



## Measuring the relationship between territorial exclusion and depopulation – A municipal classification proposal to guide territorial balance

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### ABSTRACT

The rural exodus in Europe has triggered population loss and ageing in many regions, exacerbating demographic and socio-economic imbalances. This study employs a comprehensive methodology to address these challenges, introducing a Territorial Exclusion indicator that covers deficiencies in services, economic stagnation, and limited accessibility of municipalities. Using structural equation modeling, we demonstrate how territorial exclusion acts as a fundamental factor driving depopulation. Furthermore, the study identifies homogeneous groups of municipalities based on their level of territorial exclusion, emphasizing the need for differentiated approaches in developing targeted and effective territorial development policies. To illustrate these findings, we focus on the region of Aragon (Spain) as an extreme example, providing valuable insights into the broader implications of territorial exclusion and informing strategies for addressing depopulation challenges in the region and beyond.

### 1. Introduction

The rural exodus in Europe, which began with the Industrial Revolution, has led to significant population declines in many rural areas of the EU (Li et al., 2019; Gil-Alonso et al., 2023). This trend has created a cycle of depopulation and ageing, as young people who could support or increase birth rates are the most likely to leave (Bade, 2008; Coleman and Rowthorn, 2011; Burillo et al., 2020; Llorent-Bedmar et al., 2021; Pérez-Morote et al., 2021). Consequently, rural areas often experience a demographic imbalance, with older residents left behind due to higher emigration rates among the youth and women (Alonso-Carrillo et al., 2023; Pérez-Morote et al., 2023). This ageing population poses economic challenges, making it harder to promote entrepreneurship and reverse the decline (Bock, 2016; Granados-López et al., 2018; Navarro, 2019).

Key factors worsening rural depopulation include a shrinking working-age population (Bock, 2016), limited job opportunities (Granados López et al., 2018), long distances from development centers

(Jonard et al., 2009; Camarero and Oliva, 2019), poor infrastructure and connectivity (Preston and Rajé, 2007; Alamá-Sabater et al., 2019; Briglauer et al., 2019), limited access to essential services (Escribano-Pizarro, 2012; Bock et al., 2014), or stagnation in the real estate market (Kabisch and Grossmann, 2013). These challenges vary across regions, complicating the issue further (Dax and Fischer, 2018; Merino and Prats, 2020; Reynaud et al., 2020).

Current EU rural development policies have not effectively addressed these issues, often employing a one-size-fits-all approach that overlooks regional specifics. To combat worsening regional disparities, targeted policies are needed, especially for municipalities with severe demographic disadvantages (Zúñiga-Antón et al., 2022). To identify effectively where to intervene, it is crucial to quantify the degree of deficiencies each municipality faces. Therefore, developing an indicator to measure these shortcomings is essential.

To that aim, we have developed a *Territorial Exclusion* indicator, which focuses on three dimensions identified in the literature as key determinants of demographic change: accessibility, economic

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conditions, and the availability of facilities and services (Augère-Granier, 2017; Alamá-Sabater et al., 2021). By quantifying these dimensions, we aim to provide a clearer understanding of how they contribute to population loss and ageing, ultimately facilitating targeted interventions to address depopulation.

Our methodology employs advanced statistical techniques to address these issues. Specifically, we use Structural Equation Modeling (SEM) that provides a very powerful tool for measuring and establishing relationships among theoretical concepts (Hair et al., 2022) and it has been applied to migration and non-migration problems (Dufhues et al., 2021). In our case, we use SEM to create a comprehensive framework that explores the relationship between *Territorial Exclusion* and *Depopulation*. The SEM framework constructs 2 s-order constructs the *Territorial Exclusion* indicator, which measures deficiencies in essential services, economic stagnation, and difficulties in accessing more prosperous areas, and the *Depopulation* indicator, which captures both population loss and ageing trends.

After quantifying the levels of territorial exclusion and depopulation, we apply cluster analysis to classify municipalities based on their exclusion levels. This approach allows us to identify homogeneous patterns and tailor strategies effectively to address the specific needs of different regions.

We apply this methodology to Aragon, a region in north-eastern Spain, which faces severe depopulation and ageing issues (Palacios et al., 2017). Aragon's case illustrates the link between territorial exclusion and depopulation, providing insights that are relevant not only for Aragon but also for other similar regions in Europe (Alonso et al., 2023).

The study makes several key contributions. First, it designs a *Territorial Exclusion* indicator to measure socio-economic factors and service deficiencies at the municipal level, enhancing understanding of depopulation causes. Second, it applies advanced multivariate statistical techniques, including SEM and cluster analysis, to analyze and classify depopulation patterns, demonstrating the effectiveness of these methods in addressing complex socio-economic issues. Third, it highlights the need for adaptive policies tailored to specific regional challenges rather than a uniform approach. Lastly, focusing on Aragon offers valuable insights for developing targeted strategies to mitigate depopulation impacts, which can be applied more broadly within Europe.

This work is organized as follows. Section 2 establishes the theoretical framework. Section 3 presents the case study, describes the variables, and specifies the structural equation models used. Section 4 details the results of the analysis. Section 5 discusses the implications of the findings and offers some preliminary recommendations and actions. Finally, Section 6 concludes the paper and outlines future directions for research. We also include three appendices with additional details about the indicator variables and the assessment of the models.

## 2. Theoretical framework

The theoretical framework of the proposed “territorial exclusion” indicator is linked to the concept of “territorial marginality”, which generally refers to the exclusion and disadvantage experienced by certain territories compared to others in terms of comprehensive development (Vendemmia et al., 2023). Territorial marginality encompasses various forms of exclusion and disadvantage, including economic deficiencies, social exclusion, spatial disadvantages, political and institutional neglect, cultural discrimination, technological limitations, and environmental challenges (Bock, 2016; Málíková et al., 2016; Vecchio, 2022; Vendemmia and Lanza, 2022). These dimensions interact and overlap, creating a complex web of exclusion that profoundly affects a territory's development and well-being.

Our research aims to connect this broad concept of territorial marginality with the specific issue of depopulation. To achieve this, we focus on three key dimensions —accessibility, availability of facilities and services, and economic conditions— that we collectively refer to as

“territorial exclusion” to distinguish them from the broader concept of territorial marginality. These dimensions have already been identified in the literature, and they have been recognized as key drivers of demographic change by regional policymakers (Augère-Granier, 2017; Alamá-Sabater et al., 2021). By concentrating on these dimensions, we seek to understand how deficiencies in each area can limit a territory's ability to attract and retain population, leading to demographic decline and ageing.

Accessibility is critical because it determines how easily residents and potential inhabitants can access opportunities and resources. Adequate transportation and communication infrastructure is essential for attracting and retaining population, while a lack of accessibility can lead to emigration toward more accessible regions (Christiaanse, 2020; Wisniewski et al., 2021; Panagiotopoulos and Kaliampakos, 2024).

Essential services (health centers, schools, social services, shops, bars, restaurants, etc.) directly impact quality of life. Deficiencies or absences of these services can discourage residents from living in rural areas, thereby accelerating depopulation (Briglaue et al., 2019; Christiaanse, 2020; Merino and Prats, 2020; Pinilla and Sáez, 2021; Jelić and Kolarević, 2021; Dubois and Sielker, 2022; Nilsen et al., 2023). In turn, the loss of public and private services contributes to further deterioration in development opportunities, as economic activity is minimal due primarily to the decline in the working-age population (Higgs and Langford, 2013; Camarero and Oliva, 2019).

Economic conditions encompass the health of the labor market, economic development opportunities, and the state of the real estate market. These factors are vital for demographic stability, influencing a region's ability to offer employment, adequate housing, and a conducive environment for business growth (Wojewódzka-Wiewiórska, 2019; Johnson and Lichter, 2019; Merino and Prats, 2020).

Although we are dealing with a historical phenomenon, the lack of genuine concern for finding practical solutions to stop depopulation has led to an alarming situation in many EU territories (Pinilla et al., 2008; Navarro, 2019; Eurostat, 2020). The issues of lack of accessibility, deficiencies in services, and economic shortcomings affect each area differently, highlighting the need for a precise assessment of the level of exclusion experienced. To address this reality, it is essential to identify accurately these structural problems, measure them on an appropriate territorial scale, and use relevant variables and indicators to guide effective policy actions (Serra et al., 2023). Therefore, in our specific case, it is necessary to define an indicator that captures the degree of deficiency in each municipality, allowing for targeted and tailored interventions to effectively address the problem of demographic decline.

This work focuses on determining how to quantify the indicator and how it influences depopulation specifically for the case of Aragon, a region that is experiencing significant challenges with both depopulation and ageing. Aragon serves as a detailed example to illustrate how deficiencies in accessibility (López-Escolano et al., 2016), availability of services (Escalona-Orcao and Díez-Cornago, 2007; Alonso et al., 2023), and economic conditions (Ayuda et al., 2000; Mancha-Navarro et al., 2017) contribute to demographic decline, though the impact varies from municipality to municipality. Aragon characterises a situation that could occur in other European regions with similar socio-demographic trends (Alonso et al., 2023). By applying our methodology, we aim to provide actionable insights and demonstrate the practical application of our indicators, ultimately contributing to more effective and targeted interventions to address depopulation and ageing issues in similar regions.

## 3. Materials and methods

### 3.1. Area of study

Aragon is a Spanish Autonomous Community located in the north-east of the country (Fig. 1). It is administratively organized into 731 municipalities, grouped into 33 *comarcas* (counties) and 3 provinces. Its diverse territory ranges from the high peaks of the Pyrenees to the vast

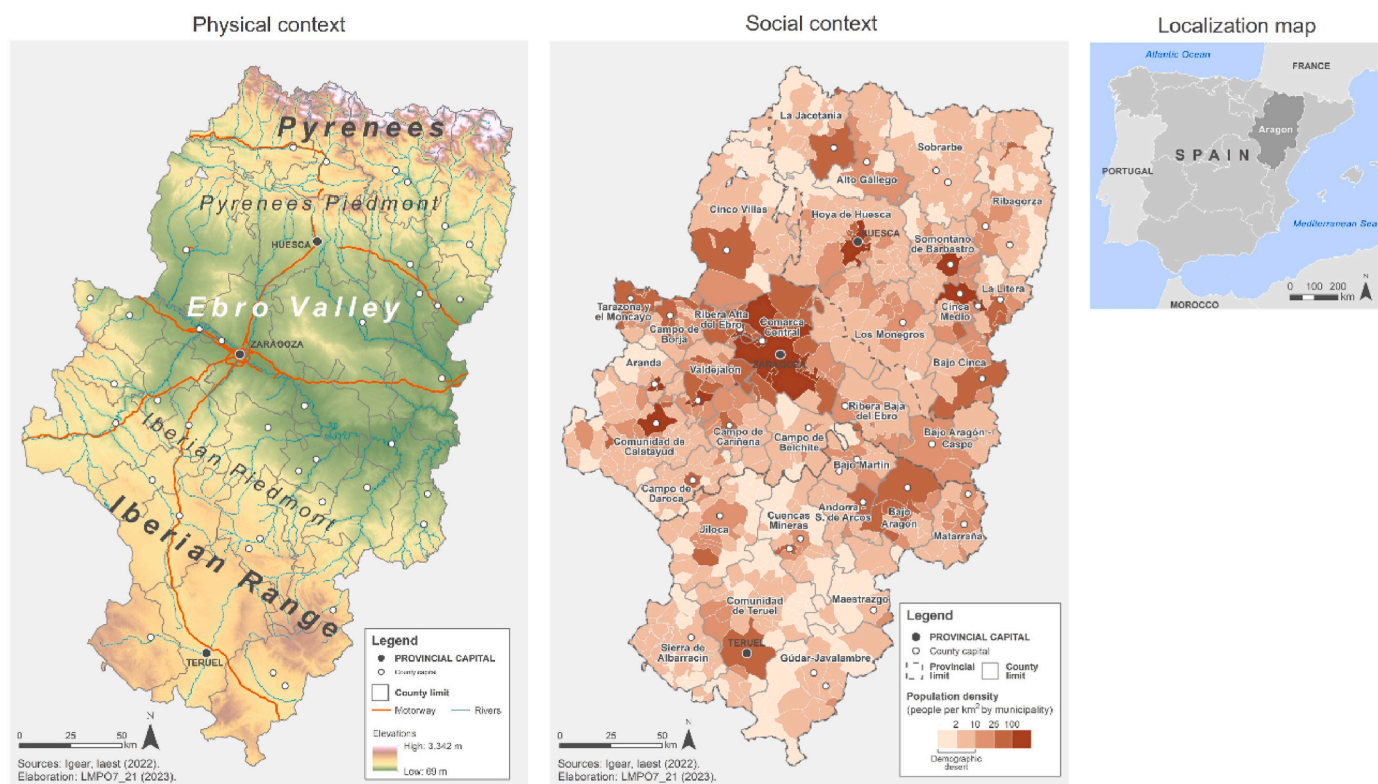


Fig. 1. Physical and demographic characteristics of Aragon.

plains of the Ebro depression, results in significant geographical contrasts; which also is reflected in marked

differences in the distribution of the population and socio-economic development. According to the latest annual population census by the National Institute of Statistics (INE), Aragon has a population of 1,341,289 inhabitants, with Zaragoza, the region’s capital, housing 683,949 of these residents. Zaragoza attracts substantial investments and has become a hub for logistics, services, and manufacturing, hosting major international companies due to its strategic connectivity and economic diversity. However, many rural areas within the region face substantial territorial challenges, including a notable lack of entrepreneurial activity, which is a common issue affecting rural spaces across Spain (Del Olmo-García et al., 2023).

Moving away from urban centers, we find municipalities with predominantly agricultural and livestock economies affected by a lack of access to services and limited economic diversification. These contrasts lead to a labor dichotomy and differences in the quality of life between urban and rural areas. Tourism also plays an essential role in this scenario of contrasts since the tourist destinations of the Pyrenees and the areas of most significant historical and cultural interest attract visitors. In contrast, tourism is not an alternative for development in many rural municipalities.

In this territory, the constant migration of rural residents to the urban centers has left a landscape of declining towns and regions that feel abandoned (Del Molino, 2020). This trend translates into disturbing figures: more than 70% of the municipalities of Aragon struggle to maintain a population level that avoids their classification as “demographic deserts” (Zúñiga-Antón et al., 2022). The city of Zaragoza concentrates 54% of the population of Aragon, a proportion that reaches 70% when adding the population of the municipalities of more than 10, 000 inhabitants in the region (12). Faced with this situation, 212 towns (29%) have less than 100 inhabitants and only represent 0.96% of the total population. All this translates into deficiencies that affect the economic and social development of these depopulated territories and cause severe problems of territorial exclusion, with obstacles to having

the same opportunities and services as in urban areas. All these difficulties aggravate the process of loss of population and intensify ageing. In short, Aragon is presented as a microcosm in which demographic, economic, and social problems are intertwined, and which allows the exploration of innovative strategies and adaptive solutions that could have broader applications in the European and international context. As such, Aragon represents an internal challenge for Spain and a relevant test bed for addressing the complexities of depopulation and territorial exclusion in the 21st century within the European context (Alonso et al., 2023).

### 3.2. The model

A second-order structural equation model is used to analyze the influence of *Territorial Exclusion* on the *Depopulation* (Fig. 2). *Territorial Exclusion* is defined as a second-order formative construct based on the constructs *Lack of Services*, *Lack of Economic Dynamism*, and *Lack of Accessibility*, allowing us to capture this complex phenomenon’s interconnection and multidimensionality. The construct *Lack of Services* addresses the lack of essential benefits such as medical care, education, social services, and other vital factors influencing the population’s quality of life and well-being, such as commerce, hospitality, and connectivity. The *Lack of Economic Dynamism* encompasses economic vitality, business diversity, and the capacity to generate job opportunities in the territory. *Lack of Accessibility* measures the difficulty of access to prosperous centers provided with services and opportunities.

For its part, *Depopulation* is defined as a second-order reflective construct, encompassing the reflective constructs *Population Loss* and *Ageing*. The construct *Population Loss* captures the quantitative decline in population in each area, reflecting migration and the attraction of new residents. The construct *Ageing* addresses the qualitative transformation of the demographic structure, highlighting the growing proportion of older people.

Our objective is to understand how *Territorial Exclusion* influences *Depopulation*. In other words, we look to investigate how the lack of

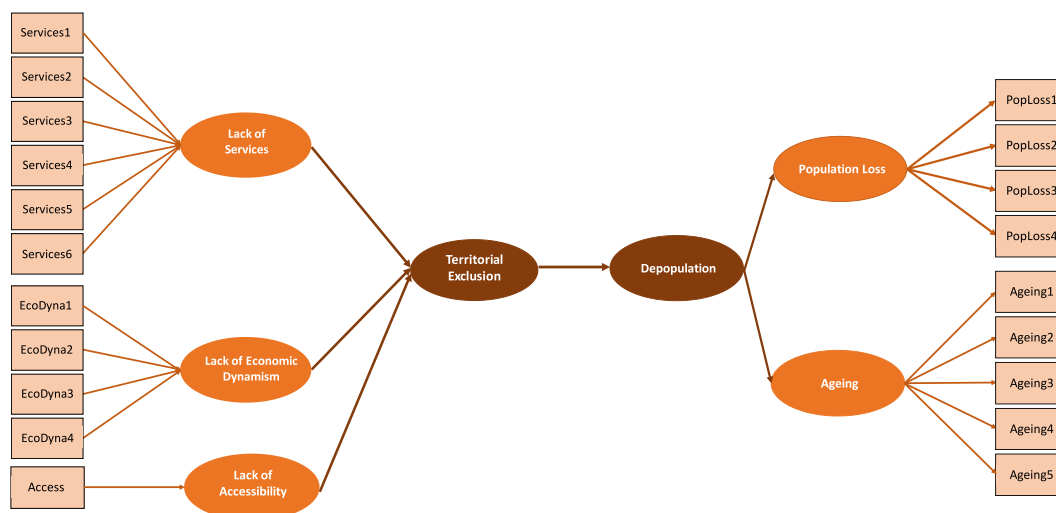


Fig. 2. Complete structural equation model.

services, the lack of economic dynamism, and limited accessibility contribute to population loss and ageing in a municipality.

We used the two-stage disjoint estimation method described in Sarstedt et al. (2019) applied to the model in Fig. 2 to estimate its parameters.

In the first stage, the relationships between the observable indicator variables and the values of the first-order constructs are estimated using the first-order structural model described in Fig. 3.

In the second stage, the relationships between the first and second-order constructs are estimated using the structural model described in Fig. 4. In this step, the estimated values of the first-order constructs are used as their "observed" values.

### 3.3. Indicator variables

In this Section, we describe the indicator variables of the first-order constructs used in the model. We employed information from the year 2021 and various sources. Demographic and socio-economic data were obtained from statistics available at the *Instituto Aragonés de Estadística* (Aragonese Institute of Statistics, IAEST). For the variables related to real estate activity, we turned to the *Colegio de Registradores de la Propiedad, Mercantiles y Bienes Muebles de España* (Registrar's Association of Property, Commerce, and Personal Property of Spain). Regarding the information on the travel time to the *comarca* capitals, we relied on data provided by the *Instituto Geográfico de Aragón* (Geographic Institute of Aragón, IGEAR).

#### 3.3.1. Population loss

Population and residential change rates were chosen to address the complex dynamics of population loss.<sup>1</sup> The population rate of change measures shifts in the total population size in each municipality over a specific period, thereby offering a trajectory view of the direction of demographic fluctuations. On the other hand, the residential variation rate provides additional nuance to the analysis by focusing specifically on changes in the resident population in each area. In regions characterized by territorial exclusion, where the lack of services and opportunities can discourage the arrival of new residents, this variable can

<sup>1</sup> **Population variation** refers to the total change in the number of inhabitants in a municipality over a specific period, encompassing all factors affecting population growth or decline, such as births, deaths, and migration. **Residential variation** focuses on changes in the number of inhabitants due to moves within the same municipality, recording entries and exits in municipal registers due to changes in residence.

shed light on whether population loss is due, to a greater extent, to selective migration or to the lack of attraction of new residents.

Thus, to analyze the *Population Loss* of each municipality, two rates of variation in its population have been calculated – one in the medium term, the demographic growth rate between 2005 and 2021 (**PopLoss1**), and another in the short term, the population growth rate between 2015 and 2021 (**PopLoss2**). The residential variation rate between 2005 and 2021 has also been incorporated (**PopLoss3**) to capture the medium-term and residential variation rate between 2015 and 2021 (**PopLoss4**) to capture the short term to identify whether this population loss is due to people emigrating from the municipality.<sup>2</sup>

#### 3.3.2. Ageing

The dependency ratio (**Ageing3**) measures the relationship between the dependent population (young people and older people) and the working-age population. This rate provides a direct view of the burden on the workforce to support those who are not economically productive. In a context of territorial exclusion, where the lack of opportunities can lead to the emigration of the active population, this rate can increase significantly, exacerbating economic and social challenges.

The youth rate (**Ageing2**) and the percentage of women of childbearing age (**Ageing4**) are complementary since they reflect the proportion of the young population and women in reproductive conditions. In regions affected by ageing and population loss, a decline in the proportion of young people and women of childbearing age may indicate lower demographic vitality and the possibility of a lower birth rate. These variables allow us to identify whether the active and reproductive population is being affected by territorial exclusion.<sup>3</sup>

The average age (**Ageing 1**) and the percentage of people over 65 (**Ageing 5**) complete the demographic variables of the model by providing a direct measure of population ageing.

#### 3.3.3. Lack of services

*Lack of Services* is a formative construct that tries to encompass essential aspects such as health (**Services1**), education (**Services2**), and social services (**Services3**), and other elements contributing to a

<sup>2</sup> The four variables used in the model are multiplied by (−1) so that the construct measures population loss and not population gain.

<sup>3</sup> We considered the difference 100 minus the youth rate, and we have called it *Maturity Index* (**Ageing2**); and the difference is 100 minus the percentage of women of childbearing age, which we have called *Percentage of women outside of childbearing age over the total* (**Ageing4**) so that they appear with positive loadings in the construct *Ageing* (Table 1).

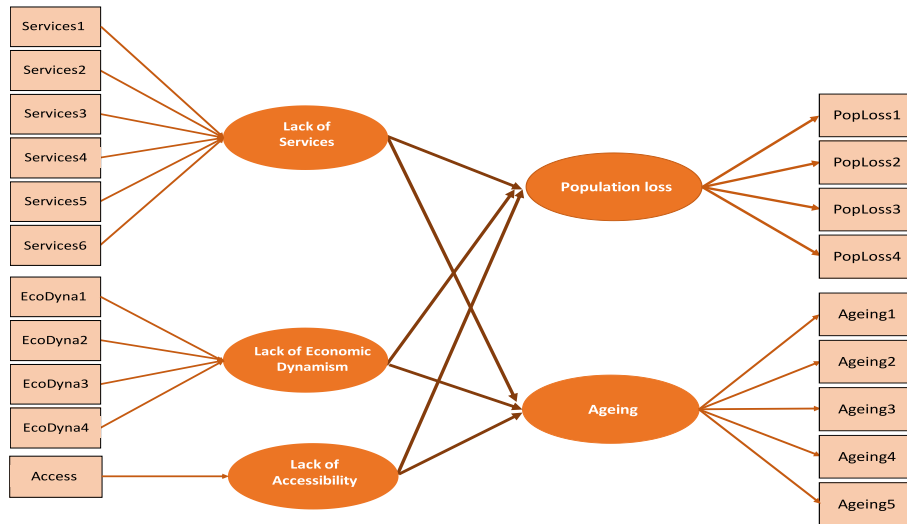


Fig. 3. Structural equation model for first-order constructs (first step of the disjoint two-stage estimation method).

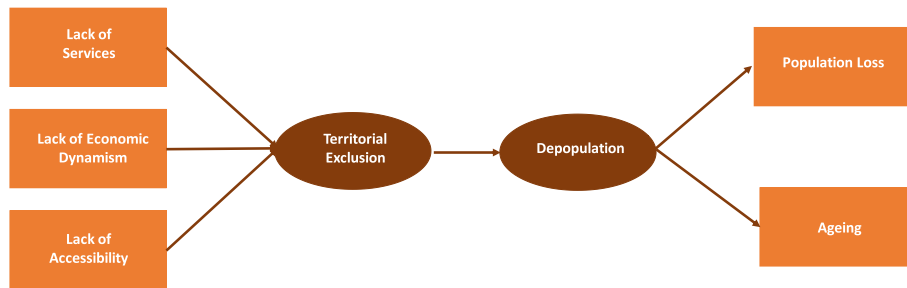


Fig. 4. Structural equation model for second-order constructs (second step of the disjoint two-stage estimation method).

community’s vitality and quality of life. The combination of public and private services in this construct reflects the diversity of needs and shortcomings that can coexist in regions affected by territorial exclusion.

Thus, education is vital for human and economic development, and its absence can limit the opportunities of young generations. Similarly, the lack of medical and social services can lead to deterioration in the health and well-being of the population, especially among the most vulnerable groups.

On the other hand, incorporating essential private services, such as shops (**Services4**), bars and restaurants (**Services5**), and internet connectivity (**Services6**), broadens the perspective on the lack of services. These services contribute to social cohesion and create an area’s attractiveness for residents and visitors. The lack of stores can limit purchasing options and access to essential products. The shortage of bars and restaurants can affect community life and local economic activity. Poor internet coverage in the digital age can exclude communities from online opportunities and global connectivity.

Including these indicators in the construct *Lack of Services* highlights the lack of essential services that can substantially impact an area’s quality of life, social well-being, and attractiveness to attract and retain the population. [Appendix A](#) provides a more detailed information of the specific indicators used in this study.

### 3.3.4. Lack of economic dynamism

This is a formative construct that seek to measure the complexity of economic challenges in the context of territorial exclusion. Each of the variables selected for this construct offers a complementary perspective, allowing for a deeper understanding of how the lack of economic dynamism can influence the vitality of a municipality.

The inclusion of labor dynamism, measured by the replacement ratio

(**EcoDyna1**) and the structure ratio of the active population (**EcoDyna2**), constitutes a critical element of evaluating the economic health of a territory. The replacement ratio reflects the relationship between workers leaving the labor market and those entering it and offers a view of the municipality’s ability to retain and attract new workers. For its part, the active population structure ratio analyzes the distribution of ages and work skills, quantifying the degree of adaptability and competitiveness of the local labor market.

The percentage of affiliates in the general labor regime (**EcoDyna3**) is an indicator linked to the municipality’s business offering. It reflects the proportion of workers affiliated with the general Social Security regime, which shows the diversity and robustness of the local business fabric. This signals the presence of various economic sectors and companies in the area, suggesting more significant economic dynamics and stability.

We also include a real estate activity indicator (**EcoDyna4**) based on the number of housing transactions and the number of mortgages, together with the price and amount, which provides valuable information about the economic dynamism of a municipality. These variables reflect the health and dynamism of the real estate market. A more significant number of transactions and an active housing market can indicate a growing economy and an attractive municipality for investment and population.

Following a similar idea to the Real Estate Activity Registry Index

(IRAI),<sup>4</sup> the indicator proposed here was calculated in several stages. Firstly, we calculate simple indices of prices and quantities of sales carried out in each municipality in 2020 and 2021 and simple indices of amounts and number of mortgages. In each case, the index was calculated as the arithmetic mean of their respective simple indices. Finally, the arithmetic mean of the two previously obtained indices was calculated to get the final indicator, combining real estate transactions and their mortgage financing into a single composite indicator of real estate activity.

The selection of these variables<sup>5</sup> for the construct of *Lack of Economic Dynamism* provides a comprehensive and detailed image of the economic situation of a territory.

### 3.3.5. Lack of accessibility

*Lack of Accessibility* is a single indicator measuring the access time from a municipality to the nearest *comarca* capital (**Access**). The ability to efficiently access to larger population centers that offer diversified services is a determining factor in ensuring local populations' quality of life and development. The distance in access time to a *comarca* capital reflects a municipality's connectivity and integration in the surrounding region. More commuting time may indicate more isolation, which may be related to reduced availability of essential services and economic opportunities. This lack of connectivity can deter the working population and young people from searching for better prospects, contributing to population loss and ageing.

As a summary of all the previous sections, **Table 1** shows the names of the indicator variables grouped by their corresponding first-order constructs, and the related first-order constructs for each second-order construct.

### 3.4. Cluster analysis

Once the previous structural model has been adjusted, the estimated values of the construct in *Territorial Exclusion* in each municipality are used to determine homogeneous groups regarding to their degree of exclusion. With this purpose, we apply cluster analysis techniques combine hierarchical agglomerative methods (Ward's method) to select the number of groups, with non-hierarchical methods (*k*-means) to improve the initial solutions obtained. This analysis provides a solid basis for decision-making, and the design of intervention strategies adapted to the needs and particularities of each territory.

## 4. Results

### 4.1. The structural equation model for territorial exclusion and depopulation

In this section, we show the results obtained in the estimation of the structural equation model of **Fig. 2**. These estimations were obtained using the two-stage disjoint estimation method described in Section 3.2 where we apply the PLS-SEM algorithm in each stage (Hair et al., 2022). We used program R4.1.3 and the statistical package *SEMInR*.

<sup>4</sup> IRAI index is published quarterly by the College of Property Registrars, is a global reference of real estate activity in Spain. It is a synthesis of indicators of real estate transactions, their mortgage financing and another series of indicators related to company constitutions, economic variables of the annual accounts deposited and bankrupt companies, always related to the construction and real estate sectors.

<sup>5</sup> In order to measure the *Lack of Economic Dynamism* with positive coefficients, the variables that have entered the model are linear transformations of the four variables mentioned. Specifically, the four variables are the following: **EcoDyna1** = 100 - Total working age replacement index; **EcoDyna2** = 100 - Total working population structure index; **EcoDyna3** = 100 - Percentage of affiliates in the general regime and **EcoDyna4** = 100 - Real estate activity indicator.

**Table 1**  
Indicator variables and constructs.

Second order constructs	First order constructs	Indicators	Variables
Depopulation	Population Loss	PopLoss1	(-1)*Population growth rate between 2005 and 2021
		PopLoss2	(-1)*Population growth rate between 2015 and 2021
		PopLoss3	(-1)*Residential variation rate between 2005 and 2021
		PopLoss4	(-1)*Residential variation rate between 2015 and 2021
	Ageing	Ageing1	Average age of the population
		Ageing2	Maturity index
		Ageing3	Age dependence ratio
		Ageing4	Percentage of women out of childbearing age over total
		Ageing5	Percentage of population older than 65
	Territorial Exclusion	Lack of Services	Services1
Services2			Indicator of lack of educational services
Services3			Indicator of lack of social services
Services4			Indicator of lack of shops and businesses
Services5			Indicator of lack of restaurants and bars
Services6			Indicator of lack of internet coverage
Lack of Economic Dynamism		EcoDyna1	100 - Total working age replacement index
		EcoDyna2	100 - Total working population structure index
		EcoDyna3	100 - Percentage of affiliates in the general regime
		EcoDyna4	100 - Real estate activity indicator
Lack of Accessibility	Access	Access	Access time to the nearest county head

#### 4.1.1. Second-order structural equation model estimation

**Fig. 5** shows the estimation results of the first stage model. The figures in the arrows represent the regression coefficients. All model coefficients are significant at 95% and with the expected signs.

In stage 2, we use the scores of the first-order constructs of *Lack of Services*, *Lack of Economic Dynamism*, and *Lack of Accessibility*, as well as *Ageing* and *Population Loss* obtained in stage 1 to create and estimate the model of stage 2. The result are shown in **Fig. 6**.

We observe that most of structural equation coefficients are 95% significant and have the expected signs. The only exception is the *Lack of Accessibility* that even though has the appropriate sign, is small and non-significant (0.058) indicating that its contribution to territorial exclusion is little relevant. On the other hand, the *Lack of Economic Dynamism* has the greatest importance when determining their territorial exclusion of a municipality. On the other hand, if we analyze the loadings of *Depopulation*, we see that *Ageing* has the greatest one, which highlight the importance of fighting against the problem of ageing in Aragon.

Finally, and as suspected, *Territorial Exclusion* has a significantly positive impact on *Depopulation*, which highlights the need to reduce the degree of territorial exclusion of a municipality in order to reduce its degree of depopulation.

**Appendices B and C** shows the results of evaluating the reflective and formative measurement models, as well as, the structural models of **Figs. 3 and 4** (Hair et al., 2022). The results indicate that the constructs demonstrate both validity and reliability, and the outcomes of the structural model are statistically significant.

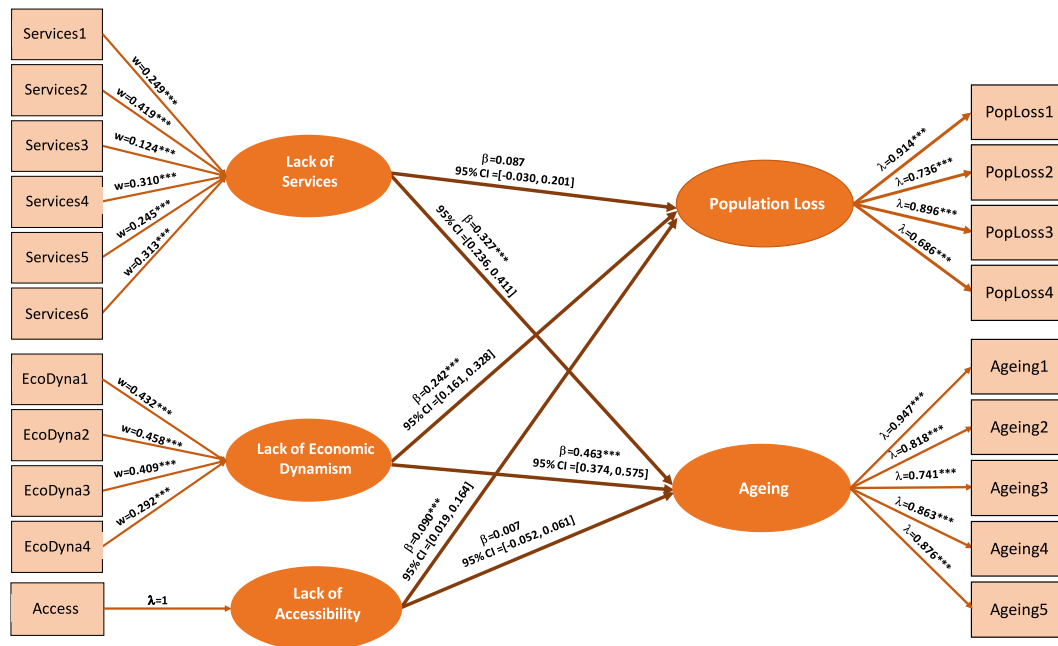


Fig. 5. Estimation of the structural model of the first stage.

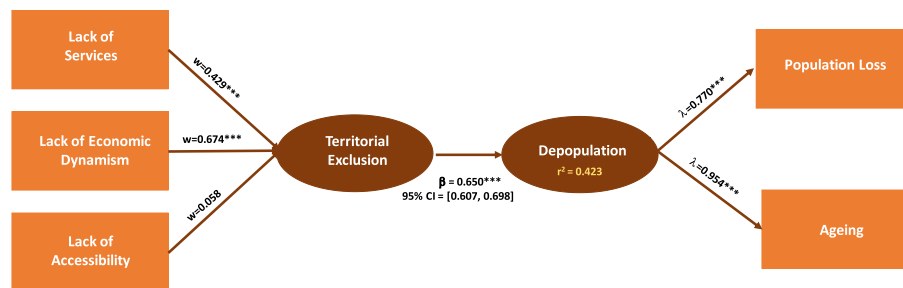


Fig. 6. Estimation of the structural model of the second stage.

4.1.2. Spatial analysis of territorial exclusion and depopulation

In Fig. 7, we show the maps corresponding to the spatial distribution of Territorial Exclusion and Depopulation at municipal level.

The map of Territorial Exclusion in Aragon (Fig. 7, left panel) reveals clear patterns in terms of spatial imbalances by assigning a divergent range of colors that represent the different levels of exclusion. Thus, areas with warm colors have the highest levels of exclusion, which face significant challenges regarding lack of essential services, opportunities, and access difficulties. On the other hand, areas with cool colors suggest less exclusion and better access to resources. The map highlights a distinct contrast between municipalities in favorable conditions (e.g., areas near the Ebro River, provincial and comarca capitals, and tourist centers in the Pyrenees and southeast of the Iberian Range) and the remainder of the region. In the latter, varying levels of exclusion are evident, albeit with differing intensities. The municipalities with a higher level of exclusion are in mountainous areas, especially in the provinces of Teruel and Zaragoza, as well as in isolated municipalities distant from development centers (see also Fig. 1 for geographical references).

Similarly, Fig. 7 (right panel) represents the construct of Depopulation, offering a revealing visual perspective on the demographic dynamics of the region. Areas shaded in warm colors denote higher levels of Depopulation, highlighting areas that are experiencing a regressive demographic pattern with a significant decline in their resident population and strong ageing, posing a threat to the survival prospects of a modest population. The results highlight high values in the

municipalities located in the south of the province of Zaragoza and in the northwest of Teruel, which agrees with the layout of the mountain massif of the Iberian Range. Conversely, lighter-colored areas indicate a younger and more stable population, and in some instances, population growth. These areas are associated with increased dynamism, often driven by tourism. For their part, the comarca capitals present very different situations from each other, although they always have much more positive depopulation values than the surrounding municipalities.

In this context, these areas have attracted young people looking for more affordable housing options, difficult to find in smaller municipalities due to lack of supply. Furthermore, it is essential to note that some towns are home to populations of foreign origin attracted by specific job opportunities such as livestock farming, agriculture, tourism, or caring for older people. All this is notably evident in fruit-growing and intensive agricultural settings, which often rely on a low-paid workforce. In short, the values of this construct confirm the low occupation of the Aragonese territory, the internal contrasts, and the survival problems that many municipalities face due to a long history of depopulation, driven by migratory flows that have left rural spaces empty, especially in some mountainous areas, where tourist attractions have not been valued. All these processes have intensified in recent years due to the ageing and mortality of the population in these areas.

4.2. Typology of municipalities

This section details the cluster analysis results that establish a

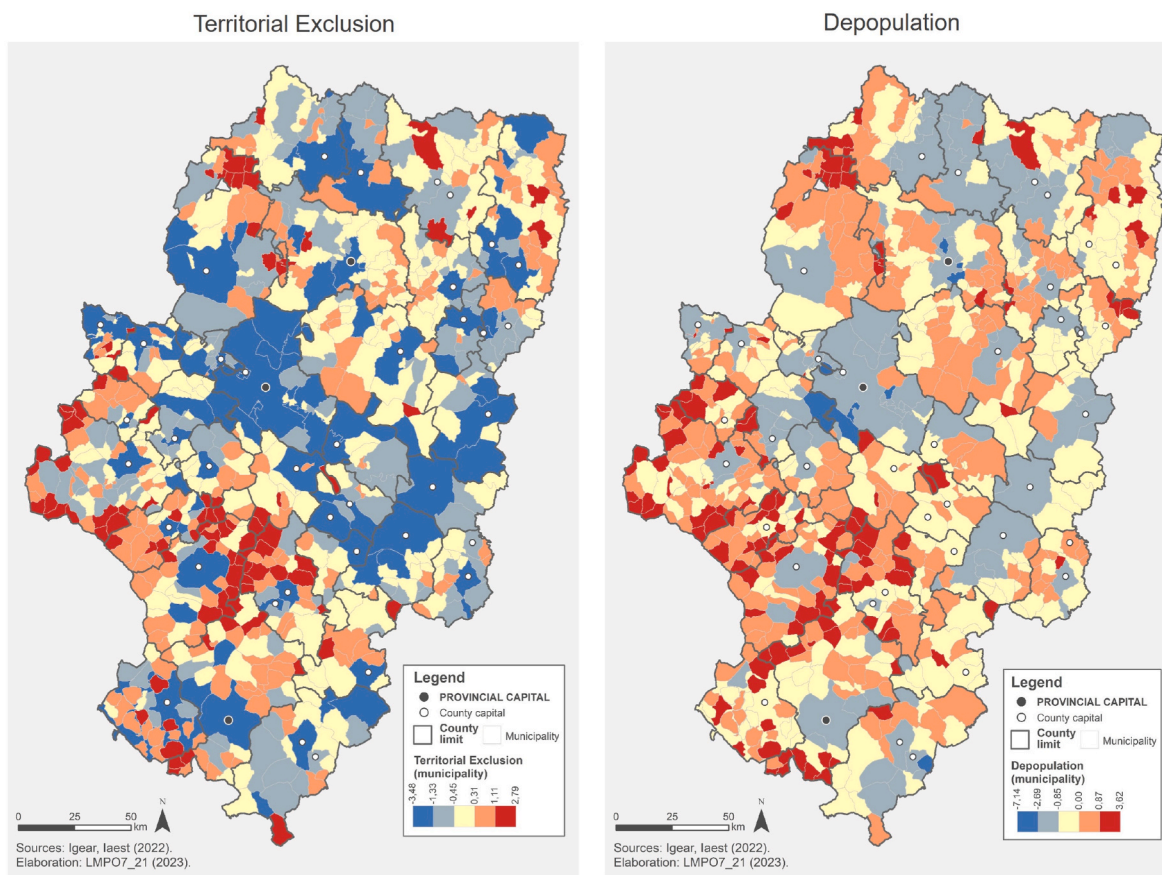


Fig. 7. Spatial distribution of the *Territorial Exclusion* (on the left) and *Depopulation* (on the right) scores.

typology of municipalities with similar profiles concerning their level of territorial exclusion. This classification could help policymakers design measures and strategies adapted to the particularities of each territory, considering its degree of territorial exclusion. Cluster analysis uses the construct of *Territorial Exclusion* determined in Section 4.1 as a grouping variable. The number of groups selected using the function *Nbclust* of the statistical program R was five. Subsequently, we combined a hierarchical agglomerative algorithm (Ward’s method) with a k-means procedure to refine the solution. Fig. 8 shows a two-panel graph. The left panel contains a map showing the spatial location of the five groups, and the right panel shows two graphs containing the boxplots obtained by crossing the two constructs (*Territorial Exclusion* and *Depopulation*) with the groups obtained from municipalities. The other two graphs include the error bars with the 95% confidence intervals for the mean score of both constructs in the different groups.

The groups are ordered in terms of increasing *Territorial Exclusion* and, although to a lesser extent, in terms of the *Depopulation*, due to the direct relationship between the two constructs. The first two groups (dark and light green, respectively) tend to have the lowest values in the two constructs. The municipalities in these two groups correspond to the three provincial capitals, the Ebro corridor, and the largest municipalities, the majority being *comarca* capitals (Figs. 7 and 8). In contrast, municipalities colored in warm tones suffer higher levels of territorial exclusion and depopulation. The most extreme cases correspond to the municipalities of Group 5 (dark maroon color), which are the most territorially excluded and the most depopulated. Furthermore, a spatial trend can be seen in the situation of the groups as result of the existence of a geographical dependency in the levels of territorial exclusion (Figs. 7 and 8). Municipalities of Group 2 tend to be located in the proximity of the municipalities of Group 1, followed by the municipalities of Groups 3 and 4. The most territorially excluded municipalities

(Group 5) tend to concentrate in spaces characterized by tiny diversified economies, low-intensive agriculture, with accessibility problems or with processes of industrial decline.

Finally, Fig. 9 presents box plots and error bars for each of the five first-order constructs (three related to *Territorial Exclusion* and two to *Depopulation*) by groups of municipalities. It can be seen that the order of box plots is consistent with the order observed in their respective constructs.

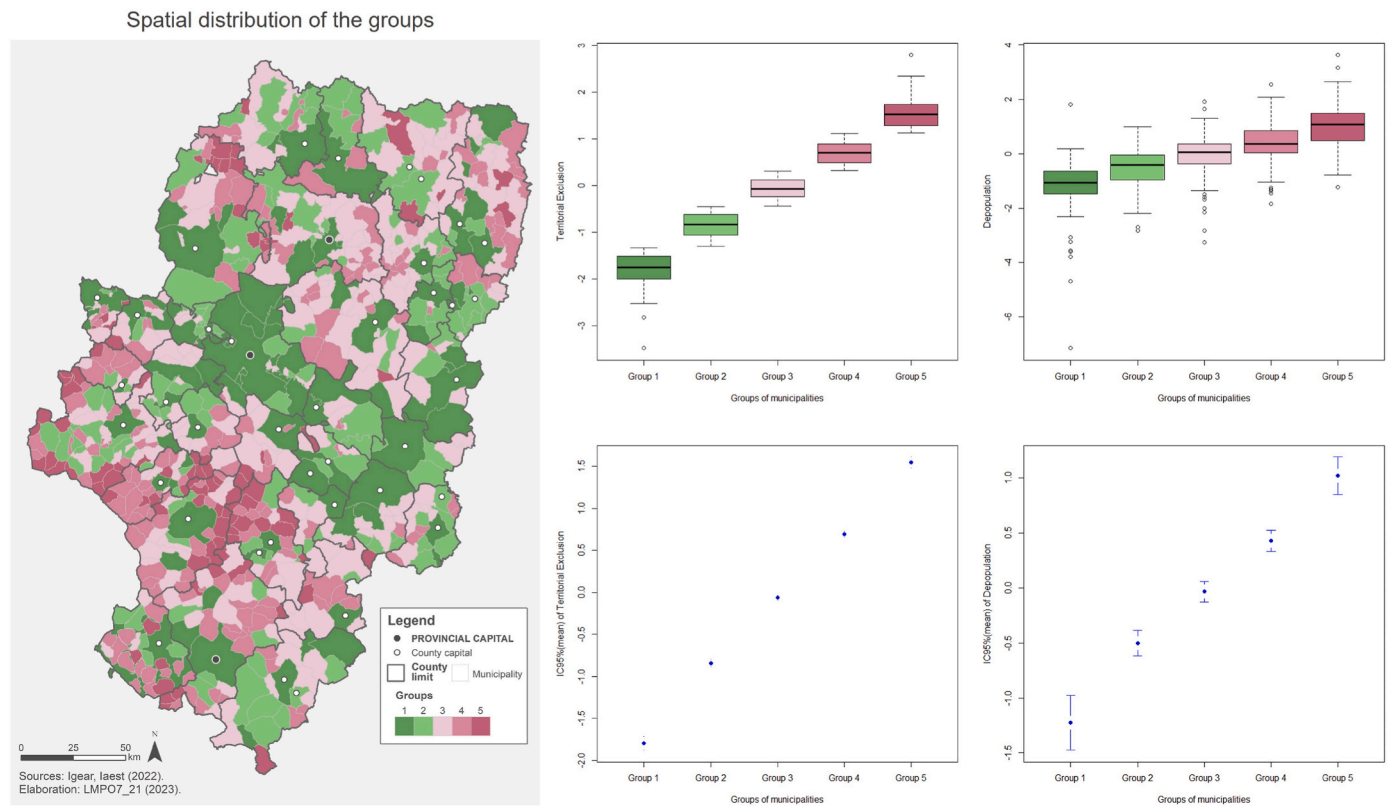
### 5. Discussion

The group profiles identified reveal diverse challenges and potentials. Some groups present marked ageing and few economic resources, while others exhibit greater economic dynamism and accessibility. This highlights the need for differentiated approaches in each group in order to address their depopulation problems effectively. To this end, in what follows, we carry out a comparative analysis of the behavior of each indicator variable in each of the groups that can provide valuable information for making informed decisions and formulating specific strategies for each typology of municipalities.

Thus, to analyze the behaviors observed in each group of the level of *Territorial Exclusion*, Fig. 10 shows the error bars for the six indicator variables that make up the construct of *Lack of Services* within the five groups of municipalities. Similarly, Fig. 11 shows the error bars for the four indicator variables that make up the construct *Lack of Economic Dynamism* while Fig. 9 analyzes said study for the variable *Lack of Accessibility*.

The analysis highlights notable variations between the five groups regarding health exclusion and internet coverage, with differences gradually increasing – however, the municipalities in Groups 4 and 5 face the most significant challenges regarding shops and restaurants.





**Fig. 8.** Two-panel graphic with the results of the cluster analysis. Left panel - Spatial distribution of the groups. Right panel – Boxplots and 95% error bars by groups for the 2-s order constructs.

Regarding education and social services, the exclusion is more pronounced in the municipalities of the groups colored in pink tones (Groups 3, 4, and 5). At the same time, if we analyze economic dynamism, the replacement ratios and structure of the active population exhibit a decreasing relationship in the five groups. Regarding the real estate activity index, Groups 1 and 2 present comparable values, while the other three groups show a decreasing trend. There is also a declining trend observed in the percentage of affiliates, with no significant differences found between municipalities in Groups 4 and 5. Furthermore, notable disparities in accessibility exist between Groups 1 and 5, with less variation observed in the intermediate groups (Fig. 7).

Finally, Figs. 12 and 13 show the results of comparison the first-order constructs (*Population Loss* and *Ageing*) indicators relating to *Depopulation*. Focusing on *Ageing* (Fig. 12) shows that its five indicators show an ascending trend in the analyzed graphs. Regarding *Population Loss* (Fig. 13), this same trend is observed in the medium term, although the differences are not so pronounced in the short term.

Based on the information presented, we propose the following measures for each identified group to encourage and facilitate population settlement or, if necessary, to address demographic decline. Each group has distinct characteristics in the analyzed dimensions that must be considered when developing potential concrete actions. These suggestions are informed by the results from the various dimensions examined in the territorial exclusion indicator and can serve as a foundation for future discussions and policy development, which can be further refined by experts in the field.

**Group 1.** given that the municipalities in this group have favorable values in all constructs, the recommendations would focus on maintaining and strengthening their current conditions:

- ✓ *Promotion of Sustainable Development:* encourage investment in sustainable projects that boost economic dynamism without compromising quality of life.
- ✓ *Quality education:* reinforce education and training to maintain an appropriate balance between generations.
- ✓ *Continuous Improvement of Services:* ensure the quality of public services and guarantee access to all age groups, maintaining accessibility and avoiding exclusion.
- ✓ *Economic Dynamism:* monitor and sustain the current economic dynamism, considering ratios of replacement and the structure of the active population.
- ✓ *Real Estate Sustainability:* promote sustainable practices in real estate development to maintain a balance between development and environmental concerns.

**Group 2.** the municipalities in this group, although they are in a favorable situation, have some areas for improvement for which specific measures should be implemented to maintain a positive situation:

- ✓ *Comprehensive Educational Development:* strengthen specific areas of certain educational levels that avoid exclusion, ensure equal opportunities, and improve economic competitiveness and labor diversification.
- ✓ *Improved Accessibility:* improve infrastructure and public transport to ensure mobility and access to more services and opportunities.
- ✓ *Incentives for Youth Participation:* implement programs that encourage the young population to actively participate in the community and establish or remain in these rural areas.
- ✓ *Improvement of social services:* enhance investment in social and health facilities to bring these services closer to those municipalities with deficiencies, seeking to homogenize the quality of life of their inhabitants.

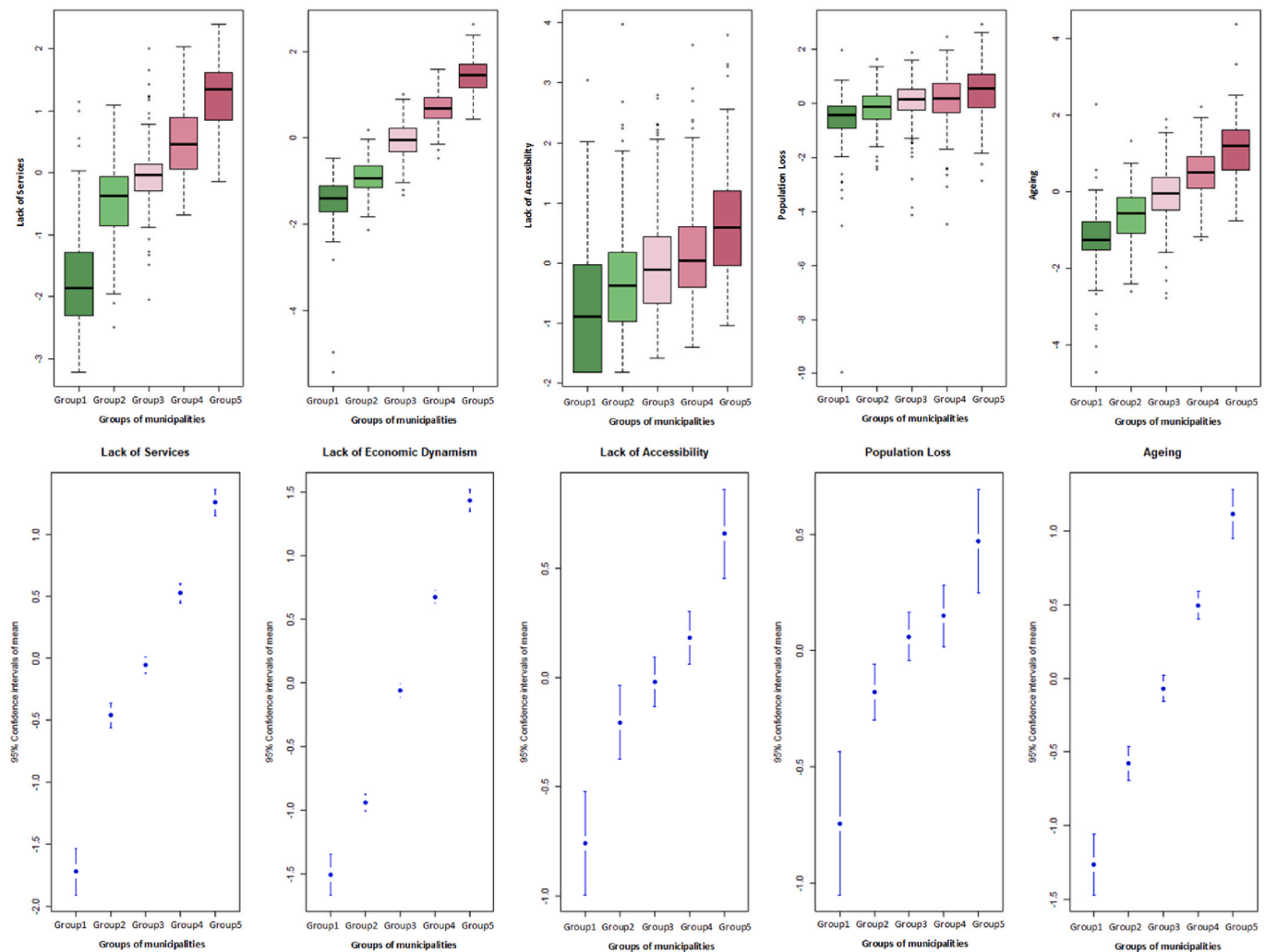


Fig. 9. Boxplots and 95% error bars by groups of municipalities for the first-order constructs.

✓ *Real Estate Sustainability*: promote sustainable practices in real estate development to maintain a balance between development and environmental concerns.

**Group 3.** the municipalities in this group are in an intermediate situation, presenting areas of improvement in most of their indicators, so the following measures are suggested:

- ✓ *Economic Revitalization Programs*: establish incentives and support for local entrepreneurs both in agricultural activities and in other sectors to diversify the economy and generate employment, prioritizing investments in community spaces that allow local roots and identity (bar, restaurant, store, service centers), with particular emphasis on the creation and consolidation of female employment.
- ✓ *Specialized Education and Training*: improve of educational establishments and promotion of educational and training programs adapted to local needs and characteristics to improve educational inclusion and employment.
- ✓ *Improved Accessibility*: financial investment for the improvement of infrastructure and public transport to ensure, in particular, accessibility to essential services and other opportunities.
- ✓ *Connectivity and Communication*: improve digital connectivity and communication to facilitate access to services and opportunities, by providing affordable broadband packages and strengthening local digital platforms for better communication and access to online

services. Encourage the creation of shared community centers as coworking spaces.

- ✓ *Improvement of Social Services*: improve services for older people and vulnerable population through the development of new care facilities and support centers, by providing training for social workers and for caregivers of older people who can create an important employment niche (nursing homes, occupational centers, etc.).
- ✓ *Real Estate Enhancement*: implement strategies to improve housing conditions by supporting building renovation, the construction of affordable housing and the revitalization of vacant buildings.

**Group 4.** it consists of municipalities facing territorial exclusion and moderate to high depopulation. While there is room for improvement in many indicators, it is recommended to implement measures similar to those applied in Group 3, but more intensively focused on encouraging the establishment of local shops, restaurants, and social spaces to enhance community interaction and local identity. Given that some municipalities in this group are used as second residences, an additional measure is suggested:

- ✓ *Second Residence Programs*: apply tax reductions to investment in housing rehabilitation for seasonal uses under criteria of sustainability and commitment to the territory.
- ✓ *Real Estate Sustainability*: introduce measures for sustainable real estate development by subsidizing housing rehabilitation or

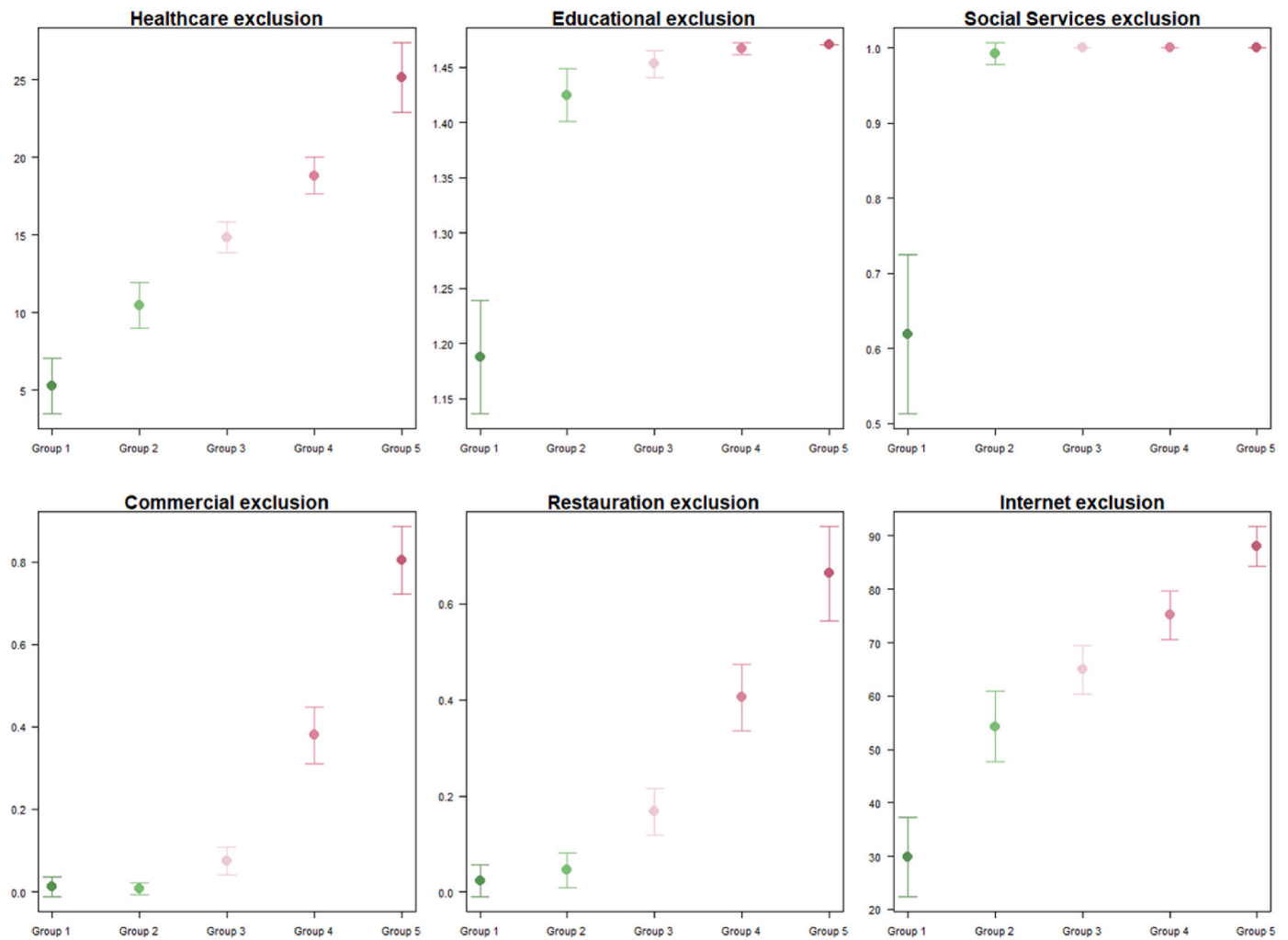


Fig. 10. 95% Error bars for the six indicator variables that compose the formative construct of *Lack of Services* by groups of municipalities.

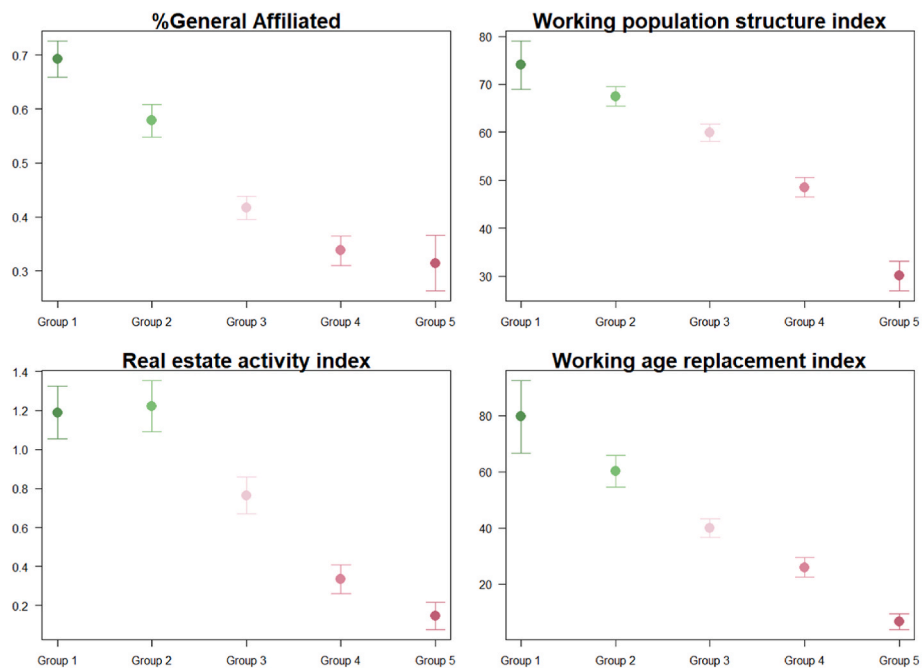


Fig. 11. 95% Error bars for the four indicator variables that compose the formative construct of *Lack of Economic Dynamism* by groups of municipalities.

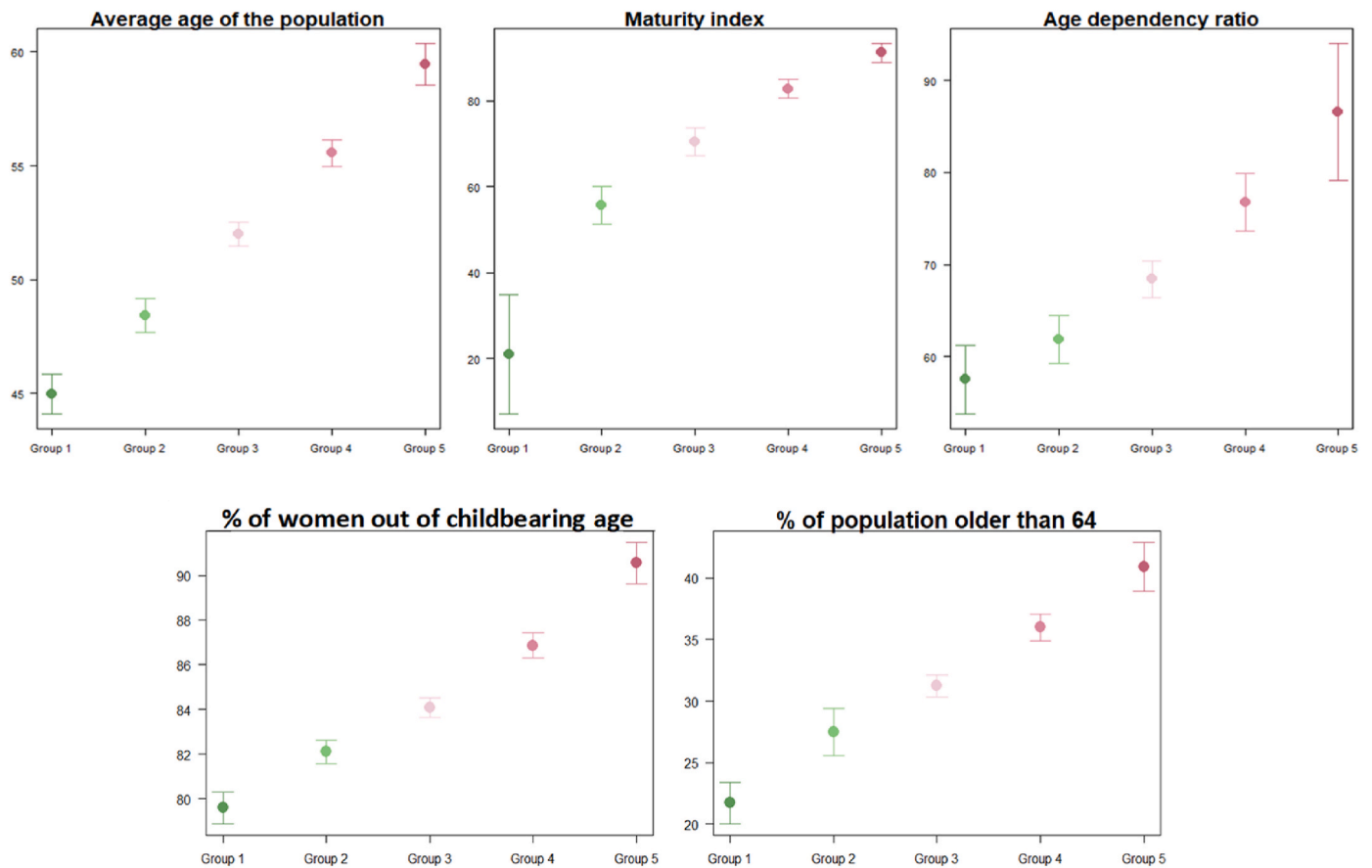


Fig. 12. 95% Error bars for the five indicator variables that compose the reflective construct of Ageing by groups of municipalities.

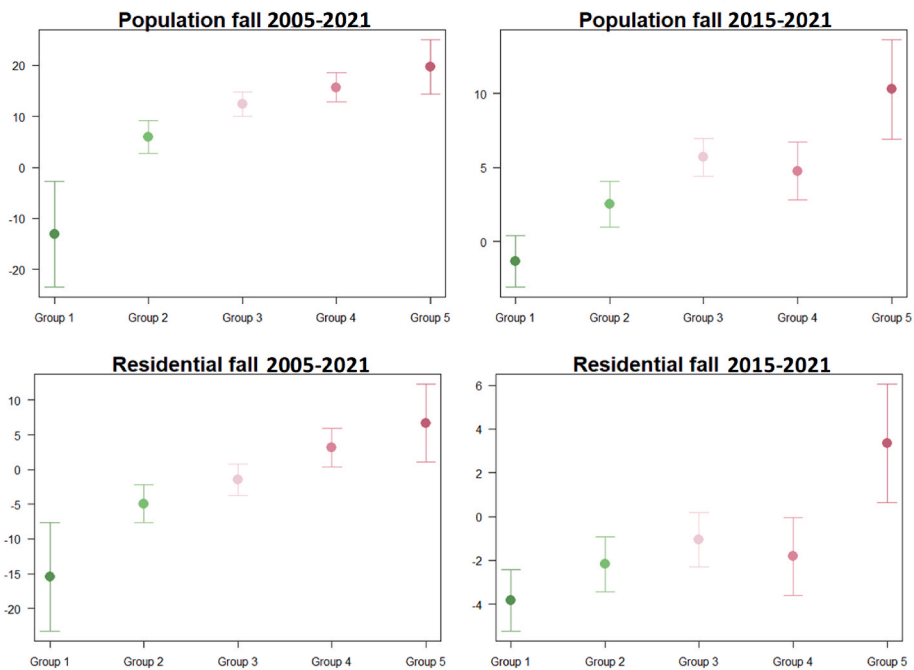


Fig. 13. 95% Error bars for the four indicator variables that compose the reflective construct of Loss of Population by groups of municipalities.

regeneration of urban spaces according to the specific needs of the municipality.

**Group 5.** it consists of municipalities facing extreme depopulation and ageing, where strategic actions are urgently needed to prevent further deterioration. The following measures are proposed:

- ✓ *Integration Initiatives*: To address the needs of these small and aging municipalities, it is necessary to develop assistance programs that integrate their needs with those of neighboring towns within the region. This may involve sharing essential services, such as healthcare and education, thereby maximizing resource use and enhancing service delivery.
- ✓ *Community Mobility Solutions*: implement local transportation options to connect residents with nearby towns for accessing jobs, services, and social activities. This will reduce isolation and improve mobility.
- ✓ *Economic Projects*: promote business ventures that can gradually alter demographic dynamics and create local job opportunities.
- ✓ *Housing Grants*: provide subsidies for both the renovation and rehabilitation of residential properties, including both permanent and temporary housing. Focus on tax incentives and sustainability measures.
- ✓ *Enhanced Digital Connectivity*: invest in basic digital infrastructure to improve connectivity as well as ensure access to the use of shared community centers created in upper-tier municipalities. This is crucial to attract remote workers seeking a high quality of life in quiet areas.
- ✓ *Support for Local Initiatives*: encourage local volunteer programs and community-led initiatives that involve residents in maintaining and managing new projects, ensuring sustainability and local engagement.

In conclusion, the efficacy of these general measures rests on their adaptation to the specific cultural, economic, and social intricacies of each municipality. A personalized and sustainable approach is essential to achieve the desired impact in addressing territorial exclusion and depopulation. Tailoring these measures to each locality's particularities, including comprehensive strategies that account for socio-economic challenges such as housing, employment, and local businesses, recognizes the multifaceted nature of the issues at hand. This holistic perspective ensures that interventions align with the unique characteristics of each community, fostering a more targeted and effective response to the challenges posed by depopulation.

## 6. Conclusions

The study offers a comprehensive understanding of depopulation, addressing socio-economic factors, service deficiencies, and accessibility challenges. This holistic approach provides a more realistic view of the multifaceted depopulation phenomenon. The creation of the *Territorial Exclusion* indicator is, in our view, a notable innovation. This tool not only quantifies socio-economic disparities but also has the potential to become a benchmark for assessing depopulation risks in various regions.

It is important to recognize that territorial exclusion can be a significant precursor to territorial marginality. The lack of access to essential services, economic opportunities and fundamental resources, characteristic of territorial exclusion, can generate an environment conducive to the emergence of social, economic and political inequalities, giving rise to territorial marginality. This interconnection highlights the need to address and understand territorial exclusion as a key factor in preventing and mitigating marginality in various regions.

The emphasis on policy implications and the development of municipal typologies contribute to the practical utility of our findings. Policymakers can utilize this information to tailor interventions based on the specific needs of each region, fostering more effective and targeted policies against depopulation.

Our findings call for action, not only in terms of the implementation of practical strategies but also in the sense of raising awareness and mobilizing resources in the fight against depopulation and territorial exclusion. The sustainability of rural communities depends on a continuous commitment to address these problems comprehensively and collaboratively. This work implicitly advocates for a departure from one-size-fits-all policies. Recognizing the unique challenges faced by

different regions underscores the importance of tailoring interventions based on regional characteristics, aligning with the growing discourse on embracing regional diversity in policy formulation.

The use of advanced statistical techniques adds methodological rigor. This elevates the credibility of your findings within the academic community, setting a precedent for future studies examining complex socio-economic phenomena. By emphasizing these aspects, our work emerges not only as an academic contribution but also as a practical guide for addressing depopulation challenges, adding value to both scholarly and policy-oriented audiences.

Placing the study within the European context, with a focus on Aragon, highlights its relevance to regional development discussions. The findings can inform strategies not only at the national level but also contribute insights to the broader discourse on addressing demographic challenges within the European Union.

In the case of Aragon, the diversity of municipal profiles identified highlights the need to design adapted actions and differentiated strategies to address these multidimensional challenges. In municipal groups with low levels of economic dynamism, it is essential to implement policies that encourage investment, local entrepreneurship, and job creation. Furthermore, promoting infrastructure and essential services can mitigate territorial exclusion, encouraging the permanence of the young population and the loss of the ageing population that requires specific services and sustainable growth. Transport and communication infrastructure investment can significantly improve accessibility, reducing isolation and stimulating economic activity. Municipalities with an older population face the need to age actively and healthily. The design of social and welfare policies adapted to this population's needs can improve the quality of life and encourage permanence in these areas. Creating opportunities for community engagement and access to healthcare and support services are crucial elements in this regard.

As we move forward, we must continue deepening our understanding of these problems and identifying practical solutions. Future lines of research can explore the application of similar approaches in other regions and contexts, thus expanding the scope of our understanding. Although our current focus has been on the three specific dimensions, we recognize that factors such as political representation, cultural and historical aspects, and environmental conditions also significantly influence demographic trends. By incorporating these additional dimensions, future studies can offer a more comprehensive view of territorial exclusion, helping to identify nuanced insights and develop more effective strategies for addressing depopulation. Additionally, we plan to conduct a dynamic analysis to track the evolution of Territorial Exclusion since the beginning of the 21st century.

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## CRediT authorship contribution statement

**M. Pilar Alonso**: Writing – original draft, Visualization, Supervision, Resources, Investigation, Formal analysis, Conceptualization. **Pilar Gargallo**: Writing – original draft, Supervision, Software, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Luis Lample**: Validation, Resources, Methodology. **Carlos López-Escolano**: Writing – review & editing, Visualization, Validation, Resources, Investigation, Data curation. **Jesús A. Miguel**: Software, Formal analysis, Data curation. **Manuel Salvador**: Writing – original draft, Supervision, Software, Project administration, Methodology, Investigation, Formal analysis, Conceptualization.

## Declaration of competing interest

The authors declare that there is not any conflict of interest.

## Data availability

Data will be made available on request.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jrurstud.2024.103421>.

## References

- Alamá-Sabater, L., Budí, V., Álvarez-Coque, J.M.G., Roig-Tierno, N., 2019. Using mixed research approaches to understand rural depopulation. *Economía Agraria y Recursos Naturales-Agricultural and Resource Economics* 19 (1), 99–120.
- Alamá-Sabater, L., Budí, V., Roig-Tierno, N., García-Álvarez-Coque, V., 2021. Drivers of depopulation and spatial interdependence in a regional context. *Cities* 114, 103217.
- Alonso-Carrillo, I., Pérez-Morote, R., Núñez-Chicharro, M., Pontones-Rosa, C., 2023. Do citizens in Spanish municipalities have the same perception of the solution to depopulation? Influence of population size. *Cities* 135, 104210.
- Alonso, M.P., Gargallo, P., López-Escolano, C., Miguel, J., Salvador, M., 2023. Financial exclusion, depopulation and ageing: an analysis based on panel data. *J. Rural Stud.* 103, 103105.
- Augère-Granier, M.-L., 2017. Rural Poverty in the European Union, PE 599. European Parliamentary Research Service, p. 333.
- Ayuda, M.I., Pinilla, V., Sáez, L.A., 2000. El problema de la despoblación en Aragón: Causas, características y perspectivas. *Revista De Demografía Histórica* 18 (1), 137–175.
- Bade, K., 2008. *Migration in European History*. John Wiley & Sons.
- Bock, B.B., 2016. Rural marginalisation and the role of social innovation; a turn towards xenogenous development and rural reconnection. *Sociol. Rural.* 56 (4), 552–573.
- Bock, B., Kovacs, K., Shucksmith, M., 2014. 10 Changing social characteristics, patterns of inequality and exclusion. *Territorial Cohesion in Rural Europe: the Relational Turn in Rural Development*, p. 193.
- Briglaue, W., Dürr, N.S., Falck, O., Hüschelrath, K., 2019. Does state aid for broadband deployment in rural areas close the digital and economic divide? *Inf. Econ. Pol.* 46, 68–85.
- Burillo, P., Salvati, L., Matthews, S.A., Benassi, F., 2020. Local-scale fertility variations in a low-fertility country: evidence from Spain (2002–2017). *Can. Stud. Popul.* 47, 279–295.
- Camarero, L., Oliva, J., 2019. Thinking in rural gap: mobility and social inequalities. *Palgrave Communications* 5 (1).
- Christiaanse, S., 2020. Rural facility decline: a longitudinal accessibility analysis questioning the focus of Dutch depopulation-policy. *Appl. Geogr.* 121, 102251.
- Coleman, D., Rowthorn, R., 2011. Who's afraid of population decline? A critical examination of its consequences. *Popul. Dev. Rev.* 37, 217–248.
- Dax, T., Fischer, M., 2018. An alternative policy approach to rural development in regions facing population decline. *Eur. Plann. Stud.* 26 (2), 297–315.
- Del Molino, S., 2020. La España vaciada. Un problema político. *Letra internacional* 130–131, 140–143.
- Del Olmo-García, F., Domínguez-Fabián, I., Crecente-Romero, F.J., del Val-Núñez, M.T., 2023. Determinant Factors for the development of rural entrepreneurship. *Technol. Forecast. Soc. Change* 191, 122487.
- Dubois, A., Sielker, F., 2022. Digitalization in sparsely populated areas: between place-based practices and the smart region agenda. *Reg. Stud.* 56 (10), 1771–1782.
- Dufhues, T., Möllers, J., Traikova, D., Buchernrieder, G., Runschke, D., 2021. Why villagers stay put- A structural equation model on staying intentions. *J. Rural Stud.* 81, 345–357.
- Escalona-Orcao, A.I., Díez-Cornago, C., 2007. Accessibility to basic services in one of the most sparsely populated areas in Europe: the province of Teruel (Spain). *Area* 39 (3), 295–309.
- Escribano Pizarro, J., 2012. Servicios educativos y sanitarios elementales en el medio rural: percepción social e influencia sobre la calidad de vida. *Revista de Estudios Geográficos* (23), CSIC.
- Eurostat, 2020. Population statistics at regional level. Retrieved from. [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Population\\_statistics\\_at\\_region\\_level](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Population_statistics_at_region_level).
- Gil-Alonso, F., Bayona-i-Carrasco, J., Pujadas-Rúbies, I., 2023. Is Spanish depopulation irreversible? Recent demographic and spatial changes in small municipalities. *Vienna Yearb. Popul. Res.* 21, 1–33.
- Granados-López, E., Rodríguez-Soler, R., Vilachá-Martínez, L., 2018. ¿El desarrollo sostenible como estrategia para abordar la despoblación en el medio rural? Estudio de caso: Almócita. *Equidad y Desarrollo* 1 (31), 217–237. <https://doi.org/10.19052/ed.4422>.
- Hair, Jr J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M., 2022. *Partial Least Squares Structural Equation Modeling (PLS-SEM)*, third ed. SAGE.
- Higgs, G., Langford, M., 2013. Investigating the validity of rural–urban distinctions in the impacts of changing service provision: the example of postal service reconfiguration in Wales. *Geoforum* 47, 53–64.
- Jelić, S.M., Kolarević, V.Ž., 2021. Depopulation and availability of services, contents for social participation and infrastructure in rural settlements: illustrated by the devastated municipalities in South-Eastern Serbia. *Socioloski Pregl.* 55 (4), 1338–1360.
- Johnson, K.M., Lichter, D.T., 2019. Rural depopulation: growth and decline processes over the past century. *Rural Sociol.* 84 (1), 3–27.
- Jonard, F., Lambotte, M., Ramos, F., Terres, J.-M., Bamps, C., 2009. Delimitations of Rural Areas in Europe Using Criteria of Population Density, Remoteness and Land Cover. *EUR 23757 EN. OPOCE, Luxembourg*, 2009. JRC49927.
- Kabisch, S., Grossmann, K., 2013. Challenges for large housing estates in light of population decline and ageing: results of a long-term survey in East Germany. *Habitat Int.* 39, 232–239.
- Li, Y., Westlund, H., Liu, Y., 2019. Why some rural areas decline while some others not: an overview of rural evolution in the world. *J. Rural Stud.* 68, 135–143.
- Llorent-Bedmar, V., Palma, V.C.C.-D., Navarro-Granados, M., 2021. The rural exodus of young people from empty Spain. Socio-educational aspects. *J. Rural Stud.* 82, 303–314.
- López-Escolano, C., Pueyo Campos, Á., Postigo Vidal, R., Alonso Logroño, M.P., 2016. Valoración y representación cartográfica de la accesibilidad viaria en la España peninsular: 1960–2014. *GeoFocus* 18, 169–189.
- Máliková, L., Farrell, M., McDonagh, J., 2016. Perception of marginality and peripherality in an Irish rural context. *Quaest. Geogr.* 35 (4), 67–76.
- Mancha-Navarro, T., Moscoso-Durán, F., Santos-Bartolomé, J.L., 2017. Un índice de competitividad regional para España. *Rev. Estud. Reg. (Segunda Epoca)* 109, 67–94.
- Merino, F., Prats, M.A., 2020. Why do some areas depopulate? The role of economic factors and local governments. *Cities* 97, 102506.
- Navarro, F., 2019. Depopulation and aging in rural areas in the European Union: practices starting from the LEADER approach. *Perspectives on rural development* 2019 (3), 223–252.
- Nilsen, T., Grillitsch, M., Hauge, A., 2023. Varieties of periphery and local agency in regional development. *Reg. Stud.* 57 (4), 749–762.
- Palacios, A., Sáez, L.A., Pinilla, V., 2017. *La despoblación en Aragón, 2000–2016: tendencias, datos y reflexiones para el diseño de políticas*. Documentos de trabajo nº 6 (Universidad de Zaragoza. Facultad de Economía y Empresa). <http://www.dteconz.unizar.es/DT2017-06.pdf>.
- Panagiotopoulos, G., Kaliampakos, D., 2024. Accessibility, rural depopulation & the modified areal unit problem: an analysis of mainland Greece. *European Journal of Geography* 15 (1), 42–53.
- Pérez-Morote, R., Pontones-Rosa, C., Núñez-Chicharro, M., Merino-Madrid, E., 2021. Determinant factors of individuals' decision to emigrate in rural Spain: the role of ICT-based public policies. *Technol. Soc.* 67, 101777.
- Pérez-Morote, R., Núñez-Chicharro, M., Carolina-Pontones, R., Alonso-Carrillo, I., 2023. Public policies and social responsibility regarding gender policies in rural areas of Spain: do men and women agree on its necessity and relevance? Influence of population size. *Women's Studies International Forum* 99, 102760.
- Pinilla, V., Ayuda, M.-I., Sáez, L.-A., 2008. Rural depopulation and the migration turnaround in Mediterranean Western Europe: a case study of Aragón. *Journal of Rural and Community Development* 3, 1–22.
- Pinilla, V., Sáez, L.A., 2021. What do public policies teach us about rural depopulation: the case study of Spain. *Eur. Countrys.* 13 (2), 330–351.
- Preston, J., Rajé, F., 2007. Accessibility, mobility and transport-related social exclusion. *J. Transport Geogr.* 15 (3), 151–160.
- Reynaud, C., Miccoli, S., Benassi, F., Naccarato, A., Salvati, L., 2020. Unravelling a demographic 'Mosaic': spatial patterns and contextual factors of depopulation in Italian Municipalities, 1981–2011. *Ecol. Indic.* 115, 106356.
- Sarstedt, M., Hair, J.F., Jun-Hwa, Ch, Becker, J.-M., Ringle, C.M., 2019. How to specify, estimate, and validate higher-order constructs in PLS-SEM. *Australasian Marketing Journal* (AM) 27 (3), 197–211.
- Serra, P., Pallares-Barbera, M., Salvati, L., 2023. Can a long-term economic subsidy counteract rural depopulation? An empirical analysis from two Spanish regions. *Qual. Quantity* 57 (4), 3065–3084.
- Vecchio, G., 2022. Ageing, therefore marginal: demographic trends and institutional capacity in marginal Chilean municipalities. *Region* 9, 67–86.
- Vendemmia, B., Kërçucu, A., Vecchio, G., 2023. Territorial marginality: causes, methods and policies. Introduction to the Special Issue. *Region* 10 (1), E1–E5.
- Vendemmia, B., Lanza, G., 2022. Redefining marginality on the Italian Apennines: an approach to reconsider the notion of basic needs in low-density territories. *Region* 9, 131–148.
- Wisniewski, R., Stepiak, M., Szejgic-Kolenda, B., 2021. Accessibility of public services in the age of ageing and shrinking population: are regions following trends. *Geografiska Annaler: Series B, Human Geography* 103 (1), 55–74.
- Wojewódzka-Wiewiórska, A., 2019. Depopulation in rural areas in Poland – socio-economic local perspective. *Research for Rural Development* 2, 126–132.
- Zúñiga-Antón, M., Guillén, J., Caudevilla, M., Bentué-Martínez, C., 2022. Mapa 174. Zonificación de los municipios españoles sujetos a desventajas demográficas graves y permanentes. *Story Map*. Downloaded from. <https://storymaps.arcgis.com/stories/9dd9b6e20cad403c95e87d4cc493c8fb>.