in decreasing order. A low number in Table 17 means high centrality. On the other hand, in Chart 9, we show the distribution of all the centrality indicators for each Region and its position in that distribution. The central box encloses what we will name "*central*" values of the said distribution. The bottom whisker goes from the minimum to the first quintile of the distribution, enclosing the values that account for 20% of the distribution in the bottom positions. Regions holding such low levels of centrality are flagged with a red dot. The upper whisker goes from the fourth quintile to the maximum, enclosing the values that account for 20% of the distribution in the upper positions. Regions holding these high levels of centrality are flagged with a green dot.

It is important to keep in mind that we have calculated centrality indicators for each province and then aggregated them to the regional level. Therefore, our analysis outlines the regional panorama, which subsumes the provincial realities at the same time that it may conceal significant provincial differences within a region.

We would highlight the following features regarding centrality in Spain's regions:

- **Andalucía** has low levels of absolute centrality. For relative centrality, the Region holds intermediate-low positions. Standardised centrality moves again to low positions.
- **Aragón** has a low level of absolute geographical centrality while population centrality is around the average (relative centrality is high). Thus, overall, the data show that there is a notable tendency of the population to reside in SE close to the province's CBD, while locations are distant. Standardised centrality moves to intermediate (geographical) and high (population) positions.
- **Asturias** presents intermediate to high levels of centrality for all indicators; with high positions in the ranking for standardised ones.

- **Illes Balears'** centrality indicators place the Region among the lowest levels, with the exception of normalised geographical centrality based on travel distances.[16]
- **Canarias'** centrality indicators place the Region among the lowest levels, except for the *Centralisation Ratio*. For this indicator, Canarias shows a level of centrality above the national average.
- **Cantabria** presents intermediate to high levels of centrality indicators except for normalised geographical centrality. It seems that in Cantabria the population has a notable tendency to settle in locations close to the CBD. However, a part of the population establishes in sufficiently distant places from the CBD to yield very low normalised geographical centrality.
- **Castilla y León** registers an intermediate level of centrality indicators. Geographical centrality indicators place the Region in lower positions than population centrality, showing that in this Region there is a mild tendency of the population to settle in locations that are close to the province's CBD. This pattern repeats itself when focusing specifically on standardised indicators, where the Region register intermediate to low level of centrality. Showing that, despite the population's tendency to settle in locations close to the province's CBD, a part of the population establishes in sufficiently distant places from the CBD to yield low normalised geographical centrality.
- **Castilla-La Mancha** registers low centrality in all indicators except for the normalised geographical centrality indicators, which place the Region in intermediate positions. This region's indicators would point to a remarkable tendency for the population to settle in distant places from the CBD. This tendency remains even when normalising by the provinces' extension.
- **Cataluña** registers high population centrality and intermediate-low geographical centrality, especially low for indicators referring to normalised geographical centrality. This region's indicators point to a remarkable tendency of the population to settle in places close to the province's CBD, though there is a part of the population in locations distant enough from the CDB to yield intermediate-low geographical centrality.
- **Comunidad Valenciana** presents intermediate levels of centrality for all the indicators with population centrality in lower positions than geographical centrality. This would

[16] Please refer to footnote 11.

point out that in this Region the population's tendency to reside in locations close to the province's CBD is weaker than the national average.

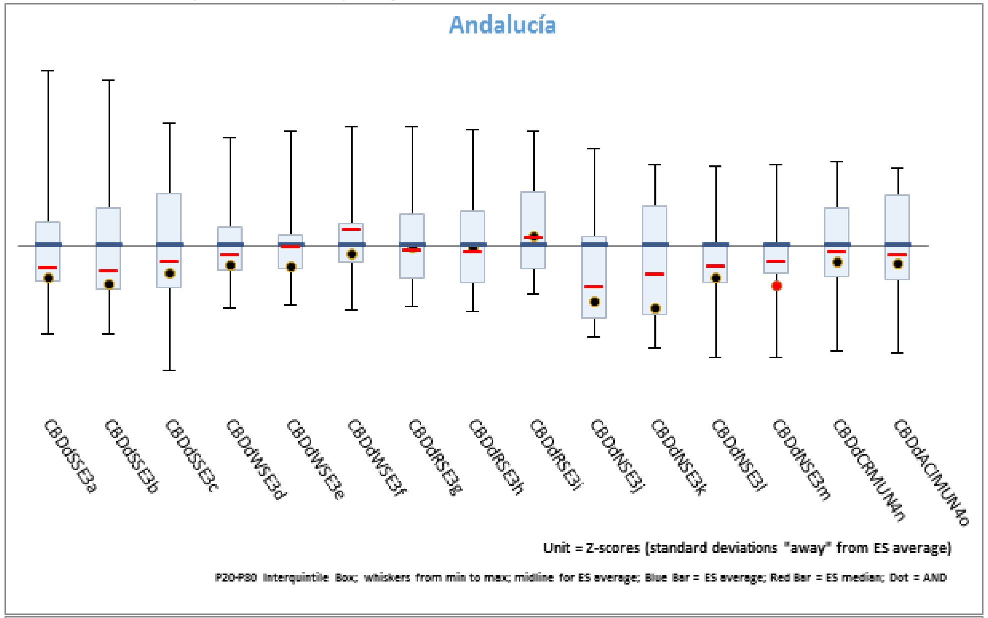
- **Extremadura's** centrality indicators place the Region among the lowest levels regardless of the way in which centrality is approached.
- **Galicia's** population centrality is low no matter the indicator considered to capture it. On the contrary, geographical centrality is intermediate-high (absolute centrality) or intermediate-low (standardised centrality). This would be pointing out that, in the Region, the population shows a weak tendency (weaker than in the country as a whole) to settle in places close to the province's CBD. In addition, although geographical centrality in absolute terms is above average, when normalising, it moves below it.
- **Madrid** registers high centrality regardless of the way in which centrality is approached.
- **Murcia** shows an intermediate-high geographical centrality and low population centrality. This region's indicators would point to a notable tendency of the population, greater than in the country as a whole, to settle in places farther away from the province's CBD.
- **Navarra** shows high geographical centrality and low population centrality. This region's indicators would point to a remarkable tendency of the population, greater than in the country as a whole, to settle in places farther away from the province's CBD.
- **País Vasco** registers high absolute centrality indicators and intermediate relative and standardised centrality indicators.
- **La Rioja** registers high levels of absolute centrality. Nonetheless, relative and standardised centrality register intermediate to low ones. Especially regarding normalised geographical centrality, pointing out the tendency of a part of the population to reside in places farther away from the province's CBD (once the size of the province is taken into account).

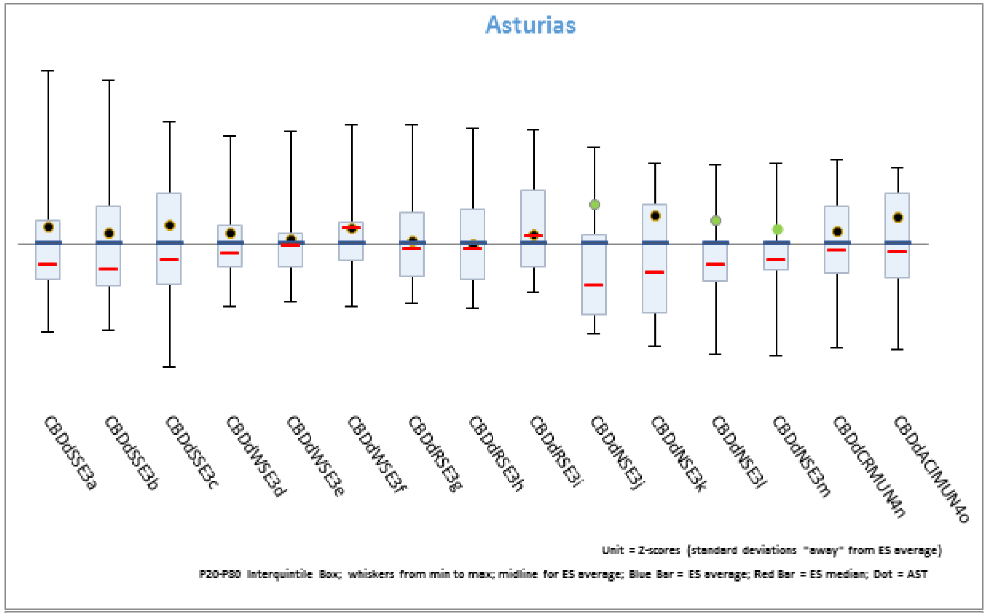
Table 17. Regional rankings of centrality indicators—Positions in decreasing order

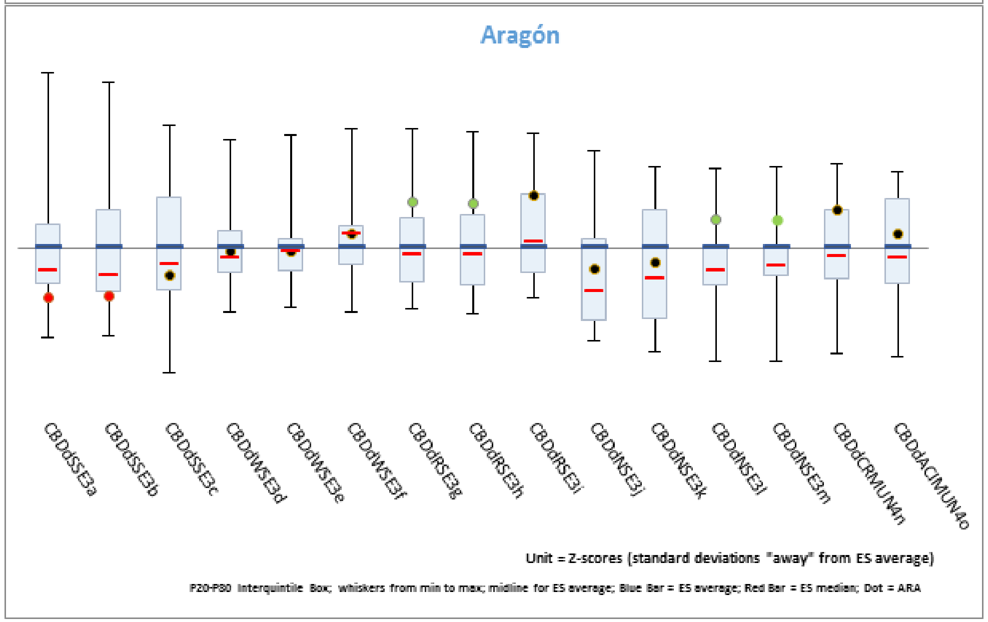
Regions	Centrality indicators based on distances from Singular Entities to the province's CBD plus Centralisation Ratio and CBD population share (DECREASING ORDER)														
	Absolute						Relative			Standardised					
	Inverse of the Simple average of straight-line distances (Km)	Inverse of the Simple average of travel distances (Km)	Inverse of the Simple average of travel durations (min)	Inverse of the Weighted average of straight-line distances (Km)	Inverse of the Weighted average of travel distances (Km)	Inverse of the Weighted average of travel durations (min)	Ratio population to geographical centrality /Straight-line distance	Ratio population to geographical centrality /Travel distance	Ratio population to geographical centrality /Travel duration	Normalised geographical centrality /Straight-line distance	Normalised geographical centrality /Travel distance	Normalised population centrality /Straight-line distance	Normalised population centrality /Travel distance	Centralisation Ratio	Centralisation Index
	$CBDdS_{SE3a}$	$CBDdS_{SE3b}$	$CBDdS_{SE3c}$	$CBDdW_{SE3d}$	$CBDdW_{SE3e}$	$CBDdW_{SE3f}$	$CBDdR_{SE3g}$	$CBDdR_{SE3h}$	$CBDdR_{SE3i}$	$CBDdN_{SE13}$	$CBDdN_{SE3k}$	$CBDdN_{SE3l}$	$CBDd_{SE3m}$	$CBDdCR_{MUN4n}$	$CBDdACI_{MUN4o}$
Andalucía	12	13	14	12	12	13	9	9	9	12	13	11	11	11	10
Aragón	14	14	13	8	9	9	2	2	3	8	7	2	2	3	5
Asturias	6	7	8	5	7	8	8	8	8	2	5	3	3	6	4
Illes Balears	15	15	16	15	15	16	14	14	15	5	3	13	10	16	15
Canarias	16	17	17	16	17	17	11	11	11	17	16	16	17	7	11
Cantabria	9	10	9	4	4	4	3	4	4	16	17	7	8	4	3
Castilla y León	11	9	10	7	6	5	5	5	5	13	11	5	4	9	9
C-La Mancha	13	12	11	14	14	14	15	15	14	7	6	15	14	15	16
Cataluña	10	11	12	6	5	6	4	3	2	14	14	6	5	2	2
C. Valenciana	8	8	6	9	8	7	10	10	10	10	8	10	7	10	7
Extremadura	17	16	15	17	16	15	13	12	12	15	12	17	16	17	17
Galicia	5	6	7	11	11	11	12	13	13	9	10	14	15	14	14
Madrid	4	3	3	2	1	1	1	1	1	4	4	1	1	1	1
Murcia	7	4	4	13	13	12	16	16	16	3	2	12	12	12	12
Navarra	2	2	2	10	10	10	17	17	17	1	1	8	9	13	13
País Vasco	1	1	1	1	2	2	6	7	7	6	9	4	6	8	8
La Rioja	3	5	5	3	3	3	7	6	6	11	15	9	13	5	6

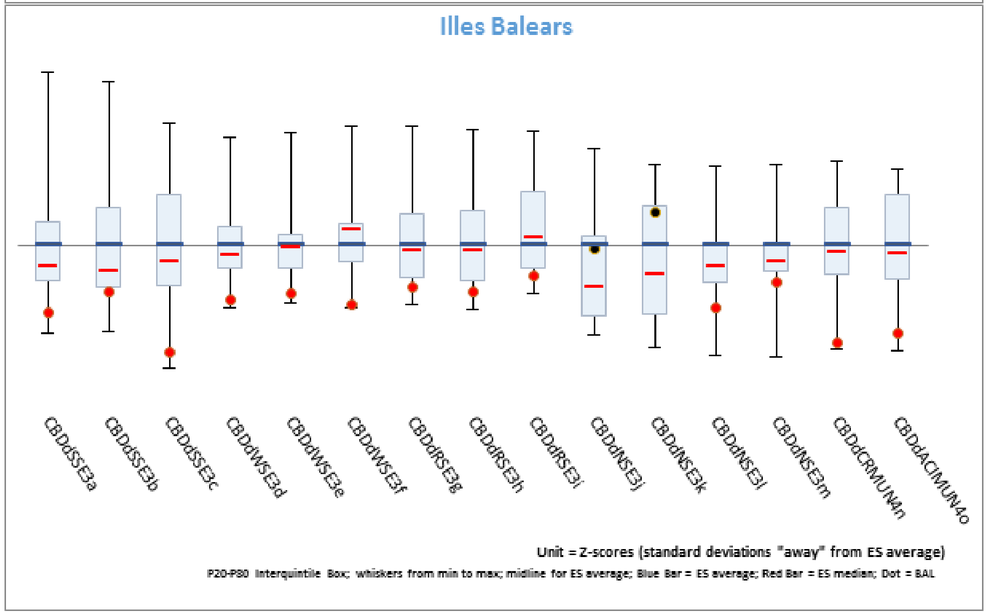
Source: Author's own work based on Tables 12, 14 and 16. Base year = 2016

Chart 9. Centrality indicators by Region 2016 (*It continues*)



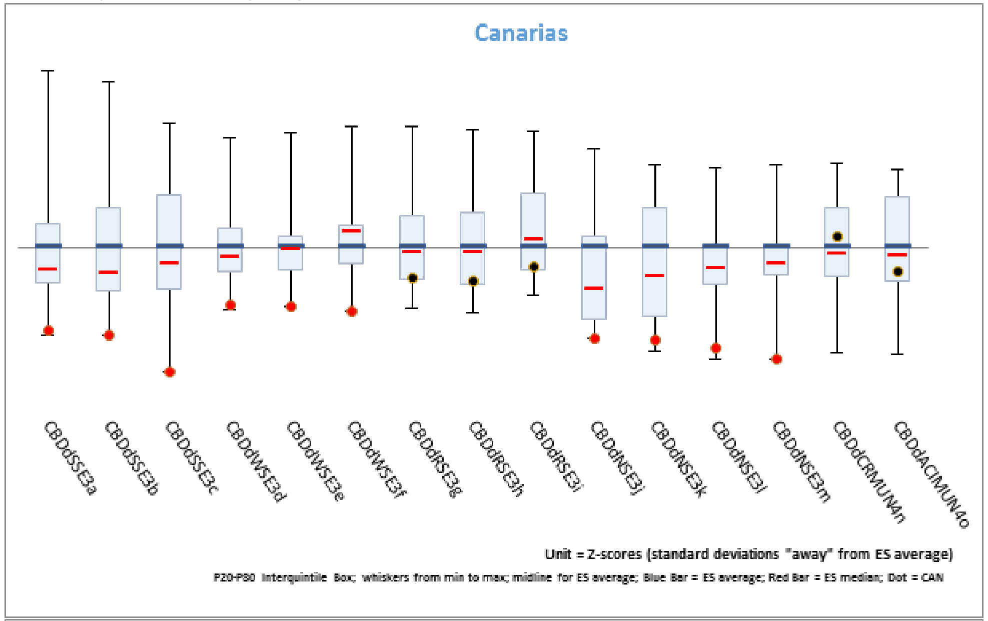


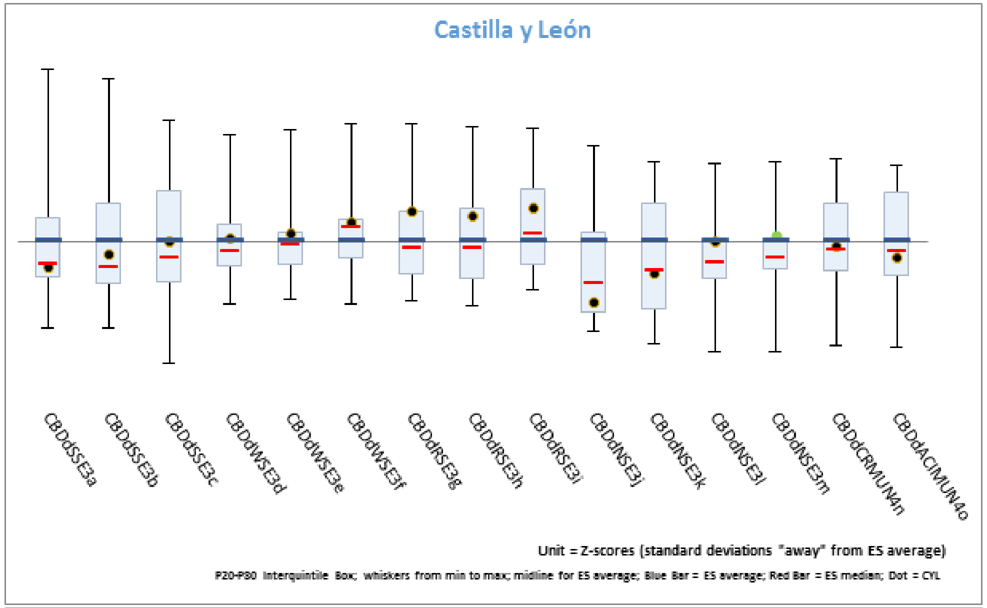


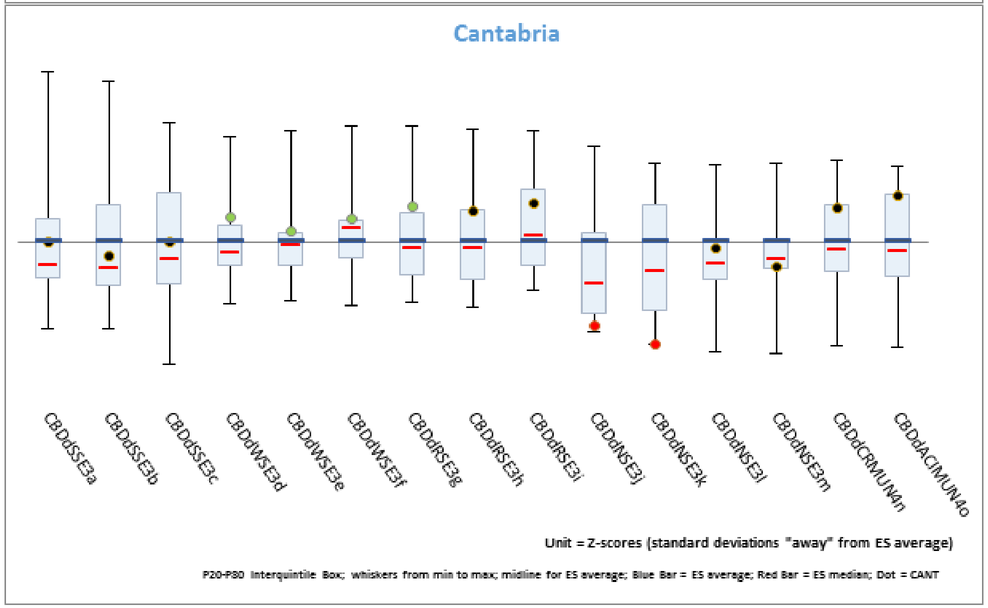


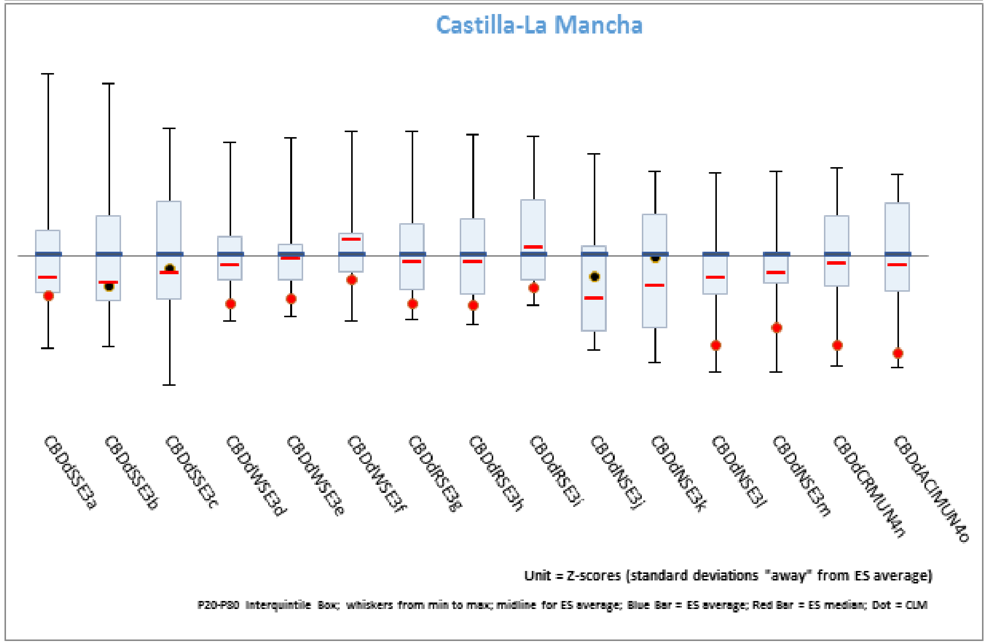
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Centrality indicators by Region 2016 *(It continues)*



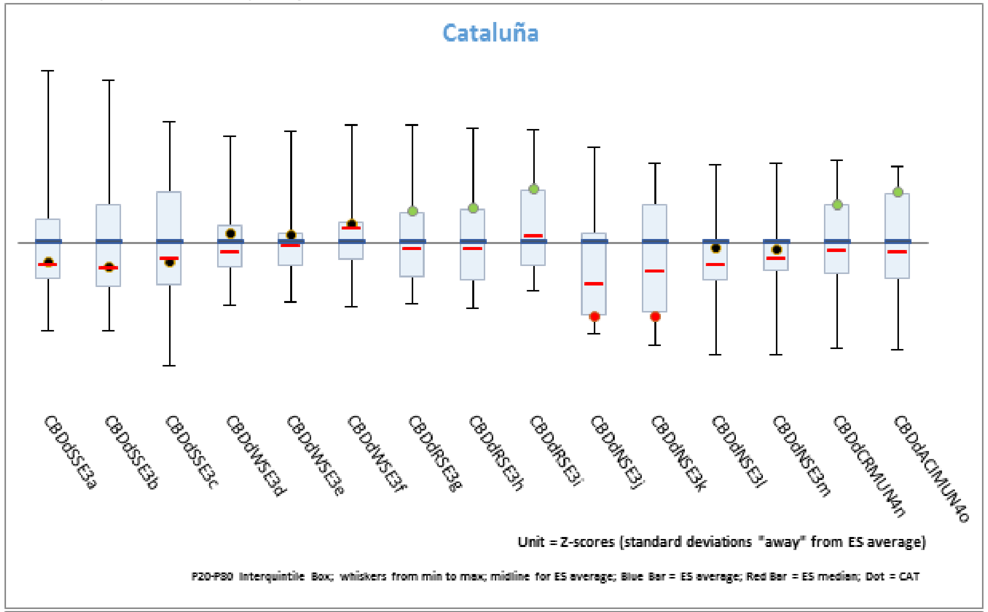


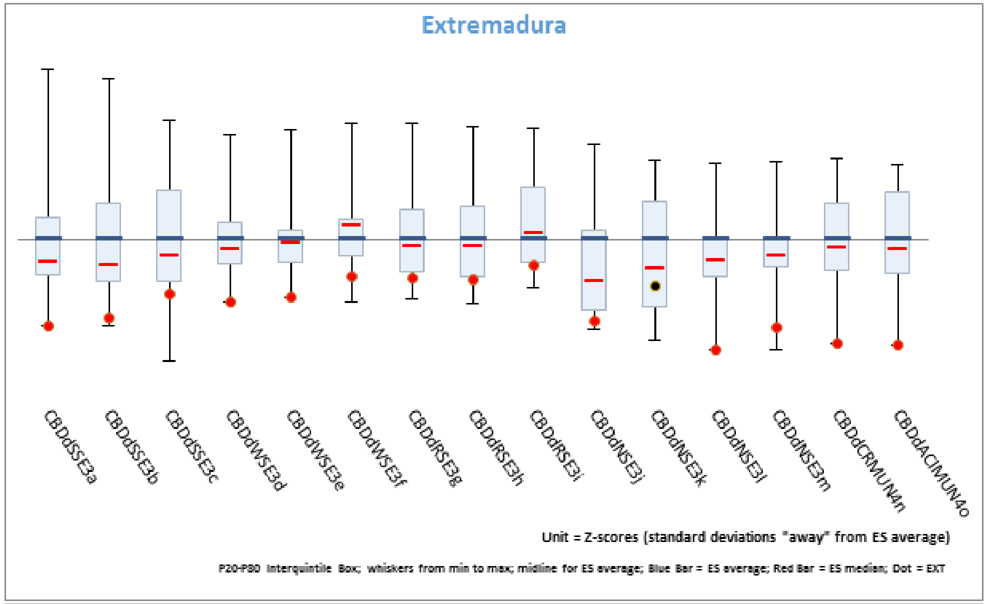


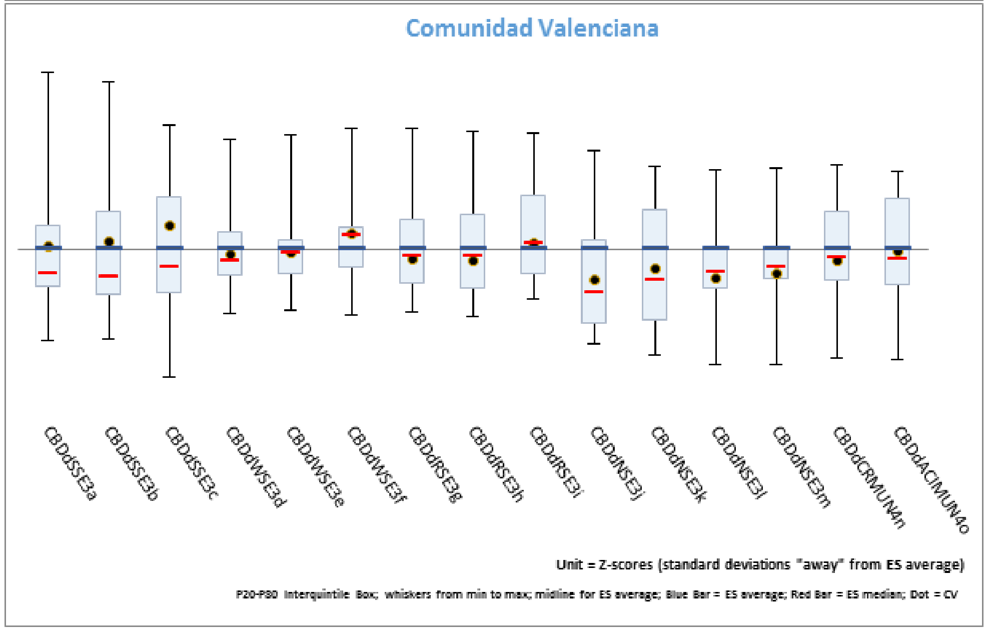


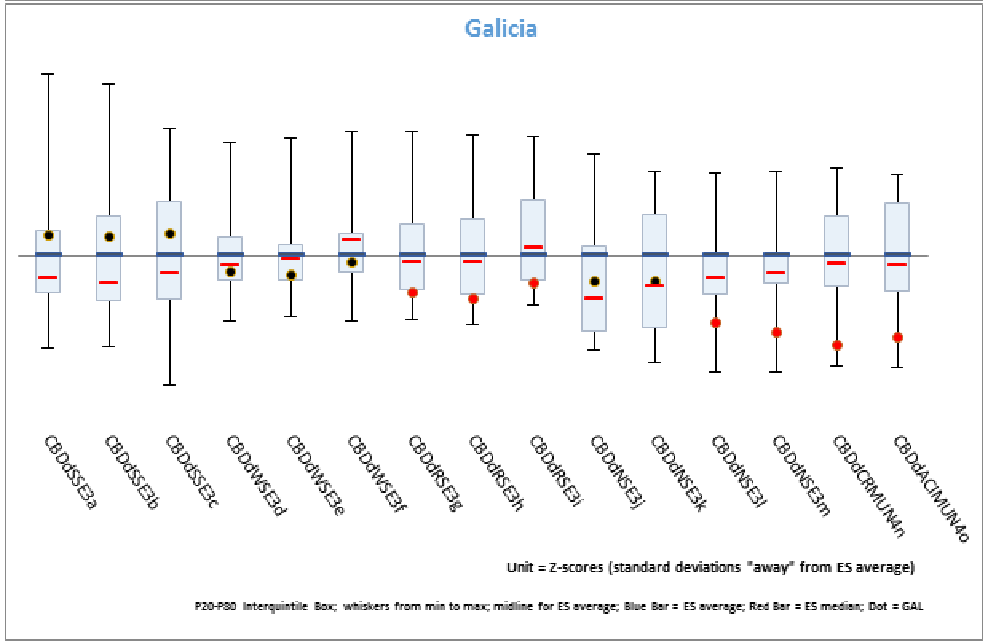
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Centrality indicators by Region 2016 *(It continues)*



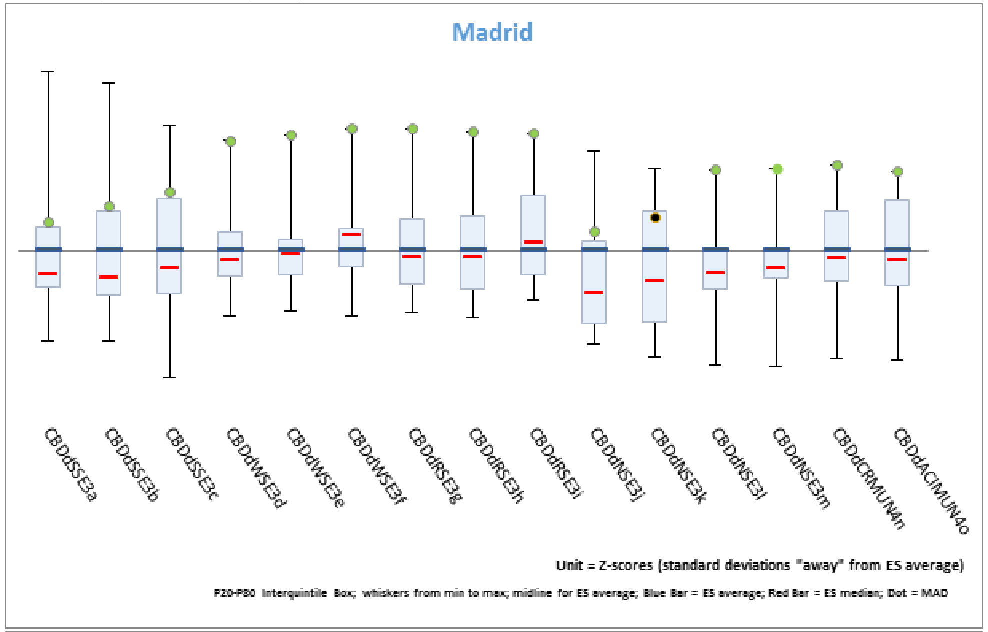


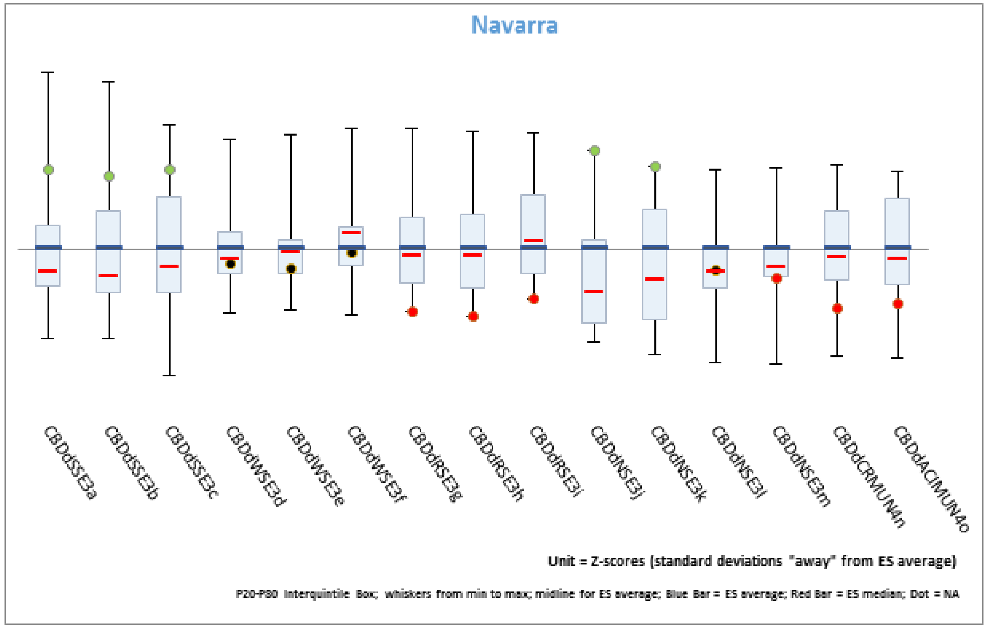


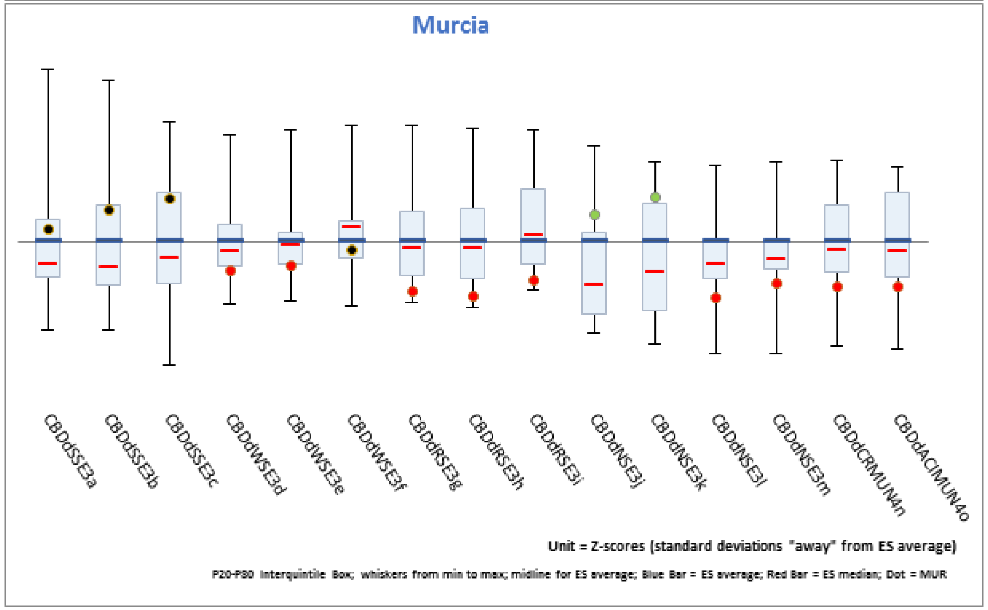


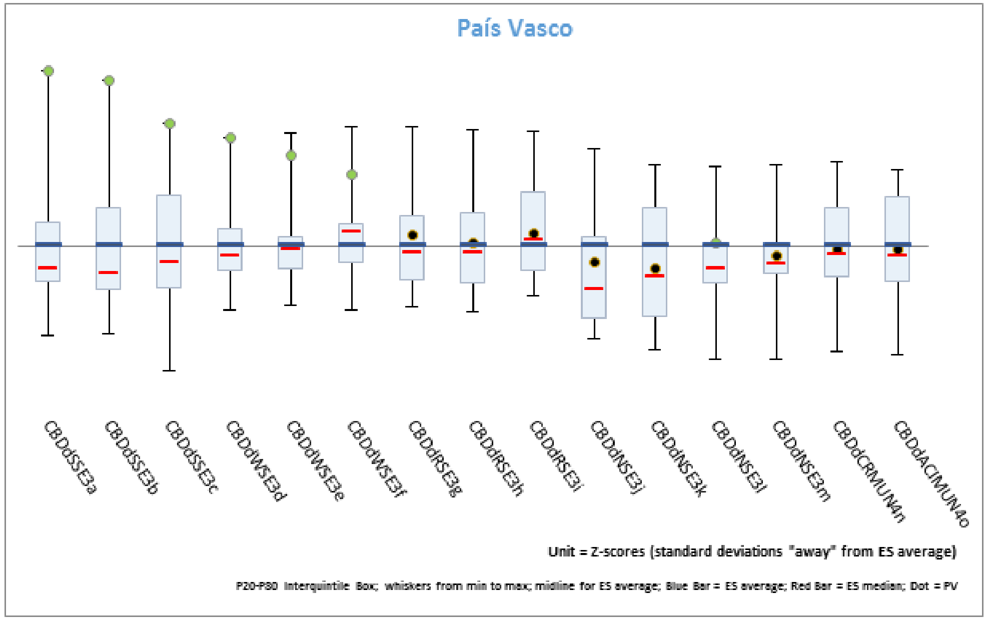
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Centrality indicators by Region 2016 *(It continues)*



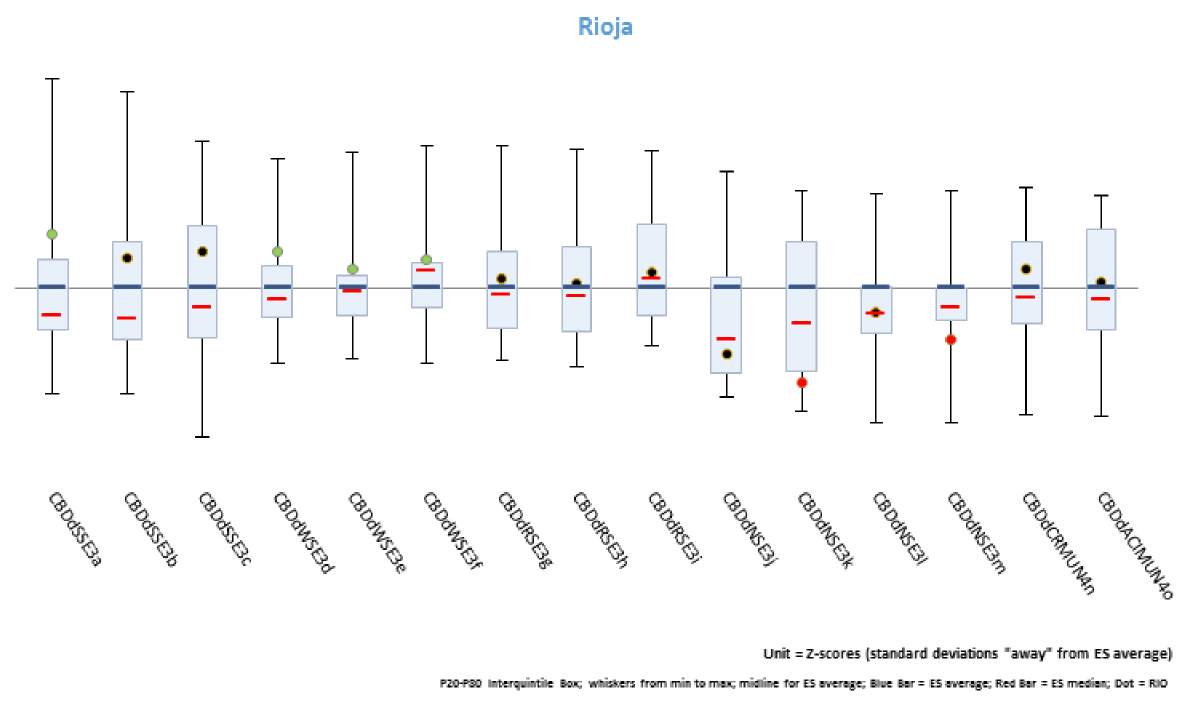






Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Centrality indicators by Region 2016 *(It concludes)*



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

In general, ***population centrality*** has increased over the period 2003-2017 at cumulative annual rates of around 0.03%, with the exceptions that we highlight next. For travel duration-based indicators, it has decreased at a cumulative annual rate of around -0.08%. The *Centralisation Ratio* and the *Centralisation Index* registered greater cumulative annual rates of increase, of 0.04% and 0.11% respectively (Table 18). From 2003 to 2008, it decreased at annual rates between -0.40% and -0.14. On the contrary, from 2008 to 2017, it increased at cumulative annual rates between 0.11% and 0.24%.

Table 18. Evolution of population centrality indicators at the national level 2003-2017

Centrality indicators		Δ Annual average 2008/2003 (%)	Δ Annual average 2017/2008 (%)	Δ Annual average 2017/2003 (%)
Inverse of the weighted average of the straight-line distances from SE to CBD (Km)	*$CBDdW_{SE3d}$*	-0.245	0.179	0.027
Inverse of the weighted average of the travel distances from SE to CBD (Km)	*$CBDdW_{SE3e}$*	-0.240	0.180	0.030
Inverse of the weighted average of the travel durations from SE to CBD (min)	*$CBDdW_{SE3f}$*	-0.403	0.105	-0.077
Ratio population centrality to geographical centrality based on straight-line distances of SE to CBD	*$CBDdR_{SE3g}$*	-0.245	0.179	0.027
Ratio population centrality to geographical centrality based on travel distances of SE to CBD	*$CBDdR_{SE3h}$*	-0.240	0.180	0.030
Ratio population centrality to geographical centrality based on travel durations of SE to CBD	*$CBDdR_{SE3i}$*	-0.403	0.105	-0.077
Normalised centrality - weighted average of the straight-line distances from SE to CBD (Km)	*$CBDdN_{SE3l}$*	-0.034	0.025	0.004
Normalised centrality - weighted average of the travel distances from SE to CBD (Km)	*$CBDdN_{SE3m}$*	-0.054	0.040	0.007
Centralisation Ratio	*$CBDdCR_{MUN4n}$*	-0.214	0.178	0.038
Centralisation Index	*$CBDdACI_{MUN4o}$*	-0.138	0.244	0.108

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Concerning the population centrality dynamic in Spain´s regions, when comparing their relative position to the national average in 2016, together with their time trend during the period 2008 to 2016 (Chart 6), we would highlight the following regional features:

- **Andalucía** has systematically below average levels of population centrality, except for relative centrality based on travel durations. In addition, centrality is evolving below the average rate of change, except when measured by the *Centralisation Index* or the *Centralisation Ratio,* for which it is slightly above average. The first dynamic pattern would trigger divergence from the national average. On the contrary, the *Centralisation Index* or the *Centralisation Ratio* point to a sluggish convergence towards the national average.
- **Aragón** has on average or above average levels of population centrality, and it is evolving above average. Thus, we would expect the Region to move towards higher positions in the ranking of centrality indicators.
- **Asturias** has systematically on average or above average levels of population centrality and it is evolving above average (except for the *Centralisation Index* that evolves below average). Thus, we would expect that the Region would move towards higher positions or remain stagnated (ACI).
- **Illes Balears** has systematically below average levels of population centrality regardless of the way in which it is measured. In addition, all related indicators show rates of change in 2008-2016 among the lowest within Spain's regions. These results show that the Region would be far from converging towards the national average.
- **Canarias** has systematically below average levels of population centrality, except for the *Centralisation Ratio*. In addition, all related indicators show below average rates of change in 2008-2016. These results show that the Region is far from converging towards the national average.
- **Cantabria** presents population centrality levels above the national average, except for population normalised indicators for which it is below average. On the other hand, population centrality is evolving below the national average or practically stagnated. These results show that the Region would be on a converging path towards the national average.

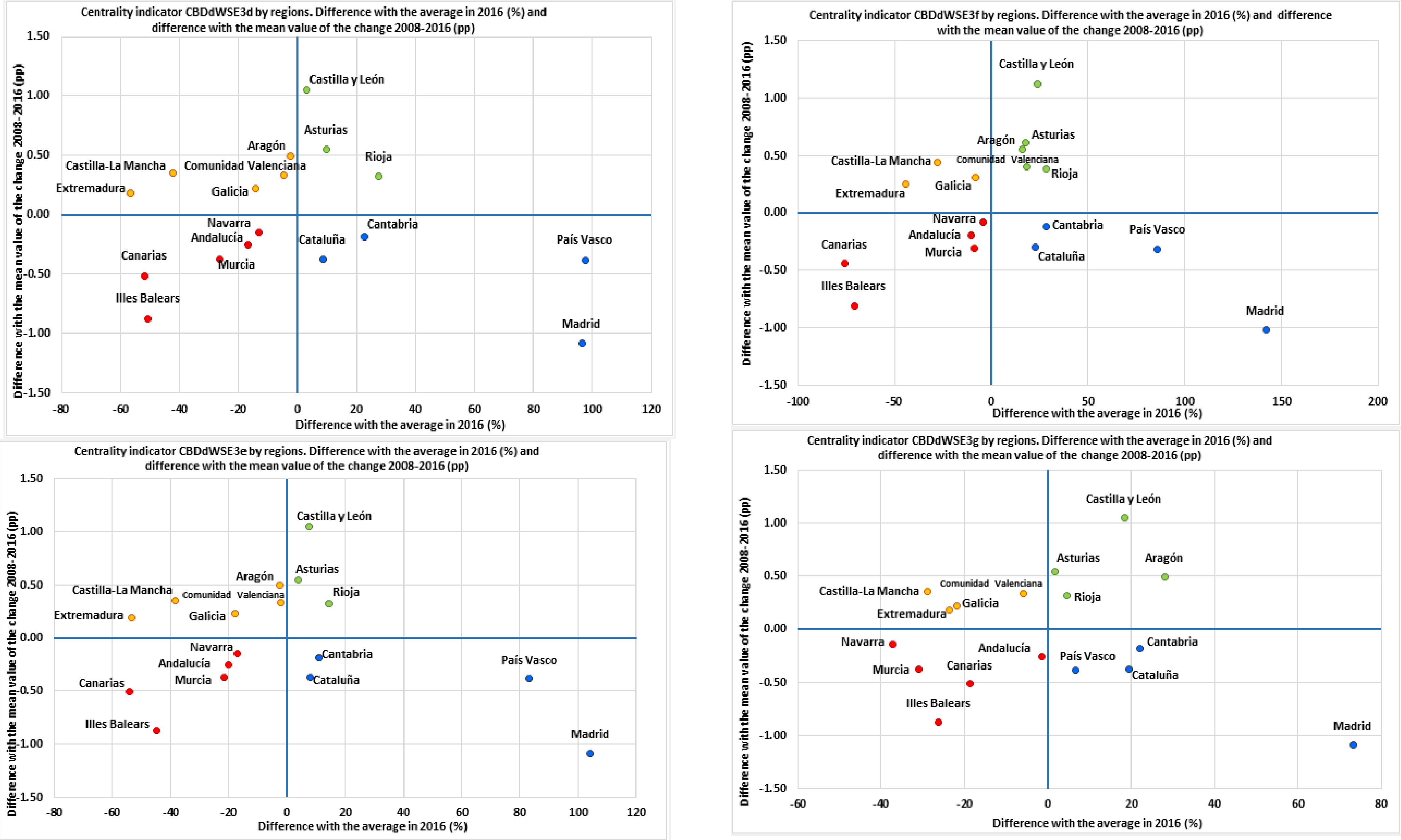
- **Castilla y León** presents population centrality levels at or above the national average, except for the *Centralisation Index* or the *Centralisation Ratio*. In addition, population centrality is evolving above the average. These results show that the Region would be on the path to move further above the average.
- **Castilla-La Mancha** presents population centrality levels below the national average, regardless of the way in which centrality is approached. Nonetheless, population centrality is evolving above average and well above it for the CR and the ACI. These results show that the Region would be converging towards the national average.
- **Cataluña** presents population centrality levels above the national average, except when standardising population centrality by the provinces' diagonal. All related indicators show rates of change at or below the average. This dynamic pattern would promote convergence towards the national average.
- **Comunidad Valenciana's** population centrality is typically below the national average (except for travel duration-based indicators) but evolving slightly above average. This dynamic pattern would promote a sluggish convergence towards the national average.
- **Extremadura's** population centrality is notably below the national average but evolving above average. This dynamic pattern would promote a sluggish convergence towards the national average.
- **Galicia's** population centrality is notably below the national average but evolving above average. This dynamic pattern would promote a sluggish convergence towards the national average.
- **Madrid's** population centrality is always above average, in the highest or among the highest positions for all the related indicators, especially for relative and standardised indicators. Nonetheless, it is evolving below average, leading the Region to a convergence towards the national average.
- **Murcia's** population centrality is typically below the national average. In addition, it is evolving below average. This dynamic pattern would promote a divergent path from the national average.
- **Navarra's** population centrality is typically below the national average and evolving slightly below average, except for the CR and the ACI, for which it is evolving well above average. This dynamic pattern would promote CR and ACI convergence towards the

national average while the rest of the population centrality indicators slightly move away from it.

- **País Vasco's** population centrality is typically above the national average, except for normalised population centrality based on travel distance, as well as for the CR and ACI. In all cases, population centrality is evolving below average. Absolute and relative indicators point to a converging path, while normalised indicators point to a divergent path.
- **La Rioja** presents population centrality levels above the national average, except when standardising by the province's diagonal. On the other hand, population centrality registers significant above average rates of change. These results indicate that the Region would be on the path to converge towards the national average or even scaling to top positions in the regional ranking.

Chart 10. The dynamic of population centrality

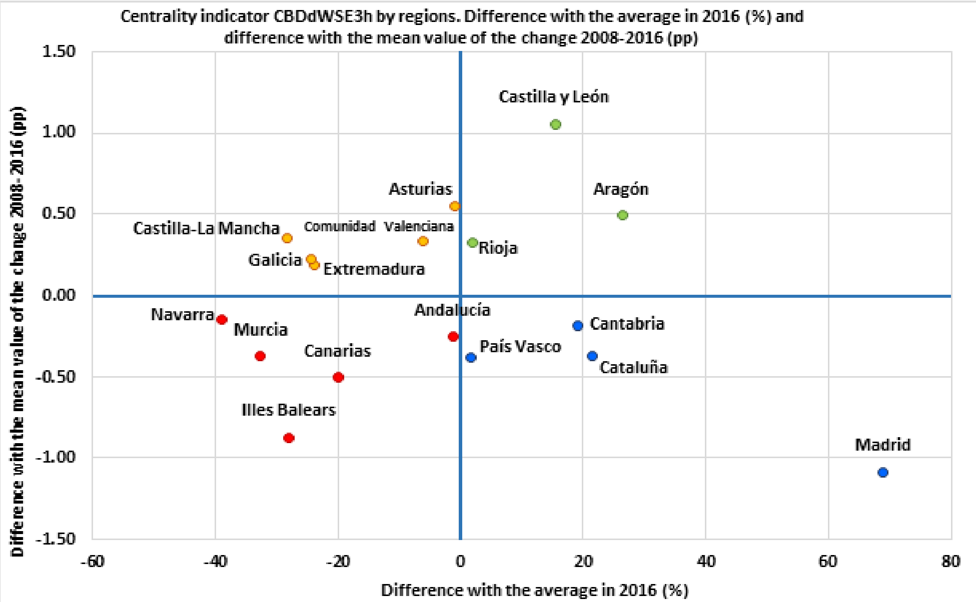
(It continues)

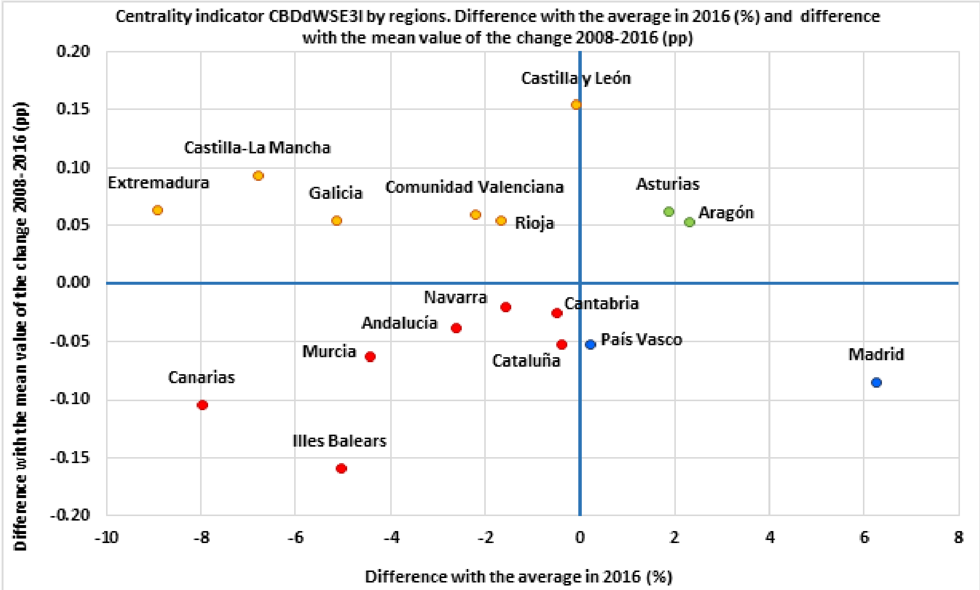


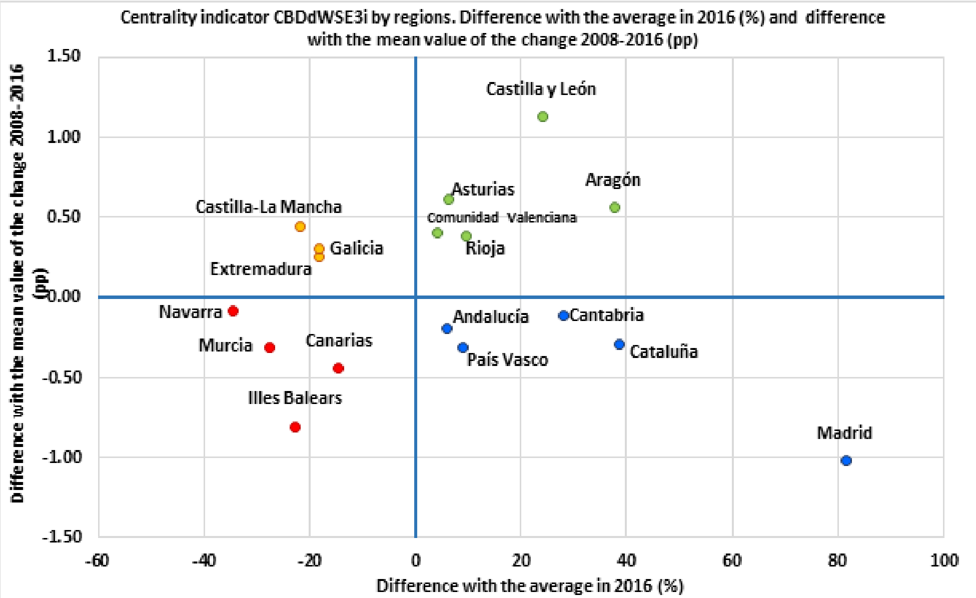
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

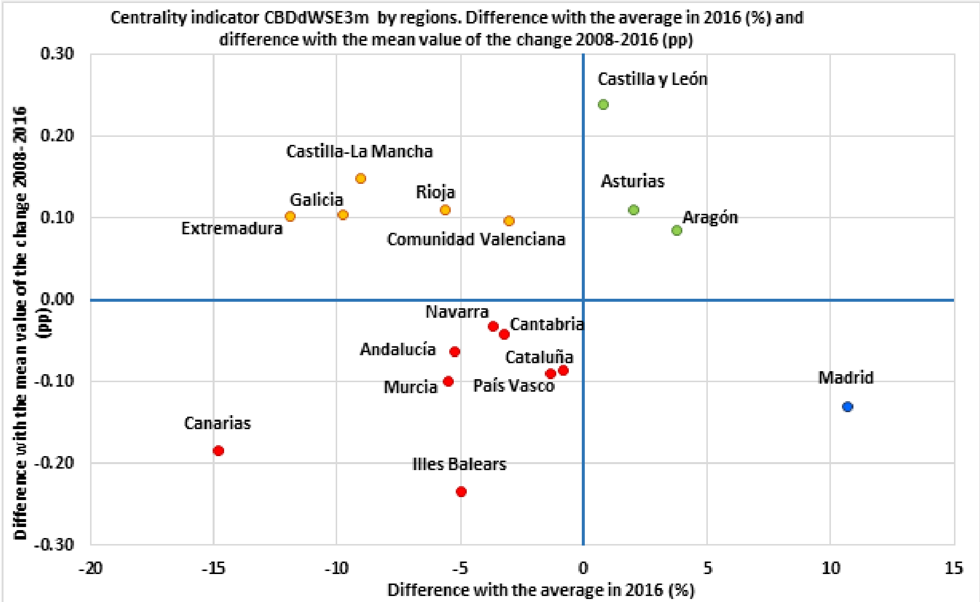
Chart 10. The dynamic of population centrality

(It continues)



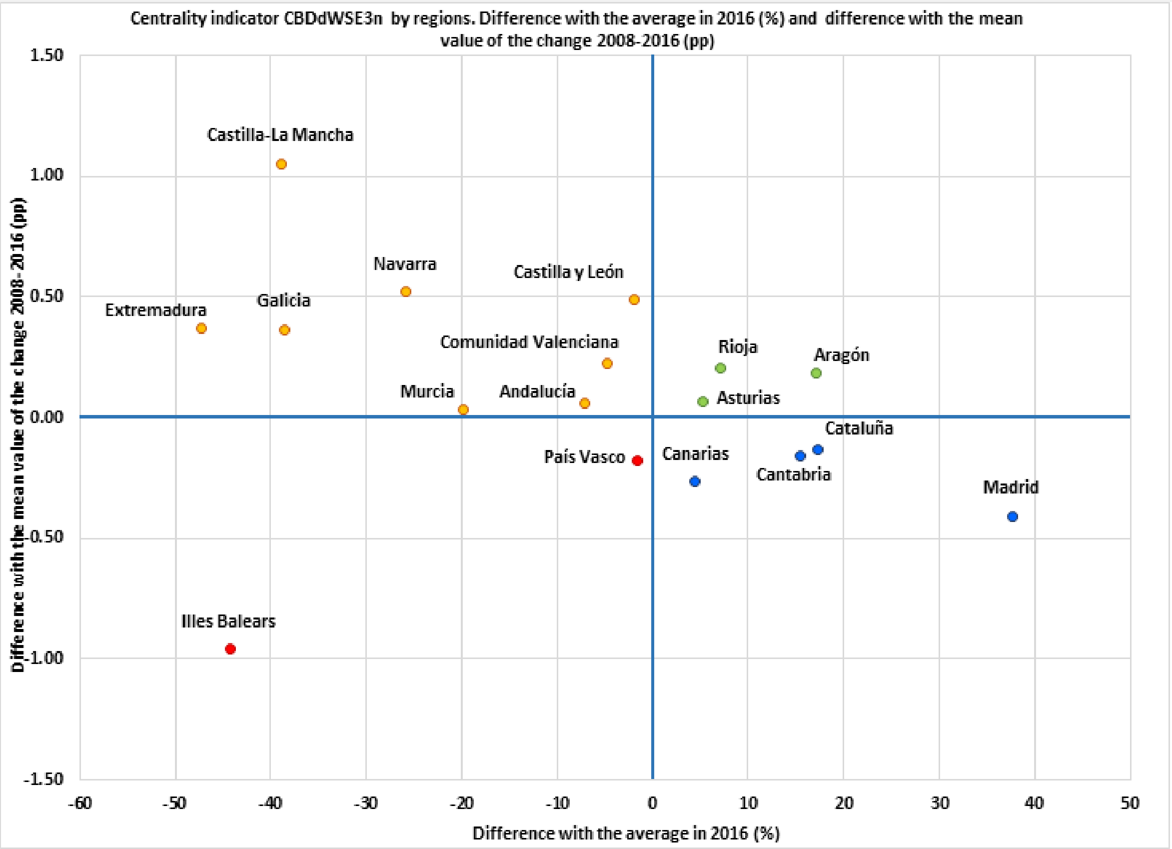


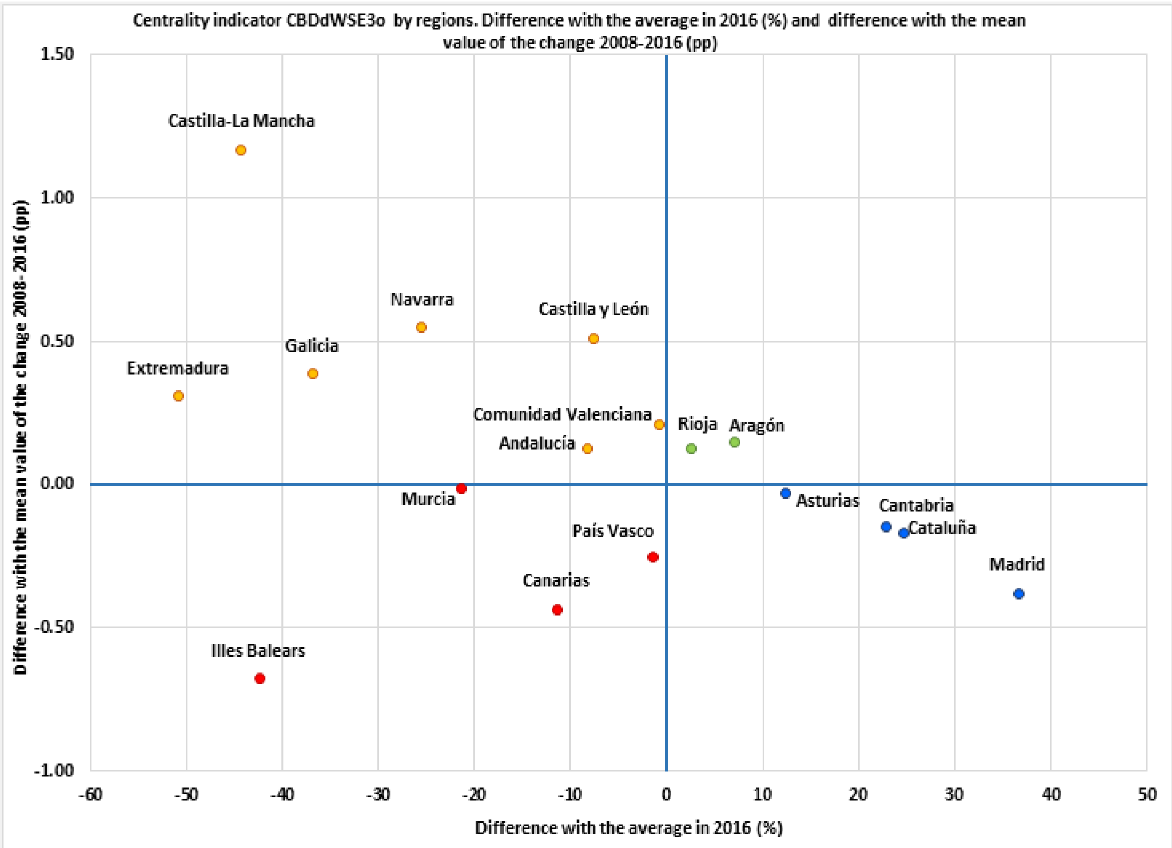




Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 10. The dynamic of population centrality (Conclusion)





Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Nuclearity

Nuclearity indicators

The set of indicators that we used captures nuclearity within province i through the degree of mononuclearity. The number of nuclei is a measure of the degree of polynuclearism. Nuclearity is maximised when the province has a mononuclear pattern of development: the CBD is the only nucleus. The higher the number of nuclei, the lower the nuclearity. Thus, we used the inverse of the number of nuclei to measure nuclearity, ensuring that low values of the indicator point to high rates of dispersion.

In addition, the percentage population in the CBD over the whole set of nuclei is a measure of mononuclearity; the lower the share of the CBD in the total population of nuclei (thus the lower the nuclearity), the higher the dispersion. Therefore, low values of the latest indicator point out high rates of dispersion (please refer to Blanco, A. et al. (2021)).

We worked with the following indicators:

- *Inverse of the number of nuclei per province SE-based (**$NUNoN_{SE5a}$**).*
- *Share of the population in the CBD over the population in nuclei SE-based (**$NUSoP_{SE5b}$**).*
- *Inverse of the number of nuclei per province MUN-based (**$NUNoN_{MUN6a}$**).*
- *Share of the population in the CBD over the population in nuclei MUN-based (**$NUSoP_{MUN6b}$**).*

In the same way as for the proximity and centrality indicators, as a general rule, we focused on SE-based indicators and present the associated MUN-based indicators in Annex I. Correlation between related SE and MUN-based nuclearity indicators ranges from 0.93 to 1.00 (Annex I. Table 0).

Nationwide, in 2016, the **inverse of the number of nuclei** per province is 0.0915 (Table 19), meaning that on average each Spanish province has 11 nuclei. The minimum value of this indicator is registered in Madrid (0.0189, meaning 53 nuclei in the province) and the maximum in Castilla y León (0.4470, meaning 2 nuclei in each province of the region), pointing out that in the provinces of Castilla y León there is the highest "*mononuclearity,*" while in Madrid there is the highest "*polinuclearity*." This indicator registers a significant variation among regions, with a CV of 118%.

Regarding the **share of the population in the CBD** over the population in nuclei within a province, nationwide, in 2016 its value is 0.44. Thus, on average, in each province 44% of the population living in nuclei resides in the CBD. The minimum value of this indicator is registered in Murcia and the maximum in Castilla y León, pointing out that in the provinces of Castilla y León there is the highest "*mononuclearity,*" while in Murcia there is the highest "*polinuclearity*." This indicator registers lower variability among regions than the previous one, with a CV of 39%, which is still high.

The regions whose nuclearity is systematically in top positions above the national average are Aragón, Castilla y León and La Rioja; and those with bottom positions are Andalucía, Cataluña, Comunidad Valenciana and Murcia (Table 20).

The distribution of both indicators among regions in Spain is quite positive asymmetric (Chart 11), meaning that most of the population in Spain resides in regions whose provinces register low levels of nuclearity.

As for the evolution from 2003 to 2017, our results show that nuclearity in Spain is decreasing. We have witnessed an increase in the number of nuclei per province at the same time that the share of the CBD's population over the whole set of nuclei has decreased (Chart 12). Nonetheless, the increase in the number of nuclei in each province is characterised by a decrease (or stagnation) in the average distance between nuclei, except in La Rioja (Annex I. Table 10). It seems that, typically, the population is moving to other nuclei different from the CBD, but still close to it and to the other nuclei.

Table 19.1. Nuclearity indicators by Region

Region	Singular entity-based indicators		
	Number of nuclei	Inverse of the number of nuclei	Share of the population in the CBD over the population in nuclei
	NUNoN$_{SE5a0}$	*NUNoN*$_{SE5a}$	*NUSoP*$_{SE5b}$
TOTAL	**673**	**0.0915**	**0.4397**
Andalucía	151	0.0535	0.3871
Aragón	13	0.2073	0.7988
Asturias	8	0.1250	0.3010
Illes Balears	18	0.0556	0.4756
Canarias	36	0.0567	0.4034
Cantabria	10	0.1000	0.4816
Castilla y León	22	0.4470	0.8000
Castilla-La Mancha	35	0.1720	0.4298
Cataluña	105	0.0367	0.3377
Comunidad Valenciana	101	0.0314	0.3301
Extremadura	13	0.1627	0.4578
Galicia	21	0.1949	0.4543
Madrid	53	0.0189	0.5368
Murcia	37	0.0270	0.1844
Navarra	10	0.1000	0.5692
País Vasco	36	0.1239	0.4796
La Rioja	4	0.2500	0.7494

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.
Note: Please note that we worked with the indicator "inverse of the number of nuclei per province." Therefore, the number of nuclei by Region is merely informative and its inverse is not the value of the indicator for that region. It has been calculated according to the formulations presented in Blanco, A. et al. (2021).

Table 19.2. Maximum and minimum values of nuclearity indicators (value and Region)

	Singular entity-based indicators	
	Inverse of the number of nuclei per province	Share of the population in the CBD over the population in nuclei
Max SE	0.4470	0.8000
Min SE	0.0189	0.1844
Max SE	Castilla y León	Castilla y León
Min SE	Madrid	Murcia

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 19.3. Inter-region variability of nuclearity indicators

	Singular entity-based indicators	
	Inverse of the number of nuclei per province	Share of the population in the CBD over the population in nuclei
Standard Deviation SE	0.1083	0.1711
CV SE	1.18	0.39

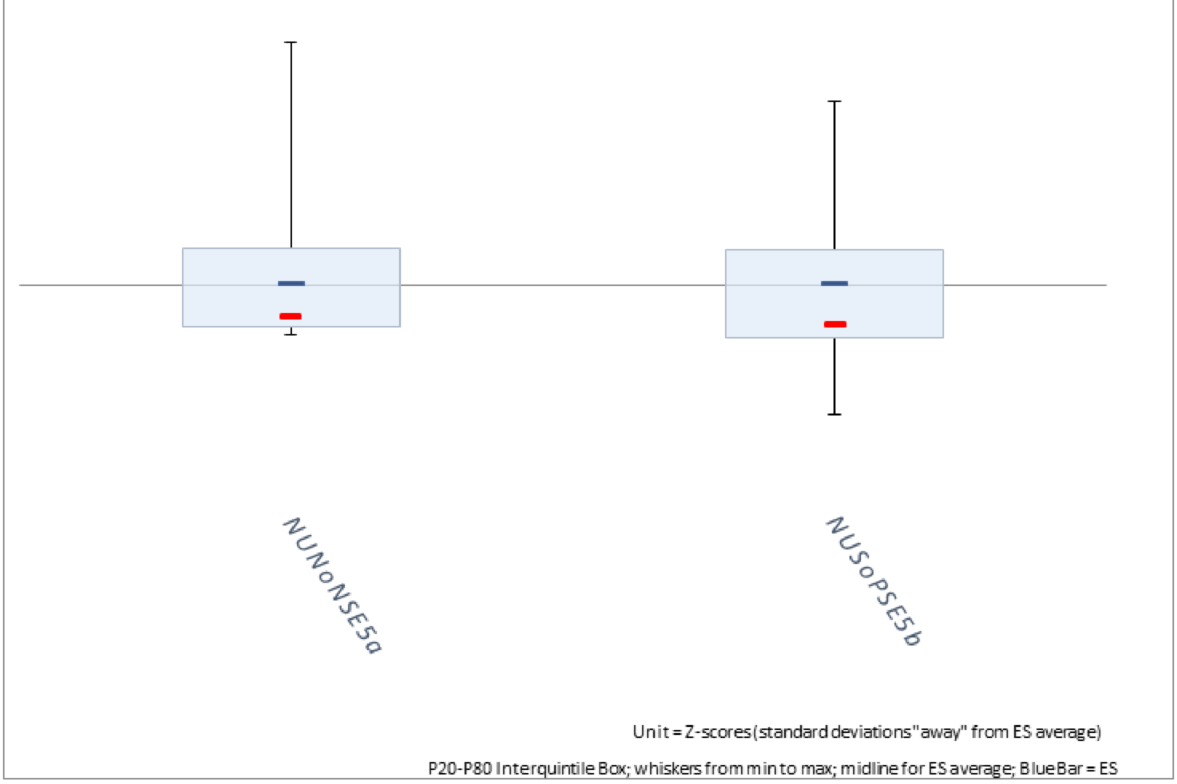
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 20. Regional rankings of nuclearity indicators—Regions in decreasing order

	Singular entity-based indicators	
	Inverse of the number of nuclei	Share of the population in the CBD over the population in nuclei
	$NUNoN_{SE5a}$	$NUSoP_{SE5b}$
ABOVE AVERAGE	Castilla y León	Castilla y León
	La Rioja	Aragón
	Aragón	La Rioja
	Galicia	Navarra
	Castilla-La Mancha	Madrid
	Extremadura	Cantabria
	Asturias	País Vasco
	País Vasco	Illes Balears
	Cantabria	Extremadura
	Navarra	Galicia
BELOW AVERAGE	Canarias	Castilla-La Mancha
	Illes Balears	Canarias
	Andalucía	Andalucía
	Cataluña	Cataluña
	Comunidad Valenciana	Comunidad Valenciana
	Murcia	Asturias
	Madrid	Murcia

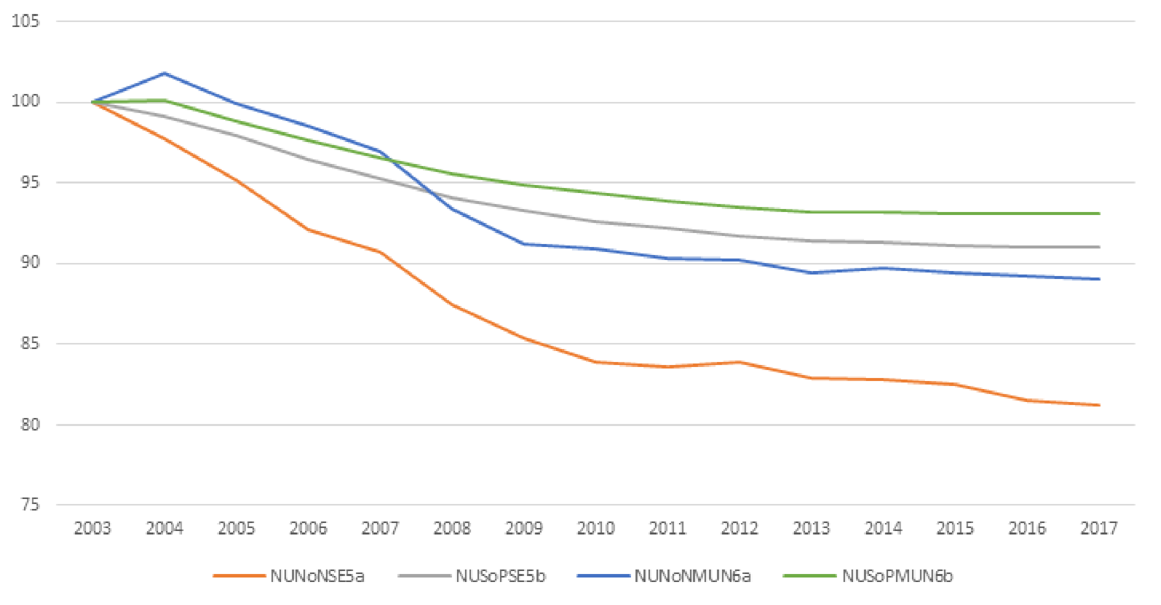
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 11. Spain (ES): Across-region distribution of nuclearity indicators 2016



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 12. Evolution of nuclearity 2003-2017 in Spain



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Some insights into nuclearity in Spain's regions

The analysis of the position that each Region registers regarding nuclearity indicators, and the comparative analysis between indicators, will provide some insights into nuclearity in Spain's regions. For the mentioned analysis, we will rely on Table 21 and Chart 13. We have built Table 21 based on the ranking position that each Region has for each nuclearity indicator, in decreasing order. A low number in Table 21 means high nuclearity. On the other hand, in Chart 13, we show the distribution of the two nuclearity indicators for each Region and its position in that distribution. The central box encloses what we will name "*central*" values of the said distribution. The bottom whisker goes from the minimum to the first quintile of the distribution, enclosing the values that account for 20% of the distribution in the bottom positions. Regions holding such low levels of nuclearity are flagged with a red dot. The upper whisker goes from the fourth quintile to the maximum, enclosing the values that account for 20% of the distribution in the upper positions. Regions holding these high levels of nuclearity are flagged with a green dot.

It is important to keep in mind that we have calculated nuclearity indicators for each province and then aggregated them to the regional level. Therefore, our analysis outlines the regional panorama, which subsumes the provincial realities at the same time that it may conceal significant provincial differences within a region.

We would highlight the following features regarding nuclearity in Spain's regions:

- **Andalucía** has low levels of nuclearity, regardless of the indicator that is used.
- **Aragón** has high levels of nuclearity, regardless of the indicator that is used.
- **Asturias** presents an intermediate level of nuclearity in terms of number of nuclei, but a low level when measured through the share of the population in the CBD over the population in nuclei. The number of nuclei is moderate but the population is more spread among the nuclei than the national average.
- **Illes Balears** shows intermediate, below average, levels of nuclearity for both indicators.
- **Canarias** shows intermediate, below average, levels of nuclearity for both indicators.
- **Cantabria** shows intermediate, above average, levels of nuclearity for both indicators.
- **Castilla y León** has the highest levels of nuclearity, regardless of the indicator that is used.
- **Castilla-La Mancha** has a high level of nuclearity regarding the number of nuclei and an intermediate one (on average) for the share of the population in the CBD over the

population in nuclei. The number of nuclei is low but the population is as spread among the nuclei as the average.

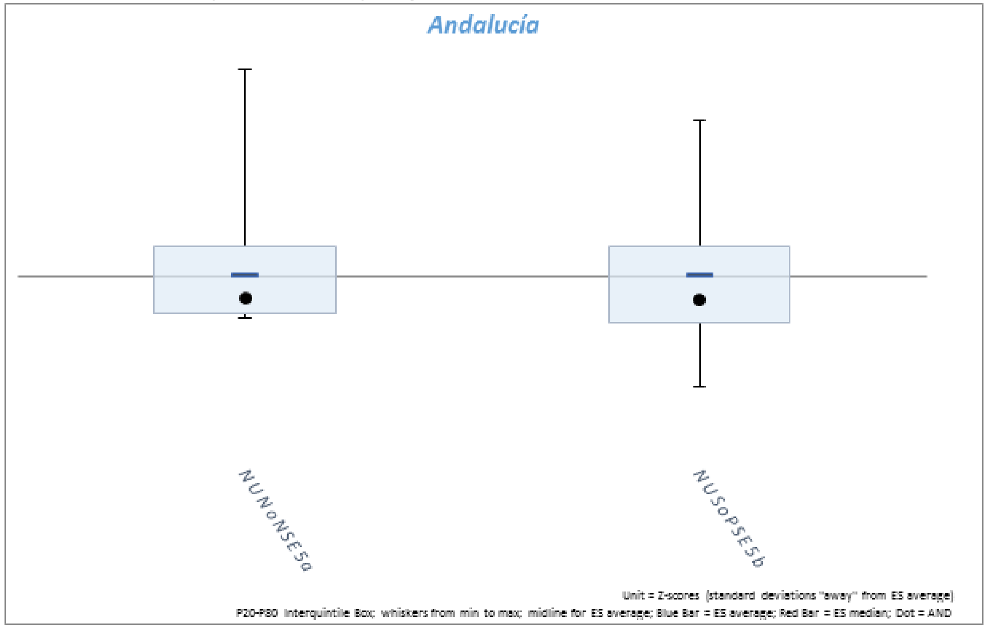
- **Cataluña** has intermediate-low levels of nuclearity, regardless of the indicator that is used.
- **Comunidad Valenciana** has intermediate-low levels of nuclearity, regardless of the indicator that is used.
- **Extremadura** has intermediate-high levels, above the national average, of nuclearity, especially when measured through the number of nuclei. The number of nuclei in Extremadura's provinces is low, but the share of the population in the CBD over the population in nuclei is around the national average of 44%.
- **Galicia** presents a high level of nuclearity in terms of number of nuclei, but an intermediate level when measured through the share of the population in the CBD over the population in nuclei. The number of nuclei is low but the population is more spread among the nuclei than the national average.
- **Madrid** presents the lowest level of nuclearity in terms of number of nuclei, but a high one when measured through the share of the population in the CBD over the population in nuclei. The number of nuclei in Madrid is the highest in Spain's provinces but the population in nuclei is highly concentrated in the CBD.
- **Murcia** has the lowest or among the lowest levels of nuclearity, regardless of the indicator that is used.
- **Navarra** has intermediate and high levels of nuclearity. The number of nuclei is average but the population in nuclei is highly concentrated in the CBD.
- **País Vasco** has intermediate, above the national average, levels of nuclearity, regardless of the indicator that is used.
- **La Rioja** has high levels of nuclearity, regardless of the indicator that is used.

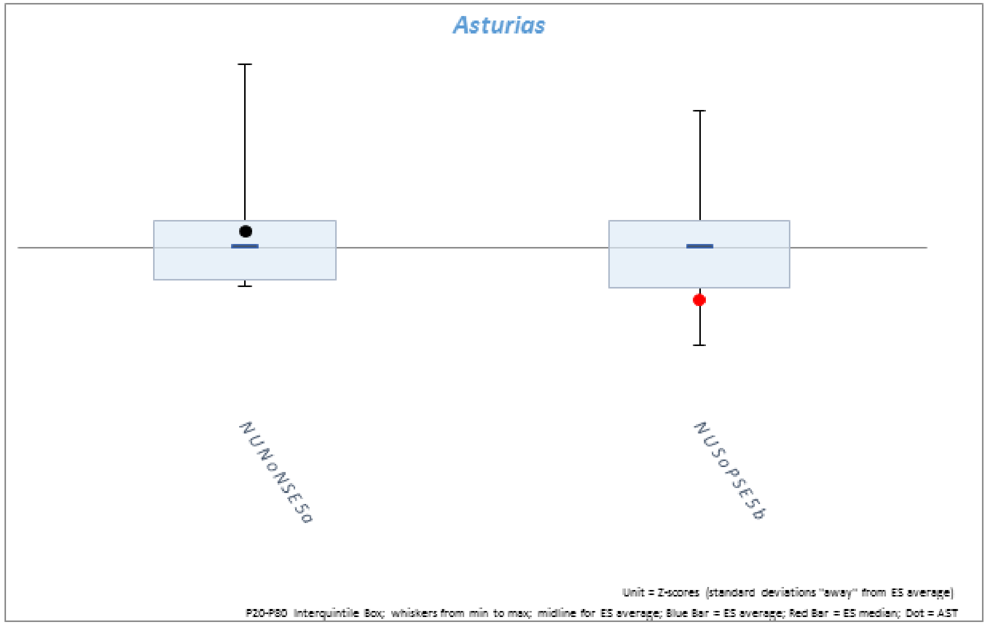
Table 21. Regional rankings of nuclearity indicators—Positions in decreasing order

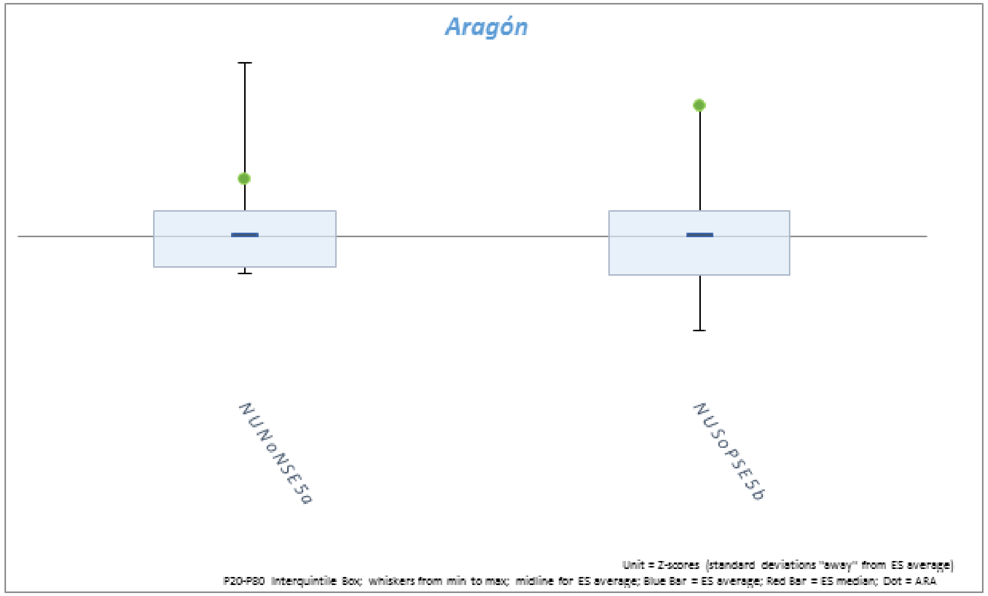
Region	Singular entity-based indicators	
	Inverse of the number of nuclei	Share of the population in the CBD over the population in nuclei
	$NUNoN_{SE5a}$	$NUSoP_{SE5b}$
Andalucía	13	13
Aragón	3	2
Asturias	7	16
Illes Balears	12	8
Canarias	11	12
Cantabria	9	6
Castilla y León	1	1
Castilla-La Mancha	5	11
Cataluña	14	14
Comunidad Valenciana	15	15
Extremadura	6	9
Galicia	4	10
Madrid	17	5
Murcia	16	17
Navarra	10	4
País Vasco	8	7
La Rioja	2	3

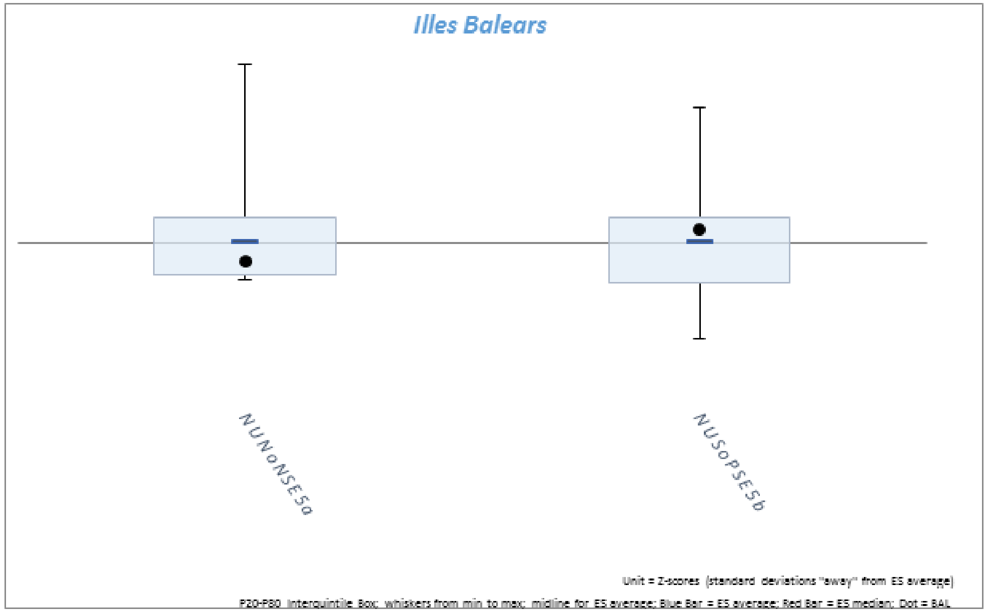
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 13. Nuclearity indicators by Region 2016 (*It continues*)



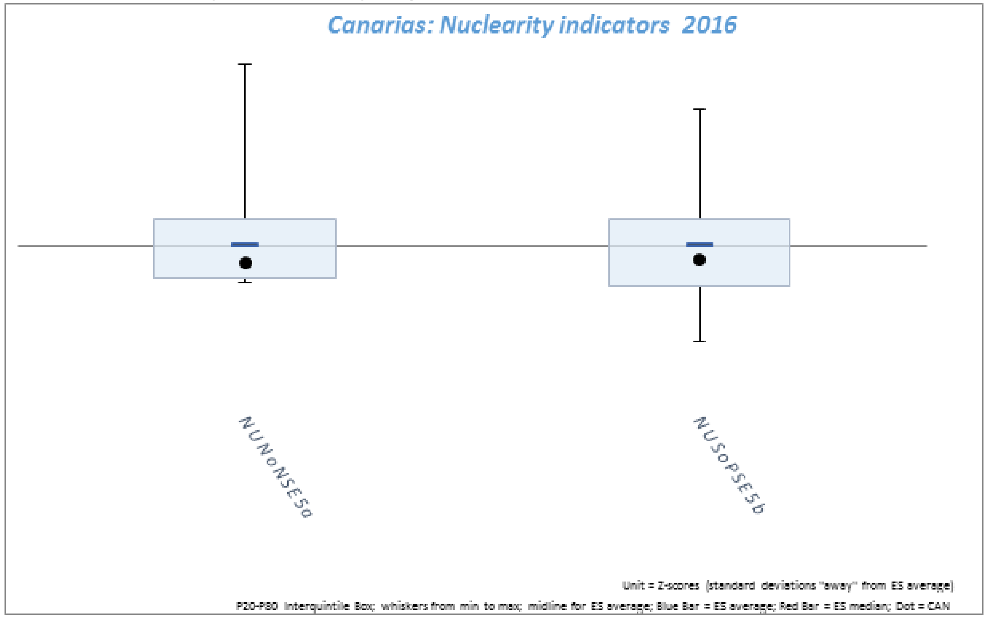


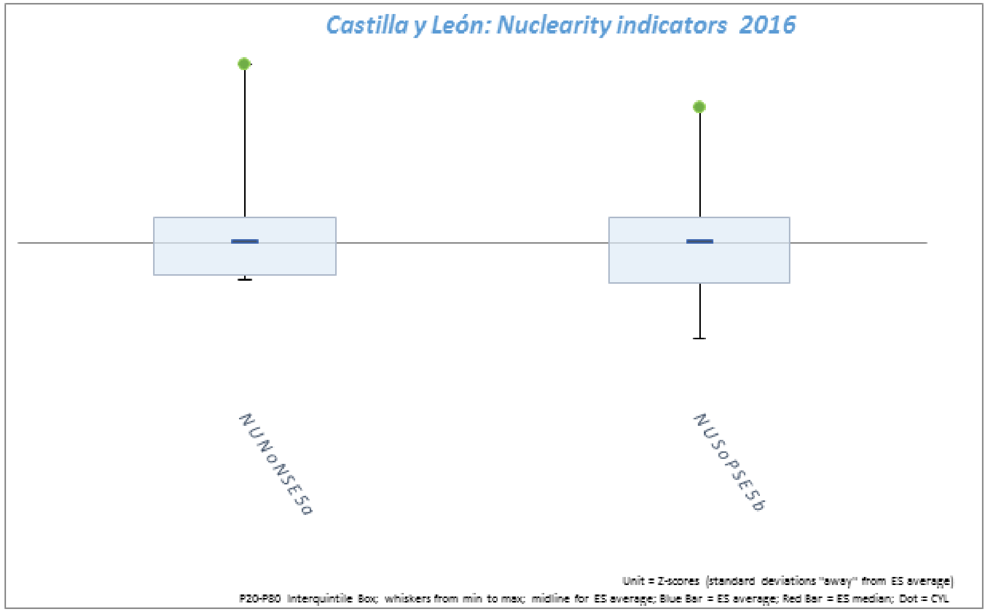


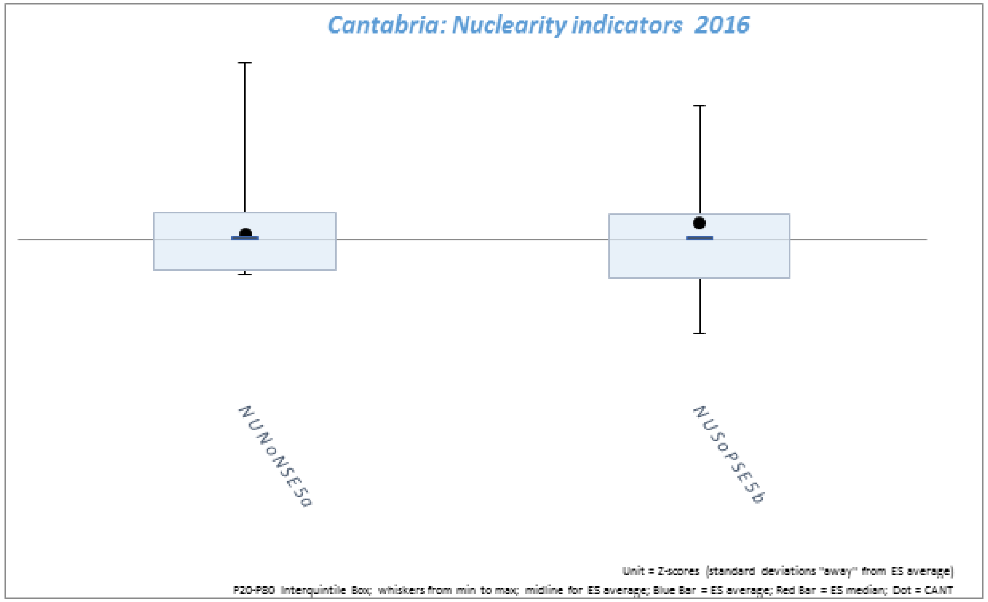


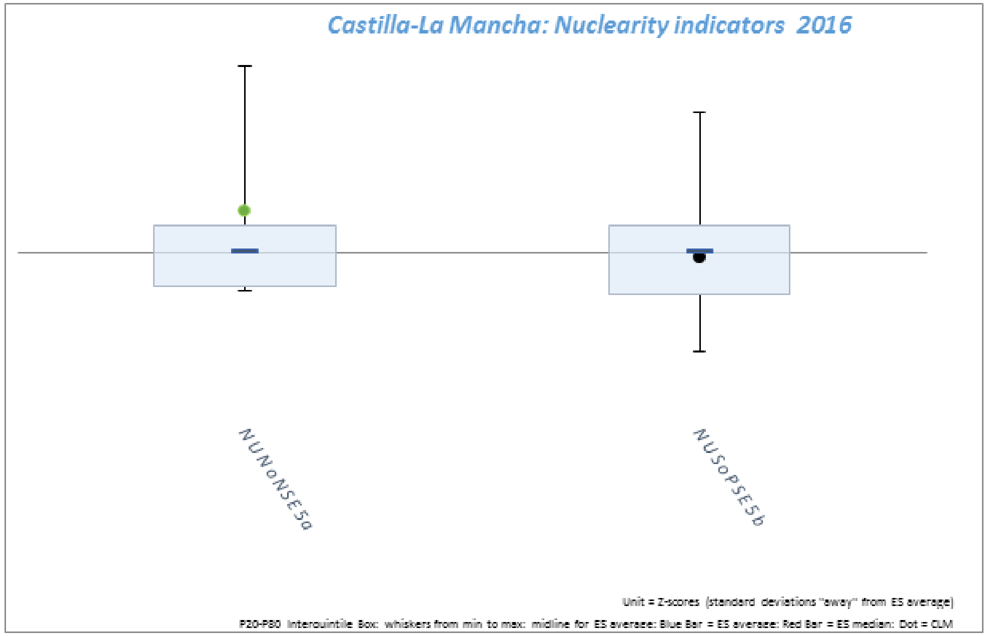
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 13. Nuclearity indicators by Region 2016 *(It continues)*



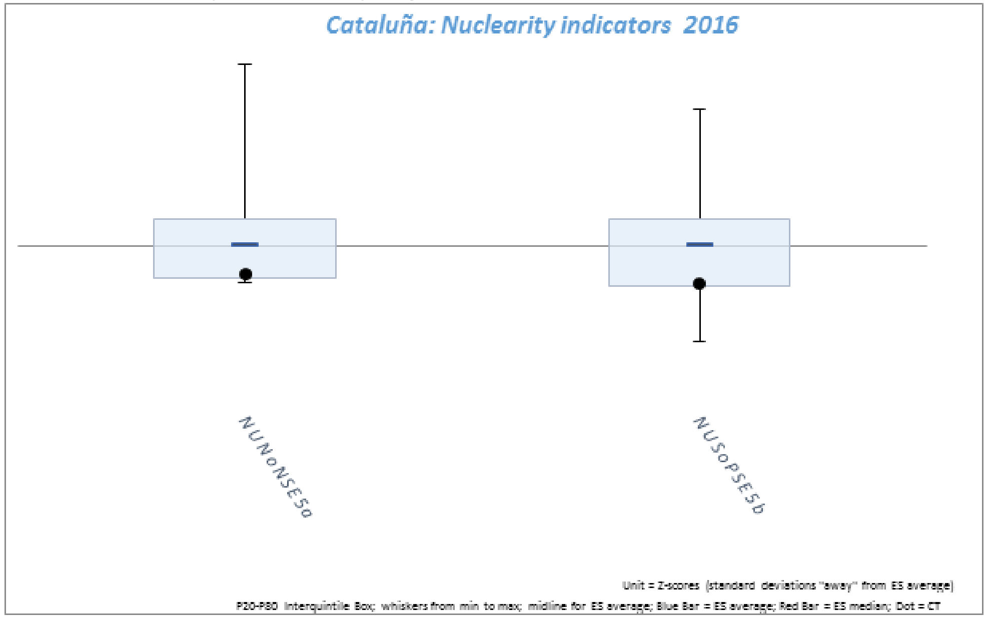


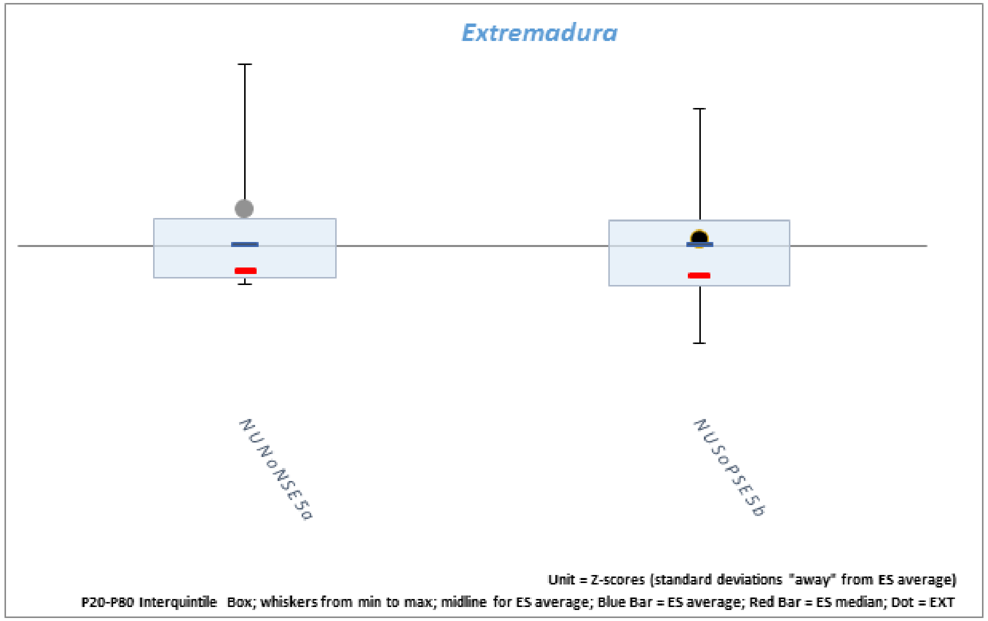


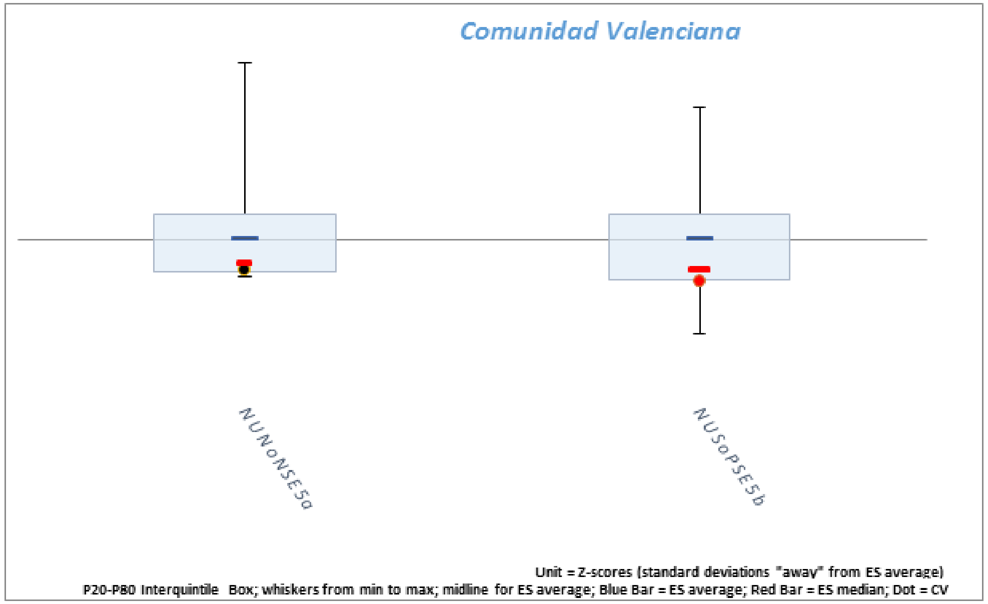


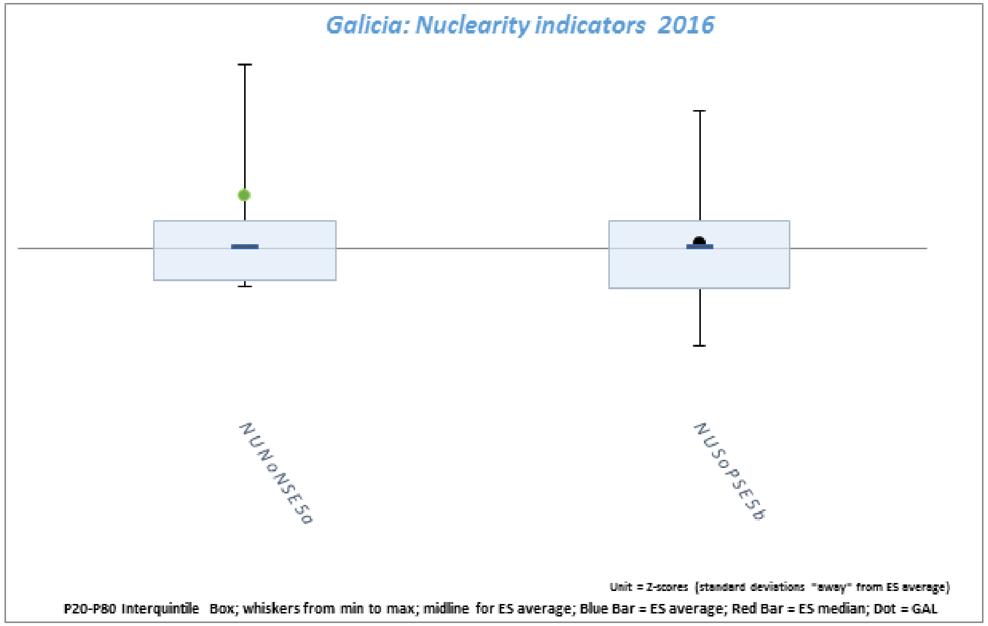
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 13. Nuclearity indicators by Region 2016 *(It continues)*





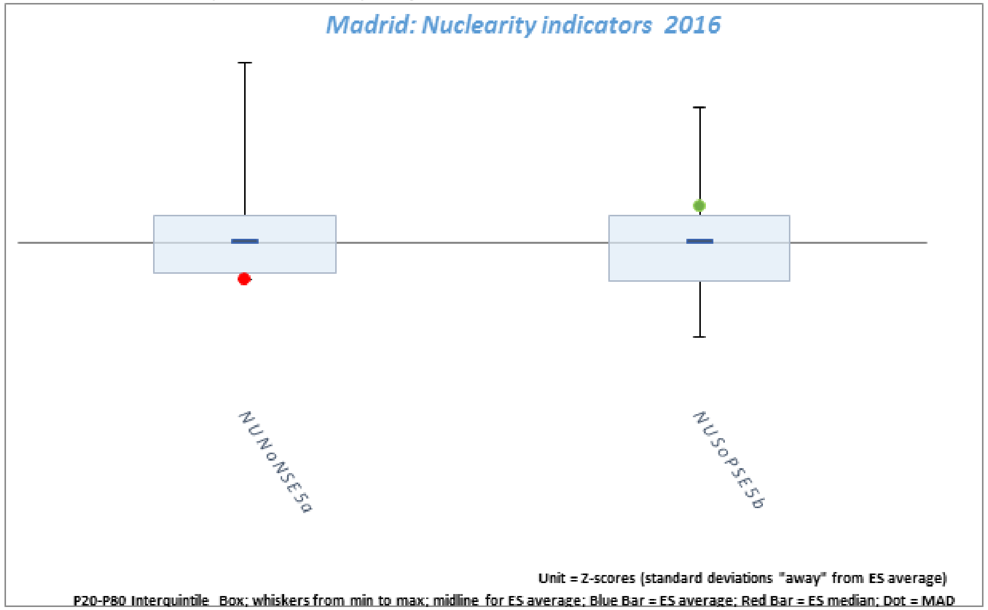


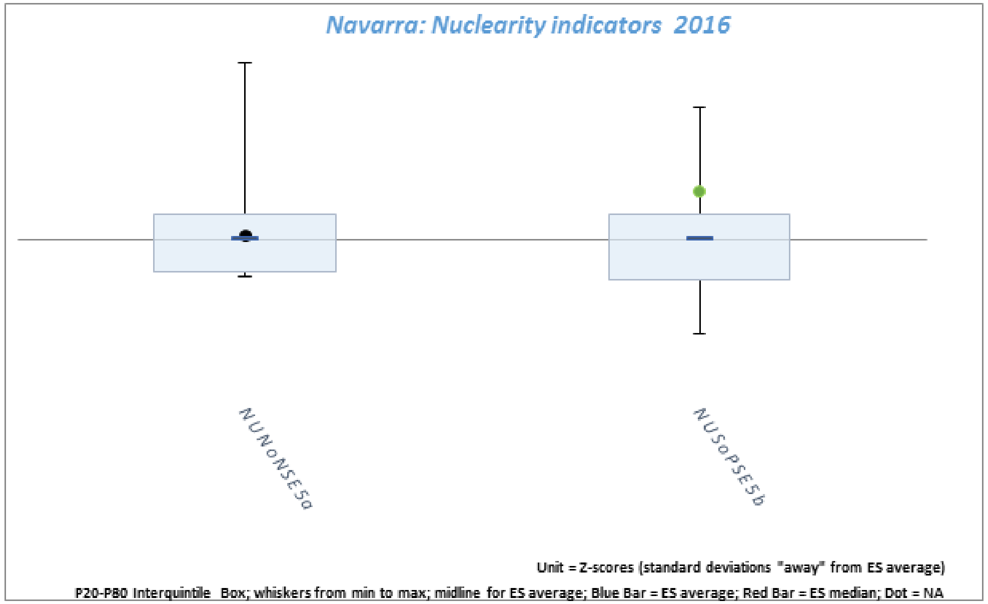


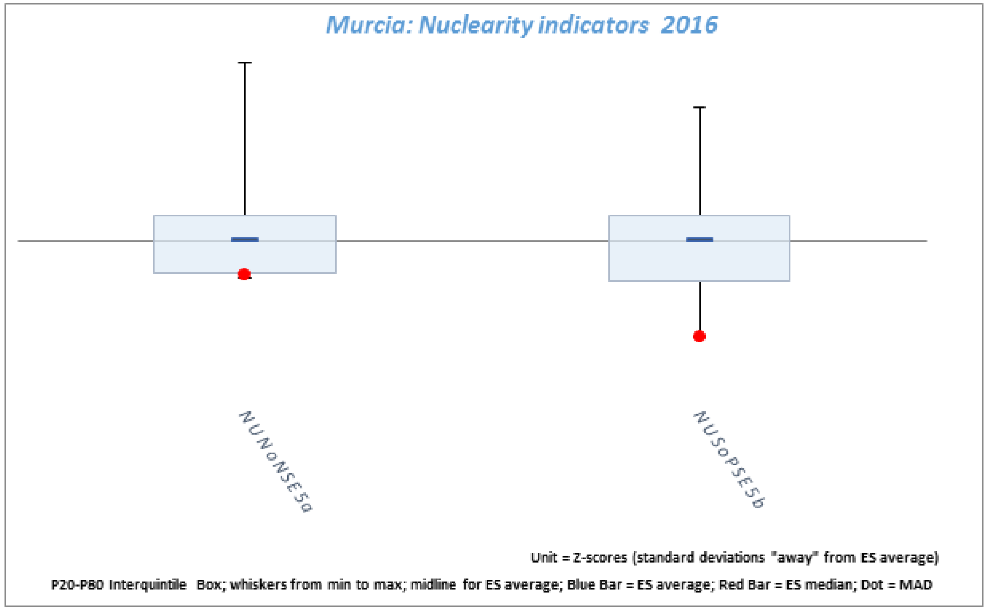
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

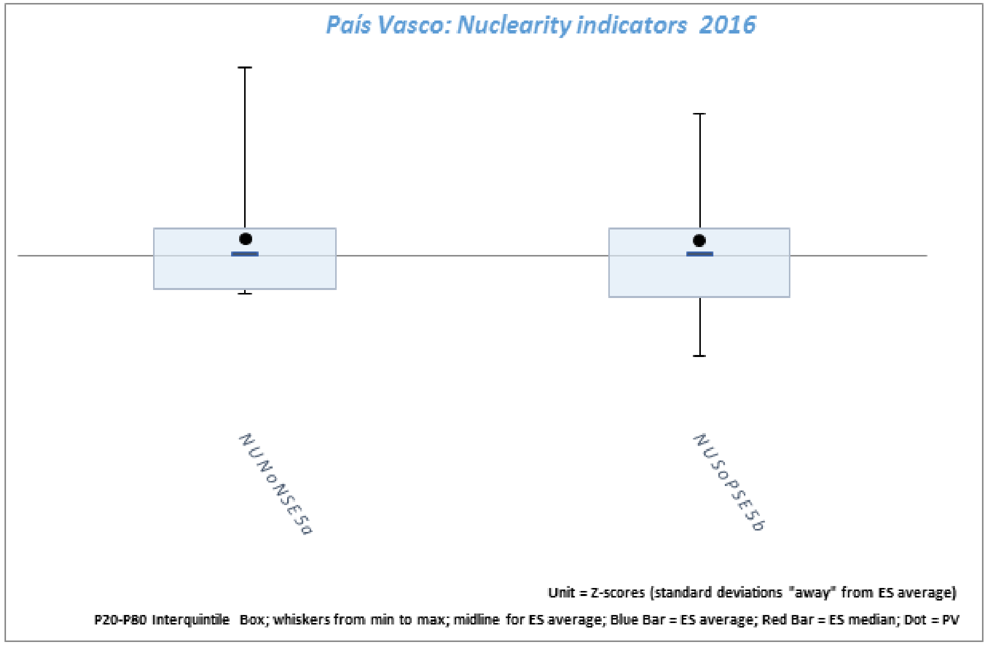
Chart 13. Nuclearity indicators by Region 2016

(It continues)



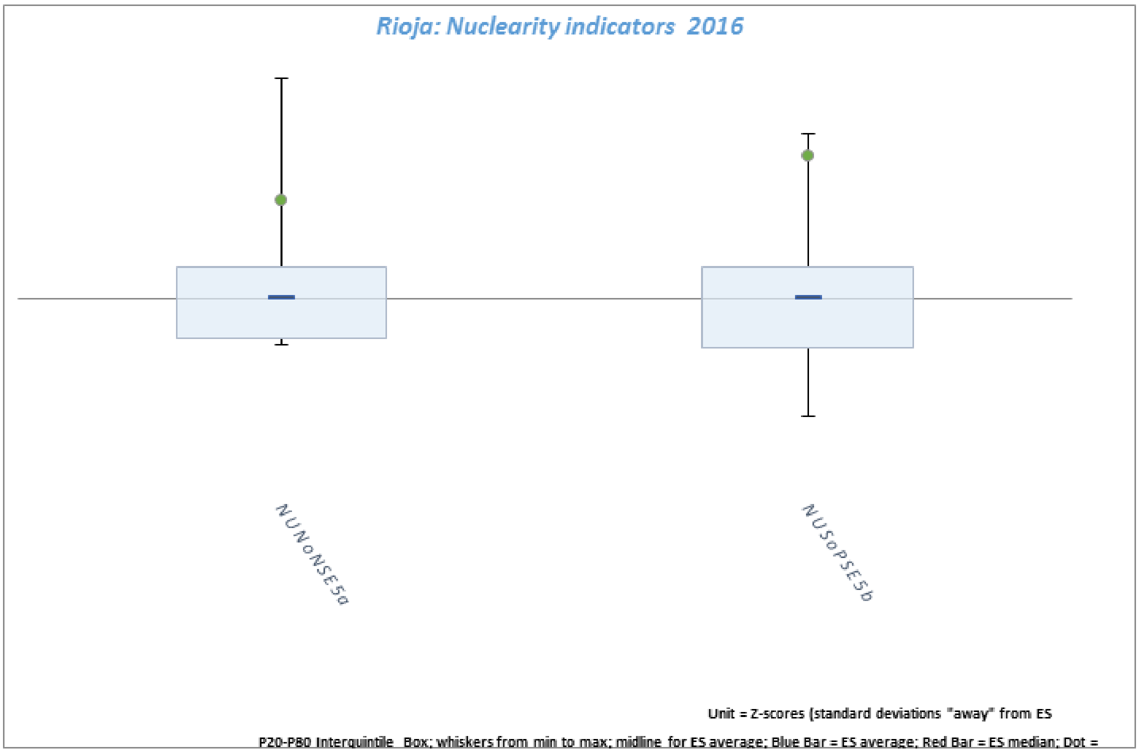






Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 13. Nuclearity indicators by Region 2016 *(It concludes)*



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

As already highlighted, ***population nuclearity*** has decreased over the period 2003-2017. The cumulative annual rates were between -1.47% to -0.67%, with a larger drop from 2003 to 2008 (Table 22).

Table 22. Evolution of population nuclearity indicators at the national level 2003-2017

Nuclearity Indicators		Δ Annual average 2008/2003 (%)	Δ Annual average 2017/2008 (%)	Δ Annual average 2017/2003 (%)
Inverse of the number of nuclei SE	*$NUNoN_{SE5a}$*	-2.637	-0.821	-1.474
Share of the population in the CBD over the population in nuclei SE	*$NUSoP_{SE5b}$*	-1.205	-0.367	-0.667

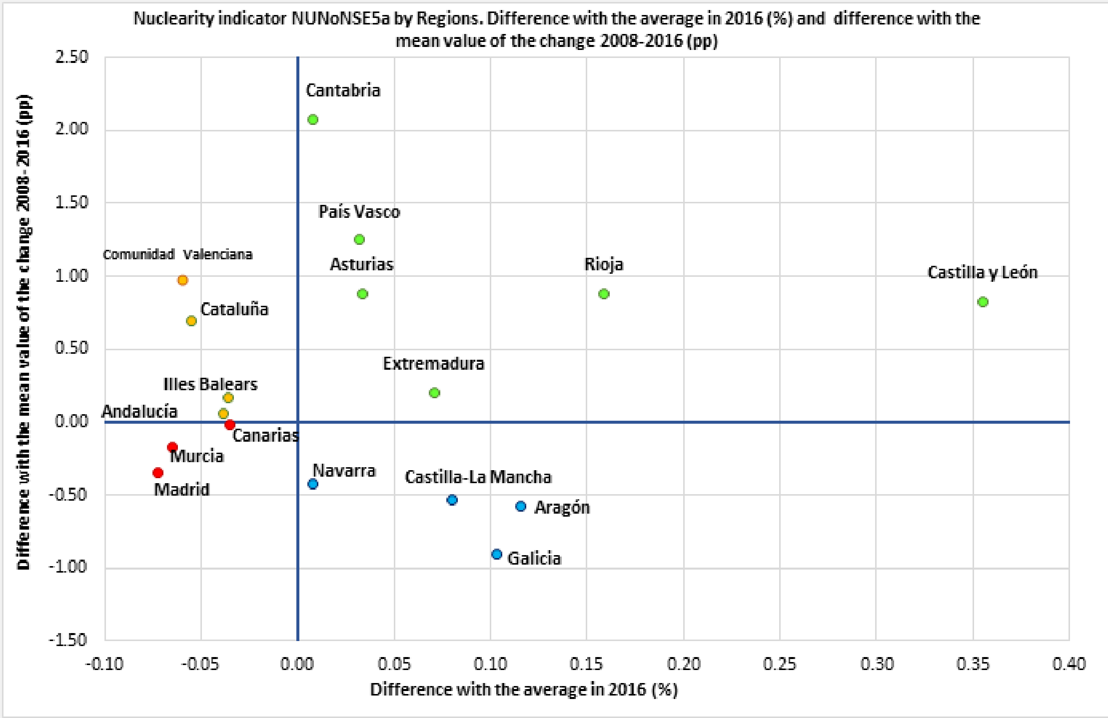
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

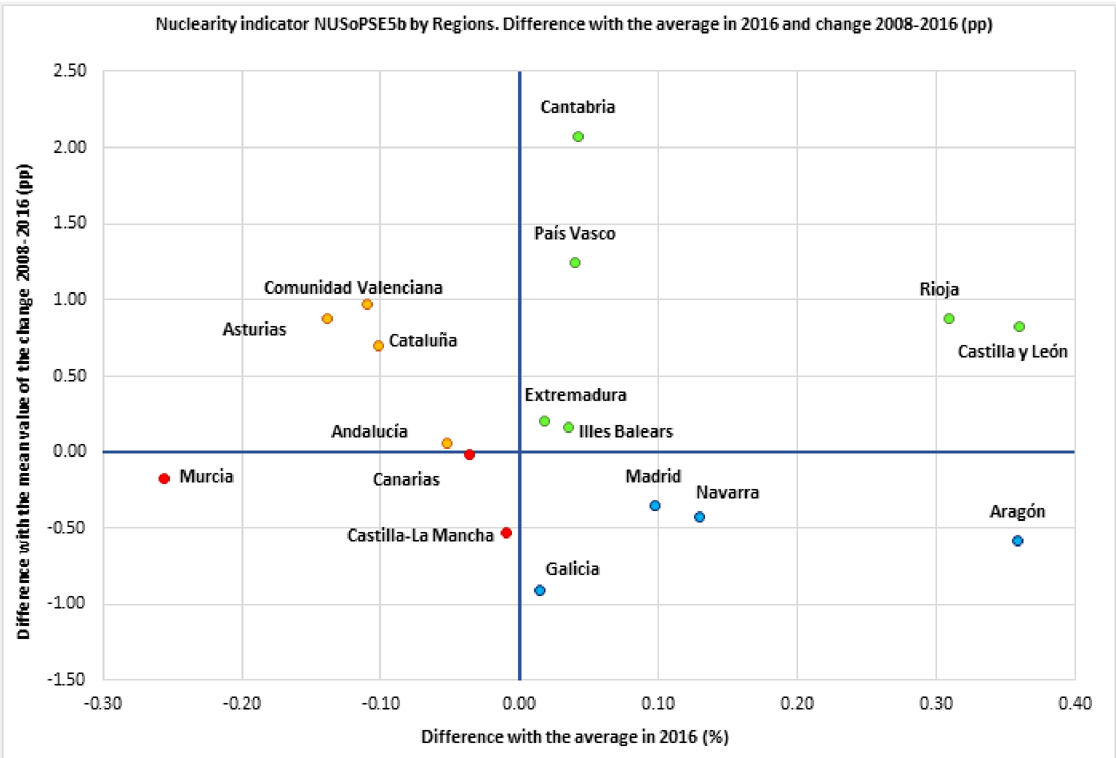
Concerning the nuclearity dynamic in Spain´s regions, when comparing their relative position to the national average in 2016 together with their time trend during the period 2003 to 2016 (Chart 14), we would highlight the following regional features:

- **Andalucía** has systematically below average levels of nuclearity. The number of nuclei in Andalucía's provinces is evolving practically at the same rate as the national average. Thus, nuclearity would remain stagnated in the region.
- **Aragón** has above average levels of nuclearity, but it is evolving below the national average. Therefore, the Region would follow a converging path towards the national average.
- **Asturias'** nuclearity is above average for the inverse of the number of nuclei and below average when based on the population in the CBD. In both cases, its evolution is above the national rate of change between 2008 and 2016. Thus, we would expect convergence towards the national average regarding the share of the CBD in all nuclei or advancing positions in relation to the number of nuclei.
- **Illes Balears'** nuclearity in terms of the inverse of the number of nuclei is below average but evolving above the national average, which would entail a converging path. When based on the population in the CBD, nuclearity is slightly above average and evolving above the average; thus, we would expect the Region to moderately scale position in the ranking.
- **Canarias** has systematically below average levels of nuclearity and rates of change below average. These results show that the Region is far from converging to the national average.
- **Cantabria** presents nuclearity levels above the national average and evolving well above the average. These results show that the Region would be on an ascending path towards top positions in the ranking.
- **Castilla y León** presents nuclearity levels well above the national average and evolving above the average. These results show that the Region would be on the path to move to higher positions in the ranking.
- **Castilla-La Mancha**´s nuclearity in terms of the inverse of the number of nuclei is above the national average but evolving below the average rate of change, which would entail convergence towards the national average. When based on the population in the CBD, nuclearity is slightly below average and evolving at a slower pace than the average rate of change; thus, we would expect some divergence towards low positions in the ranking.

- **Cataluña** presents nuclearity levels below the national average though evolving at a higher rate than average. This dynamic pattern would promote convergence towards the national average.
- **Comunidad Valenciana's** nuclearity is below the national average but evolving above the average rate of change. This dynamic pattern would promote convergence towards the national average.
- **Extremadura's** nuclearity is above the national average and evolving at a higher pace than the national rate of change. This dynamic pattern would promote the Region's upgrade within the ranking.
- **Galicia's** nuclearity is above the national average but evolving below average. This dynamic pattern would promote convergence towards the national average.
- **Madrid's** nuclearity is below average regarding the number of nuclei and it is evolving below average as well; therefore, the Region is on a diverging path away from the national average. On the other hand, concerning the population in the CBD, nuclearity is above the average but moving at a lower rate than average; thus, moving downwards in the ranking toward the average.
- **Murcia's** nuclearity is below the national average. In addition, it is evolving at a slower pace than the national rate of change. This dynamic pattern would promote divergence away from the national average.
- **Navarra's** nuclearity is above the national average yet evolving at a slower pace than the national average itself. This dynamic pattern would promote convergence towards the national average.
- **País Vasco's** nuclearity is both above and evolving at a faster pace than the national average. Therefore, the Region would be on the path to ascend positions in the ranking.
- **La Rioja** presents nuclearity levels above the national average, with rates of change notably above average. These results show that the Region would be on the path to upgrade its position in the regional ranking.

Chart 14. The dynamic of nuclearity





Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Density

Density indicators

The set of indicators that we used captures density within province i through the ***crude population densities*** of its municipalities.[17]

We used crude population density as the primary component, computed at the lowest level available of geographical breakdown. Then, we built more elaborated calculations at provincial level via population-weighted means, and by using three approaches for the density's concept: based on total land area, on urban area and on built-up area.

Thus, we propose three approaches to define population density at the provincial level. The first one captures the average number of residential units per km^2 for the total land area; we will refer to it as "***total density***." The second one captures it for the urban land area; we will refer to it as "***urban density***." The third one captures it for the built-up land area; we will refer to it as "***residential density***."

We worked with the following indicators:

- *Population-weighted density based on total land (**DEPWD**$_{MUN7a}$).*
- *Population-weighted density based on urban land (**DEPWD**$_{MUN7b}$).*
- *Population-weighted density based on built-up land area (**DEPWD**$_{MUN7c}$).*
- *Maximum density based on total land (**DENMAX**$_{MUN7d}$).*
- *Maximum density based on urban land (**DENMAX**$_{MUN7e}$).*
- *Maximum density based on built-up land area (**DENMAX**$_{MUN7f}$).*
- *Minimum density based on total land (**DENMIN**$_{MUN7g}$).*
- *Minimum density based on urban land (**DENMIN**$_{MUN7h}$).*
- *Minimum density based on built-up land area (**DENMIN**$_{MUN7i}$).*
- *Share of the population living in high-density municipalities based on total land (**DENHIGH**$_{MUN7j}$).*
- *Share of the population living in high-density municipalities based on urban land (**DENHIGH**$_{MUN7k}$).*
- *Share of the population living in high-density municipalities based on built-up land area (**DENHIGH**$_{MUN7l}$).*
- *Density of land use in the CBM based on total land (**DENCBD**$_{MUN7m}$).*
- *Density of land use in the CBM based on urban land **(DENCBD**$_{MUN7n}$).*
- *Density of land use in the CBM based on built-up land area (**DENCBD**$_{MUN7o}$).*

The ***Crude population density*** in Spain, in 2016, amounts to 92 inhabitants per km^2 (Table 23). The regions with the lowest total crude population density are Castilla y León, Castilla-La Mancha, and Extremadura (26 inhabitants per Km^2). As per urban and residential crude

[17] We have not land area for SE

population density, the minimum values correspond to Castilla y León with 2,250 and 3,856 inhabitants per Km^2, respectively. Madrid registers the maximum values for total and built-up crude density (806 and 6,734 inhabitants per Km^2). Maximum urban crude density corresponds to País Vasco with 11,343 inhabitants per Km^2. Interregional variability of crude density is high, especially for the total density, with a CV of 1.28 that practically quadruplicates that of urban (0.35) and residential density (0.32). This points out that major differences in Spain's population density lie in dissimilarities between urban and rural areas rather than among provinces themselves.

The Region hosting the municipality with the maximum crude total density is Comunidad Valenciana, with one of its municipalities having 26,218 inhabitants per Km^2. Regarding urban crude density, the Region hosting the municipality with the maximum value is Cataluña, which has a municipality with 41,066 inhabitants per urban Km^2. Finally, for residential crude density, the Region hosting the municipality with the maximum value is again Cataluña, which has a municipality with 52,746 inhabitants per built-up Km^2.

Against this backdrop, density indicators in Spain´s regions show the following basic features (Table 24):

Population-weighted total density at the national level, in 2016, amounts to 2,478 inhabitants per km^2. We observe that the most populated municipalities tend to be more thickly populated,[18] though with different intensities among provinces. The Region with the maximum population-weighted total density is Cataluña (6,313 inhabitants per km^2) and the minimum occurs in Extremadura (74 inhabitants per km^2). Interregional variability of population-weighted total density is high, with a CV of 0.81.

Population-weighted urban density at the national level, in 2016, amounts to 8,475 inhabitants per urban km^2. The Region with the maximum population-weighted urban density is Cataluña (13,548 inhabitants per urban km^2) and the minimum occurs in Murcia

[18] This is not a truism. Madrid registers the highest crude total density while it presents half of the population-weighted total density than Cataluña (the highest one in this case). It seems that the most populated municipalities in Cataluña tend to use less land area to settle than Madrid's ones. Extremadura´s crude total density is a 35% of its population-weighted total density while Castilla y León's one is a 3%, both regions accounting for 26 inhabitants per km^2 as regional crude total density. Again, it seems that the most populated municipalities in Castilla y León tend to use less land area to settle than Extremadura's ones.

(3,373 inhabitants per urban km^2). Interregional variability of population-weighted urban density is high, though lower than that of total density, with a CV of 0.38.

Population-weighted residential density at the national level, in 2016, amounts to 12,379 inhabitants per built-up km^2. The Region with the maximum population-weighted residential density is Madrid (17,804 inhabitants per built-up km^2) and the minimum occurs in Castilla-La Mancha (5,695 inhabitants per built-up km^2). Interregional variability of population-weighted residential density is high, though lower than that of total density, with a CV of 0.34, similar to the interregional variability of population-weighted urban density.

The ***maximum total density*** at the regional and national levels corresponds to the average[19] of the maximum values of the municipalities' crude total density.[20] Low values of the maximum total density (at or below the national average of population-weighted density) would entail high dispersion.[21] Overall, in Spain, the maximum total density accounts for 7,472 inhabitants per km^2. It shows a high interregional variability with a CV of 0.65. The regions that have a maximum total density at or below the national average for population-weighted total density are Aragón, Castilla y León, Castilla-La Mancha, Extremadura, and La Rioja.

The ***maximum urban density*** at the regional and national levels corresponds to the average of the maximum values of the municipalities' crude urban density. Low values of the maximum urban density (at or below the national average of population-weighted density) would entail high dispersion. Overall, in Spain, the maximum urban density accounts for 18,434 inhabitants per urban km^2. It shows a high interregional variability with a CV of 0.47. The regions that have a maximum urban density at or below the national average of population-weighted urban density are Castilla y León, Castilla-La Mancha, and Extremadura.

[19] We calculated the averages weighting by the provinces' population share both in each Region and in Spain.
[20] Please refer to the methodology for calculating dispersion indicators set in Blanco, A. et al. (2021). Thus, it does not coincides with absolute maximum values among the crude density of the municipalities within the Region or within Spain. We show the mentioned absolute maximums in Table 23's promemoria.
[21] Please notice that this could be considered a hard criteria to identify high dispersion.

The ***maximum residential density*** at the regional and national levels corresponds to the average of the maximum values of the municipalities' crude residential density. Low values of the maximum residential density (at or below the national average of population-weighted density) would entail high dispersion. However, high values of this indicator cannot be associated with low dispersion. We have included this indicator in our list only for descriptive purposes. We will not include it in the composite indicator for population dispersion. Overall, in Spain, the maximum residential density accounts for 25,192 inhabitants per built-up km^2. It shows a high interregional variability with a CV of 0.41. The regions that have a maximum residential density at or below the national average of population-weighted residential density are Castilla y León, Castilla-La Mancha, and Extremadura.

We have calculated the ***minimum total, urban and residential densities*** in a similar way as the maximum ones. We used these three indicators only for descriptive purposes as they don´t follow the general rule in which low values are associated with high dispersion. They would allow us to identify those regions with high minimum densities (i.e. above the national average of population-weighted density) that could point to low dispersion. Overall, in Spain, the minimum total density accounts for 3.48 inhabitants per km^2; 351 inhabitants per urban km^2; and 764 inhabitants per built-up km^2. All the regional values of the three indicators are far below the national respective averages of population-weighted densities. Thus, this indicator cannot be used to feature low dispersion.

Nationwide, in Spain, the ***population share in high-density municipalities*** (total) amounts to 29%, ranging from 0% in Castilla-La Mancha, Extremadura and La Rioja to 68% in Madrid with an interregional CV of 0.77. As for the case of urban density, the corresponding data is 36% at the national level, ranging from 0% in Castilla-La Mancha and Extremadura to 66% in Madrid, with an interregional CV of 0.60. Finally, for residential density, in Spain on average a 38% of the population lives in municipalities with high residential density, ranging from 0% in Extremadura to 72% in Madrid, with an interregional CV of 0.59. Please note that for the purposes of this work the thresholds for "*high density,*" both total, urban and residential, are the mean value at the national level of the corresponding population-weighted densities (see above).

This definition of high-density municipalities differs from the EU and OECD's definitions of densely populated areas. Please refer to Dijkstra, L. et al. (2014) and OECD/EU (2020). Following OECD's definition, "*The population living in cities, high density places of at least 50,000 inhabitants, has more than doubled over the last 40 years, going from 1.5 billion in 1975 to 3.5 billion in 2015. Almost half the world's population (48%) lives in cities…*" On the other hand, following the EU's definition,[22] the share of the population living in densely populated areas in the EU accounts for 40%. Spain ranks below the average with 33%, pointing to a sparsely populated country; though at a similar level as Austria, Denmark, Germany and Italy. On the other hand, the analysis by Rae, A. (2018) on "*Population Density in Europe*" shows that "*much of Spain appears to be empty; much more so than any other large European country… Yet characterising Spain as a sparsely populated country does not reflect the experience on the ground … So even though the settlement pattern appears sparse, people are actually quite tightly packed together*."[23] For this reason, when we used the indicator "*Share of the population living in high-density municipalities"* to approach concentration, we will focus on the definition of density based on built-up land.

Focusing on the CBD, the ***density of land use in the CBM*** based on total land is 4,721 inhabitants per km^2 at the national level, ranging from 84 inhabitants per km^2 in Extremadura to 12,617 inhabitants per km^2 in Cataluña; with an interregional CV of 0.81. Considering urban land, it is 13,902 inhabitants per urban km^2, ranging from 3,593 inhabitants per urban km^2 in Murcia to 22,743 inhabitants per urban km^2 in Cataluña; with an interregional CV of 0.40. Finally, regarding residential density in Spain, on average, the density of land use in the CBM accounts for 19,542 inhabitants per built-up km^2; ranging

[22] "*Contiguous grid cells of 1 km^2 with a density of at least 1,500 inhabitants per km^2 and a minimum population of 50,000*." Please notice that the definition and measurement of densely populated areas in the mentioned EU's analysis relay on the new tool of the population grid statistics as an alternative to population statistics for administrative areas. This work, on the contrary, rely on population statistics for administrative areas: singular entities and municipalities. To provide a flavour of the degree of matching of both approaches, we have calculated the share of the Spanish population residing in municipalities with at least 1,500 inhabitants per km^2 and a minimum population of 50,000. Our calculations show that at the national level the share of population living in municipalities with a density of at least 1,500 inhabitants per km^2 and a minimum population of 50,000 is 33.8% in 2016 with the following evolution path:

Evolution of the share of population living in municipalities with a density of at least 1,500 inhabitants per km^2 and a minimum population of 50,000. 2003-2017.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
SPAIN	33.6%	33.5%	34.4%	34.3%	34.0%	33.8%	33.7%	33.8%	33.9%	33.8%	33.7%	33.8%	33.8%	33.8%	33.3%

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

These results are very similar to the ones calculated for Spain in Dijkstra, L. et al. (2014). They place Spain on an intermediate-low position among the EU Member States and thus Spain on average does not qualify as a "*densely populated area (alternative name: cities): At least 50% living in high-density clusters (alternative name: urban centre)*". For further details on the EU's methodology regarding population grids, please refer to Eurostat (2018).

[23] Rae, A. (2018). Please refer also to Reig, E. et al. (2016).

from 6,413 inhabitants per built-up km^2 in Extremadura to 28,993 inhabitants per built-up km^2 in Cataluña.

The analysis that follows will focus on the following density indicators:

- *Population-weighted density based on total land (**$DEPWD_{MUN7a}$**).*
- *Population-weighted density based on urban land (**$DEPWD_{MUN7b}$**).*
- *Population-weighted density based on built-up land area (**$DEPWD_{MUN7c}$**).*
- *Share of the population living in high-density municipalities based on total land (**$DENHIGH_{MUN7j}$**).*
- *Share of the population living in high-density municipalities based on urban land (**$DENHIGH_{MUN7k}$**).*
- *Share of the population living in high-density municipalities based on built-up land area (**$DENHIGH_{MUN7l}$**).*
- *Density of land use in the CBM based on total land (**$DENCBD_{MUN7m}$**).*
- *Density of land use in the CBM based on urban land **(**$DENCBD_{MUN7n}$**).***
- *Density of land use in the CBM based on built-up land area (**$DENCBD_{MUN7o}$**).*

The regions whose density is systematically in top positions above the national average are Cataluña, Madrid and País Vasco; and those with bottom positions are Andalucía, Asturias, Castilla y León, Castilla-La Mancha, Extremadura, Galicia and Murcia (Table 25).

The distribution of density indicators among regions in Spain is typically positive asymmetric (Chart 15), with some exceptions: ***$DENCBD_{MUN7n}$***, and ***$DENCBD_{MUN7o}$***, for which it is symmetric and negative asymmetric. This means that most of the population in Spain lives in provinces with population-weighted density below the national average. In addition, most of the population in Spain lives in provinces where the share of the population in high-density municipalities is below the national average. Finally, most of the population in Spain lives in provinces with a total population density in the CBD below the national average while half or more of the population lives in provinces with urban and residential density in the CBD above the national average. These population density data draw a panorama of sparsely populated Spanish provinces throughout their entire territory but densely populated in the CBD and in urban and built-up areas.

As for the evolution from 2003 to 2017 (Chart 16), our results show that population-weighted density in Spain registered an increasing trend from 2003 to 2009 (2010 for the residential one) and then declined until 2015 to start a new rising path, which was especially pronounced for total density. Over the whole period, we observe that the population-weighted total density remains practically stagnated, while the urban and residential ones increased; mainly residential density.

The population share living in high total density municipalities declined between 2003 and 2017. It fell until 2010 and then started to rise until 2017, although it did reach 2003 levels. On the contrary, the population share living in high urban and residential density municipalities shows an increasing tendency.

The population density in the CBD registered an increasing trend from 2003 to 2009 (2010 for residential one) then it declined until 2015 to start a new rising path, which was especially pronounced for total density. To highlight that, as of 2015, the rhythm of increase for total population density in the CBD is more intense than for urban or residential densities.

The evolution of total population density shows stagnation or a decreasing trend between 2003 and 2017, except when it is measured through the density of land use in the CBD that is increasing. This could point out that, in those municipalities with higher population shares, the population kept the same total population density while people moved towards the CBD. However, considering the decreasing trend in the population share in high-density municipalities, it seems that there were more intense movements towards nuclei that were less densely populated than the CBD.

The evolution of urban and residential population density shows an increasing trend between 2003 and 2017, regardless of the indicator that is used. Residential population density has typically increased at higher rates than urban population density, and urban population density has typically increased at higher rates than total population density. This could point out that, in those municipalities that gained population share, the urban land area expanded at higher rates than built-up land area while that the expansion of built-up land area was inferior to the increase in population.

However, the most recent evolution of total population density, as of 2015, with a rate of increase overpassing that of urban and residential densities, shows that there could be a latter tendency of the population to move towards those municipalities (alternatively CBDs) that are most densely populated across their territories. At the same time, they increased their urban land area and, to a lesser extent, built-up land area at greater rates than that of the population.

Table 23.1. Crude population density in Spain's regions by type of land area in 2016

Region	Population	Total Surface (Km²)	Urban Area (Km²)	Built-Up (Urban) Area (Km²)	Total Density Inhabitants per Km²	Urban Density Inhabitants per Km²	Residential Density Inhabitants per Km²
TOTAL	46,386,463	504,688	11,325	6,870	92	4,096	6,752
Andalucía	8,388,107	87,581	1,764	1,128	96	4,754	7,435
Aragón	1,308,563	47,698	361	220	27	3,621	5,945
Asturias	1,042,608	10,604	285	166	98	3,655	6,266
Illes Balears	1,107,220	4,992	236	172	222	4,698	6,419
Canarias	2,101,924	7,445	423	229	282	4,966	9,194
Cantabria	582,206	5,261	179	125	111	3,246	4,642
Castilla y León	2,447,519	93,869	1,088	635	26	2,250	3,856
Castilla-La Mancha	2,041,631	79,408	900	511	26	2,270	3,993
Cataluña	7,522,596	32,106	1,416	912	234	5,311	8,248
Comunidad Valenciana	4,959,968	23,259	1,118	707	213	4,437	7,014
Extremadura	1,087,778	41,634	321	212	26	3,385	5,138
Galicia	2,718,525	29,576	1,050	596	92	2,589	4,565
Madrid	6,466,996	8,022	964	570	806	6,705	11,343
Murcia	1,464,847	11,314	551	270	129	2,656	5,418
Navarra	640,647	9,801	260	133	65	2,467	4,813
País Vasco	2,189,534	7,092	325	235	309	6,734	9,337
La Rioja	315,794	5,028	82	48	63	3,830	6,633

Note: Please note that in this table population and surface correspond to totals in official registries, including that of SE dropped to build the database used in this work.

Table 23.2. Maximum and minimum values of crude indicators (value and Region)

	Total density Inhabitants per Km²	Urban density Inhabitants per Km²	Residential density Inhabitants per Km²
Max	806	6,734	11,343
Min	26	2,250	3,856
Max	Madrid	País Vasco	Madrid
Min	Castilla y León Castilla-La Mancha Extremadura	Castilla y León	Castilla y León

Table 23.3. Inter-region variability of crude density indicators

	Total density Inhabitants per Km²	Urban density Inhabitants per Km²	Residential density Inhabitants per Km²
Standard Deviation	117	1,443	2,156
CV MUN	1.28	0.35	0.32

* Please notice that, due the definition of crude density, the mean and standard deviation at the national level of the regional distribution should be weighted by each province's surface area.

Promemoria: Absolute maximum and minimum values of municipal density by Region

Region	Maximum municipal crude density (total)	Maximum municipal crude density (urban)	Maximum municipal crude density (residential)	Minimum municipal crude density (total)	Minimum municipal crude density (urban)	Minimum municipal crude density (residential)
TOTAL	26,218	41,066	52,746	0.4	70	156
Andalucía	9,668	32,096	33,850	8	1,571	1,903
Aragón	3,339	9,921	15,904	1	306	547
Asturias	2,989	13,921	16,272	3	445	1,015
Illes Balears	4,446	12,408	17,315	2	535	893
Canarias	3,668	18,884	29,468	16	1,040	2,668
Cantabria	4,786	11,043	14,016	3	387	698
Castilla y León	3,685	9,484	17,460	1	382	755
Castilla-La Mancha	1,764	7,422	12,588	1	240	1,114
Cataluña	18,708	41,066	52,746	2	213	398
Comunidad Valenciana	26,218	35,393	46,925	3	426	962
Extremadura	796	7,509	9,349	1	304	485
Galicia	6,449	15,038	23,536	15	322	1,039
Madrid	7,036	14,760	24,119	1	250	481
Murcia	2,534	8,516	13,340	6	70	280
Navarra	14,606	18,462	23,213	1	110	196
País Vasco	14,571	33,078	41,480	17	756	1,476
La Rioja	1,912	11,986	16,495	0.4	122	156

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Table 24.1. Density indicators by regions in 2016

REGIONS	Population-weighted density based on total land $DEPWD_{MUN7a}$	Population-weighted density based on urban land $DEPWD_{MUN7b}$	Population-weighted density based on built-up land $DEPWD_{MUN7c}$	Maximum density based on total land $DENMAX_{MUN7d}$	Maximum density based on urban land $DENMAX_{MUN7e}$	Maximum density based on built-up land $DENMAX_{MUN7f}$	Minimum density based on total land $DENMIN_{MUN7g}$	Minimum density based on urban land $DENMIN_{MUN7h}$	Minimum density based on built-up land $DENMINM_{UN7i}$	Population share living in high-density municipalities (total) $DENHIGH_{MUN7j}$	Population share living in high-density municipalities (urban) $DENHIGH_{MUN7k}$	Population share living in high-density municipalities (residential) $DENHIGH_{MUN7l}$	Density of land use in the CBM based on total land $DENCBD_{MUN7m}$	Density of land use in the CBM based on urban land $DENCBD_{MUN7n}$	Density of land use in the CBM based on built-up land $DENCBD_{MUN7o}$
TOTAL	**2,478**	**8,475**	**12,379**	**7,472**	**18,434**	**25,192**	**3.48**	**351**	**764**	**0.2944**	**0.3589**	**0.3768**	**4,721**	**13,902**	**19,542**
Andalucía	1,264	7,253	10,367	5,609	16,633	21,789	4.23	681	1,177	0.1913	0.2969	0.2983	3,318	14,262	18,171
Aragón	410	6,631	10,563	2,496	9,187	14,519	0.41	235	362	0.0002	0.5066	0.5066	556	8,808	14,155
Asturias	957	5,391	8,682	2,989	13,921	16,272	3.10	445	1,015	0.0770	0.0573	0.3282	1,181	6,705	13,190
Illes Balears	1,036	6,549	8,751	4,446	12,408	17,315	1.65	535	893	0.0448	0.4571	0.4378	1,931	9,442	12,519
Canarias	1,306	8,458	13,147	3,513	17,948	26,284	11.07	566	2,536	0.1949	0.3631	0.4437	2,565	14,812	21,807
Cantabria	1,871	5,949	7,832	4,786	11,043	14,016	2.64	387	698	0.3277	0.2966	0.2966	4,786	11,043	14,016
C. y León	834	4,274	7,053	1,855	7,152	11,479	0.86	198	408	0.1113	0.0920	0.1438	1,831	7,047	11,479
C-La Mancha	173	3,481	5,695	769	6,248	10,290	0.81	125	527	0.0000	0.0000	0.0364	265	4,495	8,466
Cataluña	6,313	13,548	17,704	14,620	33,751	43,393	0.98	189	356	0.5017	0.5325	0.5236	12,617	22,743	28,993
C. Valenciana	2,035	9,520	12,703	14,578	23,812	32,663	1.81	301	877	0.2126	0.2719	0.2676	3,698	17,380	21,943
Extremadura	74	3,717	5,721	570	6,496	9,124	1.22	300	462	0.0000	0.0000	0.0000	84	3,959	6,413
Galicia	1,152	5,415	8,117	3,887	12,913	17,933	10.63	306	830	0.1993	0.1299	0.1194	3,080	10,027	16,175
Madrid	3,786	10,154	17,804	7,036	14,760	24,119	1.14	250	481	0.6791	0.6628	0.7194	5,226	13,469	24,119
Murcia	421	3,373	6,309	2,534	8,516	13,340	6.27	70	280	0.0282	0.0282	0.0282	498	3,593	7,331
Navarra	3,573	5,906	10,309	14,606	18,462	23,213	0.65	110	196	0.4370	0.4142	0.4455	7,783	10,511	17,173
País Vasco	3,172	12,442	15,818	8,789	28,815	34,436	12.83	517	783	0.4436	0.5984	0.5598	5,511	18,486	21,810
La Rioja	999	7,593	11,229	1,912	11,986	16,495	0.42	122	156	0.0000	0.4920	0.4920	1,912	11,986	16,495

Note: Please notice that maximum and minimum densities at the regional and national levels correspond to population-weighted averages of provincial maximum and minimum municipal crude densities. Absolute values are in Table 23.

Table 24.2. Maximum and minimum values for density indicators (value and Region)

	Population-weighted density based on total land $DEPWD_{MUN7a}$	Population-weighted density based on urban land $DEPWD_{MUN7b}$	Population-weighted density based on built-up land $DEPWD_{MUN7c}$	Maximum density based on total land $DENMAX_{MUN7d}$	Maximum density based on urban land $DENMAX_{MUN7e}$	Maximum density based on built-up land $DENMAX_{MUN7f}$	Minimum density based on total land $DENMIN_{MUN7g}$	Minimum density based on urban land $DENMIN_{MUN7h}$	Minimum density based on built-up land $DENMINM_{UN7i}$	Population share living in high-density municipalities (total) $DENHIGH_{MUN7j}$	Population share living in high-density municipalities (urban) $DENHIGH_{MUN7k}$	Population share living in high-density municipalities (residential) $DENHIGH_{MUN7l}$	Density of land use in the CBM based on total land $DENCBD_{MUN7m}$	Density of land use in the CBM based on urban land $DENCBD_{MUN7n}$	Density of land use in the CBM based on built-up land $DENCBD_{MUN7o}$
Max	6,313	13,548	17,804	14,620	33,751	43,393	13	681	2,536	0.6791	0.6628	0.7194	12,617	22,743	28,993
Min	74	3,373	5,695	570	6,248	9,124	0.4	70	156	0.0000	0.0000	0.0000	84	3,593	6,413
Max	Cataluña	Cataluña	Madrid	Cataluña	Cataluña	Cataluña	País Vasco	Andalucía	Canarias	Madrid	Madrid	Madrid	Cataluña	Cataluña	Cataluña
Min	Extremadura	Murcia	C-La Mancha	Extremadura	C-La Mancha	Extremadura	Aragón	Murcia	La Rioja	C-La Mancha Extremadura La Rioja	C-La Mancha Extremadura	Extremadura	Extremadura	Murcia	Extremadura

Table 24.3. Inter-region variability of density indicators

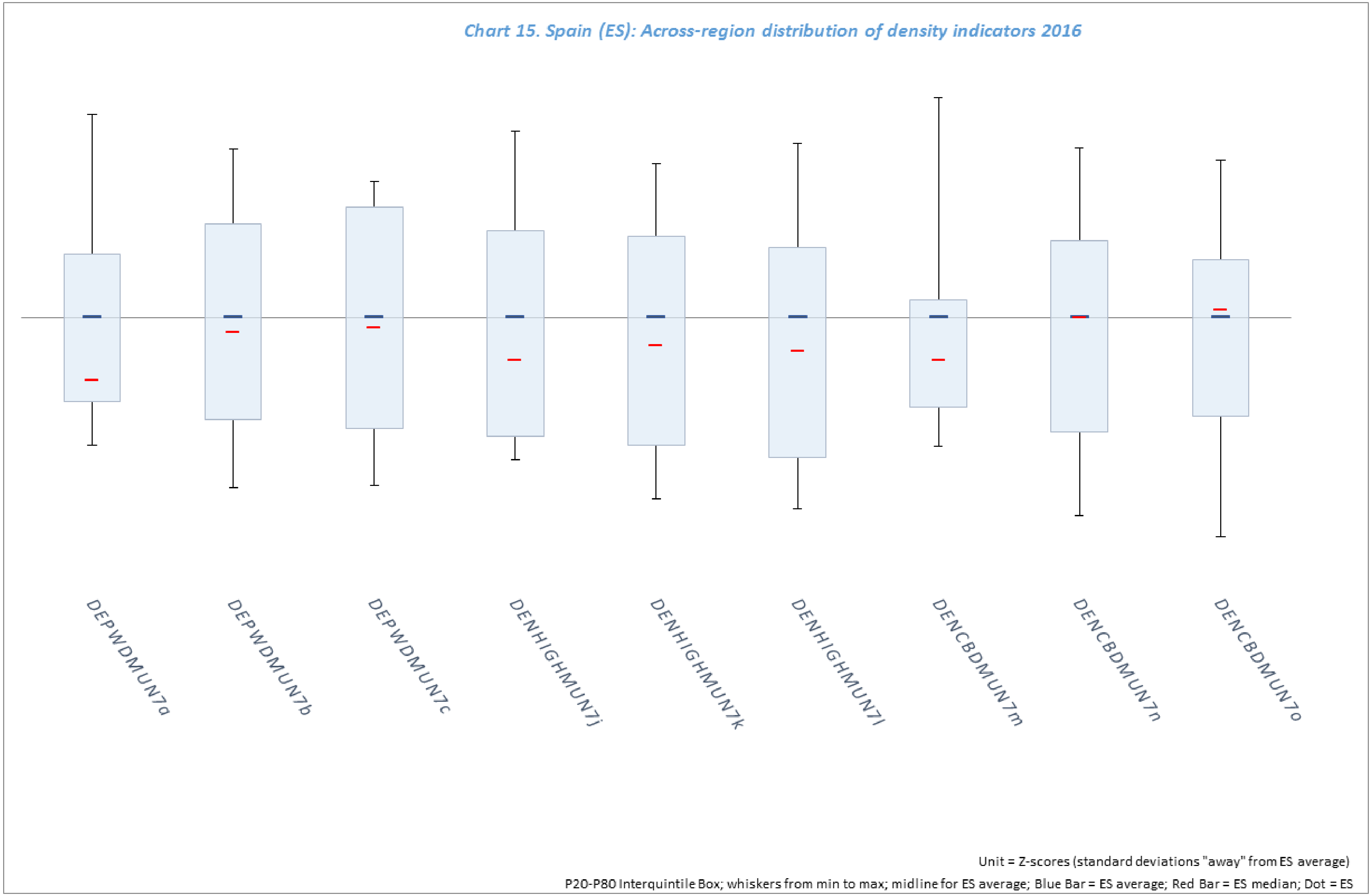
	Population-weighted density based on total land $DEPWD_{MUN7a}$	Population-weighted density based on urban land $DEPWD_{MUN7b}$	Population-weighted density based on built-up land $DEPWD_{MUN7c}$	Maximum density based on total land $DENMAX_{MUN7d}$	Maximum density based on urban land $DENMAX_{MUN7e}$	Maximum density based on built-up land $DENMAX_{MUN7f}$	Minimum density based on total land $DENMIN_{MUN7g}$	Minimum density based on urban land $DENMIN_{MUN7h}$	Minimum density based on built-up land $DENMINM_{UN7i}$	Population share living in high-density municipalities (total) $DENHIGH_{MUN7j}$	Population share living in high-density municipalities (urban) $DENHIGH_{MUN7k}$	Population share living in high-density municipalities (residential) $DENHIGH_{MUN7l}$	Density of land use in the CBM based on total land $DENCBD_{MUN7m}$	Density of land use in the CBM based on urban land $DENCBD_{MUN7n}$	Density of land use in the CBM based on built-up land $DENCBD_{MUN7o}$
Standard Deviation	2,000	3,193	4,217	4,877	8,651	10,385	4	195	495	0.2219	0.2148	0.2065	3,811	5,533	6,362
CV MUN	0.81	0.38	0.34	0.65	0.47	0.41	1.06	0.55	0.65	0.35	0.53	0.53	0.81	0.40	0.33

Source: Author's own work based on the sources described in Blanco, A. et al. (2021).

Table 25. Regional rankings of density indicators—Regions in decreasing order

	Population-weighted density based on total land	Population-weighted density based on urban land	Population-weighted density based on built-up land	Population share in high-density municipalities (total)	Population share in high-density municipalities (urban)	Population share in high-density municipalities (residential)	Density of land use in the CBM based on total land	Density of land use in the CBM based on urban land	Density of land use in the CBM based on built-up land
	$DEPWD_{MUN7a}$	$DEPWD_{MUN7b}$	$DEPWD_{MUN7c}$	$DENHIGH_{MUN7j}$	$DENHIGH_{MUN7k}$	$DENHIGH_{MUN7l}$	$DENCBD_{MUN7m}$	$DENCBD_{MUN7n}$	$DENCBD_{MUN7o}$
ABOVE AVERAGE	Cataluña	Cataluña	Madrid	Madrid	Madrid	Madrid	Cataluña	Cataluña	Cataluña
	Madrid	País Vasco	Cataluña	Cataluña	País Vasco	País Vasco	Navarra	País Vasco	Madrid
	Navarra	Madrid	País Vasco	País Vasco	Cataluña	Cataluña	País Vasco	Comunidad Valenciana	Comunidad Valenciana
	País Vasco	Comunidad Valenciana	Canarias	Navarra	Aragón	Aragón	Madrid	Canarias	País Vasco
			Comunidad Valenciana	Cantabria	La Rioja	La Rioja	Cantabria	Andalucía	Canarias
					Illes Balears	Navarra			
					Navarra	Canarias			
					Canarias	Illes Balears			
BELOW AVERAGE	Comunidad Valenciana	Canarias	La Rioja	Comunidad Valenciana	Andalucía	Asturias	Comunidad Valenciana	Madrid	Andalucía
	Cantabria	La Rioja	Aragón	Galicia	Cantabria	Andalucía	Andalucía	La Rioja	Navarra
	Canarias	Andalucía	Andalucía	Canarias	Comunidad Valenciana	Cantabria	Galicia	Cantabria	La Rioja
	Andalucía	Aragón	Navarra	Andalucía	Galicia	Comunidad Valenciana	Canarias	Navarra	Galicia
	Galicia	Illes Balears	Illes Balears	Castilla y León	Castilla y León	Castilla y León	Illes Balears	Galicia	Aragón
	Illes Balears	Cantabria	Asturias	Asturias	Asturias	Galicia	La Rioja	Illes Balears	Cantabria
	La Rioja	Navarra	Galicia	Illes Balears	Murcia	Castilla-La Mancha	Castilla y León	Aragón	Asturias
	Asturias	Galicia	Cantabria	Murcia	Castilla-La Mancha	Murcia	Asturias	Castilla y León	Illes Balears
	Castilla y León	Asturias	Castilla y León	Aragón	Extremadura	Extremadura	Aragón	Asturias	Castilla y León
	Murcia	Castilla y León	Murcia	Castilla-La Mancha			Murcia	Castilla-La Mancha	Castilla-La Mancha
	Aragón	Extremadura	Extremadura	Extremadura			Castilla-La Mancha	Extremadura	Murcia
	Castilla-La Mancha	Castilla-La Mancha	Castilla-La Mancha	La Rioja			Extremadura	Murcia	Extremadura
	Extremadura	Murcia							

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.



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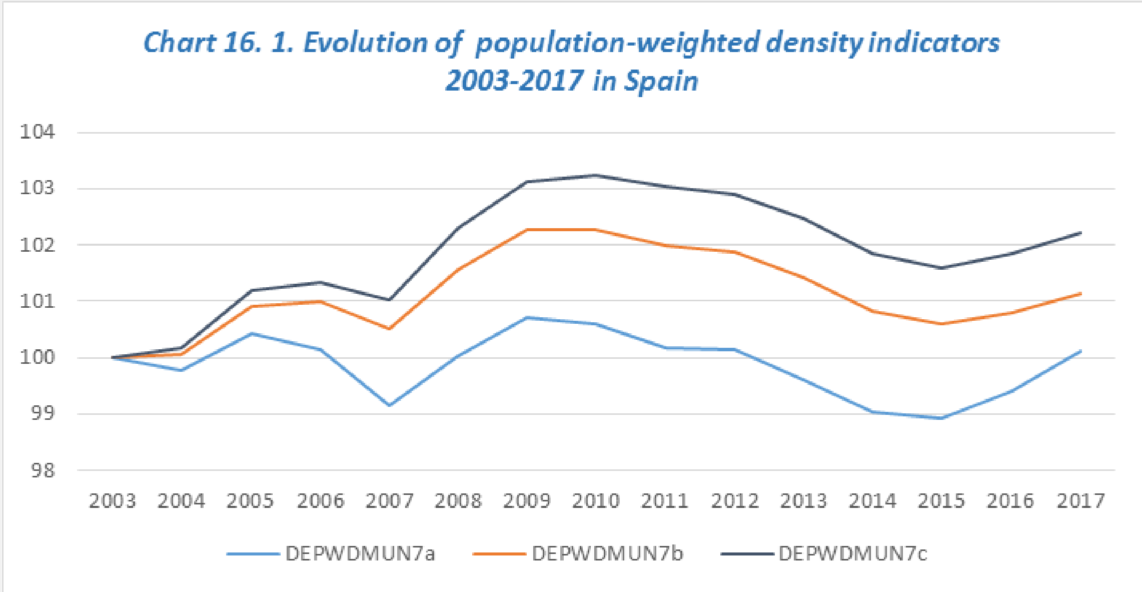
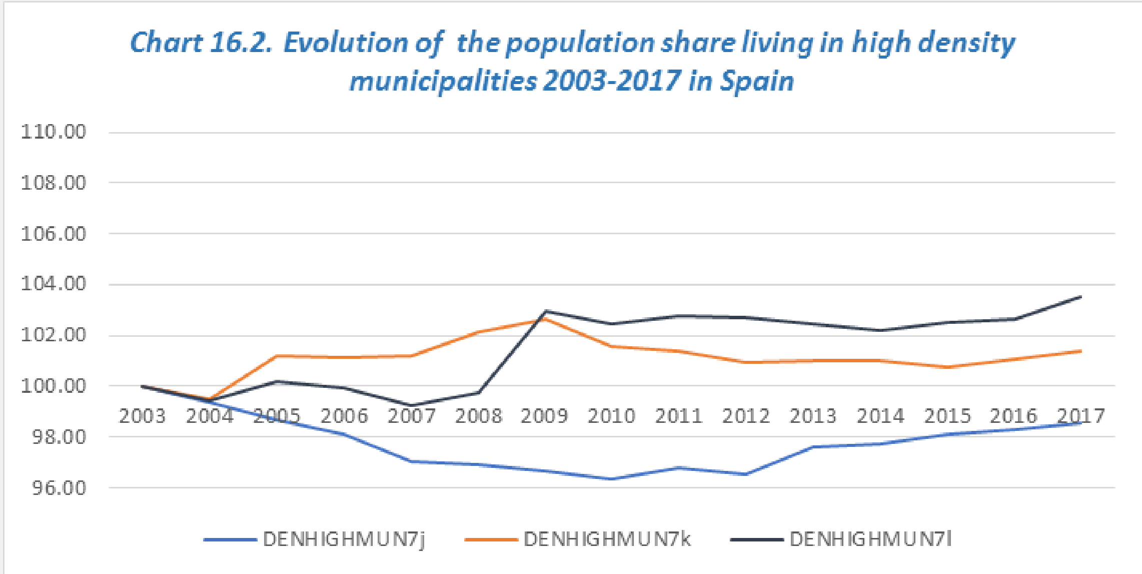
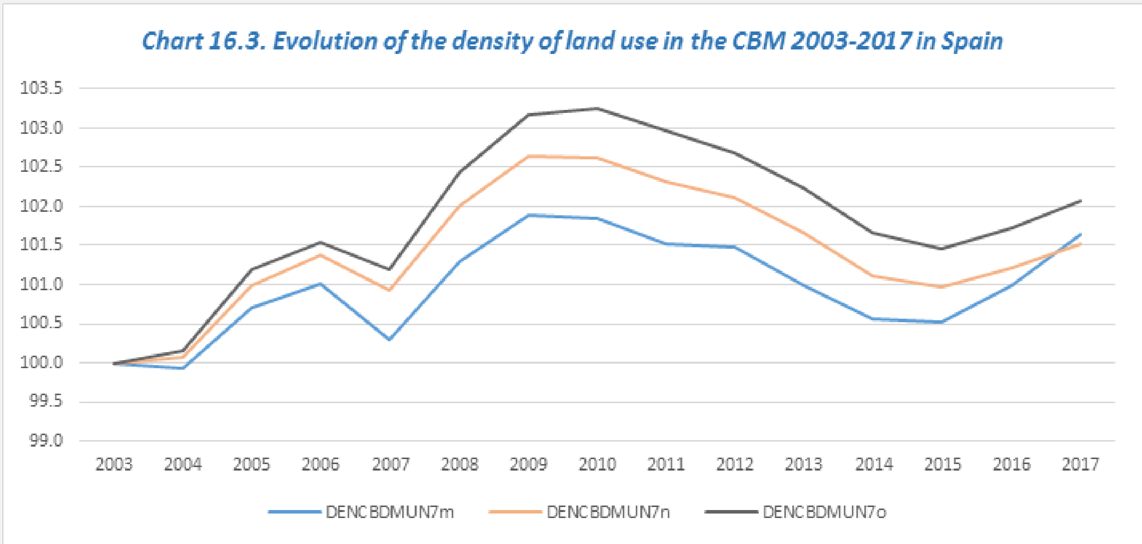






Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.
Note: Concerning the indicator "*Population share in high-density municipalities (residential")* (DENHIGH$_{MUN7l}$), in Illes Balears, there are municipalities with a residential population density at the threshold limit and small variations in residential density produce large changes

in the series because they affect municipalities with a high population weight in the province. This has been the case in 2013. To avoid spurious conclusions we have smoothed that indicator's series for this year.

Some insights into density in Spain's regions

The analysis of the position that each Region registers regarding density indicators and the comparative analysis between indicators will provide some insights into density in Spain's regions. For the mentioned analysis, we will rely on Table 26 and Chart 17. We have built Table 26 based on the ranking position each Region has for each density indicator, in decreasing order. A low number in Table 26 means high density. On the other hand, in Chart 18, we show the distribution of the nine density indicators for each Region and its position in that distribution. The central box encloses what we will name "*central*" values of the said distribution. The bottom whisker goes from the minimum to the first quintile of the distribution, enclosing the values that account for 20% of the distribution in the bottom positions. Regions holding such low levels of density are flagged with a red dot. The upper whisker goes from the fourth quintile to the maximum, enclosing the values that account for 20% of the distribution in the upper positions. Regions holding these high levels of density are flagged with a green dot.

It is important to keep in mind that we have calculated density indicators for each province and then aggregated them to the regional level. Therefore, our analysis outlines the regional panorama, which subsumes the provincial realities at the same time that it may conceal significant provincial differences within a region.

We would highlight the following features regarding population density in Spain's regions:

- **Andalucía** has intermediate to low levels of density, regardless of the indicator that is used, except for the population share living in high urban density municipalities, where the Region is at the national average.
- **Aragón** has significantly low levels of population density, regardless of the indicator that is used, except for the population share living in high urban and residential density municipalities, where the Region is among the highest positions.

- **Asturias** presents significantly low level of population density regardless of the indicator that is used. Regarding the population share living in high residential density municipalities, it is in an intermediate-low position.
- **Illes Balears** has notably low levels of population density, regardless of the indicator that is used, except for the population share living in high urban and residential density municipalities, where the Region is among the higher positions.
- **Canarias** shows intermediate-low, below average, levels of total population density and intermediate levels, yet above average, for urban and residential population density indicators.
- **Cantabria** shows intermediate-low levels of density indicators both for urban and residential density. As for total density, it is at or close to average. This means that in Cantabria the population exhibits a lower tendency to settle in thickly populated urban and built-up areas.
- **Castilla y León** has population density levels ranging among the lowest in Spain, regardless of the indicator that is used; with most of the indicators registering the very bottom positions.
- **Castilla-La Mancha** has population density levels among the lowest in Spain, regardless of the indicator that is used; with all of the indicators registering the very bottom positions.
- **Cataluña** has high levels of density, among the highest in Spain, regardless of the indicator that is used.
- **Comunidad Valenciana** has intermediate levels of density for all the indicators except for the rural and residential density in the CBD, where the indicators place the Region among the higher positions.
- **Extremadura** has very low levels of population density; with most of the indicators placing the Region in the bottom position.
- **Galicia** presents low levels of density, regardless of the indicator that is used.
- **Madrid** has high levels of density, among the highest in Spain for most of the indicators. As to total and urban density in the CBD, it is at or close to (above) average.

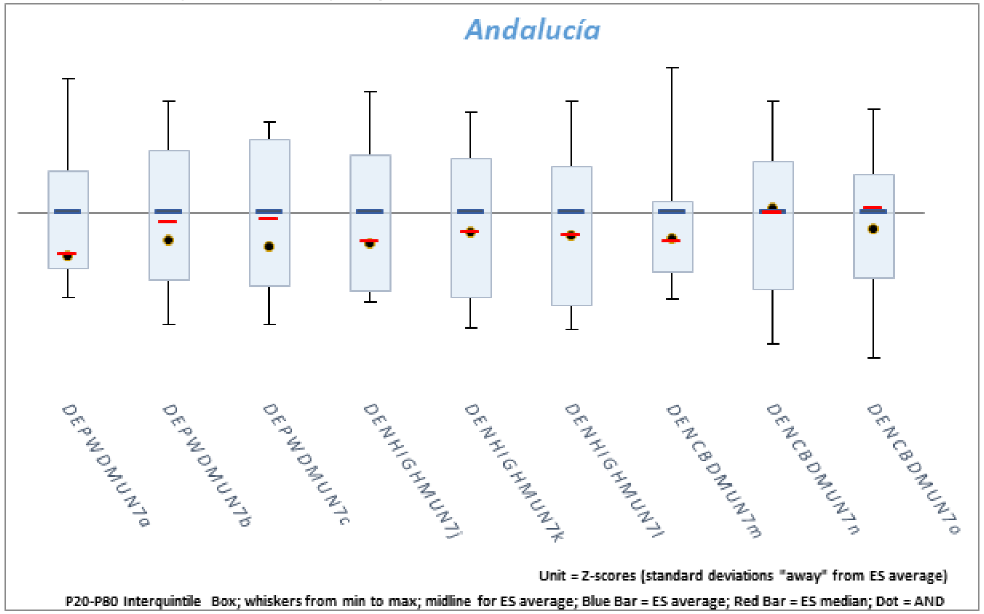
- **Murcia** has population density levels among the lowest in Spain, regardless of the indicator that is used; with all the indicators registering the very bottom positions.
- **Navarra** has high levels of total population-weighted density and total density of land use in the CBD, while the corresponding indicators for urban and built-up land place Navarra in intermediate-low positions. Regarding the population share in high-density municipalities, the three types of density indicators place the Region among high positions. This suggests that, in Navarra, most populated municipalities are intensely dense but to a lesser extent than in other provinces, pointing out that the population tends to be more uniformly distributed.
- **País Vasco** has high levels of density, among the highest in Spain for most of the indicators.
- **La Rioja** has intermediate levels of density, except for the population share living in high total density municipalities, for which La Rioja registers the lowest level in Spain.

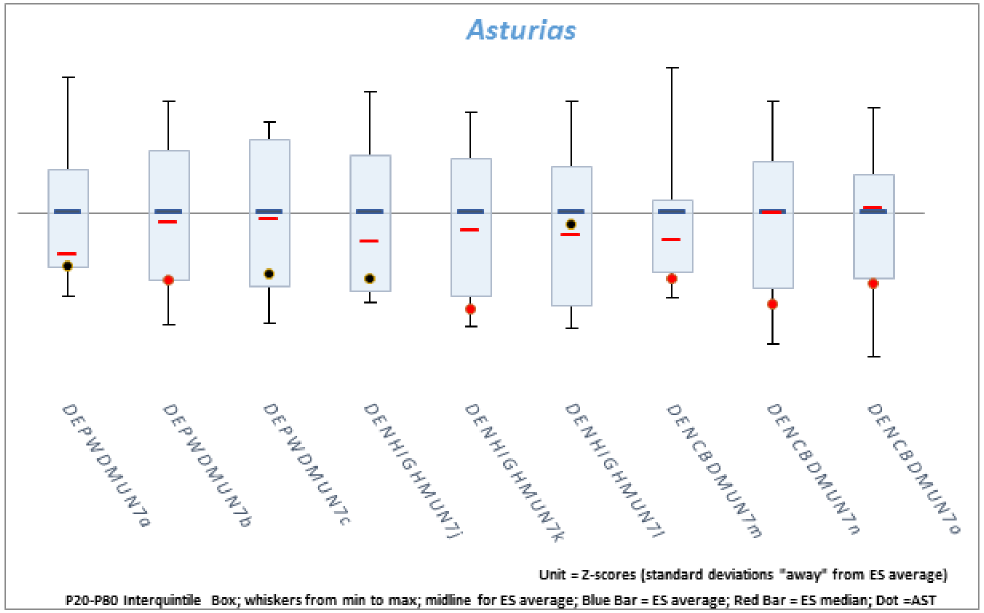
Table 26. Regional rankings of density indicators—Positions in decreasing order

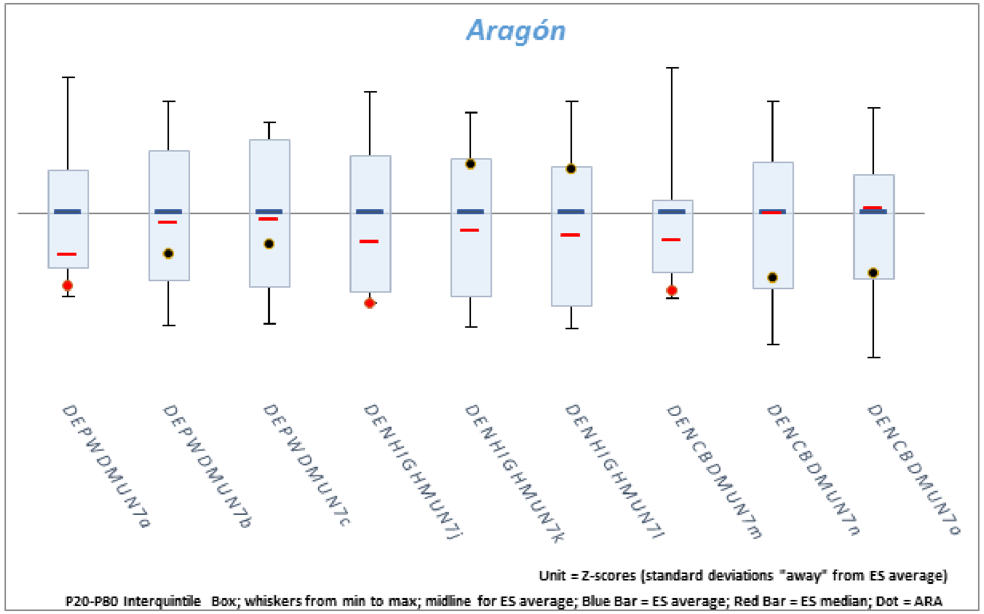
	Population-weighted density based on total land	Population-weighted density based on urban land	Population-weighted density based on built-up land	Population share in high-density municipalities (total)	Population share in high-density municipalities (urban)	Population share in high-density municipalities (residential)	Density of land use in the CBM based on total land	Density of land use in the CBM based on urban land	Density of land use in the CBM based on built-up land
Region	**$DEPWD_{MUN7a}$**	**$DEPWD_{MUN7b}$**	**$DEPWD_{MUN7c}$**	**$DENHIGH_{MUN7j}$**	**$DENHIGH_{MUN7k}$**	**$DENHIGH_{MUN7l}$**	**$DENCBD_{MUN7m}$**	**$DENCBD_{MUN7n}$**	**$DENCBD_{MUN7o}$**
Andalucía	8	7	8	9	9	10	7	5	6
Aragón	15	8	7	14	4	4	14	12	10
Asturias	12	13	11	11	14	9	13	14	12
Illes Balears	10	9	10	12	6	8	10	11	13
Canarias	7	5	4	8	8	7	9	4	5
Cantabria	6	10	13	5	10	11	5	8	11
C. y León	13	14	14	10	13	13	12	13	14
C-La Mancha	16	16	17	15	16	15	16	15	15
Cataluña	1	1	2	2	3	3	1	1	1
C. Valenciana	5	4	5	6	11	12	6	3	3
Extremadura	17	15	16	16	17	17	17	16	17
Galicia	9	12	12	7	12	14	8	10	9
Madrid	2	3	1	1	1	1	4	6	2
Murcia	14	17	15	13	15	16	15	17	16
Navarra	3	11	9	4	7	6	2	9	7
País Vasco	4	2	3	3	2	2	3	2	4
La Rioja	11	6	6	17	5	5	11	7	8

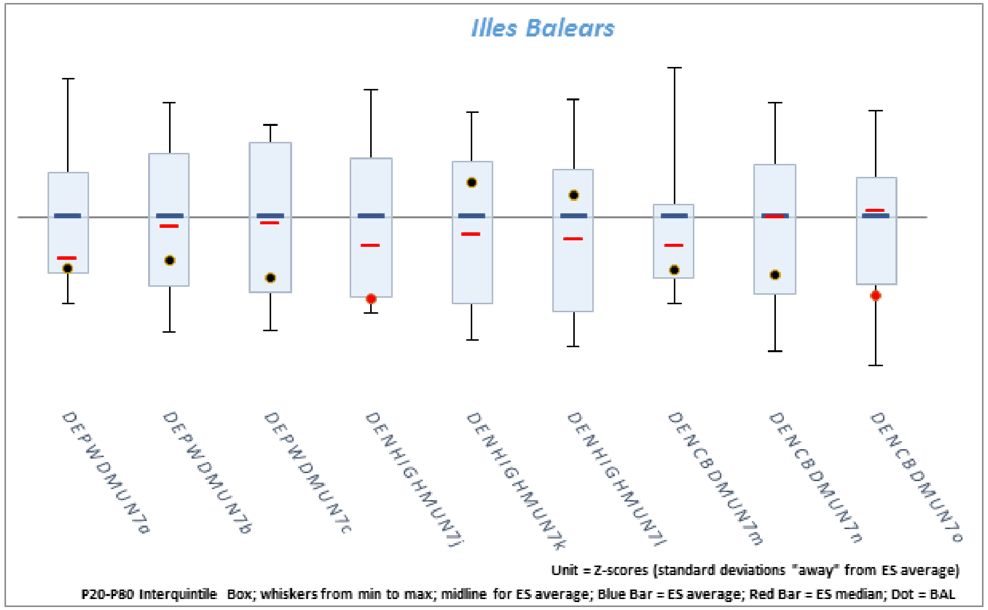
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 17. Density indicators by Region 2016 (*It continues*)





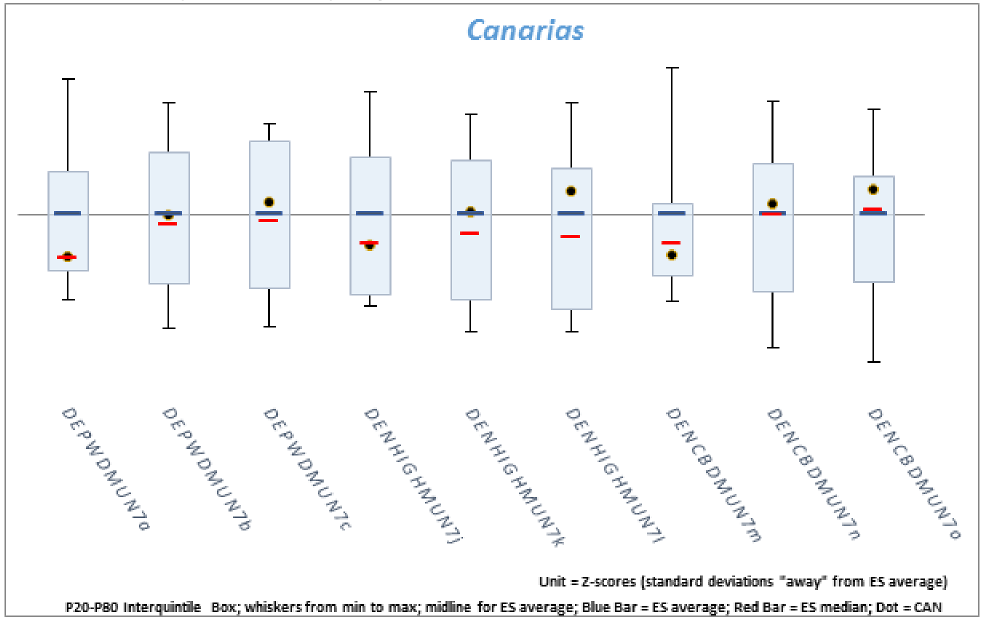


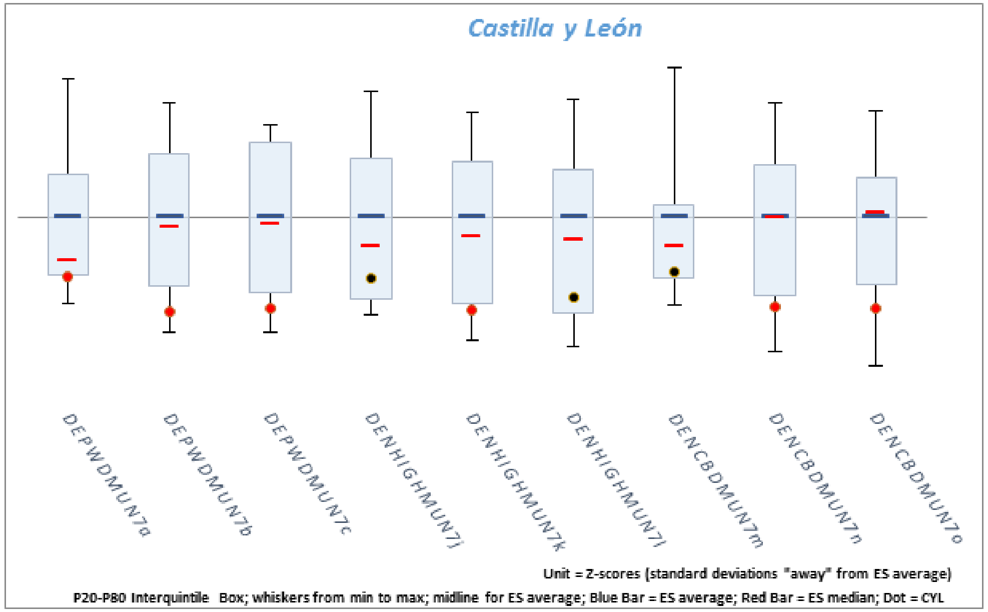


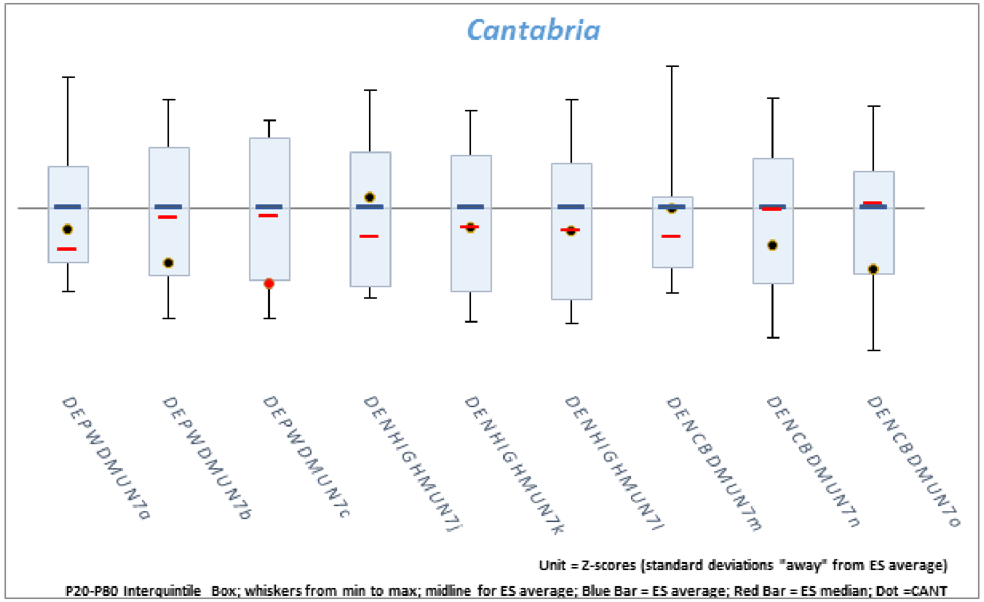
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

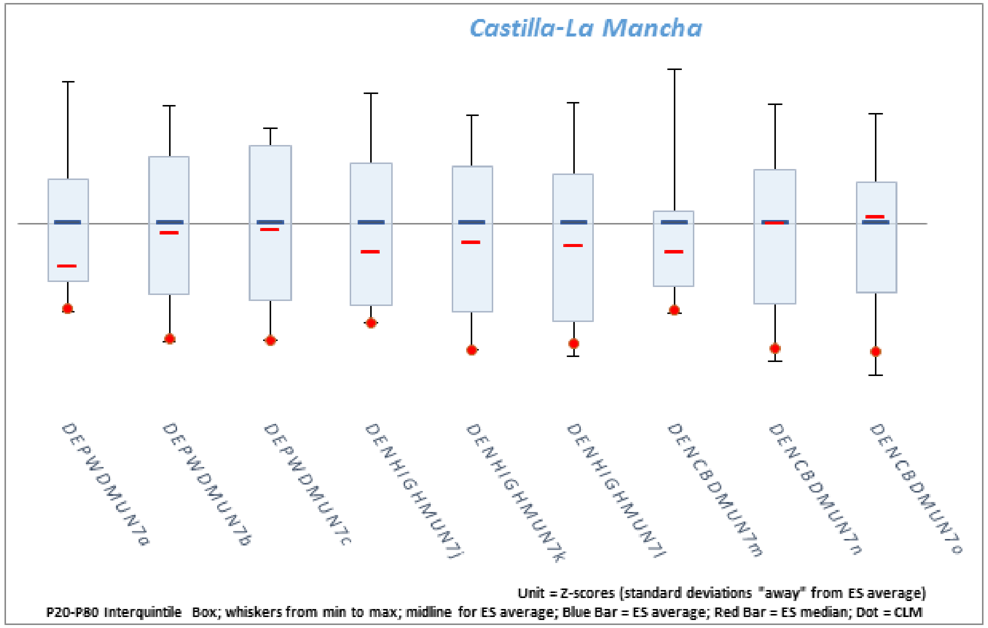
Chart 17. Density indicators by Region 2016

(It continues)





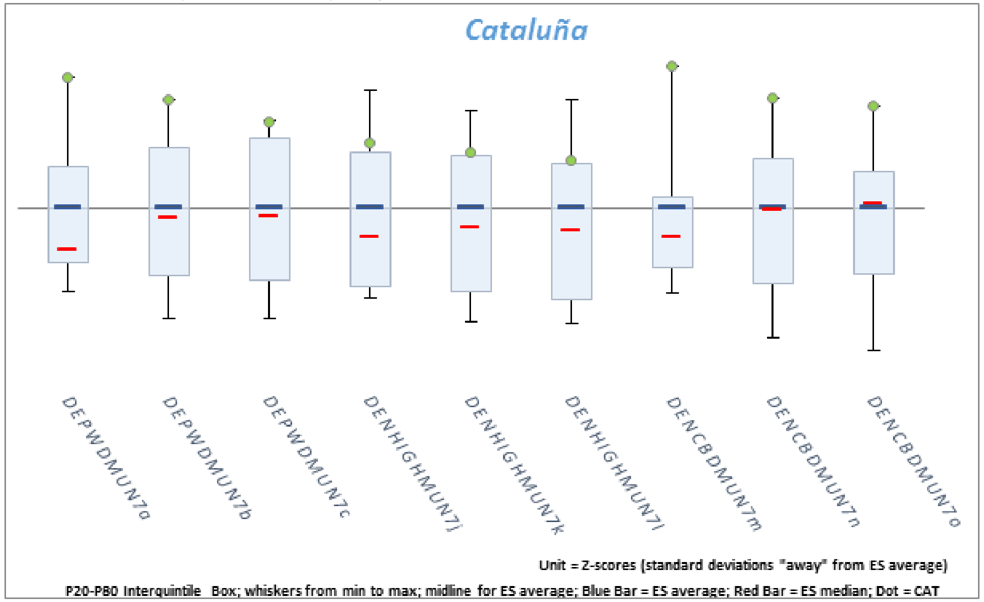


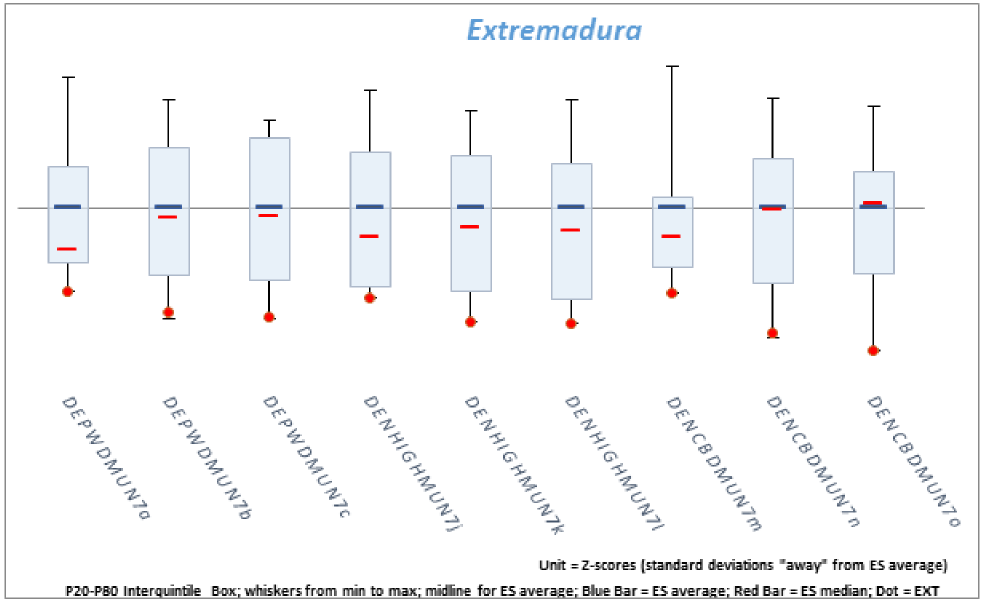


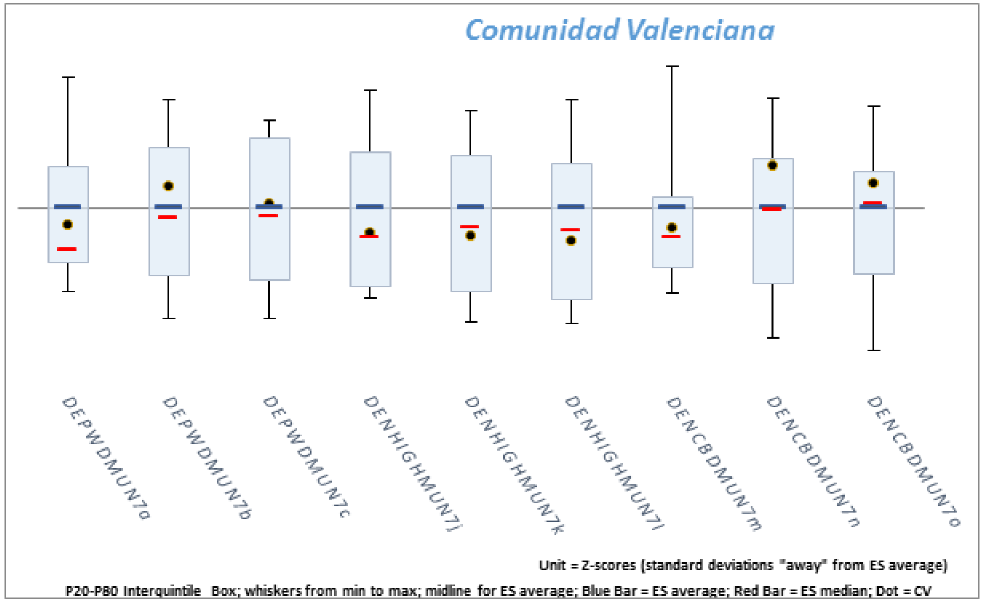
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

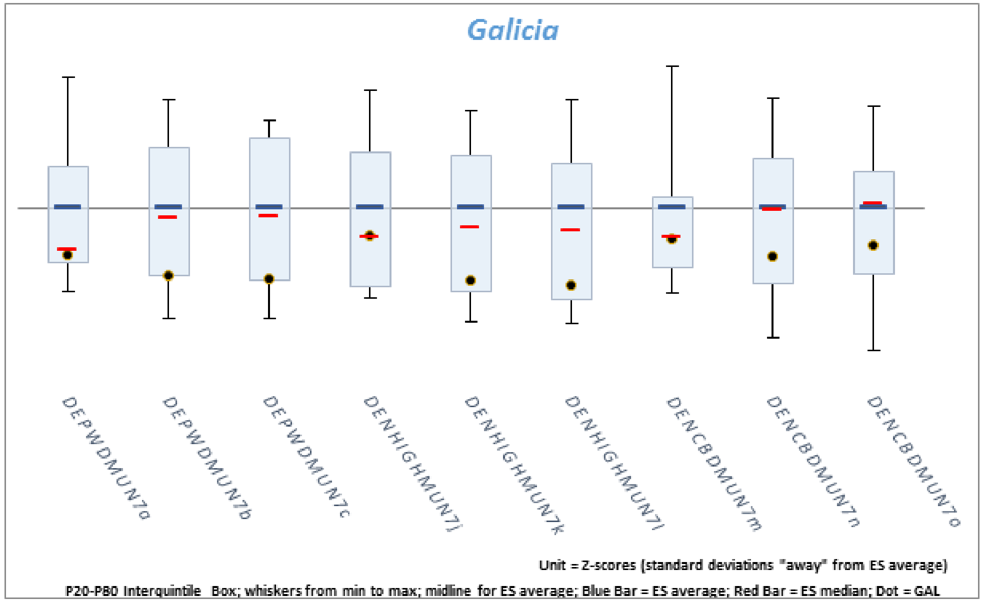
Chart 17. Density indicators by Region 2016

(It continues)



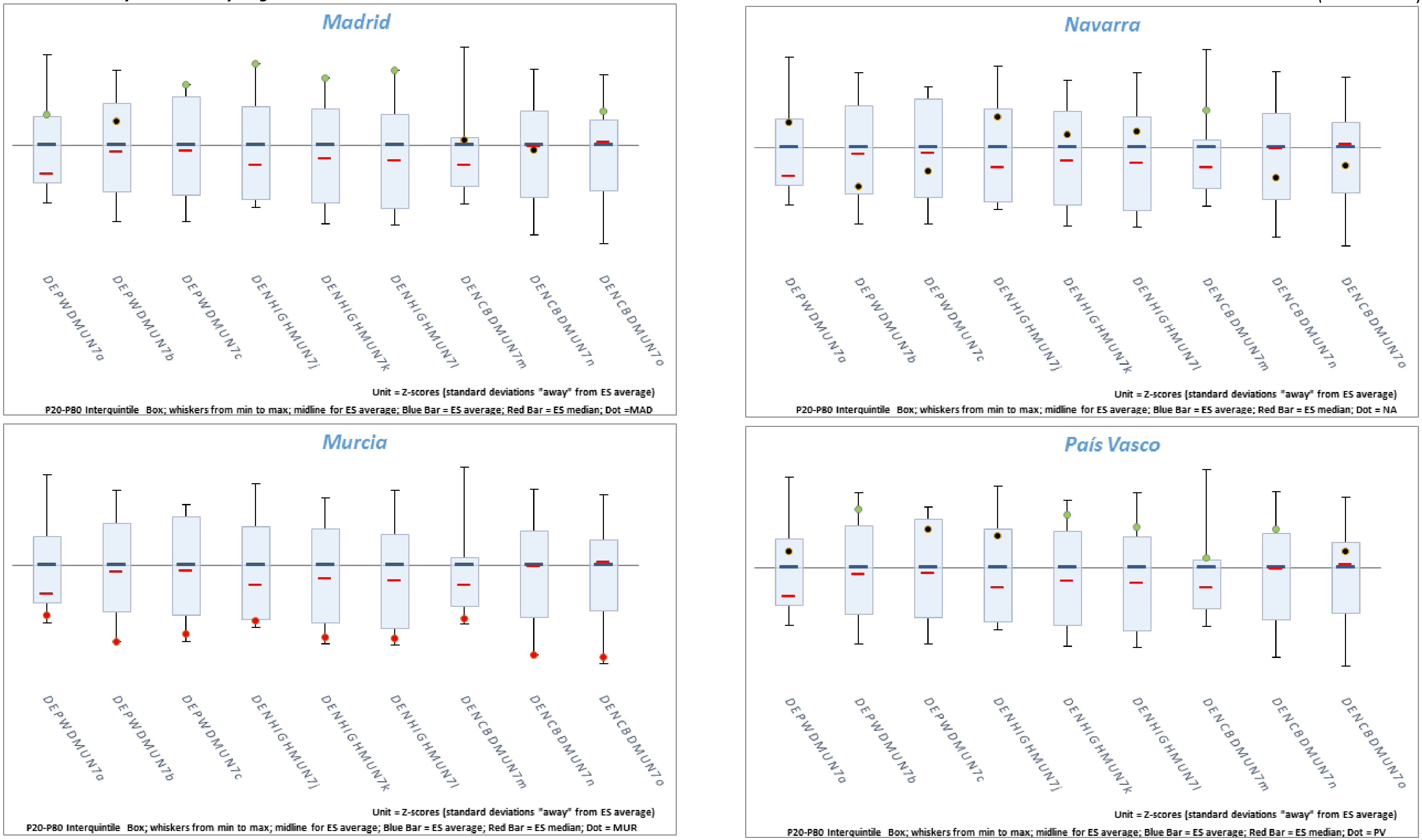






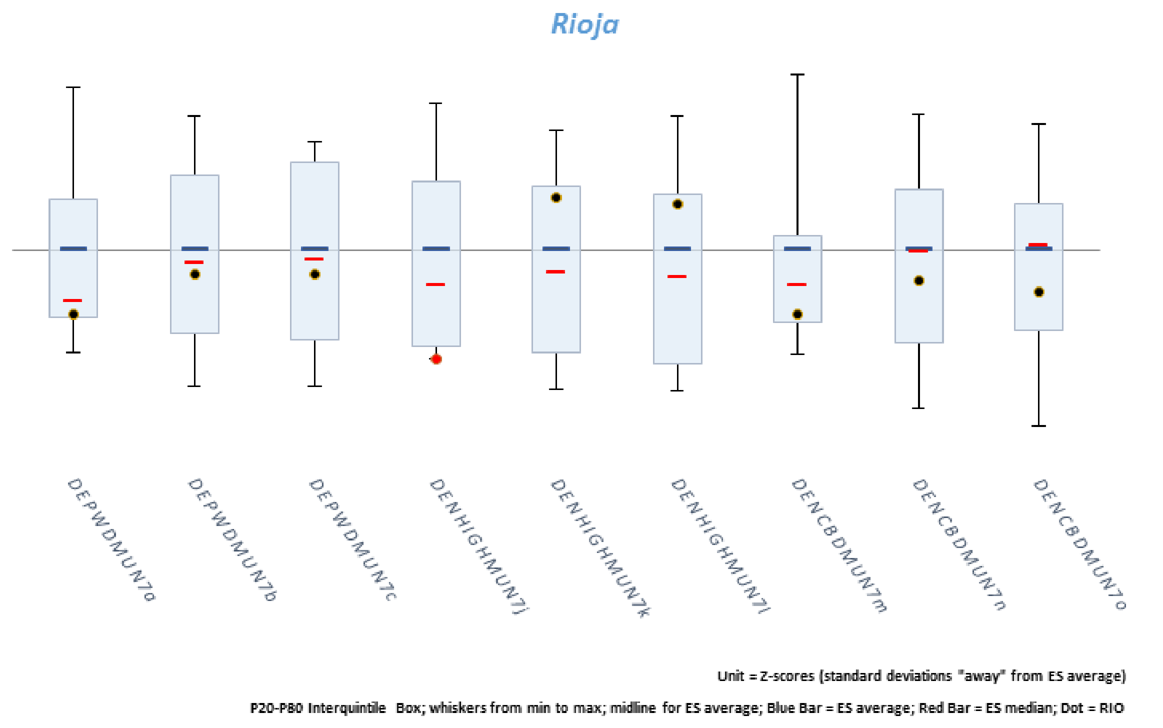
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 17. Density indicators by Region 2016 *(It continues)*



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 17. Density indicators by Region 2016 *(It concludes)*



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

In general, population density has increased over the period 2003-2017 at annual average rates between 0.01% and 0.25%, except for the population share in high total density municipalities, which has decreased at an annual average rate of around -0.10% (Table 27). In the period 2008 to 2017 it has remained stagnant, except for the *Population share in high-density municipalities,* total and residential ones, which increased at cumulative annual rates of 0.19% and 0.42% respectively.

Table 27. Evolution of population density indicators at the national level 2003-2017

Density indicators		Δ Annual average 2008/2003 (%)	Δ Annual average 2017/2008 (%)	Δ Annual average 2017/2003 (%)
Population-weighted density based on total land	*$DEPWD_{MUN7a}$*	0.01	0.01	0.01
Population-weighted density based on urban land	*$DEPWD_{MUN7b}$*	0.31	-0.05	0.08
Population-weighted density based on built-up land area	*$DEPWD_{MUN7c}$*	0.45	-0.01	0.16
Population share in high-density municipalities (total)	*$DENHIGH_{MUN7j}$*	-0.62	0.19	-0.10
Population share in high-density municipalities (urban)	*$DENHIGH_{MUN7k}$*	0.42	-0.08	0.10
Population share in high-density municipalities (residential)	*$DENHIGH_{MUN7l}$*	-0.06	0.42	0.25
Density of land use in the CBD based on total land	*$DENCBD_{MUN7m}$*	0.26	0.04	0.12
Density of land use in the CBD based on total land	*$DENCBD_{MUN7n}$*	0.40	-0.05	0.11
Density of land use in the CBD based on urban land	*$DENCBD_{MUN7o}$*	0.48	-0.04	0.15

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Concerning the density dynamic in Spain´s regions, when comparing their relative position to the national average in 2016 together with their time trend during the period 2003 to 2016 (Chart 18), we would highlight the following regional features:

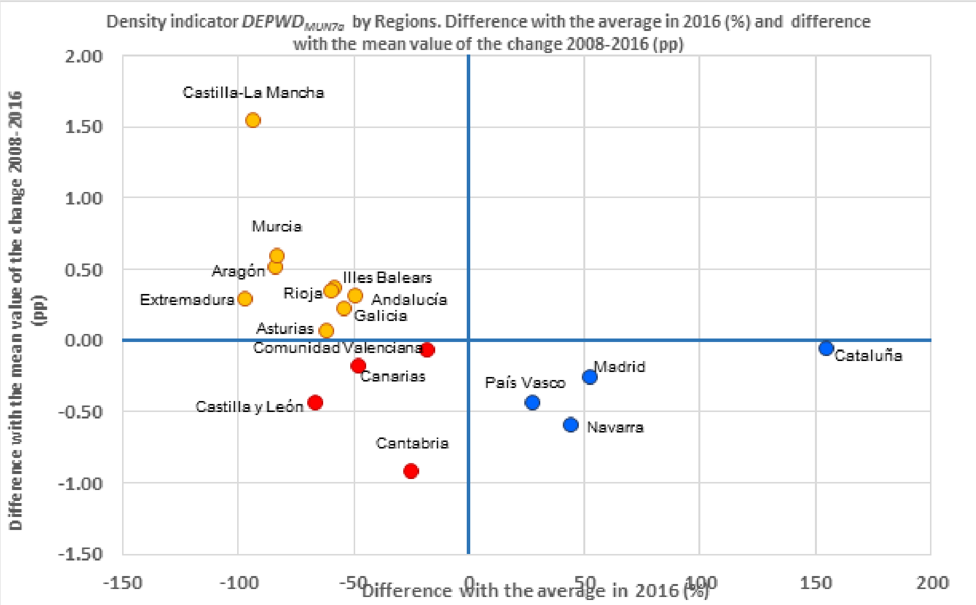
- **Andalucía** has systematically below average levels of density. Density in Andalucía is evolving at higher rates than the national average except for the density in the CBD. Thus, density would converge towards the national average, except that in the CBD.
- **Aragón** has systematically below average levels of density. For population-weighted density, it is evolving above the national average. Therefore, the Region would follow a converging path towards the national average regarding the three corresponding indicators. For the share of the population in high-density municipalities, Aragon is evolving below or close to the national average. Thus, the Region would remain stagnated or diverging from the national level. Regarding the density in the CBD, Aragón is evolving above the national average and, therefore, would converge towards it.
- **Asturias** has systematically below average levels of density and is evolving at lower rates than the national average, except for the density in the CBD. Thus, density would diverge from the national average, except that in the CBD, which will follow a convergent path.
- **Illes Balears** has systematically below average levels of density but evolving at notably higher rates than the national average. Thus, density would converge towards the national average.
- **Canarias** has systematically below average levels of density and evolving at lower rates than the national average. Thus, density would diverge from the national average.
- **Cantabria** has systematically below average levels of density and evolving at notably lower rates than the national average. Thus, density would diverge from the national average.

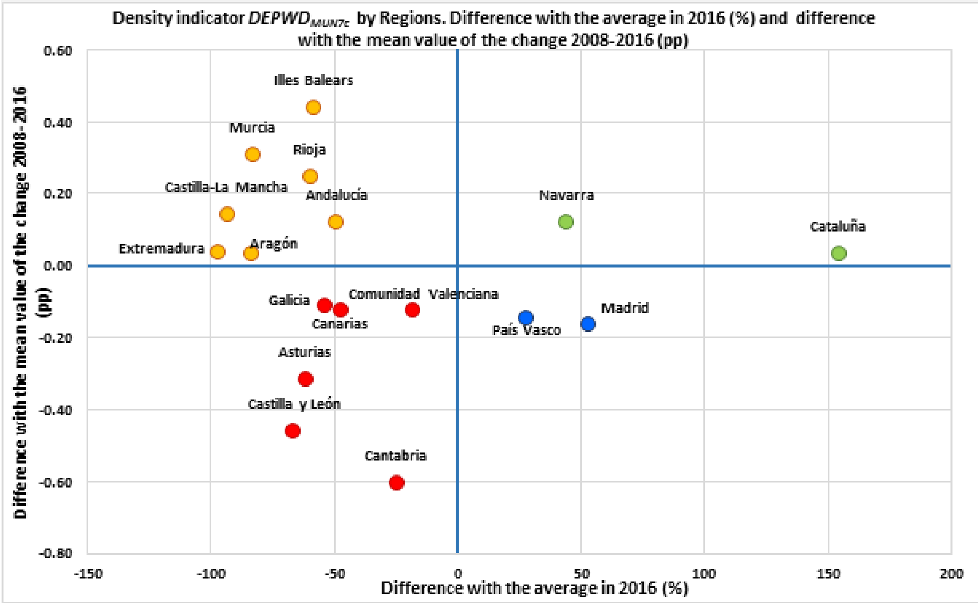
- **Castilla y León** presents systematically below average levels of density and evolving at notably lower rates than the national average. Thus, density would diverge from the national average.
- **Castilla-La Mancha** presents systematically below average levels of density but typically evolving at notably higher rates than the national average, except for the share of the population living in high-density municipalities. Thus, density would converge towards the national average, except for the share of population living in high-density municipalities, which would remain stagnated.
- **Cataluña** presents systematically well above the national average levels of density and typically evolving at the same pace as it or slightly faster. Therefore, population density in Cataluña would remain stagnated or follow an upwards divergence from the national level.
- **Comunidad Valenciana** has systematically below but close to average levels of density and evolving at lower rates than the national average, though typically close to it. Thus, density would remain stagnated or diverge from the national average.
- **Extremadura** presents systematically well below the national average levels of density and typically evolving at the same pace as it or slightly faster. Therefore, population density in Extremadura would remain stagnated or follow an upwards convergence to the national level.
- **Galicia**'s population density is below the national average and evolving with close to or lower rates than average, except for the indicators concerning the population share living in high-density municipalities. For these indicators it presents above the average rates of increase. This dynamic pattern would promote convergence towards the national average for the latest indicators and stagnation or divergence for the rest.
- **Madrid** has systematically above average levels of density but evolving at lower rates than the national average. Thus, density would follow a falling convergent path towards the national average.
- **Murcia** has systematically below average levels of density but evolving at higher rates than the national average, except for indicators concerning the population share living in high-density municipalities. For these indicators it presents below the

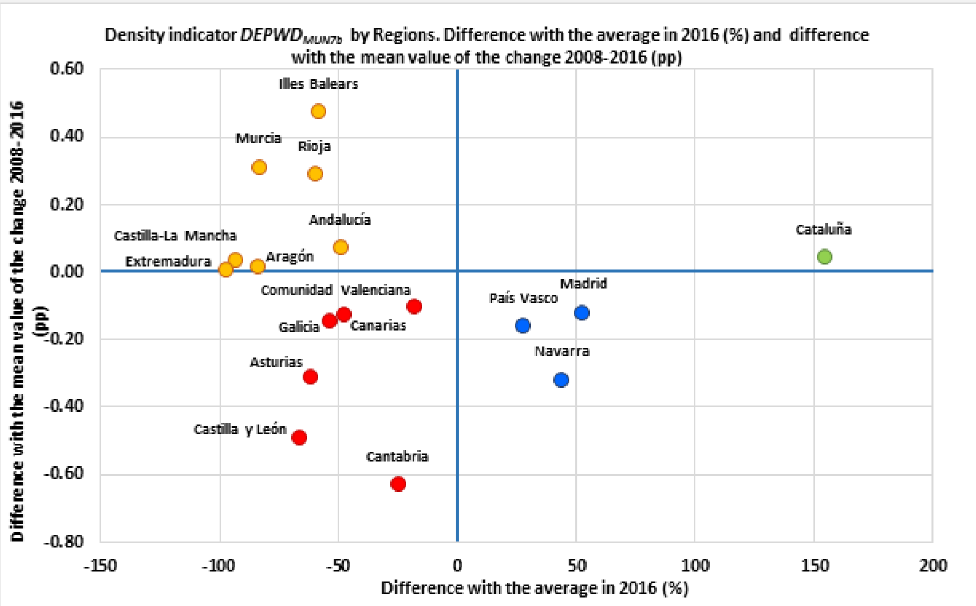
average rates of increase. These dynamic patterns would promote an increasing path towards the national average, with the exception of the mentioned indicators, which would follow a divergence path.

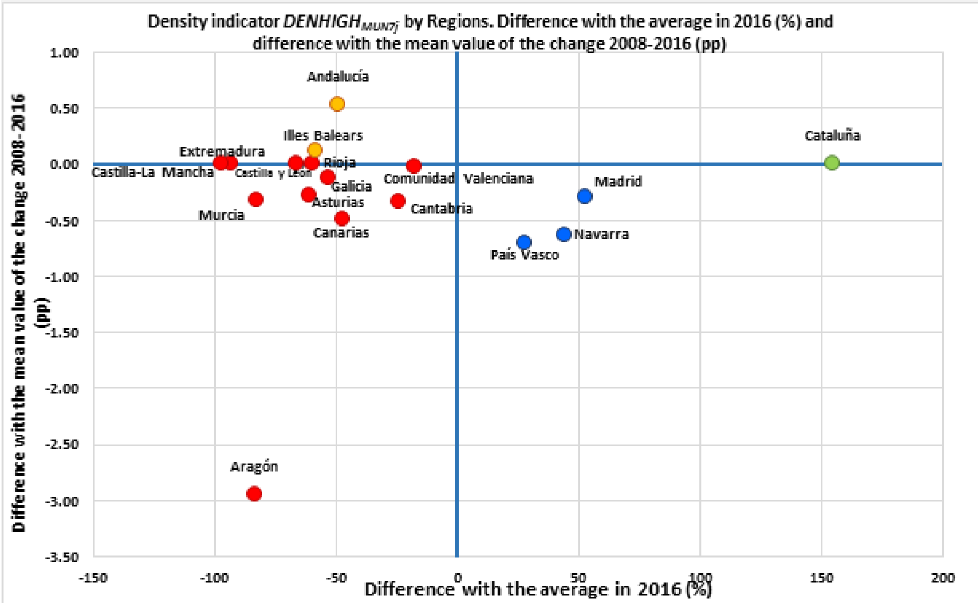
- **Navarra's** population density is above the national average but typically evolving at a slower pace than it, excepting the population-weighted residential density, which is evolving faster. This dynamic pattern would promote convergence towards the national average or an upwards divergence from it when considering population-weighted residential density.
- **País Vasco's** population density is above the national average but typically evolving at a slower pace than it. This dynamic pattern would promote downwards convergence towards the national average.
- **La Rioja** presents population density levels below the national average but with rates of change at or above the average, in some cases notably over it. These results show that the Region would be on the path to upgrade positions in the regional ranking.

Chart 18. The dynamic of density *(It continues)*



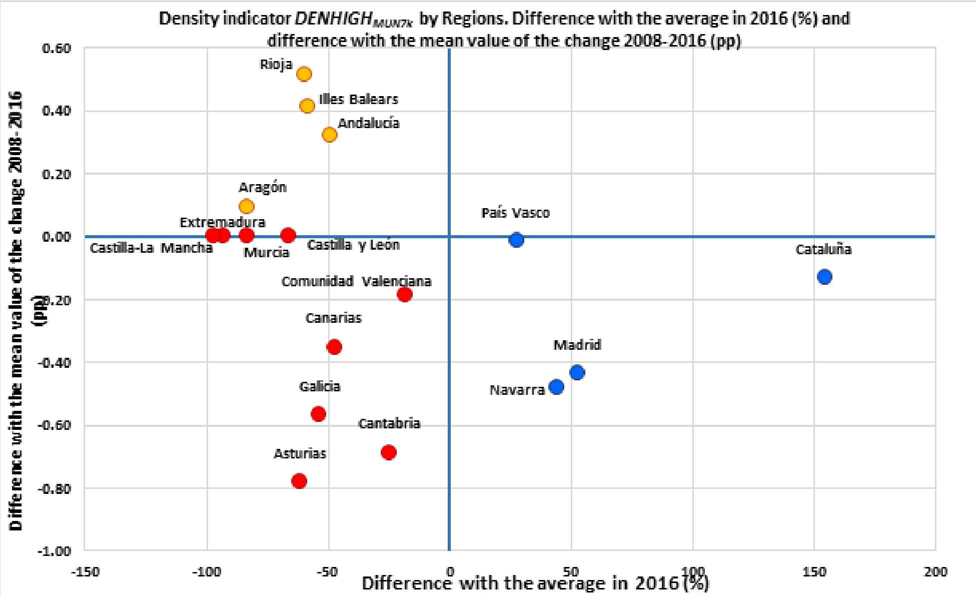


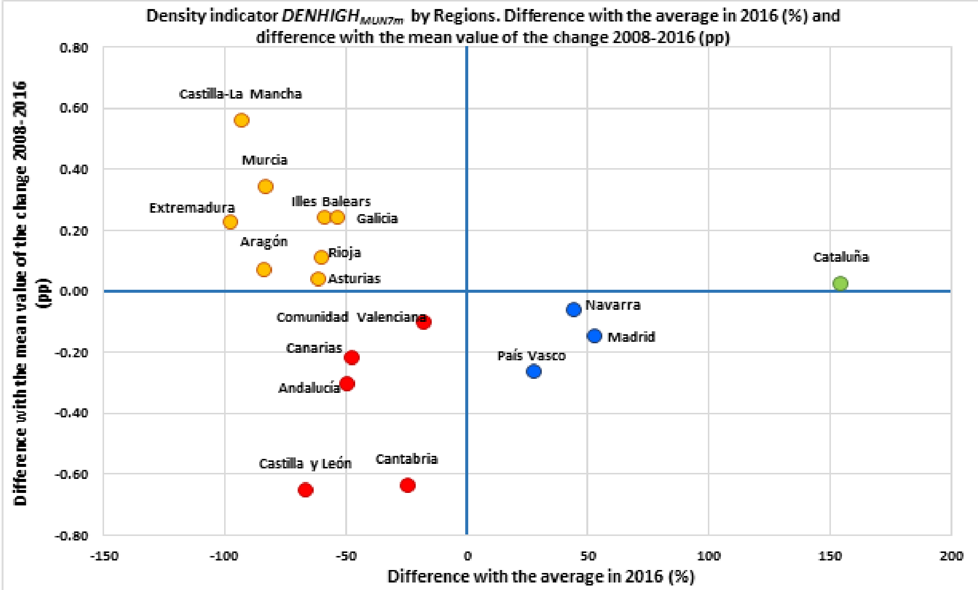


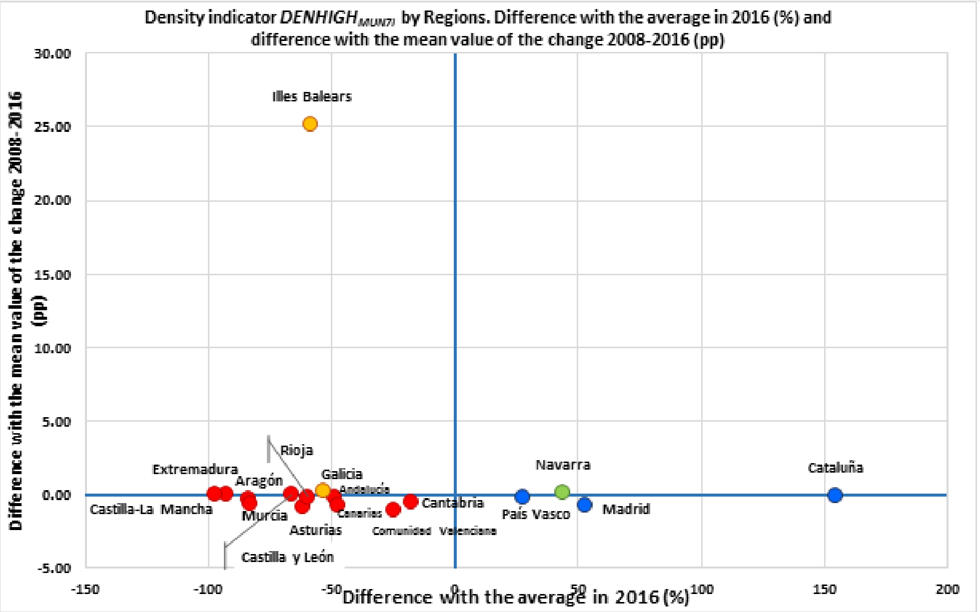


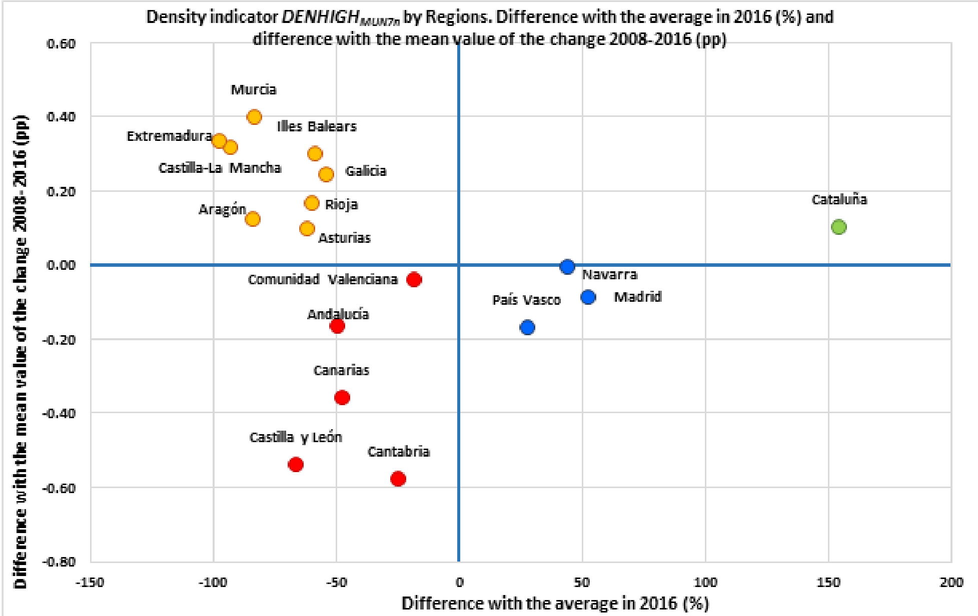
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 18. The dynamic of density *(It continues)*



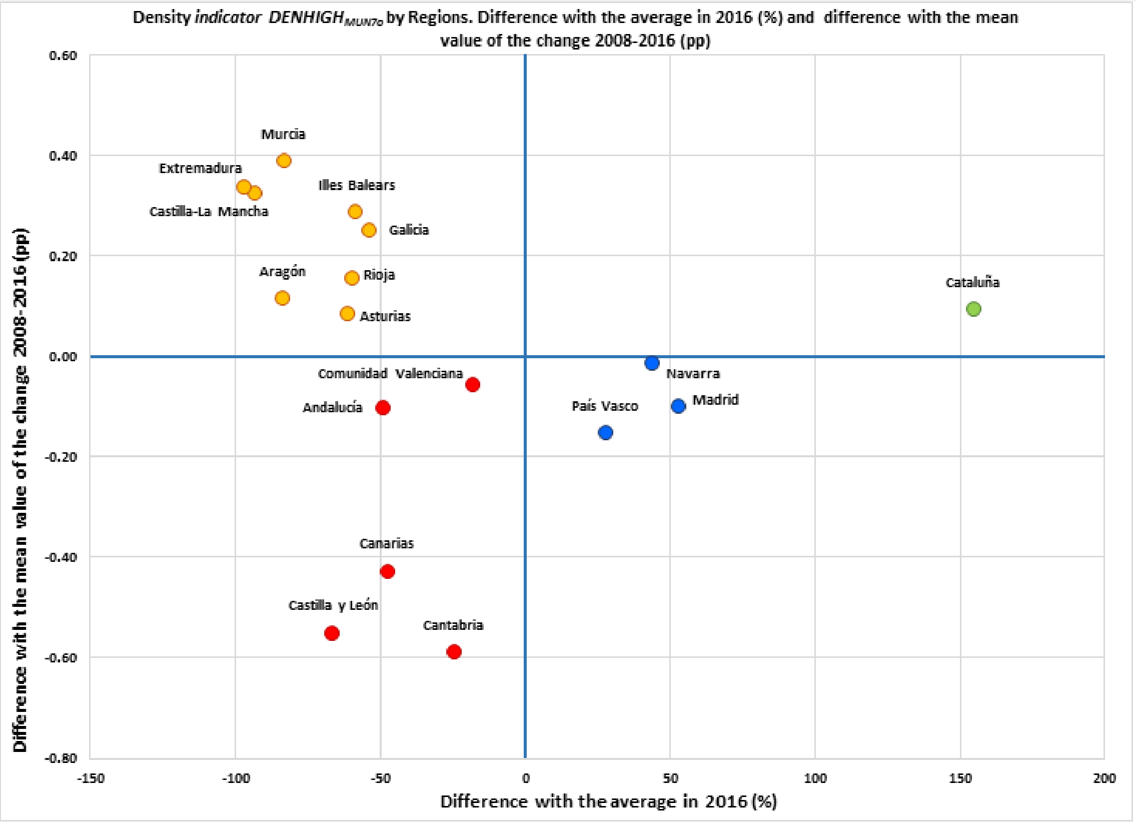






Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 18. The dynamic of density *(Conclusion)*



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Concentration

Concentration indicators

To measure concentration we focused on the population's distribution across the singular entities and municipalities. Especially, we focused on its variability and on the extent to which a small number of locations concentrate a high share of the population. To this end, we relied on a set of indicators that, on one hand, gauge the population density's variability and, on the other hand, the degree of unevenness or dissimilarity in the population's distribution. We worked with the following indicators:

- *Gini index for SE (**$CNGINI_{SE8a}$**).*
- *Standardised Theil entropy index (SE) (**$CNSTHEI_{SE8b}$**).*
- *Standardised Herfindahl index (SE) (**$CNSHHI_{SE8c}$**).*
- *Coefficient of variation of densities (**$CNDCV_{MUN9a}$**).*
- *Share of the population living in high-density municipalities based on built-up land (**$CNHGD_{MUN9b}$**).*
- *Population density gradient (**$CNPDG_{MUN9c}$**).*
- *Gini index for MUN based on population (**$CNGINI_{MUN9d}$**).*
- *Gini index for MUN based on land areas (**$CNGINI_{MUN9e}$**).*
- *Standardised Theil entropy index (MUN) (**$CNSTHEI_{MUN9f}$**).*
- *Theil index (**$CNTHI_{MUN9g}$**).*
- *Standardised Herfindahl index (MUN) (**$CNSHHI_{MUN9h}$**).*
- *Raw geographic concentration index (**$CNRGCI_{MUN9i}$**).*
- *Ellison and Glaesser (**$CNEG_{MUN9j}$**).*
- *Delta index (also Hoover index) (**$CNDI_{MUN9k}$**).*
- *Massey and Denton dissimilarity index for urban land (**$CNMDDI_{MUN9l}$**).*
- *Massey and Denton dissimilarity index for built-up land] (**$CNMDDI_{MUN9m}$**).*

We have borrowed indicators from several fields of analysis: "*variability of the population density*" (Coefficient of variation of densities, Share of the population living in high residential density municipalities, Population density gradient), income distribution (i.e. Gini or Theil indices), economic concentration (Herfindahl or Ellison and Glaeser indices) and social spatial segregation (Delta index or Massey and Deaton indices). Each of them reflects different facets of population concentration.

We present in Table 28 our results for the concentration indicators.

The ***Coefficient of variation of densities*** captures the statistical dispersion of the distribution across municipalities within the same province of the variable population density (δ_{ij}^{o}). In Spain, in 2016, at the national level, the coefficient of variation is 2.70 (or 270%) (Table 28). This high value points to a high level of concentration in Spain's regions. The minimum coefficient of variation of densities occurs in Extremadura (1.35) and the maximum in Navarra (7.33). It registers a high variability among regions.

As discussed in the methodological paper by Blanco, A. et al. (2021), one benchmark fairly used for an even population distribution is an equal or homogeneous population density across all land uses. When all land uses have the same population density, the variance of that variable is cero and so is that variance measured in relative terms of the mean value, which is the coefficient of variation (CV) of the population density. On the other hand, if just one municipality attracts all the population, the coefficient of variation tends to 1 as the number of municipalities increases.[24] Unlike other indicators that are addressed in this paper, the coefficient of variation of densities lacks an upper bound. Based on the literature review we assume that the greater the coefficient of variation of densities, the higher the spatial concentration of the population.

We highlight that Aragon, Madrid and País Vasco rank low or very low regarding the *Coefficient of variation of densities* while most of the concentration indicators place these regions in top positions (Table 29). On the contrary, Andalucía ranks high in the *Coefficient of variation of densities* while the rest of the indicators place the Region in bottom positions (except those based on urban and built-up land area concentration). Indeed, the correlation between the *Coefficient of variation of densities* and the rest of the concentration indicators is low or very low for most of them. Therefore, although the *Coefficient of variation of densities* captures concentration, it ranks some territories in a very dissimilar way as the rest of the indicators. This might be the case since the relationship between the mean and the coefficient of variation of urban population density at the province level is not particularly strong.[25]

[24] In our analysis, the minimum number of municipalities we deal with is 34 thus the minimum CV of the population density for a given province, should the population be located in just one municipality, would be 0.99.
[25] Similar situations at country level have been identified by some OECD analyses (OECD, (2018(b)).

The ***Population share living in high residential density municipalities*** *measures* the percentage population living in the most densely populated municipalities. Therefore, the higher the share, the greater the population concentration. As already discussed for density indicators, in Spain, overall, the population share in high-density municipalities (total) in 2016, amounts to 29%, ranging from 0% in Castilla y León, Castilla-La Mancha, Extremadura and La Rioja to 68% in Madrid with an interregional CV of 0.78. Regarding urban density, the corresponding data are 35% at the national level, ranging from 0% in Castilla y León, Castilla-La Mancha, and Extremadura to 66% in Madrid, with an interregional CV of 0.61. Finally, for residential density in Spain, on average in Spain a 38% of the population lives in municipalities with high residential density, ranging from 0% in Castilla y León, Castilla-La Mancha, and Extremadura to 72% in Madrid, with an interregional CV of 0.61. Please refer to Tables 23 and 28.

The ***Population density gradient*** is the rate at which density falls from the centre. A high value means that density will decline sharply with increasing distance from the province capital, thus pointing out to concentration in the CBD. The higher the gradient the greater the population concentration. Overall, in 2016, the Spanish population density gradient is 0.0408 ranging from -0.0041[26] in Illes Balears to 0.0982 in Madrid.[27] Please note that the population density gradient is the rate (ϕ) at which density falls from the centre calculated through the equation $\delta_{ij}^{0}\left(d_{ij}\right) = \delta_{CBD}e^{-\phi d_{ij}\varepsilon}$ (Blanco, A. et al. 2001). Thus, positive values reflect a fall in the population density while negative ones reflect an increase. There is high variability among regions, with a CV of 69%.

We highlight that the R^2 coefficients of determination of the OLS regressions that we have used to obtain the population density gradients (ϕ) are very low (Table 32). Thus, the calculated population density gradients would not reflect properly the extent to which density falls from the centre. As we have indicated in the methodological paper, the R^2 coefficient is a continuity indicator. Obtaining such low values for R^2 is coherent

[26] Please notice that the population density gradient is the rate (ϕ) at which density falls from the centre calculated through the equation $\delta_{ij}^{0}\left(d_{ij}\right) = \delta_{CBD}e^{-\phi d_{ij}}$ (Blanco, A. et al.2001). Thus, positive values reflect a fall in the population density while negative ones reflect an increase.

[27] In the literature, estimates for some Spain's cities yield population density gradients of 0.233 to 0.338 with R^2 between 59% to 64% for Gijon (1950-1996) and 0.05 to 0.094 with R^2 between 4% to 10% for Oviedo (1986-1996) (Mayor et al. 2000).

with the fact that our geographical unit of analysis is the province instead of a metropolitan area, and land uses are its municipalities with extensive vacant land areas.

The rest of the indicators we propose for concentration have been designed to approach inequality or dissimilarity (or alternatively, evenness). Typically, these sorts of indices are dimensionless with low values reflecting low concentration or equivalently high dispersion.

Gini's indices rank between 0 and 1 the extent to which population concentrates in few locations. We highlight that, when used as a measure of spatial concentration, the Gini index does not take into account the proximity between the different population zones.

The ***Gini index based on SE*** (***$CNGINI_{SE8a}$***) compares the accumulation of population in SE against the accumulation of the number of SE. Thus, it takes as a de-concentration benchmark the situation where all SE have the same share of the population, in which case the index is zero. Overall, the average for Spain in 2016 is 0.8728, pointing to a high level of population concentration. It ranges from 0.7675 in Extremadura to 0.9437 in Madrid. Interregional variability is low with a CV of 5%.

The ***Gini index for MUN based on population ($CNGINI_{MUN9d}$)*** compares the accumulation of population in MUN against the accumulation of the number of MUN. Thus, it takes as a de-concentration benchmark the situation where all MUN have the same share of the population, in which case the index is zero. Overall, the average for Spain in 2016 is 0.7725, pointing to a high level of population concentration. It ranges from 0.6259 in Galicia to 0.8893 in La Rioja. Interregional variability is low with a CV of 10%.

We highlight that the unit of analysis appears as a key factor to study the dynamics of concentration. Indeed, the literature review has shown that, generally, the degree of concentration increases with the size of the chosen spatial units. Typically, the indices are sensitive to the level of geographical aggregation. The integration of two or more SE or MUN normally implies a reduction of the calculated value of the index (aggregation implies erasing part of the differences). Although there is a moderately high correlation of 0.75 between the two indicators $CNGINI_{SE8a}$ and $CNGINI_{MUN9d}$, they yield different rankings for the regions (Table 29).

The ***Gini index for MUN based on land areas ($CNGINI_{MUN9e}$)*** compares the accumulation of population in MUN against the accumulation of MUN land areas. Thus, it takes as a de-concentration benchmark the situation where all MUN have the same population density, in which case the index is zero. Overall, the average for Spain in 2016 is 0.7376, pointing out to a high level of population concentration. It ranges from 0.5619 in Extremadura to 0.8409 in La Rioja. Interregional variability is low with a CV of 10%. We notice that the correlation between $CNGINI_{SE8a}$ and $CNDCV_{MUN9e}$ of 0.82 is even higher than that between $CNGINI_{SE8a}$ and $CNDCV_{MUN9d}$.

Theil entropy indices are based on the idea that “order” (the index equals 1) is associated with the concentration of the bulk of the population in a few locations (maximum concentration). While “disorder” (the index equals 0) is associated with an even distribution of the population among locations (high entropy; dispersion); that is, all the singular entities have the same share of the population.

In 2016, nationwide, the ***Standardised Theil entropy index (SE)*** (**$CNSTHEI_{SE8b}$**) is 0.3685. It ranges from 0.2783 in Extremadura to 0.5624 in Aragón. Interregional variability is high with a CV of 20%. As for the ***Standardised Theil entropy index (MUN) ($CNSTHEI_{MUN9f}$)***, Spain’s average is 0.3452. It ranges from 0.2243 in Galicia to 0.5645 in Aragón. Interregional variability is high with a CV of 24%. Once again, the correlation between SE and MUN based indices for standardised Theil entropy is high: 0.90.

The ***Theil index*** or mean logarithmic deviation is also a measure of the dissimilarity municipal densities. It has a minimum value of zero (if there is an even spatial distribution of the population), but has no upper limit. On average, it is 4.4434 for Spain, ranging from 1.7971 in Extremadura to 8.3026 in Cataluña. Interregional variability is high with a CV of 46%.

The ***Herfindahl index*** (also Herfindahl-Hirschman index) shows whether the population is concentrated in a small number of land uses, giving more relevance to the largest ones by square weighting. In 2016, nationwide, the ***SE-based Standardised Herfindahl Index*** is 0.1208, ranging from 0.0229 in Murcia to 0.3455 in Aragón. Interregional variability is high with a CV of 62%. On the other hand, the MUN-based Standardised Herfindahl Index is 0.1339, ranging from 0.0636 in Aragón to 0.3759 in Extremadura. Interregional variability is high with a CV of 53%. Once again, the correlation between SE and MUN based indices for standardised Theil entropy is high: 0.96.

The ***Raw geographic concentration index*** measures the degree to which the municipalities' population shares mimic the pattern of municipalities' surface shares. Should they match, the population would be evenly distributed and the index value would equal zero. An index greater than zero indicates the existence of other agglomeration-generating factors that go beyond the surface of the municipality. In 2016, nationwide, the Raw geographic concentration index is 0.1166, ranging from 0.0347 in Extremadura to 0.3209 in Aragón. Interregional variability is high with a CV of 47%.

Translated to population concentration, the ***Ellison and Glaesser index*** is a normalised comparison between the population's distributions against the benchmark of land area distribution. The index is a measure of population excess-concentration with respect to land area concentration. In 2016, nationwide, the Ellison and Glaesser index is 0.1109, ranging from 0.0299 in Extremadura to 0.3219 in Aragón. Interregional variability is high with a CV of 51%.

Finally, fairly used in social spatial segregation, the family of dissimilarity indices (Delta –or Hoover- index; and Massey and Denton index) provides additional measures of the evenness with which a specific variable distributes across municipalities, where evenness reflects de-concentration.

The ***Delta index*** measures dissimilarity between the population's distribution across municipalities and evenness, where evenness responds to equal population density in all municipalities. The index stands for the proportion of population residing in municipalities with an above average density of the population that would have to move in order to achieve a perfectly even distribution: one with uniform density. In 2016, nationwide, the Delta index is 0.6009, meaning that 60% of the Spanish population would have to move in order to achieve a perfectly even distribution. It ranges from 0.4416 in Extremadura to 0.6902 in La Rioja. Interregional variability is moderate with a CV of 11%.

The ***Massey and Denton dissimilarity index for urban land*** measures the dissimilarity between the distribution of urban land and evenness, where evenness means an equal share of urban land across all the municipalities. The index stands for the proportion of urban land that would have to relocate itself to achieve an even distribution. In 2016, nationwide, the Massey and Denton dissimilarity index for urban land is 0.5049, meaning that 50% of the Spanish urban land would have to move in order to achieve a perfectly even distribution. It ranges from 0.3333 in Canarias to 0.5592 in Cataluña. Interregional variability is moderate with a CV of 12%.

The ***Massey and Denton dissimilarity index for built-up land*** measures the dissimilarity between the distribution of built-up land and evenness, where evenness means an equal share of built-up land across all municipalities. The index stands for the proportion of built-up land that would have to relocate itself to achieve an even distribution. In 2016, nationwide, the Massey and Denton dissimilarity index built-up land is 0.4937, meaning that 49% of the Spanish built-up land would have to move in order to achieve a perfectly even distribution. It ranges from 0.3478 in Illes Balears to 0.5582 in Cataluña. Interregional variability is moderate with a CV of 12%.

The regions whose level of population concentration is systematically in top positions above the national average are Aragon, Asturias, Cataluña, Madrid, País Vasco and La Rioja. Those with systematically bottom positions below the national average are Andalucía, Illes Balears, Canarias, Castilla-La Mancha, Extremadura, Galicia and Murcia (Table 29).

The distribution of the concentration indicators among regions in Spain is typically positive asymmetric (Chart 19), with two exceptions: the *Massey and Denton dissimilarity indices* for urban and built-up, for which it is symmetric or negative asymmetric. This means that more than half of the population in Spain lives in regions with population concentration below the national average. However, half or more than half of the population in Spain lives in regions with concentration levels of urban and built-up land above the national average. Concerning the interregional variability of the indicators (CV), it is very high except for the Gini and dissimilarity indices.

These interregional differences happen in a general context where some indicators point to high population concentration in all Spanish regions. Indeed, Gini indices are close to one in all regions. The *Coefficient of variation of densities* is also very high, fairly over 100% reaching 733% in Navarra. The proportion of the population residing in municipalities with an above average density of population that would have to move in order to achieve a perfectly even distribution is more than 60%. The proportion of urban land that would have to relocate itself to achieve an even distribution is more than 50%; and the proportion of built-up land that would have to relocate itself to achieve an even distribution is almost 50%.

On the other hand, some indicators point out to lower degree of population concentration. This would be the case for the share of the population living in high residential density municipalities, which accounts for 38%. Being below 50%, according to Dijkstra, L. et al. (2014), overall, Spain is not a densely populated area. Nonetheless, we notice that, as reported by the mentioned work by Dijkstra, L. et al. (2014), on average, in the EU, 40% of the population lives in "*densely populated areas"* and, at the same time, pursuant to Eurostat (2018), the Gini index of population concentration (based on land areas) in the EU is rather high.

In addition, the Theil entropy indices show values farther away from the maximum attainable value, which is one. Being far from one would point to a low level of population concentration.

As for Standardised Herfindahl indices, according to the scales stemming from the economic concentration field (Lis-Gutiérrez, JP. (2013); Zurita, J. (2014)), we would say that the population in Spain's regions is deconcentrated.

We highlight that for concentration there are contradictory signals with respect to the comparison with absolute benchmarks, which seems also to be present in some analyses in the European context. Therefore, we will rely on the composite indicator for population concentration to draw our final conclusions. However, this does not affect the regional rankings analysis coming next.

Regarding the evolution from 2003 to 2017 (Chart 20), all the indicators, except the *Population share living in high residential density municipalities* and the *Population density gradient,* show a decreasing trend or stagnation.

Table 28.1. Concentration indicators by regions in 2016

REGIONS	Gini index for SE	Standardised Theil entropy index (SE)	Standardised Herfindahl index (SE)	Coefficient of variation of densities	Share of the population living in high-density municipalities *	Population density gradient	Gini index for MUN based on population	Gini index for MUN based on land areas	Standardised Theil entropy index (MUN)	Theil index	Standardised Herfindahl index (MUN)	Raw geographic concentration index	Ellison and Glaeser	Delta index	Massey and Denton dissimilarity index for urban land	Massey and Denton dissimilarity index built-up land
	$CNGINI_{SE8a}$	$CNSTHEI_{SE8b}$	$CNSHHI_{SE8c}$	$CNDCV_{MUN9a}$	$CNHGD_{MUN9b}$	$CNPDG_{MUN9c}$	$CNGINI_{MUN9d}$	$CNGINI_{MUN9e}$	$CNSTHE_{IMUN9f}$	$CNTHI_{MUN9g}$	$CNSHH_{IMUN9h}$	$CNRGCI_{MUN9i}$	$CNEG_{MUN9j}$	$CNDI_{MUN9k}$	$CNMDDI_{MUN9l}$	$CNMDDI_{MUN9m}$
TOTAL	**0.8728**	**0.3685**	**0.1208**	**2.6991**	**0.3768**	**0.0408**	**0.7725**	**0.7376**	**0.3452**	**4.4434**	**0.1339**	**0.1166**	**0.1109**	**0.6009**	**0.5049**	**0.4937**
Andalucía	0.8556	0.3582	0.0979	2.8093	0.2983	0.0277	0.7318	0.7056	0.3362	2.8766	0.1097	0.0971	0.0890	0.5661	0.5353	0.5331
Aragón	0.9008	0.5624	0.3455	2.3661	0.5066	0.0250	0.8833	0.7846	0.5645	4.6213	0.3759	0.3209	0.3219	0.6622	0.5354	0.5023
Asturias	0.9118	0.5016	0.1024	2.9594	0.3282	0.0258	0.7872	0.7889	0.3456	3.9522	0.1172	0.1216	0.1133	0.6563	0.5466	0.5466
Illes Balears	0.7931	0.3013	0.0794	1.9155	0.4378	-0.0041	0.6980	0.5847	0.2904	1.9477	0.1336	0.1132	0.1028	0.4437	0.3499	0.3478
Canarias	0.8088	0.2884	0.0557	1.8572	0.4437	0.0087	0.6398	0.6553	0.2324	2.3662	0.0943	0.0985	0.0811	0.5216	0.3333	0.3854
Cantabria	0.8649	0.3448	0.0580	3.9888	0.2966	0.0562	0.7421	0.8279	0.2961	5.2373	0.1002	0.1110	0.1042	0.6764	0.5567	0.5567
C. y León	0.8698	0.4660	0.1970	4.7795	0.1438	0.0166	0.8264	0.7783	0.4398	3.7808	0.2061	0.1953	0.1934	0.6407	0.4953	0.4506
C-La Mancha	0.8233	0.3357	0.0845	2.0905	0.0364	0.0117	0.7442	0.6703	0.2878	2.7377	0.0867	0.0701	0.0647	0.5261	0.4744	0.4420
Cataluña	0.9104	0.2896	0.0799	3.1306	0.5236	0.0591	0.8090	0.8308	0.3202	8.3026	0.0834	0.0802	0.0773	0.6798	0.5592	0.5582
C. Valenciana	0.8381	0.3328	0.0782	2.6174	0.2676	0.0380	0.7876	0.7433	0.3053	4.6939	0.0844	0.0789	0.0751	0.5961	0.5388	0.5362
Extremadura	0.7675	0.2783	0.0576	1.3543	0.0000	0.0083	0.7038	0.5619	0.2530	1.7971	0.0636	0.0347	0.0299	0.4416	0.3872	0.3624
Galicia	0.8223	0.3505	0.0593	2.6613	0.1194	0.0179	0.6259	0.6628	0.2243	2.3148	0.0838	0.0848	0.0743	0.5229	0.4304	0.4147
Madrid	0.9437	0.4519	0.2449	1.9290	0.7194	0.0982	0.8790	0.7700	0.4809	5.5091	0.2460	0.1821	0.1800	0.6567	0.5121	0.4788
Murcia	0.8652	0.2906	0.0229	1.5019	0.0282	0.0333	0.6543	0.6026	0.2555	2.0803	0.1062	0.0884	0.0738	0.4912	0.4890	0.4525
Navarra	0.9025	0.4161	0.1018	7.3266	0.4455	0.0105	0.8128	0.8038	0.3353	4.2965	0.1004	0.1023	0.0998	0.6369	0.4813	0.4500
País Vasco	0.9037	0.4580	0.1645	2.4209	0.5598	0.0432	0.7873	0.7643	0.3586	4.2847	0.1652	0.1478	0.1426	0.6321	0.4953	0.4914
La Rioja	0.9114	0.5143	0.2328	3.8599	0.4920	0.0417	0.8893	0.8409	0.4949	6.3901	0.2379	0.2268	0.2250	0.6902	0.5505	0.5476

Table 28.2. Maximum and minimum values for concentration indicators (value and Region)

	Gini index for SE	Standardised Theil entropy index (SE)	Standardised Herfindahl index (SE)	Coefficient of variation of densities	Share of the population living in high-density municipalities*	Population density gradient	Gini index for MUN based on population	Gini index for MUN based on land areas	Standardised Theil entropy index (MUN)	Theil index	Standardised Herfindahl index (MUN)	Raw geographic concentration index	Ellison and Glaeser	Delta index	Massey and Denton dissimilarity index for urban land	Massey and Denton dissimilarity index built-up land
	$CNGINI_{SE8a}$	$CNSTHEI_{SE8b}$	$CNSHHI_{SE8c}$	$CNDCV_{MUN9a}$	$CNHGD_{MUN9b}$	$CNPDG_{MUN9c}$	$CNGINI_{MUN9d}$	$CNGINI_{MUN9e}$	$CNSTHE_{IMUN9f}$	$CNTHI_{MUN9g}$	$CNSHH_{IMUN9h}$	$CNRGCI_{MUN9i}$	$CNEG_{MUN9j}$	$CNDI_{MUN9k}$	$CNMDDI_{MUN9l}$	$CNMDDI_{MUN9m}$
Max	0.9437	0.5624	0.3455	7.3266	0.7194	0.0982	0.8893	0.8409	0.5645	8.3026	0.3759	0.3209	0.3219	0.6902	0.5592	0.5582
Min	0.7675	0.2783	0.0229	1.3543	0.0000	-0.0041	0.6259	0.5619	0.2243	1.7971	0.0636	0.0347	0.0299	0.4416	0.3333	0.3478
Max	Madrid	Aragón	Aragón	Navarra	Madrid	Madrid	La Rioja	La Rioja	Aragón	Cataluña	Aragón	Aragón	Aragón	La Rioja	Cataluña	Cataluña
Min	Extremadur	Extremadura	Murcia	Extremadur	Extremadura	Illes Balears	Galicia	Extremadur	Galicia	Extremadur	Extremadura	Extremadura	Extremadur	Extremadur	Canarias	Illes Balears

Table 28.3. Inter-region variability of concentration indicators

	Gini index for SE	Standardised Theil entropy index (SE)	Standardised Herfindahl index (SE)	Coefficient of variation of densities	Share of the population living in high-density municipalities*	Population density gradient	Gini index for MUN based on population	Gini index for MUN based on land areas	Standardised Theil entropy index (MUN)	Theil index	Standardised Herfindahl index (MUN)	Raw geographic concentration index	Ellison and Glaeser	Delta index	Massey and Denton dissimilarity index for urban land	Massey and Denton dissimilarity index built-up land
	$CNGINI_{SE8a}$	$CNSTHEI_{SE8b}$	$CNSHHI_{SE8c}$	$CNDCV_{MUN9a}$	$CNHGD_{MUN9b}$	$CNPDG_{MUN9c}$	$CNGINI_{MUN9d}$	$CNGINI_{MUN9e}$	$CNSTHE_{IMUN9f}$	$CNTHI_{MUN9g}$	$CNSHH_{IMUN9h}$	$CNRGCI_{MUN9i}$	$CNEG_{MUN9j}$	$CNDI_{MUN9k}$	$CNMDDI_{MUN9l}$	$CNMDDI_{MUN9m}$
Standard Deviation	0.0457	0.0742	0.0747	0.9109	0.2094	0.0282	0.0744	0.0701	0.0835	2.0408	0.0712	0.0550	0.0569	0.0676	0.0593	0.0585
CV MUN	0.05	0.20	0.62	0.34	0.56	0.69	0.10	0.10	0.24	0.46	0.53	0.47	0.51	0.11	0.12	0.12

Source: Author's own work based on the sources described in Blanco, A. et al. (2021).

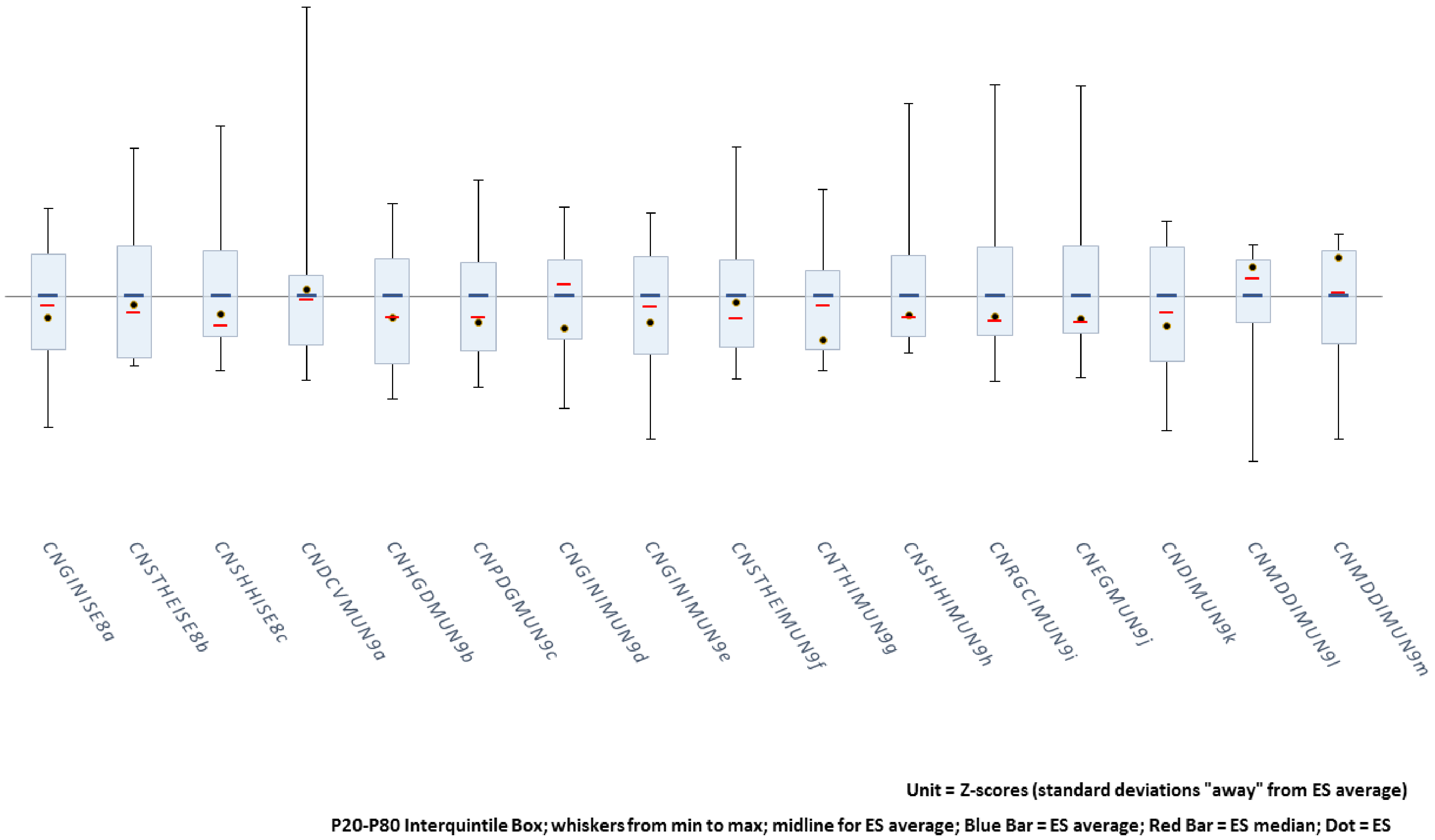
* Based on built-up area.

Table 29. Regional rankings of concentration indicators—Regions in decreasing order

	Gini index for SE	Standardised Theil entropy index (SE)	Standardised Herfindahl index (SE)	Coefficient of variation of densities	Share of the population living in high-density municipalities	Population density gradient	Gini index for MUN based on population	Gini index for MUN based on land areas	Standardised Theil entropy index (MUN)	Theil index	Standardised Herfindahl index (MUN)	Raw geographic concentration index	Ellison and Glaesser	Delta index	Massey and Denton dissimilarity index for urban land	Massey and Denton dissimilarity index built-up land
	$CNGINI_{SE8a}$	$CNSTHEI_{SE8b}$	$CNSHHI_{SE8c}$	$CNDCV_{MUN9a}$	$CNHGD_{MUN9b}$	$CNPDG_{MUN9c}$	$CNGINI_{MUN9d}$	$CNGINI_{MUN9e}$	$CNSTHEI_{MUN9f}$	$CNTHI_{MUN9g}$	$CNSHHI_{MUN9h}$	$CNRGCI_{MUN9i}$	$CNEG_{MUN9j}$	$CNDI_{MUN9k}$	$CNMDDI_{MUN9l}$	$CNMDDI_{MUN9m}$
ABOVE AVERAGE	Madrid	Aragón	Aragón	Navarra	Madrid	Madrid	La Rioja	La Rioja	Aragón	Cataluña	Aragón	Aragón	Aragón	La Rioja	Cataluña	Cataluña
	Asturias	Rioja	Madrid	C. León	País Vasco	Cataluña	Aragón	Cataluña	La Rioja	La Rioja	Madrid	La Rioja	La Rioja	Cataluña	Cantabria	Cantabria
	La Rioja	Asturias	Rioja	Cantabria	Cataluña	Cantabria	Madrid	Cantabria	Madrid	Madrid	La Rioja	C. León	C. León	Cantabria	La Rioja	La Rioja
	Cataluña	Castilla y León	Castilla y León	La Rioja	Aragón	País Vasco	C. León	Navarra	C. León	Cantabria	C. León	Madrid	Madrid	Aragón	Asturias	Asturias
	País Vasco	País Vasco	País Vasco	Cataluña	La Rioja	La Rioja	Navarra	Asturias	País Vasco	C.Valenciana	País Vasco	País Vasco	País Vasco	Madrid	C.Valenciana	C.Valencian
	Navarra	Madrid		Asturias	Navarra		Cataluña	Aragón	Asturias	Aragón		Asturias	Asturias	Asturias	Aragón	Andalucía
	Aragón	Navarra		Andalucía	Canarias		C.Valenciana	C. León						C. León	Andalucía	Aragón
					Illes Balears		País Vasco	Madrid						Navarra	Madrid	
							Asturias	País Vasco						País Vasco		
								C.Valenciana								
BELOW AVERAGE	C. León	Andalucía	Asturias	Galicia	Asturias	C.Valenciana	C-La Mancha	Andalucía	Andalucía	Navarra	Illes Balears	Illes Balears	Cantabria	C.Valenciana	C. León	País Vasco
	Murcia	Galicia	Navarra	C.Valenciana	Andalucía	Murcia	Cantabria	C-La Mancha	Navarra	País Vasco	Asturias	Cantabria	Illes Balears	Andalucía	País Vasco	Madrid
	Cantabria	Cantabria	Andalucía	País Vasco	Cantabria	Andalucía	Andalucía	Galicia	Cataluña	Asturias	Andalucía	Navarra	Navarra	C-La Mancha	Murcia	Murcia
	Andalucía	C-La Mancha	C-La Mancha	Aragón	C.Valenciana	Asturias	Extremadura	Canarias	C.Valenciana	C. León	Murcia	Canarias	Andalucía	Galicia	Navarra	C. León
	C.Valenciana	C. Valenciana	Cataluña	C-La Mancha	C. León	Aragón	Illes Balears	Murcia	Cantabria	Andalucía	Navarra	Andalucía	Canarias	Canarias	C-La Mancha	Navarra
	C-La Mancha	Illes Balears	Illes Balears	Madrid	Galicia	Galicia	Murcia	Illes Balears	Illes Balears	C-La Mancha	Cantabria	Murcia	Cataluña	Murcia	Galicia	C-La Mancha
	Galicia	Murcia	C. Valenciana	Illes Balears	C-La Mancha	C. León	Canarias	Extremadura	C-La Mancha	Canarias	Canarias	Galicia	C.Valenciana	Illes Balears	Extremadura	Galicia
	Canarias	Cataluña	Galicia	Canarias	Murcia	C-La Mancha	Galicia		Murcia	Galicia	C-La Mancha	Cataluña	Galicia	Extremadura	Illes Balears	Canarias
	Illes Balears	Canarias	Cantabria	Murcia	Extremadura	Navarra			Extremadura	Murcia	C.Valenciana	C.Valenciana	Murcia		Canarias	Extremadura
	Extremadura	Extremadura	Extremadura	Extremadura		Canarias			Canarias	Illes Balears	Galicia	C-La Mancha	C-La Mancha			Illes Balears
			Canarias			Extremadura			Galicia	Extremadura	Cataluña	Extremadura	Extremadura			
			Murcia			Illes Balears					Extremadura					

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 19. Spain (ES): Across-region distribution of concentration indicators 2016



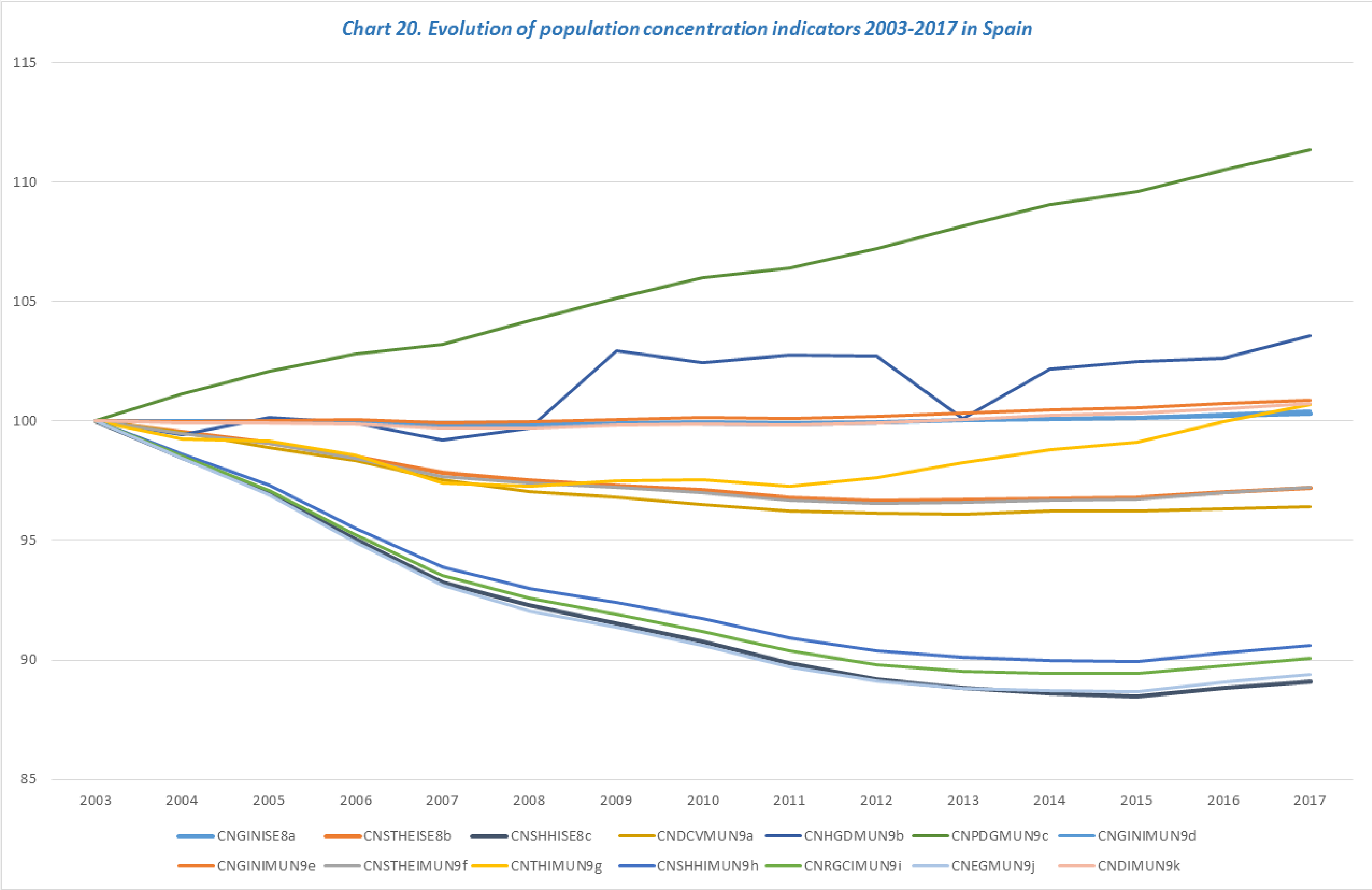


Chart 20. Evolution of population concentration indicators 2003-2017 in Spain
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CNGINISE8a
CNSTHEISE8b
CNSHHISE8c
CNDCVMUN9a
CNHGDMUN9b
CNPDGMUN9c
CNGINIMUN9d
CNGINIMUN9e
CNSTHEIMUN9f
CNTHIMUN9g
CNSHHIMUN9h
CNRGCIMUN9i
CNEGMUN9j
CNDIMUN9k

Some insights into concentration in Spain's regions

The analysis of the position that each Region registers regarding concentration indicators, as well as the comparative analysis between indicators, will provide some insights into concentration in Spain's regions. For the mentioned analysis, we will rely on Table 30 and Chart 20. We have built Table 30 based on the ranking position each Region has for each concentration indicator, in decreasing order. A low number in Table 30 means high population concentration. On the other hand, in Chart 20, we show the distribution of the sixteen concentration indicators for each Region and its position in that distribution. The central box encloses what we will name "*central*" values of the said distribution. The bottom whisker goes from the minimum to the first quintile of the distribution, enclosing the values that account for 20% of the distribution in the bottom positions. Regions holding such low levels of population concentration are flagged with a red dot. The upper whisker goes from the fourth quintile to the maximum, enclosing the values that account for 20% of the distribution in the upper positions. Regions holding these high levels of concentration are flagged with a green dot.

It is important to keep in mind that we have calculated concentration indicators for each province and then aggregated them to the regional level. Therefore, our analysis outlines the regional panorama, which subsumes the provincial realities at the same time that it may conceal significant provincial differences within a region.

We would highlight the following features regarding population concentration in Spain's regions:

- **Andalucía** has intermediate-low levels of population concentration, except when approached through the coefficient of variation of densities and urban and built-up land concentration, for which it has intermediate levels.
- **Aragón** has intermediate to high levels of population concentration, except when approached through the coefficient of variation of densities and the population density gradient, for which it has intermediate-low levels.
- **Asturias** presents intermediate to high levels of population concentration.

- **Illes Balears** has intermediate to low levels of population concentration, except when approached through the share of the population living in high-density municipalities based on built-up land.
- **Canarias** has intermediate to low levels of population concentration, except when approached through the share of the population living in high-density municipalities based on built-up land.
- **Cantabria** shows intermediate to high levels of population concentration. Generally, Cantabria ranks high when measuring population concentration with those indicators that identify concentration through the evenness of population densities across municipalities or through the concentration of urban and built-up land. We highlight that Cantabria's position concerning the SE-based Standardised Theil entropy index and Standardised Herfindahl index is quite low. This would point out that there is a great number of singular entities with very low population shares and, at the same time, the highest population shares are not too different from the rest in comparison to other regions.
- **Castilla y León** has intermediate to high population concentration levels.
- **Castilla-La Mancha** has intermediate to low population concentration levels.
- **Cataluña** ranks over the national average for most indicators of population concentration. However, the Region ranks low concerning the *Standardised Theil entropy index (SE)*, the *Standardised Herfindahl index* as well as the *Raw geographic concentration* and the *Ellison and Glaesser* indices. This would point out that there is a great number of singular entities with very low population shares and, at the same time, the highest population shares are not too different from the rest in comparison to other regions.
- **Comunidad Valenciana** has intermediate to low levels of population concentration for all the indicators except for the *Theil index* and the *Massey and Denton dissimilarity indices*.
- **Extremadura** has very low levels of population concentration in Spain; with most of the indicators placing the Region in the bottom position.
- **Galicia** presents low levels of population concentration, regardless of the indicator that is used.

- **Madrid** has very high levels of concentration, among the highest in Spain, for most of the indicators. The *Coefficient of variation of densities* places Madrid in a low position in the regional ranking. As already mentioned, the correlation between the *Coefficient of variation of densities* and the rest of concentration indicators is low or very low for most of them. Therefore, although the *Coefficient of variation of densities* captures concentration, it ranks some territories in a very dissimilar way as the rest of the indicators. In addition, the Massey and Denton dissimilarity indices show intermediate values, which points out that in Madrid urban and especially built-up land in Madrid are comparatively less concentrated than population.
- **Murcia** has population concentration levels that are among the lowest in Spain, regardless of the indicator that is used.
- **Navarra** has intermediate to high levels of population concentration, except for the population density gradient, for which it ranks low.
- **País Vasco** has intermediate to high levels of population concentration.
- **La Rioja** has high levels of population concentration, among the highest ones in Spain.

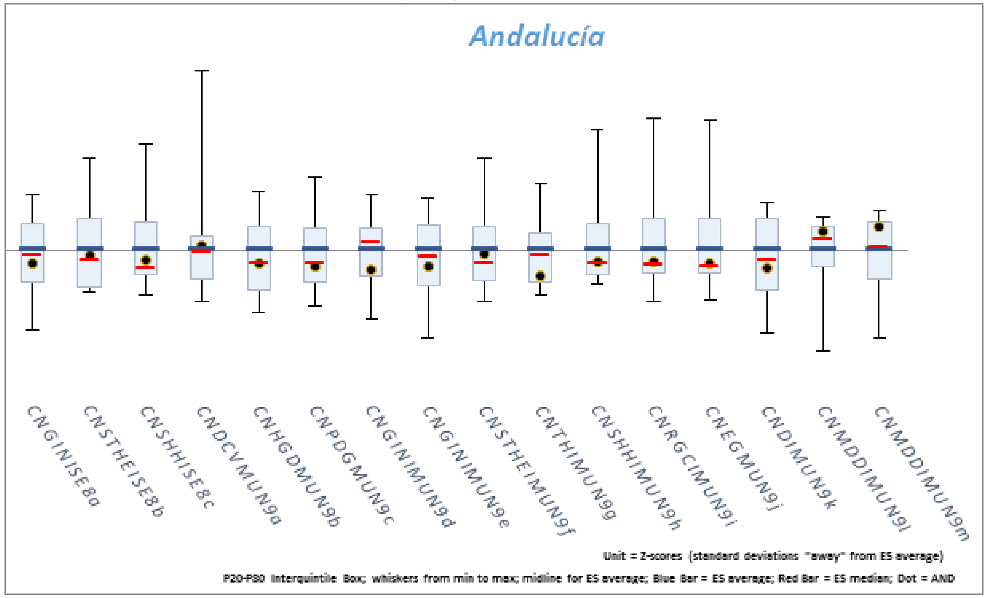
Table 30. Regional rankings of absolute concentration indicators—Positions in decreasing order

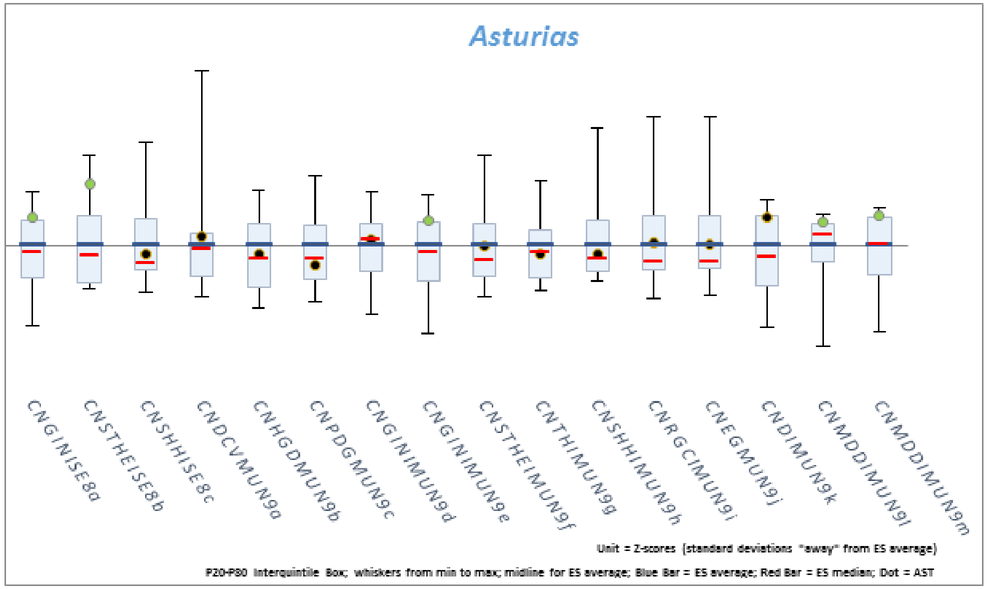
Region	Gini index for SE	Standardised Theil entropy index (SE)	Standardised Herfindahl index (SE)	Coefficient of variation of densities	Share of the population living in high-density municipalities *	Population density gradient	Gini index for MUN based on population	Gini index for MUN based on land areas	Standardised Theil entropy index (MUN)	Theil index	Standardised Herfindahl index (MUN)	Raw geographic concentration index	Ellison and Glaesser	Delta index	Massey and Denton dissimilarity index for urban land	Massey and Denton dissimilarity index built-up land
	$CNGINI_{SE8a}$	$CNSTHEI_{SE8b}$	$CNSHHI_{SE8c}$	$CNDCV_{MUN9a}$	$CNHGD_{MUN9b}$	$CNPDG_{MUN9c}$	$CNGINI_{MUN9d}$	$CNGINI_{MUN9e}$	$CNSTHE_{IMUN9f}$	$CNTHI_{MUN9g}$	$CNSHH_{IMUN9h}$	$CNRGCI_{MUN9i}$	$CNEG_{MUN9j}$	$CNDI_{MUN9k}$	$CNMDDI_{MUN9l}$	$CNMDDI_{MUN9m}$
Andalucía	11	8	8	7	10	8	12	11	7	11	8	11	10	11	7	6
Aragón	7	1	1	11	4	10	2	6	1	6	1	1	1	4	6	7
Asturias	2	3	6	6	9	9	9	5	6	9	7	6	6	6	4	4
Illes Balears	16	13	11	14	8	17	14	16	12	16	6	7	8	16	16	17
Canarias	15	16	16	15	7	15	16	14	16	13	12	10	11	14	17	15
Cantabria	10	10	14	3	11	3	11	3	11	4	11	8	7	3	2	2
C. y León	8	4	4	2	13	12	4	7	4	10	4	3	3	7	9	11
C-La Mancha	13	11	9	12	15	13	10	12	13	12	13	16	16	12	13	13
Cataluña	4	15	10	5	3	2	6	2	9	1	16	14	12	2	1	1
C. Valenciana	12	12	12	9	12	6	7	10	10	5	14	15	13	10	5	5
Extremadura	17	17	15	17	17	16	13	17	15	17	17	17	17	17	15	16
Galicia	14	9	13	8	14	11	17	13	17	14	15	13	14	13	14	14
Madrid	1	6	2	13	1	1	3	8	3	3	2	4	4	5	8	9
Murcia	9	14	17	16	16	7	15	15	14	15	9	12	15	15	11	10
Navarra	6	7	7	1	6	14	5	4	8	7	10	9	9	8	12	12
País Vasco	5	5	5	10	2	4	8	9	5	8	5	5	5	9	10	8
La Rioja	3	2	3	4	5	5	1	1	2	2	3	2	2	1	3	3

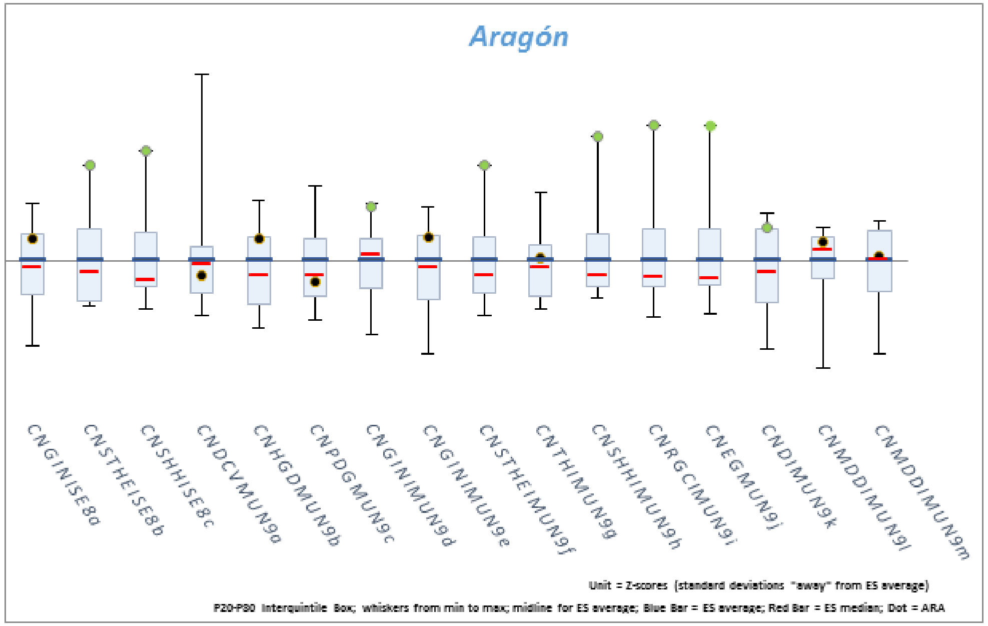
Source: Author's own work based on the sources described in Blanco, A. et al. (2021).

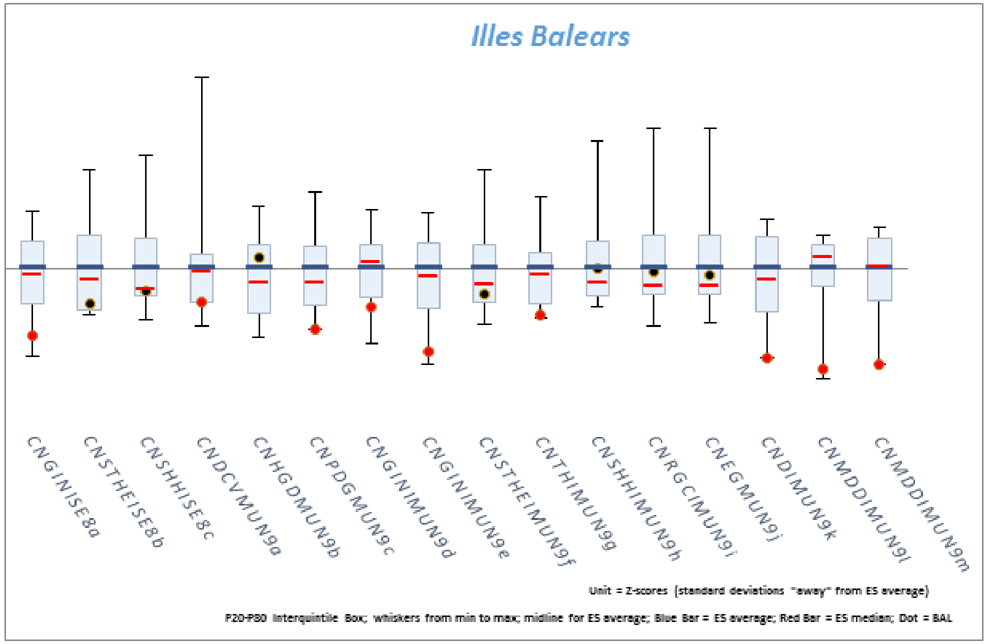
* Based on built-up area.

Chart 21. Concentration indicators by Region 2016 (*It continues*)





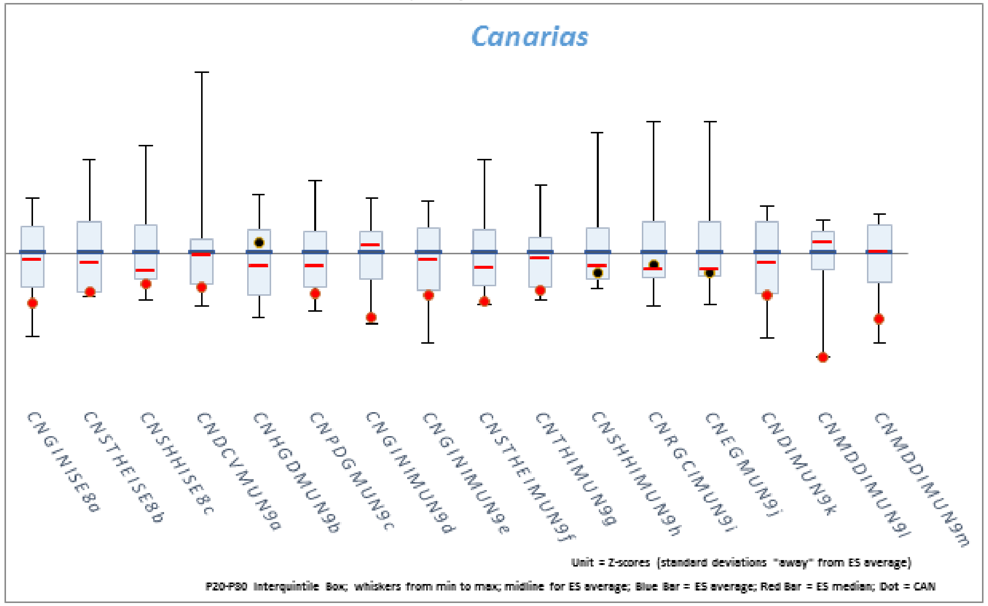


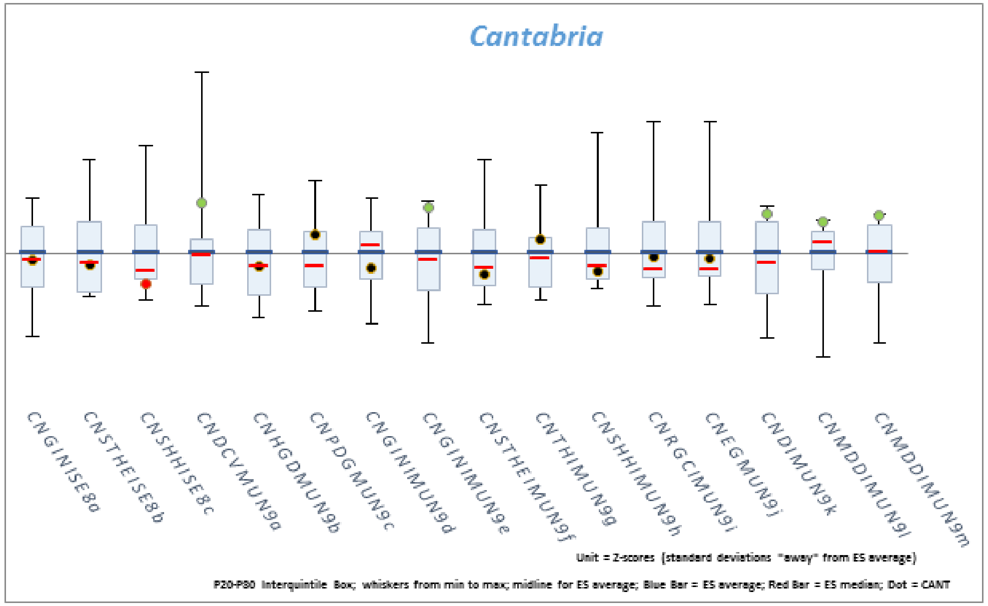


Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

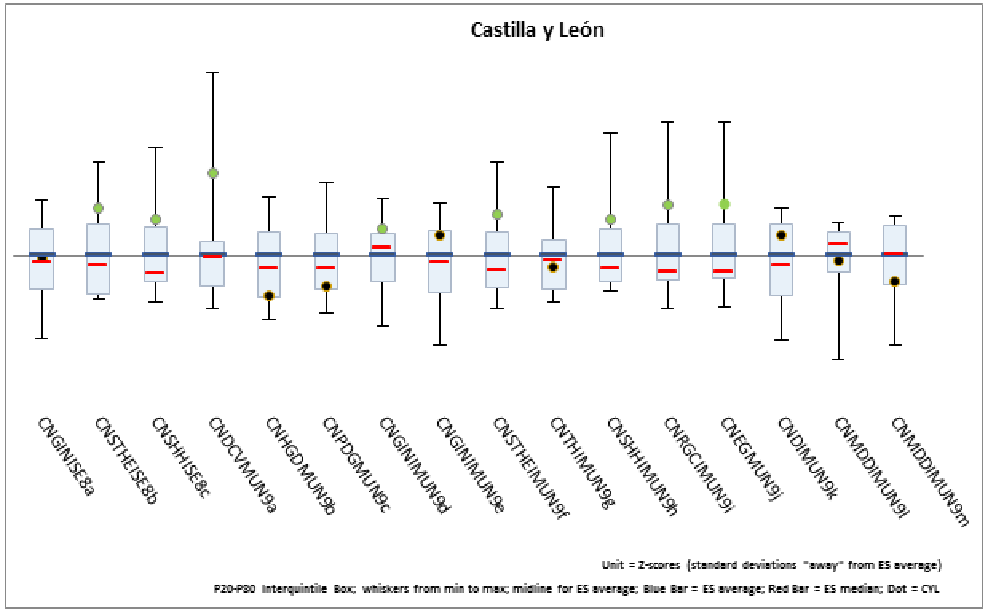
Chart 21. Concentration indicators by Region 2016

(It continues)





Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.



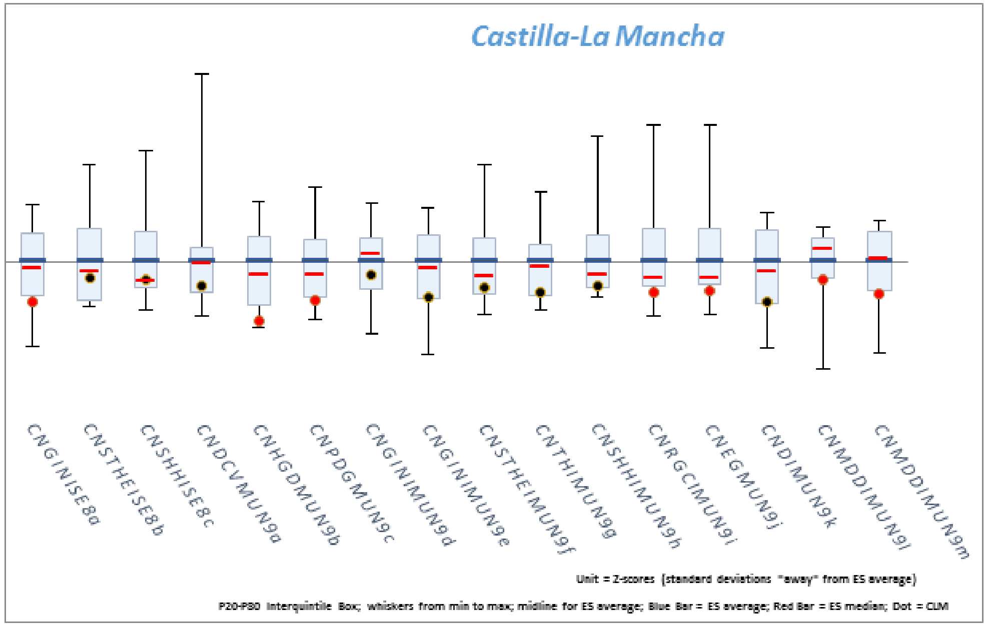
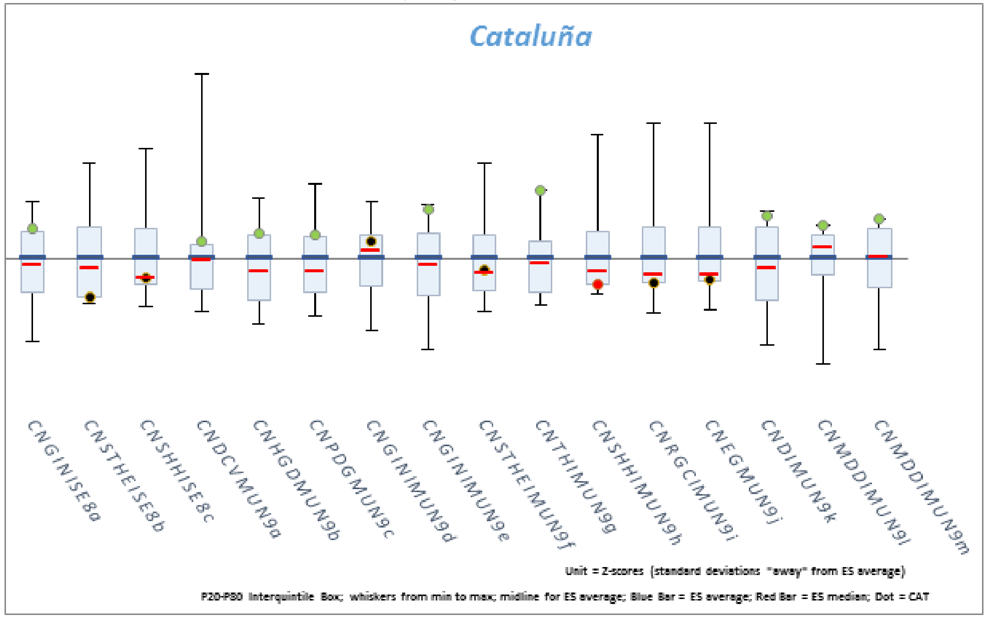
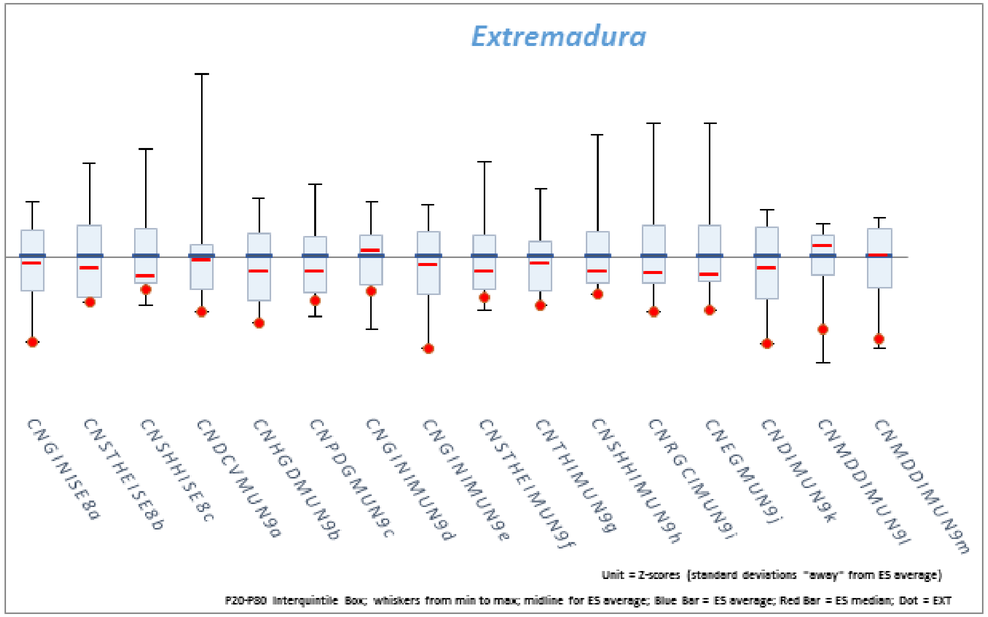
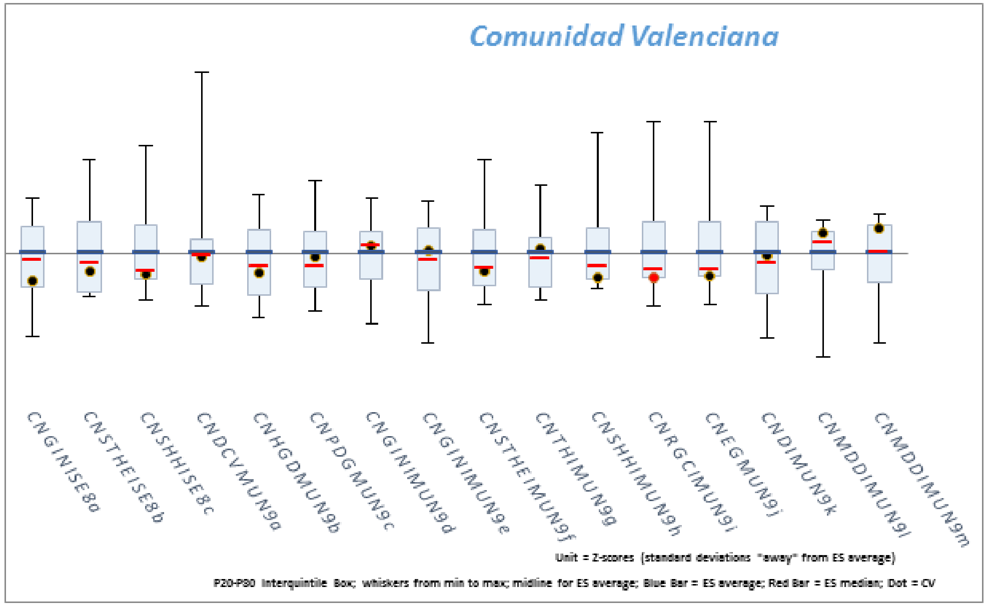
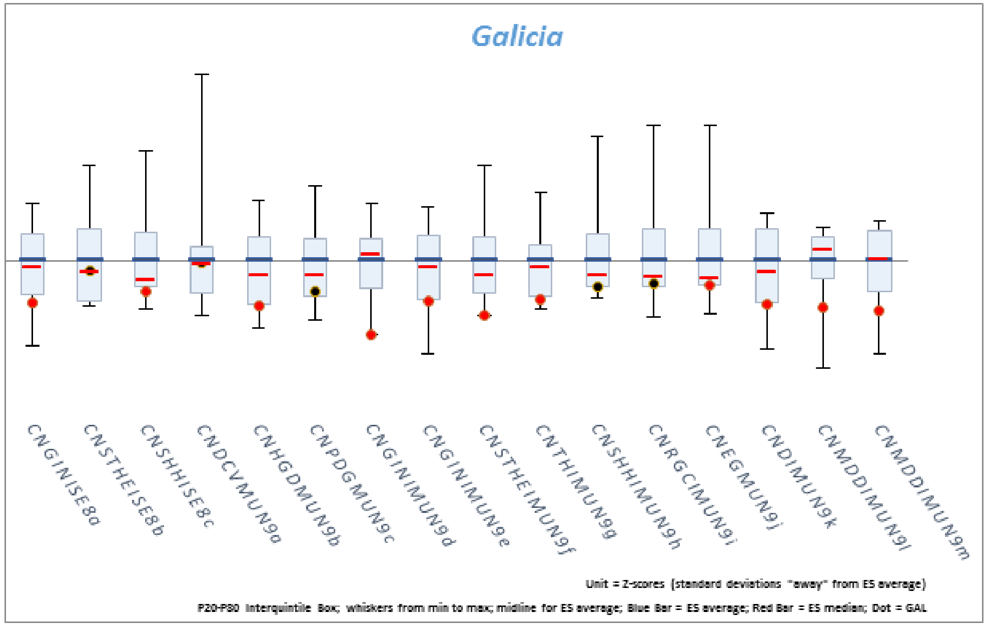


Chart 21. Concentration indicators by Region 2016 *(It continues)*



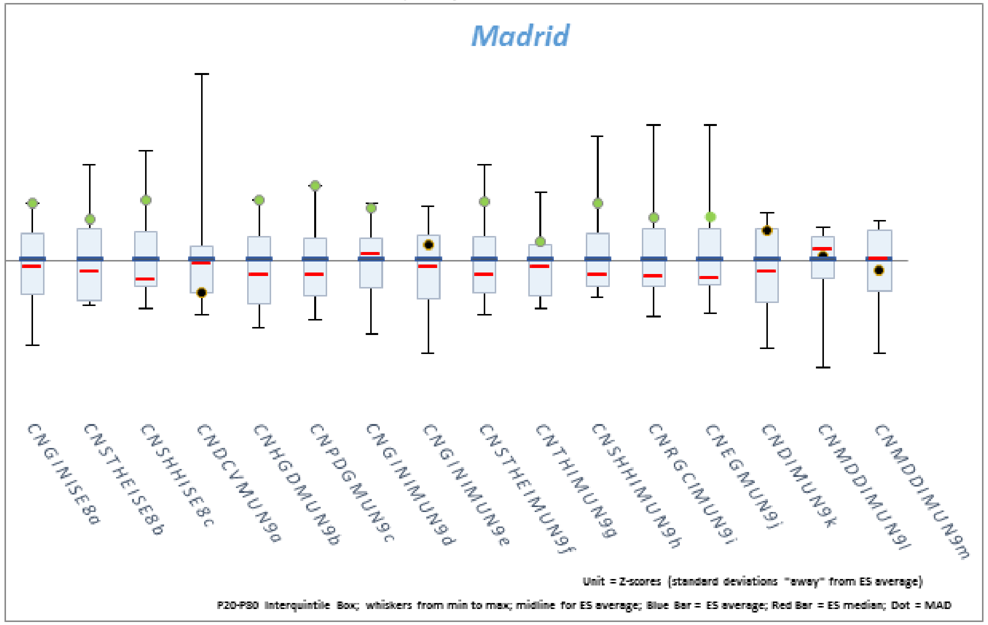


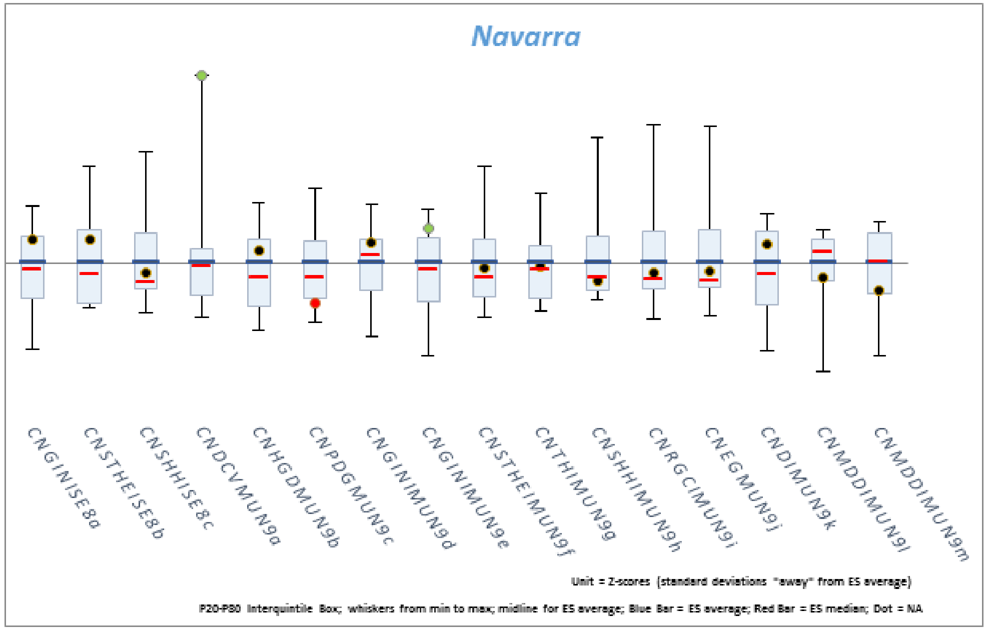


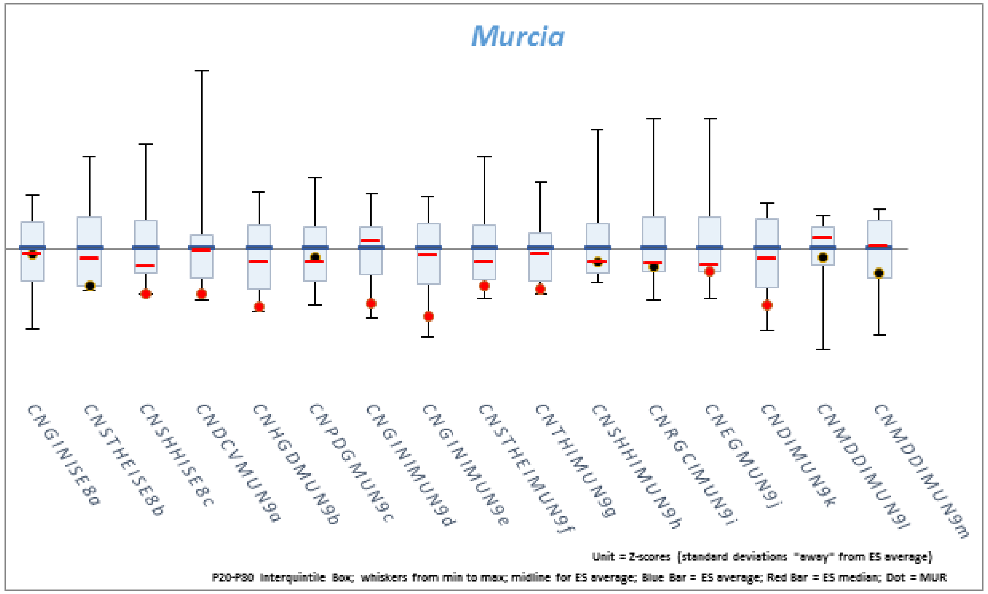


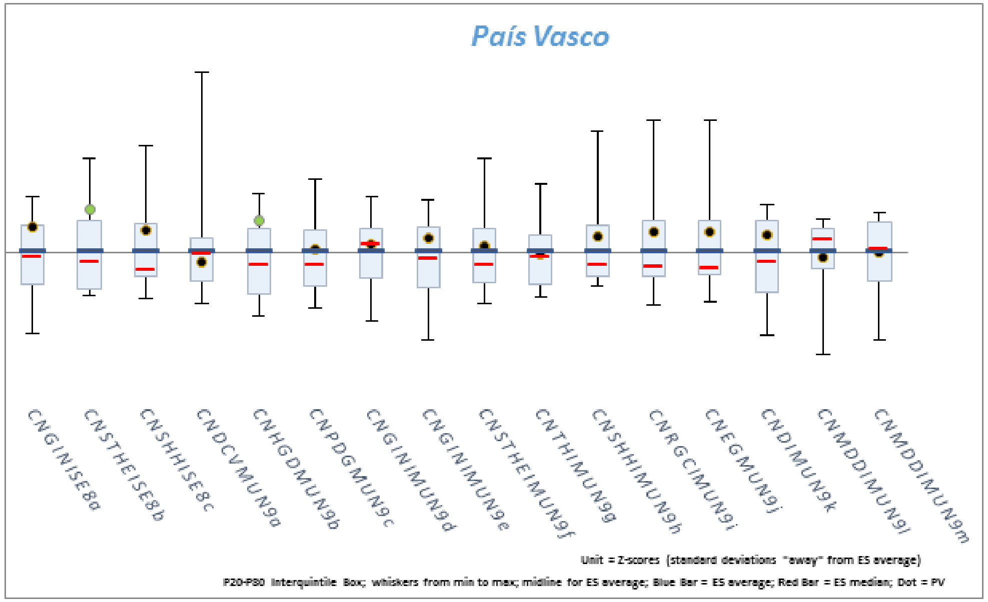
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 21. Concentration indicators by Region 2016 *(It continues)*



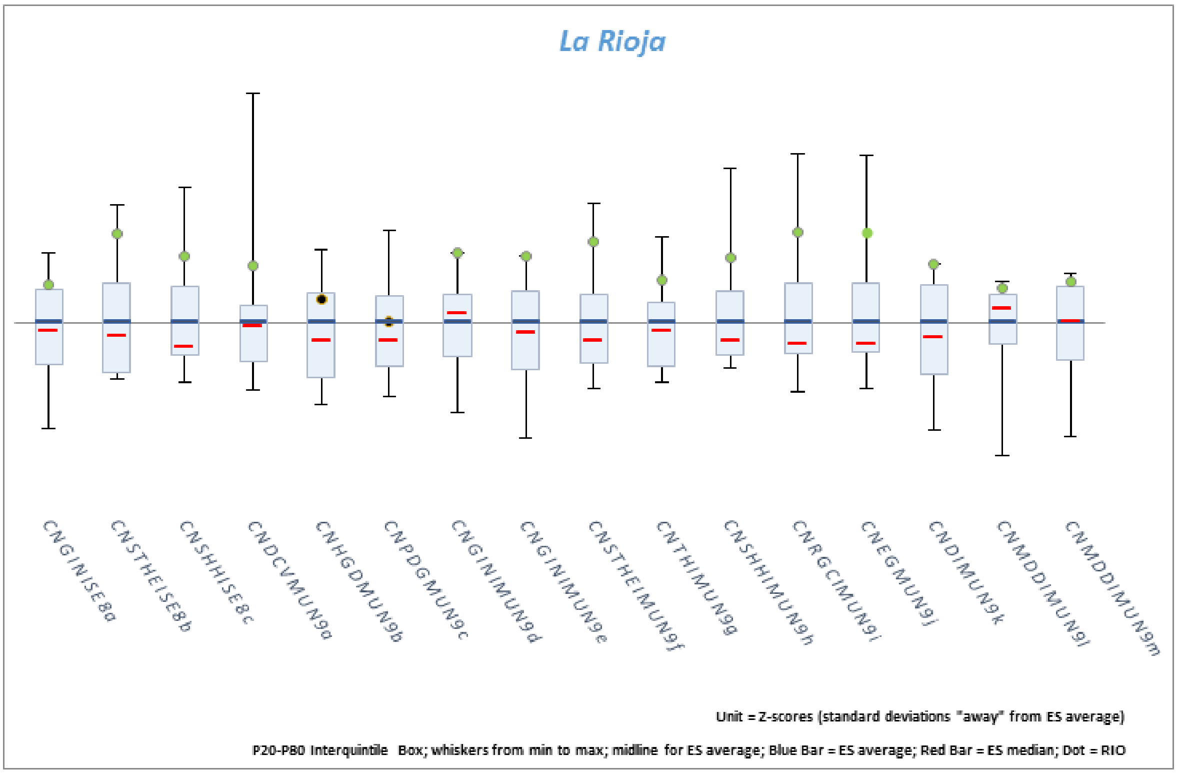






Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 21. Concentration indicators by Region 2016 *(It concludes)*



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

In general, population concentration has decreased or has remained stable during the period 2003-2017 (Table 31). Decreasing rates range from -0.83% to -0.20%. The indicators that have remained stable show evolution rates from 0.02% to 0.06%. The *Population share living in high residential density municipalities* has increased at a rate of 0.25%. However, concerning this indicator, we highlight that the evolution rates are highly volatile as small variations in high residential density regarding municipalities at the threshold limit produce large changes in the series. This occurs because they affect municipalities with a high population weight in the province. Finally, the *Population density gradient* evolves at a rate of 0.77%. However, as we have indicated, we doubt that this indicator adequately captures the rate at which the density falls from the CBD due to the lack of adjustment of the OLS regression for this parameter.

Table 31. Evolution of population concentration indicators at the national level 2003-2017

Concentration indicators		Δ Annual average 2008/2003	Δ Annual average 2017/2008	Δ Annual average 2017/2003
Gini index for SE	$CNGINI_{SE8a}$	-0.02	0.05	0.02
Standardised Theil entropy index	$CNSTHEI_{SE8b}$	-0.62	-0.08	-0.28
Standardised Herfindahl index (SE)	$CNSHHI_{SE8c}$	-1.61	-0.40	-0.83
Coefficient of variation of densities	$CNDCV_{MUN9a}$	-0.60	-0.07	-0.26
Share of the population living in high-density municipalities based on built land	$CNHGD_{MUN9b}$	-0.06	0.42	0.25
Population density gradient	$CNPDG_{MUN9c}$	0.83	0.74	0.77
Gini index for MUN based on population	$CNGINI_{MUN9d}$	-0.03	0.06	0.03
Gini index for MUN based on land areas	$CNGINI_{MUN9e}$	0.00	0.10	0.06
Standardised Theil entropy index	$CNSTHEI_{MUN9f}$	-0.53	-0.02	-0.20
Theil index	$CNTHI_{MUN9g}$	-0.55	0.38	0.05
Standardised Herfindahl index (MUN)	$CNSHHI_{MUN9h}$	-1.44	-0.29	-0.70
Raw geographic concentration index	$CNRGCI_{MUN9i}$	-1.53	-0.31	-0.75
Ellison and Glaesser	$CNEG_{MUN9j}$	-1.64	-0.33	-0.80
Delta index	$CNDI_{MUN9k}$	-0.06	0.11	0.05

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Concerning the concentration dynamic in Spain´s regions, when comparing their relative position to the national average in 2016, together with their time trend during the period 2003 to 2016 (Chart 22), we would highlight the following regional features:

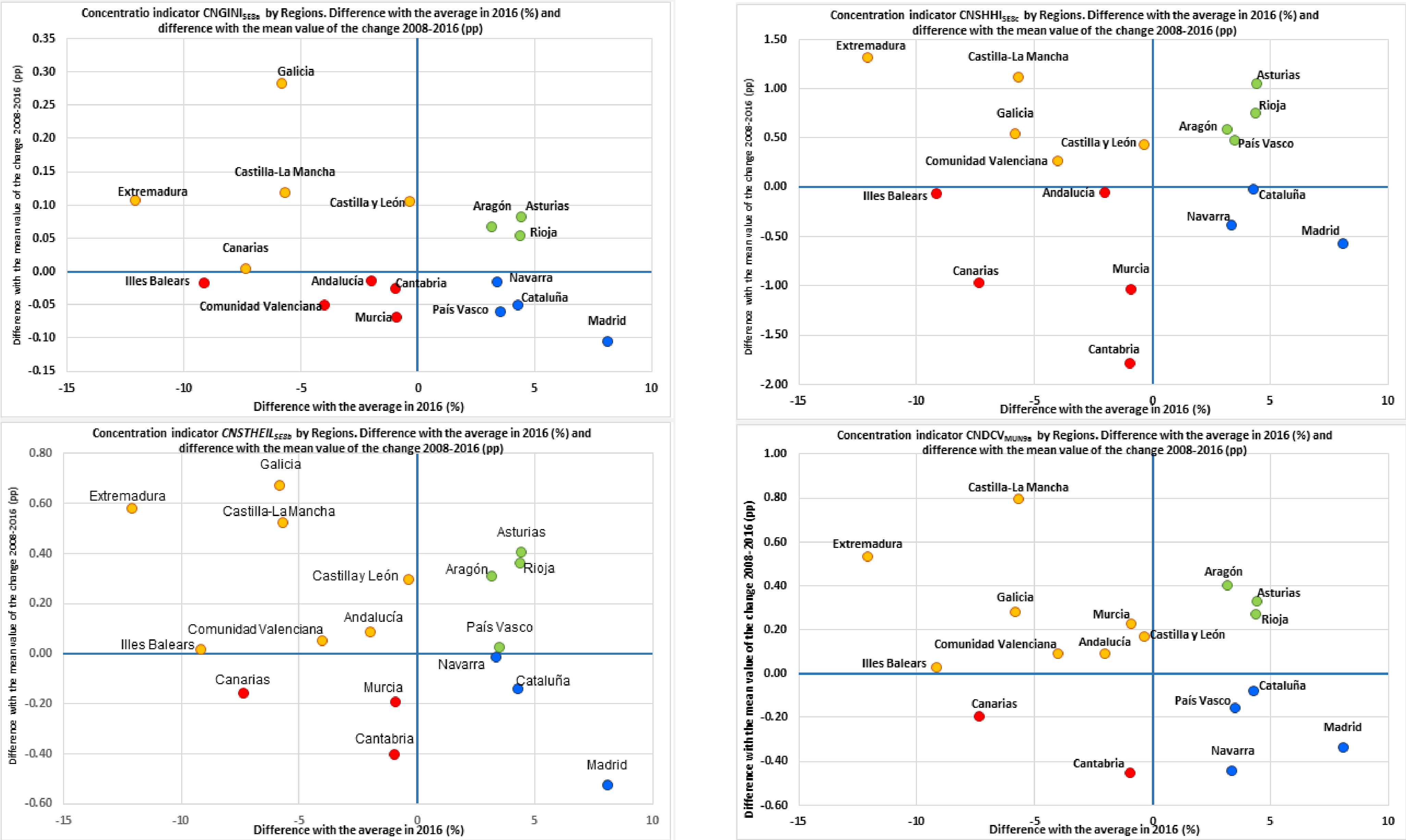
- **Andalucía** has systematically below average levels of concentration. Concentration in Andalucía is evolving at lower rates than the national average or slightly over it. Thus, over time, the concentration would follow a falling path divergent from the national average or remain stagnant.
- **Aragón** has systematically above average levels of concentration. In addition, concentration is evolving above the national average, thus the Region would follow an upwards divergence from the national level.
- **Asturias** has systematically above average levels of concentration. In addition, concentration is evolving above the national average, thus the Region would follow an upwards divergence from the national level.
- **Illes Balears** has systematically below average levels of concentration, which is evolving at lower rates than the national average or slightly over it, except for the

Share of the population living in high-density municipalities based on built-up land. Thus, the concentration would follow a falling path divergent from the national average or remain stagnant. The increasing trend shown by the *Share of the population living in high-density municipalities based on built-up land* should be interpreted in light of the volatility we have noted for this indicator.

- **Canarias** has systematically below average levels of concentration, which is evolving at lower rates than the national average. Thus, over time, the concentration would follow a falling path divergent from the national average.
- **Cantabria** has systematically below average levels of concentration, which is evolving at lower rates than the national average. Thus, over time, the concentration would follow a falling path divergent from the national average.
- **Castilla y León** presents systematically below average levels of concentration, which is evolving at equal or higher rates than the national average. Thus, the concentration would normally converge towards the national average.
- **Castilla-La Mancha** presents systematically below average levels of concentration, which is typically evolving at notably higher rates than the national average. Thus, concentration would converge towards the national average.
- **Cataluña** presents systematically above the national average levels of concentration, which is typically evolving at the same or slower pace than the national average itself. Therefore, population concentration in Cataluña would remain stagnated or follow a decreasing convergence path towards the national level.
- **Comunidad Valenciana** has systematically below average levels of concentration, which is evolving at similar rates to the national average. Thus, the concentration would remain stagnated.
- **Extremadura** presents systematically well below the national average levels of concentration, which is typically evolving at a faster pace than the national average itself, although in some cases at the same pace. Therefore, population concentration in Extremadura would remain stagnated or follow an upwards convergence to the national level.

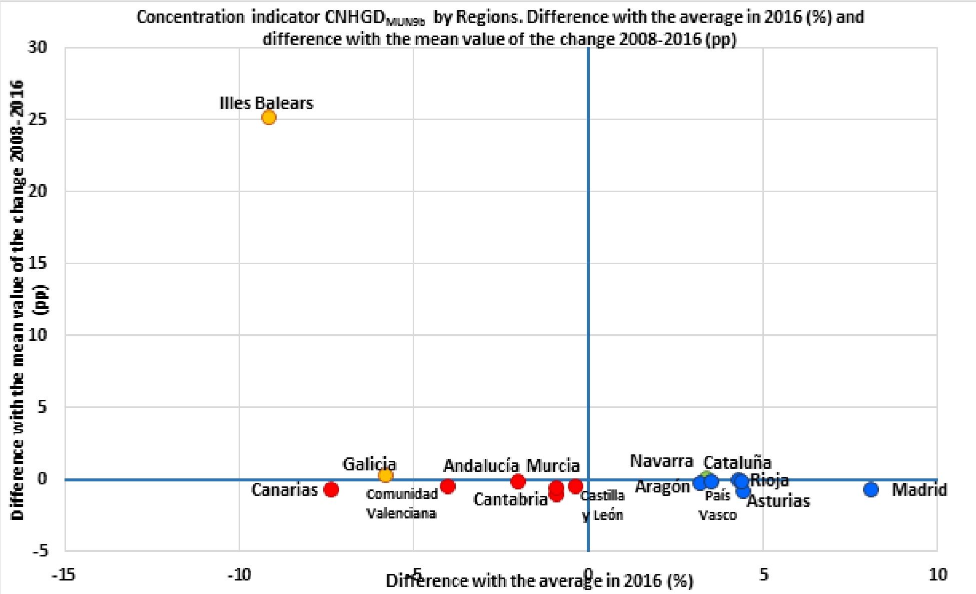
- **Galicia**'s population concentration is below the national average but evolving with higher rates than average. This dynamic pattern would promote convergence towards the national average.
- **Madrid** has systematically above average levels of concentration, which is evolving at lower rates than the national average. Thus, the concentration would follow a falling convergent path towards the national average.
- **Murcia** has systematically below average levels of concentration, which is evolving at lower rates than the national average or slightly over. These dynamic patterns would promote a decreasing path divergent from the national average or stagnation.
- **Navarra's** population concentration is above the national average but typically evolving at the same or slower pace than the national average, or slightly over it. This dynamic pattern would promote convergence towards the national average or stagnation.
- **País Vasco's** population concentration is above the national average but typically evolving at a slower pace than it is. This dynamic pattern would promote downwards convergence towards the national average.
- **La Rioja** presents population concentration levels above the national average and rates of change at or above average. These results show that the Region would be on the path to upgrade positions in the regional ranking.

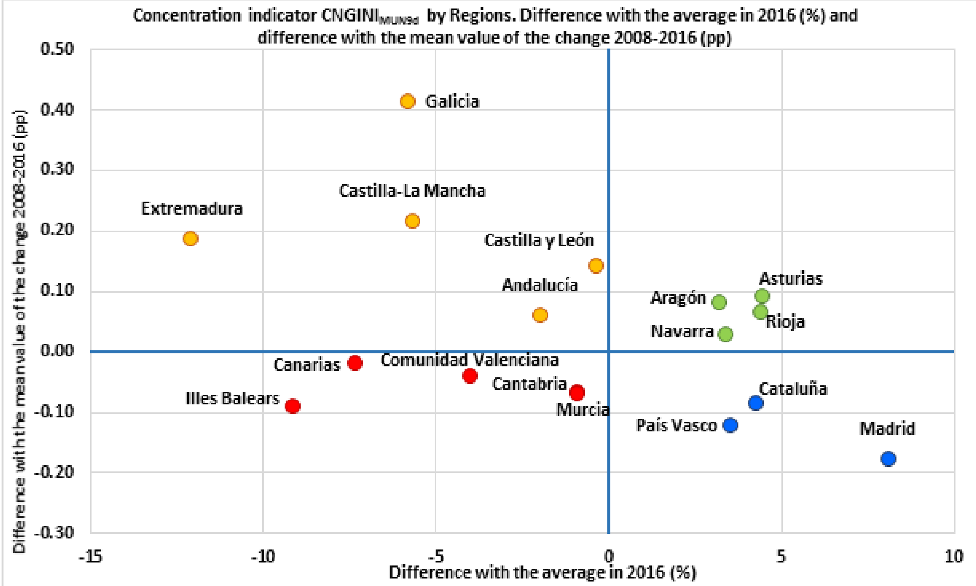
Chart 22. The dynamic of concentration *(It continues)*

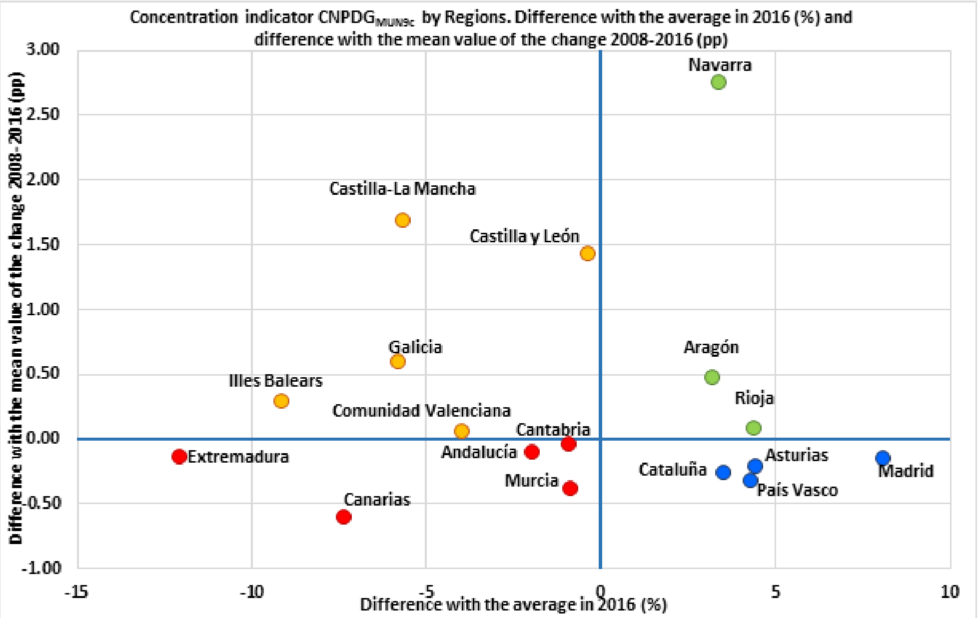


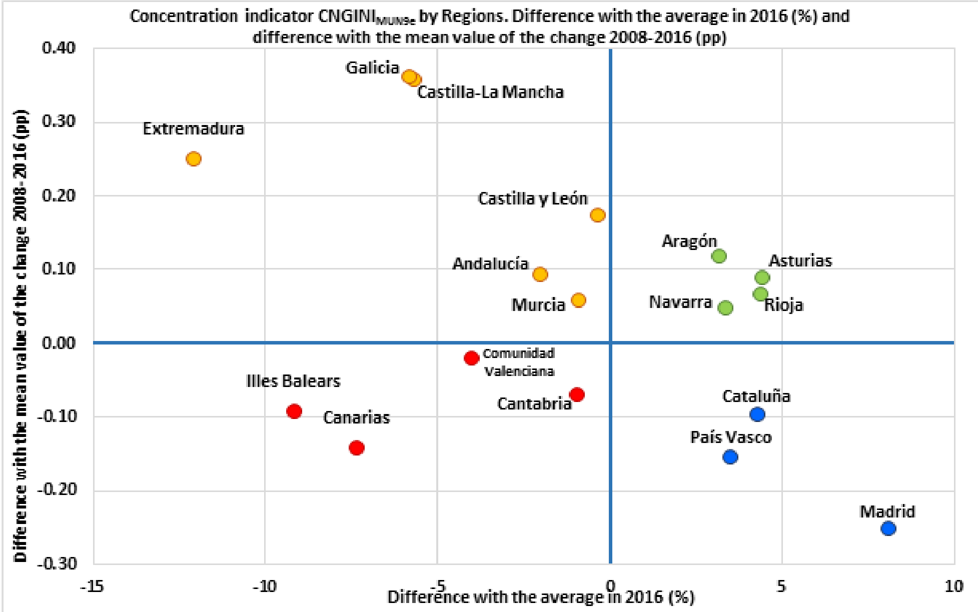
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 22. The dynamic of concentration *(It continues)*



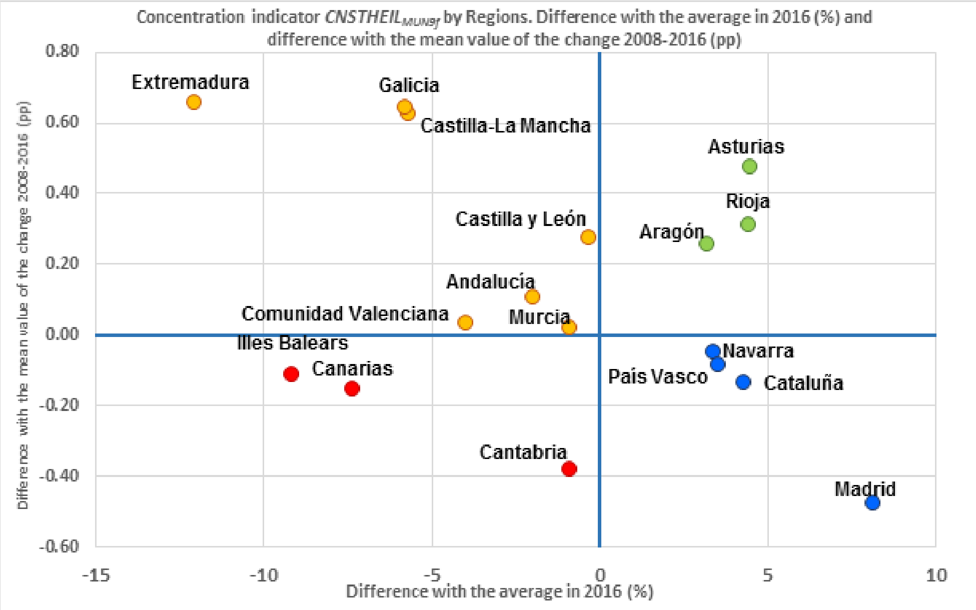


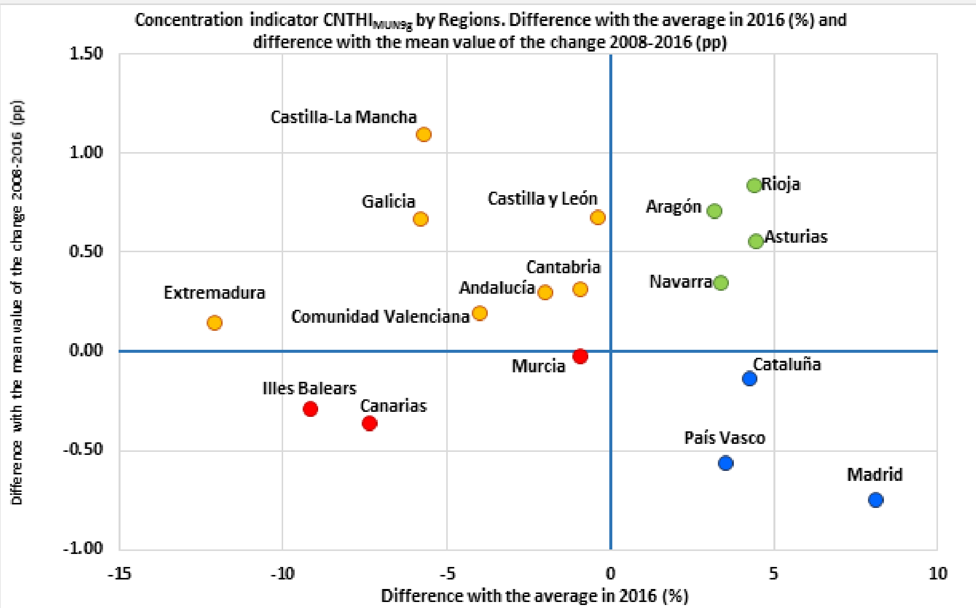




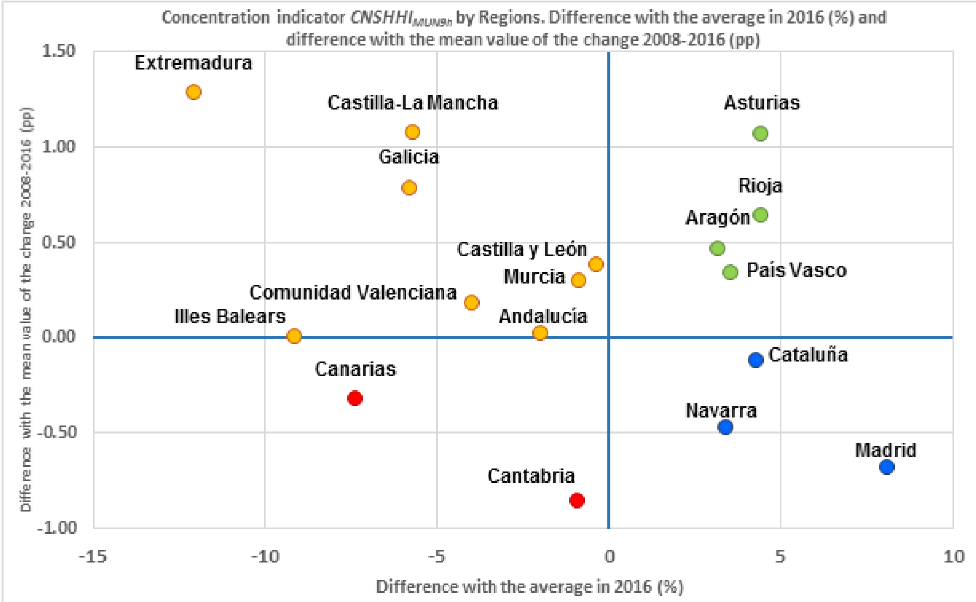
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 22. The dynamic of concentration *(It continues)*





Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.



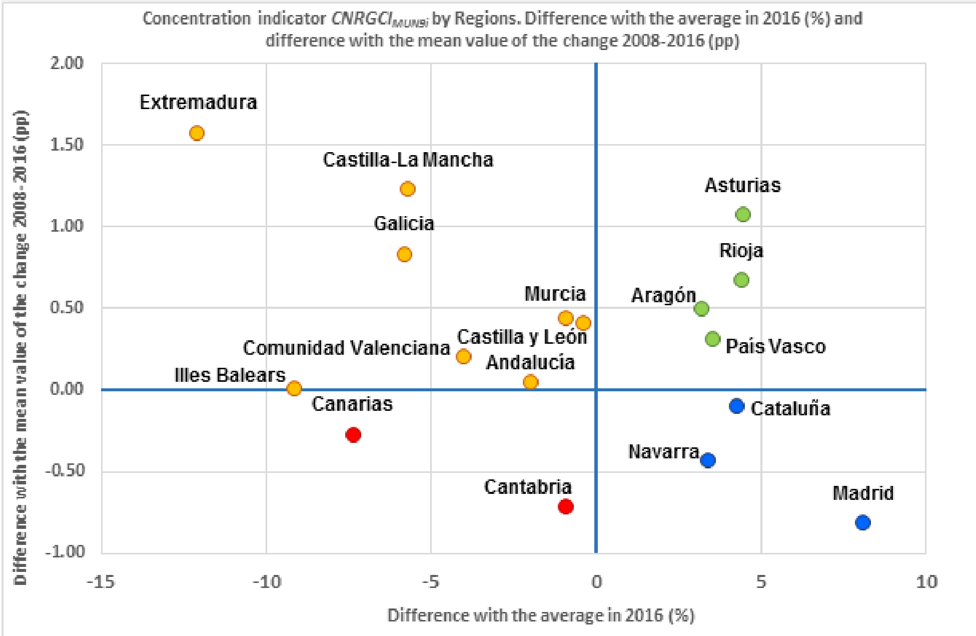
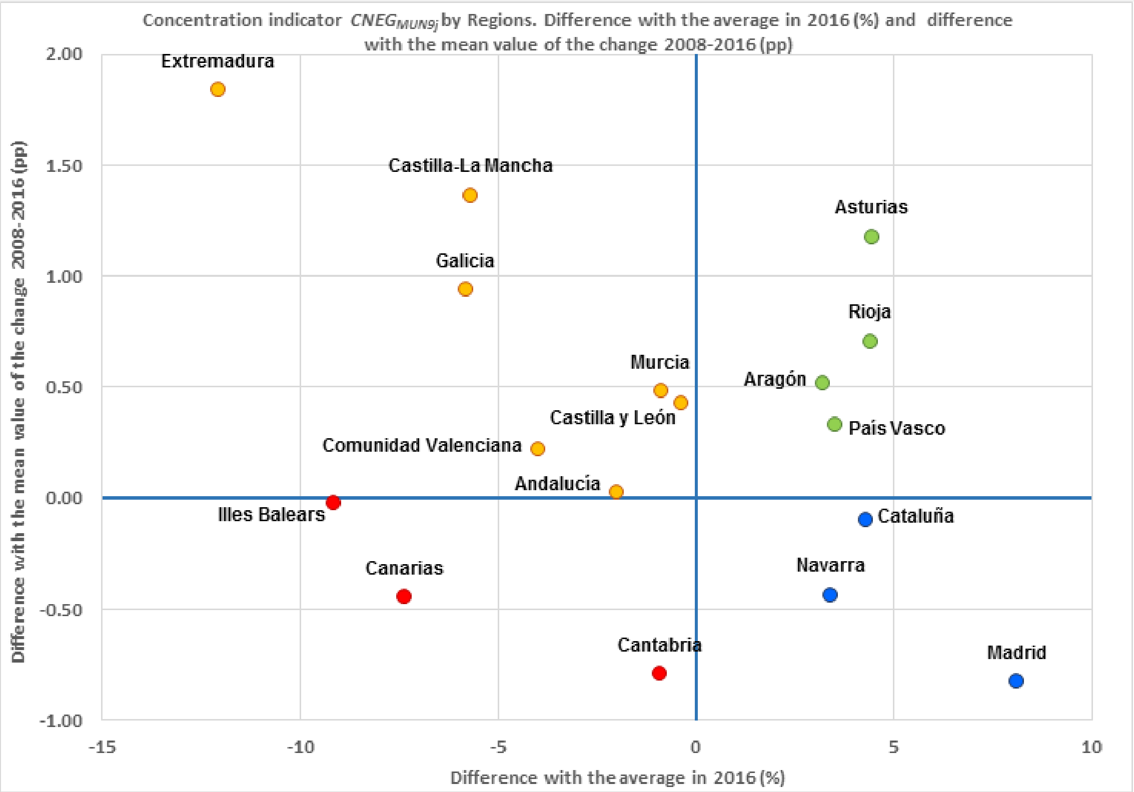
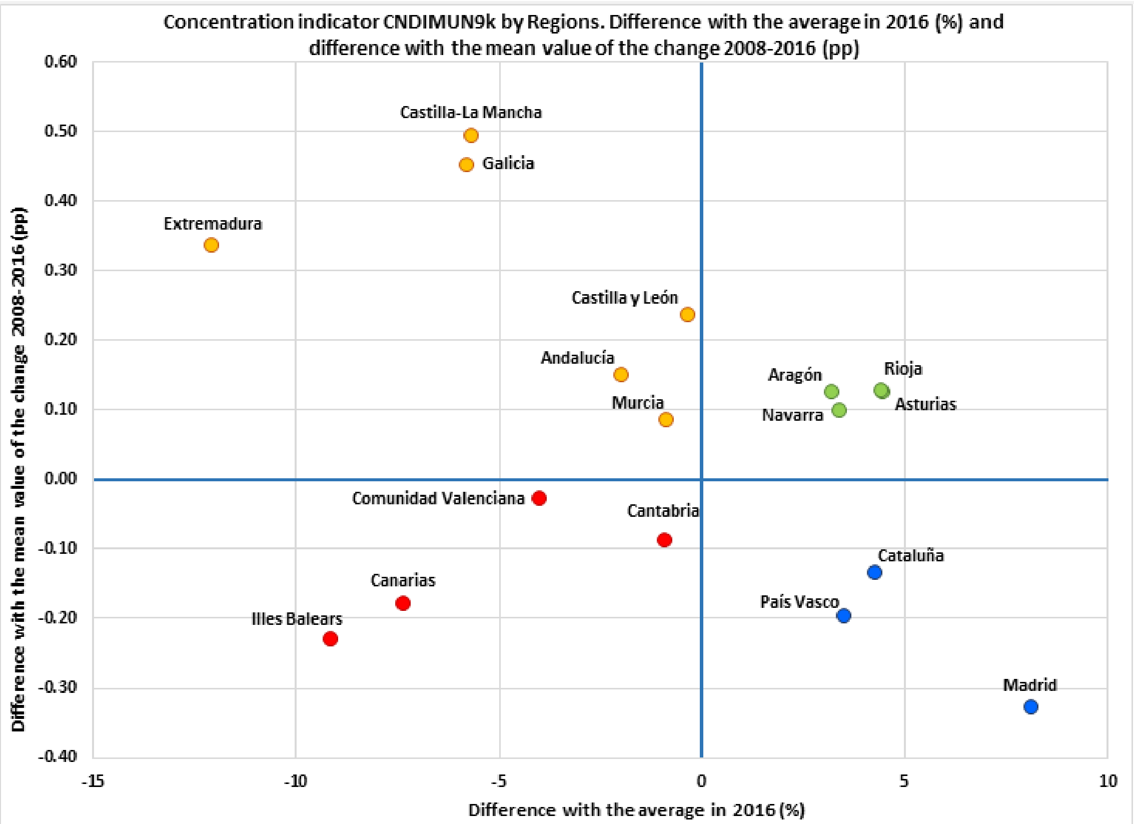


Chart 22. The dynamic of concentration *(It concludes)*





Source: Author’s own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Continuity

Continuity indicators

To measure continuity we used three indicators. First, we approached continuity through the ratio urban or built-up land area to total land area, adapted from Ghandi, SR. et al. (2016). The lower the ratio the lower the continuity and the greater the dispersion. Second, we addressed continuity through the degree to which municipalities' crude population density fits an exponential pattern as a function of the distance from the province's centre (CBD). That is to say, through the level of adjustment of the equation $\ln \delta_{ij}^{0}(d_{ij}) = \delta_0 - \phi d_{ij}$ measured by the determination coefficient R^2 of the OLS regression that provides the parameters δ_0 (CBD density) and ϕ (population density gradient). The determination coefficient R^2 of the exponential density function provides an indicator of continuity (Malpezzi, S. et al. (2001); Tsai, YH. (2005)). The lower the R^2, the lower the continuity and the greater the dispersion. We worked with the following indicators:

- *Ratio urban land area to total land area (**CNTRUT$_{PROV10a}$**).*
- *Ratio built-up land area to total land area (**CNTRUT$_{PROV10b}$**).*
- *R-square of the exponential density function (**CNTR2$_{PROV10c}$**).*

We present in Table 32 our results for the continuity indicators referred to 2016.

The ***Ratio urban land area to total land area*** in Spain is 5.43%. We have no benchmarks to assess the extent to which it points out low continuity. We highlight that it has been calculated at the provincial level and, unlike what happens in the analyses on urban sprawl, the provinces, our geographic units of analysis, enclose extensive areas of vacant land. Therefore, once again we developed our analysis based on interregional comparisons with the national average and the distribution across regions as a reference. The minimum ratio occurs in Extremadura (0.80%) and the maximum in Madrid (12.02%). It registers a high variability among regions with a CV of 63%. The ***Ratio built-up land area to total land area*** in Spain, on its side, is 3.38% in 2016. The minimum ratio occurs in Extremadura (0.53%) and the maximum in Madrid (7.11%). It registers a high variability among regions with a CV of 62%.

The ***R-square of the exponential density function*** on average at the national level is 31.26%, which is low. The minimum value occurs in Navarra (1.81%) and the maximum in Madrid (76.12%). It registers a high variability among regions with a CV of 67%.

Interregional differences are high with CV between 62% and 67%. The regions whose level of population continuity is systematically in top positions above the national average are Cataluña and Madrid. Those with systematically bottom positions below the national average are Aragon, Castilla y León, Castilla-La Mancha, Extremadura and La Rioja (Table 33).

The distribution of the continuity indicators among regions in Spain is slightly positive asymmetric (Chart 23), meaning that more than half of the population lives in regions with a share of urban or built-up land area, or with R-square of the exponential density function, below the national average.

As for the evolution from 2003 to 2017, with the available information, it seems that population continuity is increasing (Chart 24).

Table 32.1. Continuity indicators by region

Region	Ratio urban land area to total land area	Ratio built-up land area to total land area	R-square of the exponential density function
	$CNTRUT_{PROV10a}$	$CNTRBT_{PROV10b}$	$CNTR2_{PROV10c}$
NATIONAL	**5.4348**	**3.3762**	**0.3126**
Andalucía	2.6038	1.6755	0.2570
Aragón	1.0704	0.6381	0.2293
Asturias	2.6901	1.5693	0.2635
Illes Balears	4.7216	3.4557	0.0264
Canarias	5.6821	3.0839	0.2104
Cantabria	3.4099	2.3843	0.3951
Castilla y León	1.3363	0.7819	0.1195
Castilla-La Mancha	1.3662	0.7719	0.1333
Cataluña	7.9529	5.2843	0.4255
Comunidad Valenciana	5.4894	3.5332	0.2563
Extremadura	0.8046	0.5333	0.2141
Galicia	5.3624	3.0373	0.1088
Madrid	12.0229	7.1075	0.7612
Murcia	4.8742	2.3899	0.2080
Navarra	2.6498	1.3580	0.0181
País Vasco	5.1697	3.7474	0.1038
La Rioja	1.6400	0.9469	0.1313

Source: Author's own work based on the sources described in Blanco, A. et al. (2021).

Table 32.2. Maximum and minimum values of continuity indicators (value and Region)

	Ratio urban land area to total land area	Ratio built-up land area to total land area	R-square of the exponential density function
Max SE	12.0229	7.1075	0.7612
Min SE	0.8046	0.5333	0.0181
Max SE	Madrid	Madrid	Madrid
Min SE	Extremadura	Extremadura	Navarra

Source: Author's own work based on the sources described in Blanco, A. et al. (2021).

Table 32.3. Inter-region variability of continuity indicators

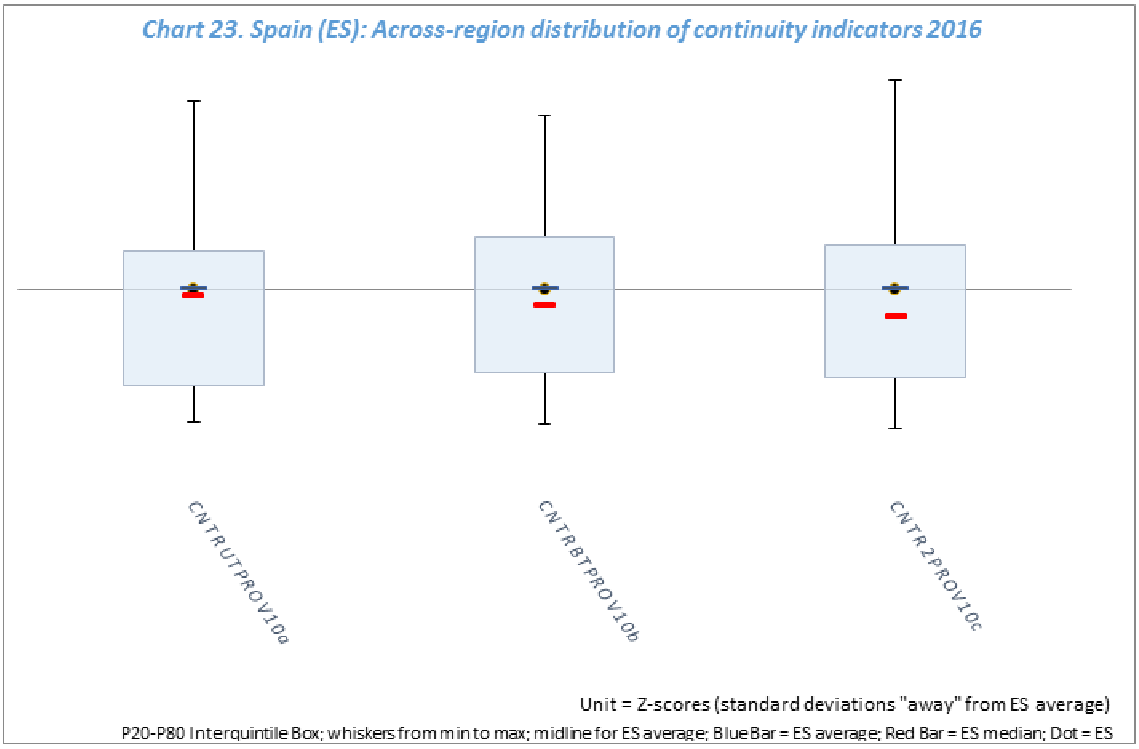
	Ratio urban land area to total land area	Ratio built-up land area to total land area	R-square of the exponential density function
Standard Deviation SE	3.41	2.08	0.21
CV SE	0.63	0.62	0.67

Source: Author's own work based on the sources described in Blanco, A. et al. (2021).

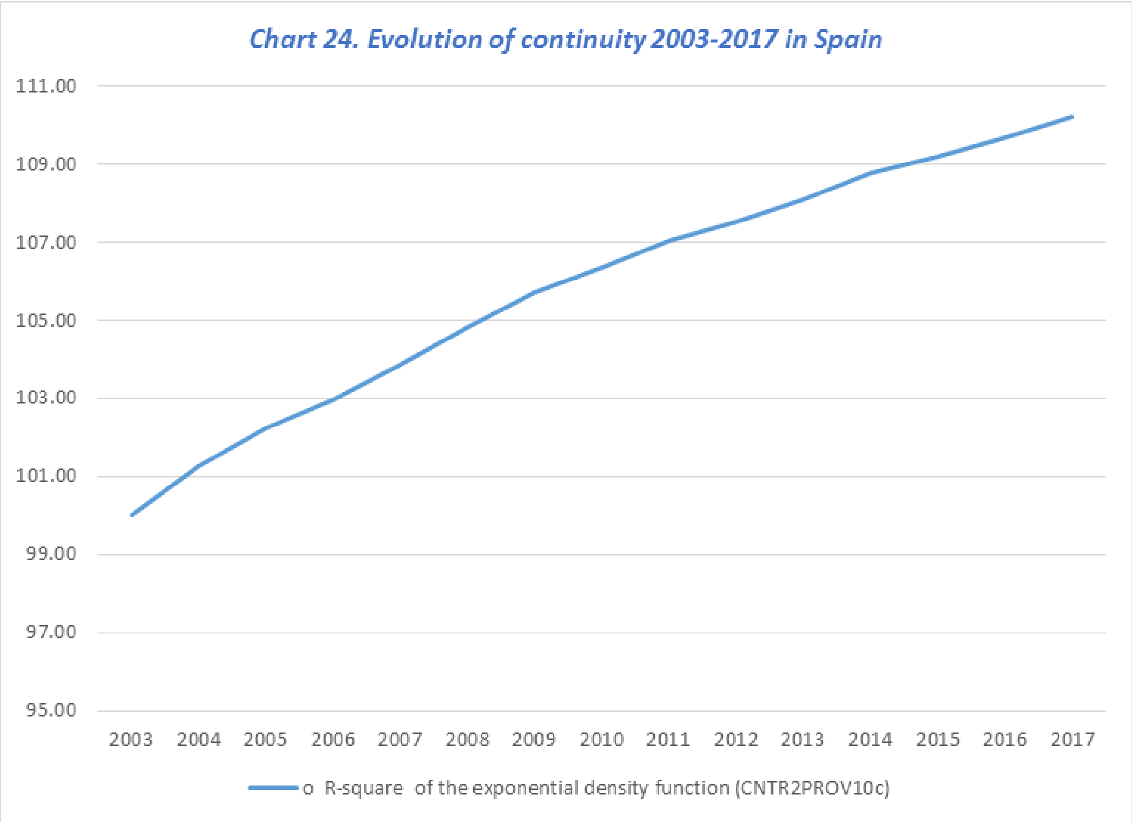
Table 33. Regional rankings of continuity indicators—Regions in decreasing order

	Ratio urban land area to total land area	Ratio BUILT-UP land area to total land area	R-square of the exponential density function
	$CNTRUT_{PROV10a}$	$CNTRBT_{PROV10b}$	$CNTR2_{PROV10c}$
ABOVE AVERAGE	Madrid	Madrid	Madrid
	Cataluña	Cataluña	Cataluña
	Canarias	País Vasco	Cantabria
	Comunidad Valenciana	Comunidad Valenciana	
		Illes Balears	
BELOW AVERAGE	Galicia	Canarias	Asturias
	País Vasco	Galicia	Andalucía
	Murcia	Murcia	Comunidad Valenciana
	Illes Balears	Cantabria	Aragón
	Cantabria	Andalucía	Extremadura
	Asturias	Asturias	Canarias
	Navarra	Navarra	Murcia
	Andalucía	La Rioja	Castilla-La Mancha
	La Rioja	Castilla y León	La Rioja
	Castilla-La Mancha	Castilla-La Mancha	Castilla y León
	Castilla y León	Aragón	Galicia
	Aragón	Extremadura	País Vasco
	Extremadura		Illes Balears
			Navarra

Source: Author's own work based on the sources described in Blanco, A. et al. (2021).



Source: Author's own work based on the sources described in Blanco, A. et al. (2021).



Source: Author's own work based on the sources described in Blanco, A. et al. (2021).

Some insights into continuity in Spain's regions

The analysis of the position that each Region registers regarding continuity indicators, as well as the comparative analysis between indicators, will provide some insights into continuity in Spain's regions. For the mentioned analysis, we will rely on Table 34 and Chart 25. We have built Table 34 based on the ranking position each Region has for each continuity indicator, in decreasing order. A low number in Table 34 means high population continuity. On the other hand, in Chart 25, we show the distribution of the three continuity indicators for each Region and its position in that distribution. The central box encloses what we will name "*central*" values of the said distribution. The bottom whisker goes from the minimum to the first quintile of the distribution, enclosing the values that account for 20% of the distribution in the bottom positions. Regions holding such low levels of population continuity are flagged with a red dot. The upper whisker goes from the fourth quintile to the maximum, enclosing the values that account for 20% of the distribution in the upper positions. Regions holding these high levels of continuity are flagged with a green dot.

It is important to keep in mind that we have calculated continuity indicators for each province and then aggregated them to the regional level. Therefore, our analysis outlines the regional panorama, which subsumes the provincial realities at the same time that it may conceal significant provincial differences within a region.

We would highlight the following features regarding population continuity in Spain's regions:

- **Andalucía** has intermediate-low levels of population continuity, especially low for the ratios urban and built-up land to total land.
- **Aragón** has low levels of population continuity, especially low for the ratios urban and built-up land to total land, for which the Region presents among the lowest regional values in Spain.
- **Asturias** presents intermediate to low levels of population continuity.
- **Illes Balears** has intermediate to low levels of population continuity.

- **Canarias** has intermediate levels of population continuity.
- **Cantabria** has intermediate levels of population continuity.
- **Castilla y León** has low levels of population continuity.
- **Castilla-La Mancha** has low levels of population continuity.
- **Cataluña** has high levels of population continuity.
- **Comunidad Valenciana** has intermediate levels of population continuity.
- **Extremadura** has very low levels of population continuity; especially for the ratios urban and built-up land to total land, for which the Region presents the lowest regional values in Spain.
- **Galicia** presents intermediate to low levels of population continuity.
- **Madrid** has the highest levels of continuity in Spain regardless of the indicator that is used.
- **Murcia** has population continuity levels that are among the lowest in Spain, regardless of the indicator that is used.
- **Navarra** has intermediate levels of population continuity.
- **País Vasco** has intermediate to low levels of population continuity.
- **La Rioja** has low levels of population continuity.

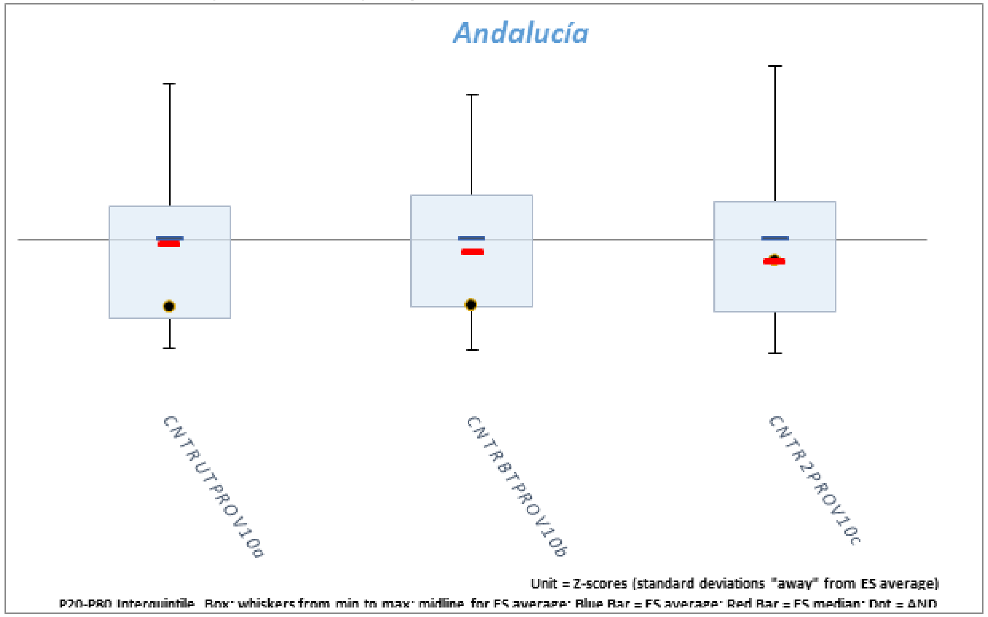
Table 34. Regional rankings of continuity indicators—Positions in decreasing order

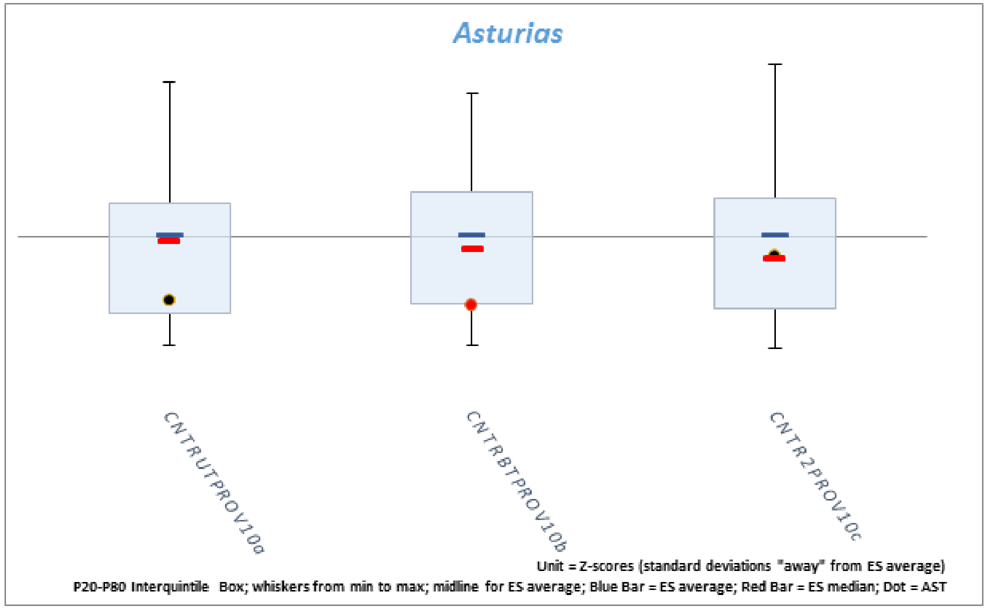
Region	*Ratio urban land area to total land area*	*Ratio BUILT-UP land area to total land area*	*R-square of the exponential density function*
	CNTRUTPROV10a	*CNTRBTPROV10b*	*CNTR2PROV10c*
Andalucía	12	10	5
Aragón	16	16	7
Asturias	10	11	4
Illes Balears	8	5	16
Canarias	3	6	9
Cantabria	9	9	3
Castilla y León	15	14	13
Castilla-La Mancha	14	15	11
Cataluña	2	2	2
Comunidad Valenciana	4	4	6
Extremadura	17	17	8
Galicia	5	7	14
Madrid	1	1	1
Murcia	7	8	10
Navarra	11	12	17
País Vasco	6	3	15
La Rioja	13	13	12

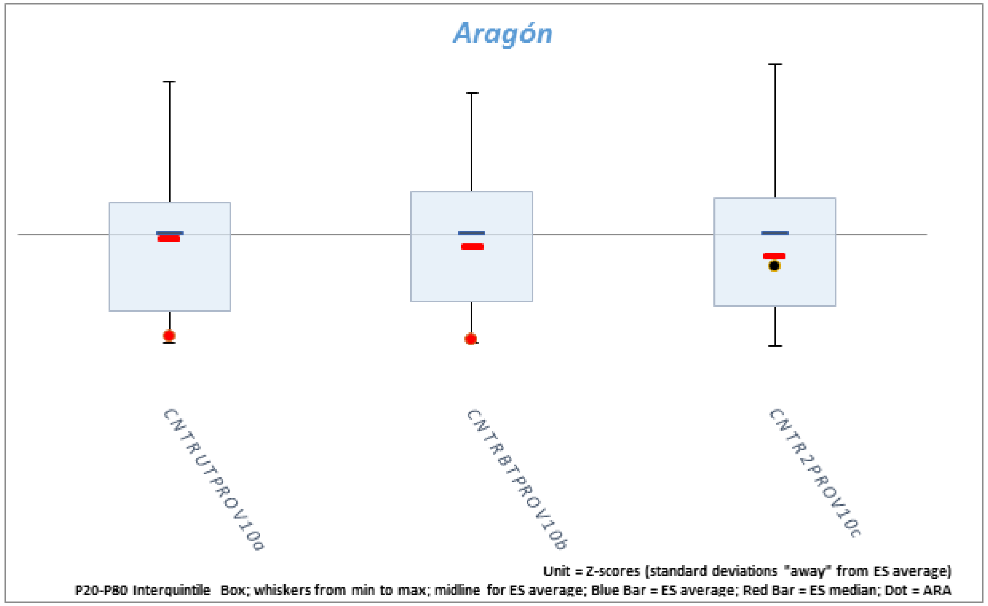
Source: Author's own work based on the sources described in Blanco, A. et al. (2021).

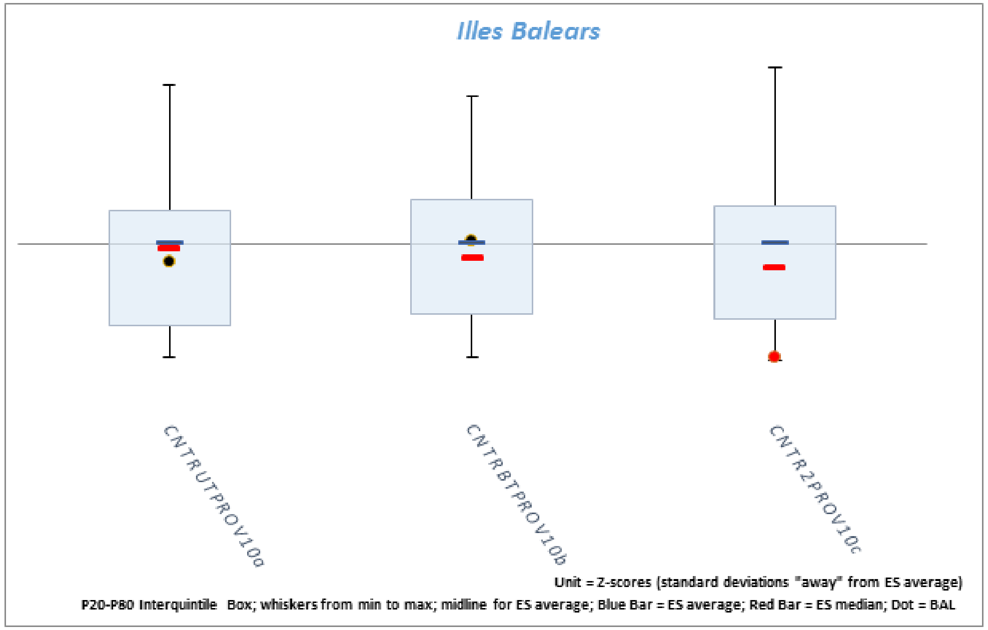
Chart 25. Continuity indicators by Region 2016

(*It continues*)





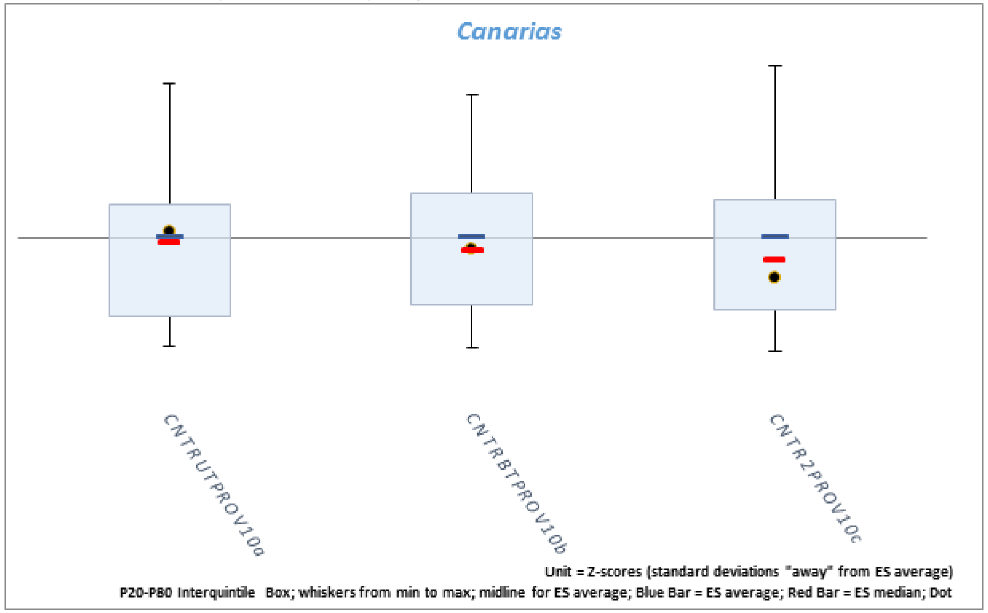


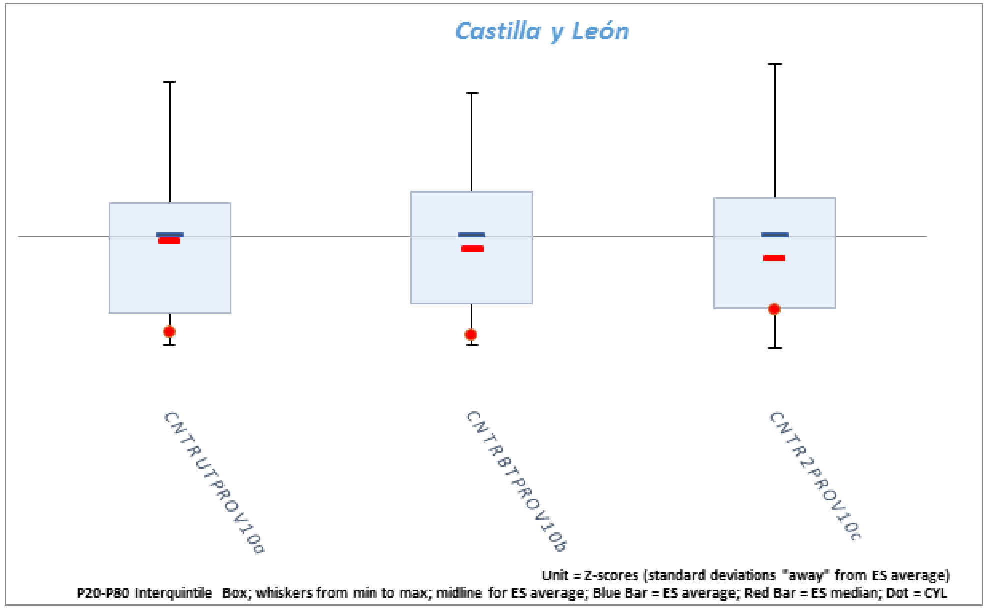


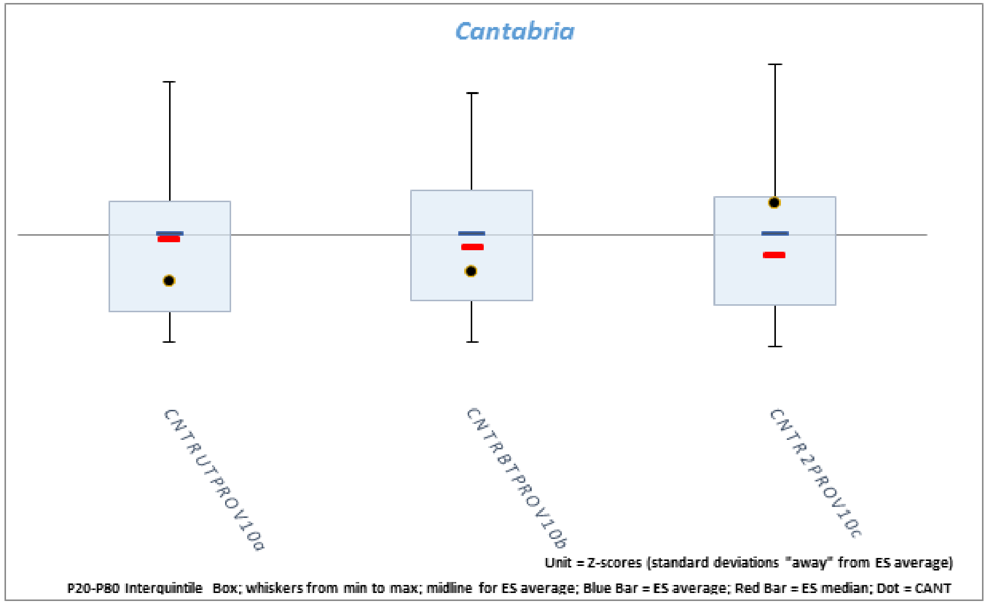
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

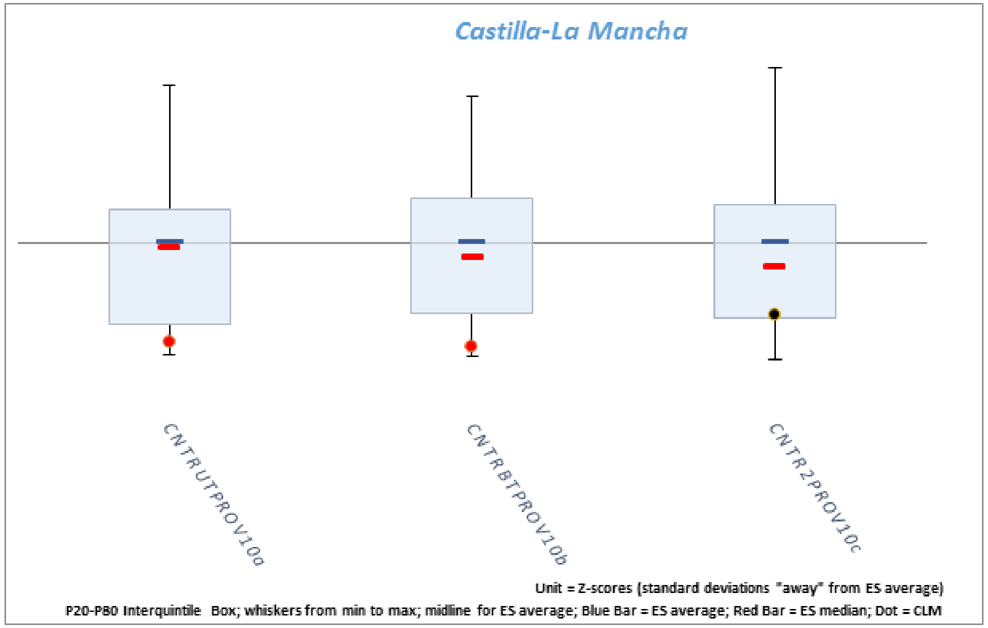
Chart 25. Continuity indicators by Region 2016

(It continues)



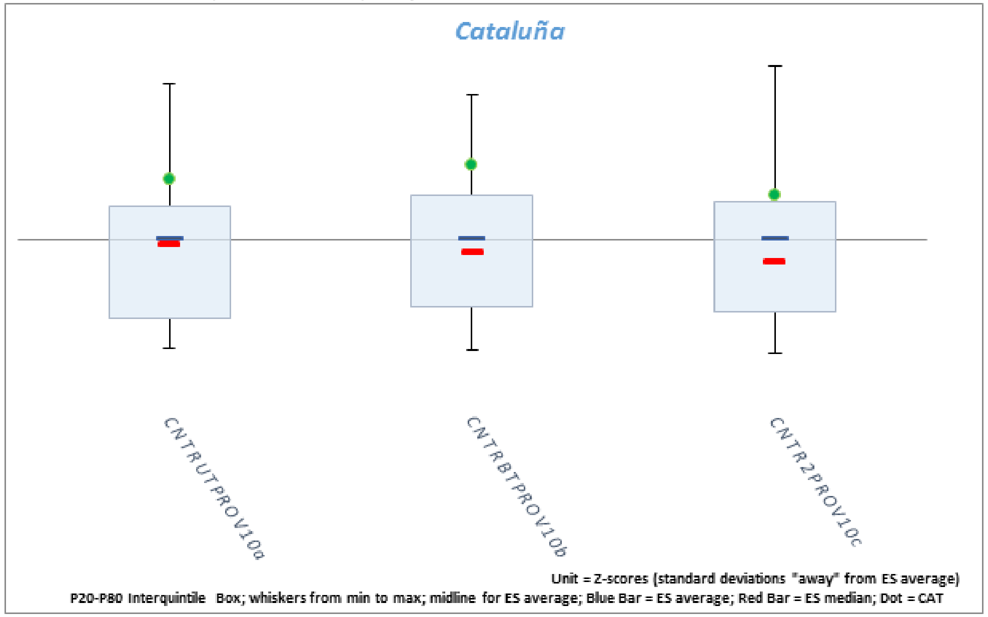


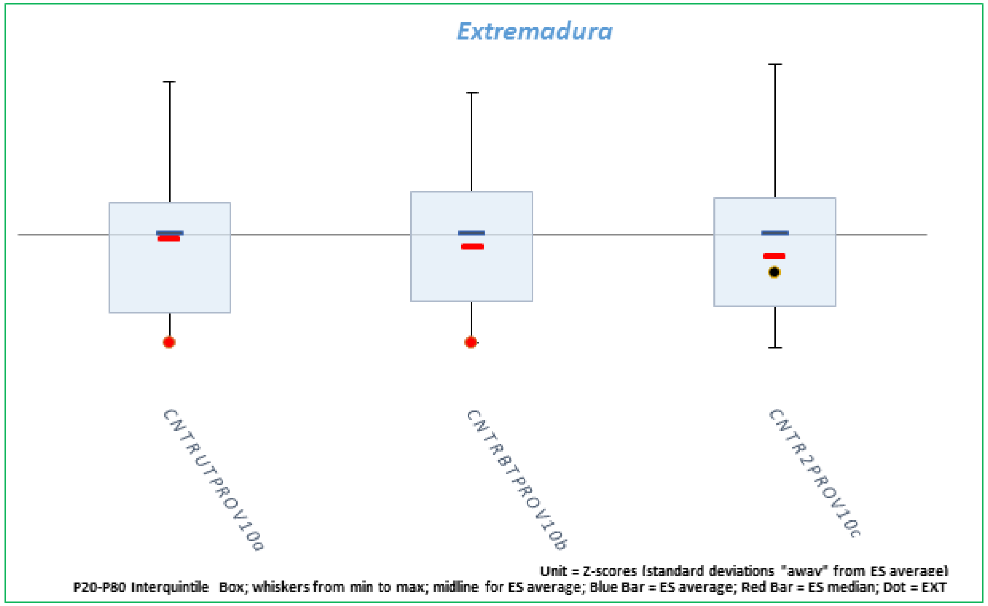


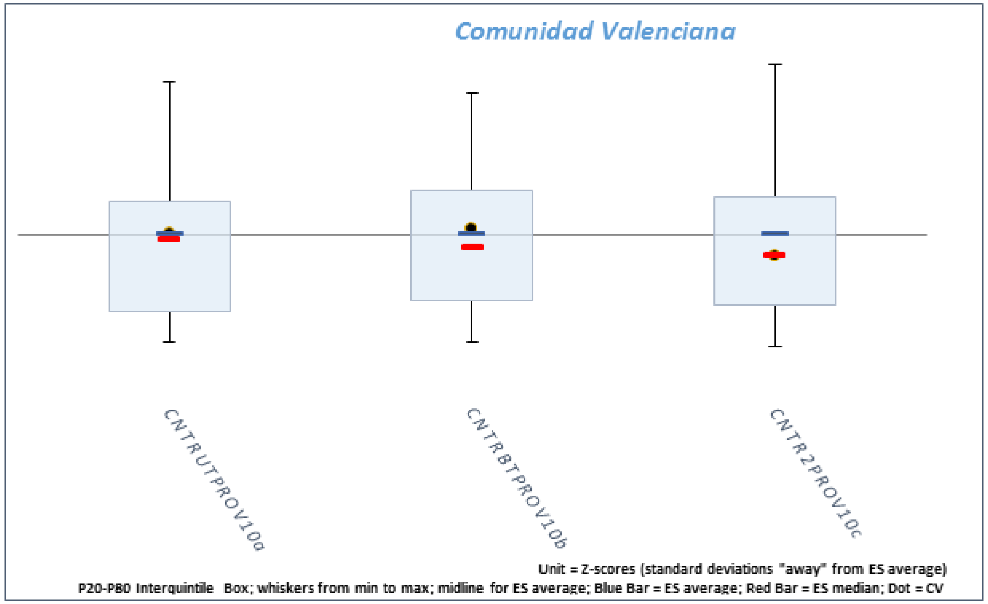


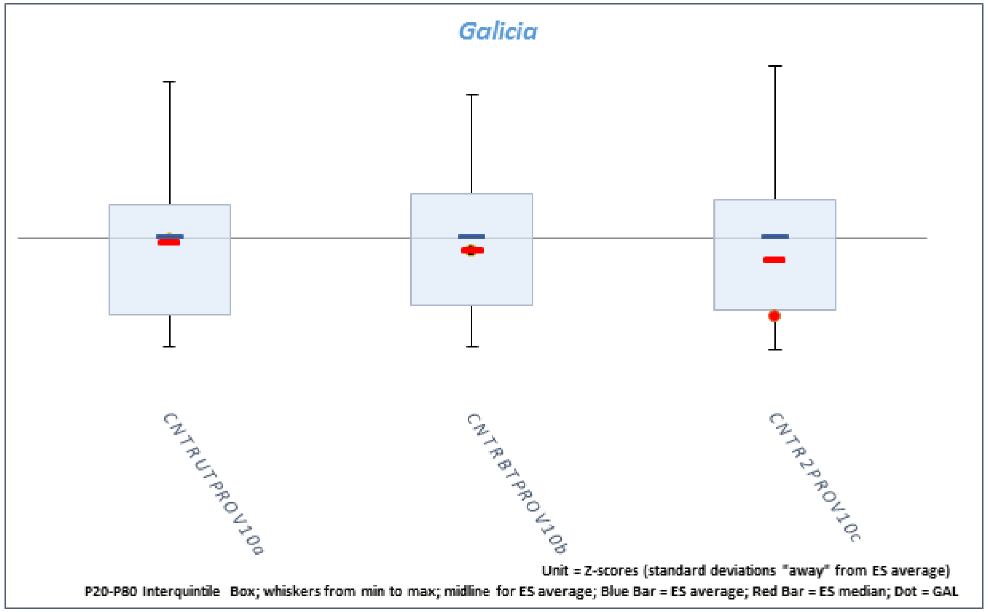
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 25. Continuity indicators by Region 2016 *(It continues)*





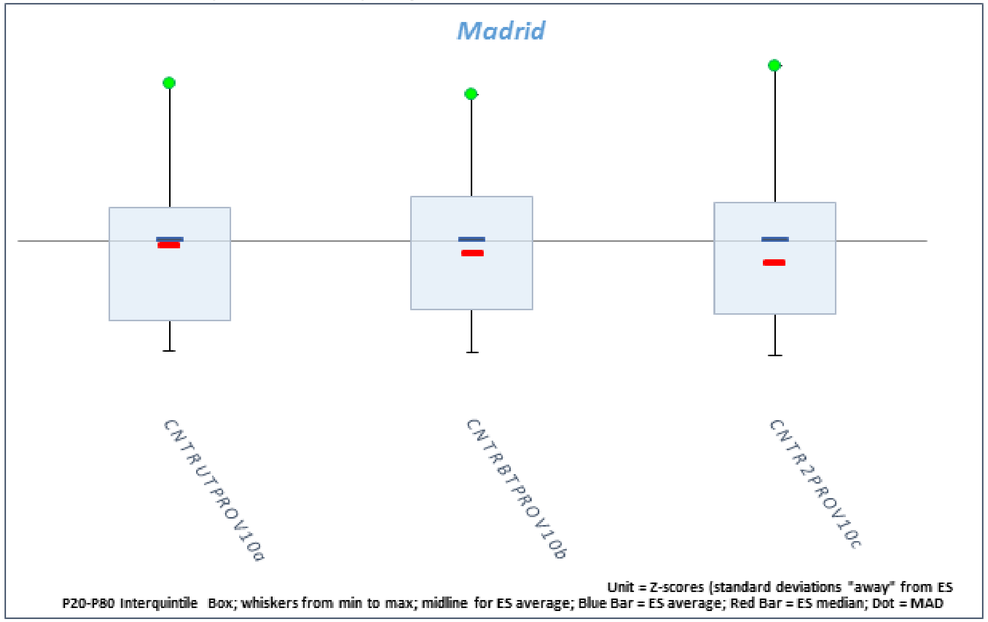


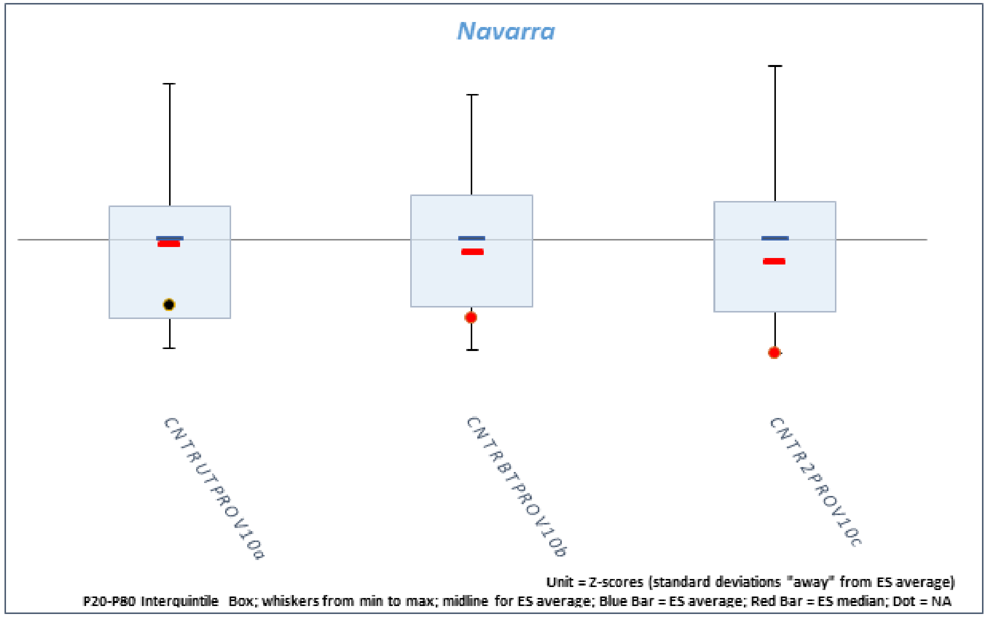


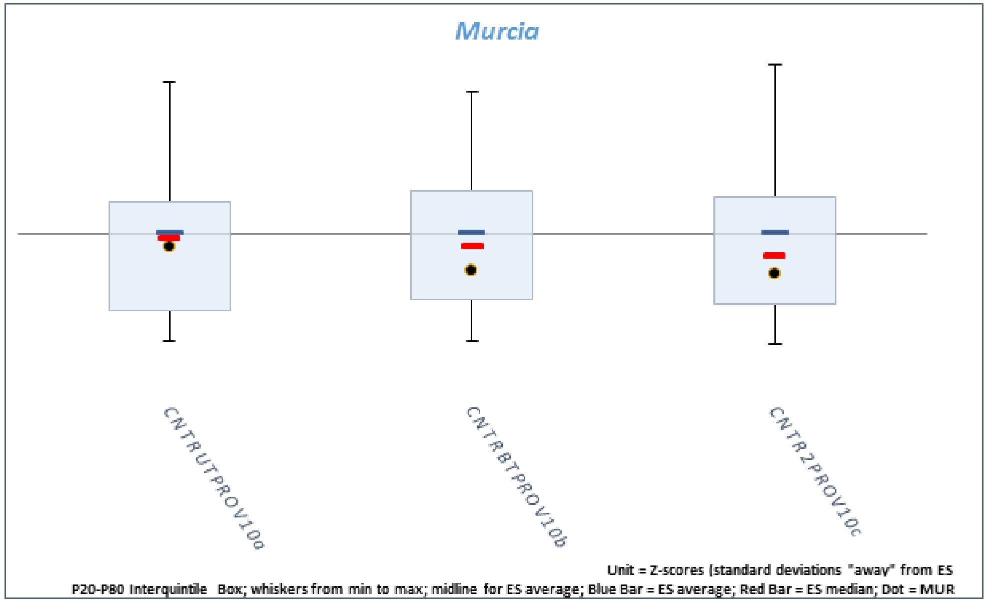
Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

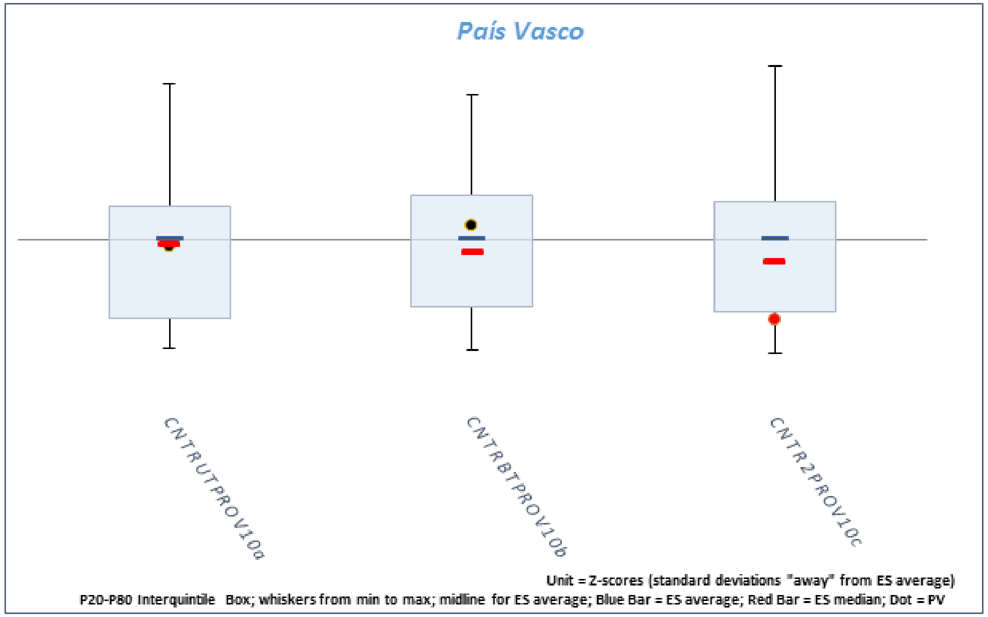
Chart 25. Continuity indicators by Region 2016

(It continues)



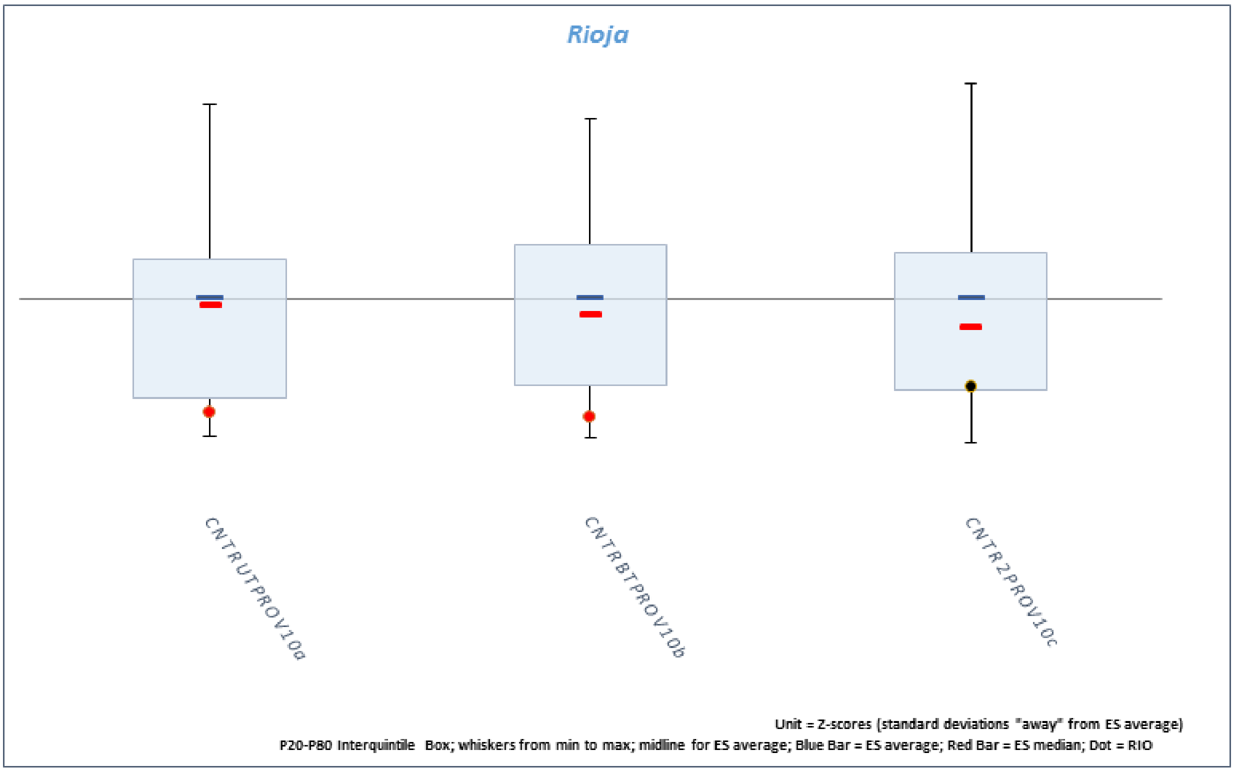






Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Chart 25. Continuity indicators by Region 2016 *(It concludes)*



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

In general, population continuity has steadily increased over the period 2003-2017 (Table 35) at a cumulative annual rate of 0.7%.

Table 35. Evolution of population concentration indicators at the national level 2003-2017

Continuity indicators		Δ Annual average 2008/2003	Δ Annual average 2017/2008	Δ Annual average 2017/2003
R-square of the exponential density function	*$CNTR2_{PROV10c}$*	0.943	0.562	0.698

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

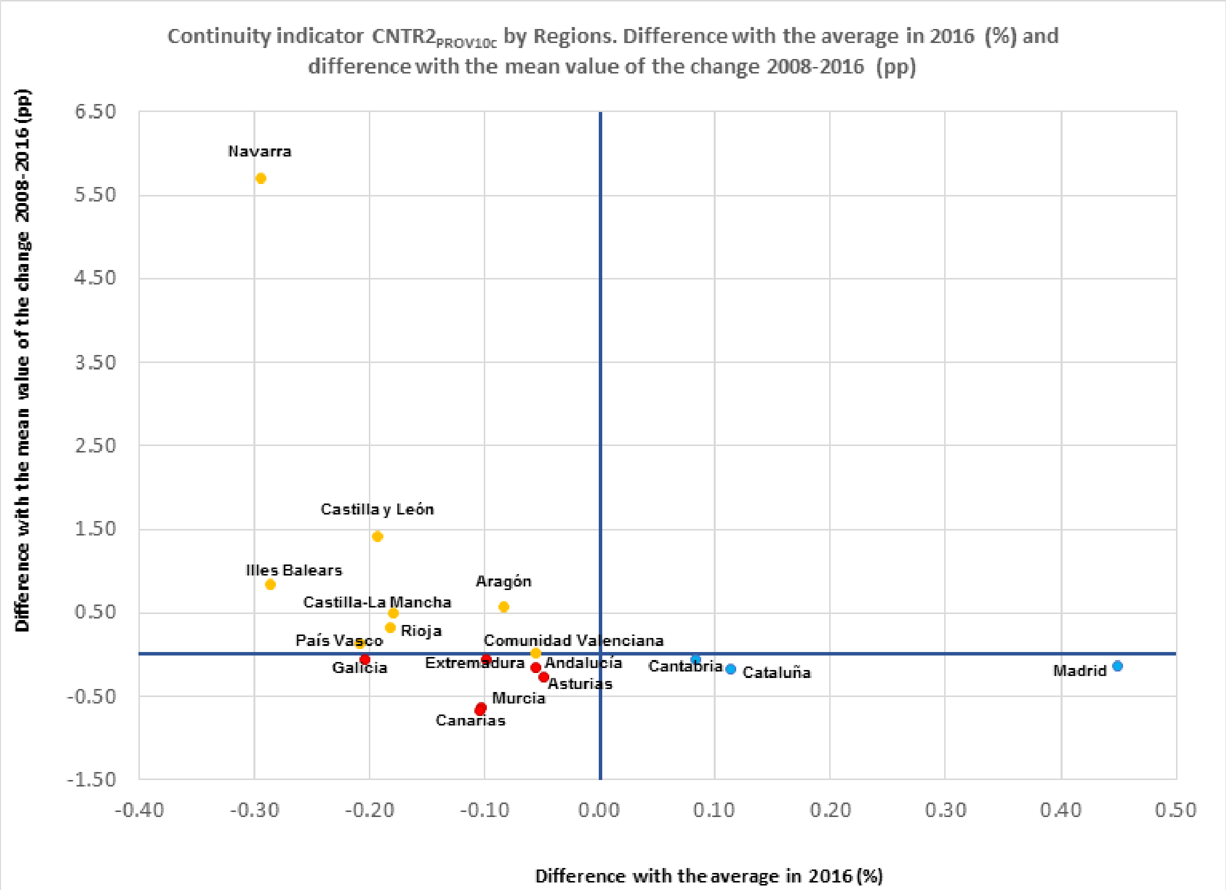
Concerning the continuity dynamic in Spain´s regions, when comparing their relative position to the national average in 2016, together with their time trend during the period 2003 to 2016 (Chart 26), we would highlight the following regional features:

- **Andalucía** has below average levels of continuity. Continuity in Andalucía is evolving at slightly lower rates than the national average. Thus, over time, continuity would follow a sluggish falling path divergent from the national average or remain stagnant.

- **Aragón** has below average levels of continuity. However, it is evolving above the national average, thus the Region would follow an upwards convergence towards the national level.
- **Asturias** has below average levels of continuity. Continuity in Asturias is evolving at slightly lower rates than the national average. Thus, over time, continuity would follow a sluggish falling path divergent from the national average or remain stagnant.
- **Illes Balears** has well below average levels of continuity. However, it is evolving above the national average, thus the Region would follow an upwards convergence towards the national levels, setting it on the path to upgrade positions in the regional ranking.
- **Canarias** has below average levels of continuity, which is evolving at notably lower rates than the national average. Thus, over time, continuity would follow a falling path divergent from the national average.
- **Cantabria** has above average levels of continuity, which is evolving at slightly lower rates than the national average. Thus, over time, continuity would follow a slow falling path convergent to the national average.
- **Castilla y León** presents well below average levels of continuity. However, it is evolving notably above the national average, thus the Region would follow an upwards convergence towards the national level.
- **Castilla-La Mancha** presents well below average levels of continuity. However, it is evolving over the national average, thus the Region would follow an upwards convergence towards the national level.
- **Cataluña** presents above average levels of continuity, which is evolving at lower rates than the national average. Thus, over time, continuity would follow a falling path convergent to the national average.
- **Comunidad Valenciana** has below average levels of continuity, which is evolving at similar rates to the national average. Thus, continuity would remain stagnated.
- **Extremadura** presents below average levels of continuity, which is evolving at slightly lower rates than the national average. Thus, over time, continuity would follow a stagnant falling path divergent from the national average.

- **Galicia**'s population continuity is well below the national average and evolving at slightly lower rates than the national average. This dynamic pattern would promote stagnant divergence from the national average.
- **Madrid** has above average levels of continuity, which is evolving at lower rates than the national average. Thus, continuity would follow a falling convergent path towards the national average.
- **Murcia** has below average levels of continuity, which is evolving at notably lower rates than the national average. Thus, over time, continuity would follow a falling path divergent from the national average.
- **Navarra's** population continuity is well below the national average but evolving at a significantly slower pace than the national average. This dynamic pattern would promote an upwards convergence towards the national average, setting it on the path to upgrade positions in the regional ranking.
- **País Vasco's** population continuity is well below the national average but evolving at a higher pace than the national average. This dynamic pattern would promote upwards convergence towards the national average.
- **La Rioja** presents well below average levels of continuity. However, continuity is evolving over the national average, thus the Region would follow an upwards convergence towards the national level.

Chart 26. The dynamic of continuity



Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

3. MAIN FEATURES OF DISPERSION DIMENSIONS IN SPAIN

There are not standard references available against which benchmarking the value of our indicators. Therefore, we developed our analysis based on interregional comparisons with the national average and the distribution across regions as a reference.

In spite of that, for some indicators we have some "*absolute*" references, such as the Gini indices. It is widely acknowledged that this index ranges between 0 and 1, with zero representing a population that is equally distributed among land uses and one representing the maximum population concentration in just one land use. Nevertheless, for the purpose of our work, our indicators must be analysed in comparative terms.

The regional rankings show that there is a bulk of systematic elements across indicators within the same dimension. On the other hand, we have identified some differences among them that put forward that each indicator or group of indicators captures different facets of population dispersion. Thus, pointing to the need to select those indicators most suited to the objective of capturing the extent to which dispersion is a driver of spending in FPS. In this vein, we describe here the basic criteria that have been followed to select the relevant indicators. In addition, for future aggregation purposes, minimizing the number of indicators is desirable on other grounds, such as transparency, interpretability and parsimony.

We summarise in this point the main features of dispersion's dimensions. We will rely on it together with the analysis done in point two to underpin our decision concerning the selection of indicators that we will finally use to build a composite indicator that synthesises the different dimensions of population dispersion. In the understanding that, even if we focus on a subset of indicators, the regularities identified for dispersion in Spain's regions are retained.

Main features of proximity

In Spain, typically, most people live in regions with low proximity (below the national average).[28] Depending on how proximity is approached, between 53% and 93% of the population lives in regions with below average proximity. Only three indicators, out of the twenty-nine we used for measuring proximity, yield percentages above 50% for the share of population living in regions whose proximity is above the national average.[29]

Population proximity is higher than geographical proximity: the spatial separation between the people (*"population distance"*) is around 60% to 63% of the spatial separation between the locations (*"location distance"*), depending on whether we measure it through straight-line distance, travel distance or travel duration. This indicates that the population tends to reside in singular entities that are closer to each other than the whole set of locations.

Population proximity is increasing since 2008. Nationwide, the indicators show that from 2003 to 2008 population proximity decreased, and subsequently initiated a raising trend that continued until 2017, our last analysed year. Our results show that over time population has moved to reside in land uses that are close to each other, mainly in terms of travel distances. Between 2008 and 2017, the cumulative annual rate of increase for the ratio "*location distance*" to "*population distance*" (relative proximity) ranges between 0.15% and 0.17%, depending on whether it is measured through straight-line distance, travel distance (with the highest rate) or travel duration. In addition, these movements seem to be more intense concerning SE than municipalities: the rates of increase for population proximity measured with SE overpass that of population proximity measured with municipalities. One plausible explanation could be that the population has moved towards municipality capitals, as well as, and in a more intense manner, towards municipalities that are close to each other.

Proximity indicators present a significant variability among regions, with high interregional coefficients of variation, except when proximity is measured with standardised indicators.

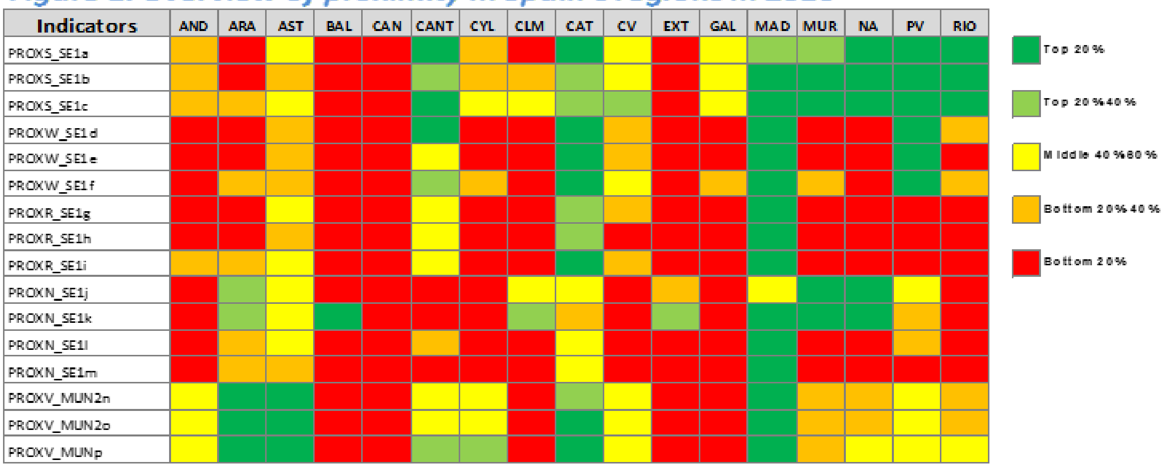
[28] We have no absolute benchmark nor international standard to calibrate the extent to which the values of proximity indicators in Spain are low or high. Therefore, our reference is the national average.

[29] $PROXS_{SE1b}$, $PROXS_{SE1c}$, $PROXV_{MUNp}$.

The regional rankings show some systematic elements, such as the islands are typically being in bottom proximity positions or Cataluña and Madrid in top ones. However, we have identified some differences in the regional rankings depending on how proximity is approached. For instance, we note that Galicia, Murcia, Navarra and La Rioja move from positions over the national average to below it when the focus is placed on population proximity instead of geographical proximity.

In Figure 1, we present an overview of the population proximity situation in Spain according to the distribution of all the related indicators across regions. For a given territory, when the value of proximity ranges within 20% of the distribution's bottom positions, the Region is flagged in red. On the contrary, if proximity ranges within 20% of the distribution's upper positions, the Region is flagged with dark green. For intermediate positions, the Region is flagged according to the legend in the figure.

Figure 1. Overview of proximity in Spain's regions in 2016



Source: Author's own work

Against the backdrop of our analyses concerning proximity, we considered that the selection criteria for the most suitable indicators according to the objective of this work would be the following:

- *Focus on relative and standardised indicators.*
  On the grounds that we improve regional comparability and avoid confounding factors when analysing the association of dispersion and the cost of FPS.
- *Use indicators measuring both population and geographical proximities*.

To ensure that we measure population dispersion taking into account equality of access considerations and not only efficiency gains derived from economies of scale associated with the fact that the proximity of the people is higher than the proximity of the locations they inhabit.

- *Use indicators based on travel distances*.

  Travel distance or travel duration are more suitable than the straight-line distance to reflect service accessibility. We opted for travel distance because we have travel distance-based indicators available in the three categories of indicators, and our analyses point out that this variable is leading more than travel duration people's decision concerning movements within a province along the analysed period.

Therefore, we selected the following indicators to characterise population proximity:

1. *Ratio of population proximity to geographical proximity (SE & travel distances) (**$PROXR_{SE1h}$**).*
2. *Normalised population proximity (SE & travel distances) (**$PROXN_{SE1m}$**).*
3. *Standardised Proximity Index (SPI) based on travel distance (**$PROXV_{MUN2o}$**).*

Correlations between these three selected indicators are below 0.95. Therefore, no "*double counting*" issues arise with this selection. Please refer to Annex III.

Main features of centrality

In Spain, typically, most people live in regions with low centrality (below the national average). Depending on how centrality is approached, between 53% and 79% of the population live in regions with below average centrality. Only two indicators, out of the twenty-eight used for measuring density, yield percentages above 50% for the share of population living in regions whose density is above the national average.[30]

Population centrality is higher than geographical centrality: the population's spatial separation from the CBD (*"population centrality"*) is around 58% to 60% of the spatial separation of the locations from the CBD (*"geographical centrality"*), depending on whether it is measured through straight-line distance, travel distance or travel duration.

[30] $CBDdW_{SE3f}$ (59%) and $CBDdR_{SE3i}$ (76%). Both of them measure population centrality (not sites centrality) in terms of travel duration.

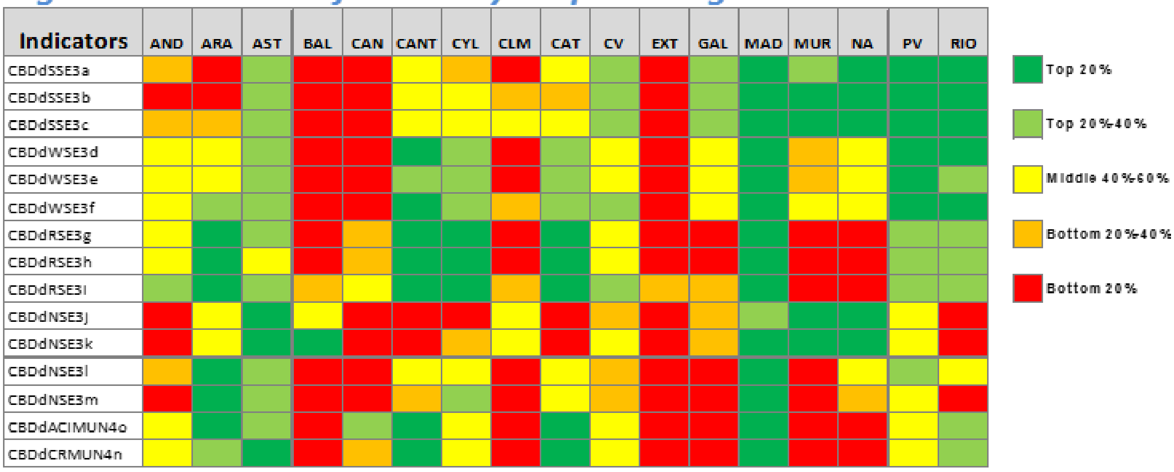
This indicates that the population tends to reside in singular entities that are closer to the CBD than the whole set of locations.

Population centrality has increased between 2003 and 2017, except for travel duration-based indicators. Nationwide, the indicators show that from 2003 to 2008 population centrality decreased, to initiate a rising trend as of 2008 that continued until 2017, our last analysed year. Our results show that over time population has moved to reside in land uses that are closer to the CBD, mainly in terms of travel distances. Between 2008 and 2017, the cumulative annual rate of increase for relative centrality indicators ranges between 0.11% and 0.18%, depending on whether it is measured through straight-line distance, travel distance (with the highest rate) or travel duration. In addition, these movements seem to be more intense concerning municipalities than SE: the rates of increase of population centrality measured with municipalities overpass that of population centrality measured with SE. One plausible explanation could be that the population has moved towards the municipalities that are close to province capitals more intensely than towards municipality capitals.

Centrality indicators present a significant variability among regions, with high interregional coefficients of variation, except when centrality is measured with normalised indicators. The regional rankings show some systematic elements, such as the low position in which Illes Balears, Canarias and Extremadura are typically found while Madrid ranks among the top ones. However, we have identified some differences in the regional ranking depending on how centrality is approached. For instance, we note that País Vasco moves from top positions to intermediate ones when transitioning from absolute indicators to relative or standardised ones. Murcia and Navarra move from top positions to bottom ones when population centrality is used instead of geographical centrality, just the opposite of what is observed for Aragón, Cantabria and Cataluña.

In Figure 2, we present an overview of the population centrality situation in Spain according to the distribution of all the related indicators across regions. For a given territory, when centrality ranges within 20% of the distribution's bottom positions, the Region is flagged in red. On the contrary, if it ranges within 20% of the distribution's upper positions, the Region is flagged with dark green. For intermediate positions, the Region is flagged according to the legend in the figure.

Figure 2. Overview of centrality in Spain's regions in 2016



Source: Author's own work

Against the backdrop of our analyses concerning centrality, we considered that we should:

- *Focus on relative and standardised indicators.*

  On the grounds that we improve regional comparability and avoid confounding factors when analysing the association of dispersion and the cost of FPS.

- *Use indicators measuring both population and geographical centralities*.

  To ensure that we measure population dispersion taking into account equality of access considerations and not only efficiency gains derived from economies of scale associated with the fact that the population's centrality is higher than the centrality of the locations they inhabit.

- *Use indicators based on travel distances*.

  Travel distance or travel duration are more suitable than the straight-line distance to reflect service accessibility. We opted for travel distance because we have travel distance-based indicators available in the three categories, and our analyses point out that this variable is leading more than travel duration people's decision concerning movements towards the CBD within a province along the analysed period.

- *Disregard the Centralisation Ratio indicator*.

On the grounds that it has a correlation of 0.97[31] with the *Centralisation Index* indicator and this will facilitate capturing the very different facets of population concentration enclosed in the indicators while avoiding "*double counting*" (Annex III).

Therefore, we selected the following indicators to characterise population centrality:

4. *Ratio population centrality to geographical (SE & travel distances) (**$CBDdR_{SE3h}$**).*
5. *Normalised population centrality (SE & travel distances) (**$CBDdN_{SE3m}$**).*
6. *Centralisation index (**$CBDdACI_{MUN4o}$**).*

Main features of nuclearity

In Spain, typically, most people live in regions with low nuclearity (below the national average). Depending on how nuclearity is approached, between 59% and 69% of the population live in regions with below average nuclearity.

Nuclearity in Spain is decreasing. Over the period 2003 to 2017, we have witnessed an increase in the number of nuclei per province at the same time that the share of CBD population over the whole set of nuclei has decreased. Nonetheless, the increase in the number of nuclei in each province is characterised by a decrease (or stagnation) in the average distance between nuclei, except in La Rioja. It seems that, typically, the population is moving to reside in other nuclei different from the CBD, although close to it, as well as to other nuclei.

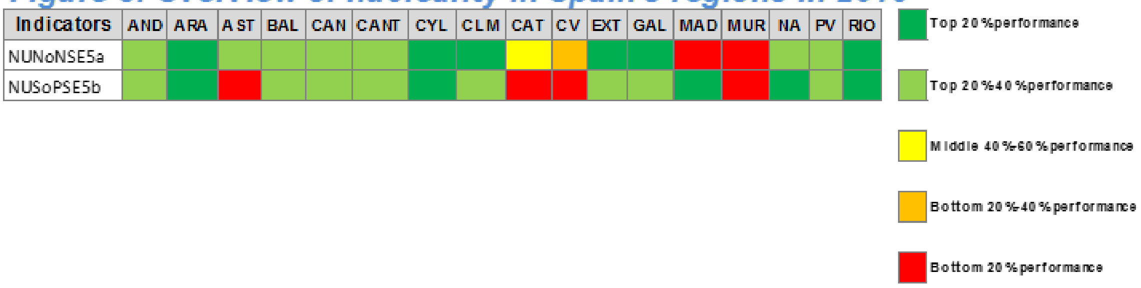
Nuclearity indicators present a significant variability among regions, with high interregional coefficients of variation. The regional rankings show some systematic elements such as the bottom positions in which Cataluña, Comunidad Valenciana and Murcia are systematically found, while Aragón, Castilla y León and La Rioja are systematically in top positions. However, we have identified some differences in the regional ranking depending on how nuclearity is approached. For instance, we note that Madrid moves from bottom to top

[31] As a rule of thumb, we define the correlation of 0.95 as the threshold beyond which the correlation is a symptom of double counting.

positions when transitioning from measuring nuclearity via the number of nuclei to measuring it via the share of the population in the CBD over the population in nuclei. A similar situation occurs in Navarra, meaning that in Madrid and Navarra there is a relatively high number of nuclei but the population in nuclei is mainly settled in the CBD. We observe the opposite for Asturias and Castilla-La Mancha, where there is a relatively low number of nuclei and the population in nuclei is more evenly distributed, with a relatively low share of the CBD.

In Figure 3, we present an overview of the nuclearity situation in Spain according to the distribution of all the related indicators across regions. For a given territory, when nuclearity ranges within 20% of the distribution's bottom positions, the Region is flagged in red. On the contrary, if it ranges within 20% of the distribution's upper positions, the Region is flagged with dark green. For intermediate positions, the Region is flagged according to the legend in the figure.

Figure 3. Overview of nuclearity in Spain's regions in 2016



Source: Author's own work

We selected all the indicators to characterise population nuclearity:

7. *Inverse of the number of nuclei per province SE-based (**$NUNoN_{SE5a}$**).*
8. *Share of the population in the CBD over the population in nuclei SE-based (**$NUSoP_{SE5b}$**).*

Main features of density

Overall, in Spain, the total density is 92 inhabitants per Km^2, below the EU average of 118. However, some analyses show that "*much of Spain appears to be empty; much more so than any other large European country… Yet characterising Spain as a sparsely populated country does not reflect the experience on the ground … So even though the settlement pattern appears sparse, people are actually quite tightly packed together*." Rae, A. (2018).

By measuring population density with more fine-tuned indicators than the crude ratio population to land area, our results draw a panorama of sparsely populated Spanish provinces throughout their entire territory but densely populated in their CBD, as well as in urban and built-up areas.

Most people live in regions with low density (below the national average). Depending on how density is approached, between 51% and 67% of the population lives in regions with below average density. Only three indicators, out of the fifteen used for measuring concentration, yield percentages above 50% for the share of population living in regions whose density is above the national average. The three indicators refer to urban density (based on urban land area) and residential density (based on built-up land area), whose distribution across regions tends to be more symmetric than for total density (based on total land area).

The evolution of total population density shows stagnation or a decreasing trend between 2003 and 2017, except when measured through the density of land use in the CBD. This could point out that those municipalities with higher population shares maintained or decreased their total population density while the population moved towards the CBD. However, considering the decreasing trend in the population share in high-density municipalities, it seems that there were also movements towards less densely populated locations.

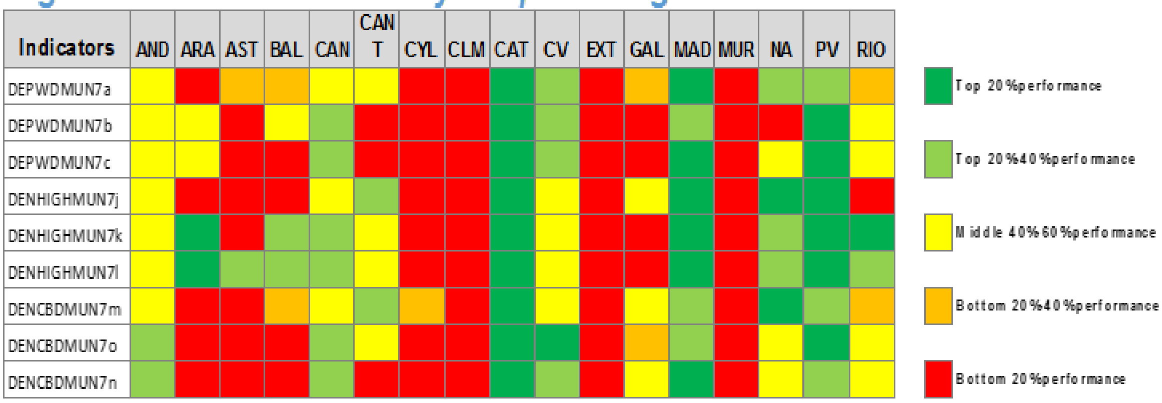
The evolution of urban and residential population density shows an increasing trend between 2003 and 2017, regardless of the indicator that is used. Residential population density has typically increased at higher rates than urban population density and urban population density has typically increased at higher rates than total population density. This could point out that in those municipalities that gained population share, the urban land area expanded at higher rates than built-up land area at the same time that the expansion of built-up land area was inferior to the increase of the population.

However, the most recent evolution of total population density from 2015, with rates of increase overpassing those of urban and residential densities, shows that there could be a latter tendency of the population to move towards those municipalities (alternatively CBDs) that are most densely populated across their territories. At the same time, they increase their urban land area and, to a lesser extent, built-up land area at greater rates than those of the population.

Density indicators present a significant variability among regions, with high interregional coefficients of variation. The regional rankings show some systematic elements: Andalucía, Asturias, Cantabria, Castilla y León, Castilla-La Mancha, Extremadura, Galicia and Murcia always present at or below average density for all indicators. On the contrary, Cataluña, Madrid and País Vasco show density values at or over the national average. However, we have identified some differences in the regional ranking depending on how density is approached. For instance, Aragon and La Rioja hold bottom positions except for the share of the population in high urban and residential density municipalities; while Navarra moves from top positions to intermediate or bottom ones when switching from total density to urban and residential density.

In Figure 4, we present an overview of the population density situation in Spain according to the distribution of all the related indicators across regions. For a given territory, when density ranges within 20% of the distribution's bottom positions, the Region is flagged in red. On the contrary, if it ranges within 20% of the distribution's upper positions, the Region is flagged with dark green. For intermediate positions, the Region is flagged according to the legend in the figure.

Figure 4. Overview of density in Spain's regions in 2016



Source: Author's own work

Against the backdrop of our analyses concerning density, we considered that we should:

- *Use urban density or residential density but not both*.

  Considering the high correlation between both indicators (0.95).
- *Use indicators measuring both total and urban or residential density*.

  To ensure that population dispersion is measured taking into account equality of access considerations and not only efficiency gains derived from economies of scale associated with high-density settlements.
- *Disregard indicators on the density of land use in the CBD*.

  Considering the high correlation between these indicators and the ones on the share of population living in high-density municipalities (between 0.94 and 0.97).
- *Disregard the indicators Population-weighted density based on urban land and Share of the population living in high-density municipalities based on urban land*.

  On the grounds that they have a correlation of 0.95 with the indicators *Population-weighted density based on built-up land and Share of the population living in high-density municipalities based on built-up land.* This will facilitate capturing the different facets of population concentration enclosed in the indicators while avoiding "*double counting*" (Annex III).

We selected the following indicators to characterise population density:

9. *Population-weighted density based on total land (**$DEPWD_{MUN7a}$**).*
10. *Population-weighted density based on built-up land area (**$DEPWD_{MUN7c}$**).*
11. *Share of the population living in high-density municipalities based on total land (**$DENHIGH_{MUN7j}$**).*
12. *Share of the population living in high-density municipalities based on built-up land area (**$DENHIGH_{MUN7l}$**).*

Main features of concentration

Most people live in regions with low population concentration (below the national average).[32] Depending on how concentration is approached, between 51% and 73% of the population live in regions with below average population concentration. Only four indicators, out of the sixteen used for measuring concentration, yield percentages

[32] Please remember that we develop our analyses in comparative terms with the national average of each indicator and its distribution across regions as references. Therefore, it is not a contradiction to state that most people live in regions with low population concentration at the same time that declaring that the Gini indices are close to one in all regions.

overpassing 50% for the share of population living in regions whose density is above the national average.[33]

The first one is $CNGINI_{MUN9d}$, which is a Gini index based on municipality population instead of SE population. As highlighted in Blanco et al. (2021), the spatial unit of analysis appears as a key factor to study the dynamics of concentration and the literature has shown that, generally, the concentration degree increases with the size of the chosen spatial units. Typically, when data are grouped, the indices are sensitive to the definition and the number of categories used. The integration of two or more categories always implies a reduction of the index's calculated value; unless the two of them have the same population share (aggregation implies erasing part of the differences). There seems to be a certain consensus about the choice of local units as the most appropriate. We have calculated the Gini and Standardised Herfindahl indices both based on SE and municipalities and will opt for using the SE-based version. The other three ways are $CNGINI_{MUN9e}$, $CNMDDI_{MUN9l}$, and $CNMDDI_{MUN9m}$. These correspond to the Gini and dissimilarity indices, which take as benchmark the distribution of land area.

The evolution of concentration from 2003 to 2017 presents a decreasing trend or stagnation, except for $CNHGD_{MUN9b}$ and $CNPDG_{MUN9c}$. The *Population share living in high residential density municipalities* has increased at a cumulative annual rate of 0.25%. However, its evolution rates are highly volatile as small variations in high residential density municipalities at the threshold limit produce large changes in the series since they affect municipalities with a high population weight in the province. As for the *Population density gradient,* it evolves at a cumulative annual rate of 0.77%. However, as we have indicated, we doubt that this indicator adequately captures the rate at which the density falls from the CBD due to the OLS regression's lack of adjustment for this parameter.

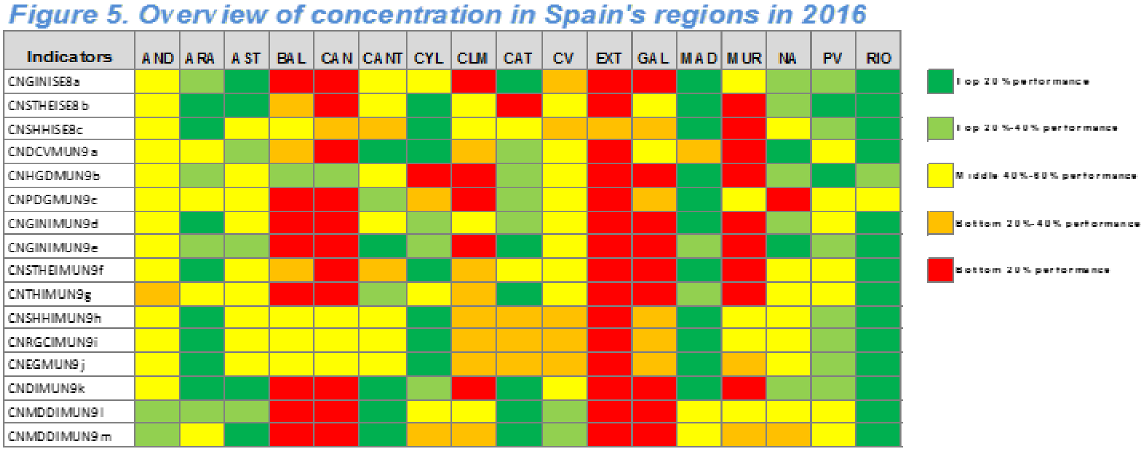
Population concentration indicators present a significant variability among regions, with high interregional coefficients of variation, except for the Gini and dissimilarity indices. The regional rankings show some systematic elements, such as the top positions in which La Rioja is systematically found at. In addition, Aragón, Asturias, Cataluña, Madrid and País

[33] $CNGINI_{MUN9d}$ (58%), $CNGINI_{MUN9e}$ (59%), $CNMDDI_{MUN9l}$ (66%) and $CNMDDI_{MUN9m}$ (52%).

Vasco are typically also in top positions. On the contrary, Extremadura is systematically in a bottom position. In addition, Illes Balears, Canarias, Castilla-La Mancha, Galicia and Murcia are typically also in bottom positions. However, we have identified some differences in the regional ranking depending on how density is approached. For instance, Cantabria, Castilla y León and Navarra present positions above or below the national average depending on how concentration is measured.

In Figure 5, we present an overview of the population concentration situation in Spain according to the distribution of all the related indicators across regions. For a given territory, when concentration ranges within 20% of the distribution's bottom positions, the Region is flagged in red. On the contrary, if it ranges within 20% of the distribution's upper positions, the Region is flagged with dark green. For intermediate positions, the Region is flagged according to the legend in the figure.

Figure 5. Overview of concentration in Spain's regions in 2016



Source: Author's own work

Against the backdrop of our analyses concerning population concentration, we considered that we should:

- *Use SE-based indicators, where possible*.

  To take into account the concentration indices' sensitivity to the level of geographical aggregation (aggregation implies erasing part of the differences).
- *Use indicators that utilise both criteria of evenness: equal share of population and equal density*.

  To ensure that we capture the different facets of concentration that each provides.
- *Disregard the Population density gradient indicator*.

Considering our doubts about this indicator's capability to adequately capture the rate at which density falls from the CBD, due to the OLS regression's lack of adjustment for this parameter.

- *Disregard the Raw geographic concentration index indicator*.

  On the grounds that its correlation with the *Ellison and Glaesser index* is 1.
- *Disregard the Standardised Herfindahl index (SE) and Massey and Denton dissimilarity index for urban land indicators*.

  On the grounds that they have a correlation of 0.95 with the *Ellison and Glaesser index,* and this will facilitate capturing the very different facets of population concentration enclosed in the indicators while avoiding "*double counting*" (Annex III).

We selected the following indicators to characterise population concentration:

13. *Gini index for SE (**$CNGINI_{SE8a}$**).*
14. *Standardised Theil entropy index (SE) (**$CNSTHEI_{SE8b}$**).*
15. *Share of the population living in high-density municipalities based on built-up land (**$CNHGD_{MUN9b}$**).*
16. *Population density gradient (**$CNPDG_{MUN9c}$**).*
17. *Theil index (**$CNTHI_{MUN9g}$**).*
18. *Ellison and Glaesser (**$CNEG_{MUN9j}$**).*
19. *Delta index (also Hoover index) (**$CNDI_{MUN9k}$**).*
20. *Massey and Denton dissimilarity index for built-up land] (**$CNMDDI_{MUN9m}$**).*

Main features of continuity

Most people live in regions with low population continuity (below the national average).[34] Depending on how continuity is approached, between 52% and 69% of the population live in regions with below average population continuity.

The evolution of continuity from 2003 to 2017 presents an increasing trend measured with the only indicator for which we have time series data.

Population continuity indicators present a significant variability among regions, with high interregional coefficients of variation. The regional rankings show some systematic elements such as the bottom positions in which Castilla y León and Castilla-La Mancha are

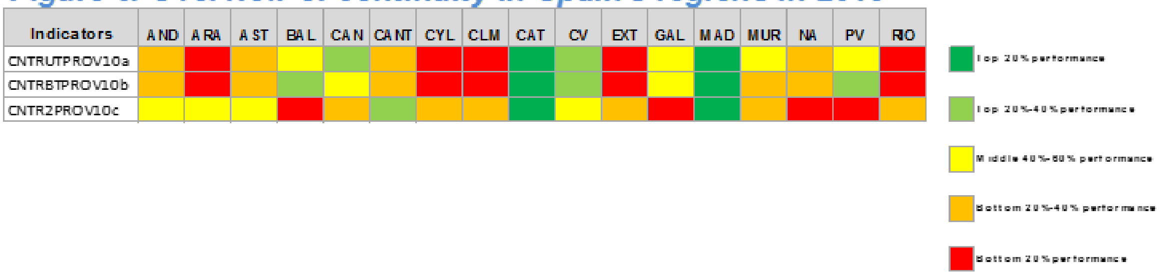
[34] Please remember that we develop our analyses in comparative terms with the national average of each indicator and its distribution across regions as references. Therefore, it is not a contradiction to state that most people live in regions with low population concentration at the same time that declaring that the Gini indices are close to one in all regions.

systematically found at. On the contrary, that Madrid and Cataluña are systematically in the top ones.

However, we have identified some differences in the regional ranking depending on how density is approached. There is a notable difference between the rankings produced by the indicators based on the ratio urban and built-up land area to total land area and those based on the *R-square of the exponential density function*.

In Figure 6, we present an overview of the population continuity situation in Spain according to the distribution of all the related indicators across regions. For a given territory, when continuity ranges within 20% of the distribution's bottom positions, the Region is flagged in red. On the contrary, if it ranges within 20% of the distribution's upper positions, the Region is flagged with dark green. For intermediate positions, the Region is flagged according to the legend in the figure.

Figure 6. Overview of continuity in Spain's regions in 2016



Source: Author's own work

Against the backdrop of our analyses concerning population concentration, we considered that we should:

- *Disregard the Ratio urban land area to total land area indicator*.
  On the grounds that it has a correlation of 0.98 with the *Ratio built-up land area to total land area,* and this will facilitate capturing the very different facets of population concentration enclosed in the indicators while avoiding "*double counting*" (Annex III).

We selected the following indicators to characterise population continuity:

21. *Ratio built-up land area to total land area (**CNTRUT**$_{PROV10b}$).*
22. *R-square of the exponential density function (**CNTR2**$_{PROV10c}$).*

4. POPULATION DISPERSION AND AGEING

Our analyses on population dispersion in Spain show that the population has moved toward the provincial nuclei, which are closer to each other than the set of locations as a whole, leaving a set of distant settlements with sparse population. Therefore, economies of scale derived from increases in population proximity would be offset by losses of economies of scale derived from that set of distant settlements with sparse population. The mentioned losses are enhanced by the interaction between population dispersion and ageing.

The aging of the population in Spain is a growing phenomenon that affects to a greater extent the population entities that are farther away from the nuclei in which people tend to reside.

In a given province, we have considered that people live far when they reside in singular entities that are farther away from the CBD than the average distance to it within the province.

We have calculated that, at the national level, the ageing of the population living far from its capital or CBD ("living far") is around 2 percentage points (p.p.) greater than the ageing of the whole population. We observe that the ageing of the population "living far" overpasses the one of the whole population of each province in all of them except Balears, Palmas, Madrid and Bizkaia. The provinces with the highest differential are Almeria, Huelva, Zaragoza, Salamanca, Segovia and Guadalajara. That differential is increasing for the very old people (aged 85 and more): in 2003, it was 0.38 p.p. and, in 2017, it was 0.53 p.p. Although not for the elderly as a whole, for whom it is decreasing: it was 2.95 p.p. in 2003 and 1.83 p.p. in 2017.

In Table 35, we can appreciate that, in Spain, the population aged 65 or more represents 18.64% in 2016 and 18.86% in 2017, with an increasing trend since 2003. The province with the highest share is Ourense, while the lowest one is in Almeria. Regarding the population "living far," the rates are 20.54% (2016) and 20.59% (2017); also with an increasing trend. The province with the highest share is again Ourense, while the lowest one is in Las Palmas.

Table 36. Population dispersion and ageing. It continues

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ESPAÑA															
%Population “living far”	20.63	20.57	20.61	20.63	20.67	20.66	20.57	20.49	20.45	20.39	20.30	20.14	20.06	19.94	19.81
%Population 65+	17.05	16.92	16.64	16.76	16.68	16.56	16.68	16.90	17.59	17.43	17.73	18.09	18.43	18.64	18.86
%Population 65+ “living far”	20.00	19.72	19.32	19.37	19.22	19.00	19.10	19.30	20.03	19.74	19.98	20.15	20.41	20.54	20.69
%Population 75+	7.64	7.78	7.90	8.06	8.20	8.31	8.47	8.66	9.26	9.06	9.18	9.23	9.19	9.37	9.39
%Population 75+ “living far”	9.19	9.30	9.38	9.55	9.66	9.75	9.96	10.18	10.88	10.62	10.75	10.71	10.63	10.80	10.79
%Population 85+	1.83	1.84	1.85	1.91	1.96	2.04	2.12	2.23	2.33	2.45	2.54	2.68	2.80	2.92	3.02
%Population 85+ “living far”	2.21	2.21	2.21	2.27	2.33	2.41	2.51	2.63	2.76	2.89	2.99	3.13	3.28	3.42	3.55

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ANDALUCÍA															
%Population living far	22.78	22.73	22.73	22.66	22.66	22.65	22.60	22.49	22.44	22.38	22.21	22.09	22.00	21.96	21.77
%Population 65+	14.84	14.76	14.59	14.70	14.63	14.59	14.75	14.95	15.52	15.41	15.65	15.91	16.19	16.32	16.55
%Population 65+ “living far”	16.86	16.72	16.46	16.58	16.51	16.40	16.54	16.75	17.37	17.19	17.37	17.50	17.72	17.78	17.96
%Population 75+	6.23	6.35	6.47	6.61	6.75	6.89	7.05	7.21	7.69	7.56	7.65	7.66	7.68	7.83	7.84
%Population 75+ “living far”	7.14	7.26	7.38	7.57	7.75	7.90	8.09	8.28	8.85	8.71	8.83	8.79	8.76	8.90	8.88
%Population 85+	1.36	1.36	1.37	1.41	1.45	1.50	1.56	1.64	1.72	1.80	1.86	1.94	2.05	2.13	2.23
%Population 85+ “living far”	1.56	1.54	1.54	1.59	1.64	1.70	1.77	1.85	1.96	2.07	2.13	2.23	2.35	2.45	2.56

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ALMERÍA															
%Population living far	22.03	22.04	21.92	21.52	21.93	22.17	22.13	21.99	22.02	21.98	21.82	21.22	21.01	20.73	18.95
%Population 65+	13.57	13.38	12.78	12.68	12.68	12.54	12.56	12.71	13.23	13.27	13.49	13.66	13.92	14.00	14.24
%Population 65+ “living far”	18.30	17.87	17.23	17.39	17.26	17.02	17.31	17.82	18.71	18.94	19.44	19.59	19.94	20.06	20.97
%Population 75+	5.70	5.77	5.68	5.69	5.82	5.87	5.94	6.08	6.51	6.41	6.51	6.50	6.45	6.54	6.53
%Population 75+ “living far”	7.98	8.01	7.87	8.00	8.00	7.93	8.01	8.27	8.92	8.80	9.03	9.06	9.01	9.16	9.40
%Population 85+	1.24	1.22	1.19	1.18	1.21	1.27	1.30	1.37	1.45	1.53	1.59	1.67	1.75	1.80	1.88
%Population 85+ “living far”	1.73	1.71	1.71	1.72	1.70	1.77	1.82	1.92	2.06	2.15	2.25	2.39	2.45	2.55	2.70

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CÁDIZ															
%Population living far	29.04	28.96	29.04	29.11	29.10	29.13	29.07	28.99	29.02	28.93	28.57	28.76	28.84	28.98	29.00
%Population 65+	12.54	12.60	12.62	12.82	12.83	12.93	13.22	13.46	14.04	14.10	14.41	14.78	15.12	15.35	15.68
%Population 65+ “living far”	13.36	13.39	13.29	13.44	13.43	13.47	13.70	13.96	14.55	14.56	14.90	15.07	15.31	15.41	15.60
%Population 75+	4.94	5.07	5.20	5.34	5.52	5.75	5.91	6.07	6.48	6.43	6.55	6.62	6.72	6.93	6.98
%Population 75+ “living far”	5.34	5.45	5.55	5.72	5.87	6.06	6.19	6.39	6.86	6.79	6.96	6.95	7.00	7.14	7.17
%Population 85+	1.03	1.04	1.06	1.09	1.13	1.19	1.23	1.28	1.34	1.42	1.47	1.54	1.63	1.71	1.82
%Population 85+ “living far”	1.10	1.10	1.11	1.14	1.19	1.23	1.27	1.35	1.42	1.51	1.57	1.64	1.73	1.82	1.91

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CÓRDOBA															
%Population living far	28.92	28.89	28.87	28.74	28.73	28.76	28.71	28.70	28.66	28.61	28.47	28.44	28.38	28.28	28.22
%Population 65+	17.26	17.23	17.11	17.24	17.19	17.11	17.23	17.39	18.04	17.67	17.82	18.16	18.42	18.45	18.63
%Population 65+ “living far”	19.62	19.51	19.34	19.45	19.29	19.05	19.07	19.16	19.83	19.26	19.32	19.56	19.83	19.80	19.80
%Population 75+	7.64	7.89	8.11	8.32	8.57	8.74	8.99	9.14	9.79	9.54	9.59	9.64	9.64	9.79	9.75
%Population 75+ “living far”	8.97	9.20	9.47	9.74	9.98	10.13	10.39	10.56	11.30	10.97	11.02	11.04	11.06	11.15	11.01
%Population 85+	1.68	1.71	1.75	1.81	1.90	1.97	2.09	2.19	2.32	2.45	2.55	2.73	2.89	3.01	3.15
%Population 85+ “living far”	2.01	2.01	2.03	2.11	2.21	2.27	2.41	2.53	2.71	2.87	3.00	3.20	3.42	3.57	3.71

Table 36. Population dispersion and ageing. It continues

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
GRANADA															
%Population living far	26.36	26.15	26.10	25.99	25.92	25.80	25.72	25.31	25.16	24.97	24.66	24.58	24.46	24.32	24.25
%Population 65+	16.73	16.59	16.25	16.29	16.14	15.94	16.07	16.11	16.65	16.46	16.55	16.89	17.15	17.27	17.47
%Population 65+ “living far”	18.71	18.55	18.12	18.33	18.19	17.95	18.09	18.23	18.82	18.60	18.48	18.98	19.23	19.33	19.47
%Population 75+	7.08	7.23	7.33	7.51	7.65	7.78	8.01	8.15	8.68	8.52	8.58	8.62	8.60	8.73	8.72
%Population 75+ “living far”	7.80	7.94	8.06	8.30	8.47	8.63	8.92	9.15	9.75	9.63	9.74	9.87	9.83	10.05	10.04
%Population 85+	1.53	1.54	1.52	1.56	1.56	1.64	1.72	1.82	1.91	2.02	2.09	2.23	2.36	2.46	2.59
%Population 85+ “living far”	1.77	1.71	1.68	1.73	1.72	1.79	1.87	1.96	2.05	2.20	2.26	2.42	2.57	2.71	2.85

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
HUELVA															
%Population living far	16.42	16.18	15.92	15.61	15.42	15.15	14.95	14.79	14.65	14.47	14.24	14.25	14.22	14.18	14.11
%Population 65+	15.23	15.06	14.92	14.91	14.73	14.48	14.62	14.76	15.22	15.05	15.27	15.61	15.83	16.02	16.23
%Population 65+ “living far”	22.75	22.47	22.15	22.02	21.75	21.35	21.29	21.25	21.74	21.19	21.31	21.37	21.28	21.28	21.33
%Population 75+	6.57	6.67	6.79	6.82	6.90	6.97	7.16	7.25	7.66	7.54	7.53	7.49	7.49	7.68	7.65
%Population 75+ “living far”	10.65	10.95	11.16	11.42	11.70	11.86	12.14	12.23	12.87	12.51	12.44	12.17	11.90	11.83	11.59
%Population 85+	1.51	1.52	1.54	1.57	1.60	1.61	1.65	1.69	1.72	1.79	1.82	1.91	1.98	2.06	2.13
%Population 85+ “living far”	2.55	2.55	2.64	2.71	2.88	2.94	3.01	3.12	3.17	3.31	3.38	3.57	3.68	3.76	3.87

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
JAÉN															
%Population living far	18.00	17.87	17.67	17.62	17.56	17.55	17.51	17.49	17.45	17.47	17.29	17.17	17.09	17.05	16.96
%Population 65+	18.12	18.07	17.78	18.03	17.87	17.75	17.78	17.83	18.33	17.82	17.95	18.26	18.47	18.51	18.63
%Population 65+ “living far”	20.77	20.81	20.47	20.74	20.49	20.20	20.09	19.95	20.29	19.44	19.56	19.93	20.05	20.14	20.15
%Population 75+	7.71	7.96	8.23	8.53	8.76	8.96	9.22	9.46	10.08	9.83	10.04	10.11	9.98	10.22	10.17
%Population 75+ “living far”	8.88	9.24	9.58	9.98	10.19	10.40	10.68	10.89	11.54	11.15	11.46	11.61	11.37	11.62	11.48
%Population 85+	1.68	1.66	1.68	1.74	1.79	1.87	1.96	2.09	2.21	2.34	2.46	2.66	2.84	2.99	3.16
%Population 85+ “living far”	1.91	1.92	1.94	2.03	2.07	2.13	2.21	2.33	2.44	2.56	2.69	2.96	3.19	3.40	3.58

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MÁLAGA															
%Population living far	24.68	24.75	25.01	25.08	25.09	25.15	25.28	25.26	25.22	25.26	25.21	24.90	24.84	24.84	24.80
%Population 65+	14.44	14.26	14.10	14.25	14.22	14.31	14.57	14.95	15.65	15.71	16.07	16.10	16.43	16.54	16.73
%Population 65+ “living far”	14.77	14.51	14.32	14.48	14.55	14.67	14.94	15.38	16.12	16.22	16.56	16.24	16.55	16.71	16.91
%Population 75+	5.96	5.97	6.04	6.16	6.25	6.40	6.52	6.72	7.22	7.14	7.30	7.16	7.22	7.36	7.37
%Population 75+ “living far”	5.96	5.90	5.95	6.10	6.26	6.47	6.61	6.85	7.39	7.36	7.51	7.23	7.28	7.44	7.47
%Population 85+	1.31	1.29	1.30	1.35	1.35	1.42	1.47	1.55	1.64	1.72	1.77	1.74	1.82	1.88	1.94
%Population 85+ “living far”	1.29	1.24	1.22	1.26	1.30	1.40	1.44	1.53	1.63	1.74	1.76	1.68	1.77	1.83	1.92

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
SEVILLA															
%Population living far	16.56	16.52	16.44	16.38	16.32	16.25	16.12	16.02	15.94	15.87	15.81	15.74	15.60	15.53	15.45
%Population 65+	13.82	13.79	13.76	13.88	13.83	13.80	13.97	14.18	14.72	14.62	14.83	15.18	15.47	15.61	15.90
%Population 65+ “living far”	16.08	15.99	15.91	15.99	15.93	15.84	15.91	16.00	16.53	16.23	16.26	16.50	16.66	16.57	16.80
%Population 75+	5.81	5.92	6.07	6.19	6.31	6.43	6.57	6.69	7.12	7.02	7.02	7.08	7.15	7.29	7.33
%Population 75+ “living far”	6.72	6.87	7.05	7.24	7.48	7.69	7.89	8.01	8.56	8.48	8.49	8.49	8.48	8.57	8.58
%Population 85+	1.27	1.27	1.29	1.35	1.38	1.42	1.47	1.55	1.60	1.67	1.70	1.79	1.89	1.95	2.02
%Population 85+ “living far”	1.44	1.42	1.46	1.52	1.61	1.64	1.69	1.76	1.84	1.92	1.99	2.09	2.20	2.29	2.41

Table 36. Population dispersion and ageing. It continues

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ARAGÓN															
%Population living far	20.85	20.60	20.51	20.40	20.30	20.17	20.02	19.91	19.82	19.64	19.45	19.54	19.38	19.28	19.09
%Population 65+	21.34	20.97	20.52	20.48	20.17	19.75	19.62	19.75	20.51	20.06	20.22	20.76	21.04	21.27	21.42
%Population 65+ “living far”	27.00	26.57	25.87	25.69	25.18	24.51	24.17	24.11	24.81	24.00	24.03	24.23	24.47	24.48	24.52
%Population 75+	10.26	10.42	10.55	10.71	10.78	10.79	10.88	11.06	11.78	11.36	11.37	11.44	11.32	11.43	11.42
%Population 75+ “living far”	13.55	13.77	13.91	14.12	14.14	14.11	14.19	14.33	15.16	14.55	14.57	14.49	14.25	14.26	14.18
%Population 85+	2.46	2.50	2.53	2.63	2.73	2.81	2.92	3.08	3.21	3.33	3.45	3.65	3.80	3.95	4.09
%Population 85+ “living far”	3.42	3.44	3.46	3.61	3.71	3.79	3.93	4.11	4.24	4.35	4.50	4.71	4.92	5.10	5.31

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
HUESCA															
%Population living far	42.72	42.61	42.68	42.48	42.43	42.33	42.21	42.17	42.20	42.19	42.14	42.04	42.06	42.06	42.07
%Population 65+	23.87	23.47	22.87	22.50	22.10	21.54	21.29	21.29	22.04	21.46	21.54	21.82	22.08	22.13	22.28
%Population 65+ “living far”	24.91	24.54	23.76	23.46	23.10	22.40	22.10	22.05	22.77	22.08	22.10	22.27	22.42	22.41	22.46
%Population 75+	11.99	12.16	12.29	12.39	12.45	12.40	12.42	12.55	13.36	12.82	12.89	12.81	12.58	12.46	12.39
%Population 75+ “living far”	12.58	12.74	12.77	12.87	12.96	12.85	12.84	12.99	13.79	13.22	13.32	13.24	12.89	12.78	12.72
%Population 85+	3.02	3.01	3.05	3.16	3.28	3.38	3.48	3.67	3.84	4.01	4.17	4.36	4.50	4.59	4.76
%Population 85+ “living far”	3.15	3.19	3.22	3.37	3.51	3.55	3.64	3.82	3.98	4.15	4.26	4.40	4.52	4.59	4.75

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
TERUEL															
%Population living far	50.61	50.59	50.51	50.36	50.23	50.27	50.20	50.24	50.26	49.99	49.81	49.83	49.81	49.67	49.64
%Population 65+	26.76	26.27	25.51	25.28	24.59	23.90	23.59	23.66	24.32	23.41	23.43	23.63	23.72	23.85	23.96
%Population 65+ “living far”	27.43	26.94	26.18	26.05	25.33	24.59	24.31	24.32	24.92	24.09	24.21	24.43	24.52	24.74	24.91
%Population 75+	13.31	13.55	13.78	13.98	14.00	14.02	14.23	14.42	15.32	14.64	14.70	14.59	14.26	14.36	14.24
%Population 75+ “living far”	13.62	13.91	14.13	14.38	14.32	14.33	14.62	14.76	15.61	14.97	15.01	14.93	14.60	14.75	14.65
%Population 85+	3.34	3.30	3.37	3.47	3.52	3.62	3.82	4.02	4.18	4.30	4.53	4.80	5.06	5.33	5.58
%Population 85+ “living far”	3.33	3.28	3.33	3.50	3.57	3.68	3.87	4.08	4.21	4.33	4.57	4.85	5.08	5.34	5.62

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ZARAGOZA															
%Population living far	10.88	10.70	10.60	10.48	10.42	10.31	10.21	10.13	10.02	9.91	9.76	9.82	9.66	9.59	9.44
%Population 65+	19.87	19.56	19.19	19.25	19.02	18.69	18.63	18.81	19.58	19.24	19.45	20.09	20.41	20.70	20.86
%Population 65+ “living far”	28.65	28.23	27.67	27.58	27.08	26.48	26.09	25.96	26.75	25.83	25.83	26.04	26.50	26.41	26.35
%Population 75+	9.36	9.53	9.63	9.81	9.89	9.91	10.01	10.21	10.89	10.53	10.53	10.66	10.59	10.77	10.79
%Population 75+ “living far”	14.42	14.65	14.83	15.13	15.15	15.16	15.17	15.32	16.18	15.57	15.51	15.42	15.37	15.41	15.33
%Population 85+	2.19	2.25	2.28	2.38	2.48	2.55	2.65	2.80	2.92	3.02	3.12	3.31	3.46	3.60	3.73
%Population 85+ “living far”	3.73	3.79	3.79	3.91	3.99	4.11	4.25	4.43	4.51	4.57	4.68	4.93	5.20	5.44	5.65

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ASTURIAS															
%Population living far	13.45	13.36	13.22	13.10	13.03	12.90	12.73	12.62	12.56	12.44	12.35	12.32	12.22	12.15	12.06
%Population 65+	22.09	22.09	21.91	21.93	21.88	21.75	21.82	22.01	22.95	22.67	23.05	23.53	24.04	24.41	24.79
%Population 65+ “living far”	27.71	27.69	27.57	27.65	27.57	27.53	27.64	27.70	28.73	28.18	28.47	28.69	29.07	29.28	29.51
%Population 75+	10.35	10.71	10.98	11.35	11.62	11.91	12.15	12.41	13.24	12.85	12.89	12.87	12.79	12.78	12.74
%Population 75+ “living far”	14.02	14.35	14.63	15.00	15.18	15.48	15.72	16.03	17.04	16.60	16.71	16.68	16.53	16.52	16.56
%Population 85+	2.47	2.54	2.61	2.73	2.85	3.00	3.13	3.29	3.47	3.65	3.80	4.00	4.20	4.37	4.52
%Population 85+ “living far”	3.75	3.85	3.96	4.10	4.21	4.32	4.49	4.62	4.76	4.98	5.17	5.43	5.60	5.81	5.98

Table 36. Population dispersion and ageing. It continues

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
BALEARES															
%Population living far	21.50	21.55	21.96	22.15	22.08	22.22	22.39	22.54	22.63	22.79	23.24	23.27	23.26	23.24	23.19
%Population 65+	14.08	13.87	13.70	13.84	13.69	13.58	13.71	13.97	14.56	14.53	14.67	14.83	15.08	15.21	15.33
%Population 65+ “living far”	12.38	12.13	12.01	12.21	12.08	12.00	12.17	12.49	13.11	13.01	13.08	13.18	13.45	13.56	13.64
%Population 75+	6.45	6.44	6.43	6.52	6.49	6.47	6.55	6.65	7.09	6.90	6.94	6.90	6.92	6.99	6.98
%Population 75+ “living far”	5.48	5.41	5.36	5.44	5.41	5.43	5.52	5.68	6.09	5.91	5.87	5.81	5.90	5.96	5.95
%Population 85+	1.59	1.59	1.59	1.64	1.64	1.68	1.72	1.78	1.84	1.91	1.94	1.98	2.05	2.09	2.12
%Population 85+ “living far”	1.34	1.32	1.30	1.32	1.29	1.32	1.39	1.47	1.54	1.58	1.59	1.58	1.66	1.66	1.72

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CANARIAS															
%Population living far	16.06	16.28	16.60	16.81	17.00	17.31	17.34	17.23	17.25	17.30	17.34	17.24	17.30	17.35	17.53
%Population 65+	12.04	12.05	12.08	12.34	12.43	12.67	12.97	13.40	14.04	14.21	14.45	14.55	14.81	15.07	15.31
%Population 65+ “living far”	11.02	10.87	10.75	10.94	10.90	11.02	11.40	11.91	12.47	12.58	12.90	12.99	13.23	13.42	13.59
%Population 75+	4.70	4.80	4.95	5.10	5.19	5.39	5.61	5.91	6.41	6.44	6.55	6.55	6.57	6.73	6.80
%Population 75+ “living far”	4.67	4.68	4.70	4.78	4.69	4.76	4.94	5.21	5.63	5.58	5.72	5.73	5.73	5.84	5.91
%Population 85+	1.18	1.17	1.17	1.20	1.17	1.20	1.25	1.33	1.40	1.46	1.51	1.57	1.64	1.73	1.81
%Population 85+ “living far”	1.30	1.28	1.27	1.27	1.20	1.22	1.28	1.34	1.37	1.41	1.46	1.52	1.58	1.64	1.67

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PALMAS															
%Population living far	19.36	19.93	20.73	21.21	21.77	22.48	22.63	22.47	22.49	22.59	22.76	22.64	22.82	23.02	23.39
%Population 65+	10.80	10.88	10.91	11.12	11.17	11.40	11.63	12.05	12.69	12.83	13.13	13.41	13.77	14.08	14.36
%Population 65+ “living far”	6.91	6.85	6.83	7.08	7.16	7.40	7.82	8.32	8.88	9.17	9.55	9.66	9.97	10.20	10.42
%Population 75+	4.08	4.20	4.34	4.48	4.57	4.78	4.98	5.24	5.70	5.71	5.84	5.92	5.99	6.15	6.22
%Population 75+ “living far”	2.63	2.64	2.67	2.71	2.68	2.78	2.91	3.12	3.44	3.49	3.64	3.64	3.69	3.81	3.90
%Population 85+	0.99	1.00	0.99	1.01	0.99	1.03	1.07	1.14	1.21	1.25	1.30	1.38	1.46	1.56	1.62
%Population 85+ “living far”	0.67	0.67	0.67	0.68	0.64	0.67	0.71	0.74	0.77	0.81	0.85	0.88	0.92	0.94	0.96

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
SC TENERIFE															
%Population living far	12.50	12.36	12.20	12.14	11.93	11.78	11.69	11.65	11.65	11.55	11.42	11.30	11.22	11.13	11.09
%Population 65+	13.36	13.31	13.34	13.65	13.78	14.02	14.39	14.85	15.48	15.71	15.89	15.80	15.96	16.16	16.36
%Population 65+ “living far”	17.88	17.82	17.85	18.12	18.17	18.39	18.80	19.28	19.91	19.84	20.19	20.34	20.53	20.74	20.94
%Population 75+	5.37	5.44	5.60	5.75	5.85	6.03	6.30	6.62	7.17	7.24	7.33	7.25	7.20	7.37	7.43
%Population 75+ “living far”	8.08	8.19	8.39	8.61	8.59	8.80	9.14	9.52	10.16	10.04	10.25	10.33	10.32	10.45	10.56
%Population 85+	1.37	1.36	1.37	1.39	1.36	1.38	1.45	1.54	1.61	1.69	1.74	1.78	1.84	1.93	2.01
%Population 85+ “living far”	2.35	2.32	2.35	2.37	2.31	2.35	2.46	2.57	2.61	2.70	2.80	2.95	3.07	3.22	3.32

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CANTABRIA															
%Population living far	12.23	12.39	12.48	12.50	12.57	12.53	12.49	12.48	12.43	12.37	12.26	12.21	12.17	12.16	12.10
%Population 65+	19.15	18.99	18.72	18.69	18.58	18.44	18.37	18.51	19.23	18.99	19.32	19.81	20.27	20.67	21.06
%Population 65+ “living far”	21.30	20.81	20.37	20.14	19.87	19.65	19.52	19.59	20.33	19.99	20.27	20.64	21.09	21.40	21.73
%Population 75+	9.02	9.25	9.43	9.64	9.80	9.98	10.06	10.24	10.92	10.57	10.62	10.64	10.53	10.61	10.63
%Population 75+ “living far”	10.42	10.52	10.66	10.73	10.85	11.02	11.14	11.34	12.08	11.63	11.63	11.55	11.45	11.45	11.41
%Population 85+	2.28	2.33	2.36	2.42	2.48	2.57	2.65	2.79	2.94	3.08	3.19	3.37	3.50	3.64	3.77
%Population 85+ “living far”	2.72	2.73	2.78	2.79	2.88	2.88	2.98	3.20	3.38	3.50	3.65	3.79	3.91	4.05	4.23

Table 36. Population dispersion and ageing. It continues

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CASTILLA Y LEÓN															
%Population living far	26.82	26.61	26.43	26.23	26.11	25.92	25.53	25.39	25.28	25.12	24.91	24.72	24.61	24.43	24.27
%Population 65+	22.92	22.81	22.58	22.62	22.53	22.32	22.45	22.64	23.51	23.07	23.35	23.79	24.17	24.51	24.81
%Population 65+ "living far"	27.45	27.38	27.09	27.09	26.90	26.56	26.73	26.84	27.80	27.12	27.33	27.70	28.00	28.29	28.53
%Population 75+	11.22	11.53	11.75	12.03	12.23	12.39	12.63	12.89	13.75	13.41	13.52	13.54	13.50	13.67	13.75
%Population 75+ "living far"	13.70	14.14	14.43	14.79	15.00	15.20	15.56	15.91	16.98	16.57	16.70	16.72	16.65	16.83	16.91
%Population 85+	2.94	2.97	3.01	3.11	3.22	3.35	3.53	3.72	3.90	4.10	4.28	4.52	4.72	4.92	5.12
%Population 85+ "living far"	3.67	3.72	3.74	3.88	4.00	4.16	4.40	4.62	4.85	5.11	5.35	5.66	5.91	6.21	6.49
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
ÁVILA															
%Population living far	30.61	30.24	30.06	29.75	29.44	28.76	28.51	28.32	28.06	27.97	27.84	27.76	27.74	27.67	27.56
%Population 65+	25.87	25.68	25.32	25.28	24.92	24.30	24.27	24.26	24.95	24.32	24.51	24.83	25.16	25.38	25.54
%Population 65+ "living far"	30.70	30.52	30.24	30.28	30.00	29.82	29.69	29.76	30.72	29.76	29.82	30.03	30.20	30.27	30.40
%Population 75+	13.13	13.38	13.59	13.83	13.88	13.82	14.00	14.22	14.98	14.54	14.60	14.59	14.52	14.71	14.72
%Population 75+ "living far"	16.00	16.32	16.62	17.01	17.06	17.39	17.55	17.95	19.17	18.40	18.34	18.21	18.11	18.20	18.34
%Population 85+	3.42	3.46	3.52	3.64	3.71	3.85	3.97	4.19	4.36	4.56	4.73	4.92	5.13	5.34	5.56
%Population 85+ "living far"	4.21	4.25	4.33	4.51	4.58	4.82	4.98	5.37	5.64	5.92	6.11	6.33	6.56	6.78	7.07
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
BURGOS															
%Population living far	34.10	34.14	34.12	34.13	34.24	34.22	32.72	32.57	32.39	32.17	31.87	31.70	31.51	31.29	31.21
%Population 65+	21.43	21.31	20.97	20.89	20.77	20.45	20.67	20.90	21.75	21.37	21.66	22.19	22.57	22.96	23.34
%Population 65+ "living far"	23.69	23.59	23.07	22.83	22.56	22.06	22.68	22.94	23.89	23.41	23.73	24.29	24.58	24.92	25.23
%Population 75+	10.58	10.88	11.04	11.26	11.44	11.48	11.72	11.96	12.74	12.35	12.38	12.44	12.35	12.51	12.59
%Population 75+ "living far"	11.78	12.12	12.26	12.51	12.61	12.60	13.08	13.42	14.36	13.94	14.01	14.14	13.96	14.12	14.17
%Population 85+	2.66	2.73	2.75	2.84	3.00	3.12	3.34	3.54	3.72	3.91	4.03	4.27	4.42	4.64	4.82
%Population 85+ "living far"	2.93	3.03	3.01	3.11	3.24	3.37	3.66	3.88	4.13	4.40	4.60	4.87	5.01	5.31	5.51
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
LEÓN															
%Population living far	33.85	33.59	33.44	33.28	33.26	33.17	33.13	33.05	32.99	32.91	32.79	32.63	32.62	32.57	32.44
%Population 65+	24.78	24.89	24.61	24.66	24.59	24.38	24.44	24.51	25.40	24.89	25.07	25.44	25.75	26.06	26.36
%Population 65+ "living far"	24.68	24.89	24.69	24.76	24.68	24.47	24.51	24.60	25.52	25.04	25.18	25.60	25.89	26.24	26.62
%Population 75+	11.85	12.38	12.64	12.99	13.30	13.61	13.93	14.27	15.28	14.95	15.05	15.07	15.01	15.16	15.20
%Population 75+ "living far"	11.43	12.02	12.32	12.67	12.98	13.35	13.70	14.14	15.20	15.00	15.16	15.23	15.22	15.47	15.58
%Population 85+	2.97	3.05	3.08	3.23	3.35	3.51	3.73	3.95	4.15	4.41	4.62	4.94	5.17	5.36	5.61
%Population 85+ "living far"	2.85	2.93	2.95	3.16	3.26	3.39	3.59	3.79	4.01	4.26	4.48	4.82	5.05	5.29	5.58
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
PALENCIA															
%Population living far	19.91	19.76	19.56	19.27	19.06	18.76	18.59	18.53	18.47	18.29	18.14	17.91	17.79	17.62	17.43
%Population 65+	22.91	22.78	22.67	22.60	22.52	22.46	22.57	22.73	23.60	23.08	23.32	23.69	24.00	24.29	24.57
%Population 65+ "living far"	27.40	27.41	27.29	27.22	27.11	27.23	27.19	26.98	27.74	27.06	27.22	27.26	27.50	27.79	28.06
%Population 75+	11.53	11.89	12.22	12.51	12.75	12.98	13.16	13.38	14.21	13.78	13.78	13.67	13.47	13.46	13.42
%Population 75+ "living far"	14.14	14.79	15.22	15.64	16.10	16.53	16.81	16.84	17.63	17.16	17.12	16.87	16.63	16.59	16.54
%Population 85+	2.89	2.95	3.02	3.10	3.28	3.46	3.72	3.93	4.11	4.37	4.56	4.79	4.94	5.14	5.29
%Population 85+ "living far"	3.54	3.67	3.73	3.89	4.18	4.56	4.95	5.17	5.28	5.55	5.75	6.08	6.34	6.68	7.04

Table 36. Population dispersion and ageing. It continues

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
SALAMANCA															
%Population living far	29.48	28.90	28.58	28.19	27.92	27.67	27.36	27.08	26.93	26.67	26.43	26.06	25.93	25.69	25.45
%Population 65+	23.66	23.50	23.37	23.55	23.58	23.54	23.66	23.94	24.95	24.52	24.87	25.15	25.59	25.92	26.18
%Population 65+ "living far"	31.86	31.86	31.79	32.08	32.03	31.86	32.01	32.22	33.49	32.64	32.94	33.18	33.57	33.94	34.08
%Population 75+	11.73	11.96	12.22	12.55	12.82	13.05	13.27	13.58	14.60	14.27	14.52	14.50	14.56	14.79	14.91
%Population 75+ "living far"	16.46	16.91	17.36	17.90	18.28	18.57	18.91	19.30	20.78	20.26	20.57	20.55	20.57	20.91	21.05
%Population 85+	3.26	3.26	3.31	3.41	3.53	3.66	3.81	4.03	4.26	4.46	4.66	4.88	5.13	5.38	5.61
%Population 85+ "living far"	4.77	4.82	4.94	5.01	5.18	5.32	5.55	5.84	6.19	6.46	6.75	7.07	7.42	7.87	8.30
SEGOVIA															
%Population living far	24.26	24.10	23.79	23.50	23.06	22.91	22.68	22.62	22.52	22.42	22.17	22.06	21.98	21.83	21.63
%Population 65+	23.37	23.01	22.41	22.35	21.84	21.17	21.07	21.19	21.86	21.29	21.43	21.81	22.07	22.26	22.49
%Population 65+ "living far"	29.22	28.86	28.25	28.28	27.96	26.86	26.74	26.73	27.42	26.62	26.75	27.10	27.40	27.44	27.58
%Population 75+	11.61	11.82	11.93	12.19	12.22	12.10	12.24	12.47	13.20	12.82	12.92	12.96	12.84	12.97	12.97
%Population 75+ "living far"	15.02	15.32	15.43	15.88	16.00	15.76	16.09	16.32	17.10	16.57	16.69	16.72	16.59	16.69	16.74
%Population 85+	3.09	3.05	3.05	3.14	3.22	3.32	3.48	3.69	3.83	4.02	4.18	4.43	4.64	4.84	5.02
%Population 85+ "living far"	4.27	4.17	4.17	4.33	4.49	4.57	4.80	5.00	5.13	5.35	5.48	5.79	6.04	6.32	6.57
SORIA															
%Population living far	37.45	37.11	36.33	36.10	35.74	35.35	35.11	34.93	34.71	34.57	34.38	34.11	33.80	33.44	33.30
%Population 65+	27.02	26.65	26.02	25.88	25.64	25.16	25.01	24.85	25.49	24.79	24.93	25.12	25.34	25.57	25.54
%Population 65+ "living far"	31.24	30.91	30.54	30.32	30.12	29.80	29.58	29.47	30.21	29.30	29.44	29.70	30.04	30.30	30.09
%Population 75+	14.07	14.28	14.39	14.62	14.78	14.92	15.08	15.14	15.97	15.40	15.47	15.41	15.26	15.37	15.24
%Population 75+ "living far"	16.68	17.07	17.40	17.50	17.61	17.77	18.03	18.17	19.07	18.39	18.55	18.48	18.47	18.59	18.50
%Population 85+	4.18	4.16	4.13	4.20	4.31	4.47	4.70	4.77	4.88	5.05	5.29	5.52	5.78	6.05	6.19
%Population 85+ "living far"	4.95	5.03	5.00	5.00	5.16	5.43	5.79	5.84	5.89	6.15	6.48	6.76	7.17	7.43	7.51
VALLADOLID															
%Population living far	12.72	12.72	12.58	12.37	12.31	12.19	12.07	12.01	11.90	11.76	11.60	11.44	11.37	11.20	11.11
%Population 65+	17.59	17.53	17.49	17.70	17.80	17.86	18.19	18.60	19.50	19.41	19.90	20.58	21.15	21.63	22.09
%Population 65+ "living far"	25.72	25.32	25.15	25.31	25.06	24.74	24.78	24.85	25.78	25.21	25.53	26.01	26.40	26.69	26.96
%Population 75+	8.16	8.35	8.54	8.74	8.92	9.07	9.27	9.51	10.17	10.02	10.15	10.25	10.36	10.62	10.83
%Population 75+ "living far"	12.54	12.76	13.15	13.61	13.77	13.89	14.14	14.38	15.32	15.13	15.27	15.35	15.40	15.54	15.67
%Population 85+	2.12	2.13	2.14	2.21	2.26	2.36	2.48	2.61	2.73	2.89	3.03	3.21	3.38	3.51	3.67
%Population 85+ "living far"	3.43	3.37	3.35	3.50	3.51	3.63	3.80	3.98	4.18	4.48	4.75	5.10	5.42	5.69	6.01
ZAMORA															
%Population living far	27.61	27.53	27.46	27.49	27.50	27.34	27.21	27.10	27.22	27.16	27.03	26.95	26.89	26.71	26.63
%Population 65+	28.52	28.48	28.35	28.44	28.35	28.15	28.35	28.53	29.58	28.74	29.01	29.43	29.74	29.99	30.19
%Population 65+ "living far"	31.54	31.47	31.21	31.17	30.95	30.71	30.80	31.05	32.07	31.12	31.33	31.70	31.99	32.24	32.45
%Population 75+	14.24	14.70	15.06	15.42	15.71	16.01	16.41	16.80	17.96	17.59	17.84	17.81	17.69	17.88	17.92
%Population 75+ "living far"	15.96	16.54	16.86	17.26	17.44	17.75	18.14	18.65	19.82	19.43	19.65	19.57	19.35	19.60	19.69
%Population 85+	3.81	3.90	3.97	4.09	4.26	4.44	4.66	4.87	5.11	5.36	5.66	5.94	6.16	6.43	6.70
%Population 85+ "living far"	4.38	4.44	4.51	4.64	4.77	4.99	5.19	5.43	5.64	5.95	6.31	6.65	6.82	7.18	7.48

Table 36. Population dispersion and ageing. It continues

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CASTILLA-LA MANCHA															
%Population living far	39.37	39.04	38.71	38.27	37.76	37.43	37.02	36.77	36.51	36.27	35.96	35.74	35.49	35.24	34.95
%Population 65+	19.76	19.45	18.84	18.82	18.31	17.76	17.60	17.61	18.12	17.62	17.76	18.10	18.39	18.58	18.74
%Population 65+ "living far"	22.32	22.05	21.45	21.57	21.18	20.60	20.53	20.54	21.14	20.52	20.67	21.06	21.40	21.60	21.76
%Population 75+	9.25	9.40	9.50	9.62	9.62	9.55	9.63	9.73	10.33	9.99	10.10	10.17	10.03	10.30	10.23
%Population 75+ "living far"	10.44	10.65	10.85	11.07	11.18	11.15	11.37	11.53	12.27	11.90	12.09	12.20	12.06	12.44	12.38
%Population 85+	2.19	2.19	2.18	2.22	2.27	2.34	2.43	2.54	2.66	2.80	2.92	3.10	3.28	3.43	3.57
%Population 85+ "living far"	2.42	2.45	2.45	2.50	2.60	2.67	2.80	2.94	3.08	3.24	3.39	3.64	3.89	4.11	4.31
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ALBACETE															
%Population living far	33.55	33.48	33.32	33.24	32.99	32.98	32.78	32.68	32.49	32.36	32.21	32.14	31.93	31.79	31.58
%Population 65+	18.02	18.00	17.66	17.93	17.74	17.57	17.60	17.68	18.24	17.82	17.95	18.28	18.48	18.69	18.85
%Population 65+ "living far"	20.11	20.05	19.66	19.80	19.65	19.31	19.41	19.39	20.01	19.44	19.53	19.82	20.02	20.15	20.32
%Population 75+	8.14	8.39	8.60	8.88	9.02	9.15	9.34	9.48	10.13	9.85	9.98	10.09	9.92	10.27	10.25
%Population 75+ "living far"	9.17	9.43	9.70	9.94	10.15	10.27	10.54	10.68	11.44	11.07	11.20	11.31	11.14	11.48	11.44
%Population 85+	1.81	1.86	1.86	1.94	2.02	2.12	2.24	2.37	2.49	2.63	2.74	2.91	3.07	3.25	3.39
%Population 85+ "living far"	2.02	2.06	2.08	2.13	2.24	2.35	2.48	2.60	2.75	2.90	3.01	3.21	3.47	3.71	3.88
CIUDAD REAL															
%Population living far	43.87	43.89	43.98	44.12	43.93	44.24	44.08	44.09	44.00	43.96	43.74	43.62	43.45	43.32	43.12
%Population 65+	19.78	19.60	19.13	19.17	18.86	18.40	18.37	18.39	19.01	18.50	18.60	18.96	19.24	19.45	19.63
%Population 65+ "living far"	21.19	20.92	20.33	20.33	20.06	19.36	19.34	19.23	19.84	19.24	19.30	19.67	19.98	20.14	20.28
%Population 75+	9.11	9.32	9.53	9.70	9.84	9.86	10.01	10.13	10.81	10.46	10.56	10.62	10.46	10.76	10.65
%Population 75+ "living far"	9.76	9.96	10.18	10.35	10.53	10.45	10.65	10.74	11.44	11.04	11.15	11.23	11.05	11.42	11.32
%Population 85+	2.01	2.04	2.08	2.12	2.22	2.31	2.42	2.51	2.66	2.81	2.91	3.10	3.28	3.44	3.59
%Population 85+ "living far"	2.11	2.15	2.18	2.22	2.34	2.40	2.54	2.63	2.78	2.94	3.04	3.26	3.47	3.63	3.81
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CUENCA															
%Population living far	59.76	59.78	59.63	59.41	59.07	59.15	59.20	59.05	58.95	58.92	58.83	58.44	58.07	58.03	57.97
%Population 65+	24.97	24.69	23.98	24.32	23.80	23.13	22.81	22.73	23.10	22.33	22.52	22.84	23.09	23.18	23.26
%Population 65+ "living far"	24.90	24.60	23.94	24.45	24.04	23.31	23.03	22.98	23.36	22.59	22.78	23.27	23.68	23.75	23.84
%Population 75+	11.89	12.15	12.35	12.66	12.68	12.63	12.83	13.00	13.68	13.27	13.58	13.68	13.48	13.90	13.87
%Population 75+ "living far"	11.57	11.82	12.02	12.39	12.48	12.40	12.69	12.87	13.58	13.23	13.60	13.81	13.74	14.27	14.24
%Population 85+	2.91	2.95	2.92	2.99	3.08	3.19	3.30	3.44	3.54	3.67	3.90	4.18	4.44	4.66	4.86
%Population 85+ "living far"	2.78	2.84	2.82	2.86	2.95	3.01	3.12	3.28	3.35	3.47	3.70	4.04	4.34	4.59	4.78
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
GUADALAJARA															
%Population living far	10.76	10.30	9.76	9.12	8.42	8.24	7.87	7.72	7.62	7.38	7.11	7.03	6.97	6.81	6.62
%Population 65+	19.52	18.72	17.77	17.24	16.41	15.49	15.17	15.12	15.59	15.04	15.12	15.43	15.80	15.93	16.04
%Population 65+ "living far"	39.05	38.01	37.24	37.56	37.30	34.93	34.47	33.96	34.67	32.65	32.20	31.99	32.23	32.03	31.55
%Population 75+	9.75	9.62	9.46	9.30	9.03	8.77	8.69	8.72	9.23	8.78	8.80	8.83	8.76	8.80	8.71
%Population 75+ "living far"	21.87	21.75	22.15	22.72	23.09	22.39	22.51	22.26	23.33	22.05	21.96	21.61	21.30	21.22	20.74
%Population 85+	2.64	2.54	2.47	2.50	2.45	2.42	2.49	2.59	2.71	2.83	2.91	3.09	3.25	3.32	3.40
%Population 85+ "living far"	6.31	6.16	6.24	6.64	6.77	6.65	7.12	7.36	7.70	7.82	8.14	8.49	8.86	9.12	9.45
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
TOLEDO															
%Population living far	41.43	40.85	40.34	39.54	38.97	38.06	37.39	36.94	36.54	36.17	35.76	35.45	35.18	34.83	34.43
%Population 65+	19.10	18.65	17.92	17.75	17.07	16.42	16.22	16.26	16.74	16.33	16.53	16.91	17.23	17.48	17.70
%Population 65+ "living far"	21.77	21.51	20.83	20.91	20.33	19.93	19.89	20.08	20.75	20.32	20.65	21.12	21.54	21.90	22.18
%Population 75+	9.01	9.07	9.07	9.10	8.99	8.82	8.82	8.92	9.44	9.13	9.26	9.32	9.22	9.47	9.39
%Population 75+ "living far"	10.19	10.40	10.53	10.73	10.75	10.75	10.96	11.21	11.96	11.68	11.95	12.08	11.98	12.39	12.36
%Population 85+	2.18	2.17	2.13	2.13	2.15	2.18	2.25	2.36	2.47	2.60	2.73	2.90	3.06	3.22	3.35
%Population 85+ "living far"	2.39	2.43	2.41	2.45	2.52	2.61	2.71	2.89	3.03	3.22	3.41	3.68	3.91	4.17	4.40

Table 36. Population dispersion and ageing.

It continues

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CATALUÑA															
%Population living far	14.90	15.00	15.14	15.26	15.43	15.55	15.55	15.53	15.50	15.45	15.41	15.34	15.28	15.20	15.15
%Population 65+	17.17	16.94	16.48	16.50	16.44	16.26	16.31	16.52	17.23	17.03	17.36	17.81	18.16	18.36	18.54
%Population 65+ “living far”	19.45	18.96	18.23	18.04	17.81	17.46	17.45	17.65	18.35	18.09	18.39	18.87	19.22	19.41	19.63
%Population 75+	7.82	7.92	7.98	8.07	8.22	8.29	8.40	8.55	9.14	8.91	9.05	9.09	8.99	9.18	9.18
%Population 75+ “living far”	9.17	9.23	9.17	9.19	9.27	9.26	9.39	9.57	10.21	9.91	10.02	10.04	9.85	10.00	10.00
%Population 85+	1.87	1.88	1.89	1.94	2.02	2.09	2.17	2.27	2.39	2.50	2.59	2.72	2.83	2.94	3.03
%Population 85+ “living far”	2.18	2.20	2.19	2.21	2.29	2.35	2.45	2.59	2.71	2.83	2.94	3.09	3.22	3.35	3.48

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
BARCELONA															
%Population living far	10.36	10.50	10.63	10.78	10.92	11.02	11.05	11.05	11.05	11.02	11.03	11.01	10.98	10.95	10.93
%Population 65+	16.86	16.69	16.33	16.42	16.43	16.32	16.40	16.63	17.36	17.18	17.51	17.98	18.33	18.50	18.65
%Population 65+ “living far”	18.61	18.16	17.50	17.31	17.13	16.84	16.82	17.04	17.75	17.50	17.77	18.22	18.59	18.76	18.98
%Population 75+	7.60	7.71	7.81	7.93	8.13	8.23	8.37	8.53	9.13	8.91	9.07	9.12	9.03	9.23	9.22
%Population 75+ “living far”	8.64	8.70	8.69	8.71	8.85	8.89	9.03	9.20	9.84	9.58	9.68	9.65	9.48	9.61	9.58
%Population 85+	1.82	1.83	1.85	1.90	1.99	2.06	2.14	2.25	2.37	2.49	2.58	2.70	2.81	2.92	3.01
%Population 85+ “living far”	2.04	2.06	2.06	2.06	2.14	2.21	2.30	2.44	2.58	2.69	2.78	2.92	3.06	3.18	3.29

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
GIRONA															
%Population living far	34.71	34.41	34.25	34.09	34.06	33.97	33.81	33.73	33.53	33.46	33.35	33.34	33.27	33.21	33.05
%Population 65+	17.34	16.86	16.21	16.07	15.84	15.56	15.51	15.65	16.25	16.04	16.31	16.72	17.03	17.26	17.51
%Population 65+ “living far”	18.74	18.15	17.54	17.39	17.16	16.93	16.92	17.06	17.72	17.48	17.78	18.22	18.48	18.66	18.90
%Population 75+	8.07	8.08	8.02	8.03	8.06	8.06	8.10	8.24	8.76	8.51	8.60	8.59	8.44	8.58	8.59
%Population 75+ “living far”	8.81	8.82	8.76	8.78	8.84	8.80	8.94	9.09	9.67	9.36	9.49	9.48	9.29	9.39	9.39
%Population 85+	1.92	1.92	1.90	1.93	2.01	2.06	2.11	2.20	2.30	2.42	2.50	2.61	2.72	2.81	2.90
%Population 85+ “living far”	2.06	2.10	2.08	2.11	2.21	2.26	2.36	2.46	2.57	2.69	2.81	2.92	3.01	3.11	3.23

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
LLEIDA															
%Population living far	34.71	34.41	34.25	34.09	34.06	33.97	33.81	33.73	33.53	33.46	33.35	33.34	33.27	33.21	33.05
%Population 65+	17.34	16.86	16.21	16.07	15.84	15.56	15.51	15.65	16.25	16.04	16.31	16.72	17.03	17.26	17.51
%Population 65+ “living far”	18.74	18.15	17.54	17.39	17.16	16.93	16.92	17.06	17.72	17.48	17.78	18.22	18.48	18.66	18.90
%Population 75+	8.07	8.08	8.02	8.03	8.06	8.06	8.10	8.24	8.76	8.51	8.60	8.59	8.44	8.58	8.59
%Population 75+ “living far”	8.81	8.82	8.76	8.78	8.84	8.80	8.94	9.09	9.67	9.36	9.49	9.48	9.29	9.39	9.39
%Population 85+	1.92	1.92	1.90	1.93	2.01	2.06	2.11	2.20	2.30	2.42	2.50	2.61	2.72	2.81	2.90
%Population 85+ “living far”	2.06	2.10	2.08	2.11	2.21	2.26	2.36	2.46	2.57	2.69	2.81	2.92	3.01	3.11	3.23

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
TARRAGONA															
%Population living far	31.02	30.71	30.50	30.04	29.87	29.72	29.52	29.45	29.37	29.27	28.95	28.81	28.68	28.47	28.31
%Population 65+	17.38	17.00	16.27	16.17	15.88	15.52	15.60	15.87	16.56	16.45	16.84	17.36	17.82	18.11	18.45
%Population 65+ “living far”	21.90	21.46	20.43	20.39	20.05	19.48	19.53	19.76	20.52	20.21	20.64	21.24	21.66	21.94	22.18
%Population 75+	7.99	8.03	7.95	7.94	7.93	7.87	7.96	8.14	8.70	8.49	8.63	8.72	8.64	8.89	8.97
%Population 75+ “living far”	10.55	10.64	10.49	10.56	10.55	10.41	10.57	10.80	11.50	11.12	11.30	11.45	11.25	11.57	11.69
%Population 85+	1.89	1.90	1.87	1.90	1.94	2.00	2.07	2.20	2.28	2.38	2.47	2.62	2.75	2.86	2.98
%Population 85+ “living far”	2.55	2.57	2.52	2.57	2.66	2.71	2.84	3.04	3.14	3.22	3.37	3.61	3.77	3.96	4.13

Table 36. Population dispersion and ageing. It continues

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
COMUNIDAD VALENCIANA															
%Population living far	22.95	22.70	23.12	23.34	23.63	23.82	23.74	23.73	23.81	23.79	23.74	23.03	22.89	22.62	22.40
%Population 65+	16.57	16.30	16.02	16.26	16.26	16.18	16.41	16.76	17.54	17.50	17.92	18.06	18.39	18.53	18.71
%Population 65+ "living far"	19.57	18.84	18.54	18.83	18.89	18.91	19.35	19.87	20.79	20.85	21.40	20.75	20.94	20.87	20.91
%Population 75+	7.24	7.23	7.29	7.42	7.53	7.58	7.78	8.00	8.61	8.43	8.66	8.68	8.66	8.92	8.95
%Population 75+ "living far"	8.37	8.10	8.09	8.24	8.35	8.43	8.77	9.10	9.86	9.77	10.11	9.77	9.76	10.02	10.05
%Population 85+	1.59	1.56	1.56	1.61	1.67	1.74	1.82	1.93	2.04	2.16	2.25	2.33	2.44	2.53	2.61
%Population 85+ "living far"	1.81	1.71	1.68	1.73	1.77	1.87	1.99	2.12	2.26	2.42	2.52	2.47	2.59	2.71	2.80

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ALICANTE															
%Population living far	31.03	30.58	31.32	31.84	32.14	32.45	32.44	32.44	32.57	32.64	32.69	31.34	31.18	30.77	30.38
%Population 65+	16.65	16.20	16.12	16.55	16.71	16.79	17.22	17.77	18.66	18.78	19.27	18.87	19.11	19.07	19.19
%Population 65+ "living far"	19.95	18.69	18.75	19.23	19.58	19.86	20.59	21.42	22.50	22.79	23.45	21.92	21.95	21.60	21.47
%Population 75+	7.06	6.89	6.95	7.16	7.29	7.37	7.66	7.95	8.61	8.52	8.79	8.58	8.59	8.81	8.86
%Population 75+ "living far"	8.08	7.43	7.45	7.64	7.82	7.98	8.45	8.89	9.75	9.81	10.25	9.45	9.50	9.69	9.75
%Population 85+	1.47	1.40	1.41	1.48	1.55	1.62	1.73	1.86	1.98	2.11	2.20	2.19	2.28	2.37	2.46
%Population 85+ "living far"	1.65	1.47	1.46	1.52	1.58	1.69	1.85	1.99	2.16	2.33	2.45	2.18	2.26	2.35	2.44

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CASTELLÓN															
%Population living far	21.07	20.88	20.81	20.80	20.92	20.92	20.86	20.82	20.87	20.85	20.75	20.66	20.63	20.57	20.63
%Population 65+	17.28	16.95	16.43	16.36	16.13	15.80	15.89	16.09	16.81	16.66	16.99	17.60	18.06	18.34	18.06
%Population 65+ "living far"	22.31	21.92	21.21	21.09	20.80	20.29	20.28	20.42	21.19	20.88	21.21	21.53	21.92	22.00	21.92
%Population 75+	7.96	7.98	7.97	7.98	7.98	7.95	8.09	8.24	8.82	8.57	8.76	8.91	8.86	9.15	8.86
%Population 75+ "living far"	10.75	10.73	10.68	10.71	10.66	10.57	10.67	10.86	11.56	11.16	11.36	11.39	11.23	11.49	11.23
%Population 85+	1.80	1.80	1.80	1.83	1.88	1.96	2.03	2.11	2.22	2.33	2.42	2.57	2.69	2.81	2.69
%Population 85+ "living far"	2.53	2.49	2.49	2.53	2.59	2.71	2.80	2.91	3.03	3.17	3.27	3.38	3.53	3.69	3.53

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
VALENCIA															
%Population living far	17.68	17.57	17.75	17.76	18.00	18.07	17.93	17.89	17.91	17.81	17.64	17.47	17.35	17.18	17.06
%Population 65+	16.35	16.22	15.85	16.03	15.96	15.82	15.93	16.16	16.87	16.73	17.10	17.58	17.94	18.19	18.51
%Population 65+ "living far"	18.38	18.20	17.57	17.72	17.48	17.26	17.43	17.63	18.34	18.16	18.56	19.00	19.35	19.61	19.90
%Population 75+	7.22	7.31	7.37	7.48	7.60	7.66	7.81	7.98	8.56	8.34	8.54	8.70	8.66	8.96	9.03
%Population 75+ "living far"	8.09	8.21	8.21	8.36	8.42	8.44	8.69	8.90	9.56	9.33	9.57	9.74	9.69	10.04	10.11
%Population 85+	1.62	1.62	1.62	1.66	1.71	1.77	1.85	1.94	2.05	2.16	2.25	2.38	2.50	2.59	2.69
%Population 85+ "living far"	1.81	1.79	1.76	1.80	1.81	1.88	1.97	2.07	2.20	2.34	2.42	2.60	2.76	2.91	3.06

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EXTREMADURA															
%Population living far	33.02	32.87	32.64	32.44	32.23	31.94	31.73	31.70	31.61	31.49	31.34	31.31	31.26	31.16	31.10
%Population 65+	19.39	19.28	19.11	19.24	19.01	18.88	19.01	19.18	19.72	19.30	19.44	19.68	19.93	20.03	20.28
%Population 65+ "living far"	23.09	22.97	22.73	22.92	22.71	22.57	22.69	22.72	23.29	22.68	22.77	22.90	23.04	23.10	23.27
%Population 75+	8.65	8.89	9.12	9.34	9.55	9.79	10.06	10.30	10.97	10.75	10.80	10.76	10.73	10.89	10.80
%Population 75+ "living far"	10.62	10.85	11.10	11.42	11.72	12.03	12.42	12.65	13.46	13.15	13.23	13.17	12.99	13.19	13.04
%Population 85+	2.00	2.01	2.06	2.13	2.19	2.27	2.38	2.51	2.61	2.75	2.86	3.02	3.19	3.31	3.49
%Population 85+ "living far"	2.49	2.48	2.53	2.64	2.74	2.85	2.97	3.14	3.26	3.44	3.59	3.74	3.91	4.09	4.30

Table 36. Population dispersion and ageing. It continues

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
BADAJOZ															
%Population living far	32.44	32.27	32.02	31.83	31.67	31.40	31.19	31.15	31.03	30.92	30.75	30.71	30.67	30.55	30.46
%Population 65+	18.28	18.17	17.92	18.01	17.75	17.61	17.73	17.92	18.39	17.98	18.15	18.45	18.70	18.80	19.07
%Population 65+ “living far”	22.32	22.17	21.78	21.84	21.48	21.26	21.29	21.36	21.84	21.21	21.27	21.50	21.61	21.64	21.83
%Population 75+	8.05	8.27	8.46	8.61	8.79	9.00	9.22	9.43	10.01	9.82	9.86	9.83	9.77	9.91	9.81
%Population 75+ “living far”	10.26	10.46	10.66	10.86	11.07	11.33	11.61	11.81	12.53	12.22	12.23	12.19	11.93	12.06	11.86
%Population 85+	1.82	1.83	1.88	1.93	2.00	2.05	2.14	2.26	2.32	2.43	2.52	2.66	2.80	2.90	3.05
%Population 85+ “living far”	2.37	2.37	2.40	2.48	2.56	2.64	2.74	2.88	2.97	3.13	3.24	3.37	3.50	3.62	3.79

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CÁCERES															
%Population living far	33.96	33.84	33.65	33.44	33.16	32.86	32.65	32.62	32.60	32.44	32.32	32.31	32.26	32.19	32.17
%Population 65+	21.20	21.08	21.04	21.26	21.10	21.01	21.16	21.29	21.94	21.51	21.62	21.76	22.00	22.12	22.34
%Population 65+ “living far”	24.29	24.20	24.22	24.61	24.66	24.66	24.92	24.89	25.60	25.04	25.19	25.15	25.32	25.44	25.59
%Population 75+	9.64	9.90	10.19	10.54	10.80	11.10	11.47	11.76	12.57	12.33	12.40	12.33	12.35	12.54	12.48
%Population 75+ “living far”	11.17	11.44	11.78	12.31	12.75	13.15	13.71	14.00	14.94	14.64	14.85	14.74	14.70	15.00	14.92
%Population 85+	2.29	2.30	2.36	2.46	2.52	2.65	2.78	2.94	3.09	3.28	3.43	3.63	3.84	4.00	4.23
%Population 85+ “living far”	2.68	2.65	2.74	2.89	3.04	3.19	3.34	3.55	3.73	3.94	4.15	4.34	4.58	4.85	5.10

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
GALICIA															
%Population living far	31.64	31.48	31.43	31.36	31.33	31.26	31.19	30.74	30.67	30.47	30.30	30.23	30.15	30.07	30.00
%Population 65+	21.27	21.29	21.24	21.47	21.57	21.65	21.89	22.10	23.02	22.83	23.12	23.55	23.98	24.31	24.57
%Population 65+ “living far”	23.73	23.73	23.61	23.82	23.88	23.92	24.10	24.32	25.25	24.95	25.21	25.57	25.96	26.26	26.47
%Population 75+	9.78	10.06	10.33	10.63	10.89	11.22	11.53	11.81	12.68	12.48	12.64	12.65	12.65	12.85	12.95
%Population 75+ “living far”	11.30	11.60	11.82	12.14	12.36	12.68	13.01	13.34	14.29	14.05	14.19	14.13	14.09	14.28	14.37
%Population 85+	2.56	2.63	2.69	2.80	2.87	3.00	3.12	3.22	3.33	3.46	3.60	3.77	3.96	4.14	4.30
%Population 85+ “living far”	3.04	3.12	3.17	3.33	3.40	3.54	3.66	3.77	3.88	4.02	4.17	4.33	4.52	4.70	4.87

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CORUÑA															
%Population living far	37.57	37.43	37.41	37.38	37.36	37.26	37.21	36.15	36.08	35.95	35.79	35.82	35.81	35.76	35.73
%Population 65+	20.12	20.19	20.16	20.42	20.58	20.71	21.02	21.20	22.08	22.01	22.42	22.89	23.33	23.66	23.95
%Population 65+ “living far”	20.28	20.33	20.23	20.52	20.69	20.86	21.15	21.46	22.33	22.23	22.66	23.09	23.51	23.85	24.13
%Population 75+	8.92	9.20	9.47	9.78	10.07	10.39	10.74	10.98	11.81	11.70	11.91	11.94	11.95	12.15	12.27
%Population 75+ “living far”	9.20	9.48	9.68	9.98	10.25	10.60	10.96	11.31	12.13	12.01	12.22	12.20	12.16	12.36	12.49
%Population 85+	2.28	2.34	2.39	2.50	2.58	2.69	2.79	2.85	2.95	3.08	3.23	3.39	3.57	3.75	3.92
%Population 85+ “living far”	2.39	2.44	2.49	2.66	2.76	2.89	2.98	3.06	3.15	3.26	3.41	3.55	3.71	3.87	4.04

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
LUGO															
%Population living far	42.09	41.93	41.86	41.62	41.48	41.35	41.20	41.03	40.92	40.76	40.59	40.47	40.35	40.25	40.17
%Population 65+	27.66	27.65	27.54	27.68	27.73	27.64	27.68	27.74	28.73	28.07	28.13	28.33	28.57	28.70	28.78
%Population 65+ “living far”	29.91	29.89	29.80	29.97	29.94	29.83	29.88	29.95	31.01	30.28	30.32	30.54	30.86	31.09	31.13
%Population 75+	13.68	14.09	14.44	14.81	15.14	15.46	15.79	16.13	17.27	16.84	16.94	16.89	16.79	16.90	16.86
%Population 75+ “living far”	15.12	15.56	15.89	16.34	16.54	16.85	17.24	17.56	18.79	18.30	18.36	18.29	18.23	18.40	18.32
%Population 85+	3.64	3.75	3.84	4.00	4.15	4.35	4.53	4.69	4.90	5.12	5.32	5.56	5.77	5.98	6.16
%Population 85+ “living far”	4.18	4.30	4.40	4.57	4.65	4.87	5.06	5.21	5.39	5.61	5.79	6.07	6.28	6.57	6.71

Table 36. Population dispersion and ageing. It continues

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
OURENSE															
%Population living far	34.32	34.11	33.95	33.78	33.75	33.58	33.37	33.15	33.11	32.88	32.60	32.32	32.07	31.83	31.52
%Population 65+	28.03	28.03	28.03	28.24	28.40	28.47	28.64	28.83	29.94	29.46	29.68	30.06	30.47	30.78	31.01
%Population 65+ "living far"	31.68	31.70	31.81	32.15	32.31	32.32	32.53	32.70	33.85	33.21	33.44	33.76	34.25	34.57	34.86
%Population 75+	13.82	14.19	14.56	14.91	15.20	15.64	15.98	16.37	17.51	17.12	17.28	17.28	17.30	17.54	17.66
%Population 75+ "living far"	15.92	16.36	16.82	17.22	17.54	18.00	18.32	18.75	19.93	19.51	19.70	19.71	19.82	20.18	20.37
%Population 85+	3.80	3.91	3.98	4.13	4.24	4.47	4.65	4.83	4.99	5.13	5.31	5.55	5.83	6.07	6.26
%Population 85+ "living far"	4.31	4.44	4.55	4.79	4.96	5.21	5.42	5.62	5.72	5.85	6.07	6.36	6.72	6.97	7.17

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PONTEVEDRA															
%Population living far	19.58	19.48	19.53	19.58	19.64	19.71	19.72	19.68	19.64	19.36	19.25	19.19	19.13	19.10	19.10
%Population 65+	17.62	17.65	17.61	17.87	17.97	18.10	18.37	18.74	19.64	19.59	19.88	20.40	20.93	21.34	21.67
%Population 65+ "living far"	21.15	21.14	20.89	21.00	20.92	20.89	21.04	21.28	22.22	22.01	22.14	22.57	23.00	23.35	23.58
%Population 75+	7.77	8.00	8.21	8.50	8.71	9.03	9.31	9.61	10.37	10.20	10.34	10.38	10.42	10.66	10.79
%Population 75+ "living far"	9.83	10.03	10.13	10.37	10.49	10.73	11.03	11.35	12.27	12.10	12.11	12.03	12.02	12.16	12.30
%Population 85+	2.00	2.07	2.13	2.20	2.24	2.33	2.44	2.54	2.64	2.74	2.83	2.97	3.14	3.30	3.45
%Population 85+ "living far"	2.73	2.79	2.82	2.90	2.87	2.92	3.03	3.14	3.26	3.41	3.48	3.59	3.73	3.88	4.06

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MADRID															
%Population living far	3.79	3.90	3.97	4.10	4.21	4.27	4.30	4.31	4.33	4.36	4.39	4.38	4.38	4.34	4.34
%Population 65+	14.53	14.48	14.21	14.48	14.41	14.30	14.45	14.71	15.39	15.39	15.80	16.37	16.83	17.11	17.38
%Population 65+ "living far"	15.99	15.56	15.10	14.95	14.57	14.24	14.32	14.53	15.21	15.03	15.28	15.82	16.29	16.63	16.89
%Population 75+	6.40	6.55	6.65	6.83	6.94	7.02	7.17	7.34	7.86	7.76	7.93	8.09	8.13	8.37	8.44
%Population 75+ "living far"	7.53	7.45	7.49	7.46	7.40	7.39	7.55	7.71	8.25	8.01	8.11	8.33	8.38	8.62	8.66
%Population 85+	1.62	1.63	1.64	1.69	1.72	1.79	1.87	1.95	2.05	2.16	2.27	2.41	2.55	2.65	2.74
%Population 85+ "living far"	2.04	1.99	1.96	1.97	1.93	2.00	2.12	2.23	2.36	2.45	2.53	2.71	2.86	2.98	3.10

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MURCIA															
%Population living far	38.09	37.98	37.99	37.98	37.65	37.50	37.36	37.25	37.14	37.14	37.20	36.90	36.79	36.60	36.51
%Population 65+	14.08	14.07	13.73	13.77	13.73	13.58	13.62	13.74	14.35	14.27	14.50	14.72	14.94	15.07	15.25
%Population 65+ "living far"	14.99	14.93	14.54	14.55	14.66	14.54	14.66	14.79	15.47	15.39	15.65	15.85	16.06	16.13	16.32
%Population 75+	5.97	6.11	6.16	6.26	6.39	6.47	6.62	6.74	7.22	7.08	7.21	7.34	7.30	7.49	7.50
%Population 75+ "living far"	6.39	6.56	6.58	6.70	6.89	6.99	7.14	7.29	7.80	7.64	7.76	7.90	7.83	7.99	8.02
%Population 85+	1.24	1.23	1.24	1.25	1.30	1.38	1.43	1.52	1.62	1.73	1.80	1.92	2.02	2.13	2.21
%Population 85+ "living far"	1.30	1.30	1.30	1.30	1.38	1.47	1.52	1.63	1.74	1.86	1.92	2.08	2.19	2.31	2.39

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NAVARRA															
%Population living far	42.75	42.52	42.39	42.11	41.88	41.64	41.50	41.36	41.11	40.72	40.43	40.13	39.95	39.77	39.58
%Population 65+	17.79	17.64	17.43	17.42	17.44	17.24	17.26	17.36	18.09	17.86	18.14	18.60	18.93	19.19	19.36
%Population 65+ "living far"	21.06	20.81	20.47	20.44	20.42	20.12	20.00	19.99	20.79	20.46	20.65	21.06	21.32	21.51	21.56
%Population 75+	8.62	8.77	8.87	9.01	9.13	9.15	9.19	9.26	9.89	9.57	9.59	9.64	9.61	9.73	9.72
%Population 75+ "living far"	10.53	10.74	10.85	11.06	11.18	11.19	11.22	11.25	12.02	11.58	11.56	11.54	11.46	11.55	11.46
%Population 85+	2.18	2.23	2.24	2.33	2.42	2.49	2.56	2.65	2.77	2.87	2.96	3.11	3.22	3.34	3.40
%Population 85+ "living far"	2.55	2.60	2.63	2.76	2.89	3.00	3.12	3.23	3.38	3.54	3.67	3.87	4.01	4.15	4.20

Table 36. Population dispersion and ageing. It concludes

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PAÍS VASCO															
%Population living far	19.44	19.43	19.43	19.44	19.56	19.64	19.62	19.62	19.60	19.63	19.65	19.64	19.62	19.59	19.54
%Population 65+	18.17	18.25	18.23	18.44	18.54	18.62	18.85	19.17	20.01	19.84	20.22	20.75	21.13	21.45	21.70
%Population 65+ “living far”	19.17	19.20	19.17	19.30	19.29	19.24	19.41	19.69	20.52	20.25	20.49	20.95	21.29	21.59	21.84
%Population 75+	7.93	8.24	8.52	8.82	9.12	9.42	9.70	9.97	10.68	10.44	10.58	10.68	10.64	10.79	10.85
%Population 75+ “living far”	8.40	8.70	8.97	9.26	9.50	9.77	10.03	10.33	11.07	10.82	10.91	11.01	10.96	11.07	11.12
%Population 85+	1.87	1.90	1.94	2.02	2.13	2.24	2.36	2.50	2.64	2.79	2.92	3.13	3.28	3.43	3.58
%Population 85+ “living far”	1.93	1.96	2.01	2.10	2.21	2.31	2.44	2.57	2.70	2.85	2.95	3.18	3.33	3.48	3.61

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ÁLAVA															
%Population living far	19.37	19.42	19.38	19.36	19.41	19.37	19.27	19.20	19.14	19.04	19.02	18.95	18.80	18.69	18.55
%Population 65+	16.18	16.28	16.26	16.52	16.64	16.74	16.99	17.33	18.15	18.01	18.54	19.07	19.51	19.88	20.16
%Population 65+ “living far”	19.16	19.16	19.09	19.15	19.10	19.08	19.16	19.24	20.08	19.70	19.96	20.33	20.72	21.06	21.28
%Population 75+	7.09	7.31	7.48	7.73	8.01	8.22	8.45	8.68	9.32	9.11	9.28	9.38	9.40	9.61	9.69
%Population 75+ “living far”	8.40	8.65	8.89	9.18	9.50	9.69	9.91	10.03	10.78	10.56	10.66	10.77	10.75	10.85	10.87
%Population 85+	1.80	1.82	1.84	1.91	2.00	2.10	2.18	2.28	2.40	2.49	2.60	2.74	2.86	3.02	3.15
%Population 85+ “living far”	1.97	2.01	2.04	2.14	2.30	2.39	2.49	2.56	2.68	2.82	2.89	3.07	3.22	3.45	3.58

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
BIZKAIA															
%Population living far	14.00	14.04	14.06	14.10	14.21	14.28	14.29	14.30	14.31	14.37	14.38	14.38	14.37	14.37	14.37
%Population 65+	18.83	18.91	18.88	19.07	19.17	19.27	19.48	19.79	20.60	20.38	20.73	21.28	21.65	21.96	22.19
%Population 65+ “living far”	18.93	18.89	18.82	18.97	18.95	18.97	19.19	19.52	20.29	19.99	20.27	20.83	21.21	21.52	21.77
%Population 75+	8.14	8.50	8.82	9.14	9.47	9.82	10.14	10.43	11.17	10.93	11.07	11.20	11.15	11.28	11.32
%Population 75+ “living far”	8.39	8.64	8.88	9.13	9.27	9.55	9.82	10.13	10.87	10.60	10.68	10.81	10.74	10.88	10.98
%Population 85+	1.86	1.89	1.94	2.02	2.13	2.25	2.38	2.53	2.69	2.87	3.02	3.28	3.44	3.60	3.77
%Population 85+ “living far”	1.91	1.93	1.99	2.08	2.16	2.26	2.38	2.50	2.63	2.78	2.88	3.12	3.24	3.36	3.49

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
GIPUZKOA															
%Population living far	28.48	28.35	28.34	28.31	28.52	28.61	28.58	28.58	28.54	28.57	28.56	28.53	28.49	28.43	28.35
%Population 65+	17.94	18.00	18.02	18.25	18.34	18.39	18.65	19.00	19.89	19.79	20.15	20.64	21.02	21.33	21.63
%Population 65+ “living far”	19.36	19.47	19.49	19.62	19.64	19.51	19.66	19.96	20.83	20.63	20.83	21.22	21.52	21.80	22.05
%Population 75+	7.95	8.22	8.49	8.78	9.04	9.29	9.54	9.81	10.50	10.25	10.35	10.42	10.39	10.53	10.61
%Population 75+ “living far”	8.41	8.77	9.08	9.39	9.68	9.98	10.25	10.59	11.32	11.08	11.17	11.24	11.21	11.28	11.30
%Population 85+	1.92	1.95	1.99	2.08	2.19	2.29	2.40	2.54	2.66	2.80	2.91	3.07	3.22	3.34	3.47
%Population 85+ “living far”	1.93	1.98	2.03	2.10	2.23	2.33	2.46	2.63	2.75	2.91	3.02	3.25	3.44	3.59	3.71

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
LA RIOJA															
%Population living far	31.46	31.59	31.39	31.14	31.19	31.07	31.05	30.87	30.73	30.54	30.34	30.25	30.16	30.13	30.02
%Population 65+	19.34	18.96	18.46	18.41	18.35	18.01	18.02	18.24	18.96	18.62	18.94	19.44	19.86	20.14	20.43
%Population 65+ “living far”	21.93	21.39	20.88	20.79	20.52	20.06	19.93	20.15	20.92	20.39	20.65	21.00	21.30	21.42	21.64
%Population 75+	9.24	9.36	9.39	9.55	9.68	9.71	9.84	10.06	10.72	10.37	10.43	10.46	10.43	10.59	10.69
%Population 75+ “living far”	10.48	10.59	10.71	10.92	11.03	11.07	11.20	11.50	12.24	11.78	11.75	11.74	11.64	11.71	11.72
%Population 85+	2.21	2.24	2.27	2.32	2.44	2.53	2.62	2.80	2.93	3.07	3.20	3.35	3.50	3.66	3.80
%Population 85+ “living far”	2.32	2.36	2.39	2.47	2.59	2.68	2.82	3.05	3.24	3.39	3.48	3.66	3.86	4.01	4.15

Source: Author’s own work

Note: In a given province, we have considered that people live far when they reside in singular entities that are farther away from the CBD than the average distance to it within the province.

5. A COMPOSITE INDICATOR FOR POPULATION DISPERSION

"A composite indicator is formed when individual indicators are compiled into a single index on the basis of an underlying model. The composite indicator should ideally measure multi-dimensional concepts which cannot be captured by a single indicator."[35]

In Blanco et al. (2021), we developed a model to define and measure population dispersion in Spain. That model set population dispersion as a multidimensional concept represented by low values in one or more of six distinct dimensions: proximity, centrality, nuclearity, density, concentration and continuity. Each dimension can be measured through several indicators that we have quantified and analysed in this paper. Out of the ninety-four indicators that we have identified as candidates to quantify population dispersion, we have selected twenty-two based on their relevance to the phenomenon being measured, the objective of our study, and the relationship to each other (to avoid high collinearity). We show the twenty-two indicators in Figure 7:

Figure 7. Selected indicators used to build the composites.

DIMENSION	INDICATOR	ACROIND
PROXIMITY	1. *Ratio of population proximity to geographical proximity (SE/travel distances) (**$PROXR_{SE1h}$**).*	PROXRSE1h
PROXIMITY	2. *Normalised proximity - weighted average of travel distances between SE (**$PROXN_{SE1m}$**).*	PROXNSE1m
PROXIMITY	3. *Standardised Proximity Index (SPI) based on travel distances (**$PROXV_{MUN2o}$**).*	PROXVMUN2o
CENTRALITY	4. *Ratio population centrality to geographical centrality based on travel distances of SE to CBD (**$CBDdR_{SE3h}$**).*	CBDdRSE3h
CENTRALITY	5. *Normalised centrality - weighted average of travel distances from SE to CBD (**$CBDdN_{SE3m}$**).*	CBDdNSE3m
CENTRALITY	6. *Centralisation index (**$CBDdACI_{MUN4o}$**).*	CBDdACIMUN4o
NUCLEARITY	7. *Inverse of the number of nuclei per province SE-based (**$NUNoN_{SE5a}$**).*	NUNoNSE5a
NUCLEARITY	8. *Share of the population in the CBD over the population in nuclei SE-based (**$NUSoP_{SE5b}$**).*	NUSoPSE5b
DENSITY	9. *Population-weighted density based on total land (**$DEPWD_{MUN7a}$**).*	DEPWDMUN7a
DENSITY	10. *Population-weighted density based on built-up land area (**$DEPWD_{MUN7c}$**).*	DEPWDMUN7c
DENSITY	11. *Share of the population living in high-density municipalities based on total land (**$DENHIGH_{MUN7j}$**).*	DENHIGHMUN7j
DENSITY	12. *Share of the population living in high-density municipalities based on built-up land area (**$DENHIGH_{MUN7l}$**).*	DENHIGHMUN7l
CONCENTRATION	13. *Gini index for SE (**$CNGINI_{SE8a}$**).*	CNGINISE8a
CONCENTRATION	14. *Standardised Theil entropy index (SE) (**$CNSTHEI_{SE8b}$**).*	CNSTHEISE8b
CONCENTRATION	15. *Share of the population living in high-density municipalities based on built-up land (**$CNHGD_{MUN9b}$**).*	CNHGDMUN9b
CONCENTRATION	16. *Population density gradient (**$CNPDG_{MUN9c}$**).*	CNPDGMUN9c
CONCENTRATION	17. *Theil index (**$CNTHI_{MUN9g}$**).*	CNTHIMUN9g
CONCENTRATION	18. *Ellison and Glaesser (**$CNEG_{MUN9j}$**).*	CNEGMUN9j
CONCENTRATION	19. *Delta index (also Hoover index) (**$CNDI_{MUN9k}$**).*	CNDIMUN9k
CONCENTRATION	20. *Massey and Denton dissimilarity index for built-up land] (**$CNMDDI_{MUN9m}$**).*	CNMDDIMUN9m
CONTINUITY	21. *Ratio built-up land area to total land area (**$CNTRUT_{PROV10b}$**).*	CNTRUTPROV10b
CONTINUITY	22. *R-square of the exponential density function (**$CNTR2_{PROV10c}$**).*	CNTR2PROV10c

[35] OECD et al. (2008). We built our composite indicators based on this handbook on constructing composite indicators by the OECD and the EU JRC.

The twenty-two indicators have been aggregated in one meaningful synthetic index that summarises the multi-dimensional reality behind population dispersion. It is easier to interpret than a battery of many separate indicators yet avoids dropping the underlying information that has been gathered. Our objective for this composite indicator is to help us construct and underpin narratives for lay and literate audiences, with a view to: i) promoting accountability; ii) enabling users to compare complex dimensions effectively; and iii) supporting decision makers.

We notice that the use of composite indicators might cause controversy. The selection of indicators and weights could be the subject of political dispute and it might increase the difficulty of identifying proper remedial action. This mainly happens when the construction process is not transparent or lacks sound statistical or conceptual principles. The key objection to aggregation by the non-aggregators is what they see as the arbitrary nature of the weighting process by which the variables are combined.

In fact, methodological issues need to be addressed transparently prior to the construction and use of composite indicators in order to avoid data manipulation and misrepresentation.

Indeed, the quality of a composite indicator, as well as the soundness of the messages it conveys, depends on the methodology used in its construction and, primarily on the quality of the framework and the data used. We believe that the methodology presented in Blanco et al. (2021), together with the information presented in the preceding points of this paper, guarantees the needed transparency as well as sound statistical and conceptual principles to avoid all the mentioned drawbacks.

Following OECD et al. (2008), we summarise below the steps in the construction of composite indicators:

- *"**Step1: Theoretical framework**. A theoretical framework should be developed to provide the basis for the selection and combination of single indicators into a meaningful composite indicator under a fitness-for-purpose principle…*

• ***Step 2: Data selection****. Indicators should be selected based on their analytical soundness, measurability, coverage, relevance to the phenomenon being measured and relationship to each other…*

• ***Step 3: Imputation of missing data****. Consideration should be given to different approaches for imputing missing values…*

• ***Step 4: Multivariate analysis.*** *An exploratory analysis should investigate the overall structure of the indicators…*

• ***Step 5: Normalisation****. Indicators should be normalised to render them comparable…*

• ***Step 6: Weighting and aggregation.*** *Indicators should be aggregated and weighted according to the underlying theoretical framework...*

• ***Step 7: Robustness and sensitivity****. Analysis should be undertaken to assess the robustness of the composite indicator…*

• ***Step 8: Back to the real data****. Composite indicators should be transparent and fit to be decomposed into their underlying indicators or values…*

• ***Step 9: Links to other variables.*** *Attempts should be made to correlate the composite indicator with other published indicators, as well as to identify linkages through regressions…*

• ***Step 10: Presentation and Visualisation****. Composite indicators can be visualised or presented in a number of different ways, which can influence their interpretation..."*

Theoretical framework, data selection and imputation, and multivariate analysis (steps 1-4)

The methodology presented in Blanco et al. (2021), including the description of the databases and their sources, together with the information presented in the preceding points of this paper, covers steps 1 to 4.[36]

[36] Please notice that we had no need of doing data imputation and we have addressed multivariate analysis through the correlation matrices of the indicators in each dimension.

Normalisation (step 5)

We have used the **z-scores method to normalise the indicators**.[37] The method converts indicators to a common scale with a mean of zero and a standard deviation of one.

Weighting and aggregation (step 6)

As for weighting and aggregation (step 6), we have broken down the process into two phases: first, we calculated weights in order to aggregate the indicators within each of the six dispersion dimensions. Second, we calculated weights in order to aggregate the six composite indicators obtained as a result of phase one, yielding one final composite indicator.

- ***Weighting indicators to build composite indicators for each dimension***

As mentioned, the relative importance of the indicators is a source of contention. A number of weighting techniques exist as described in OECD et al. (2008). To obtain weights, we will rely on statistical models, specifically on principal components or factor analysis techniques. "*Principal components analysis, and more specifically factor analysis, groups together individual indicators which are collinear to form a composite indicator that captures as much as possible of the information common to individual indicators. Each factor (usually estimated using principal components analysis) reveals the set of indicators with which it has the strongest association. The idea under PCA/FA is to account for the highest possible variation in the indicator set using the smallest possible number of factors.*" [38]

We have selected this statistical tool to reduce the dimension of the data set since we are interested in accounting for the highest possible variation in the indicator set, on the grounds that this is crucial to analyse the extent to which population dispersion is a driver of FPS cost.[39]

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[37] Please notice that we mean statistical normalisation or typification, which is different of the sort of standardisation we managed to define standardised proximity or centrality indicators.
[38] OECD et al. (2008).
[39] "*Most composite indicators rely on equal weighting (EW), i.e. all variables are given the same weight. This essentially implies that all variables are "worth" the same in the composite, but it could also disguise the absence of a statistical or an empirical basis, e.g. when there is insufficient knowledge of causal relationships or a lack of consensus on the alternative. In any case, equal weighting does not mean "no weights", but implicitly implies that the weights are equal. Moreover, if variables are grouped into dimensions and those are further aggregated into the composite, then applying equal weighting to the variables may imply an unequal weighting of the dimension*

The ***first action in PCA/FA*** is to check the correlation structure of the data. If the correlation between the indicators is weak, then it is unlikely that they share common factors. In Table 37, we present the correlation matrices of the selected indicators within the same dimension. We observe that it is typically high. Nonetheless, as already discussed, we have selected indicators with the criteria of avoiding "double counting," therefore correlations within the same dimension are always below 0.95 (Annex III).

Table 37. Correlation matrices for indicators on dispersion dimensions

PROXIMITY	*PROXRSE1h*	*PROXNSE1m*	*PROXVMUN2o*
PROXRSE1h	1		
PROXNSE1m	0.81	1	
PROXVMUN2o	0.76	0.75	1

CENTRALITY	*CBDdRSE3h*	*CBDdNSE3m*	*CBDdACIMUN4o*
CBDdRSE3h	1		
CBDdNSE3m	0.80	1	
CBDdACIMUN4o	0.84	0.73	1

NUCLEARITY	*NUNoNSE5a*	*NUSoPSE5b*
NUNoNSE5a	1	
NUSoPSE5b	0.72	1

DENSITY	*DEPWDMUN7a*	*DEPWDMUN7c*	*DENHIGHMUN7j*	*DENHIGHMUN7l*
DEPWDMUN7a	1			
DEPWDMUN7c	0.81	1		
DENHIGHMUN7j	0.88	0.78	1	
DENHIGHMUN7l	0.62	0.85	0.65	1

CONCENTRATION	*CNGINISE8a*	*CNSTHEISE8b*	*CNHGDMUN9b*	*CNPDGMUN9c*	*CNTHIMUN9g*	*CNEGMUN9j*	*CNDIMUN9k*	*CNMDDIMUN9m*
CNGINISE8a	1							
CNSTHEISE8b	0.68	1						
CNHGDMUN9b	0.70	0.50	1					
CNPDGMUN9c	0.70	0.24	0.58	1				
CNTHIMUN9g	0.74	0.29	0.66	0.73	1			
CNEGMUN9j	0.53	0.84	0.52	0.24	0.30	1		
CNDIMUN9k	0.86	0.66	0.69	0.64	0.85	0.55	1	
CNMDDIMUN9m	0.69	0.38	0.38	0.61	0.71	0.22	0.80	1

CONTINUITY	*CNTRBTPROV10b*	*CNTR2PROV10c*
CNTRBTPROV10b	1	
CNTR2PROV10c	0.66	1

Source: Author's own work.

(the dimensions grouping the larger number of variables will have higher weight). This could result in an unbalanced structure in the composite index." (OECD et al. (2008)).

The ***second action in PCA/FA*** is the identification of a certain number of latent factors (fewer than the number of individual indicators) representing the data.

Indeed, for a given set of Q indicators, $\boldsymbol{I}' = [I_1, \dots, I_Q]$, we can build with statistical/mathematical tools a set of M < Q orthogonal factors $\boldsymbol{F}' = [F_1, \dots, F_M]$ that represent the data: they reflect most of the information (variability) observed in the data set.

The information enclosed in the data set is represented by its variability, which is accounted for by the covariance matrix:

$$Var\ (\boldsymbol{I}) = (\sigma_{pq}) = \boldsymbol{\Sigma} \qquad\qquad p, q = 1, \dots, Q$$

Or, alternatively, by the correlation matrix:

$$Corr\ (\boldsymbol{I}) = (\rho_{pq}) = \mathbf{R} \qquad\qquad p, q = 1, \dots, Q$$

If the off-diagonal elements of Σ are small or those of the correlation matrix R essentially zero, the variables (indicators) are not related and factor analysis will not prove useful. If Σ (or R) appears to deviate significantly from a diagonal matrix, then a factor model can be contemplated. The idea behind factor analysis is to extract a number M < Q of factors controlling the information loss. Furthermore, they can account for a large part of our indicators' variability, thus facilitating striking a balance between data reduction and interpretability. The M factors can then replace the Q indicators, reducing the original data set to a smaller one, which retains almost as much information as the original one. In this case:[40]

$$\underset{(Q\times 1)}{\boldsymbol{I}} = \underset{(Q\times 1)}{\boldsymbol{\mu}} + \underset{(Q\times M)}{\boldsymbol{L}}\ \underset{(M\times 1)}{\boldsymbol{F}} + \underset{(Q\times 1)}{\boldsymbol{\varepsilon}}$$

Where:

$\boldsymbol{\mu}$ is the vector of the indicators' averages.

$\boldsymbol{L} = (l_{pm}), \quad p = 1, \dots, Q, m = 1, \dots, M$ is the matrix of factor loadings.

$\boldsymbol{\varepsilon}$ is called an error term which is unobservable with zero mean and $Var\ (\boldsymbol{\varepsilon}) = diag(\psi_p)$.

[40] Please, be aware that here μ does not stand for the number of municipalities in Spain as stated in the nomenclature used in the previous paper by Blanco et al. (2021). We have opted for using the standard statistical notation in PCA the average of a variable is typically named by the Greek letter μ.

Considering that we will work with normalised variables (z-scores) $\boldsymbol{Z}(\boldsymbol{I})$, $\boldsymbol{\mu} = \boldsymbol{0}$:

$$\underset{(Q\times 1)}{\boldsymbol{Z}(\boldsymbol{I})} = \underset{(Q\times M)}{\boldsymbol{L}} \underset{(M\times 1)}{\boldsymbol{F}} + \underset{(Q\times 1)}{\boldsymbol{\varepsilon}}$$

PCA/FA builds the factors based on what is called the principal components of the Q indicators. Thus, to construct M < Q factors, we started with the following Q principal components $\boldsymbol{Y} = [Y_1, \ldots, Y_Q]$:

$$Y_p = \boldsymbol{e}_p'\boldsymbol{I} = e_{1p}I_1 + \cdots + e_{1Q}I_Q \quad p = 1, \ldots, Q$$

Where:

$\boldsymbol{e}_p'$ *is the eigenvector of* Σ *with associated eigenvalue* λ_p [41] $\quad p = 1, \ldots, Q$

$\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_Q \geq 0$

$Var(Y_p) = \lambda_p$

$Cov(Y_p, Y_q) = 0 \quad with\ p \neq q$

$Var\ (\boldsymbol{Y}) = \Lambda = \text{diag}\ (\lambda_p)$

Total population variance is $\sum_p \sigma_{pp}$ and the principal components have been constructed in such a way that they reap all this variability as follows:

$$\sum\nolimits_p \sigma_{pp} = \sum\nolimits_p \lambda_p$$

Using the principal components, we can construct M common latent factors as follows:

$$F_m = \boldsymbol{e}_m'\boldsymbol{I} = \sqrt{\lambda_m}e_{1m}I_1 + \cdots + \sqrt{\lambda_m}e_{Qm}I_Q \quad m = 1, \ldots, M$$

Therefore:

[41] Please, be aware that here λ_p does not stand for the diagonal of the axes-aligned 2-dimensional bounding box of province p as stated in the nomenclature used in the previous paper by Blanco et al. (2021). We have opted for using the standard statistical notation in PCA and vector spaces where the eigenvalues of a matrix are typically named by the Greek letter λ.

$l_{pm} = \sqrt{\lambda_m} e_{pm}$ with $p = 1, \dots, Q;\ m = 1, \dots, M$ $(factors\ loadings)$

$\sum_p l_{pm}^2 = \lambda_m; m = 1, \dots, M$ *For each factor, the sum of the square of the factor loadings represents that part of the total variance of the indicators that is explained by the factor.*

$\sigma_{pp} = l_{p1}^2 + \cdots + l_{pm}^2 + \psi_p$ $\begin{cases} communality = h_p^2 = l_{p1}^2 + \cdots + l_{pm}^2 \\ uniqueness = \psi_p \end{cases}$

Standard practice to determine the number M of principal components that are retained as common factors is based on various "sensible" criteria (Johnson et al. (1992); OECD et al (2008)):

- To retain few rather than many factors.
- To increase the number of common factors retained in the model until a "suitable portion" of the total population variance $((\lambda_1 + \dots + \lambda_M) / (\lambda_1 + \dots + \lambda_Q))$ has been explained: as for Johnson et al. (1992), it could be 80% to 90%; as for OECD et al. (2008), it could be more than 60%.
- The common factors retained are those that have associated eigenvalues larger than one ($\lambda > 1$).
- The common factors retained are those that contribute individually to the explanation of overall variance by more than 10%.

The factor loadings provide the information on the adequacy with which the factors represent that indicator: for each indicator, the sum of the squared factor loadings (*communality:* $h_p^2 = \ell_{p1}^2 + \dots + \ell_{pM}^2$) constitute that part of the indicator's variability captured by the factors. They also provide the information for the interpretation of the factors as they measure the correlation between each individual indicator and each latent factor:

$$\rho_{F_m I_p} = \frac{l_{\text{pm}}}{\sigma_{pp}} = l_{\text{pm}}$$

Moreover, they will be the information needed to obtain the indicators' weights.

Factor loadings **L** are not unique. They are only determined up to an orthogonal matrix (rotation). Normally, a rotation can be run based on criteria selected for "*ease-of-interpretation.*"

Therefore, the ***third action in PCA/FA*** deals with the rotation of factors. According to OECD et al. (2008), "*The rotation (usually the varimax rotation) is used to minimise the number of individual indicators that have a high loading on the same factor. The idea behind transforming the factorial axes is to obtain a "simpler structure" of the factors (ideally, a structure in which each indicator is loaded exclusively on one of the retained factors). Rotation is a standard step in factor analysis – it changes the factor loadings and hence the interpretation of the factors, while leaving unchanged the analytical solutions obtained ex-ante and ex-post the rotation."*

We developed factor analysis using principal component analysis as the extraction method, and Varimax as the rotation method. We work with a database that pools together the indicator values for the seventeen Spanish regions and the fifteen years we examined in this work, including thus 255 observations. We note that, for the purpose of composite indicators, we calculated the national averages as population weighted averages of the regional values.

Latent factors in dispersion dimensions

Concerning the indicators that measure each dispersion dimension, we have extracted with PCA/FA as many principal components (latent factors) as indicators. We could explain more than 80% of the information embedded within the indicators with the first three principal components (indeed, except for concentration, we would need just one factor to reach this level). Nonetheless, considering that we worked with a low number of indicators and our main goal was building indicator weights to create a composite one for each dimension, we retained all the principal components for each dimension ((λ>0). We present the factor loadings in Table 38.

Table 38. Factor loadings of dispersion dimensions' latent factors (Based on principal components) **(It continues)**

PROXIMITY				
Indicator		*Factor loadings*		
Ratio of population proximity to geographical proximity (SE/travel distances)	***$PROXR_{SE1h}$***	0.3770	0.4020	0.8350
Normalised proximity - weighted average of travel distances between SE	***$PROXN_{SE1m}$***	0.3720	0.8380	0.3980
Standardised Proximity Index (SPI) based on travel distances	***$PROXV_{MUN2o}$***	0.8710	0.3470	0.3490

CENTRALITY				
Indicator		*Factor loadings*		
Ratio population centrality to geographical centrality based on travel distances of SE to CBD	***$CBDdR_{SE3h}$***	0.4250	0.4560	0.7820
Normalised centrality - weighted average of travel distances from SE to CBD	***$CBDdN_{SE3m}$***	0.8760	0.3360	0.3450
Centralisation index	***$CBDdACI_{MUN4o}$***	0.3500	0.8550	0.3830

NUCLEARITY			
Indicator		*Factor loadings*	
Inverse of the number of nuclei per province SE-based	***$NUNoN_{SE5a}$***	0.9210	0.3900
Share of the population in the CBD over the population in nuclei SE-based	***$NUSoP_{SE5b}$***	0.3900	0.9210

DENSITY					
Indicator		*Factor loadings*			
Population-weighted density based on total land	***$DEPWD_{MUN7a}$***	0.2970	0.4920	0.7820	0.2410
Population-weighted density based on built-up land area	***$DEPWD_{MUN7c}$***	0.6010	0.3520	0.4010	0.5950
Share of the population living in high-density municipalities based on total land	***$DENHIGH_{MUN7j}$***	0.3220	0.8230	0.4170	0.2110
Share of the population living in high-density municipalities based on built-up land area	***$DENHIGH_{MUN7l}$***	0.9190	0.2600	0.2250	0.1940

Table 38. Factor loadings of dispersion dimensions' latent factors (Based on principal components) **(Conclusion)**

CONCENTRATION									
Indicator		*Factor loadings*							
Gini index for SE	***CNGINI**$_{SE8a}$*	0.4170	0.4140	0.3900	0.3340	0.2480	0.5730	0.0200	0.0320
Standardised Theil entropy index (SE)	***CNSTHEI**$_{SE8b}$*	0.8840	0.2520	0.0490	0.1830	0.0310	0.2270	0.2470	0.0740
Share of the population living in high-density municipalities based on built-up land	***CNHGD**$_{MUN9b}$*	0.3250	0.1450	0.2770	0.8550	0.2190	0.1260	0.0080	0.0240
Population density gradient	***CNPDG**$_{MUN9c}$*	0.0760	0.3000	0.8850	0.2500	0.2090	0.1190	0.0020	0.0220
Theil index	***CNTHI**$_{MUN9g}$*	0.1380	0.4560	0.3690	0.3370	0.7120	0.1290	-0.0090	0.0030
Ellison and Glaesser	***CNEG**$_{MUN9j}$*	0.9460	0.0780	0.0960	0.1980	0.1440	0.0090	-0.1700	-0.0200
Delta index (also Hoover index)	***CNDI**$_{MUN9k}$*	0.4330	0.5740	0.2620	0.3240	0.4250	0.2170	0.0510	0.2800
Massey and Denton dissimilarity index for built-up land	***CNMDDI**$_{MUN9m}$*	0.1650	0.9150	0.2670	0.0990	0.2010	0.1140	0.0110	-0.0050

CONTINUITY			
Indicator		*Factor loadings*	
Ratio built-up land area to total land area	***CNTRUT**$_{PROV10b}$*	0.3520	0.9360
R-square of the exponential density function	***CNTR2**$_{PROV10c}$*	0.9360	0.3520

Source: Author's own work based on the database of selected indicators by Region and year, using SPSS.
Extraction method: Principal component analysis.
Rotation method: Varimax normalization with Kaiser.

Finally, the ***last action*** in PCA/FA analysis deals with the construction of the weights from the matrix of factor loadings after rotation, and more specifically from the squared factor loadings, given that the square of factor loadings represents the proportion of the total variance of the indicator that is explained by the factors.

Following the approach used by OECD et al., (2008) we scaled the squared factor loadings of each factor m (m = 1,…, M) to unity sum, which will facilitate the identification of the relevant indicators in each factor:

$$\tilde{l}_{pm}^2 = \frac{l_{pm}^2}{l_{1m}^2+\cdots+l_{Mm}^2} = \frac{l_{pm}^2}{\lambda_p} \qquad \mathrm{p} = 1, \ldots, \mathrm{M};\ \mathrm{m} = 1, \ldots, \mathrm{M}$$

Then, we retained only the relevant factor loadings of each factor:

$$\tilde{\tilde{l}}_{pm}^2 = \begin{cases} \tilde{l}_{pm}^2\ if\ \tilde{l}_{pm}^2 & is\ not\ negligible\ \ (> 0.1) \\ 0 & otherwise \end{cases} \qquad \mathrm{p} = 1, \ldots, \mathrm{M};\ \mathrm{m} = 1, \ldots, \mathrm{M}$$

We built the weight of each indicator with the retained relevant factor loadings. Each factor loading was given a different relevance proportional to the explained variance by the factor in the data set:

$$w_p = \sum_{m=1}^{M} \lambda_m\, \tilde{\tilde{l}}_{pm}^2 \Big/ \sum_{p=1}^{Q} \sum_{m=1}^{M} \lambda_m\, \tilde{\tilde{l}}_{pm}^2$$

We present the indicator weights based on principal components analysis in Table 39.

Table 39. Indicator weights based on principal components analysis

PROXIMITY		
Indicator		*WEIGHTS*
Ratio of population proximity to geographical proximity (SE/travel distances)	$PROXR_{SE1h}$	0.3336
Normalised proximity - weighted average of travel distances between SE	$PROXN_{SE1m}$	0.3329
Standardised Proximity Index (SPI) based on travel distances	$PROXV_{MUN2o}$	0.3335

CENTRALITY		
Indicator		*WEIGHTS*
Ratio population centrality to geographical centrality based on travel distances of SE to	$PROXR_{SE1h}$	0.3334
Normalised centrality - weighted average of travel distances from SE to CBD	$PROXN_{SE1m}$	0.3331
Centralisation index	$PROXV_{MUN2o}$	0.3334

NUCLEARITY		
Indicator		*WEIGHTS*
Inverse of the number of nuclei per province SE-based	$NUNoN_{SE5a}$	0.5000
Share of the population in the CBD over the population in nuclei SE-based	$NUSoP_{SE5b}$	0.5000

DENSITY		
Indicator		*WEIGHTS*
Population-weighted density based on total land	$DEPWD_{MUN7a}$	0.2527
Population-weighted density based on built-up land area	$DEPWD_{MUN7c}$	0.2772
Share of the population living in high-density municipalities based on total land	$DENHIGH_{MUN7j}$	0.2360
Share of the population living in high-density municipalities based on built-up land area	$DENHIGH_{MUN7l}$	0.2341

CONCENTRATION		
Indicator		*WEIGHTS*
Gini index for SE	$CNGINI_{SE8a}$	0.0789
Standardised Theil entropy index (SE)	$CNSTHEI_{SE8b}$	0.1468
Share of the population living in high-density municipalities based on built-up land	$CNHGD_{MUN9b}$	0.1201
Population density gradient	$CNPDG_{MUN9c}$	0.1286
Theil index	$CNTHI_{MUN9g}$	0.1398
Ellison and Glaesser	$CNEG_{MUN9j}$	0.1517
Delta index (also Hoover index)	$CNDI_{MUN9k}$	0.0966
Massey and Denton dissimilarity index for built-up land	$CNMDDI_{MUN9m}$	0.1375

CONTINUITY		
Indicator		*WEIGHTS*
Ratio built-up land area to total land area	$CNTRUT_{PROV10}$	0.5000
R-square of the exponential density function	$CNTR2_{PROV10c}$	0.5000

Source: Author's own work based on Table 38.

- ***Aggregating indicators to build composite indicators for each dimension***

After calculating the weights, we aggregated the indicators using a compensatory-based tool[42] so that weights express trade-offs between indicators and a deficit in one dimension can be offset (compensated) by a surplus in another. Specifically, we used linear aggregation methods on the grounds that linear aggregations reward base indicators proportionally to the weights, while geometric aggregations reward those regions with higher scores. By far, the most widespread linear aggregation method is the summation of weighted and normalised individual indicators:

$$CI = \sum_{q=1}^{22} w_q I_q$$

$$with \sum_{q} w_q = 1 \;\; and \; 0 \leq w_q \leq 1 \; for \; all \; q = 1, \ldots, Q$$

$Where$:

- I_q $are\ the\ z - scores\ of\ the\ selectec\ indicators, q = 1, \ldots, Q$
- Q $is\ the\ number\ of\ indicators$

In Table 40, we presented the composite indicators for the six dispersion dimensions in 2016 by regions. Charts 27 to 32 show the corresponding regional rankings.

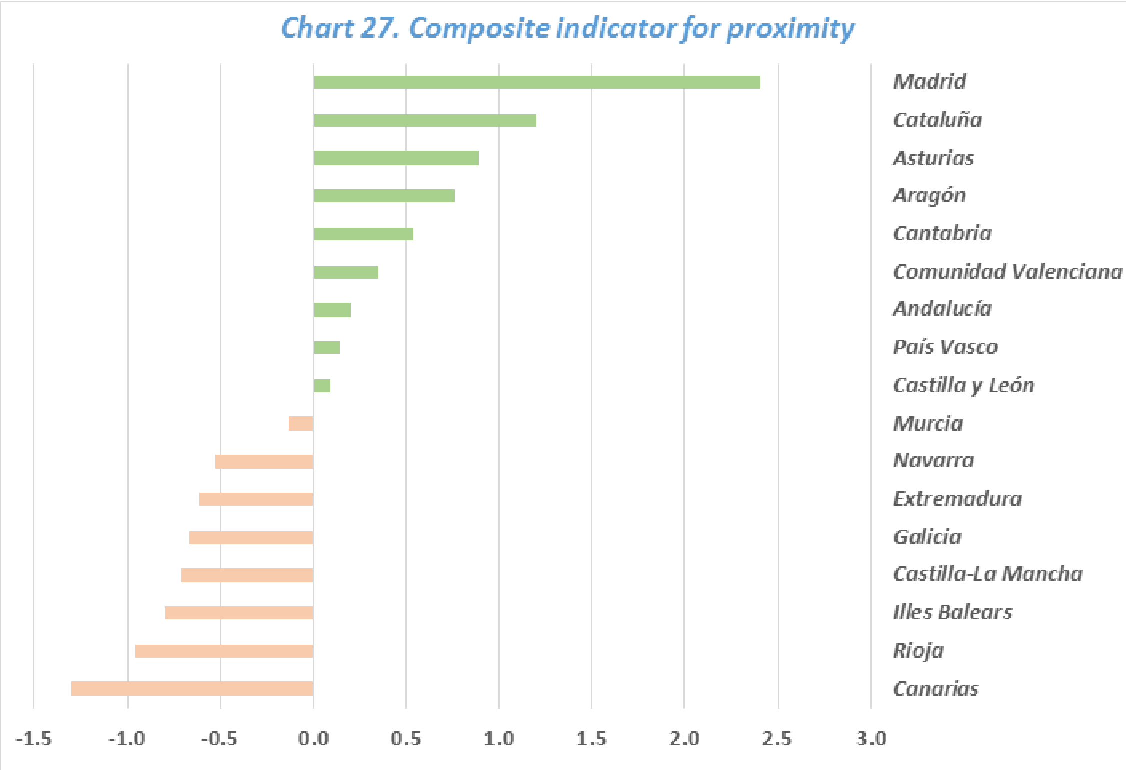
It is important to keep in mind that indicators have been calculated to reflect low values when population dispersion is high. We observe that Madrid and Cataluña are systematically in top positions, showing low levels of population dispersion. On the contrary, Extremadura, Castilla-La Mancha, Illes Balears, Canarias and Galicia tend to be in bottom positions, showing high levels of population dispersion.

[42] According to OECD et al. (2008), aggregation methods can have a compensatory or non-compensatory approach. Linear and geometric aggregation method have a compensatory one. A non-compensatory multi-criteria approach (MCA) could assure non-compensability. In its basic form, this approach retains only ordinal information. If multi-criteria analysis entails full non-compensability, the use of a geometric aggregation could be an in-between solution. "*Compensability of aggregations is widely studied in fuzzy set theory, for example Zimmermann & Zysno (1983) use the geometric operator* $\left(\prod_q I_q\right)^{1-\gamma}\left(1-\prod_q(1-I_q)\right)^{\gamma}$ *where* γ *is a parameter of compensation: the larger* γ*, the higher the degree of compensation between individual indicators*."

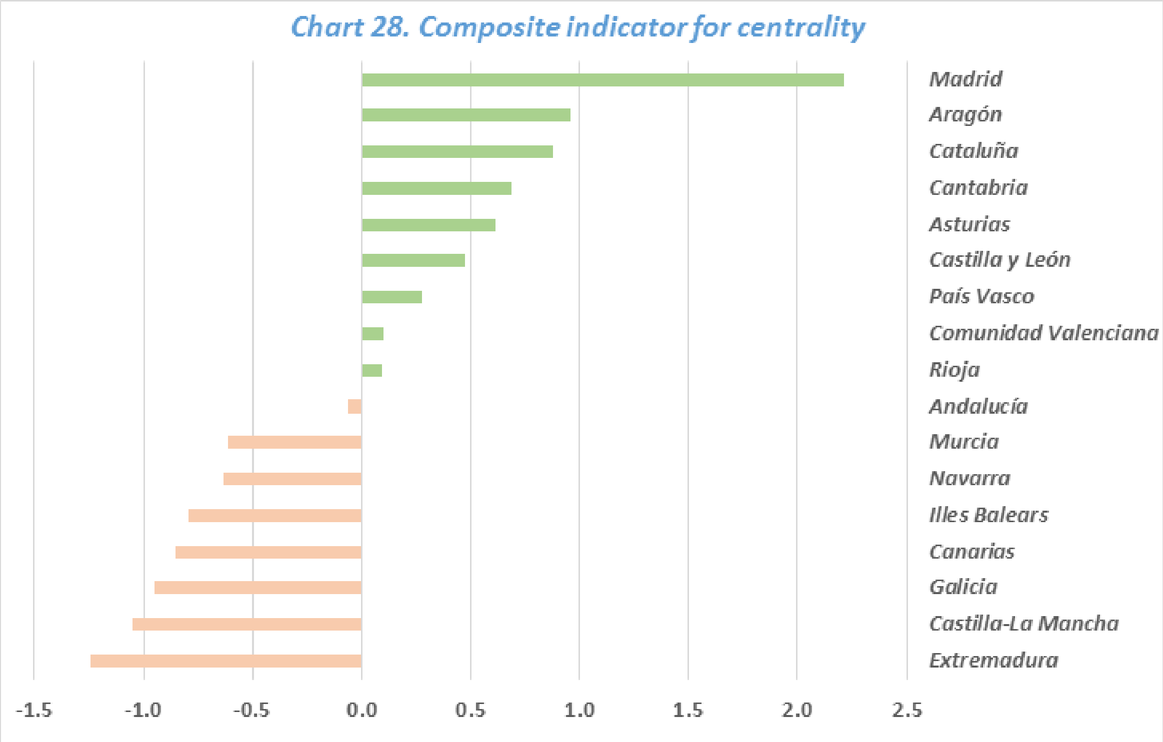
Table 40. Composite indicators for the six dispersion dimensions in 2016 (zscores-based)

REGION	PROXIMITY	CENTRALITY	NUCLEARITY	DENSITY	CONCENTRATION	CONTINUITY
Andalucía	0.2038	-0.0608	-0.6840	-0.1290	-0.1257	-0.1208
Aragón	0.7660	0.9549	1.2601	-0.2350	1.0763	-0.4999
Asturias	0.8898	0.6129	-0.6160	-0.3972	0.4798	-0.1319
Illes Balears	-0.7945	-0.7972	-0.4079	-0.2947	-0.9834	-0.2962
Canarias	-1.3045	-0.8509	-0.6199	0.2461	-0.7522	0.1436
Cantabria	0.5404	0.6874	-0.1863	-0.0634	0.4214	0.4919
Castilla y León	0.0904	0.4763	2.3601	-0.7012	0.1393	-0.7847
Castilla-La Mancha	-0.7094	-1.0527	-0.0132	-1.1510	-0.7491	-0.7466
Cataluña	1.2014	0.8745	-0.9095	1.7996	0.7460	1.4120
Comunidad Valenciana	0.3536	0.1008	-0.9566	0.1510	0.0015	0.4087
Extremadura	-0.6131	-1.2440	0.0288	-1.2051	-1.3846	-0.5751
Galicia	-0.6672	-0.9495	0.1659	-0.5005	-0.7183	-0.1712
Madrid	2.4075	2.2136	-0.3914	1.8359	1.1975	2.9308
Murcia	-0.1352	-0.6080	-1.4155	-1.0446	-0.6972	-0.0621
Navarra	-0.5267	-0.6323	0.0774	0.6736	0.0838	-0.9212
País Vasco	0.1442	0.2788	-0.0830	1.1467	0.5701	0.0171
Rioja	-0.9614	0.0939	1.3066	-0.1115	1.1589	-0.7027

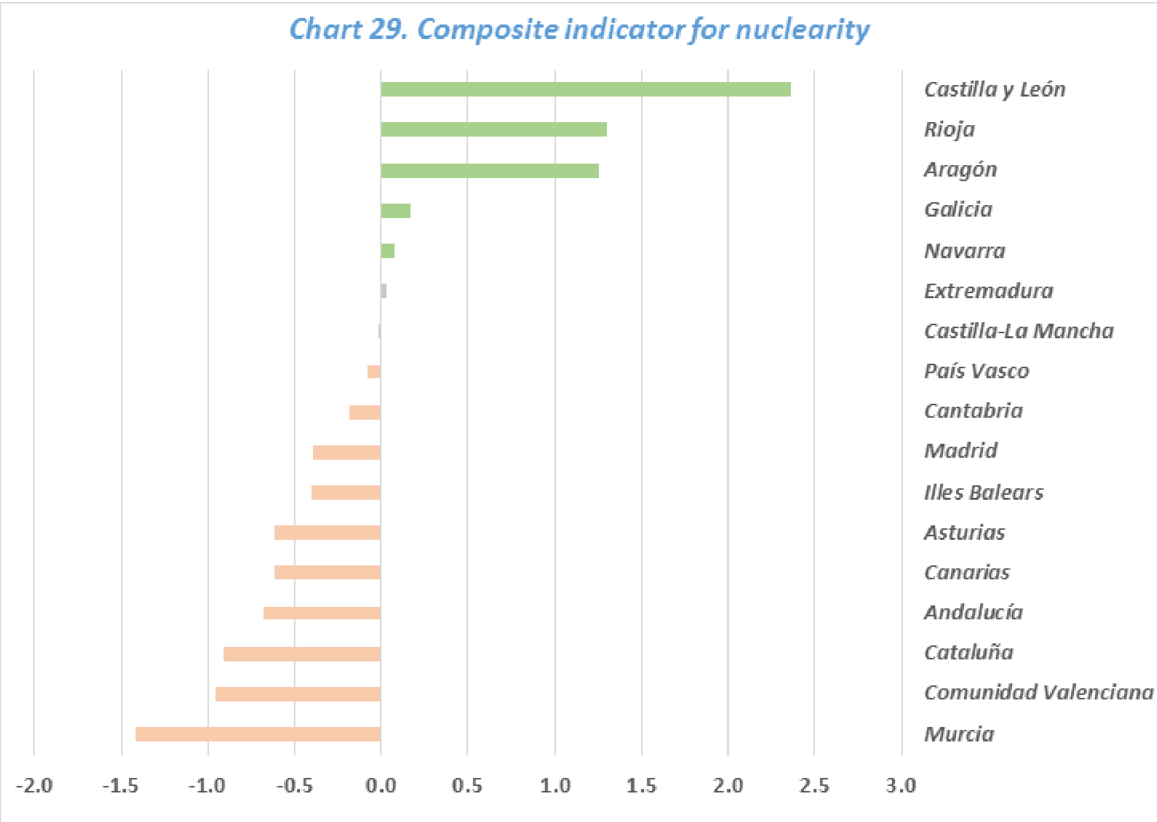
Source: Author's own work based on Table 39.
Note: Please note that composite indicators have been calculated with typified data (*zscores*).



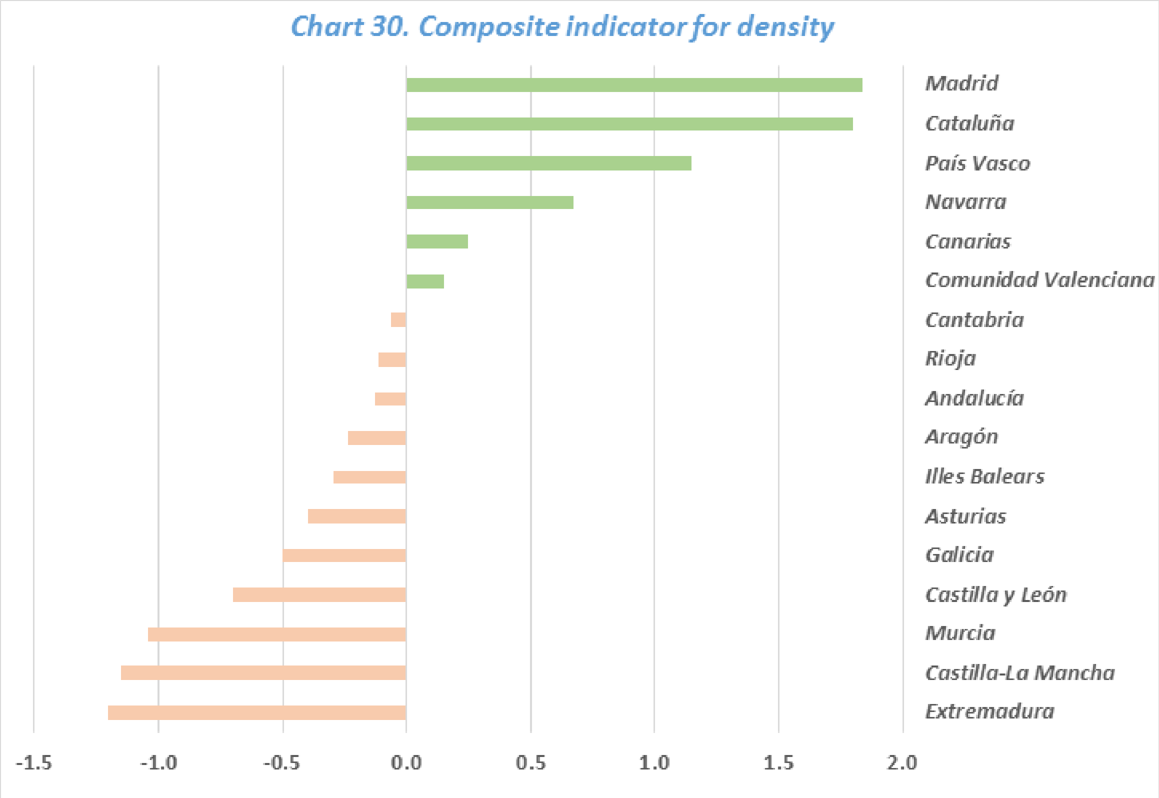
Source: Author's own work based on Table 40.



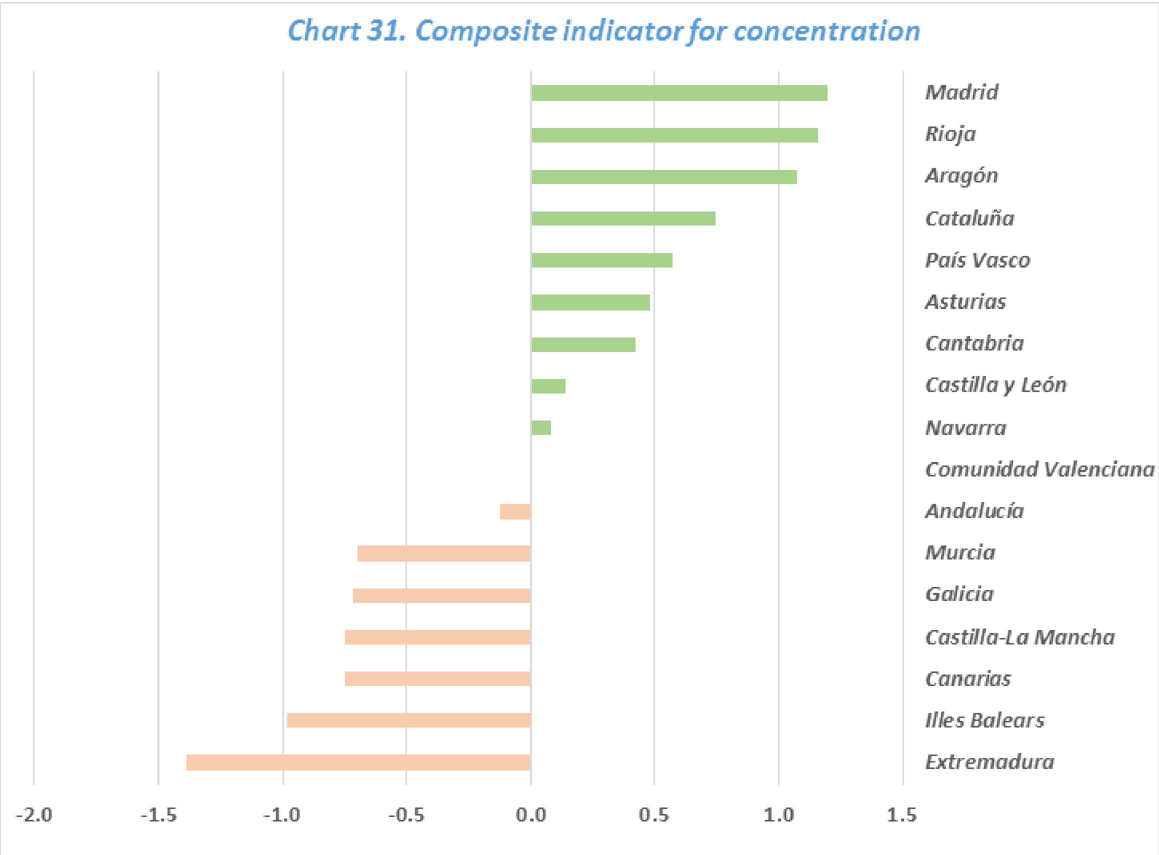
Source: Author's own work based on Table 40.



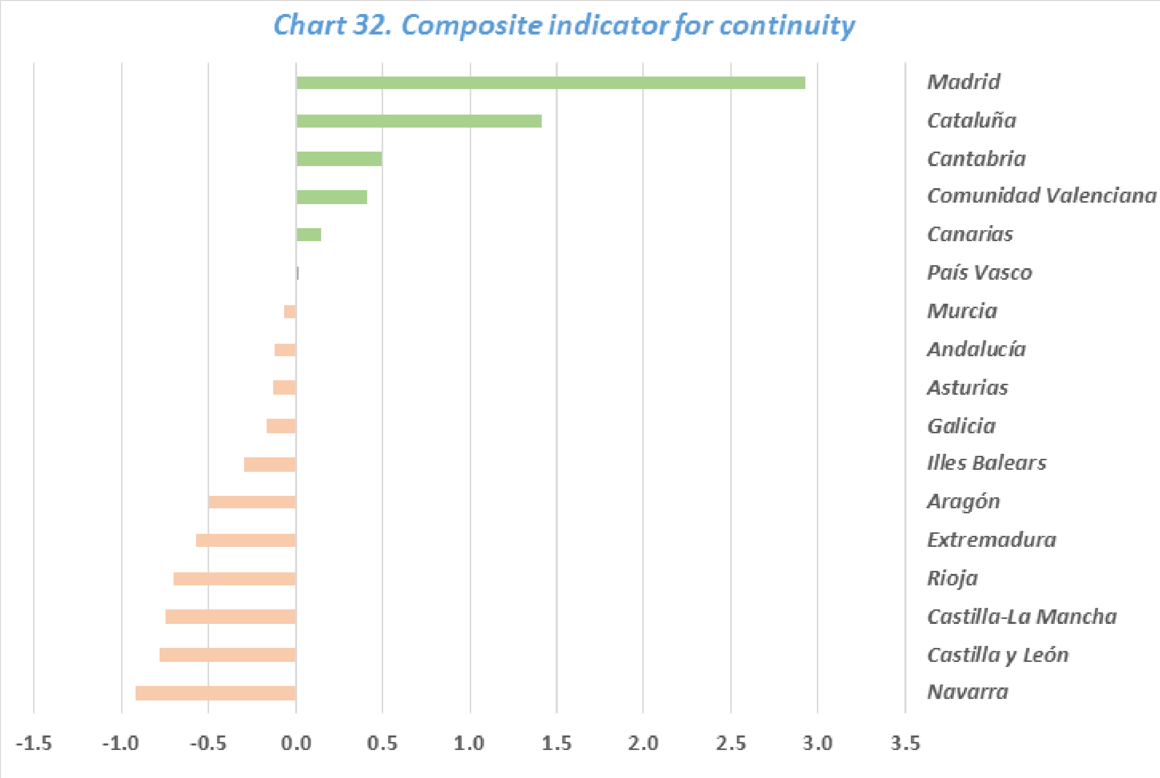
Source: Author's own work based on Table 40.



Source: Author's own work based on Table 40.



Source: Author's own work based on Table 40.



Source: Author's own work based on Table 40.

○ ***Weighting dimensions to build one composite indicator for population dispersion***

As a next step, we calculated a composite indicator for population dispersion based on the composite indicators for its dimensions. We calculated the weights in order to aggregate the dimension using PCA/FA.

We followed the same procedure in order to calculate the composite indicators for each dimension. Thus, once again, the first action was to check the correlation structure of the data. In Table 41, we present the correlation matrices of the dimensions' composite indicators. We observe that the correlations between dimensions are generally high pointing to the existence of common latten factors.

Table 41. Correlations between composite indicators of population dispersion

CORRELATIONS	*PROXIMITY*	*CENTRALITY*	*NUCLEARITY*	*DENSITY*	*CONCENTRATION*	*CONTINUITY*
PROXIMITY	1					
CENTRALITY	0.90	1				
NUCLEARITY	-0.22	0.03	1			
DENSITY	0.62	0.69	-0.21	1		
CONCENTRATION	0.66	0.86	0.22	0.67	1	
CONTINUITY	0.80	0.73	-0.45	0.73	0.44	1

Source: Author's own work.

Concerning the composite indicator of population dispersion, we have extracted with PCA/FA as many principal components (latent factors) as dimensions (λ>0). We could explain more than 85% of the information embedded within the dimension's indicators with the first two principal components. Nonetheless, considering that we worked with six indicators and our main goal was building dimension weights to create a composite indicator, retained all the principal components. We present the factor loadings in Table 42. The data for the dimension weights based on principal components analysis are in Table 43.

Table 42. Factor loadings of population dispersion's latent factor (Based on principal components)

Indicator	*Factor loadings*					
Proximity	0.898	0.327	0.235	-0.146	0.086	-0.050
Centrality	0.715	0.571	0.299	0.068	0.194	0.177
Nuclearity	-0.091	0.122	-0.098	0.981	-0.073	0.003
Density	0.299	0.345	0.870	-0.137	0.131	0.010
Concentration	0.368	0.848	0.328	0.191	0.038	-0.022
Continuity	0.620	0.126	0.436	-0.331	0.547	0.011

Source: Author's own work based on the database of dimension's composite indicators, using SPSS.
Extraction method: Principal component analysis.
Rotation method: Varimax normalization with Kaiser.

Table 43. Dimension weights based on principal components analysis

Indicator	*WEIGHTS*
Proximity	**0.1605**
Centrality	**0.1804**
Nuclearity	**0.1915**
Density	**0.1506**
Concentration	**0.1431**
Continuity	**0.1739**

Source: Author's own work based on Table 42.

○ *Aggregating dimensions to build one composite indicator for population dispersion*

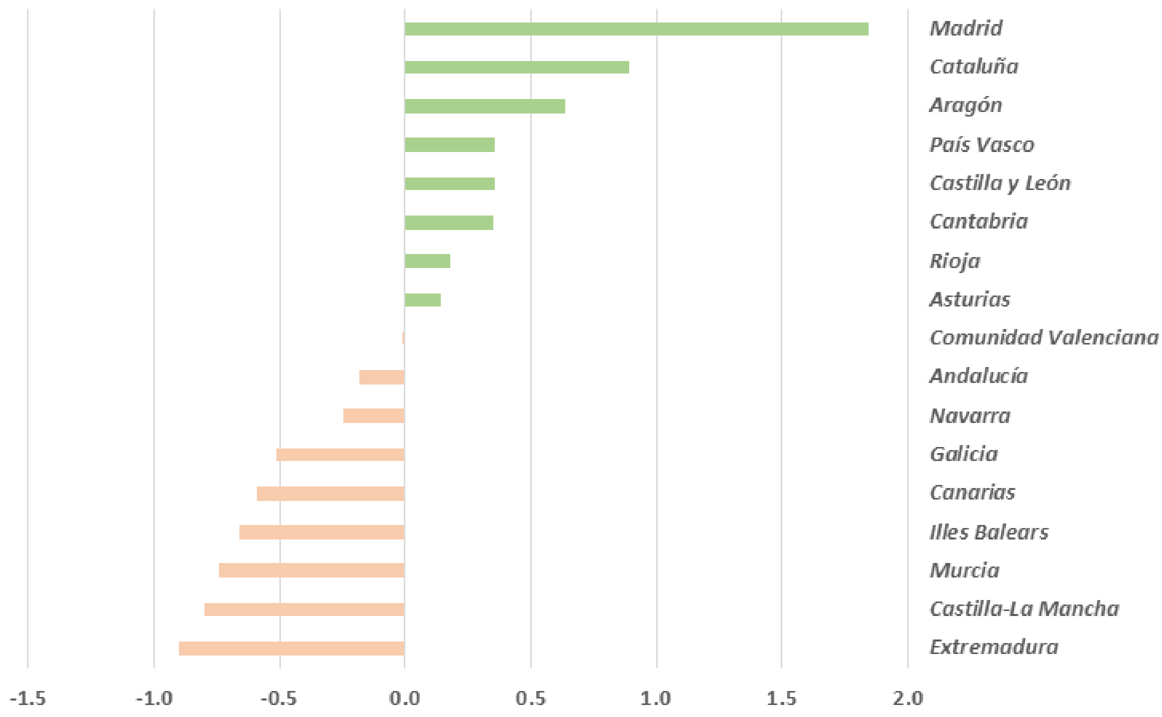
In Table 44, we present the composite indicator for population dispersion in 2016 by regions. Chart 33 shows the corresponding regional rankings.

Table 44. Composite indicator for population dispersion in 2016 (*zscores-based*)

POPULATION DISPERSION COMPOSITE INDICATOR	
Andalucía	-0.1847
Aragón	0.6387
Asturias	0.1422
Illes Balears	-0.6600
Canarias	-0.5879
Cantabria	0.3486
Castilla y León	0.3552
Castilla-La Mancha	-0.7993
Cataluña	0.8935
Comunidad Valenciana	-0.0131
Extremadura	-0.9015
Galicia	-0.5116
Madrid	1.8486
Murcia	-0.7448
Navarra	-0.2481
País Vasco	0.3580
Rioja	0.1765

Source: Author's own work based on Table 43.
Note: Please note that composite indicators have been calculated with typified data (*zscores*).

Chart 33. Composite indicator for population dispersion



Source: Author's own work based on Table 44.

Sensitivity analysis (step 7)

We used sensitivity analysis to assess the robustness of composite indicators. To develop sensitivity analysis, potential sources of uncertainty should be addressed. The approach taken to assess uncertainties could include the following points: *Selection of individual indicators, data quality, normalisation, weighting and aggregation method.* Sufficient attention has been paid to the two first points throughout the document and we believe that they do not represent a relevant source of uncertainty. Concerning the other three, we think that normalisation using "*zscores"* and aggregation using the indicators' weighted sum, besides being widely used, provide an intuitive interpretation. Therefore, for the sake of parsimony, we focused the sensitivity analysis on controlling by the uncertainty behind the different extraction methods.

The statistical software used provides different methods for extracting factors and each of them depends on the value of the indicated eigenvalue (λ) indicated. We have run all the available methods indicating two values: $\lambda = 0$ and $\lambda = 1$. We present a summary of the methods that have converged and resulted in valid factor loadings and ultimately factor weights in Figure 8. Regardless of the extraction method, we have used the factor loadings to calculate the indicator weights with the same criteria that were employed for principal components. The corresponding weights are in Tables 45 to 51. They show that our weight estimates would be robust. In addition, they show that the proposed solution for weighting components is not far from the option of "*equal weights.*" Even more, as for nuclearity and continuity, it is precisely the only solution. It seems that the highest inter-weight variability, depending on the extraction method, lies in concentration indicators.

We have found three extraction methods that converge for all the dimensions. They also converge for dispersion itself. They are shown in Figure 9.

Figure 9. Converging factor extraction methods

Principal components analysis ($\lambda > 0$) (Base case)
Principal components analysis ($\lambda > 1$) (Simulation 1)
Image factorization ($\lambda > 1$) (Simulation 2)

In addition to the base case for the dispersion dimensions composite indicators presented in Table 40, and the base case for the population dispersion composite indicator presented in table 44, we have built two more sets of composite indicators based on the weights derived from the extraction methods indicated in Figure 9. We present them in Tables 52 to 54. Our results point out that we obtain composite indicators for population dispersion that change little or very little depending on the method for extracting factors we had considered. Indeed:

1. The rankings of regions are stable or with negligible differences.
2. The shares of resource needs derived from the rankings are similar, with differences in absolute value ranging between 0.001 p.p. and 0.6 p.p.

We thus conclude that the weights determined with PCA/FA are suitable for the purpose of building composite indicators of the dispersion dimensions and the population dispersion.

Figure 8. Methods of factor extraction that converged

PROXIMITY	CENTRALITY	NUCLEARITY	DENSITY	CONCENTRATION	CONTINUITY	POPULATION DISPERSION
Principal components analysis (λ = 0; 3)	*Principal components analysis (λ = 0; 3)*	*Principal components analysis (λ = 0; 2)*	*Principal components analysis (λ = 0; 4)*	*Principal components analysis (λ = 0; 8)*	*Principal components analysis (λ = 0; 2)*	*Principal components analysis (λ > 0; 6)*
Principal components analysis (λ = 1; 1)	*Principal components analysis (λ = 1; 1)*	*Principal components analysis (λ = 1; 1)*	*Principal components analysis (λ = 1; 1)*	*Principal components analysis (λ = 1; 3)*	*Principal components analysis (λ = 1; 1)*	*Principal components analysis (l > 1; 2)*
—	—	—	—	—	—	—
Unweighted least squares (λ = 1; 1)	*Unweighted least squares (λ = 1; 1)*	—	*Unweighted least squares (λ = 1; 1)*	*Unweighted least squares (λ = 1; 3)*	—	*Unweighted least squares (l > 1; 2)*
—	—	—	—	*Generalised least squares (λ = 0; 7)*	—	—
Generalised least squares (λ = 1; 1)	*Generalised least squares (λ = 1; 1)*	—	*Generalised least squares (λ = 1; 1)*	*Generalised least squares (λ = 1; 3)*	—	*Generalised least squares (l > 1; 2)*
—	—	—	—	—	—	—
Maximum likelihood (λ = 1; 1)	*Maximum likelihood (λ = 1; 1)*	—	*Maximum likelihood (λ = 1; 1)*	*Maximum likelihood (λ = 1; 3)*	—	*Maximum likelihood (l > 1; 2)*
Principal axes factorization (λ = 0; 2)	*Principal axes factorization (λ = 0; 2)*	—	*Principal axes factorization (λ = 0; 3)*	—	—	—
Principal axes factorization (λ = 1; 1)	*Principal axes factorization (λ = 1; 1)*	*Principal axes factorization (λ = 1; 1)*	*Principal axes factorization (λ = 1; 1)*	—	*Principal axes factorization (λ = 1; 1)*	*Principal axes factorization (l > 1; 2)*
Alpha factorization (λ = 0; 2)	*Alpha factorization (λ = 0; 2)*	—	*Alpha factorization (λ = 0; 3)*	—	—	—
Alpha factorization (λ = 1; 1)	*Alpha factorization (λ = 1; 1)*	*Alpha factorization (λ = 1; 1)*	*Alpha factorization (λ = 1; 1)*	—	*Alpha factorization (λ = 1; 1)*	*Alpha factorization (l > 1; 2)*
Image factorization (λ = 0; 2)	*Image factorization (λ = 0; 2)*	—	*Image factorization (λ = 0; 3)*	*Image factorization (λ = 0; 7)*	—	*Image factorization (l > 0; 5)*
Image factorization (λ = 1; 1)	*Image factorization (λ = 1; 1)*	*Image factorization (λ = 1; 1)*	*Image factorization (λ = 1; 1)*	*Image factorization (λ = 1; 3)*	*Image factorization (λ = 1; 1)*	*Image factorization (l > 1; 2)*

Source: Author's own work based on SPSS statistical software. For each method, we have run the procedure indicating to the system to extract those factors associated to eigenvalues both greater than 0 and greater than 1. In brackets, the minimum value for the eigenvalue and the number of factors extracted. In the table, we present the methods with convergent solutions. In light blue shadow, the method with convergent solutions for all the dimensions. We have used the three of them for the simulations.

Table 45. PROXIMITY Indicators and their weights by method of factor extraction

Method of factor extraction	Indicator weights		
	$PROXR_{SE1h}$	$PROXN_{SE1m}$	$PROXV_{MUN2o}$
Principal components analysis (λ>0; 3)	**0.3336**	**0.3329**	**0.3335**
Principal components analysis (λ>1; 1)	0.3393	0.3379	0.3228
Unweighted least squares (λ>1; 1)	0.3499	0.3460	0.3041
Generalised least squares (λ>1; 1)	0.3506	0.3460	0.3034
Maximum likelihood (λ>1; 1)	0.3499	0.3460	0.3041
Principal axes factorization (λ>0; 2)	0.3424	0.3416	0.3160
Principal axes factorization (λ>1; 1)	0.3496	0.3457	0.3046
Alpha factorization (λ>0; 2)	0.3436	0.3428	0.3136
Alpha factorization (λ>1; 1)	0.3499	0.3460	0.3041
Image factorization (λ>0; 2)	0.3415	0.3397	0.3188
Image factorization (λ>1; 1)	0.3448	0.3423	0.3128

Source: Author's own work based on the database of dispersion indicators by Region and year, using SPSS. In brackets, the number of factors extracted. For each method we have run the procedure indicating the system to extract those factors associated to eigenvalues both greater than 0 and greater than 1. In the table, we present the results of the convergent solutions. In green, the method that we have finally used to build our composite indicator. In light blue, the method used for the simulations.

Table 46. CENTRALITY Indicators and their weights by method of factor extraction

Method of factor extraction	Indicator weights		
	$CBDdR_{SE3h}$	$CBDdN_{SE3m}$	$CBDdACI_{MUN4o}$
Principal components analysis (λ>0; 3)	***0.3334***	***0.3331***	***0.3334***
Principal components analysis (λ>1; 1)	0.3500	0.3190	0.3311
Unweighted least squares (λ>1; 1)	0.3866	0.2909	0.3225
Generalised least squares (λ>1; 1)	0.3872	0.2906	0.3222
Maximum likelihood (λ>1; 1)	0.3872	0.2906	0.3222
Principal axes factorization (λ>0; 2)	0.3699	0.3006	0.3295
Principal axes factorization (λ>1; 1)	0.3861	0.2911	0.3228
Alpha factorization (λ>0; 2)	0.3736	0.2977	0.3287
Alpha factorization (λ>1; 1)	0.3861	0.2911	0.3228
Image factorization (λ>0; 2)	0.3596	0.3066	0.3338
Image factorization (λ>1; 1)	0.3615	0.3050	0.3335

Source: Author's own work based on the database of dispersion indicators by Region and year, using SPSS. In brackets, the number of factors extracted. For each method we have run the procedure indicating the system to extract those factors associated to eigenvalues both greater than 0 and greater than 1. In the table, we present the results of the convergent solutions. In green, the method that we have finally used to build our composite indicator. In light blue, the method used for the simulations.

Table 47. NUCLEARITY Indicators and their weights by method of factor extraction

Method of factor extraction	Indicator weights	
	$NUNoN_{SE5a}$	$NUSoP_{SE5b}$
Principal components analysis (λ>0; 2)	**0.5000**	**0.5000**
Principal components analysis (λ>1; 1)	0.5000	0.5000
Principal axes factorization (λ>1; 1)	0.5000	0.5000
Alpha factorization (λ>1; 1)	0.5000	0.5000
Image factorization (λ>1; 1)	0.5000	0.5000

Source: Author's own work based on the database of dispersion indicators by Region and year, using SPSS. In brackets, the number of factors extracted. For each method we have run the procedure indicating the system to extract those factors associated to eigenvalues both greater than 0 and greater than 1. In the table, we present the results of the convergent solutions. In green, the method that we have finally used to build our composite indicator. In light blue, the method used for the simulations.

Table 48. DENSITY Indicators and their weights by method of factor extraction

Method of factor extraction	Indicator weights			
	DEPWD_MUN7a	DEPWD_MUN7c	DENHIGH_MUN7j	DENHIGH_MUN7l
Principal components analysis (λ>0; 4)	**0.2527**	**0.2772**	**0.2360**	**0.2341**
Principal components analysis (λ>1; 1)	0.2537	0.2723	0.2520	0.2220
Unweighted least squares (λ>1; 1)	0.2556	0.2944	0.2504	0.1996
Generalised least squares (λ>1; 1)	0.2635	0.2793	0.2465	0.2106
Maximum likelihood (λ>1; 1)	0.2724	0.2665	0.2653	0.1958
Principal axes factorization (λ>0; 3)	0.2326	0.2922	0.2652	0.2100
Principal axes factorization (λ>1; 1)	0.2554	0.2943	0.2508	0.1995
Alpha factorization (λ>0; 3)	0.2330	0.2963	0.2649	0.2059
Alpha factorization (λ>1; 1)	0.2521	0.3031	0.2498	0.1951
Image factorization (λ>0; 3)	0.2330	0.2963	0.2649	0.2059
Image factorization (λ>1; 1)	0.2592	0.2762	0.2509	0.2137

Source: Author's own work based on the database of dispersion indicators by Region and year, using SPSS. In brackets, the number of factors extracted. For each method we have run the procedure indicating the system to extract those factors associated to eigenvalues both greater than 0 and greater than 1. In the table, we present the results of the convergent solutions. In green, the method that we have finally used to build our composite indicator. In light blue, the method used for the simulations.

Table 49. CONCENTRATION Indicators and their weights by method of factor extraction

Method of factor extraction	Indicator weights							
	CNGINI_SE8a	CNSTHEI_SE8b	CNHGD_MUN9b	CNPDG_MUN9c	CNTHI_MUN9g	CNEG_MUN9j	CNDI_MUN9k	CNMDDI_MUN9m
Principal components analysis (λ>0; 8)	***0.0789***	***0.1468***	***0.1201***	***0.1286***	***0.1398***	***0.1517***	***0.0966***	***0.1375***
Principal components analysis (λ>1; 3)	0.1045	0.1421	0.1153	0.1337	0.1391	0.1399	0.0810	0.1445
Unweighted least squares (λ>1; 3)	0.1058	0.1608	0.0990	0.0781	0.1411	0.1173	0.1607	0.1371
Generalised least squares (λ>0; 7)	0.0885	0.1401	0.1196	0.1293	0.1527	0.1386	0.0909	0.1403
Generalised least squares (λ>1; 3)	0.1435	0.1566	0.0917	0.0725	0.1543	0.1229	0.1270	0.1315
Maximum likelihood (λ>1; 3)	0.1423	0.1586	0.0912	0.0720	0.1562	0.1248	0.1248	0.1301
Image factorization (λ>0; 7)	0.1442	0.1434	0.0373	0.1161	0.1467	0.1260	0.1632	0.1231
Image factorization (λ>1; 3)	0.1432	0.1402	0.0753	0.0996	0.1411	0.1243	0.1598	0.1163

Source: Author's own work based on the database of dispersion indicators by Region and year, using SPSS. In brackets, the number of factors extracted. For each method we have run the procedure indicating the system to extract those factors associated to eigenvalues both greater than 0 and greater than 1. In the table, we present the results of the convergent solutions. In green, the method that we have finally used to build our composite indicator. In light blue, the method used for the simulations.

Table 50. CONTINUITY Indicators and their weights by method of factor extraction

Method of factor extraction	Indicator weights	
	CNTRUT_PROV10b	CNTR2_PROV10c
Principal components analysis (λ>0; 2)	***0.5000***	***0.5000***
Principal components analysis (λ>1; 1)	0.5000	0.5000
Principal axes factorization (λ>1; 1)	0.5000	0.5000
Alpha factorization (λ>1; 1)	0.5000	0.5000
Image factorization (λ>1; 1)	0.5000	0.5000

Source: Author's own work based on the database of dispersion indicators by Region and year, using SPSS. In brackets, the number of factors extracted. For each method we have run the procedure indicating the system to extract those factors associated to eigenvalues both greater than 0 and greater than 1. In the table, we present the results of the convergent solutions. In green, the method that we have finally used to build our composite indicator. In light blue, the method used for the simulations.

Table 51. DIMENSIONS Indicators and their weights by method of factor extraction

Method of factor extraction	Indicators' Weights					
	Proximity	*Centrality*	*Nuclearity*	*Density*	*Concentration*	*Continuity*
Principal components analysis (λ>0; 6)	***0.1605***	***0.1804***	***0.1915***	***0.1506***	***0.1431***	***0.1739***
Principal components analysis (λ>1; 2)	0.1584	0.1901	0.1847	0.1324	0.1569	0.1775
Unweighted least squares (λ>1; 2)	0.1548	0.2176	0.1171	0.1168	0.1818	0.2119
Generalised least squares (λ>1; 2)	0.1659	0.2155	0.1088	0.1249	0.1712	0.2137
Maximum likelihood (λ>1; 2)	0.1786	0.2210	0.1196	0.1054	0.1642	0.2112
Principal axes factorisation (λ>1; 2)	0.1551	0.2179	0.1183	0.1167	0.1810	0.2109
Alpha (λ>1; 2)	0.1501	0.2179	0.1223	0.1155	0.1858	0.2083
Image factorization (λ>0; 5)	0.1750	0.2088	0.1110	0.1484	0.1714	0.1853
Image factorization (λ>1; 2)	0.1780	0.2129	0.1073	0.1215	0.1920	0.1882

Source: Author's own work based on the database of dispersion indicators by Region and year, using SPSS. In brackets, the number of factors extracted. For each method we have run the procedure indicating the system to extract those factors associated to eigenvalues both greater than 0 and greater than 1. In the table, we present the results of the convergent solutions. In green, the method that we have finally used to build our composite indicator. In light blue, the method used for the simulations.

Table 52. Composite indicators for the six dispersion dimensions in 2016 (zscores-based) Simulation 1.

REGION	PROXIMITY	CENTRALITY	NUCLEARITY	DENSITY	CONCENTRATION	CONTINUITY
Andalucía	0.2065	-0.0564	-0.6840	-0.1287	-0.1109	-0.1208
Aragón	0.7535	0.9523	1.2601	-0.2625	1.0374	-0.4999
Asturias	0.8887	0.5985	-0.6160	-0.4056	0.4945	-0.1319
Illes Balears	-0.7846	-0.8055	-0.4079	-0.3120	-1.0062	-0.2962
Canarias	-1.2979	-0.8344	-0.6199	0.2347	-0.7708	0.1436
Cantabria	0.5439	0.6958	-0.1863	-0.0487	0.4263	0.4919
Castilla y León	0.0863	0.4758	2.3601	-0.6942	0.1163	-0.7847
Castilla-La Mancha	-0.7116	-1.0514	-0.0132	-1.1452	-0.7452	-0.7466
Cataluña	1.2094	0.8784	-0.9095	1.8048	0.7753	1.4120
Comunidad Valenciana	0.3570	0.0964	-0.9566	0.1523	0.0079	0.4087
Extremadura	-0.6076	-1.2329	0.0288	-1.1973	-1.3926	-0.5751
Galicia	-0.6634	-0.9451	0.1659	-0.4863	-0.7199	-0.1712
Madrid	2.4073	2.2163	-0.3914	1.8420	1.2191	2.9308
Murcia	-0.1342	-0.6197	-1.4155	-1.0367	-0.6582	-0.0621
Navarra	-0.5336	-0.6515	0.0774	0.6861	0.0880	-0.9212
País Vasco	0.1463	0.2749	-0.0830	1.1458	0.5753	0.0171
Rioja	-0.9764	0.1000	1.3066	-0.1386	1.1468	-0.7027

Source: Author's own work based on Table 51.
Note: Please note that composite indicators have been calculated with typified data (zscores).

Table 53. Composite indicators for the six dispersion dimensions in 2016 (zscores-based) Simulation 2.

REGION	PROXIMITY	CENTRALITY	NUCLEARITY	DENSITY	CONCENTRATION	CONTINUITY
Andalucía	0.2090	-0.0520	-0.6840	-0.1293	-0.1452	-0.1208
Aragón	0.7418	0.9482	1.2601	-0.2730	1.0527	-0.4999
Asturias	0.8876	0.5881	-0.6160	-0.4096	0.5730	-0.1319
Illes Balears	-0.7756	-0.8156	-0.4079	-0.3198	-1.1089	-0.2962
Canarias	-1.2916	-0.8155	-0.6199	0.2312	-0.8181	0.1436
Cantabria	0.5473	0.7066	-0.1863	-0.0505	0.4518	0.4919
Castilla y León	0.0826	0.4728	2.3601	-0.6931	0.2196	-0.7847
Castilla-La Mancha	-0.7136	-1.0523	-0.0132	-1.1429	-0.7249	-0.7466
Cataluña	1.2168	0.8846	-0.9095	1.8181	0.8020	1.4120
Comunidad Valenciana	0.3601	0.0944	-0.9566	0.1577	-0.0164	0.4087
Extremadura	-0.6026	-1.2260	0.0288	-1.1939	-1.4418	-0.5751
Galicia	-0.6599	-0.9421	0.1659	-0.4826	-0.7197	-0.1712
Madrid	2.4071	2.2158	-0.3914	1.8382	1.1602	2.9308
Murcia	-0.1334	-0.6284	-1.4155	-1.0328	-0.6744	-0.0621
Navarra	-0.5402	-0.6673	0.0774	0.6861	0.1869	-0.9212
País Vasco	0.1482	0.2720	-0.0830	1.1454	0.5737	0.0171
Rioja	-0.9900	0.1076	1.3066	-0.1460	1.1804	-0.7027

Source: Author's own work based on Table 51.
Note: Please note that composite indicators have been calculated with typified data (zscores).

Table 54. Composite indicator for population dispersion in 2016 (zscores-based) Base case and simulations

POPULATION DISPERSION COMPOSITE INDICATOR	POPULATION DISPERSION Base case	POPULATION DISPERSION Simulation 1	POPULATION DISPERSION Simulation 2
Andalucía	-0.1847	-0.1765	-0.1270
Aragón	0.6387	0.6442	0.6135
Asturias	0.1422	0.1651	0.2872
Illes Balears	-0.6600	-0.6824	-0.7477
Canarias	-0.5879	-0.6070	-0.6393
Cantabria	0.3486	0.3717	0.4470
Castilla y León	0.3552	0.3514	0.1945
Castilla-La Mancha	-0.7993	-0.7995	-0.8575
Cataluña	0.8935	0.8974	1.0550
Comunidad Valenciana	-0.0131	-0.0061	0.0821
Extremadura	-0.9015	-0.9119	-1.0103
Galicia	-0.5116	-0.5206	-0.5928
Madrid	1.8486	1.8696	2.0508
Murcia	-0.7448	-0.7248	-0.6426
Navarra	-0.2481	-0.2722	-0.3036
País Vasco	0.3580	0.3483	0.3722
Rioja	0.1765	0.1815	0.0965

Source: Author's own work based on Tables 44, 52 and 53.
Note: Please note that composite indicators have been calculated with typified data (zscores).

De-constructing composite indicators (step 8)

De-constructing composite indicators means digging deeper into the indicators to broaden regional performance analyses. In our case, we have worked with a bottom-up approach and have analysed in advance and in depth the individual indicators that conform the composite ones for proximity, centrality, nuclearity, density, concentration and continuity.

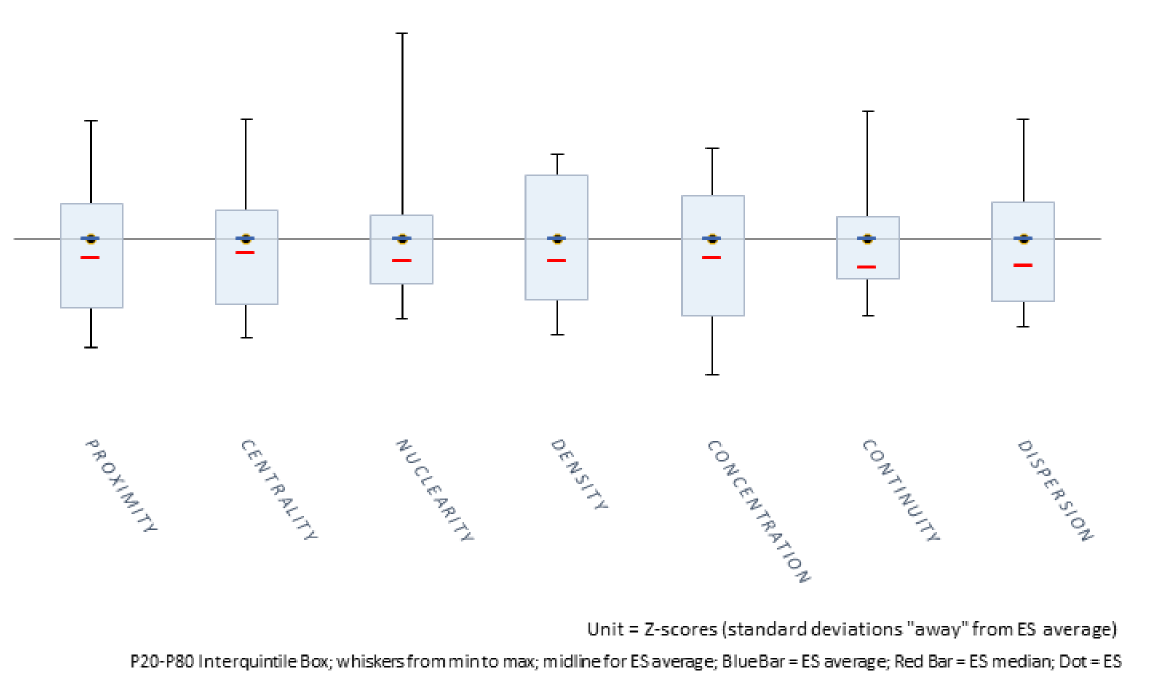
At this point, we will focus on the performance analysis of the composite indicators. As there are not standard references available against which benchmarking them, we develop our analysis based on interregional comparisons with the national average and the distribution across regions as a reference.

In Chart 34, we observe that the distribution across regions of dispersion dimensions is quite asymmetric, meaning that most of the population lives in regions with low values of proximity, centrality, nuclearity, density, concentration and continuity. This is completely coherent with the results we obtained and presented in points 2 and 3 concerning individual indicators. Our results show that the population percentage living in regions with low values (below the national average) of the composite indicator for these dimensions rages between 58% and 71%, depending on the dimension.

Regarding the composite for dispersion, considering that we have built this indicator to reflect low values when population dispersion is high, the positive asymmetric distribution means that most of the Spanish population lives in regions with high dispersion.

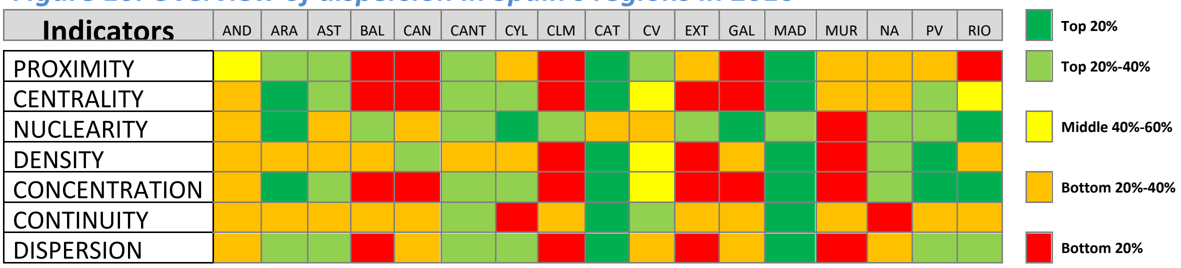
In Figure 10, we present an overview of the dispersion situation in Spain according to the distribution of the composite indicators across regions. For a given region, when the value of dispersion dimensions or the composite dispersion ranges within 20% of the distribution's bottom positions, the Region is flagged in red. On the contrary, if it ranges within 20% of the distribution's upper positions, the Region is flagged with dark green. For intermediate positions, the Region is flagged according to the legend in the figure. We can see at a glance that Andalucía, Illes Balears, Canarias, Castilla-La Mancha, Extremadura, Galicia and Murcia systematically rank among the lower positions of dispersion dimensions, thus pointing out to high levels of dispersion in these territories. Popultion dispersion and all its dimensions have a positive asymmetric distribution. Once again, in coherence with our previous analyses. The population percentage living in regions with population dispersion below the national average is 56%. Thus, population dispersion in Spain is high.

Chart 34 Spain (ES): Dispersion indicator and its dimensions 2016



Source: Author's own work.
Note: Please note that the composite indicator for dispersion have been built in such a way that the lower the indicator the greater the dispersion.

Figure 10. Overview of dispersion in Spain's regions in 2016



Source: Author's own work.

Chart 35 allows identifying the extent to which a given Region ranks above or below the national average, which is marked with the orange line in the spider web, and thus how each dimension would contribute to the overall dispersion composite indicator. The analyses derived from Chart 35 are coherent with our analyses in points 2 and 3.[43] We will revisit Chart 35 after examining the evolution of the composite indicators to provide a joint overview of their performance, including both static and dynamic considerations.

[43] Please notice that in Canarias continuity is over the average in spite of being islands, with different islands conforming one unique province. Indeed, the density gradient is well below the average. Nonetheless, the other two indicators based on the ratios urban and built-up land to total land are close or even above the average.

Chart 35. Andalucía

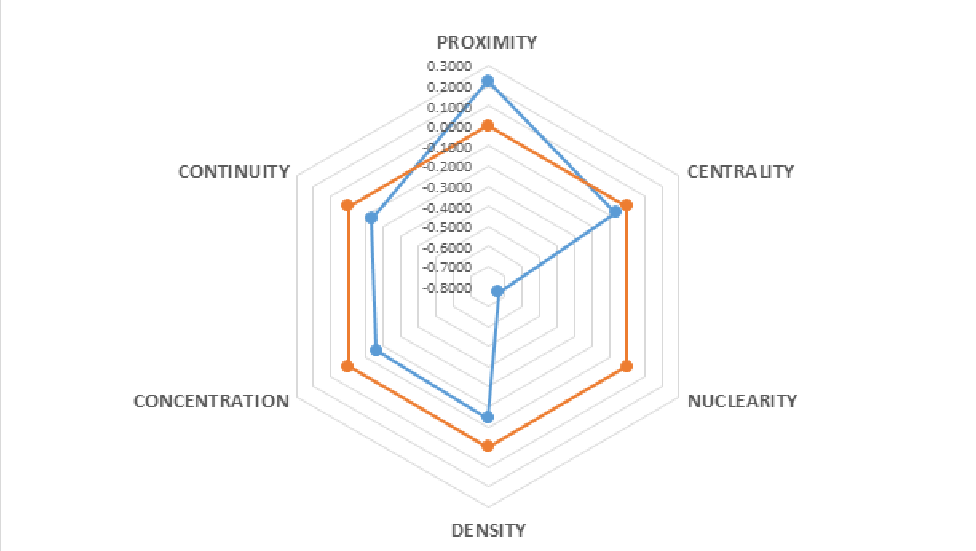
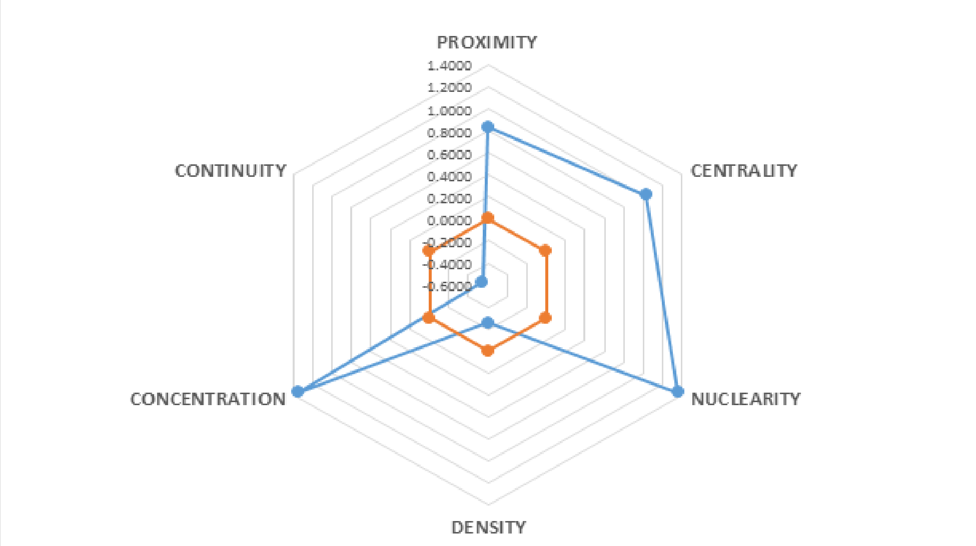


Chart 35. Aragón



Source: Author's own work.
Note: Please keep in mind that we have built composite indicators based on the original indicators' zscores. Thus, they have zero mean. National values have been calculated as population weighted averages of regional values.

Chart 35. Asturias

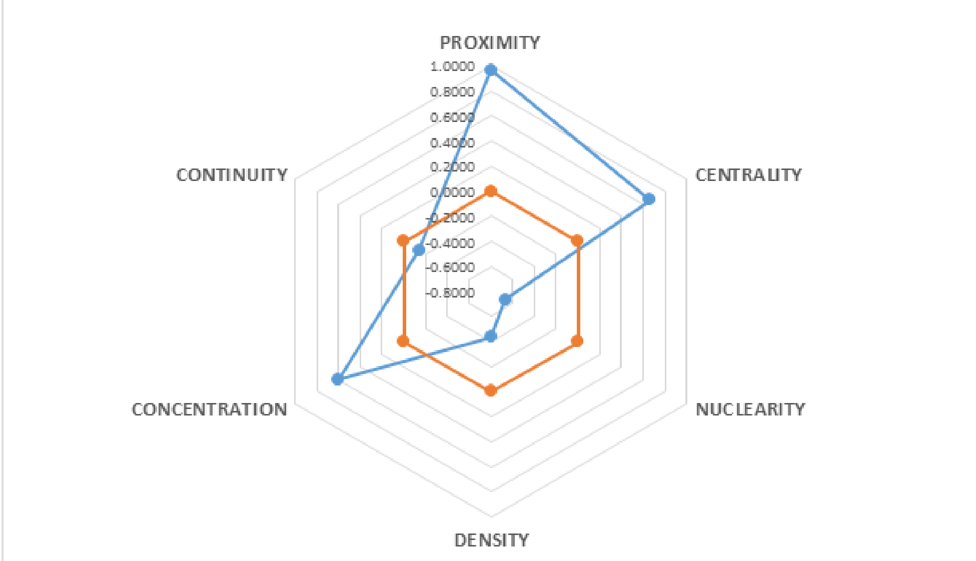


Chart 35. Illes Balears

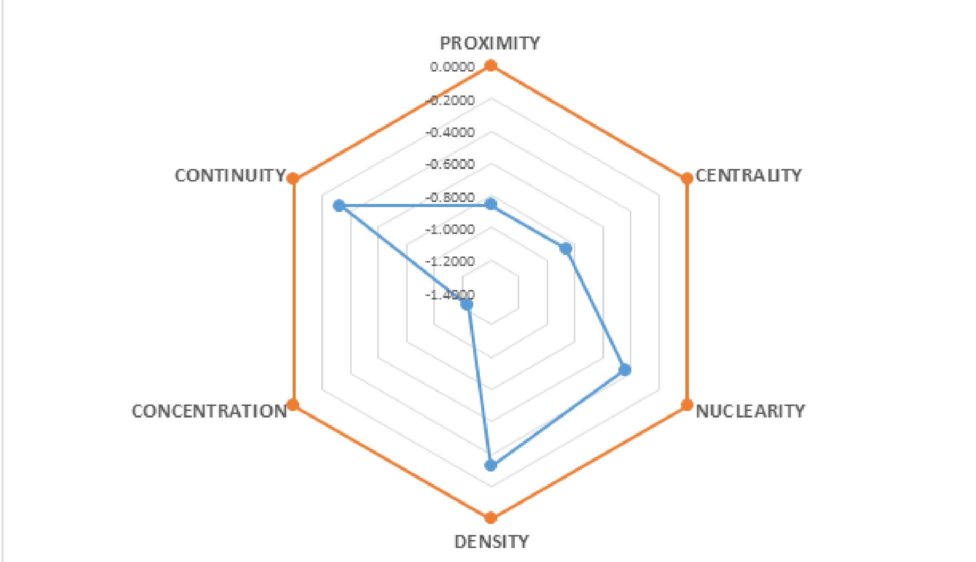


Chart 35. Canarias

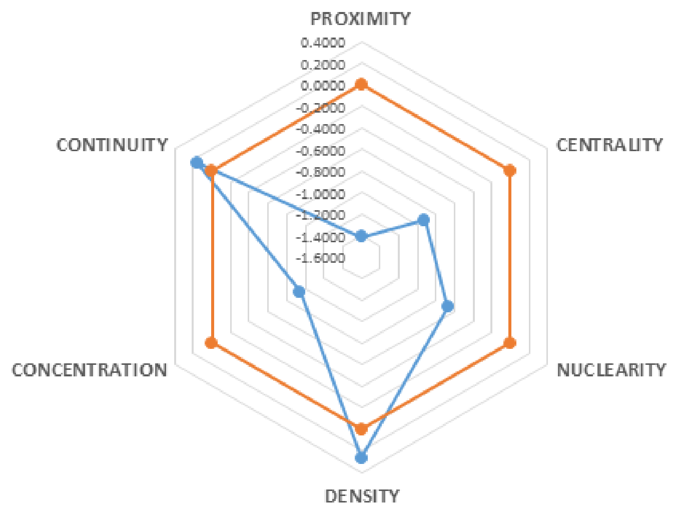


Chart 35. Castilla y León

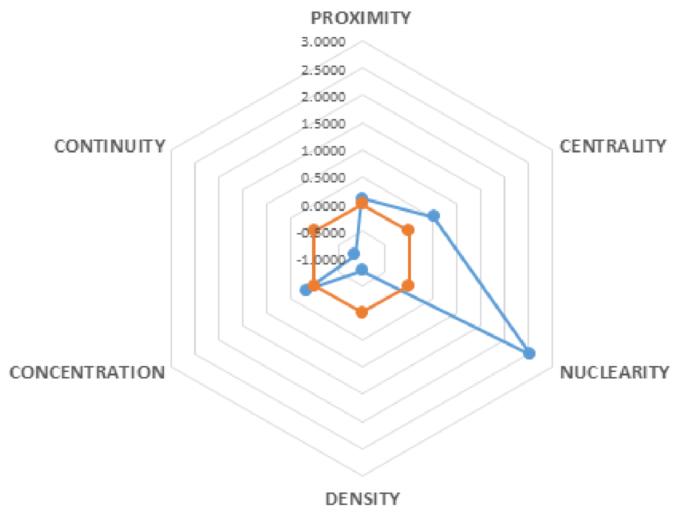


Chart 35. Cantabria

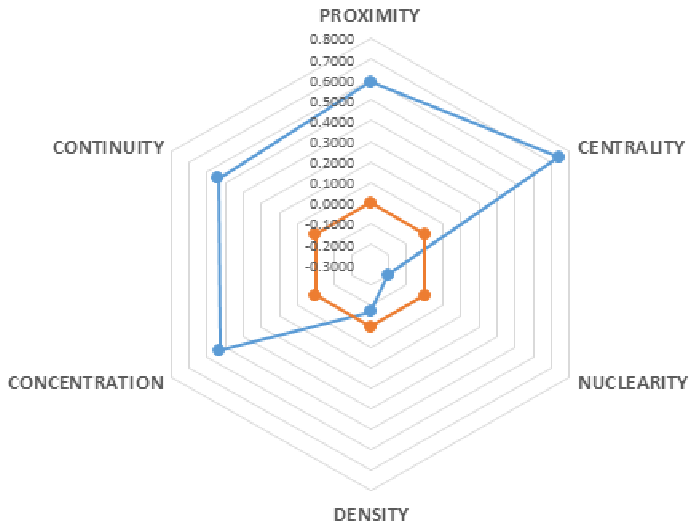
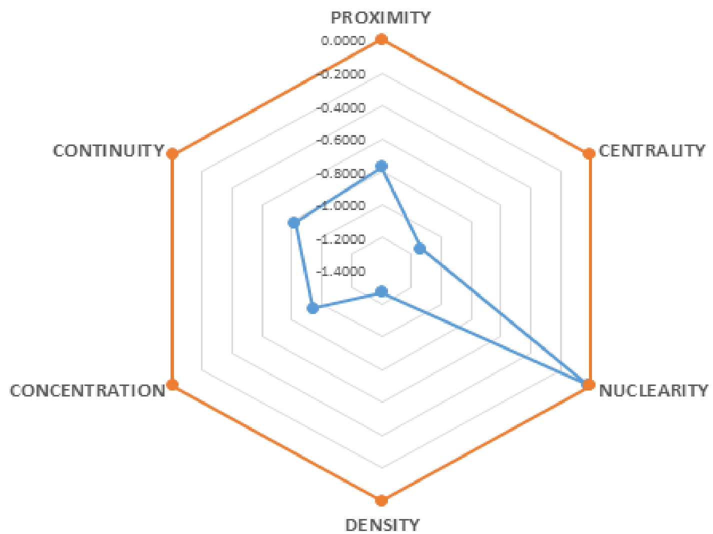


Chart 35. Castilla-La Mancha



Source: Author's own work.

Note: Please keep in mind that we have built composite indicators based on the original indicators' zscores. Thus, they have zero mean. National values have been calculated as population weighted averages of regional values.

Chart 35. Cataluña

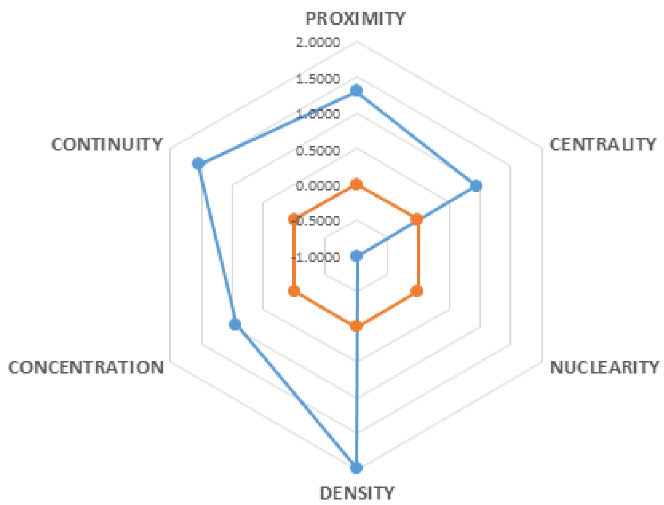


Chart 35. Extremadura

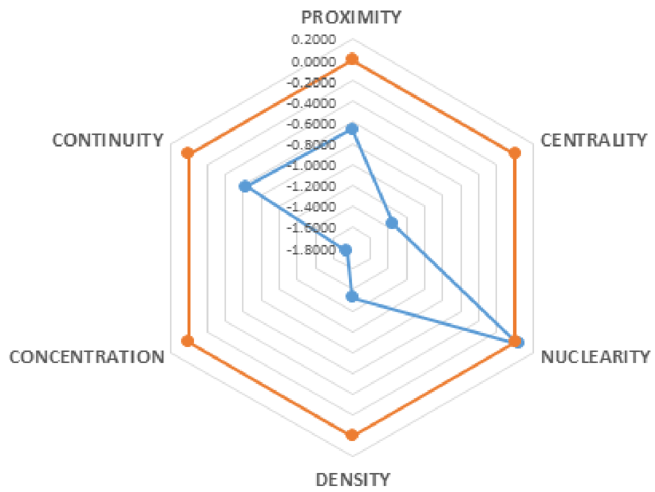


Chart 35. Comunidad Valenciana

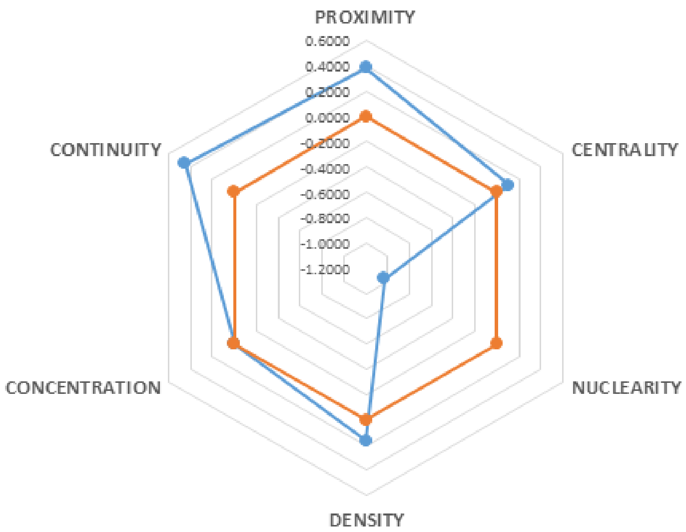
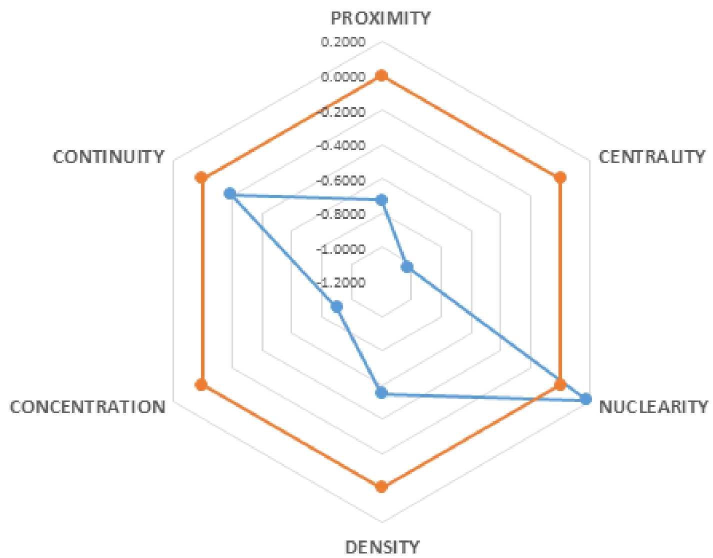


Chart 35. Galicia



Source: Author's own work.
Note: Please keep in mind that we have built composite indicators based on the original indicators' zscores. Thus, they have zero mean. National values have been calculated as population weighted averages of regional values.

Chart 35. Madrid

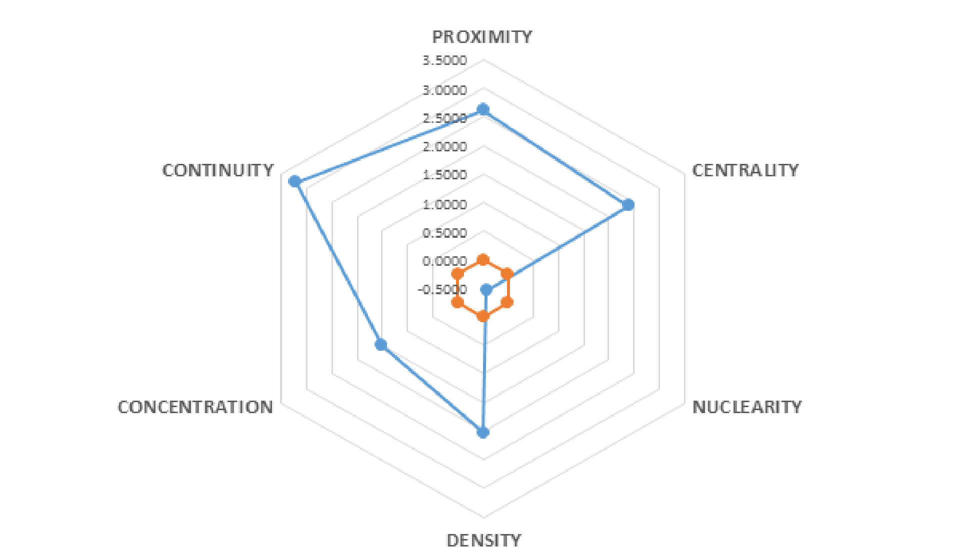


Chart 35. Navarra

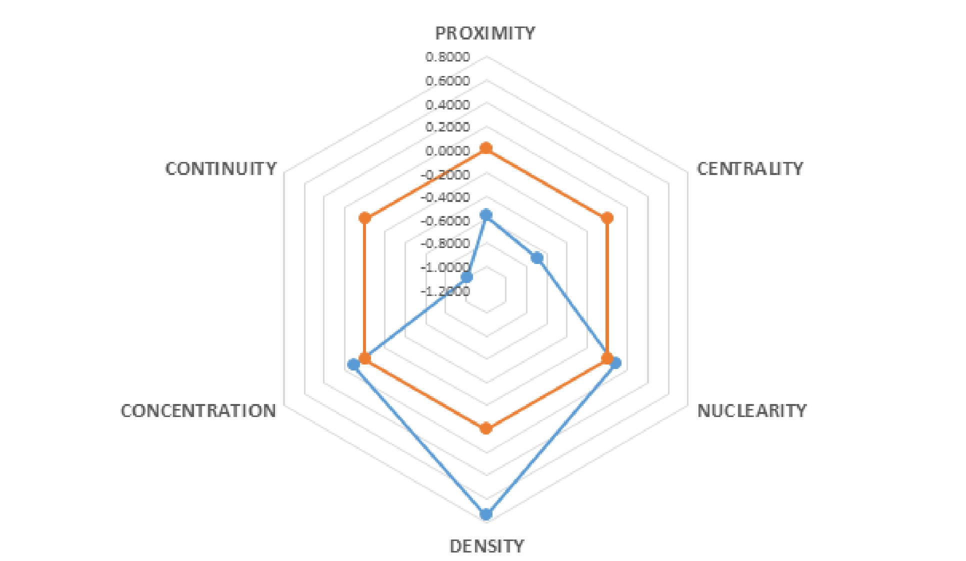


Chart 35. Murcia

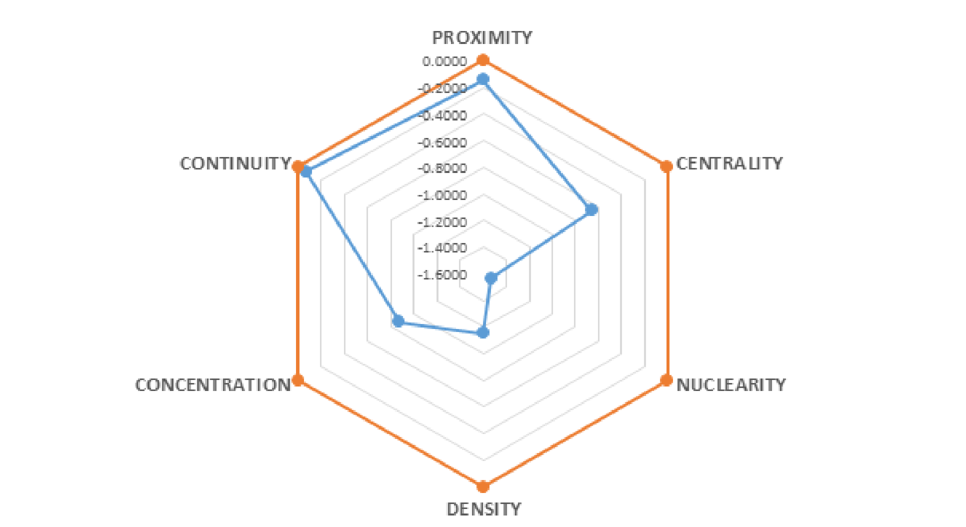
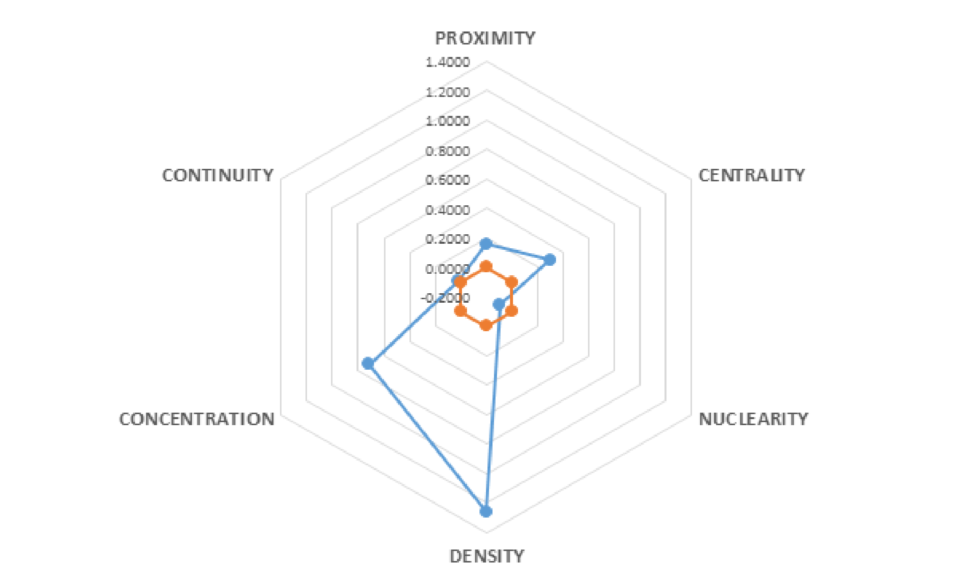
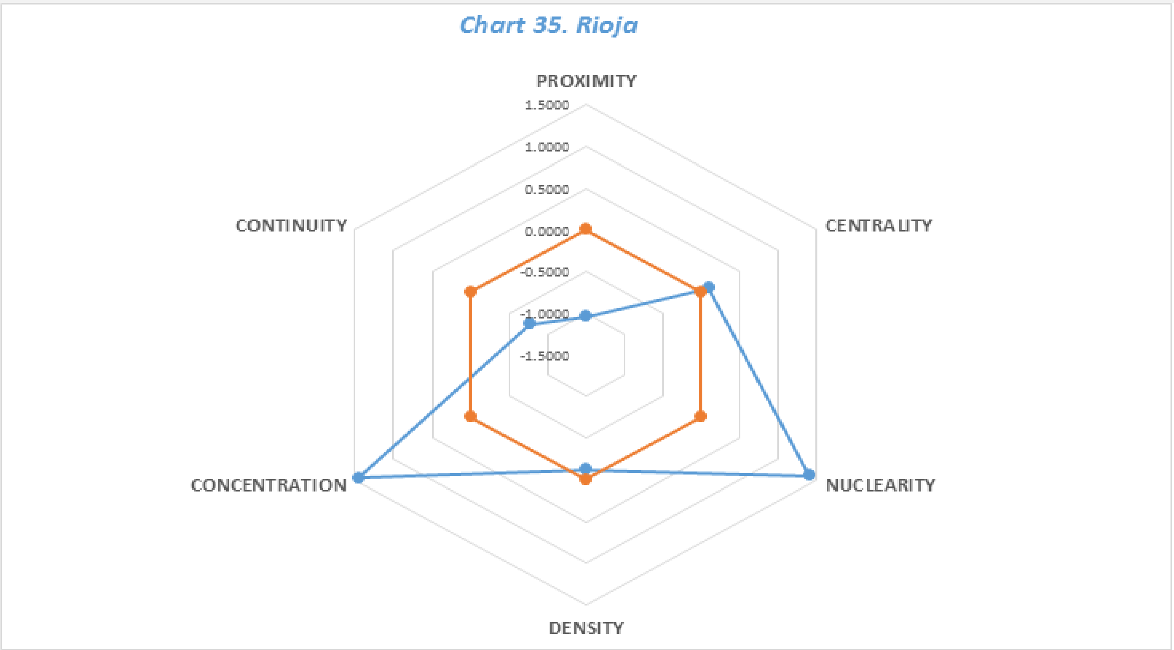


Chart 35. País Vasco



Source: Author's own work.
Note: Please keep in mind that we have built composite indicators based on the original indicators' zscores. Thus, they have zero mean. National values have been calculated as population weighted averages of regional values.

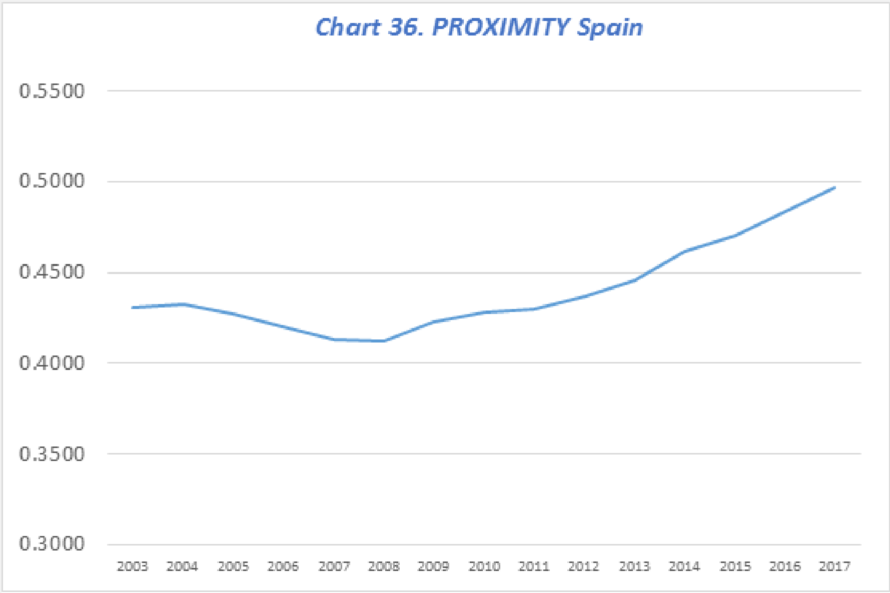


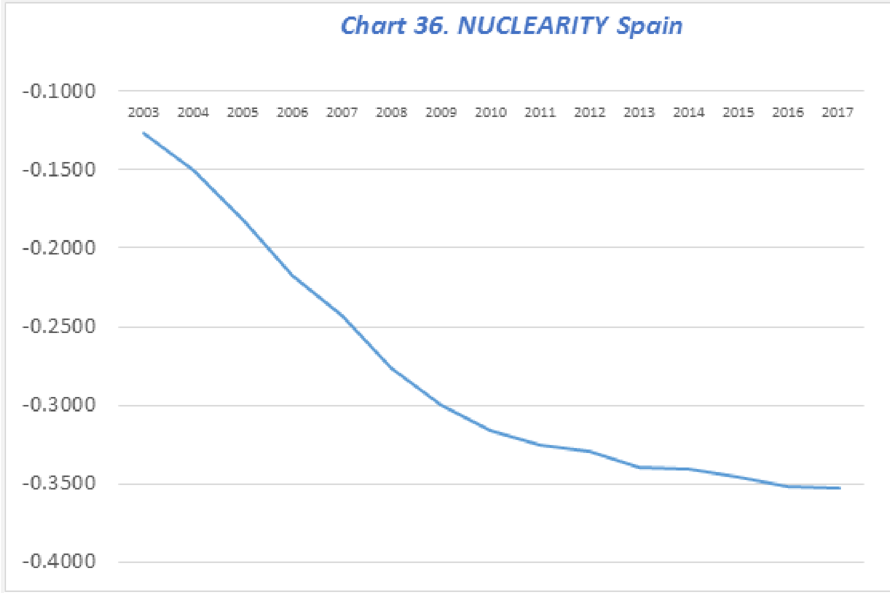
Source: Author's own work.
Note: Please keep in mind that we have built composite indicators based on the original indicators' zscores. Thus, they have zero mean. National values have been calculated as population weighted averages of regional values.

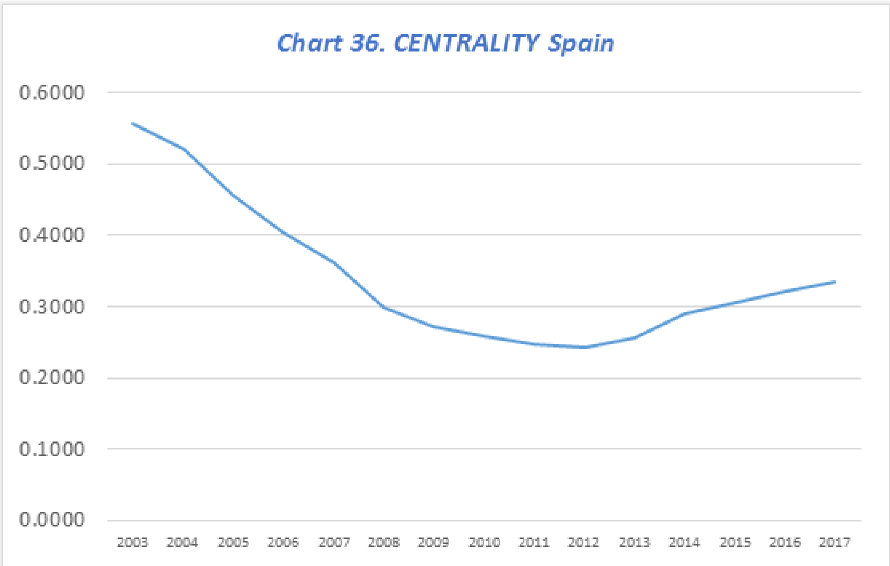
Concerning the evolution of the composite indicators, this is shown in Chart 36. Proximity is increasing as of 2008, following a decreasing trend from 2003 to 2008. Centrality is increasing as of 2011, following a decreasing trend.[44] Population density, in line with what we observed in point 2, presents a more irregular evolution; it registers an overall increasing trend over the whole period and as of 2014. Population concentration is increasing as of 2013, following a period of stagnation between 2007 and 2013; it decreased from 2003 to 2007. Continuity shows an increasing trend over the whole period. It is important to highlight that analyses at the national level outline the national panorama, which subsumes the regional realities. However, it conceals at the same time significant regional differences within Spain. We will later provide further details on the evolution of dispersion by regions.

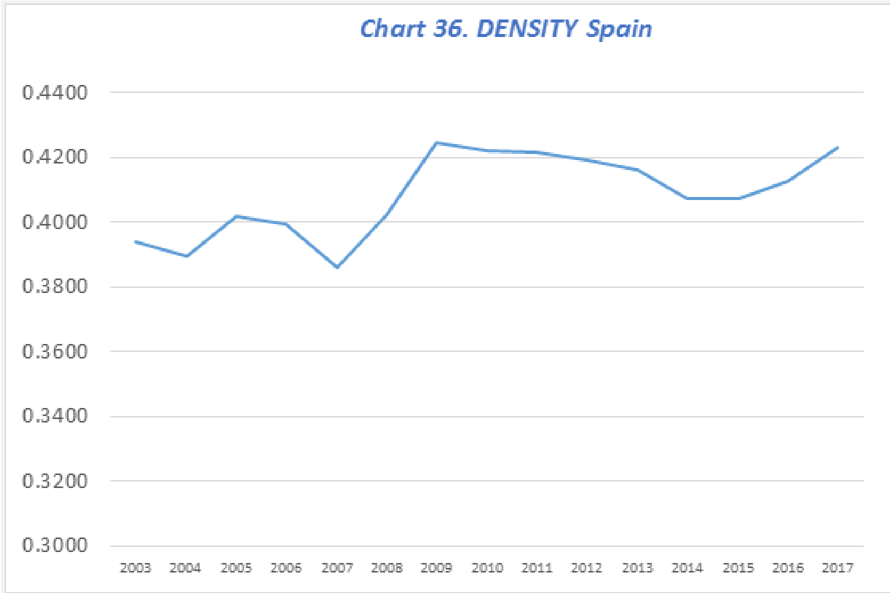
At the national level, the composite indicator for population dispersion presents a decreasing evolution from 2003 to 2011 and is increasing as of 2011. We show it in Chart 37.

[44] Please note that individual centrality indicators (see point 2) typically decreased until 2008 to start a increasing trend from that moment on. The pattern with the composite is the same changing 2008 to 2011. The difference is due to the fact that, for the purpose of composite indicators, we calculated the national averages as population weighted averages of the regional values, which in some cases differ from the algorithms used with individual indicators (please refer to Blanco, A. et al. (2021)).

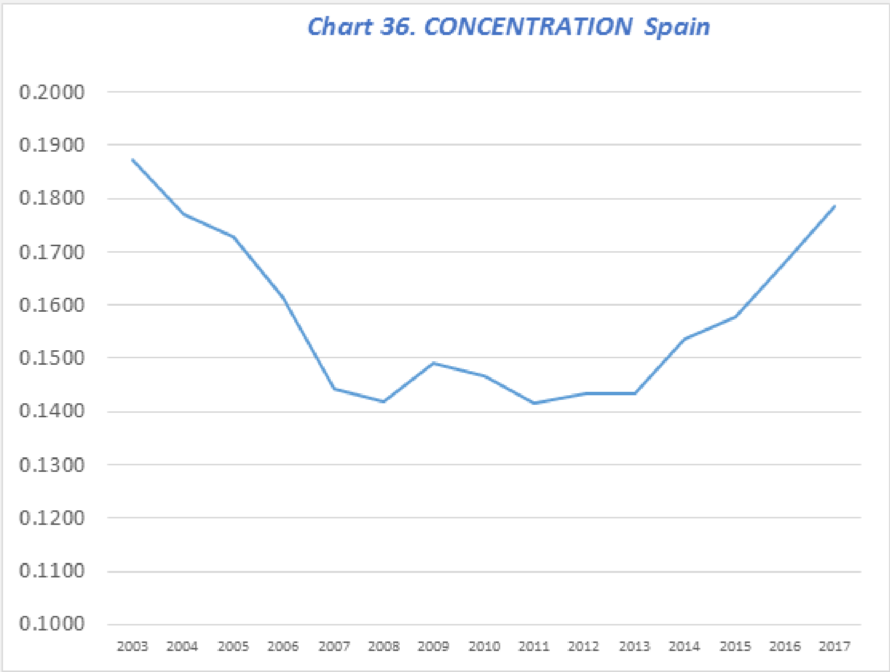


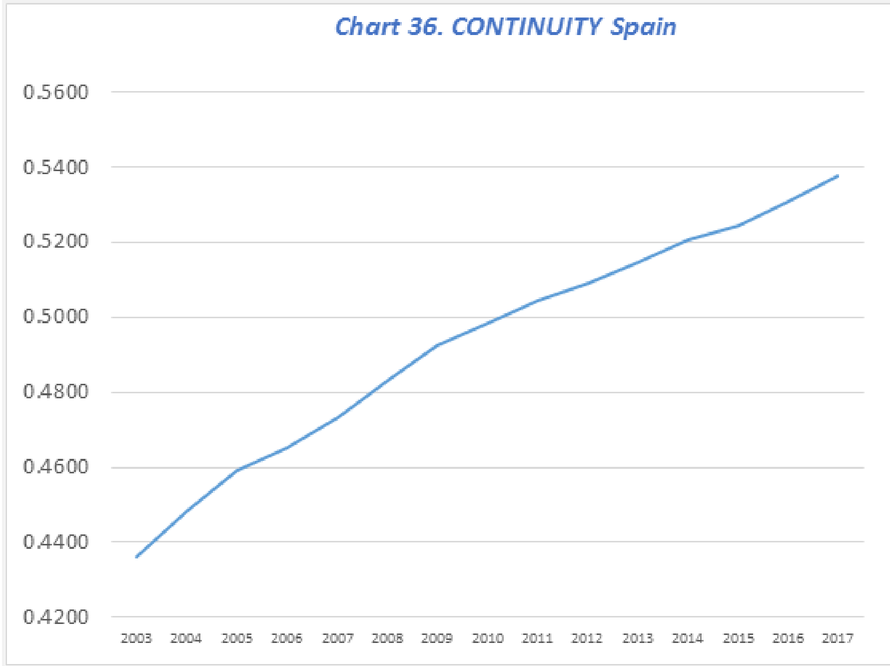




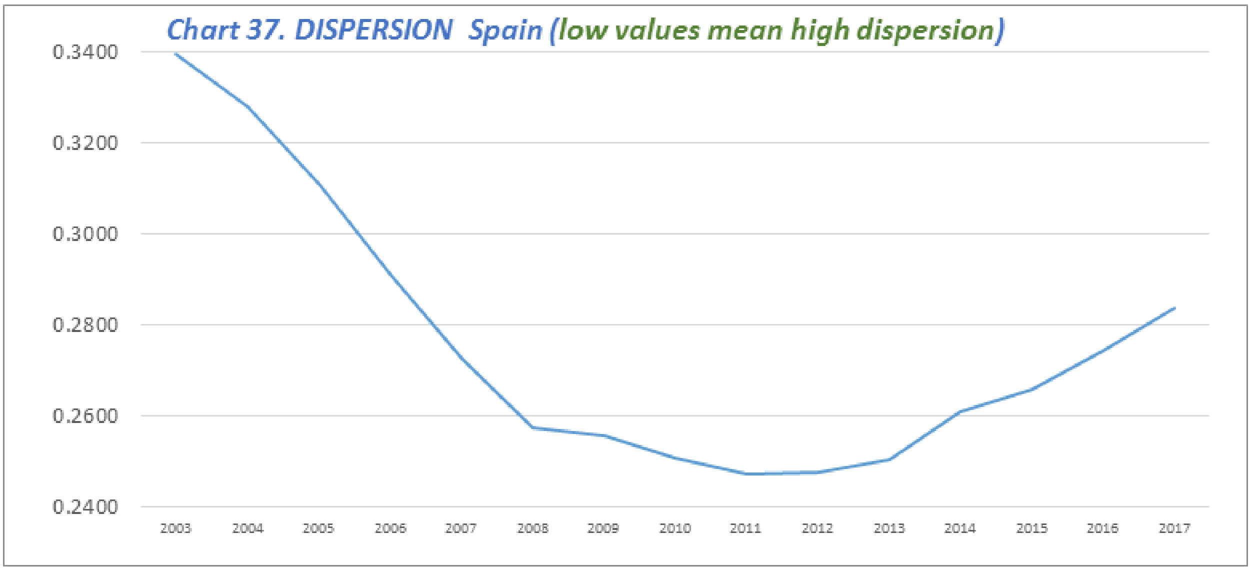


Source: Author's own work.



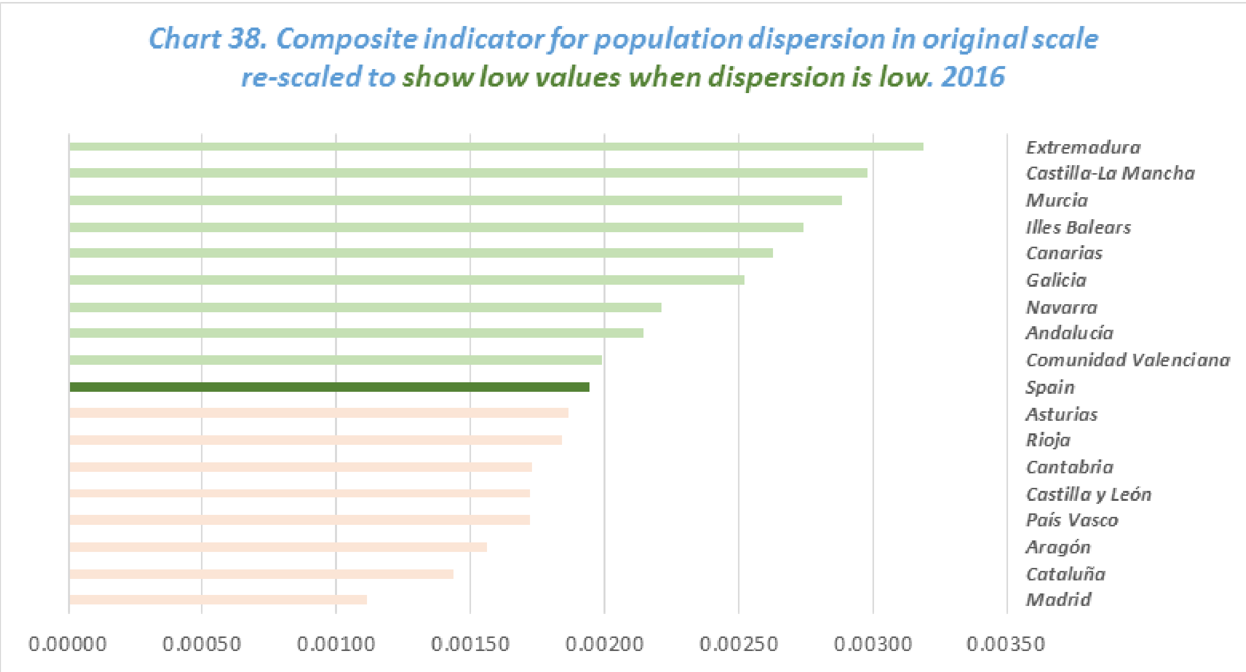


Source: Author’s own work.



Source: Author's own work.

Please note that this indicator has been built to reflect low values when population dispersion is high. Therefore, the proper interpretation is as follows: population dispersion increased from 2003 to 2011 to start a decreasing trend from that moment forward. For the sake of facilitating the analysis and an intuitive interpretation, we have de-typified the composite indicator for population dispersion (transformed the values to the original scale) and re-scaled it to reflect low dispersion when the indicator is low, thus providing a direct interpretation of population dispersion's evolution. We present the results in Chart 38 for 2016 and in Table 55.



Source: Author's own work.

Note: Please bear in mind that we have de-typified the composite indicator for population dispersion (transformed the values to the original scale) and re-scaled it **to show low values when dispersion is low**, thus providing a direct interpretation of the evolution of population dispersion.

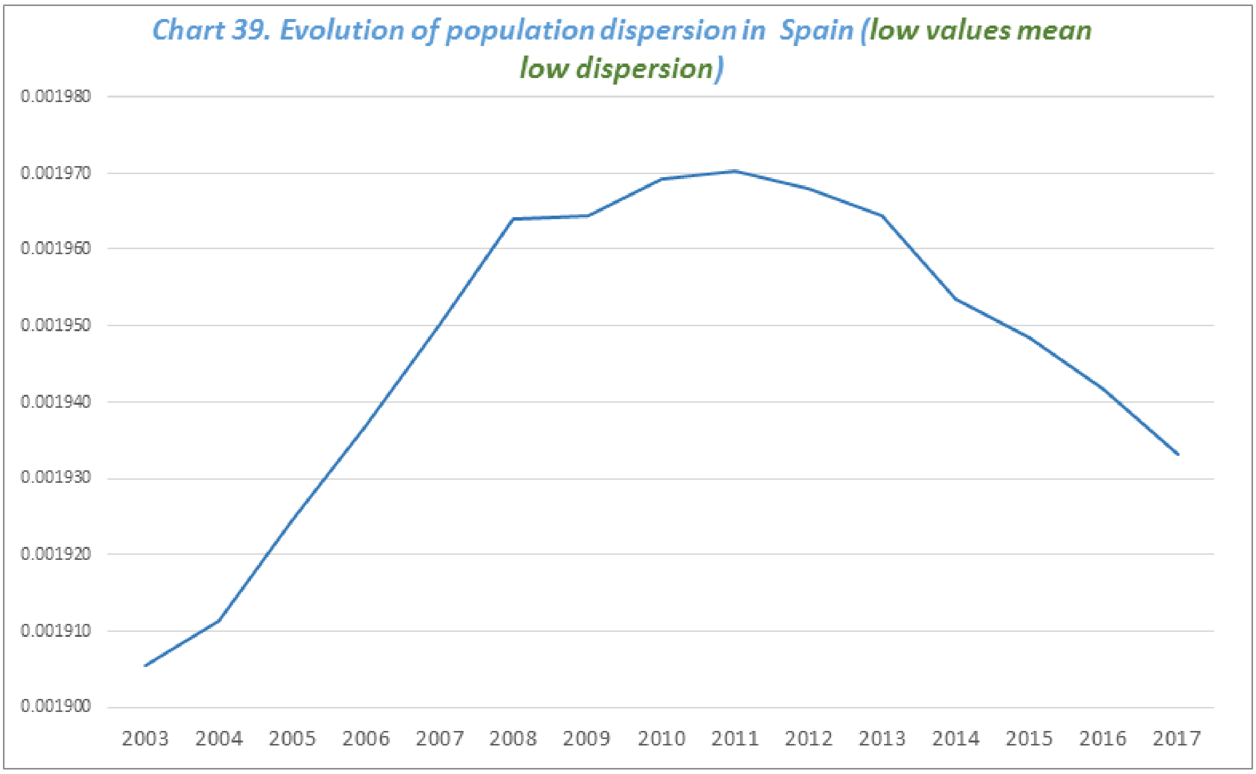
Table 55. Composite indicator for population dispersion from 2003 to 2017 (*)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**0.001905**	**0.001911**	**0.001925**	**0.001937**	**0.001950**	**0.001964**	**0.001964**	**0.001969**	**0.001970**	**0.001968**	**0.001964**	**0.001953**	**0.001949**	**0.001942**	**0.001933**
Andalucía	0.002104	0.002111	0.002125	0.002139	0.002152	0.002167	0.002170	0.002168	0.002171	0.002171	0.002161	0.002153	0.002147	0.002146	0.002133
Aragón	0.001610	0.001601	0.001599	0.001595	0.001594	0.001593	0.001589	0.001584	0.001580	0.001571	0.001575	0.001576	0.001568	0.001560	0.001550
Asturias	0.001941	0.001949	0.001942	0.001932	0.001925	0.001917	0.001907	0.001900	0.001895	0.001889	0.001881	0.001877	0.001870	0.001868	0.001860
Balears	0.002588	0.002597	0.002643	0.002687	0.002741	0.002807	0.002673	0.002688	0.002703	0.002705	0.002798	0.002751	0.002745	0.002740	0.002737
Canarias	0.002247	0.002287	0.002362	0.002420	0.002474	0.002536	0.002569	0.002576	0.002584	0.002614	0.002617	0.002599	0.002616	0.002630	0.002645
Cantabria	0.001692	0.001705	0.001712	0.001719	0.001728	0.001735	0.001738	0.001739	0.001743	0.001745	0.001730	0.001729	0.001727	0.001726	0.001723
Castilla y León	0.001817	0.001805	0.001798	0.001798	0.001795	0.001801	0.001784	0.001777	0.001773	0.001764	0.001751	0.001740	0.001733	0.001722	0.001711
Castilla-La Mancha	0.003125	0.003119	0.003128	0.003121	0.003124	0.003137	0.003160	0.003160	0.003125	0.003108	0.003071	0.003062	0.003033	0.002982	0.002937
Cataluña	0.001384	0.001396	0.001405	0.001417	0.001430	0.001438	0.001443	0.001446	0.001447	0.001446	0.001446	0.001443	0.001440	0.001438	0.001436
Comunidad Valenciana	0.001945	0.001947	0.001974	0.001991	0.002020	0.002041	0.002044	0.002048	0.002058	0.002058	0.002057	0.002015	0.002006	0.001990	0.001981
Extremadura	0.003334	0.003318	0.003302	0.003285	0.003273	0.003259	0.003246	0.003270	0.003261	0.003247	0.003228	0.003219	0.003208	0.003189	0.003168
Galicia	0.002464	0.002474	0.002502	0.002519	0.002515	0.002541	0.002554	0.002593	0.002589	0.002552	0.002536	0.002527	0.002517	0.002522	0.002513
Madrid	0.001049	0.001058	0.001066	0.001078	0.001085	0.001091	0.001095	0.001099	0.001103	0.001108	0.001111	0.001113	0.001115	0.001113	0.001114
Murcia	0.002786	0.002795	0.002819	0.002835	0.002845	0.002867	0.002880	0.002888	0.002893	0.002904	0.002911	0.002892	0.002892	0.002883	0.002877
Navarra	0.002208	0.002199	0.002201	0.002196	0.002223	0.002224	0.002230	0.002238	0.002251	0.002241	0.002234	0.002221	0.002216	0.002210	0.002202
País Vasco	0.001695	0.001697	0.001701	0.001702	0.001707	0.001712	0.001714	0.001713	0.001715	0.001717	0.001721	0.001721	0.001720	0.001720	0.001719
Rioja	0.001834	0.001918	0.001910	0.001901	0.001908	0.001906	0.001903	0.001895	0.001892	0.001880	0.001868	0.001856	0.001849	0.001842	0.001834

Source: Author's own work.

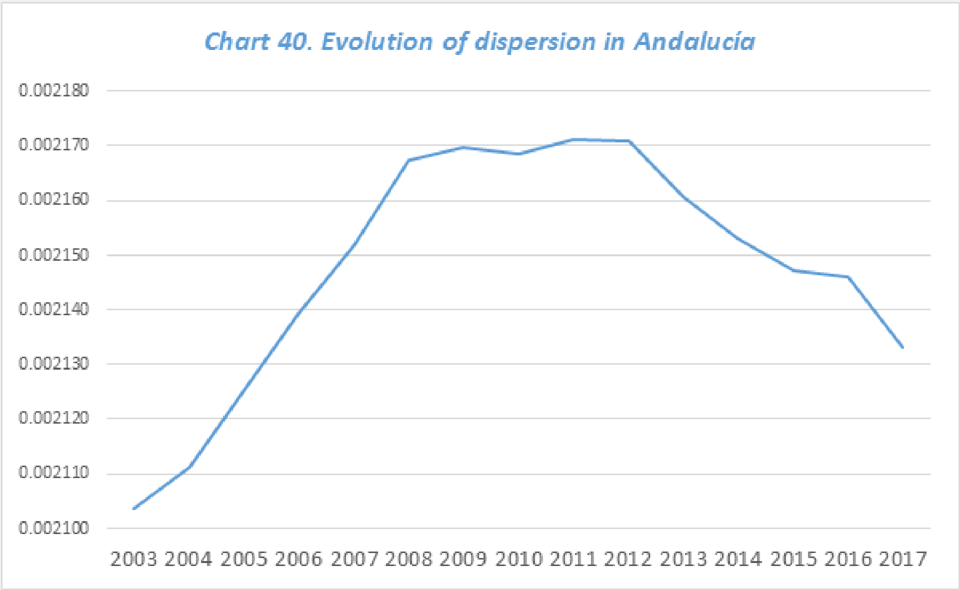
(*) Note: Data correspond to de-typified (transformed values to the original scale) and re-scaled to reflect low dispersion when the indicator is low.

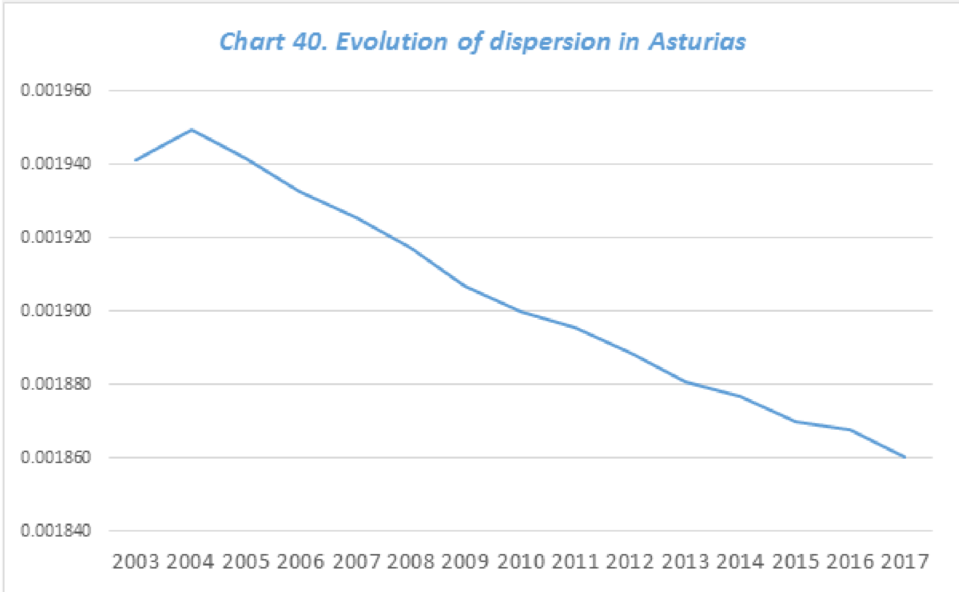
The evolution of population dispersion at the national level, expressed in the original scale and re-scaled to show low values when dispersion is low, is shown in Chart 39. As indicated, there are differences among regions. They are displayed in Chart 40.

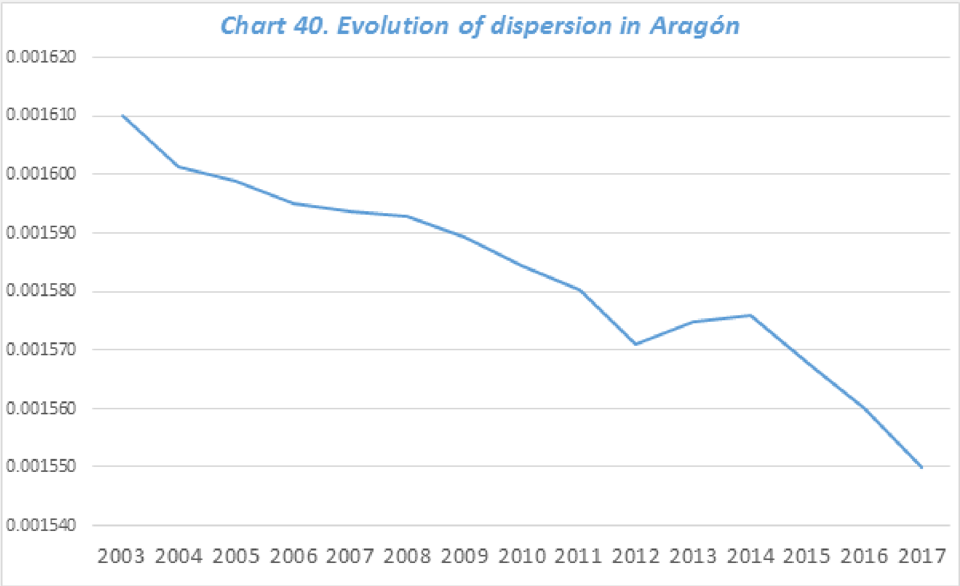


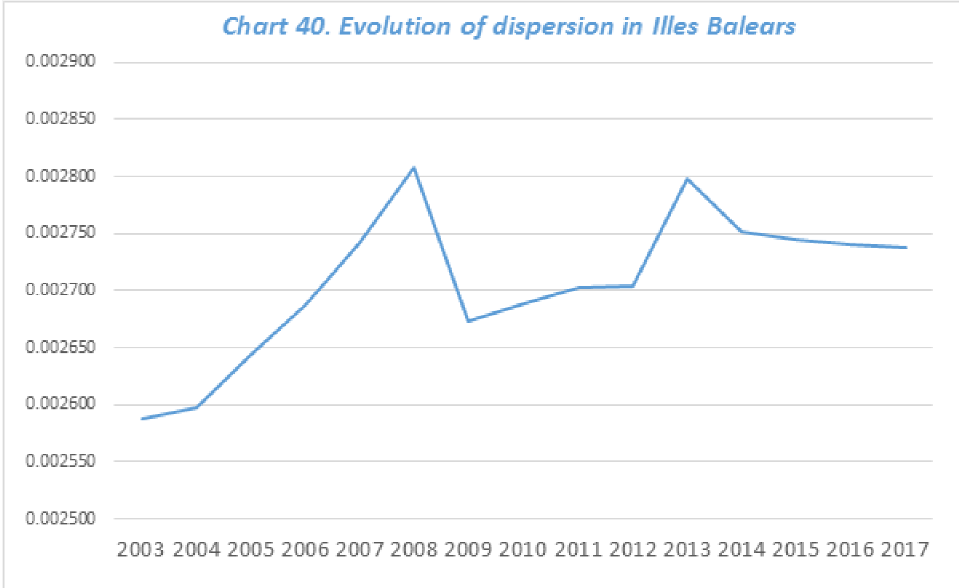
Source: Author's own work.

Note: Please bear in mind that we have de-typified the composite indicator for population dispersion (transformed the values to the original scale) and re-scaled it **to show low values when dispersion is low**, thus providing a direct interpretation of the evolution of population dispersion.



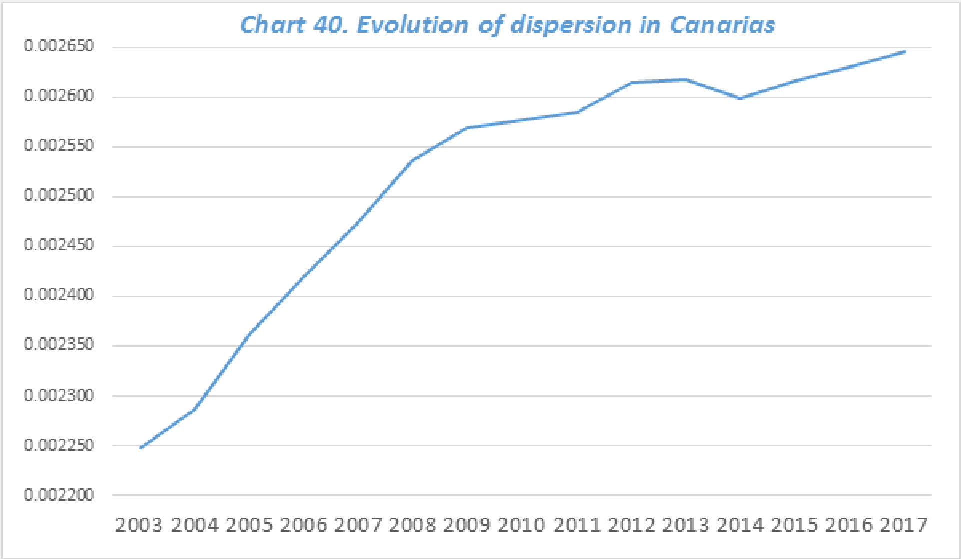


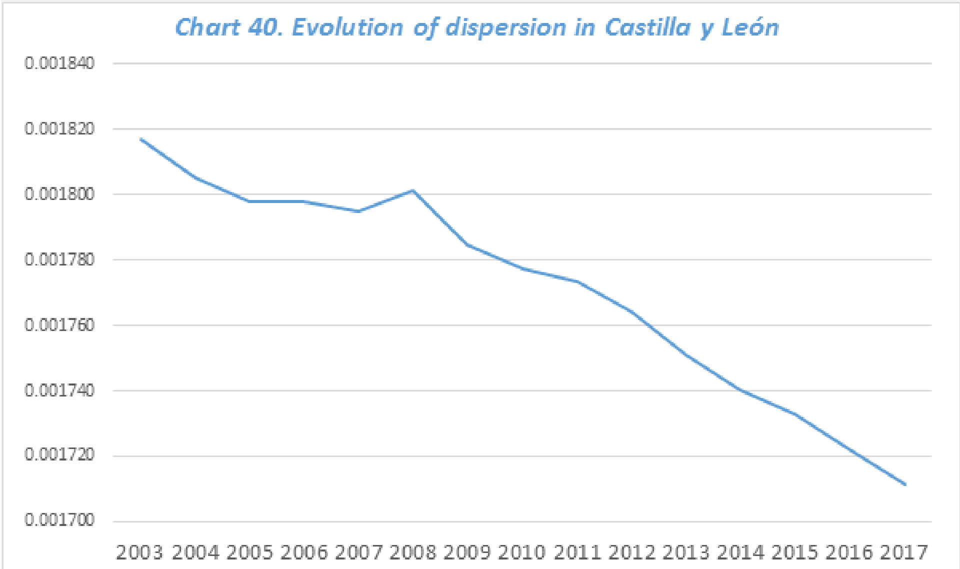


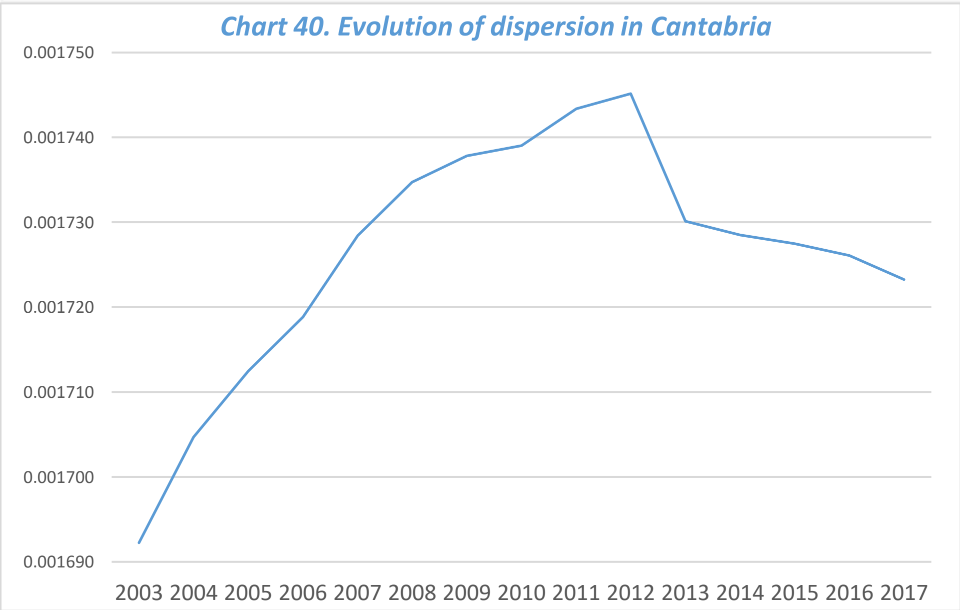


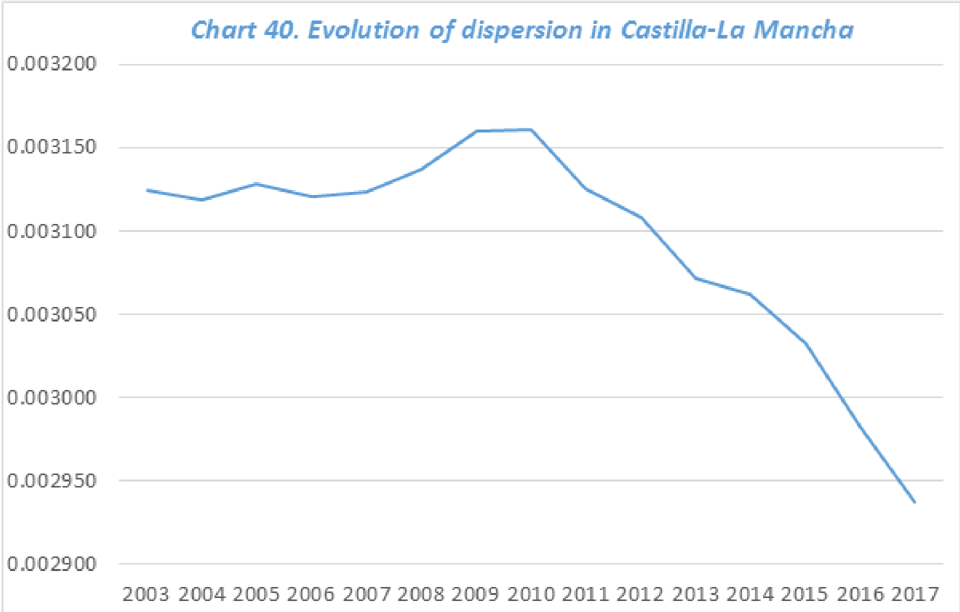
Source: Author's own work.

Note: Please bear in mind that we have de-typified the composite indicator for population dispersion (transformed the values to the original scale) and re-scaled it **to show low values when dispersion is low**, thus providing a direct interpretation of the evolution of population dispersion.









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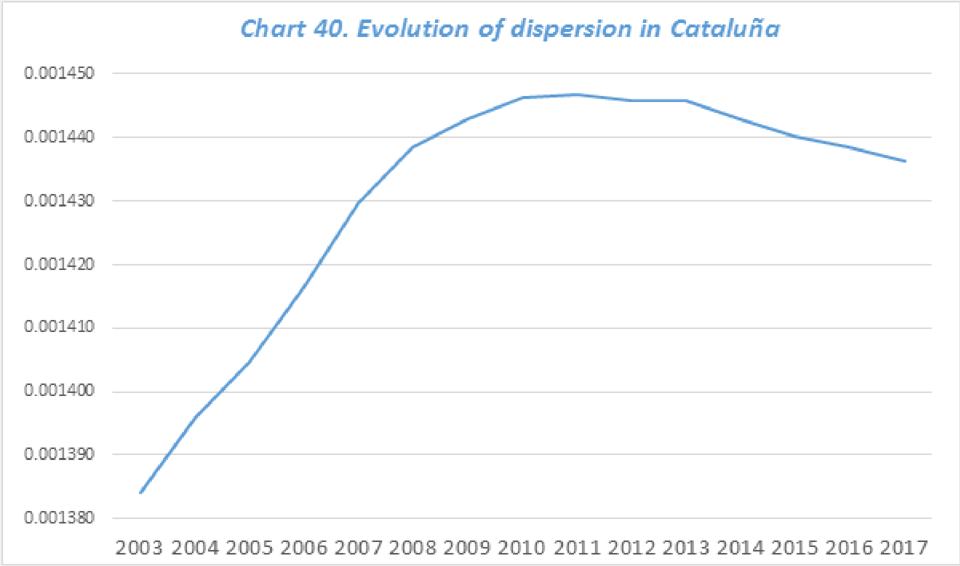

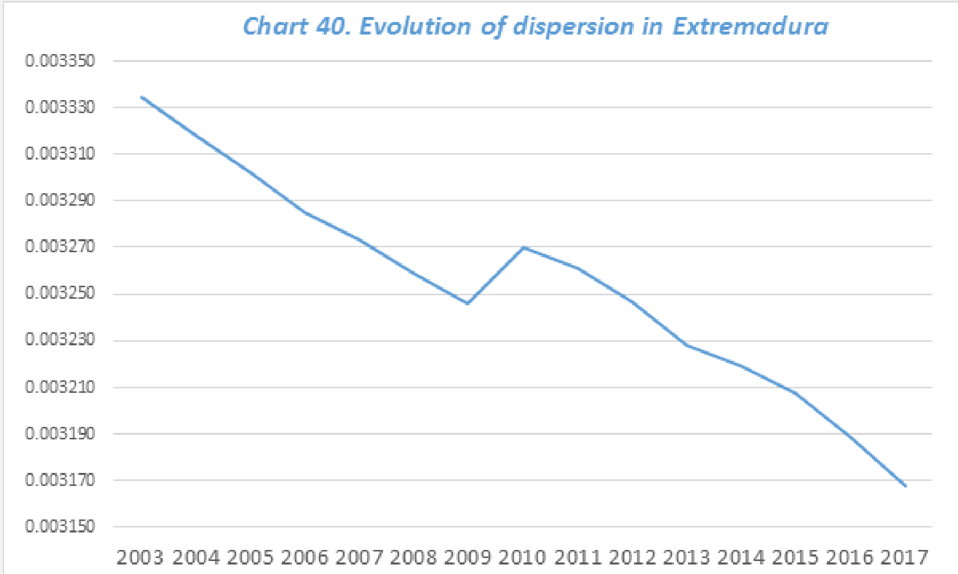

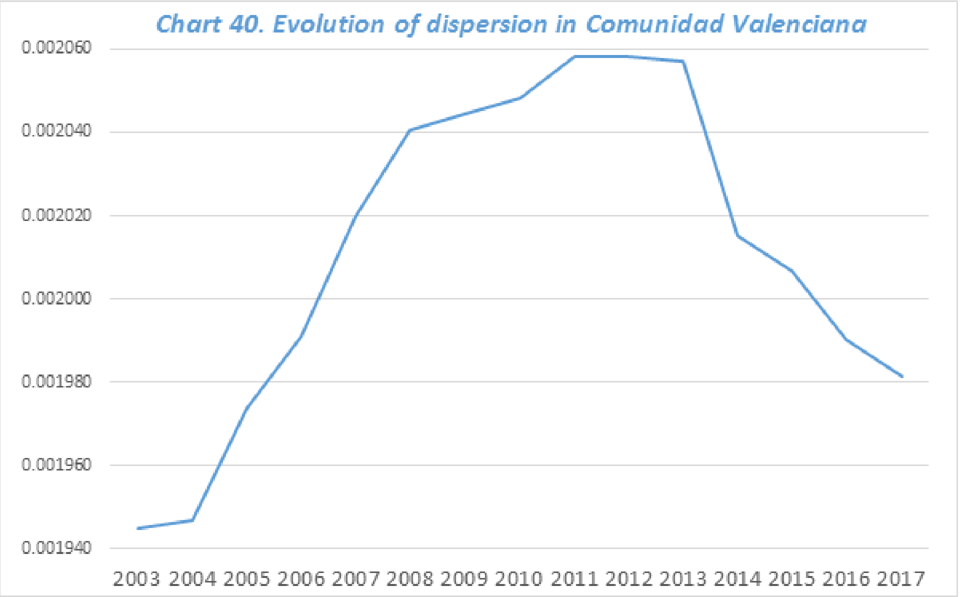

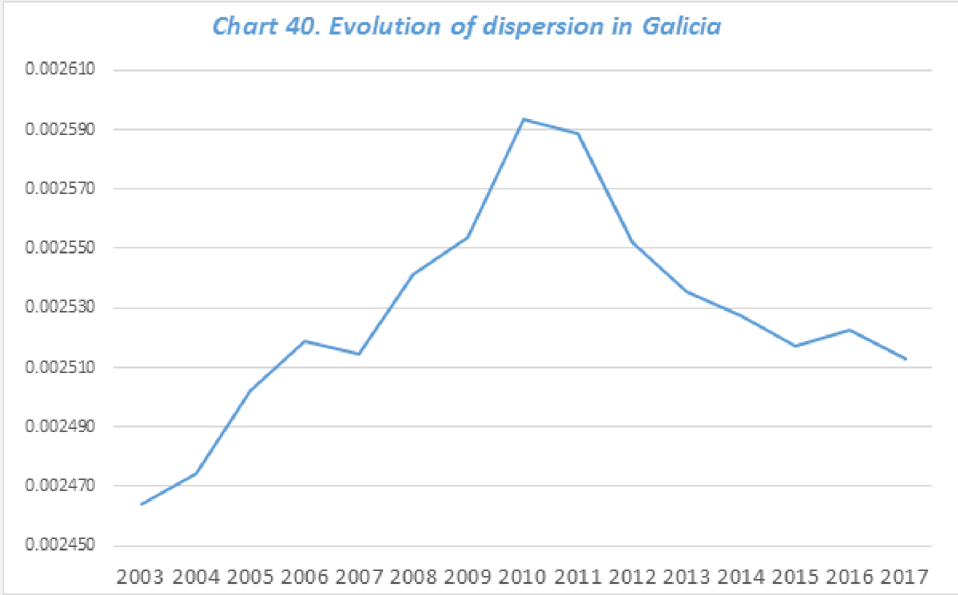

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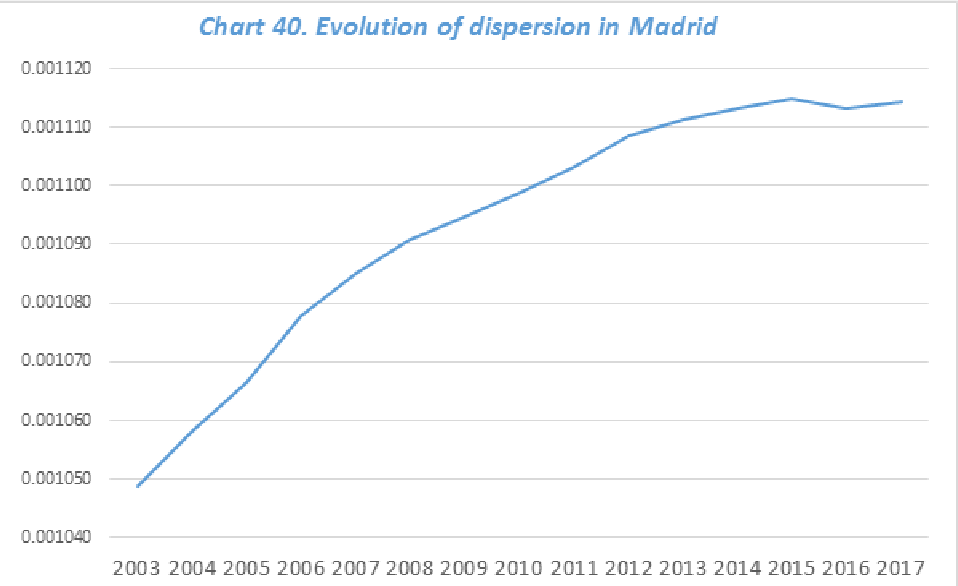

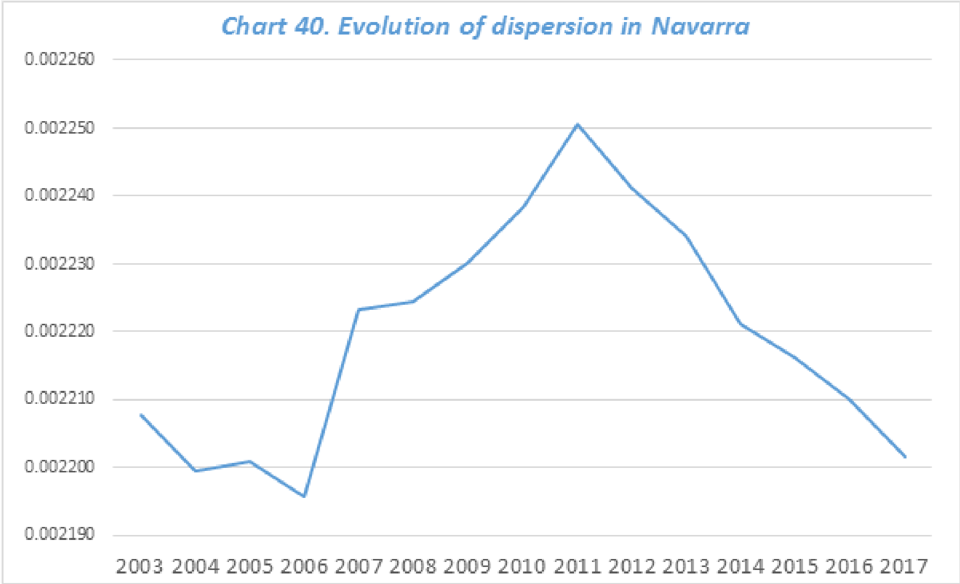

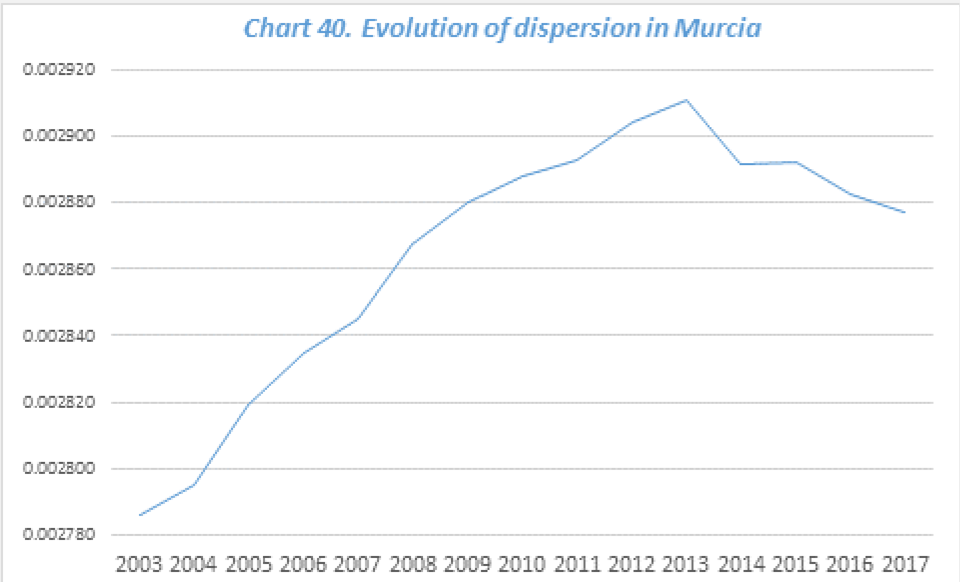

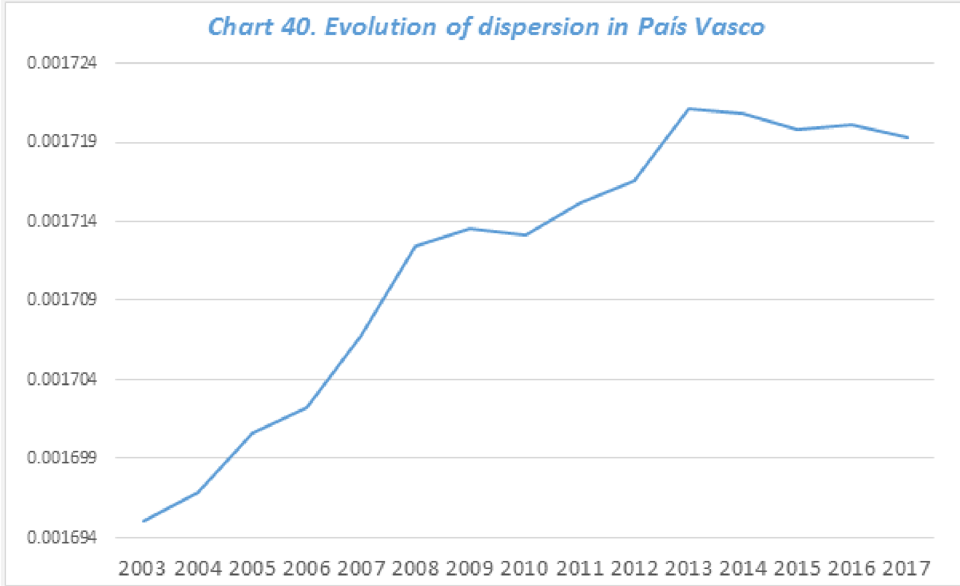

Source: Author's own work.
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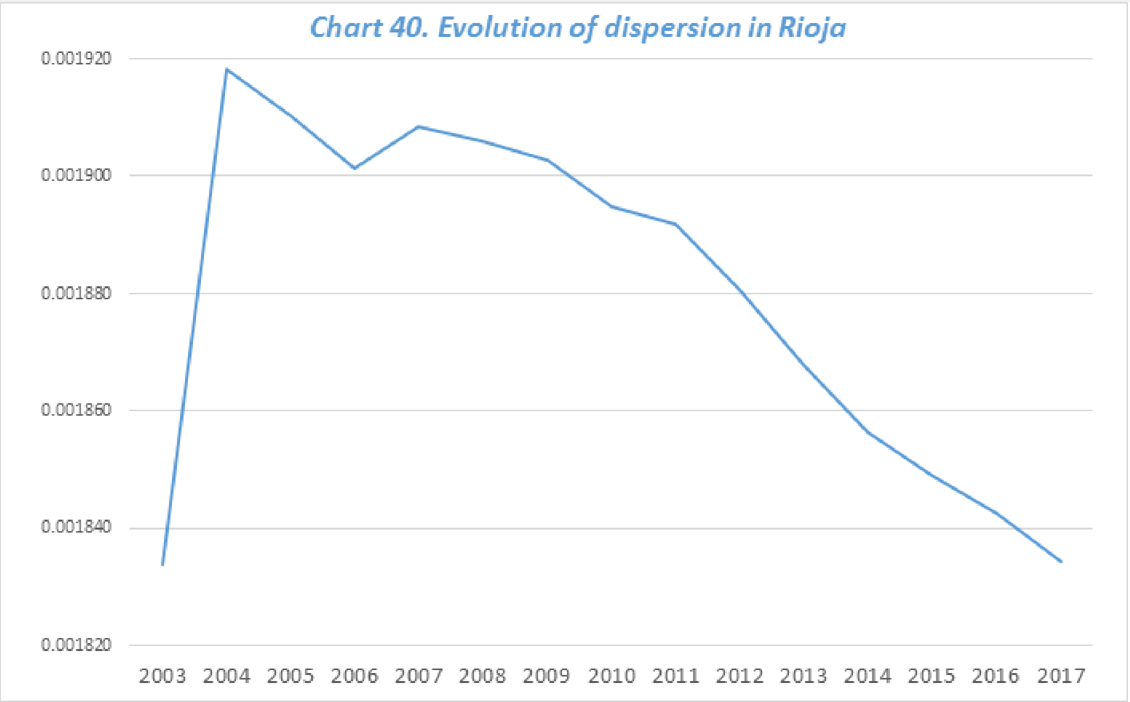


Source: Author's own work.
Note: Please bear in mind that we have de-typified the composite indicator for population dispersion (transformed the values to the original scale) and re-scaled it **to show low values when dispersion is low**, thus providing a direct interpretation of the evolution of population dispersion.

We have found significant inter-regional differences in Spain both regarding dispersion dimensions and concerning dispersion itself as the aggregate. In 2016, dispersion in Extremadura, the highest in Spain, was 2.86 times that of Madrid, the lowest one. Typically, Illes Balears, Canarias, Castilla-La Mancha, Extremadura and Galicia show below average levels of proximity, centrality, nuclearity, density, concentration and continuity, thus presenting high levels of population dispersion. On the other hand, Aragón, Cantabria, Castilla y León, Cataluña, Madrid and País Vasco typically show above average levels in the mentioned dimensions, thus presenting low levels of population dispersion.

At the national level, as said, dispersion is decreasing since 2011, after having registered an increasing trend from 2003 to 2011. Its evolution has significant inter-regional differences. We highlight that in Canarias and Madrid it is increasing over the whole analysed period. On the other hand, it has systematically decreased over the analysed period 2003-2017 in Aragón, Asturias, Castilla y León, Castilla-La Mancha, Extremadura and La Rioja.

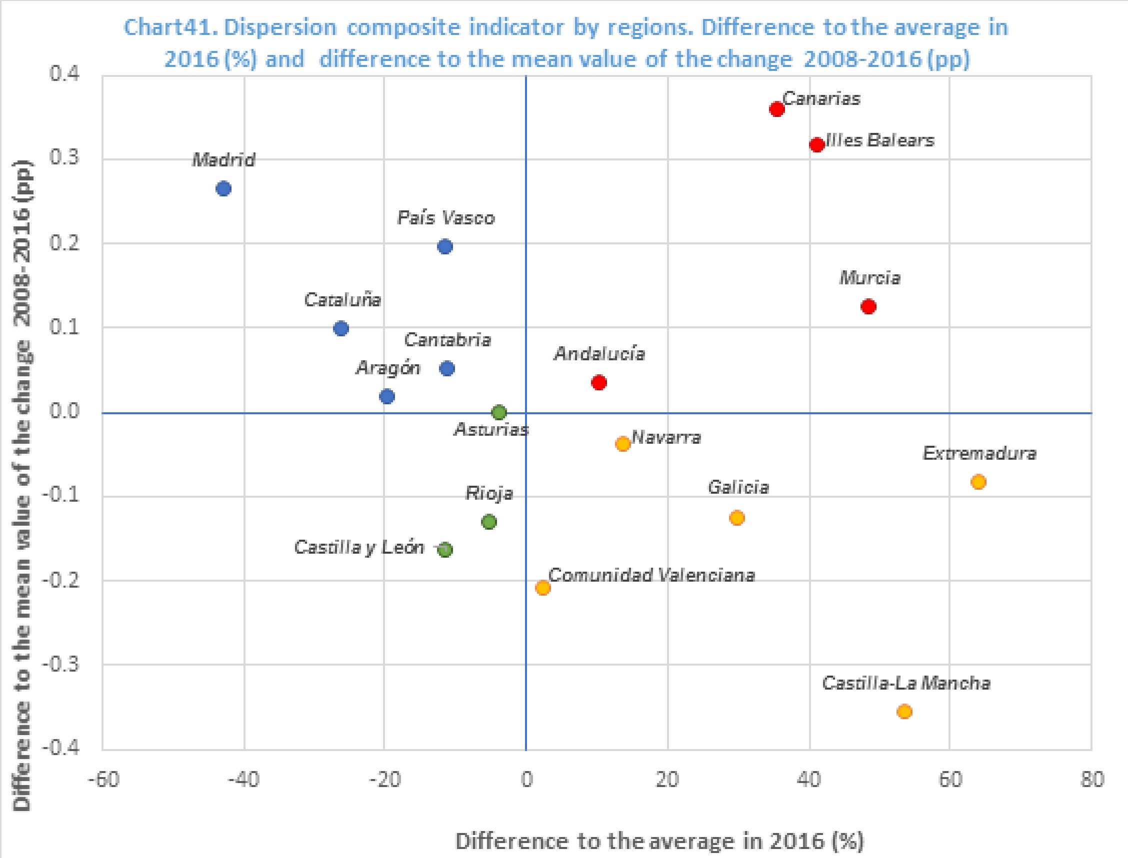
The analysis of the position that each Region registers regarding dispersion, and the comparative analysis between its dimensions, will provide some insights into population dispersion. We have complemented it with the analysis of the dynamic of dispersion in Spain´s regions, comparing their relative position to the national average in 2016, together with their time trend during the period 2008 to 2016 (Chart 41). Based on this information, we would highlight the following features regarding population dispersion in Spain's regions:

- **Andalucía** has an intermediate level of population dispersion, above the national average but close to it; resulting from intermediate to low levels in all the dimensions except for population proximity, where it ranks above the national average. The issue in Andalucía is that, in addition to being above the national average, dispersion is evolving at higher rates than the national average. This dynamic pattern would trigger an ascendant divergence from the national average.
- **Aragón** has a low level of population dispersion following high levels of proximity, centrality, nuclearity and concentration. These levels clearly compensate for low levels of density and continuity. In addition, dispersion is evolving at slightly higher rates than the national average, thus pointing out that the Region would follow a sluggish ascending convergence or remain stagnated.
- **Asturias** presents a dispersion level below the national average but close to it. It is the result of high levels in proximity, centrality and concentration. They compensate for low levels of nuclearity, density and continuity. In addition, dispersion is evolving at the same rates as the national average, thus pointing out that the Region would remain stagnated in its position.
- **Illes Balears** has a high level of dispersion pursuant to below average levels in all dimensions. The Region's dynamic, with significantly higher rates than the national average, puts forward that the Region will follow an ascendant divergence from the national average.
- **Canarias** has a high level of dispersion pursuant to below average levels in all dimensions, except for density and continuity, where it ranks above the national average. The Region's dynamic, with significantly higher rates than the national

average, puts forward that the Region will follow an ascendant divergence from the national average.

- **Cantabria** shows a below average level of dispersion, conforming to high levels in all dimensions except nuclearity and density. The population dispersion dynamic in Cantabria shows that the Region would follow a decreasing divergent path from the national average.
- **Castilla y León** shows a below average level of dispersion, conforming to high levels in proximity, centrality, nuclearity and concentration. This compensates for the low rates in density and continuity. In addition, population dispersion is evolving at significantly lower rates than the national average, pointing to a decreasing divergent path away from the national average.
- **Castilla-La Mancha** has a high level of population dispersion, among the highest in Spain, in line with low levels in all dispersion dimensions. However, dispersion in Castilla-La Mancha is evolving at significantly higher rates than the national average. Thus, the Region would be in an ascending convergent path towards the national average.
- **Cataluña** has a low level of population dispersion, among the lowest in Spain, in line with high levels in all dispersion dimensions, except nuclearity. However, its dynamic points out to an ascending convergence toward the national average.
- **Comunidad Valenciana** has an above average level of dispersion conforming to above the average levels in all dispersion dimensions, except nuclearity. Dispersion in Comunidad Valenciana is close to the national average and its dynamic, with evolution rates notably below the national ones, would trigger a descendent path towards the mean.
- **Extremadura** has a high level of population dispersion, among the highest in Spain, in line with low levels in all dispersion dimensions. However, dispersion in Extremadura is evolving at significantly higher rates than the national average. Thus, the Region would be in an ascending convergent path towards the national average.

- **Galicia** has a high level of population dispersion. However, dispersion is evolving at lower rates than the national average. Thus, the Region would be in a falling convergent path towards the national average.
- **Madrid** has a low level of population dispersion, among the lowest in Spain, in line with high levels in all dispersion dimensions, except nuclearity. However, its dynamic points to an ascending convergence toward the national average.
- **Murcia** has a high level of population dispersion following low levels in all dispersion dimensions. In addition, dispersion in Murcia is evolving at higher rates than the national average. Thus, the Region would be in an ascending divergent path away from the national average.
- **Navarra** has an intermediate level of dispersion, above the national average as a result of high levels in nuclearity, density and concentration. This compensates for the low levels in proximity, centrality and continuity. The dispersion dynamic in Navarra shows lower rates than the national average although close to it. This points to a sluggish descent path towards the mean.
- **País Vasco** has a low level of population dispersion, among the lowest in Spain, in line with high levels in all dispersion dimensions, except nuclearity. However, its dynamic points to an ascending convergence towards the national average.
- **La Rioja** has an intermediate level of dispersion, above the national average because of high levels in centrality, nuclearity and concentration. This compensates for the low levels in proximity, density and continuity. Dispersion in La Rioja is evolving at significantly lower rates than the national average, pointing to a decreasing divergent path from the national average.



Source: Author's own work.

Note: Please bear in mind that we have de-typified the composite indicator for population dispersion (transformed the values to the original scale) and re-scaled it **to show low values when dispersion is low**, thus providing a direct interpretation of the evolution of population dispersion.

6. ASSOCIATION BETWEEN POPULATION DISPERSION AND EXPENDITURE IN FPS

The purpose of this section is to capture the association between per capita spending in fundamental public services and population dispersion. To this end, we have estimated panel data models relating per capita spending in FPS, education, health and essential social services with the population dispersion, controlling by other need spending drivers or determining factors.

The notion of "*fundamental public services*" set in the Spanish Constitution constitutes an indeterminate legal concept that allows the legislator a very wide freedom of configuration. There has been extensive controversy regarding the content of such services; mainly because the LOFCA[45] requires the Government to guarantee a minimum level throughout the territory.

In its current wording, the LOFCA provides that "*For the purposes of this article, education, health and essential social services shall be considered fundamental public services.*" The issue would be with what the LOFCA calls "*essential social services*."

According to Aguado, M. et al. (2015), the very first approaches to this concept assumed a broad reading, redirecting to it practically all the services connected with the idea of the Social State. Essential social services were identified as those contained in the functional groups of the Spanish budget for *"security, protection and social promotion"* as well as *"production of public goods of a social nature"*. Nonetheless, Spain's regions, in general, have followed a uniform or homogeneous line, coinciding in the articulation of the mentioned social services. Thus, along with the policies on dependency, the sectoral policies for social assistance to singular social groups would be included: elderly, minors, family, youth, disability, immigration, equality; or even other public services incidental to the social issue, such as housing, sports, or the environment.

[45] Organic Law 8/1980, of September 22, on Financing of the Autonomous Communities: https://www.boe.es/buscar/pdf/1980/BOE-A-1980-21166-consolidado.pdf. In its current version, the LOFCA states that fundamental public services are education, health and essential social services.

Our analysis refers to the national level and focuses on fundamental public services whose cost of provision is linked to population dispersion. We consider that dispersion would not be a cost driver of the provision of retirement pensions, unemployment benefits, or similar benefits with an income substitution rationale, mainly provided in Spain by the Social Security. We understand that our focus should be on education, health and essential social services, where essential social services follow the articulation given by the Spanish regions, described in the previous paragraph, which suits to our objective. They are mainly provided by the regions and local governments and, to a lesser extent, by the central and social security administrations.

To quantify the spending in FPS we have utilised National Accounts data published by the Ministry of Finance of Spain (IGAE). More specifically, we have used the data of public spending classified by functions according to the Classification of the Functions of Government (COFOG) (EUROSTAT (2019)). The following three COFOG functions have been included:

- 07. Health
- 09. Education
- 10. Social protection
  - 10.1 Sickness and disability
  - 10.2 Old age
  - 10.3 Survivors
  - 10.4 Family and children
  - 10.5 Unemployment
  - 10.6 Housing
  - 10.7 Social exclusion n.e.c.
  - 10.8 R&D social protection
  - 10.9 Social protection n.e.c

From the spending in function "10.Social protection" we have deducted the accounting concept of "*Social benefits other than social transfers in kind.*" We have complemented this source with other sources to calculate the spending and its distribution by region. For education and health expenditure, we have used the public spending statistics of the Ministry of Education (ME (2021)) and the Ministry of Health (MS (2021a)). For essential social services, we have used the work by Ruiz, O. (2019). In all the cases, the total spending has been calibrated to the total values disseminated by the IGAE.[46] In Tables 56 through 60, we present our estimates for spending in fundamental public services in Spain by regions and subsectors of National Accounts, both total in € and per capita. We also present the breakdown of spending in fundamental public services by education, health and essential social services in Tables 61 through 63.

[46] Please, bear in mind that, to quantify spending in essential social services, we have taken the total spending in the function "10.Social protection" from which we have deducted the accounting concept of "Social benefits other than social transfers in kind." Except for País Vasco, for which we have not apply any deduction to keep the coherence with the rest of regions and sources.

Table 56. Total public spending in FPS in Spain from 2003 to 2017.

Million Euros	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**85,318**	**94,455**	**102,933**	**112,293**	**121,378**	**133,063**	**142,876**	**139,333**	**136,326**	**125,815**	**122,371**	**122,621**	**127,766**	**130,674**	**134,181**
Andalucía	14,661	16,345	17,743	19,679	21,186	23,714	24,678	24,089	23,115	21,740	21,713	20,576	21,213	22,269	22,851
Aragón	2,424	2,731	2,911	3,170	3,461	3,753	4,101	3,922	3,940	3,618	3,576	3,575	3,673	3,818	3,955
Asturias	2,244	2,419	2,595	2,772	2,959	3,142	3,495	3,340	3,333	2,924	2,914	2,947	3,018	3,009	3,064
Illes Balears	1,647	1,831	2,150	2,231	2,432	2,637	2,916	3,177	3,037	2,578	2,625	2,744	2,892	2,860	3,025
Canarias	3,645	3,989	4,467	4,766	5,039	5,485	5,870	5,513	5,244	4,859	4,940	5,075	5,253	5,342	5,549
Cantabria	1,286	1,424	1,580	1,700	1,846	1,852	1,998	2,021	1,926	1,867	1,827	1,883	1,947	1,912	1,934
Castilla y León	5,334	5,744	6,347	6,894	6,979	7,846	8,047	7,905	7,507	7,380	7,154	7,080	7,452	7,505	7,778
Castilla-La Mancha	3,820	4,053	4,834	5,370	5,865	6,496	7,093	7,046	6,967	5,833	5,635	5,587	5,909	6,001	6,188
Cataluña	13,225	15,194	16,135	17,958	19,663	21,426	23,041	22,870	21,913	20,325	19,342	19,624	20,402	21,345	22,042
Comunidad Valenciana	8,980	9,544	10,266	11,052	11,999	13,213	14,678	14,420	13,921	12,764	11,727	12,233	13,065	13,233	13,396
Extremadura	2,354	2,565	2,761	3,005	3,275	3,547	3,821	3,674	3,606	3,269	3,281	3,346	3,464	3,453	3,485
Galicia	5,413	5,964	6,377	6,941	7,441	8,087	8,619	8,327	7,816	7,425	7,497	7,364	7,707	7,908	8,006
Madrid	10,741	12,235	13,302	14,407	15,527	16,735	18,136	16,886	17,923	16,387	15,689	15,903	16,595	16,354	16,942
Murcia	2,485	2,767	3,079	3,370	3,807	4,438	4,763	4,676	4,642	4,179	4,119	4,108	4,306	4,368	4,496
Navarra	1,335	1,470	1,569	1,675	1,808	2,025	2,183	2,152	2,114	1,879	1,798	1,825	1,892	1,984	2,060
País Vasco	5,147	5,531	6,081	6,422	7,055	7,715	8,443	8,334	8,363	7,905	7,674	7,880	8,061	8,339	8,430
Rioja	577	651	736	883	1,036	950	995	979	959	883	859	869	917	972	981

Euros per capita	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**1,997**	**2,187**	**2,334**	**2,512**	**2,685**	**2,883**	**3,056**	**2,963**	**2,889**	**2,662**	**2,596**	**2,622**	**2,740**	**2,807**	**2,881**
Andalucía	1,927	2,126	2,260	2,467	2,629	2,891	2,972	2,878	2,744	2,573	2,573	2,449	2,526	2,655	2,727
Aragón	1,970	2,185	2,294	2,482	2,669	2,829	3,048	2,911	2,927	2,681	2,655	2,697	2,787	2,918	3,022
Asturias	2,087	2,252	2,410	2,574	2,753	2,908	3,220	3,080	3,082	2,714	2,728	2,776	2,871	2,886	2,960
Illes Balears	1,739	1,918	2,187	2,229	2,359	2,458	2,662	2,873	2,729	2,303	2,361	2,487	2,618	2,583	2,711
Canarias	1,924	2,082	2,269	2,388	2,487	2,642	2,790	2,602	2,466	2,294	2,332	2,411	2,501	2,541	2,632
Cantabria	2,340	2,566	2,810	2,992	3,222	3,182	3,390	3,413	3,247	3,144	3,087	3,199	3,327	3,285	3,333
Castilla y León	2,144	2,303	2,528	2,732	2,760	3,068	3,139	3,089	2,934	2,899	2,839	2,838	3,015	3,066	3,206
Castilla-La Mancha	2,104	2,192	2,551	2,779	2,966	3,179	3,408	3,358	3,294	2,749	2,682	2,688	2,869	2,940	3,046
Cataluña	1,973	2,230	2,307	2,517	2,727	2,910	3,082	3,044	2,906	2,685	2,561	2,610	2,717	2,837	2,917
Comunidad Valenciana	2,008	2,101	2,188	2,299	2,456	2,627	2,881	2,821	2,720	2,489	2,293	2,444	2,623	2,668	2,711
Extremadura	2,192	2,385	2,548	2,766	3,005	3,231	3,466	3,318	3,250	2,950	2,972	3,042	3,169	3,174	3,227
Galicia	1,968	2,168	2,309	2,508	2,684	2,905	3,083	2,977	2,796	2,670	2,711	2,679	2,821	2,909	2,956
Madrid	1,878	2,108	2,230	2,398	2,553	2,668	2,840	2,614	2,762	2,522	2,415	2,464	2,578	2,529	2,604
Murcia	1,958	2,137	2,305	2,459	2,735	3,112	3,293	3,198	3,157	2,835	2,798	2,801	2,935	2,982	3,058
Navarra	2,308	2,514	2,644	2,782	2,985	3,263	3,462	3,379	3,293	2,914	2,790	2,848	2,953	3,097	3,202
País Vasco	2,437	2,615	2,862	3,010	3,294	3,577	3,887	3,826	3,828	3,605	3,502	3,600	3,682	3,809	3,842
Rioja	2,008	2,218	2,444	2,881	3,352	2,994	3,092	3,038	2,969	2,728	2,666	2,725	2,894	3,077	3,110

Source: Author's own work based on IGAE (2021), ME (2021) and MS (2021a), several years and Ruiz, O. (2019).
Note: It includes spending of the following subsectors: Central Administration, Social Security, Regional Administration and Local Administration.

Table 57. Public spending in FPS in Spain from 2003 to 2017. Central Administration

Million Euros	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**4,964**	**5,588**	**5,301**	**5,675**	**6,085**	**6,732**	**7,500**	**7,318**	**7,648**	**6,601**	**5,979**	**6,020**	**5,854**	**6,034**	**5,982**
Andalucía	879	1,002	950	1,029	1,099	1,238	1,335	1,317	1,367	1,197	1,086	1,014	981	1,042	1,044
Aragón	135	153	143	152	164	178	203	192	202	183	159	172	164	174	171
Asturias	129	141	132	139	147	158	182	172	182	159	145	145	140	141	136
Illes Balears	89	99	101	103	111	122	141	147	148	121	120	130	127	124	129
Canarias	193	213	206	214	222	242	276	251	249	223	222	234	228	233	234
Cantabria	81	91	88	95	102	107	118	121	127	120	94	97	90	93	90
Castilla y León	320	353	337	360	368	415	442	437	450	397	359	353	351	357	351
Castilla-La Mancha	232	255	259	284	307	346	390	389	414	324	289	287	283	293	287
Cataluña	767	890	827	902	979	1,079	1,204	1,193	1,228	1,049	947	963	929	989	990
Comunidad Valenciana	493	534	499	526	565	625	722	697	709	610	540	568	574	573	568
Extremadura	140	155	145	156	168	184	205	198	209	177	167	174	165	163	156
Galicia	312	347	323	346	367	401	445	428	431	380	358	362	351	363	354
Madrid	639	736	701	747	802	880	985	939	1,050	886	790	799	777	764	765
Murcia	142	160	154	166	184	214	241	233	245	214	201	202	196	201	198
Navarra	75	84	77	81	87	98	111	108	113	97	80	83	81	88	87
País Vasco	304	334	318	332	361	397	447	441	470	416	380	394	375	387	376
Rioja	34	39	38	44	51	49	53	52	55	47	41	43	41	47	45

Euros per capita	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**116**	**129**	**120**	**127**	**135**	**146**	**160**	**156**	**162**	**140**	**127**	**129**	**126**	**130**	**128**
Andalucía	115	130	121	129	136	151	161	157	162	142	129	121	117	124	125
Aragón	110	122	113	119	126	134	151	142	150	136	118	130	124	133	131
Asturias	120	131	123	129	137	146	168	159	169	147	136	136	133	135	132
Illes Balears	94	104	102	103	108	114	129	133	133	108	108	118	115	112	115
Canarias	102	111	105	107	110	117	131	119	117	105	105	111	109	111	111
Cantabria	148	165	157	166	179	183	200	205	214	203	159	165	153	161	155
Castilla y León	129	142	134	143	146	162	172	171	176	156	142	141	142	146	145
Castilla-La Mancha	128	138	137	147	155	169	187	185	196	153	138	138	137	144	141
Cataluña	114	131	118	126	136	147	161	159	163	139	125	128	124	132	131
Comunidad Valenciana	110	118	106	109	116	124	142	136	139	119	106	113	115	115	115
Extremadura	130	144	134	144	154	168	186	179	188	160	152	158	151	150	145
Galicia	113	126	117	125	132	144	159	153	154	137	129	132	129	134	131
Madrid	112	127	118	124	132	140	154	145	162	136	122	124	121	118	117
Murcia	112	124	116	121	132	150	167	160	167	145	136	138	134	137	135
Navarra	130	143	130	135	144	157	175	170	176	150	124	130	126	137	136
País Vasco	144	158	150	156	169	184	206	203	215	190	174	180	171	177	171
Rioja	119	133	127	144	164	154	166	162	169	144	128	134	131	149	142

Source: Author's own work based on IGAE (2021), ME (2021) and MS (2021a), several years and Ruiz, O. (2019).

Table 58. Public spending in FPS in Spain from 2003 to 2017. Social Security.

Million Euros	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**3,603**	**3,891**	**4,138**	**4,533**	**4,740**	**5,016**	**5,020**	**4,961**	**4,616**	**4,393**	**4,307**	**4,223**	**4,078**	**4,136**	**4,091**
Andalucía	674	729	770	846	879	943	932	920	848	816	837	691	670	729	729
Aragón	88	97	101	111	116	121	121	118	112	109	103	108	101	107	106
Asturias	93	99	103	111	114	118	120	116	110	105	103	100	97	93	90
Illes Balears	55	60	68	71	76	80	80	86	78	69	78	88	82	70	77
Canarias	104	111	121	132	138	146	141	135	124	116	130	133	132	127	133
Cantabria	72	78	82	89	93	94	95	96	87	91	77	78	71	72	68
Castilla y León	246	263	276	305	305	328	320	318	289	282	276	270	266	265	258
Castilla-La Mancha	184	195	219	243	255	275	282	281	260	241	240	234	232	240	228
Cataluña	580	622	662	735	776	818	822	819	753	717	698	722	662	717	722
Comunidad Valenciana	291	314	339	372	390	410	413	413	382	356	313	324	345	323	318
Extremadura	106	113	119	129	137	142	142	140	130	122	126	130	121	112	105
Galicia	220	238	246	268	277	288	287	280	255	243	244	245	235	243	233
Madrid	490	540	575	622	655	696	708	688	670	631	606	612	592	551	555
Murcia	98	107	116	128	136	149	148	147	138	131	133	132	131	128	127
Navarra	51	55	58	63	66	70	70	70	65	62	45	46	45	53	51
País Vasco	225	241	253	273	287	301	303	300	280	269	270	278	268	271	255
Rioja	26	29	31	36	40	38	37	37	34	32	29	30	28	36	34

Euros per capita	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**84**	**90**	**94**	**101**	**105**	**109**	**107**	**106**	**98**	**93**	**91**	**90**	**87**	**89**	**88**
Andalucía	89	95	98	106	109	115	112	110	101	97	99	82	80	87	87
Aragón	72	77	79	87	90	91	90	87	83	81	76	82	77	82	81
Asturias	86	92	96	103	106	109	111	107	102	97	96	95	92	89	87
Illes Balears	58	62	69	71	74	74	73	77	70	62	70	80	74	63	69
Canarias	55	58	62	66	68	70	67	64	58	55	61	63	63	60	63
Cantabria	131	141	146	157	162	161	162	162	147	153	130	133	122	123	117
Castilla y León	99	105	110	121	121	128	125	124	113	111	110	108	108	108	106
Castilla-La Mancha	101	106	115	126	129	135	135	134	123	114	114	113	113	118	112
Cataluña	87	91	95	103	108	111	110	109	100	95	92	96	88	95	96
Comunidad Valenciana	65	69	72	77	80	82	81	81	75	69	61	65	69	65	64
Extremadura	99	105	110	119	125	129	128	126	117	110	114	119	111	103	98
Galicia	80	87	89	97	100	104	103	100	91	87	88	89	86	89	86
Madrid	86	93	96	104	108	111	111	106	103	97	93	95	92	85	85
Murcia	77	83	87	93	98	105	102	100	94	89	90	90	89	87	86
Navarra	89	95	97	104	109	112	112	109	102	96	70	72	70	82	80
País Vasco	107	114	119	128	134	139	139	138	128	123	123	127	122	124	116
Rioja	90	98	103	119	130	119	115	113	106	99	90	94	90	115	108

Source: Author's own work based on IGAE (2021), ME (2021) and MS (2021a), several years and Ruiz, O. (2019).

Table 59. Public spending in FPS in Spain from 2003 to 2017. Regional Administration.

Million Euros	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**71,160**	**78,607**	**86,185**	**93,824**	**101,472**	**112,049**	**120,179**	**117,559**	**114,960**	**106,789**	**104,081**	**104,307**	**109,228**	**111,558**	**114,666**
Andalucía	12,156	13,621	14,911	16,410	17,644	19,974	20,658	20,190	19,307	18,341	18,330	17,639	18,251	19,002	19,457
Aragón	2,084	2,330	2,512	2,732	2,988	3,249	3,527	3,403	3,432	3,141	3,118	3,094	3,189	3,314	3,441
Asturias	1,889	2,031	2,194	2,337	2,502	2,670	2,973	2,825	2,842	2,485	2,485	2,522	2,590	2,590	2,649
Illes Balears	1,390	1,538	1,822	1,901	2,080	2,269	2,504	2,735	2,629	2,232	2,261	2,343	2,504	2,516	2,647
Canarias	3,173	3,466	3,900	4,173	4,401	4,792	5,151	4,857	4,607	4,289	4,347	4,462	4,631	4,726	4,894
Cantabria	1,032	1,147	1,284	1,368	1,488	1,491	1,609	1,645	1,558	1,514	1,529	1,574	1,649	1,606	1,632
Castilla y León	4,430	4,770	5,282	5,732	5,789	6,557	6,689	6,599	6,218	6,218	6,043	5,983	6,322	6,368	6,621
Castilla-La Mancha	3,130	3,304	3,978	4,426	4,809	5,413	5,912	5,888	5,844	4,851	4,671	4,627	4,903	4,956	5,141
Cataluña	10,855	12,467	13,286	14,750	16,198	17,779	19,073	19,084	18,214	17,019	16,242	16,337	17,089	17,733	18,332
Comunidad Valenciana	7,713	8,146	8,795	9,461	10,313	11,423	12,694	12,512	12,079	11,156	10,283	10,716	11,428	11,647	11,826
Extremadura	1,955	2,129	2,301	2,512	2,726	2,993	3,221	3,099	3,042	2,775	2,776	2,822	2,949	2,965	3,007
Galicia	4,561	5,017	5,382	5,883	6,299	6,899	7,334	7,130	6,656	6,378	6,466	6,316	6,662	6,821	6,917
Madrid	8,828	10,008	10,990	11,854	12,786	13,833	14,985	13,934	14,908	13,744	13,193	13,363	14,030	13,891	14,365
Murcia	2,096	2,324	2,597	2,847	3,209	3,780	4,086	4,013	4,004	3,618	3,561	3,543	3,727	3,789	3,906
Navarra	1,118	1,218	1,298	1,385	1,507	1,685	1,835	1,825	1,792	1,587	1,571	1,592	1,664	1,724	1,804
País Vasco	4,266	4,548	5,038	5,313	5,863	6,439	7,089	6,998	7,025	6,692	6,471	6,633	6,847	7,095	7,201
Rioja	483	544	617	741	871	804	839	821	803	748	735	741	792	815	826

Euros per capita	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**1,666**	**1,820**	**1,954**	**2,099**	**2,245**	**2,428**	**2,571**	**2,500**	**2,436**	**2,259**	**2,208**	**2,230**	**2,343**	**2,396**	**2,462**
Andalucía	1,598	1,772	1,900	2,057	2,189	2,435	2,488	2,412	2,292	2,171	2,172	2,099	2,173	2,265	2,322
Aragón	1,695	1,865	1,980	2,138	2,304	2,449	2,621	2,526	2,549	2,328	2,315	2,335	2,419	2,533	2,629
Asturias	1,757	1,892	2,038	2,170	2,327	2,472	2,739	2,605	2,628	2,306	2,326	2,375	2,464	2,484	2,560
Illes Balears	1,467	1,610	1,853	1,899	2,018	2,115	2,286	2,473	2,362	1,994	2,034	2,123	2,267	2,272	2,372
Canarias	1,675	1,809	1,981	2,091	2,172	2,308	2,448	2,293	2,166	2,025	2,052	2,120	2,205	2,249	2,322
Cantabria	1,878	2,068	2,283	2,408	2,598	2,561	2,730	2,778	2,626	2,550	2,583	2,673	2,818	2,759	2,812
Castilla y León	1,781	1,913	2,104	2,272	2,289	2,564	2,609	2,578	2,430	2,442	2,398	2,398	2,557	2,602	2,729
Castilla-La Mancha	1,724	1,787	2,100	2,290	2,432	2,649	2,841	2,806	2,763	2,286	2,223	2,226	2,381	2,427	2,531
Cataluña	1,619	1,830	1,899	2,067	2,246	2,414	2,551	2,540	2,416	2,248	2,150	2,173	2,276	2,357	2,426
Comunidad Valenciana	1,725	1,793	1,874	1,968	2,111	2,271	2,492	2,448	2,360	2,175	2,011	2,141	2,295	2,348	2,393
Extremadura	1,821	1,980	2,123	2,312	2,501	2,727	2,922	2,799	2,742	2,504	2,515	2,567	2,698	2,726	2,784
Galicia	1,658	1,824	1,948	2,126	2,272	2,478	2,623	2,549	2,381	2,293	2,338	2,298	2,438	2,509	2,554
Madrid	1,544	1,724	1,843	1,973	2,102	2,206	2,346	2,157	2,297	2,115	2,031	2,070	2,180	2,148	2,207
Murcia	1,651	1,795	1,944	2,077	2,305	2,651	2,825	2,745	2,724	2,454	2,419	2,415	2,540	2,586	2,657
Navarra	1,933	2,082	2,186	2,301	2,487	2,716	2,911	2,865	2,791	2,462	2,438	2,484	2,599	2,690	2,805
País Vasco	2,020	2,150	2,371	2,490	2,737	2,985	3,264	3,213	3,216	3,051	2,952	3,030	3,128	3,240	3,282
Rioja	1,679	1,851	2,049	2,417	2,819	2,532	2,609	2,548	2,486	2,310	2,282	2,323	2,499	2,582	2,620

Source: Author's own work based on IGAE (2021), ME (2021) and MS (2021a), several years and Ruiz, O. (2019).

Table 60. Public spending in FPS in Spain from 2003 to 2017. Local Administration.

Million Euros	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**5,591**	**6,369**	**7,309**	**8,261**	**9,081**	**9,266**	**10,177**	**9,495**	**9,102**	**8,032**	**8,004**	**8,071**	**8,606**	**8,946**	**9,442**
Andalucía	952	993	1,111	1,395	1,564	1,559	1,754	1,663	1,593	1,385	1,465	1,239	1,323	1,497	1,619
Aragón	115	151	155	176	194	205	250	209	195	185	197	198	218	223	237
Asturias	133	148	166	185	197	196	219	227	199	176	180	179	189	185	187
Illes Balears	114	135	160	156	164	167	191	210	182	155	165	183	179	151	173
Canarias	175	198	240	246	279	305	302	269	263	230	242	247	263	255	289
Cantabria	101	107	125	149	163	161	176	159	154	141	127	135	136	141	144
Castilla y León	338	358	452	496	517	547	597	552	550	483	471	468	503	515	542
Castilla-La Mancha	274	298	378	418	493	462	509	488	450	416	431	433	481	512	529
Cataluña	1,023	1,216	1,360	1,570	1,709	1,751	1,942	1,774	1,718	1,541	1,456	1,607	1,730	1,906	2,005
Comunidad Valenciana	483	549	634	694	731	756	850	798	752	642	591	616	707	691	682
Extremadura	153	168	196	208	244	227	253	237	225	194	212	219	228	212	215
Galicia	320	361	426	444	499	499	553	489	473	423	428	439	456	482	499
Madrid	784	950	1,036	1,184	1,284	1,326	1,458	1,325	1,294	1,126	1,103	1,134	1,202	1,148	1,266
Murcia	149	175	212	229	279	295	288	282	255	216	225	232	254	251	266
Navarra	91	113	137	145	148	172	167	149	144	133	102	104	102	120	117
País Vasco	351	409	472	504	545	579	603	595	588	529	555	580	579	585	598
Rioja	34	40	50	62	74	60	65	69	67	57	53	55	55	73	76

Euros per capita	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**131**	**147**	**166**	**185**	**201**	**201**	**218**	**202**	**193**	**170**	**170**	**173**	**185**	**192**	**203**
Andalucía	125	129	142	175	194	190	211	199	189	164	174	147	158	178	193
Aragón	94	121	122	138	150	154	186	155	145	137	146	150	165	171	181
Asturias	123	137	154	172	183	181	202	209	184	163	169	169	180	178	181
Illes Balears	120	141	163	155	160	156	174	190	163	139	148	166	162	136	155
Canarias	92	104	122	123	138	147	144	127	124	108	114	117	125	121	137
Cantabria	184	193	223	261	284	276	298	269	260	237	215	229	233	242	248
Castilla y León	136	143	180	197	204	214	233	216	215	190	187	188	203	210	223
Castilla-La Mancha	151	161	199	216	249	226	245	232	213	196	205	209	234	251	260
Cataluña	153	178	194	220	237	238	260	236	228	204	193	214	230	253	265
Comunidad Valenciana	108	121	135	144	150	150	167	156	147	125	116	123	142	139	138
Extremadura	143	156	181	191	224	207	230	214	203	175	192	200	209	195	199
Galicia	116	131	154	161	180	179	198	175	169	152	155	160	167	177	184
Madrid	137	164	174	197	211	211	228	205	199	173	170	176	187	178	195
Murcia	117	135	159	167	200	207	199	193	173	147	153	158	173	171	181
Navarra	157	194	230	241	244	278	264	234	224	206	159	162	160	187	182
País Vasco	166	193	222	236	254	269	278	273	269	241	253	265	265	267	273
Rioja	120	136	165	201	239	189	202	215	208	175	165	174	174	232	240

Source: Author's own work based on IGAE (2021), ME (2021) and MS (2021a), several years and Ruiz, O. (2019).

Table 61. Total public spending in Education in Spain from 2003 to 2017.

Million Euros	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**32,276**	**35,089**	**36,726**	**39,813**	**43,316**	**47,026**	**49,671**	**48,489**	**47,118**	**43,286**	**42,106**	**42,552**	**44,390**	**45,333**	**46,449**
Andalucía	5,419	5,968	6,346	7,130	7,885	8,599	9,018	8,997	8,675	8,186	8,007	8,163	8,325	8,549	8,728
Aragón	870	944	982	1,068	1,178	1,285	1,376	1,312	1,277	1,214	1,211	1,214	1,242	1,295	1,359
Asturias	780	798	835	900	982	1,011	1,067	1,042	993	870	870	859	889	896	913
Illes Balears	650	701	764	828	870	954	1,047	1,058	1,032	946	935	954	1,016	1,040	1,084
Canarias	1,506	1,632	1,750	1,867	1,919	1,989	2,110	1,972	1,854	1,776	1,776	1,827	1,841	1,888	1,954
Cantabria	366	398	445	482	544	580	627	625	633	578	571	593	598	622	624
Castilla y León	1,949	2,004	2,213	2,221	2,364	2,556	2,659	2,539	2,474	2,361	2,298	2,256	2,338	2,377	2,396
Castilla-La Mancha	1,434	1,525	1,662	1,803	2,042	2,213	2,300	2,295	2,374	1,909	1,789	1,774	1,858	1,870	1,954
Cataluña	4,635	5,817	5,705	6,286	6,863	7,461	7,811	7,730	7,448	6,927	6,357	6,427	7,037	7,337	7,480
Comunidad Valenciana	3,972	3,934	3,908	4,192	4,563	5,122	5,603	5,311	5,069	4,320	4,263	4,364	4,682	4,705	4,824
Extremadura	862	914	946	1,019	1,071	1,172	1,260	1,180	1,161	1,059	1,085	1,101	1,166	1,166	1,181
Galicia	2,002	2,073	2,236	2,421	2,641	2,866	2,928	2,881	2,691	2,537	2,530	2,516	2,581	2,666	2,710
Madrid	4,101	4,488	4,741	5,171	5,454	5,728	6,008	5,715	5,605	5,139	5,108	5,081	5,242	5,239	5,401
Murcia	949	1,004	1,085	1,190	1,395	1,586	1,670	1,653	1,601	1,493	1,456	1,441	1,492	1,524	1,556
Navarra	526	562	592	619	662	767	778	779	756	643	682	692	701	717	754
País Vasco	2,055	2,117	2,286	2,364	2,596	2,846	3,094	3,086	3,173	3,043	2,879	3,000	3,055	3,125	3,205
Rioja	200	210	228	253	288	292	315	314	301	285	288	292	325	316	326

Euros per capita	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**756**	**812**	**833**	**890**	**958**	**1,019**	**1,063**	**1,031**	**998**	**916**	**893**	**910**	**952**	**974**	**997**
Andalucía	712	776	808	894	978	1,048	1,086	1,075	1,030	969	949	971	991	1,019	1,042
Aragón	707	755	774	836	909	968	1,022	974	948	900	899	916	943	990	1,039
Asturias	726	744	776	836	913	936	983	961	918	808	814	809	846	860	882
Illes Balears	686	734	777	827	844	889	956	956	927	845	841	864	920	940	971
Canarias	795	852	889	935	947	958	1,003	931	872	838	838	868	876	898	927
Cantabria	666	718	792	849	949	996	1,063	1,055	1,068	973	965	1,007	1,022	1,069	1,075
Castilla y León	783	804	881	880	935	999	1,037	992	967	927	912	904	946	971	988
Castilla-La Mancha	790	825	877	933	1,033	1,083	1,105	1,094	1,122	900	851	854	902	916	962
Cataluña	691	854	816	881	952	1,013	1,045	1,029	988	915	842	855	937	975	990
Comunidad Valenciana	888	866	833	872	934	1,018	1,100	1,039	991	842	834	872	940	949	976
Extremadura	803	850	873	938	982	1,068	1,143	1,066	1,047	956	983	1,002	1,066	1,072	1,094
Galicia	728	754	810	875	953	1,029	1,047	1,030	963	912	915	915	945	981	1,001
Madrid	717	773	795	861	897	913	941	885	864	791	786	787	814	810	830
Murcia	748	775	812	868	1,002	1,112	1,154	1,130	1,089	1,012	989	982	1,017	1,041	1,058
Navarra	909	960	997	1,028	1,092	1,236	1,234	1,223	1,178	997	1,059	1,081	1,094	1,119	1,172
País Vasco	973	1,001	1,076	1,108	1,212	1,320	1,425	1,416	1,452	1,387	1,313	1,370	1,396	1,427	1,461
Rioja	695	716	759	824	932	920	979	973	931	880	895	916	1,027	1,001	1,034

Source: Author's own work based on IGAE (2021) and ME (2021).
Note: It includes spending of the following subsectors: Central Administration, Social Security, Regional Administration and Local Administration.

Table 62. Total public spending in Health in Spain from 2003 to 2017.

Million Euros	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**41,519**	**46,921**	**52,471**	**56,717**	**61,280**	**67,344**	**72,997**	**71,136**	**69,306**	**64,734**	**63,377**	**63,507**	**66,489**	**67,724**	**69,312**
Andalucía	6,945	7,897	8,658	9,397	9,943	11,386	11,629	11,152	10,451	9,981	10,080	9,617	9,999	10,348	10,527
Aragón	1,325	1,538	1,655	1,791	1,950	2,096	2,322	2,218	2,270	2,052	2,012	2,005	2,084	2,145	2,194
Asturias	1,187	1,325	1,440	1,509	1,596	1,713	1,978	1,863	1,905	1,666	1,666	1,719	1,750	1,760	1,798
Illes Balears	861	983	1,222	1,214	1,356	1,449	1,614	1,871	1,753	1,405	1,423	1,468	1,571	1,594	1,662
Canarias	1,931	2,132	2,467	2,612	2,813	3,153	3,388	3,178	3,023	2,757	2,791	2,861	3,000	3,070	3,154
Cantabria	658	743	825	863	925	854	919	956	849	892	921	942	1,014	944	966
Castilla y León	2,551	2,847	3,161	3,565	3,446	4,000	4,007	4,029	3,688	3,824	3,724	3,676	3,928	3,940	4,147
Castilla-La Mancha	1,730	1,814	2,381	2,653	2,837	3,171	3,585	3,570	3,395	2,851	2,792	2,779	2,938	2,951	3,055
Cataluña	6,741	7,369	8,199	9,094	10,055	10,905	11,914	11,908	11,202	10,473	10,258	10,280	10,637	10,850	11,160
Comunidad Valenciana	4,232	4,768	5,418	5,769	6,268	6,779	7,654	7,727	7,460	7,199	6,484	6,836	7,158	7,457	7,493
Extremadura	1,140	1,274	1,405	1,520	1,711	1,833	1,980	1,928	1,874	1,701	1,683	1,705	1,770	1,810	1,839
Galicia	2,743	3,178	3,366	3,640	3,871	4,204	4,600	4,387	4,060	3,944	4,063	3,923	4,199	4,252	4,296
Madrid	4,954	5,919	6,530	6,918	7,600	8,223	9,102	8,203	9,318	8,566	8,117	8,290	8,761	8,708	8,959
Murcia	1,242	1,443	1,637	1,765	1,969	2,355	2,556	2,496	2,508	2,209	2,196	2,197	2,313	2,351	2,428
Navarra	657	744	797	849	927	1,012	1,138	1,112	1,093	999	988	1,001	1,058	1,078	1,121
País Vasco	2,326	2,595	2,905	3,045	3,388	3,691	4,082	4,017	3,947	3,749	3,716	3,745	3,834	3,983	4,028
Rioja	294	350	406	514	624	520	530	520	511	466	462	462	476	483	486

Euros per capita	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**972**	**1,086**	**1,190**	**1,269**	**1,356**	**1,459**	**1,562**	**1,513**	**1,469**	**1,370**	**1,345**	**1,358**	**1,426**	**1,455**	**1,488**
Andalucía	913	1,027	1,103	1,178	1,234	1,388	1,401	1,332	1,241	1,181	1,194	1,145	1,190	1,234	1,256
Aragón	1,077	1,231	1,304	1,402	1,504	1,580	1,726	1,647	1,686	1,520	1,494	1,512	1,581	1,639	1,676
Asturias	1,104	1,234	1,337	1,401	1,485	1,586	1,823	1,718	1,761	1,546	1,560	1,619	1,665	1,688	1,737
Illes Balears	909	1,029	1,243	1,213	1,316	1,351	1,473	1,691	1,575	1,255	1,280	1,330	1,423	1,440	1,490
Canarias	1,019	1,113	1,253	1,309	1,389	1,519	1,610	1,500	1,421	1,302	1,317	1,359	1,428	1,461	1,496
Cantabria	1,197	1,339	1,467	1,520	1,615	1,467	1,560	1,615	1,431	1,503	1,556	1,601	1,732	1,622	1,665
Castilla y León	1,026	1,142	1,259	1,413	1,363	1,564	1,563	1,574	1,441	1,502	1,478	1,473	1,589	1,610	1,710
Castilla-La Mancha	953	981	1,256	1,373	1,435	1,552	1,722	1,701	1,605	1,344	1,329	1,337	1,427	1,446	1,504
Cataluña	1,005	1,082	1,172	1,275	1,394	1,481	1,594	1,585	1,486	1,383	1,358	1,367	1,417	1,442	1,477
Comunidad Valenciana	947	1,050	1,155	1,200	1,283	1,348	1,502	1,512	1,458	1,404	1,268	1,366	1,437	1,503	1,516
Extremadura	1,062	1,185	1,296	1,399	1,570	1,670	1,796	1,741	1,689	1,535	1,524	1,551	1,619	1,664	1,703
Galicia	997	1,155	1,218	1,315	1,396	1,510	1,645	1,568	1,452	1,418	1,469	1,427	1,537	1,564	1,586
Madrid	866	1,020	1,095	1,151	1,250	1,311	1,425	1,270	1,436	1,318	1,250	1,284	1,361	1,347	1,377
Murcia	979	1,115	1,226	1,288	1,414	1,652	1,767	1,708	1,706	1,499	1,492	1,498	1,576	1,605	1,651
Navarra	1,136	1,272	1,343	1,410	1,530	1,632	1,805	1,746	1,702	1,549	1,533	1,562	1,652	1,683	1,743
País Vasco	1,101	1,227	1,367	1,427	1,582	1,711	1,879	1,844	1,807	1,709	1,696	1,711	1,751	1,819	1,836
Rioja	1,022	1,191	1,350	1,677	2,019	1,636	1,646	1,613	1,583	1,441	1,434	1,448	1,500	1,529	1,540

Source: Author's own work based on IGAE (2021) and MS (2021a).
Note: It includes spending of the following subsectors: Central Administration, Social Security, Regional Administration and Local Administration.

Table 63. Total public spending in Essential Social Services in Spain from 2003 to 2017.

Million Euros	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**11,523**	**12,445**	**13,736**	**15,763**	**16,782**	**18,693**	**20,208**	**19,708**	**19,902**	**17,795**	**16,888**	**16,562**	**16,887**	**17,617**	**18,420**
Andalucía	2,297	2,479	2,739	3,153	3,357	3,730	4,031	3,940	3,990	3,573	3,625	2,796	2,889	3,372	3,596
Aragón	229	249	273	312	333	372	403	391	394	352	354	356	347	378	402
Asturias	277	295	320	363	381	418	449	435	436	388	378	370	379	353	353
Illes Balears	137	147	164	189	205	233	254	249	252	226	266	323	304	226	279
Canarias	208	225	250	287	307	343	371	363	366	326	373	386	412	383	442
Cantabria	262	283	310	355	377	418	452	440	444	396	335	348	335	346	344
Castilla y León	834	893	973	1,107	1,169	1,291	1,382	1,337	1,345	1,195	1,131	1,149	1,186	1,188	1,235
Castilla-La Mancha	656	713	791	914	985	1,111	1,209	1,182	1,198	1,073	1,054	1,034	1,112	1,181	1,179
Cataluña	1,850	2,008	2,231	2,578	2,745	3,060	3,317	3,232	3,263	2,925	2,726	2,917	2,729	3,158	3,401
Comunidad Valenciana	775	841	940	1,091	1,168	1,313	1,420	1,382	1,391	1,245	980	1,033	1,225	1,071	1,079
Extremadura	352	377	411	466	493	542	581	566	571	509	513	539	528	476	465
Galicia	668	713	775	879	928	1,018	1,091	1,059	1,064	945	905	926	927	991	1,000
Madrid	1,685	1,827	2,031	2,318	2,473	2,784	3,027	2,967	3,000	2,682	2,464	2,532	2,591	2,408	2,582
Murcia	293	320	357	415	444	496	538	527	533	477	468	471	502	493	512
Navarra	152	164	180	207	220	246	267	261	265	237	128	131	133	189	185
País Vasco	766	819	890	1,013	1,072	1,178	1,267	1,231	1,243	1,114	1,080	1,135	1,172	1,232	1,197
Rioja	83	91	101	116	124	139	150	146	147	132	108	115	116	173	169

Euros per capita	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	**270**	**288**	**311**	**353**	**371**	**405**	**432**	**419**	**422**	**376**	**358**	**354**	**362**	**378**	**396**
Andalucía	302	323	349	395	417	455	486	471	474	423	430	333	344	402	429
Aragón	186	199	215	244	257	281	300	291	292	261	262	269	263	289	307
Asturias	257	275	297	337	355	387	413	401	403	360	354	348	360	339	341
Illes Balears	144	154	167	189	199	218	232	225	227	202	239	293	275	204	250
Canarias	110	117	127	144	151	165	177	171	172	154	176	184	196	182	210
Cantabria	477	509	551	624	658	718	767	743	748	668	565	591	572	594	593
Castilla y León	335	358	387	439	462	505	539	523	526	469	449	461	480	485	509
Castilla-La Mancha	361	386	417	473	498	544	581	563	567	506	502	497	540	578	580
Cataluña	276	295	319	361	381	416	444	430	433	386	361	388	363	420	450
Comunidad Valenciana	173	185	200	227	239	261	279	270	272	243	192	206	246	216	218
Extremadura	328	350	379	429	452	494	527	511	514	459	465	490	483	438	430
Galicia	243	259	280	318	335	366	390	378	381	340	327	337	339	364	369
Madrid	295	315	341	386	407	444	474	459	462	413	379	392	403	372	397
Murcia	231	247	267	303	319	348	372	360	363	324	318	321	342	337	348
Navarra	263	281	304	344	363	396	423	410	412	368	198	205	208	295	288
País Vasco	363	387	419	475	500	546	583	565	569	508	493	519	535	562	546
Rioja	290	310	336	380	401	437	467	453	455	407	337	361	367	547	536

Source: Author's own work based on IGAE, and Ruiz, O. (2019).

Note: It includes spending of the following subsectors: Central Administration, Social Security, Regional Administration and Local Administration.

To capture the association between per capita spending in fundamental public services (y) and population dispersion (x_1), we have specified a model based on the FPS cost drivers that the financing model of the Spanish regions considers: population dispersion, surface and population structure.[47] We completed them with other variables that the literature has shown are also determining factors, such as regional income (GDP per capita) (x_2).

To estimate the effects of the determining factors on FPS spending we once again worked with the pooled database including the indicator values for the seventeen Spanish regions and the fifteen years we examined in this work.

If we had used simple linear regression to estimate the "pool data model":

$$y_{it} = \beta_0 + \beta_1 x_{1it} + \varepsilon_{it}$$

$$i = 1 \ldots 17 \; for\ the\ individual\ or\ regional\ label\ and$$
$$t = 1 \ldots 15 \; for\ the\ temporal\ label$$

[47] The rationale behind these basic age groups is detailed below.
Education target population:
0-2 (x_3) First cycle of early childhood education, which according to the Ministry of Education has soared 10 pp during the last decade in Spain and overpasses in 12 pp the OECD average.
(ME (2020): https://www.educacionyfp.gob.es/en/prensa/actualidad/2020/09/20200908-panoramadelaeducacion.html)
3-25 (x_4) It starts with the second cycle of early childhood education (3-6). The period in life cycle from 7 to 18, is significant regarding education services, given that primary education (compulsory) takes places between 6 and 12 years of age, and compulsory secondary education between 12 and 16 years of age. Post compulsory secondary education holds for teens between 16 and 18 years old. From 18 to 25, after secondary education, it comes some kind of higher education, either at university or occupational training aimed at some profession. It is not compulsory but we believe that it is highly spread out: according to the Ministry of Education "*The access rate to higher education is 64.8% in Spain, while the OECD average is 49%.*"
ME(2020): https://www.educacionyfp.gob.es/en/prensa/actualidad/2020/09/20200908-panoramadelaeducacion.html)
Health target population:
0-2 This period in life cycle is significant regarding health services: Per capita health expenditure is high in the first year of life and in paediatric care within primary health care spending is mainly driven by consultation by children under 2 (80% of total spending) (Aguado, A. (2012)).
26-44 (x_5) This age period is relevant in terms of health care because it is the fertile age for women and the age range when the most car accidents takes place. These facts produce a perceptible shift in the per capita health expenditure profile (Blanco et al. (2019)).
45-64 (x_6) Late adult life is significant regarding health care as health expenditure per capita start to increase at a higher pace as of the age of 45. It remains since then with an increasing trend. We have though opted for dividing the group 65+ into three groups for the reasons pointed out below.
65-84 (x_7) This period of life is significant regarding health services: Some studies point out that over 60% of the health care spending a person needs over a lifetime takes place after 65. Primary health care spending for people over 74 years old is estimated to be six times higher than for the group of people between 15 and 44 years old. (Aguado, A. (2012)).
85+ (x_8) We breakdown this age group from that of 65+ because it is relevant on the ground that a third of the spending in health care in one´s life period is estimated to take place after 85. Even when spending in hospitals for this age section is lower, total health care spending as a whole is higher than for other ages.
These facts are further supported by other analysis regarding the profile of per capita health care spending, such as the one by Blanco et al. (2019).
Essential social services target population:
We considered the same relevant groups as for health care.

we would have obtained biased estimates for the coefficients that shape the association between both variables, thus distorting the conclusions. A major issue in this case is that of non-observable heterogeneity. Even if we control by other cost drivers, such as population structure, surface, and other determining factors of per capita FPS spending, such as GDP per capita, non-observable heterogeneity would still be an issue, considering the complexity of per capita FPS drivers.

Thus, the estimation was done in a panel data context controlling for both cross-section dependence and unobserved heterogeneity. A one-way fixed effect error component model was considered due to our focus on the regional differences in FPS expending rather than differences across time. Therefore, we used a panel data model to estimate the association between per capita FPS spending and population dispersion, controlling by population structure, GDP per capita and enclosing in transversal (regional) effects non-observable heterogeneity.

To propose the model that we have finally estimated, we have taken into account the following considerations:

- Generally, the panel data model considers that transversal (α_i) and temporal (λ_t) effects can be fixed or random. Nonetheless, following Arellano, "*The problem is not whether the effects are fixed or random. In fact, as the above discussion reveals, the effects can always be considered random without loss of generality. The problem is whether the effects are correlated with x_i, or not.*" (Arellano, (1993)). In our case, the omitted variables most likely will be correlated to our included control variables, thus we will consider α_i fixed effects.

- Transversal fixed effects are different among individuals (regions) and invariant over time and it is assumed that they directly affect the decisions made by the public authority concerning FPS. Generally, these types of effects would be identified with issues of services managing capacity, operational efficiency, "know-how", access to technology, presence of reference services, etc. In our specific case, we would mention as well the health status[48] and the disability status as examples.[49] Normally, we would have included provincial surface as one of the variables in the model. Nonetheless, it is constant over time and cannot be explicitly included in its estimation because of multicollinearity effects, which would distort the parameter estimates leading to an unrealistic lack of statistical significance. Thus, its effect will be embedded in transversal effects.

- On the other hand, temporary fixed effects are those that are invariant among regions and that, in addition, vary over time. These types of effects are usually associated, for example, with macroeconomic shocks that affect the regions equally (a rise in interest rates, an increase in energy prices, an increase in inflation, etc.), or changes in the system's regulations. We have disregarded time-specific effects (λ_t) which are regionally invariable as we have considered more plausible that most per capita FPS determining factors will present regional differences. Nevertheless, we highlight that future analysis expanding the temporal horizon of this study will have to include the temporal effect to capture the impact of the COVID-19 pandemic.

- Based on our findings concerning the interaction between population dispersion and ageing (ζ), we have included the interactions between population dispersion and the population structure in the model.

Our general model is:

$$y_{it} = \sum_{k \in \Im} \beta_k x_{kit} + \sum_{k \in \aleph} \zeta_{1k} x_{1it} x_{kit} + \alpha_i + \varepsilon_{it} \quad [1]$$

$With$:

$$Constant\ term\ embedded\ in\ transversal\ effects$$
$$All\ the\ variables\ in\ natural\ logarithm$$
$$Spending\ in\ constant\ terms\ (Euros\ of\ 2003).$$

Where:

$$i = 1 \dots 17\ for\ the\ individual\ or\ regional\ label$$
$$t = 1 \dots 15\ for\ the\ temporal\ label$$

[48] With an average annual increase in the analysed period between 0.3% and 0.4% at the national level and among regions. MS (2021b)
[49] With an average annual increase in the analysed period between -0.1% and 2.3% at the national level and among regions. MS (2021b)

$\mathfrak{I}$	Set of variable indices depending on the type of spending. They represent the explanatory variables included in each model. Population dispersion and income are always included. However, to avoid multicollinearity, the age-structure-related variables (which are described below) cannot be all included simultaneously. They have been selected according to the target population for each type of spending and transformed as required (typically, by aggregation).
$\aleph$	Set of variable indices for interaction between population dispersion and age structure. According to our analysis, we have included up to two types of interactions. First with population aged 0 to 2 and second with population aged 65 and over.
y	*Per capita spending in FPS (alternatively, education, health, or essential social services)*
x_1	*Population dispersion*
x_2	*Per capita GDP*
x_3	*Percentage population aged 0 to 2*
x_4	*Percentage population aged 3 to 25*
x_5	*Percentage population aged 26 to 44*
x_6	*Percentage population aged 45 to 64*
x_7	*Percentage population aged 65 to 84*
x_8	*Percentage population aged 85 and over*
x_{4^*}	*Percentage population aged over 25*
x_{6^*}	*Percentage population aged 26 to 64*
x_{7^*}	*Percentage population aged 65 and over*
α_i	*Individual (regional) specific effect*
ε_{it}	*Error term.*

A model for the association between per capita FPS spending and population dispersion

For spending in FPS we present two equations (p-value below the parameters estimates in brackets):

$$y_{it} = \alpha_i + \underset{(0.0000)}{4.16} x_{1it} + \underset{(0.0000)}{0.92} x_{2it} + \underset{(0.0002)}{4.50} x_{3it} + \underset{(0.0000)}{1.05} x_{x_{6^*it}} + \underset{(0.0958)}{2.75} x_{7^*it} + \underset{(0.0007)}{0.64} x_{1it} x_{3it} + \underset{(0.0786)}{0.46} x_{1it} x_{7^*it} \quad [FPS]$$

We present the results in Table 64. Each model explains 83% of the variability observed in per capita FPS spending. The percentage population aged from 0 to 2 has the largest effect on per capita FPS, with a coefficient of 4.50, followed by the population dispersion (4.16) and the percentage population aged 65 and over (2.75). The coefficient of per capita GDP is 0.92, pointing to an income-elasticity of per capita FPS spending below 1.

Table 64. Estimates for the panel data model [FPS] for FPS spending

		Panel Data Model [FPS]	
		Parameter estimates	p-value
INDEPENDENT VARIABLE			
Per capita FPS spending	***y***	*Per capita FPS spending*	
EXPLANATORY VARIABLES			
Population dispersion	x_1	4.1576	0.0000
Per capita GDP	x_2	0.9186	0.0000
Percentage population aged 0 to 2	x_3	4.5045	0.0002
Percentage population aged 26 to 64	x_{6^*}	1.0493	0.0000
Percentage population aged 65 and over	x_{7^*}	2.7499	0.0958
Interaction x_1 and x_3	$x_1 * x_3$	0.6396	0.0007
Interaction x_1 and x^*_7	$x_1 * x_{7^*}$	0.4577	0.0786
Determination coefficient	R^2	**0.8269**	

Source: Author's own work. Based on:

- The database on population dispersion built ad hoc for this work.
- Tables 55 and 56.
- Population data provided by the INE under petition.
- GDP data from Regional Accounts. INE
- Households Final Consumption from the database BDMORES. Ministry of Finances (MH (2021)).

Note: Constant term embedded in transversal effects. Variables in natural logarithm. Spending in constant Euros of 2003. We have calculated R^2 as follows:

$$R^2 = \frac{EV}{TV} = \frac{\sum(\hat{y}_{it} - \bar{y})^2}{\sum(y_{it} - \bar{y})^2}$$

Where $\hat{y}_{it}$ represents the values predicted by the model.
We omit the fixed effects as our focus is on the rest of the variables.

A model for the association between per capita spending in education and population dispersion

The model estimated for spending in education is (p-value below the parameters estimates in brackets):

$$y_{it} = \alpha_i + \underset{(0.0091)}{2.11_1 x_{1it}} + \underset{(0.0000)}{0.87 x_{2it}} + \underset{(0.0174)}{3.12 x_{3it}} + \underset{(0.0105)}{0.19 x_{4it}} + \underset{(0.0478)}{0.42 x_{1it} x_{2it}} \quad [E]$$

We present the results in Table 65. The model explains 76% of the variability observed in per capita spending in education. Population dispersion has a high effect, with a coefficient of 2.11. Nonetheless, the highest coefficient is that of the percentage population aged 0 to 2 (3.12). The coefficient of per capita GDP is 0.87, pointing to an income-elasticity of per capita spending in education below 1.

Table 65. Estimates for the panel data model [E] for education spending

		Panel Data Model [E]	
		Parameter estimates	p-value
INDEPENDENT VARIABLE			
Per capita education spending	***y***	*Per capita education spending*	
EXPLANATORY VARIABLES			
Population dispersion	x_1	2.1134	0.0091
Per capita GDP	x_2	0.8747	0.0000
Percentage population aged 0 to 2	x_3	3.1229	0.0174
Percentage population aged 3 to 25	x_4	0.1941	0.0105
Interaction x_1 and x_3	$x_1 * x_3$	0.4165	0.0478
Determination coefficient	R^2	**0.7640**	

Source: Author's own work. Based on:

- The database on population dispersion built ad hoc for this work.
- Tables 55 and 61.
- Population data provided by the INE under petition.
- GDP data from Regional Accounts. INE
- Households Final Consumption from the database BDMORES. Ministry of Finances.

Note: Constant term embedded in transversal effects. Variables in natural logarithm. Spending in constant Euros of 2003. We have calculated R^2 as follows:

$$R^2 = \frac{EV}{TV} = \frac{\sum(\hat{y}_{it} - \bar{y})^2}{\sum(y_{it} - \bar{y})^2}$$

Where $\hat{y}_{it}$ represents the values predicted by the model.
We omit the fixed effects as our focus is on the rest of the variables.

A model for the association between per capita spending in health and population dispersion

The model estimated for spending in health is (p-value below the parameters estimates in brackets):

$$y_{it} = \alpha_i + \underset{(0.0000)}{3.65x_{1it}} + \underset{(0.0000)}{0.97x_{2it}} + \underset{(0.0001)}{5.10x_{3it}} + \underset{(0.0000)}{1.40x_{4^*it}} + \underset{(0.0008)}{0.70x_{1it}x_{3it}} \quad [H]$$

We present the results in Table 66. The model explains 75% of the variability observed in per capita spending in health. Population dispersion has a high effect, with a coefficient of 3.65. Nonetheless, the highest coefficient is that of the percentage population aged 0 to 2 (5.10). The coefficient of per capita GDP is 0.97, pointing out an income-elasticity of per capita health spending below 1.

Regarding the estimate for the per capita GDP parameter, which is an estimate of the income-elasticity of health spending, we highlight that other studies have reached different estimates for the value of the mentioned elasticity. We obtained an elasticity value below 1, which is in line with similar analyses such as the one by Baltagi et al. (2010). This points out that, in Spain, health would be a necessity good instead of a luxury one.

Table 66. Estimates for the panel data model [H] for health spending

		Panel Data Model [H]	
		Parameter estimates	p-value
INDEPENDENT VARIABLE			
Per capita health spending	***y***	*Per capita health spending*	
EXPLANATORY VARIABLES			
Population dispersion	x_1	3.6467	0.0000
Per capita GDP	x_2	0.9671	0.0000
Percentage population aged 0 to 2	x_3	5.1017	0.0001
Percentage population aged over 25	x_{4^*}	1.3997	0.0000
Interaction x_1 and x_3	$x_1 * x_3$	0.7048	0.0008
Determination coefficient	R^2	**0.7514**	

Source: Author's own work. Based on:

- The database on population dispersion built ad hoc for this work.
- Tables 55 and 62.
- Population data provided by the INE under petition.
- GDP data from Regional Accounts. INE
- Households Final Consumption from the database BDMORES. Ministry of Finances.

Note: Constant term embedded in transversal effects. Variables in natural logarithm. Spending in constant Euros of 2003. We have calculated R^2 as follows:

$$R^2 = \frac{EV}{TV} = \frac{\sum(\hat{y}_{it} - \bar{y})^2}{\sum(y_{it} - \bar{y})^2}$$

Where $\hat{y}_{it}$ represents the values predicted by the model.
We omit the fixed effects as our focus is on the rest of the variables.

A model for the association between per capita spending in essential social services and population dispersion

The model estimated for spending in essential social services is (p-value below the parameters estimates in brackets):

$$y_{it} = \alpha_i + \underset{(0.0001)}{3.88}x_{1it} + \underset{(0.0000)}{0.95}x_{2it} + \underset{(0.0001)}{0.51}x_{3it} + \underset{(0.0000)}{1.98}x_{6^*it} + \underset{(0.0712)}{5.50}x_{7it} + \underset{(0.0539)}{0.94}x_{1it}x_{7it} \quad [SS]$$

We present the results in Table 67. The model explains 93% of the variability observed in per capita spending in essential social services. Population dispersion has a high effect, with a coefficient of 3.88. Nonetheless, the highest coefficient is that of the percentage population aged 65 to 84 (5.45). The coefficient of per capita GDP is 0.95, pointing out an income-elasticity of per capita spending in essential social services above 1.

Table 67. Estimates for the panel data model [ESS] for essential social services spending

		Panel Data Model [SS]	
		Parameters' estimates	p-value
INDEPENDENT VARIABLE			
Per capita essential social services spending	***y***	*Per capita essential social services spending*	
EXPLANATORY VARIABLES			
Population dispersion	x_1	3.8848	0.0001
Per capita GDP	x_2	0.9450	0.0000
Percentage population aged 0 to 2	x_3	0.5141	0.0001
Percentage population aged 26 to 64	x_{6^*}	1.9836	0.0000
Percentage population aged 65 to 84	x_7	5.4979	0.0712
Interaction x_1 and x_7	$x_1 * x_7$	0.9392	0.0539
Determination coefficient	R^2	**0.9343**	

Source: Author's own work. Based on:

- The database on population dispersion built ad hoc for this work.
- Tables 55 and 63.
- Population data provided by the INE under petition.
- GDP data from Regional Accounts. INE
- Households Final Consumption from the database BDMORES. Ministry of Finances.

Note: Constant term embedded in transversal effects. Variables in natural logarithm. Spending in constant terms: Euros of 2003. We have calculated R^2 as follows:

$$R^2 = \frac{EV}{TV} = \frac{\sum(\hat{y}_{it} - \bar{y})^2}{\sum(y_{it} - \bar{y})^2}$$

Where $\hat{y}_{it}$ represents the values predicted by the model.
We omit the fixed effects as our focus is on the rest of the variables.

7. SUMMARY AND POLICY RECOMMENDATIONS

Our results show that population dispersion in Spain is moderately high: most of the population (56%) the population lives in regions with high level of dispersion. There are significant inter-regional differences between the Spanish regions. In 2016, the value of the composite indicator for population dispersion in Extremadura, the highest in Spain, was 2.86 times that of Madrid, the lowest one. Population dispersion is a condition of land use resulting from aggregating six dimensions: proximity, centrality, nuclearity, density, concentration and continuity. For all of them, most of the population lives in regions with low values of their respective dimension composite indicators.

The interest in population dispersion derives from its effect on spending in the welfare state's fundamental public services: education, health and essential social services (FPS). This effect depends on the ageing of the population with which dispersion interacts. In 2016, an increase of 1% in the composite indicator of population dispersion would have produced, *ceteris paribus*, an increase of the mentioned spending of 1.09%. The increase of population dispersion would have the highest effect on essential social services spending (2.15%), followed by health spending (1.11%) and, finally, for education, it would be 0.62%, the lowest one.

The ultimate concern lies in the sustainability of FPS spending. It can be measured by the percentage of FPS spending over GDP. In Spain, from 2003 to 2017, the income-elasticity of FPS spending (0.92), as well as for education (0.87), health (0.97) and essential social services (0.96), points out that fundamental public services in Spain are necessity goods. Having such an elasticity below 1, will help to maintain the spending sustainable, should the services remain necessity goods in the future.

Our results support that population dispersion is one of the drivers of spending in the welfare state's fundamental public services, and it is thus a factor of sustainability of public finances. It is a driver of the mentioned expenditure not yet explored in Spain as much as others have been; such as population ageing, with which it interacts. Indeed, ageing is around two percentage points (p.p.) higher in population entities farther away from the province capital, and this differential is increasing for the very old people (aged 85 and over) although not for the elderly as a whole (aged 65 and over) for whom it is decreasing.

We have verified through econometric techniques that population dispersion has a relevant effect on per capita FPS spending. Likewise for education, health and essential social services spending separately. In addition, we have found a positive interaction between population dispersion and ageing.

Due to sustainability reasons, population dispersion is a factor that should be considered in the decision-making process regarding the budgeting and planning of FPS. Geographic areas with high population dispersion would need to offer services at higher rates of intensity of resources to ensure equality of access. In Spain, it concerns the decision-making process in territorial administrations, which requires them to be able to maintain the full exercise of their autonomy within a framework of budgetary stability.

Considering the evolution of population dispersion in Spain's regions, the sustainability of public spending would require disruptive solutions to address the provision of education, health, and social services in geographic areas with high population dispersion. The first step in addressing the integration of population dispersion into the decision-making process would be to ensure the availability of sound indicators, for it to be evidence-based.

This work focuses on providing an indicator of population dispersion in Spain's regions and at the national level. To this end, we have used a definition of population dispersion that is shaped as the result of aggregating six dimensions. Indeed, population dispersion is a multidimensional concept representing a specific pattern of land use by the population for residential purposes that is typified by low values on one or more of six distinct dimensions: proximity, centrality, nuclearity, density, concentration and continuity. The lower the level of each dimension, the higher the population dispersion.

For each dimension, we have identified a set of associated indicators that measure it, together with the basic elements for constructing these indicators. After analysing a set of ninety-four indicators, we concluded that the approach to measure population dispersion should be based on a composite indicator consisting of measures that capture each of its six dimensions. These measures should provide information on the extent to which a part of the population remains in locations that are far from those where the bulk of the population tends to settle and should be independent of the breadth of the provinces in order to avoid confounding factors in further analyses relating it to other FPS determinant factors.

We have built a composite indicator for each dimension and aggregated them to obtain our population dispersion indicator, a composite one as well. To do so, we have followed the joint OECD and EU methodology on composite indicators. Out of the ninety-four individual indicators explored, we have selected twenty-two. We created selection criteria based on a detailed analysis of the individual indicators that yielded an extensive description of the main features of the six distinct dimensions. We have extracted these features from the systematic regularities observed in the individual indicators using a static analysis focused on our base year 2016, and a dynamic one focused on the period 2003-2017.

There are not standard references available against which benchmarking the performance of Spain's regions regarding population dispersion and its dimensions. Thus, we cannot say in absolute terms whether our dispersion indicator points to high or low dispersion in absolute terms. To approach our performance analyses we have recoursed to interregional comparisons with the national average and the distribution across regions as a reference.

We have found significant inter-regional differences in Spain both regarding dispersion dimensions and concerning dispersion itself as the aggregate. In 2016, dispersion in Extremadura, the highest in Spain, was 2.86 times that of Madrid, the lowest one. Typically, Illes Balears, Canarias, Castilla-La Mancha, Extremadura and Galicia show below average levels of proximity, centrality, nuclearity, density, concentration and continuity;

thus presenting relative high levels of population dispersion. On the other hand, Aragón, Cantabria, Castilla y León, Cataluña, Madrid and País Vasco typically show above average levels in the mentioned dimensions, thus presenting relative low levels of population dispersion.

At the national level, dispersion is decreasing since 2011, after having registered an increasing trend since 2003. The evolution of dispersion has significant inter-regional differences. We highlight that in Canarias and Madrid it is increasing over the entire analysed period. On the other hand, it has systematically decreased over the analysed period 2003-2017 in Aragón, Asturias, Castilla y León, Castilla-La Mancha, Extremadura and La Rioja.

From the perspective of public spending sustainability, we based the assessment of the extent to which dispersion could put pressure on it on three pillars:

1. A static analysis of each territory's position in the regional ranking of population dispersion and its dimensions.

2. An analysis of the evolution of dispersion in each territory.

3. An analysis of each Region's dynamic, jointly considering its position with respect to the national average as well as the differential of its evolution rate with the average evolution rate at the national level.

Concerns arise regarding Andalucía, Illes Balears, Canarias and Murcia due to their levels of dispersion being above the national average, compounded with an ascending divergence away from it. Attention should be paid to Castilla-La Mancha, Comunidad Valenciana, Extremadura, Galicia and Navarra: despite recording a descending convergence towards the mean, they are still above the national average. We found an intermediate group of regions that would need less intense monitoring regarding dispersion pressure on public spending, as they currently hold a position below the national average but, nonetheless, may scale positions in the regional ranking due to higher-than-average rates in their dispersion evolution: Aragón, Cantabria, Cataluña, Madrid and País Vasco. Finally, Asturias, Castilla y León and La Rioja pose no relevant concerns as they hold low positions regarding dispersion and present a falling divergence from the mean.

The bottom-up approach that we have adopted in this work has allowed us to dig deeper into dispersion and its dimensions in Spain's territories. First, we highlight the coherence that we have found between the conclusions drawn from the individual indicators and the composite ones. We considered it important to facilitate decision-making and transparency providing a reduced panel of indicators that properly capture the performance of the regions concerning dispersion. On the other hand, we have also disseminated all the technical details about the individual indicators to allow verification and facilitate, where appropriate, the design of policies.

The analysis of the association between population dispersion and FPS spending has brought into the scene other cost drivers and determinant factors. One interesting finding is that the group of people aged from 0 to 2 has a considerably high effect in relation to the rest of the population groups, except in essential social services, where the group of 65 to 84 is the leading factor.

Regarding region performance in relation to dispersion, we highlight the following main findings:

1. In Spain, most of the population lives in regions with low values (below the national average) of proximity, centrality, nuclearity, density, concentration and continuity. As a result, most of the Spanish population lives in regions with high (above the national average) dispersion levels.

2. The population tends to reside in places that are closer to each other than the whole set of locations, with the exception of Navarra. Furthermore, the tendency of the population to reside in locations close to each other in terms of travel distances stands out. In addition, over the analysed period, the population has moved to reside

in locations that are increasingly closer to the province capital, mainly in terms of travel distances. It seems that the population has moved towards municipality capitals and, more intensely, towards the municipalities that are close to the province capitals. This seems to be coherent with OECD and EU analyses.

3. We have witnessed an increase in the number of nuclei (singular entities with 10,001 or more inhabitants) per province while the share of the province capital's population over the whole set of nuclei has decreased. Nonetheless, the increase in the number of nuclei in each province is characterised by a decrease (or stagnation) in the average distance between nuclei, except in La Rioja. It seems that, typically, the population is moving to reside in other nuclei different from the province capital, yet close to it and to the other nuclei.

4. Our results would support some analysis made in the context of the European Union: "*Much of Spain appears to be empty, much more so than any other large European country. Yet characterising Spain as a sparsely populated country does not reflect the experience on the ground. So even though the settlement pattern appears sparse, people are actually quite tightly packed together.*" Indeed, the total population density (crude density) in Spain is 92 inhabitants per Km^2, below the EU average of 118. However, if we focus on urban or built-up land the corresponding densities are 4,096 and 6,752 inhabitants per Km^2, respectively. On average, in Spain, 38% of the population lives in municipalities with high residential density (built-up land based), a similar level to Austria, Denmark, Germany and Italy.

5. We have found differences in the indicators signalling concentration: some of them point to high level of population concentration in Spain while other do not. We rely on the composite indicator for the population concentration, which reflects a low level of concentration meaning that most of the population in Spain live in regions below the national average.

6. The population's spatial separation is lower than that of the places they inhabit: the average distance between the locations of singular entities within the same province in terms of travel distance is 80.72 Km, while the average distance between the

population of singular entities within the same province in terms of travel distance is 32.41 Km. This raises one relevant issue from the perspective of the FPS organization. On one hand, higher proximity or centrality of the population would promote economies of scale regarding the offer of FPS. On the other hand, even when the proximity or centrality of the population is higher than that of the locations, the need to guarantee universal access to those population entities that are far away and less populated would imply an added cost that would offset efficiency gains from the mentioned economies of scale. Thus, regarding decision-making, even if efficiency reasons would advise focusing on population spatial separation, both types of spatial separation should be jointly considered as FPS needs drivers to take into account equality of access considerations. This is especially relevant in regions such as Aragón, Asturias, Cantabria, Castilla y León, and Comunidad Valenciana. In these regions, a relevant part of the population tends to settle in locations close to each other or to the province capital; but there is still a part of the population that remains distant enough to produce a high location spatial separation, even above average.

7. The population has moved towards provincial nuclei, which are closer to each other than the set of locations as a whole, leaving a set of distant settlements with sparse population. Therefore, economies of scale derived from increases in population proximity would be offset by losses of economies of scale derived from that set of distant settlements with a sparse population. The mentioned losses are compounded with the interaction between population dispersion and ageing (increasing share of people aged 65 and more). Indeed, the aging of the population in Spain is a growing phenomenon that affects to a greater extent the population entities that are farther away from the nuclei in which people tend to reside. We have verified that, at the national level, the ageing of the population living at a higher-than-average distance from its provincial capital (“living far”) is around 2 percentage points (p.p.) greater than the ageing of the whole population. We observed that the ageing of the population “living far” overpasses that of the whole population of each province in all of them except Balears, Palmas, Madrid and Bizkaia. The provinces with the highest differential are Almeria, Huelva, Zaragoza, Salamanca, Segovia and

Guadalajara. For the very old (aged 85 and over) the differential is increasing and, in 2003, it was 0.38 p.p. and in 2017 it was 0.53 p.p.

According to our analysis, we would highlight the following relevant elements for the design of policies that guarantee the sustainability of public spending on fundamental public services while guaranteeing equality of access:

1. Population dispersion is a multidimensional concept, and using in isolation one individual dimension to capture dispersion (such as density, which has been widely used to measure dispersion, not to mention the number of singular population entities) leads to rather different conclusions than when a more balanced definition is adopted.

2. Population dispersion is a relevant cost driver that has an impact on the sustainability of FPS public spending. The main challenges would lie in the need to design disruptive solutions to guarantee universal access addressing the provision of services in geographic areas with high population dispersion, which is compounded with ageing population demographic challenges.

3. Spain's population has spontaneously initiated since 2011 a movement towards municipality capitals and, more intensely, towards the municipalities that are close to the province capitals and other provincial nuclei close to each other. This would foster economies of scale in FPS provision. On the other hand, after the pandemic, there seem to be signs of population movements that could end up reversing the current decreasing trend of population dispersion. Therefore, an issue for debate would be the relevance of public intervention to promote population movements in one sense or another. In our opinion, this decision affects not only SPF policy, but it would have a broader focus that should achieve a balance in rural-urban migrations, which presents a high complexity in any intervention attempt. It also affects other policies related to the future shape of cities and rural areas: agriculture, energy, environment, digitization, infrastructure, etc.

8. ANNEXES

8.1. ANNEX I. MUNICIPALITY BASED INDICATORS

PROXIMITY

- Absolute:
  - *Inverse of the simple average of straight-line distances between municipalities (**PROXS**$_{MUN2a}$)*
  - *Inverse of the simple average of travel distances between municipalities (**PROXS**$_{MUN2b}$)*
  - *Inverse of the simple average of travel durations between municipalities (**PROXS**$_{MUN2c}$)*
  - *Inverse of the weighted average of straight-line distances between municipalities (**PROXW**$_{MUN2d}$)*
  - *Inverse of the weighted average of travel distances between municipalities (**PROXW**$_{MUN2e}$)*
  - *Inverse of the weighted average of travel durations between municipalities (**PROXW**$_{MUN2f}$).*
- Relative:
  - *Ratio population proximity to geographical proximity (MUN & straight-line distance) (**PROXR**$_{MUN2g}$)*
  - *Ratio of population proximity to geographical proximity (MUN & travel distance) (**PROXR**$_{MUN2h}$)*
  - *Ratio of population proximity to geographical proximity (MUN & travel duration) (**PROXR**$_{MUN2i}$).*
- Standardised:
  - *Normalised geographical proximity (MUN & straight-line distance) (**PROXN**$_{MUN2j}$)*
  - *Normalised geographical proximity (MUN & travel distance) (**PROXN**$_{MUN2k}$)*
  - *Normalised population proximity (MUN & straight-line distance) (**PROXN**$_{MUN2l}$)*
  - *Normalised population proximity (MUN & travel distance) (**PROXN**$_{MUN21m}$)*

CENTRALITY

- Absolute:
  - *Inverse of the simple average of straight-line distances from municipalities to CBD (**CBDdS**$_{MUN4a}$)*
  - *Inverse of the simple average of travel distances from SE municipalities to CBD (**CBDdS**$_{MUN4b}$)*
  - *Inverse of the simple average of travel durations from municipalities to CBD (**CBDdS**$_{MUN4c}$)*
  - *Inverse of the weighted average of straight-line distances from municipalities to CBD (**CBDdW**$_{MUN4d}$)*
  - *Inverse of the weighted average of travel distances from municipalities to CBD (**CBDdW**$_{MUN4e}$)*
  - *Inverse of the weighted average of travel durations from municipalities to CBD (**CBDdW**$_{MUN4f}$)*
- Relative:
  - *Ratio population centrality to geographical centrality (MUN & straight-line distance) (**CBDdR**$_{MUN4g}$)*
  - *Ratio of population centrality to geographical centrality (MUN & travel distance) (**CBDdR**$_{MUN4h}$)*
  - *Ratio of population centrality to geographical centrality (MUN & travel duration) (**CBDdR**$_{MUN4i}$)*
- Standardised:
  - *Normalised geographical centrality (MUN & straight-line distance) (**CBDdN**$_{MUN4j}$)*
  - *Normalised geographical centrality (MUN & travel distance) (**CBDdN**$_{MUN4k}$)*
  - *Normalised population centrality (MUN & straight-line distance) (**CBDdN**$_{MUN4l}$)*
  - *Normalised population centrality (MUN & travel distance) (**CBDdN**$_{MUN4m}$)*

NUCLEARITY

- *Inverse of the number of nuclei per province MUN-based (**NUNoN**$_{MUN6a}$)*
- *Share of the population in the CBD over the population in nuclei MUN-based (**NUSoP**$_{MUN6b}$)*

CONCENTRATION

- *Gini index for MUN based on population (**CNGINI**$_{MUN9d}$)*
- *Standardised Theil entropy index (MUN) (**CNSTHEI**$_{MUN9f}$)*
- *Standardised Herfindahl index (MUN) (**CNSHHI**$_{MUN9h}$)*

Annex I. Table 0. Correlations between SE and municipality-based based indicators

PROXIMITY	Absolute					
	Simple average /Straight-line distance	Simple average /Travel distance	Simple average /Travel duration	Weighted average /Straight-line distance	Weighted average /Travel distance	Weighted average /Travel duration
	$PROXS_{SE1a}$ & $PROXS_{MUN2a}$	$PROXS_{SE1b}$ & $PROXS_{MUN2b}$	$PROXS_{SE1c}$ & $PROXS_{MUN2c}$	$PROXW_{SE1d}$ & $PROXW_{MUN2d}$	$PROXW_{SE1e}$ & $PROXW_{MUN2e}$	$PROXW_{SE1f}$ & $PROXW_{MUN2f}$
Correlations (ρ)[1] between SE and MUN-based indicators	**0.9495**	**0.9392**	**0.9558**	**0.9979**	**0.9975**	**0.9979**

PROXIMITY	Relative			Standardised			
	Population to geographical proximity /Straight-line distance	Population to geographical proximity /Travel distance	Population to geographical proximity /Travel duration	Normalised Simple average /Straight-line distance	Normalised Simple average /Travel distance	Normalised weighted average /Straight-line distance	Normalised weighted average /Travel distance
	$PROXR_{SE1g}$ & $PROXR_{MUN2g}$	$PROXR_{SE1h}$ & $PROXR_{MUN2h}$	$PROXR_{SE1i}$ & $PROXR_{MUN2i}$	$PROXN_{SE1j}$ & $PROXN_{MUN2j}$	$PROXN_{SE1k}$ & $PROXN_{MUN2k}$	$PROXN_{SE1l}$ & $PROXN_{MUN2l}$	$PROXN_{SE1m}$ & $PROXN_{MUN2m}$
Correlations (ρ)[1] between SE and MUN-based indicators	**0.8818**	**0.8809**	**0.8935**	**0.4086**	**0.6406**	**0.9879**	**0.9891**

CENTRALITY	Absolute					
	Simple average /Straight-line distance	Simple average /Travel distance	Simple average /Travel duration	Weighted average /Straight-line distance	Weighted average /Travel distance	Weighted average /Travel duration
	$CBDdS_{SE1a}$ & $CBDdS_{MUN2a}$	$CBDdS_{SE1b}$ & $CBDd_{MUN2b}$	$CBDdS_{SE1c}$ & $CBDdS_{MUN2c}$	$CBDdW_{SE1d}$ & $CBDdW_{MUN2d}$	$CBDdW_{SE1e}$ & $CBDdW_{MUN2e}$	$CBDdW_{SE1f}$ & $CBDdW_{MUN2f}$
Correlations (ρ)[1] between SE and MUN-based indicators	**0.9193**	**0.9038**	**0.9353**	**0.9999**	**0.9999**	**0.9999**

CENTRALITY	Relative			Standardised			
	Population to geographical centrality /Straight-line distance	Population to geographical centrality /Travel distance	Population to geographical centrality /Travel duration	Normalised Simple average /Straight-line distance	Normalised Simple average /Travel distance	Normalised weighted average /Straight-line distance	Normalised weighted average /Travel distance
	$CBDdXR_{SE1g}$ & $CBDdR_{MUN2g}$	$CBDdR_{SE1h}$ & $CBDdR_{MUN2h}$	$CBDdR_{SE1i}$ & $CBDdR_{MUN2i}$	$CBDdN_{SE1j}$ & $CBDdN_{MUN2j}$	$CBDdN_{SE1k}$ & $CBDdN_{MUN2k}$	$CBDdN_{SE1l}$ & $CBDdN_{MUN2l}$	$CBDdN_{SE1m}$ & $CBDdN_{MUN2m}$
Correlations (ρ)[1] between SE and MUN-based indicators	**0.9295**	**0.9244**	**0.9254**	**0.7010**	**0.7779**	**0.9992**	**0.9991**

NUCLEARITY	Number of Nuclei	Inverse of the number of nuclei	Share of the CBD over the population in nuclei
	$NUNoN_{SE5a0}$ & $NUNoN_{MUN6a0}$	$NUNoN_{SE5a}$ & $NUNoN_{MUN6a}$	$NUSoP_{SE6a}$ & $NUSoP_{SE6b}$
Correlations (ρ)[1] between SE and MUN-based indicators	**0.9982**	**0.9516**	**0.9314**

CONCENTRATION	Gini index	Standardised Theil entropy index	Standardised Herfindahl index
	$NUNoN_{SE5a0}$ & $NUNoN_{MUN6a0}$	$NUNoN_{SE5a}$ & $NUNoN_{MUN6a}$	$NUSoP_{SE6a}$ & $NUSoP_{SE6b}$
Correlations (ρ)[1] between SE and MUN indicators	**0.9982**	**0.9516**	**0.9314**

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

(1) Please, notice that ρ equals the Pearson's correlation coefficient, which, in addition to measuring the linear association between two variables, also indicates the extent to which the observation units hold the same position concerning these two variables.

Annex I. Table 1.1 Average distance between municipalities within the same province by Region

Region	Municipality-based indicators					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
	$PROXS_{MUN2a}$	$PROXS_{MUN2b}$	$PROXS_{MUN2c}$	$PROXW_{MUN2d}$	$PROXW_{MUN2e}$	$PROXW_{MUN2f}$
TOTAL	**56.29**	**83.86**	**71.47**	**32.61**	**48.78**	**44.17**
Andalucía	54.17	86.26	74.48	42.10	64.83	56.48
Aragón	67.43	101.46	82.10	50.32	74.84	58.78
Asturias	67.77	108.38	93.17	37.03	59.22	50.91
Illes Balears	66.96	90.71	167.18	78.65	106.55	196.39
Canarias	85.71	138.25	252.61	72.93	115.79	212.67
Cantabria	41.16	69.03	58.00	30.51	51.16	42.99
Castilla y León	55.07	78.89	67.39	45.75	66.71	55.81
Castilla-La Mancha	64.38	94.35	78.64	59.18	83.72	68.29
Cataluña	48.96	76.68	68.20	28.80	43.74	36.01
Comunidad Valenciana	51.69	76.92	62.06	37.31	54.73	43.09
Extremadura	73.09	106.80	87.11	68.82	95.80	78.28
Galicia	49.85	79.10	70.66	42.11	65.91	56.90
Madrid	51.90	75.64	62.05	24.70	36.01	29.54
Murcia	44.95	64.16	53.67	47.47	67.75	56.68
Navarra	52.70	83.59	70.47	43.77	69.44	58.53
País Vasco	24.95	40.33	39.28	19.82	32.40	31.67
La Rioja	37.44	63.40	54.79	36.72	62.18	53.74

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 1.2. Maximum and minimum values of the average distance (value and Region)

	Municipality-based indicators					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
Max MUN	85.71	138.25	252.61	78.65	115.79	212.67
Min MUN	24.95	40.33	39.28	19.82	32.40	29.54
Max MUN	Canarias	Canarias	Canarias	Illes Balears	Canarias	Canarias
Min MUN	País Vasco	País Vasco	País Vasco	País Vasco	País Vasco	Madrid

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 1.3. Inter-region variability of the average distance

	Municipality-based indicators					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
Standard Deviation MUN	14.60	21.92	51.15	16.67	22.78	52.28
CV MUN	0.26	0.26	0.72	0.51	0.47	1.18

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 2.1. Absolute proximity indicators by Region

Region	Municipality-based indicators					
	Inverse of Simple average of straight-line distances (Km)	Inverse of Simple average of travel distances (Km)	Inverse of Simple average of travel durations (min)	Inverse of Weighted average of straight-line distances (Km)	Inverse of Weighted average of travel distances (Km)	Inverse of Weighted average of travel durations (min)
	$PROXS_{MUN2a}$	$PROXS_{MUN2b}$	$PROXS_{MUN2c}$	$PROXW_{MUN2d}$	$PROXW_{MUN2e}$	$PROXW_{MUN2f}$
TOTAL	**0.0178**	**0.0119**	**0.0140**	**0.0307**	**0.0205**	**0.0226**
Andalucía	0.0185	0.0116	0.0134	0.0238	0.0154	0.0177
Aragón	0.0148	0.0099	0.0122	0.0199	0.0134	0.0170
Asturias	0.0148	0.0092	0.0107	0.0270	0.0169	0.0196
Illes Balears	0.0149	0.0110	0.0060	0.0127	0.0094	0.0051
Canarias	0.0117	0.0072	0.0040	0.0137	0.0086	0.0047
Cantabria	0.0243	0.0145	0.0172	0.0328	0.0195	0.0233
Castilla y León	0.0182	0.0127	0.0148	0.0219	0.0150	0.0179
Castilla-La Mancha	0.0155	0.0106	0.0127	0.0169	0.0119	0.0146
Cataluña	0.0204	0.0130	0.0147	0.0347	0.0229	0.0278
Comunidad	0.0193	0.0130	0.0161	0.0268	0.0183	0.0232
Extremadura	0.0137	0.0094	0.0115	0.0145	0.0104	0.0128
Galicia	0.0201	0.0126	0.0142	0.0237	0.0152	0.0176
Madrid	0.0193	0.0132	0.0161	0.0405	0.0278	0.0339
Murcia	0.0222	0.0156	0.0186	0.0211	0.0148	0.0176
Navarra	0.0190	0.0120	0.0142	0.0228	0.0144	0.0171
País Vasco	0.0401	0.0248	0.0255	0.0505	0.0309	0.0316
La Rioja	0.0267	0.0158	0.0183	0.0272	0.0161	0.0186

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 2.2. Maximum and minimum values of absolute proximity indicators (value and Region)

	Municipality-based indicators					
	Inverse of Simple average of straight-line distances (Km)	Inverse of Simple average of travel distances (Km)	Inverse of Simple average of travel durations (min)	Inverse of Weighted average of straight-line distances (Km)	Inverse of Weighted average of travel distances (Km)	Inverse of Weighted average of travel durations (min)
Max MUN	0.0401	0.0248	0.0255	0.0505	0.0309	0.0339
Min MUN	0.0117	0.0072	0.0040	0.0127	0.0086	0.0047
Max MUN	País Vasco	País Vasco	País Vasco	País Vasco	País Vasco	Madrid
Min MUN	Canarias	Canarias	Canarias	Illes Balears	Canarias	Canarias

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 2.3. Inter-region variability of absolute proximity indicators

	Municipality-based indicators					
	Inverse of Simple average of straight-line distances (Km)	Inverse of Simple average of travel distances (Km)	Inverse of Simple average of travel durations (min)	Inverse of Weighted average of straight-line distances (Km)	Inverse of Weighted average of travel distances (Km)	Inverse of Weighted average of travel durations (min)
Standard Deviation MUN	0.0066	0.0039	0.0049	0.0099	0.0060	0.0078
CV MUN	0.37	0.32	0.35	0.32	0.29	0.34

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 3.1. Relative proximity indicators by Region

Region	Municipality-based indicators		
	Ratio population to geographical proximity /Straight-line distance	Ratio population to geographical proximity /Travel distance	Ratio population to geographical proximity /Travel duration
	$PROXR_{MUN2g}$	$PROXR_{MUN2h}$	$PROXR_{MUN2i}$
TOTAL	**1.7260**	**1.7189**	**1.6183**
Andalucía	1.2867	1.3305	1.3188
Aragón	1.3400	1.3558	1.3967
Asturias	1.8303	1.8303	1.8303
Illes Balears	0.8513	0.8513	0.8513
Canarias	1.1754	1.1940	1.1878
Cantabria	1.3493	1.3493	1.3493
Castilla y León	1.2037	1.1826	1.2074
Castilla-La Mancha	1.0880	1.1269	1.1515
Cataluña	1.7001	1.7532	1.8936
Comunidad Valenciana	1.3852	1.4055	1.4404
Extremadura	1.0622	1.1148	1.1128
Galicia	1.1838	1.2002	1.2417
Madrid	2.1007	2.1007	2.1007
Murcia	0.9471	0.9471	0.9471
Navarra	1.2039	1.2039	1.2039
País Vasco	1.2587	1.2447	1.2401
La Rioja	1.0196	1.0196	1.0196

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 3.2. Maximum and minimum values of relative proximity indicators (value and Region)

	Municipality-based indicators		
	Ratio population to geographical proximity /Straight-line distance	Ratio population to geographical proximity /Travel distance	Ratio population to geographical proximity /Travel durations
Max MUN	2.10	2.10	2.10
Min MUN	0.85	0.85	0.85
Max MUN	Madrid	Madrid	Madrid
Min MUN	Illes Balears	Illes Balears	Illes Balears

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 3.3. Inter-region variability of relative proximity indicators

	Municipality-based indicators		
	Ratio population to geographical proximity /Straight-line distance	Ratio population to geographical proximity /Travel distance	Ratio population to geographical proximity /Travel duration
Standard Deviation MUN	0.32	0.32	0.34
CV MUN	0.19	0.19	0.21

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 4.1.Normalised proximity indicators by Region

Region	Municipality-based indicators			
	Normalised geographical proximity /Straight-line distance	Normalised population proximity /Straight-line distance	Normalised geographical proximity /Travel distance	Normalised population proximity /Travel distance
	$PROXN_{MUN2j}$	$PROXN_{MUN2k}$	$PROXN_{MUN2l}$	$PROXN_{MUN2m}$
TOTAL	**0.7227**	**0.5869**	**0.8394**	**0.7597**
Andalucía	0.7363	0.5800	0.7950	0.6844
Aragón	0.7307	0.5947	0.7990	0.7011
Asturias	0.6839	0.4945	0.8273	0.7238
Illes Balears	0.7771	0.6981	0.7382	0.6453
Canarias	0.6786	0.4816	0.7265	0.5658
Cantabria	0.7424	0.5681	0.8091	0.6799
Castilla y León	0.7185	0.5967	0.7661	0.6590
Castilla-La Mancha	0.7254	0.5975	0.7476	0.6429
Cataluña	0.7305	0.5780	0.8415	0.7593
Comunidad Valenciana	0.7175	0.5796	0.7961	0.7009
Extremadura	0.7424	0.6237	0.7575	0.6624
Galicia	0.7101	0.5400	0.7551	0.6167
Madrid	0.7270	0.6022	0.8701	0.8106
Murcia	0.7838	0.6914	0.7717	0.6741
Navarra	0.7492	0.6022	0.7917	0.6696
País Vasco	0.7614	0.6143	0.8105	0.6902
La Rioja	0.7362	0.5532	0.7413	0.5618

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 4.2. Maximum and minimum values of normalised proximity indicators (value and Region)

	Municipality-based indicators			
	Normalised geographical proximity /Straight-line distance	Normalised population proximity /Straight-line distance	Normalised geographical proximity /Travel distance	Normalised population proximity /Travel distance
Max MUN	0.7838	0.6981	0.8701	0.8106
Min MUN	0.6786	0.4816	0.7265	0.5618
Max MUN	Murcia	Illes Balears	Madrid	Madrid
Min MUN	Canarias	Canarias	Canarias	La Rioja

Annex I. Table 4.3. Inter-region variability of normalised proximity indicators

	Municipality-based indicators			
	Normalised geographical proximity /Straight-line distance	Normalised population proximity /Straight-line distance	Normalised geographical proximity /Travel distance	Normalised population proximity /Travel distance
Standard Deviation MUN	0.03	0.06	0.04	0.06
CV MUN	0.04	0.09	0.05	0.08

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 5.1. Average distance from municipalities to the province's CBD by Region

Region	Municipality-based indicators					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
	$CBDdS_{MUN4a}$	$CBDdS_{MUN4b}$	$CBDdS_{MUN4c}$	$CBDdW_{MUN4d}$	$CBDdW_{MUN4e}$	$CBDdW_{MUN4f}$
TOTAL	**47.28**	**70.97**	**62.35**	**24.34**	**36.87**	**35.77**
Andalucía	46.73	74.19	64.88	29.26	46.00	40.04
Aragón	59.27	89.50	72.88	24.89	37.74	30.75
Asturias	48.73	77.94	67.00	22.45	35.90	30.87
Illes Balears	52.23	70.75	130.40	48.86	66.19	121.99
Canarias	82.49	132.87	242.89	49.52	78.94	144.80
Cantabria	36.54	61.28	51.49	19.81	33.22	27.91
Castilla y León	43.88	62.68	53.60	23.70	34.43	29.12
Castilla-La Mancha	53.04	77.46	64.72	42.20	60.08	49.70
Cataluña	44.02	68.90	61.56	22.50	34.37	29.33
Comunidad Valenciana	43.67	65.74	54.11	25.58	37.88	30.36
Extremadura	76.66	110.47	90.15	56.31	79.29	64.76
Galicia	38.88	61.70	54.89	28.42	44.92	39.06
Madrid	40.33	58.78	48.21	12.49	18.20	14.93
Murcia	35.47	50.62	42.35	32.28	46.07	38.54
Navarra	39.51	62.68	52.84	28.24	44.80	37.77
País Vasco	24.12	38.86	37.01	12.44	20.31	19.45
La Rioja	33.95	57.50	49.69	19.17	32.47	28.06

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 5.2. Maximum and minimum values of the average distance (value and Region)

	Municipality-based indicators					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
Max MUN	82.49	132.87	242.89	56.31	79.29	144.80
Min MUN	24.12	38.86	37.01	12.44	18.20	14.93
Max MUN	Canarias	Canarias	Canarias	Extremadura	Extremadura	Canarias
Min MUN	País Vasco	País Vasco	País Vasco	País Vasco	Madrid	Madrid

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 5.3. Inter-region variability of the average distance from municipalities to the province's CBD

	Distances from municipalities to the province's CBD					
	Simple average of straight-line distances (Km)	Simple average of travel distances (Km)	Simple average of travel durations (min)	Weighted average of straight-line distances (Km)	Weighted average of travel distances (Km)	Weighted average of travel durations (min)
Standard Deviation MUN	14.77	22.29	48.78	12.79	17.73	35.09
CV MUN	0.31	0.31	0.78	0.53	0.48	0.98

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 6.1. Absolute centrality indicators by Region

Region	Municipality-based indicators					
	Inverse of Simple average of straight-line distances (Km)	Inverse of Simple average of travel distances (Km)	Inverse of Simple average of travel durations (min)	Inverse of Weighted average of straight-line distances (Km)	Inverse of Weighted average of travel distances (Km)	Inverse of Weighted average of travel durations (min)
	$CBDdS_{MUN4a}$	$CBDdS_{MUN4b}$	$CBDdS_{MUN4c}$	$CBDdW_{MUN4d}$	$CBDdW_{MUN4e}$	$CBDdW_{MUN4f}$
TOTAL	**0.0212**	**0.0141**	**0.0160**	**0.0411**	**0.0271**	**0.0280**
Andalucía	0.0214	0.0135	0.0154	0.0342	0.0217	0.0250
Aragón	0.0169	0.0112	0.0137	0.0402	0.0265	0.0325
Asturias	0.0205	0.0128	0.0149	0.0445	0.0279	0.0324
Illes Balears	0.0191	0.0141	0.0077	0.0205	0.0151	0.0082
Canarias	0.0121	0.0075	0.0041	0.0202	0.0127	0.0069
Cantabria	0.0274	0.0163	0.0194	0.0505	0.0301	0.0358
Castilla y León	0.0228	0.0160	0.0187	0.0422	0.0290	0.0343
Castilla-La Mancha	0.0189	0.0129	0.0155	0.0237	0.0166	0.0201
Cataluña	0.0227	0.0145	0.0162	0.0444	0.0291	0.0341
Comunidad Valenciana	0.0229	0.0152	0.0185	0.0391	0.0264	0.0329
Extremadura	0.0130	0.0091	0.0111	0.0178	0.0126	0.0154
Galicia	0.0257	0.0162	0.0182	0.0352	0.0223	0.0256
Madrid	0.0248	0.0170	0.0207	0.0801	0.0549	0.0670
Murcia	0.0282	0.0198	0.0236	0.0310	0.0217	0.0259
Navarra	0.0253	0.0160	0.0189	0.0354	0.0223	0.0265
País Vasco	0.0415	0.0257	0.0270	0.0804	0.0492	0.0514
La Rioja	0.0295	0.0174	0.0201	0.0522	0.0308	0.0356

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 6.2. Maximum and minimum values of absolute centrality indicators (value and Region)

	Municipality-based indicators					
	Inverse of Simple average of straight-line distances (Km)	Inverse of Simple average of travel distances (Km)	Inverse of Simple average of travel durations (min)	Inverse of Weighted average of straight-line distances (Km)	Inverse of Weighted average of travel distances (Km)	Inverse of Weighted average of travel durations (min)
Max SE	0.0415	0.0257	0.0270	0.0804	0.0549	0.0670
Min SE	0.0121	0.0075	0.0041	0.0178	0.0126	0.0069
Max SE	País Vasco	País Vasco	País Vasco	País Vasco	Madrid	Madrid
Min SE	Canarias	Canarias	Canarias	Extremadura	Extremadura	Canarias

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 6.3. Inter-region variability of absolute centrality indicators

	Municipality-based indicators					
	Inverse of Simple average of straight-line distances (Km)	Inverse of Simple average of travel distances (Km)	Inverse of Simple average of travel durations (min)	Inverse of Weighted average of straight-line distances (Km)	Inverse of Weighted average of travel distances (Km)	Inverse of Weighted average of travel durations (min)
Standard Deviation SE	0.0068	0.0041	0.0055	0.0181	0.0114	0.0144
CV SE	0.32	0.29	0.35	0.44	0.42	0.52

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 7.1. Relative centrality indicators by Region

Region	Municipality-based indicators		
	Ratio population to geographical centrality /Straight-line distance	Ratio population to geographical proximity /Travel distance	Ratio population to geographical centrality /Travel duration
	$CBDdR_{MUN4g}$	$CBDdR_{MUN4h}$	$CBDdR_{MUN4i}$
TOTAL	**1.9428**	**1.9249**	**1.7431**
Andalucía	1.5972	1.6129	1.6203
Aragón	2.3809	2.3717	2.3703
Asturias	2.1708	2.1708	2.1708
Illes Balears	1.0689	1.0689	1.0689
Canarias	1.6656	1.6832	1.6774
Cantabria	1.8446	1.8446	1.8446
Castilla y León	1.8516	1.8205	1.8405
Castilla-La Mancha	1.2567	1.2893	1.3024
Cataluña	1.9558	2.0045	2.0988
Comunidad Valenciana	1.7075	1.7354	1.7825
Extremadura	1.3615	1.3933	1.3921
Galicia	1.3681	1.3735	1.4053
Madrid	3.2293	3.2293	3.2293
Murcia	1.0989	1.0989	1.0989
Navarra	1.3991	1.3991	1.3991
País Vasco	1.9388	1.9132	1.9025
La Rioja	1.7707	1.7707	1.7707

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016

Annex I. Table 7.2. Maximum and minimum values of relative centrality indicators (value and Region)

	Municipality-based indicators		
	Ratio population to geographical centrality /Straight-line distance	Ratio population to geographical proximity /Travel distance	Ratio population to geographical centrality /Travel duration
Max SE	3.23	3.23	3.23
Min SE	1.07	1.07	1.07
Max SE	Madrid	Madrid	Madrid
Min SE	Illes Balears	Illes Balears	Illes Balears

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 7.7. Inter-region variability of relative centrality indicators

	Municipality-based indicators		
	Ratio population to geographical centrality /Straight-line distance	Ratio population to geographical proximity /Travel distance	Ratio population to geographical centrality /Travel duration
Standard Deviation SE	0.53	0.52	0.52
CV SE	0.27	0.27	0.30

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 8.1. Normalised centrality indicators by Region

Region	Normalised geographical centrality /Straight-line distance	Normalised population centrality /Straight-line distance	Normalised geographical centrality /Travel distance	Normalised population centrality /Travel distance
	$CBDdN_{MUN4j}$	$CBDdN_{MUN4k}$	$CBDdN_{MUN4l}$	$CBDdN_{MUN4m}$
TOTAL	**0.7671**	**0.6504**	**0.8801**	**0.8184**
Andalucía	0.7725	0.6388	0.8575	0.7761
Aragón	0.7633	0.6425	0.9006	0.8493
Asturias	0.7727	0.6365	0.8953	0.8325
Illes Balears	0.8262	0.7645	0.8374	0.7797
Canarias	0.6907	0.5017	0.8143	0.7040
Cantabria	0.7714	0.6166	0.8761	0.7922
Castilla y León	0.7757	0.6796	0.8788	0.8240
Castilla-La Mancha	0.7738	0.6696	0.8200	0.7437
Cataluña	0.7578	0.6208	0.8761	0.8108
Comunidad Valenciana	0.7613	0.6407	0.8602	0.7929
Extremadura	0.7299	0.6107	0.8016	0.7206
Galicia	0.7739	0.6412	0.8348	0.7388
Madrid	0.7879	0.6908	0.9343	0.9043
Murcia	0.8294	0.7565	0.8448	0.7784
Navarra	0.8120	0.7018	0.8656	0.7868
País Vasco	0.7694	0.6283	0.8810	0.8057
La Rioja	0.7608	0.5948	0.8649	0.7712

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 8.2. Maximum and minimum values of normalised centrality indicators (value and Region)

	Normalised geographical centrality /Straight-line distance	Normalised population centrality /Straight-line distance	Normalised geographical centrality /Travel distance	Normalised population centrality /Travel distance
Max SE	0.83	0.76	0.93	0.90
Min SE	0.69	0.50	0.80	0.70
Max SE	Murcia	Illes Balears	Madrid	Madrid
Min SE	Canarias	Canarias	Extremadura	Canarias

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 8.3. Inter-region variability of normalised centrality indicators

	Normalised geographical centrality /Straight-line distance	Normalised population centrality /Straight-line distance	Normalised geographical centrality /Travel distance	Normalised population centrality /Travel distance
Standard Deviation SE	0.03	0.06	0.03	0.05
CV SE	0.04	0.09	0.04	0.06

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 9.1. Nuclearity indicators by Region

Region	Number of nuclei	Inverse of the number of nuclei	Share of the population in the CBD over the population in nuclei
	NUNoN$_{MUN6a0}$	*NUNoN*$_{MUN6a}$	*NUSoP*$_{MUN6b}$
TOTAL	**744**	**0.0794**	**0.4197**
Andalucía	154	0.0518	0.3767
Aragón	13	0.2073	0.7986
Asturias	20	0.0500	0.2462
Illes Balears	24	0.0417	0.4262
Canarias	42	0.0476	0.3058
Cantabria	10	0.1000	0.4581
Castilla y León	23	0.4405	0.7779
Castilla-La Mancha	38	0.1571	0.4126
Cataluña	120	0.0328	0.3295
Comunidad Valenciana	98	0.0310	0.3205
Extremadura	13	0.1627	0.5145
Galicia	56	0.0783	0.3129
Madrid	49	0.0204	0.5223
Murcia	29	0.0345	0.3178
Navarra	10	0.1000	0.5596
País Vasco	41	0.0939	0.4406
La Rioja	4	0.2500	0.7520

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 9.2. Maximum and minimum values of nuclearity indicators (value and Region)

Region	Singular entity-based indicators		
	Number of nuclei	Inverse of the number of nuclei	Share of the population in the CBD over the population in nuclei
Max MUN	154	0.4405	0.7986
Min MUN	4	0.0204	0.2462
Max MUN	Andalucía	Castilla y León	Aragón
Min MUN	La Rioja	Madrid	Asturias

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 9.3. Inter-region variability of nuclearity indicators

Region	Singular entity-based indicators		
	Number of nuclei	Inverse of the number of nuclei	Share of the population in the CBD over the population in nuclei
Standard Deviation MUN	42.19	0.1079	0.1725
CV MUN	0.06	1.32	0.41

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 10. Evolution of the distance between nuclei 2003-2016
(Number of nuclei - municipality based)

Region	Number of nuclei 2003	Number of nuclei 2016	Average distance between nuclei within each province 2003	Average distance between nuclei within each province 2016	Change 2003-2016 Number of nuclei	Change 2003-2016 Average distance (Km)
TOTAL	**665**	**744**	**47.59**	**46.39**	**79**	**-1.20**
Andalucía	137	154	46.39	45.81	17	-0.58
Aragón	12	13	80.89	79.13	1	-1.75
Asturias	21	20	42.57	41.08	-1	-1.48
Illes Balears	19	24	91.94	90.10	5	-1.83
Canarias	38	42	79.95	80.52	4	0.57
Cantabria	10	10	35.76	29.00	0	-6.77
Castilla y León	24	23	32.07	30.75	-1	-1.32
Castilla-La Mancha	29	38	57.05	55.93	9	-1.13
Cataluña	99	120	43.70	42.34	21	-1.36
Comunidad Valenciana	91	98	40.08	39.45	7	-0.63
Extremadura	13	13	59.85	59.85	0	0.00
Galicia	56	56	52.85	49.03	0	-3.82
Madrid	38	49	30.81	32.47	11	1.66
Murcia	27	29	53.07	52.35	2	-0.71
Navarra	8	10	34.28	29.28	2	-5.00
País Vasco	40	41	28.42	24.45	1	-3.97
La Rioja	3	4	32.28	47.25	1	14.98

Source: Author's own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

Annex I. Table 11. Evolution of the population in nuclei 2003-2017 (nuclei - municipality based)-Percentage over total population

Region	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
TOTAL	78.50	78.49	78.58	78.59	78.49	78.49	78.55	78.59	78.58	78.65	78.78	78.85	78.93	79.08	79.19
Andalucía	79.63	79.67	79.79	79.90	79.88	79.92	80.04	80.10	80.13	80.22	80.35	80.49	80.61	80.72	80.78
Aragón	68.01	68.23	68.26	68.22	68.19	68.17	68.22	68.31	68.35	68.69	69.02	68.93	69.16	69.38	69.66
Asturias	84.72	84.80	84.94	85.06	85.15	85.27	85.45	85.55	85.62	85.72	85.80	85.89	85.98	86.08	86.18
Illes Balears	85.58	85.56	85.48	85.39	85.38	85.45	85.37	85.32	85.28	85.28	85.25	85.28	85.35	85.39	85.44
Canarias	88.91	88.98	89.11	89.20	89.29	89.43	89.51	89.56	89.56	89.64	89.77	89.84	89.91	89.96	89.99
Cantabria	66.27	66.23	66.25	66.17	65.88	65.67	65.47	65.32	65.14	65.04	64.94	64.91	64.78	64.74	64.71
Castilla y León	55.12	55.29	55.38	55.44	55.26	55.36	55.28	55.28	55.20	55.34	55.59	55.65	55.73	55.91	56.07
Castilla-La Mancha	50.95	50.89	51.11	51.31	51.53	51.44	51.70	51.80	51.82	52.10	52.53	52.84	53.02	53.38	53.68
Cataluña	82.65	82.45	82.27	82.07	81.77	81.52	81.45	81.38	81.29	81.28	81.28	81.29	81.32	81.41	81.46
Comunidad Valenciana	82.91	82.73	82.75	82.67	82.31	82.14	82.08	82.02	81.88	81.93	82.02	82.07	82.09	82.21	82.18
Extremadura	45.20	45.55	46.03	46.38	46.64	47.04	47.40	47.59	47.81	48.05	48.43	48.53	48.60	48.86	49.10
Galicia	66.60	66.87	67.15	67.47	67.70	67.98	68.28	68.88	69.16	69.53	69.83	70.04	70.21	70.46	70.68
Madrid	95.55	95.31	95.14	94.93	94.74	94.61	94.52	94.46	94.37	94.29	94.23	94.22	94.20	94.21	94.19
Murcia	94.86	94.86	94.92	94.93	94.87	94.88	94.89	94.91	94.90	94.91	94.96	94.95	94.94	94.95	94.98
Navarra	55.32	55.37	55.29	55.24	54.96	54.83	54.66	54.52	54.54	54.46	54.42	54.48	54.63	54.60	54.68
País Vasco	81.19	81.04	80.92	80.79	80.55	80.39	80.30	80.20	80.10	80.03	79.96	79.92	79.91	79.92	79.91
La Rioja	64.19	64.08	64.06	63.97	63.18	63.28	63.30	63.25	63.08	63.25	63.31	63.40	63.50	63.54	63.67

Source: Author’s own work based on the sources described in Blanco, A. et al. (2021). Base year = 2016.

8.2. ANNEX II. CORRELATIONS

PROXIMITY	PROXSSE1a	PROXSSE1b	PROXSSE1c	PROXWSE1d	PROXWSE1e	PROXWSE1f	PROXRSE1g	PROXRSE1h	PROXRSE1i	PROXNSE1j	PROXNSE1k	PROXNSE1l	PROXNSE1m	PROXSMUN2a	PROXSMUN2b	PROXSMUN2c	PROXWMUN2d	PROXWMUN2e	PROXWMUN2f	PROXRMUN2g	PROXRMUN2h	PROXRMUN2i	PROXNMUN2j	PROXNMUN2k	PROXNMUN2l	PROXNMUN2m	PROXVMUN2n	PROXVMUN2o	PROXVMUN2p
PROXSSE1a	1	0.98	0.89	0.86	0.80	0.72	0.21	0.16	0.13	0.28	0.00	0.37	0.13	0.95	0.91	0.88	0.86	0.80	0.72	0.16	0.13	0.13	0.28	0.01	0.40	0.16	0.29	0.29	0.31
PROXSSE1b	0.98	1	0.91	0.86	0.83	0.75	0.22	0.17	0.14	0.32	0.12	0.39	0.20	0.95	0.94	0.90	0.86	0.82	0.74	0.15	0.13	0.12	0.36	0.14	0.41	0.23	0.30	0.30	0.31
PROXSSE1c	0.89	0.91	1	0.81	0.79	0.84	0.29	0.25	0.23	0.40	0.17	0.49	0.32	0.81	0.81	0.96	0.80	0.79	0.84	0.27	0.25	0.25	0.29	0.10	0.52	0.36	0.49	0.50	0.51
PROXWSE1d	0.86	0.86	0.81	1	0.99	0.92	0.68	0.63	0.60	0.16	-0.06	0.71	0.51	0.81	0.79	0.79	1.00	0.98	0.92	0.56	0.54	0.53	0.12	-0.06	0.73	0.53	0.58	0.58	0.59
PROXWSE1e	0.80	0.83	0.79	0.99	1	0.95	0.73	0.69	0.66	0.18	0.03	0.76	0.60	0.76	0.76	0.77	0.99	1.00	0.95	0.61	0.58	0.58	0.15	0.02	0.78	0.63	0.63	0.63	0.64
PROXWSE1f	0.72	0.75	0.84	0.92	0.95	1	0.75	0.72	0.71	0.25	0.08	0.81	0.67	0.64	0.65	0.80	0.92	0.95	1.00	0.67	0.66	0.66	0.10	0.00	0.84	0.71	0.75	0.76	0.77
PROXRSE1g	0.21	0.22	0.29	0.68	0.73	0.75	1	0.99	0.97	-0.07	-0.11	0.86	0.79	0.16	0.17	0.26	0.67	0.73	0.75	0.88	0.87	0.87	-0.21	-0.18	0.86	0.79	0.75	0.75	0.75
PROXRSE1h	0.16	0.17	0.25	0.63	0.69	0.72	0.99	1	0.99	-0.08	-0.11	0.86	0.80	0.11	0.11	0.22	0.63	0.69	0.73	0.88	0.88	0.88	-0.23	-0.18	0.86	0.81	0.76	0.76	0.76
PROXRSE1i	0.13	0.14	0.23	0.60	0.66	0.71	0.97	0.99	1	-0.05	-0.09	0.85	0.81	0.07	0.08	0.20	0.60	0.66	0.72	0.88	0.88	0.89	-0.23	-0.18	0.86	0.82	0.76	0.76	0.76
PROXNSE1j	0.28	0.32	0.40	0.16	0.18	0.25	-0.07	-0.08	-0.05	1	0.85	0.41	0.41	0.09	0.11	0.22	0.16	0.18	0.24	0.16	0.16	0.16	0.41	0.33	0.40	0.41	0.33	0.34	0.34
PROXNSE1k	0.00	0.12	0.17	-0.06	0.03	0.08	-0.11	-0.11	-0.09	0.85	1	0.28	0.47	-0.10	0.00	0.05	-0.06	0.02	0.07	0.03	0.03	0.03	0.53	0.64	0.25	0.45	0.19	0.21	0.21
PROXNSE1l	0.37	0.39	0.49	0.71	0.76	0.81	0.86	0.86	0.85	0.41	0.28	1	0.93	0.24	0.25	0.39	0.70	0.75	0.80	0.85	0.84	0.84	0.02	-0.01	0.99	0.92	0.84	0.84	0.85
PROXNSE1m	0.13	0.20	0.32	0.51	0.60	0.67	0.79	0.80	0.81	0.41	0.47	0.93	1	0.04	0.11	0.24	0.50	0.60	0.66	0.75	0.75	0.76	0.13	0.24	0.90	0.99	0.76	0.76	0.76
PROXSMUN2a	0.95	0.95	0.81	0.81	0.76	0.64	0.16	0.11	0.07	0.09	-0.10	0.24	0.04	1	0.98	0.89	0.80	0.74	0.63	-0.02	-0.05	-0.05	0.43	0.16	0.25	0.06	0.15	0.15	0.16
PROXSMUN2b	0.91	0.94	0.81	0.79	0.76	0.65	0.17	0.11	0.08	0.11	0.00	0.25	0.11	0.98	1	0.90	0.78	0.75	0.64	-0.05	-0.08	-0.08	0.52	0.30	0.25	0.12	0.16	0.16	0.17
PROXSMUN2c	0.88	0.90	0.96	0.79	0.77	0.80	0.26	0.22	0.20	0.22	0.05	0.39	0.24	0.89	0.90	1	0.78	0.76	0.78	0.11	0.09	0.09	0.41	0.22	0.41	0.27	0.39	0.40	0.41
PROXWMUN2d	0.86	0.86	0.80	1.00	0.99	0.92	0.67	0.63	0.60	0.16	-0.06	0.70	0.50	0.80	0.78	0.78	1	0.99	0.93	0.58	0.55	0.55	0.10	-0.08	0.73	0.54	0.58	0.58	0.59
PROXWMUN2e	0.80	0.82	0.79	0.98	1.00	0.95	0.73	0.69	0.66	0.18	0.02	0.75	0.60	0.74	0.75	0.76	0.99	1	0.95	0.62	0.60	0.60	0.12	0.00	0.78	0.63	0.63	0.63	0.64
PROXWMUN2f	0.72	0.74	0.84	0.92	0.95	1.00	0.75	0.73	0.72	0.24	0.07	0.80	0.66	0.63	0.64	0.78	0.93	0.95	1	0.68	0.67	0.67	0.08	-0.01	0.84	0.71	0.75	0.75	0.76
PROXRMUN2g	0.16	0.15	0.27	0.56	0.61	0.67	0.88	0.88	0.88	0.16	0.03	0.85	0.75	-0.02	-0.05	0.11	0.58	0.62	0.68	1	1.00	0.99	-0.45	-0.40	0.88	0.79	0.80	0.79	0.80
PROXRMUN2h	0.13	0.13	0.25	0.54	0.58	0.66	0.87	0.88	0.88	0.16	0.03	0.84	0.75	-0.05	-0.08	0.09	0.55	0.60	0.67	1.00	1	0.99	-0.46	-0.41	0.88	0.79	0.78	0.78	0.78
PROXRMUN2i	0.13	0.12	0.25	0.53	0.58	0.66	0.87	0.88	0.89	0.16	0.03	0.84	0.76	-0.05	-0.08	0.09	0.55	0.60	0.67	0.99	0.99	1	-0.46	-0.40	0.87	0.79	0.77	0.77	0.77
PROXNMUN2j	0.28	0.36	0.29	0.12	0.15	0.10	-0.21	-0.23	-0.23	0.41	0.53	0.02	0.13	0.43	0.52	0.41	0.10	0.12	0.08	-0.45	-0.46	-0.46	1	0.91	-0.03	0.09	-0.10	-0.08	-0.09
PROXNMUN2k	0.01	0.14	0.10	-0.06	0.02	0.00	-0.18	-0.18	-0.18	0.33	0.64	-0.01	0.24	0.16	0.30	0.22	-0.08	0.00	-0.01	-0.40	-0.41	-0.40	0.91	1	-0.06	0.20	-0.07	-0.06	-0.06
PROXNMUN2l	0.40	0.41	0.52	0.73	0.78	0.84	0.86	0.86	0.86	0.40	0.25	0.99	0.90	0.25	0.25	0.41	0.73	0.78	0.84	0.88	0.88	0.87	-0.03	-0.06	1	0.93	0.85	0.85	0.86
PROXNMUN2m	0.16	0.23	0.36	0.53	0.63	0.71	0.79	0.81	0.82	0.41	0.45	0.92	0.99	0.06	0.12	0.27	0.54	0.63	0.71	0.79	0.79	0.79	0.09	0.20	0.93	1	0.78	0.78	0.78
PROXVMUN2n	0.29	0.30	0.49	0.58	0.63	0.75	0.75	0.76	0.76	0.33	0.19	0.84	0.76	0.15	0.16	0.39	0.58	0.63	0.75	0.80	0.78	0.77	-0.10	-0.07	0.85	0.78	1	1.00	1.00
PROXVMUN2o	0.29	0.30	0.50	0.58	0.63	0.76	0.75	0.76	0.76	0.34	0.21	0.84	0.76	0.15	0.16	0.40	0.58	0.63	0.75	0.79	0.78	0.77	-0.08	-0.06	0.85	0.78	1.00	1	1.00
PROXVMUN2p	0.31	0.31	0.51	0.59	0.64	0.77	0.75	0.76	0.76	0.34	0.21	0.85	0.76	0.16	0.17	0.41	0.59	0.64	0.76	0.80	0.78	0.77	-0.09	-0.06	0.86	0.78	1.00	1.00	1

Source: Author's own work.

CENTRALITY	CBDdSSE3a	CBDdSSE3b	CBDdSSE3c	CBDdWSE3d	CBDdWSE3e	CBDdWSE3f	CBDdRSE3g	CBDdRSE3h	CBDdRSE3i	CBDdNSE3j	CBDdNSE3k	CBDdNSE3l	CBDdNSE3m	CBDdSMUN4a	CBDdSMUN4b	CBDdSMUN4c	CBDdWMUN4d	CBDdWMUN4e	CBDdWMUN4f	CBDdRMUN4g	CBDdRMUN4h	CBDdRMUN4i	CBDdNMUN4j	CBDdNMUN4k	CBDdNMUN4l	CBDdNMUN4m	CBDdCRMUN4n	CBDdACIMUN4o
CBDdSSE3a	1	0.98	0.91	0.75	0.69	0.65	0.14	0.10	0.09	0.47	0.27	0.46	0.34	0.92	0.87	0.83	0.75	0.69	0.65	0.21	0.19	0.18	0.32	0.12	0.45	0.33	0.21	0.29
CBDdSSE3b	0.98	1	0.92	0.74	0.71	0.66	0.13	0.09	0.08	0.54	0.40	0.46	0.39	0.91	0.90	0.85	0.74	0.70	0.66	0.19	0.18	0.17	0.42	0.26	0.45	0.37	0.16	0.23
CBDdSSE3c	0.91	0.92	1	0.72	0.70	0.74	0.22	0.19	0.18	0.53	0.38	0.53	0.46	0.83	0.82	0.94	0.72	0.70	0.75	0.28	0.27	0.26	0.40	0.25	0.52	0.45	0.22	0.30
CBDdWSE3d	0.75	0.74	0.72	1	0.99	0.95	0.75	0.72	0.71	0.17	0.03	0.81	0.72	0.73	0.70	0.71	1.00	0.99	0.95	0.74	0.73	0.73	0.11	-0.01	0.80	0.71	0.68	0.72
CBDdWSE3e	0.69	0.71	0.70	0.99	1	0.97	0.78	0.76	0.75	0.20	0.10	0.83	0.77	0.68	0.67	0.69	0.99	1.00	0.97	0.78	0.77	0.76	0.16	0.07	0.83	0.77	0.67	0.71
CBDdWSE3f	0.65	0.66	0.74	0.95	0.97	1	0.80	0.78	0.77	0.21	0.11	0.85	0.81	0.63	0.62	0.74	0.95	0.97	1.00	0.80	0.79	0.79	0.17	0.09	0.85	0.80	0.68	0.73
CBDdRSE3g	0.14	0.13	0.22	0.75	0.78	0.80	1	1.00	0.99	-0.17	-0.20	0.83	0.80	0.18	0.17	0.27	0.75	0.78	0.80	0.93	0.93	0.93	-0.11	-0.12	0.83	0.80	0.86	0.85
CBDdRSE3h	0.10	0.09	0.19	0.72	0.76	0.78	1.00	1	1.00	-0.19	-0.22	0.82	0.79	0.15	0.14	0.25	0.72	0.76	0.78	0.92	0.92	0.93	-0.12	-0.13	0.82	0.79	0.86	0.85
CBDdRSE3i	0.09	0.08	0.18	0.71	0.75	0.77	0.99	1.00	1	-0.20	-0.23	0.81	0.79	0.14	0.13	0.25	0.71	0.75	0.78	0.92	0.92	0.93	-0.13	-0.13	0.81	0.79	0.86	0.86
CBDdNSE3j	0.47	0.54	0.53	0.17	0.20	0.21	-0.17	-0.19	-0.20	1	0.94	0.33	0.38	0.26	0.33	0.32	0.16	0.19	0.21	0.04	0.02	0.01	0.70	0.64	0.33	0.38	-0.13	-0.07
CBDdNSE3k	0.27	0.40	0.38	0.03	0.10	0.11	-0.20	-0.22	-0.23	0.94	1	0.21	0.35	0.11	0.24	0.21	0.03	0.10	0.11	-0.04	-0.05	-0.06	0.73	0.78	0.21	0.35	-0.28	-0.24
CBDdNSE3l	0.46	0.46	0.53	0.81	0.83	0.85	0.83	0.82	0.81	0.33	0.21	1	0.96	0.41	0.40	0.49	0.81	0.83	0.85	0.85	0.83	0.83	0.27	0.17	1.00	0.96	0.78	0.83
CBDdNSE3m	0.34	0.39	0.46	0.72	0.77	0.81	0.80	0.79	0.79	0.38	0.35	0.96	1	0.31	0.36	0.44	0.72	0.77	0.81	0.80	0.79	0.79	0.38	0.36	0.96	1.00	0.67	0.72
CBDdSMUN4a	0.92	0.91	0.83	0.73	0.68	0.63	0.18	0.15	0.14	0.26	0.11	0.41	0.31	1	0.98	0.89	0.73	0.68	0.63	0.11	0.09	0.09	0.41	0.21	0.40	0.30	0.20	0.29
CBDdSMUN4b	0.87	0.90	0.82	0.70	0.67	0.62	0.17	0.14	0.13	0.33	0.24	0.40	0.36	0.98	1	0.89	0.70	0.68	0.62	0.08	0.06	0.06	0.53	0.38	0.40	0.35	0.14	0.23
CBDdSMUN4c	0.83	0.85	0.94	0.71	0.69	0.74	0.27	0.25	0.25	0.32	0.21	0.49	0.44	0.89	0.89	1	0.71	0.70	0.74	0.21	0.20	0.20	0.44	0.30	0.49	0.43	0.24	0.33
CBDdWMUN4d	0.75	0.74	0.72	1.00	0.99	0.95	0.75	0.72	0.71	0.16	0.03	0.81	0.72	0.73	0.70	0.71	1	0.99	0.95	0.74	0.73	0.73	0.12	-0.01	0.81	0.71	0.68	0.72
CBDdWMUN4e	0.69	0.70	0.70	0.99	1.00	0.97	0.78	0.76	0.75	0.19	0.10	0.83	0.77	0.68	0.68	0.70	0.99	1	0.97	0.78	0.76	0.76	0.16	0.07	0.83	0.77	0.68	0.72
CBDdWMUN4f	0.65	0.66	0.75	0.95	0.97	1.00	0.80	0.78	0.78	0.21	0.11	0.85	0.81	0.63	0.62	0.74	0.95	0.97	1	0.79	0.79	0.79	0.17	0.09	0.85	0.80	0.68	0.73
CBDdRMUN4g	0.21	0.19	0.28	0.74	0.78	0.80	0.93	0.92	0.92	0.04	-0.04	0.85	0.80	0.11	0.08	0.21	0.74	0.78	0.79	1	1.00	1.00	-0.19	-0.20	0.85	0.80	0.86	0.83
CBDdRMUN4h	0.19	0.18	0.27	0.73	0.77	0.79	0.93	0.92	0.92	0.02	-0.05	0.83	0.79	0.09	0.06	0.20	0.73	0.76	0.79	1.00	1	1.00	-0.20	-0.21	0.84	0.79	0.85	0.83
CBDdRMUN4i	0.18	0.17	0.26	0.73	0.76	0.79	0.93	0.93	0.93	0.01	-0.06	0.83	0.79	0.09	0.06	0.20	0.73	0.76	0.79	1.00	1.00	1	-0.21	-0.22	0.84	0.79	0.86	0.84
CBDdNMUN4j	0.32	0.42	0.40	0.11	0.16	0.17	-0.11	-0.12	-0.13	0.70	0.73	0.27	0.38	0.41	0.53	0.44	0.12	0.16	0.17	-0.19	-0.20	-0.21	1	0.95	0.27	0.38	-0.22	-0.11
CBDdNMUN4k	0.12	0.26	0.25	-0.01	0.07	0.09	-0.12	-0.13	-0.13	0.64	0.78	0.17	0.36	0.21	0.38	0.30	-0.01	0.07	0.09	-0.20	-0.21	-0.22	0.95	1	0.17	0.36	-0.33	-0.23
CBDdNMUN4l	0.45	0.45	0.52	0.80	0.83	0.85	0.83	0.82	0.81	0.33	0.21	1.00	0.96	0.40	0.40	0.49	0.81	0.83	0.85	0.85	0.84	0.84	0.27	0.17	1	0.96	0.79	0.84
CBDdNMUN4m	0.33	0.37	0.45	0.71	0.77	0.80	0.80	0.79	0.79	0.38	0.35	0.96	1.00	0.30	0.35	0.43	0.71	0.77	0.80	0.80	0.79	0.79	0.38	0.36	0.96	1	0.68	0.73
CBDdCRMUN4n	0.21	0.16	0.22	0.68	0.67	0.68	0.86	0.86	0.86	-0.13	-0.28	0.78	0.67	0.20	0.14	0.24	0.68	0.68	0.68	0.86	0.85	0.86	-0.22	-0.33	0.79	0.68	1	0.97
CBDdACIMUN4o	0.29	0.23	0.30	0.72	0.71	0.73	0.85	0.85	0.86	-0.07	-0.24	0.83	0.72	0.29	0.23	0.33	0.72	0.72	0.73	0.83	0.83	0.84	-0.11	-0.23	0.84	0.73	0.97	1

Source: Author's own work.

NUCLEARITY	NUNoNSE5a	NUSoPSE5b
NUNoNSE5a	1	0.70
NUSoPSE5b	0.70	1

Source: Author's own work.

DENSITY	DEPWDMUN7a	DEPWDMUN7b	DEPWDMUN7c	DENMAXMUN7d	DENMAXMUN7e	DENMAXMUN7f	DENMINMUN7g	DENMINMUN7h	DENMINMUN7i	DENHIGHMUN7j	DENHIGHMUN7k	DENHIGHMUN7l	DENCBDMUN7m	DENCBDMUN7n	DENCBDMUN7o
DEPWDMUN7a	1	0.81	0.81	0.82	0.83	0.84	-0.02	-0.07	-0.13	0.88	0.64	0.63	0.97	0.79	0.83
DEPWDMUN7b	0.81	1	0.95	0.67	0.90	0.93	0.21	0.25	0.15	0.69	0.80	0.76	0.74	0.95	0.93
DEPWDMUN7c	0.81	0.95	1	0.63	0.81	0.86	0.15	0.16	0.14	0.77	0.84	0.85	0.70	0.87	0.94
DENMAXMUN7d	0.82	0.67	0.63	1	0.83	0.83	-0.05	-0.04	-0.09	0.69	0.48	0.44	0.83	0.73	0.72
DENMAXMUN7e	0.83	0.90	0.81	0.83	1	0.98	0.29	0.24	0.17	0.65	0.57	0.55	0.82	0.92	0.87
DENMAXMUN7f	0.84	0.93	0.86	0.83	0.98	1	0.26	0.20	0.20	0.68	0.61	0.58	0.81	0.94	0.91
DENMINMUN7g	-0.02	0.21	0.15	-0.05	0.29	0.26	1	0.47	0.58	0.14	0.01	-0.01	-0.01	0.23	0.19
DENMINMUN7h	-0.07	0.25	0.16	-0.04	0.24	0.20	0.47	1	0.74	0.06	0.16	0.20	-0.05	0.31	0.22
DENMINMUN7i	-0.13	0.15	0.14	-0.09	0.17	0.20	0.58	0.74	1	-0.02	-0.01	0.08	-0.12	0.24	0.25
DENHIGHMUN7j	0.88	0.69	0.77	0.69	0.65	0.68	0.14	0.06	-0.02	1	0.62	0.62	0.82	0.67	0.76
DENHIGHMUN7k	0.64	0.80	0.84	0.48	0.57	0.61	0.01	0.16	-0.01	0.62	1	0.95	0.57	0.71	0.74
DENHIGHMUN7l	0.63	0.76	0.85	0.44	0.55	0.58	-0.01	0.20	0.08	0.62	0.95	1	0.53	0.66	0.75
DENCBDMUN7m	0.97	0.74	0.70	0.83	0.82	0.81	-0.01	-0.05	-0.12	0.82	0.57	0.53	1	0.78	0.79
DENCBDMUN7n	0.79	0.95	0.87	0.73	0.92	0.94	0.23	0.31	0.24	0.67	0.71	0.66	0.78	1	0.95
DENCBDMUN7o	0.83	0.93	0.94	0.72	0.87	0.91	0.19	0.22	0.25	0.76	0.74	0.75	0.79	0.95	1

Source: Author's own work.

CONCENTRATION	CNGINISE8a	CNSTHEISE8b	CNSHHISE8c	CNDCVMUN9a	CNHGDMUN9b	CNPDGMUN9c	CNGINIMUN9d	CNGINIMUN9e	CNSTHEIMUN9f	CNTHIMUN9g	CNSHHIMUN9h	CNRGCIMUN9i	CNEGMUN9j	CNDIMUN9k	CNMDDIMUN9l	CNMDDIMUN9m
CNGINISE8a	1	0.69	0.59	0.39	0.64	0.69	0.75	0.82	0.69	0.74	0.53	0.56	0.58	0.87	0.75	0.70
CNSTHEISE8b	0.69	1	0.86	0.33	0.44	0.22	0.76	0.63	0.86	0.36	0.81	0.85	0.86	0.69	0.50	0.42
CNSHHISE8c	0.59	0.86	1	0.11	0.55	0.32	0.82	0.50	0.97	0.41	0.96	0.94	0.95	0.57	0.37	0.27
CNDCVMUN9a	0.39	0.33	0.11	1	0.15	-0.06	0.38	0.62	0.22	0.36	0.02	0.14	0.16	0.53	0.33	0.28
CNHGDMUN9b	0.64	0.44	0.55	0.15	1	0.52	0.58	0.56	0.55	0.61	0.51	0.51	0.51	0.58	0.21	0.32
CNPDGMUN9c	0.69	0.22	0.32	-0.06	0.52	1	0.49	0.54	0.39	0.69	0.27	0.23	0.24	0.61	0.62	0.61
CNGINIMUN9d	0.75	0.76	0.82	0.38	0.58	0.49	1	0.76	0.90	0.73	0.70	0.70	0.73	0.79	0.65	0.57
CNGINIMUN9e	0.82	0.63	0.50	0.62	0.56	0.54	0.76	1	0.61	0.86	0.40	0.50	0.52	0.99	0.79	0.81
CNSTHEIMUN9f	0.69	0.86	0.97	0.22	0.55	0.39	0.90	0.61	1	0.52	0.93	0.92	0.94	0.67	0.52	0.42
CNTHIMUN9g	0.74	0.36	0.41	0.36	0.61	0.69	0.73	0.86	0.52	1	0.31	0.35	0.38	0.86	0.72	0.76
CNSHHIMUN9h	0.53	0.81	0.96	0.02	0.51	0.27	0.70	0.40	0.93	0.31	1	0.98	0.98	0.48	0.30	0.20
CNRGCIMUN9i	0.56	0.85	0.94	0.14	0.51	0.23	0.70	0.50	0.92	0.35	0.98	1	1.00	0.57	0.35	0.28
CNEGMUN9j	0.58	0.86	0.95	0.16	0.51	0.24	0.73	0.52	0.94	0.38	0.98	1.00	1	0.59	0.37	0.30
CNDIMUN9k	0.87	0.69	0.57	0.53	0.58	0.61	0.79	0.99	0.67	0.86	0.48	0.57	0.59	1	0.81	0.82
CNMDDIMUN9l	0.75	0.50	0.37	0.33	0.21	0.62	0.65	0.79	0.52	0.72	0.30	0.35	0.37	0.81	1	0.95
CNMDDIMUN9m	0.70	0.42	0.27	0.28	0.32	0.61	0.57	0.81	0.42	0.76	0.20	0.28	0.30	0.82	0.95	1

Source: Author's own work.

CONTINUITY	CNTRUTPROV10a	CNTRBTPROV10b	CNTR2PROV10c
CNTRUTPROV10a	1	0.98	0.67
CNTRBTPROV10b	0.98	1	0.65
CNTR2PROV10c	0.67	0.65	1

Source: Author's own work.

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