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Using mixed research approaches to understand rural depopulation

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ABSTRACT: There is a growing consensus on the need to propose specific policies to face rural depopulation. This article applies fuzzy-set Qualitative Comparative Analysis (QCA) to define the presence or absence in each municipality of the conditions leading to the presence or absence of depopulation. We also perform Exploratory Spatial Data Analysis (ESDA) of population growth to identify hotspots of rural depopulation. The methodologies prove useful to evaluate and guide regional policies that address depopulation processes in the context of a relatively urbanized region.

KEYWORDS: Depopulation, Exploratory Spatial Data Analysis, fsQCA, Qualitative Comparative Analysis, Rural Development.

Usando enfoques de investigación mixtos para entender la despoblación rural

RESUMEN: Existe un consenso cada vez mayor sobre la necesidad de proponer políticas específicas para enfrentar los procesos de despoblación rural. Este artículo aplica un Análisis Comparativo Cualitativo de conjuntos difusos para definir la presencia o ausencia en cada municipio de las condiciones que conducen a la presencia o ausencia de despoblación. También realizamos un Análisis Exploratorio de Datos Espaciales (ESDA) del crecimiento de la población para identificar zonas críticas de despoblación rural. La metodología resulta útil para evaluar y guiar las políticas regionales que abordan los procesos de despoblación en el contexto de una región relativamente urbanizada.

PALABRAS CLAVE: Despoblación, Análisis Exploratorio de Datos Espaciales Analysis, fsQCA, Análisis Comparativo Cualitativo, Desarrollo Rural.

Clasificación JEL/ JEL Classification: J18, R11, C21.

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1. Introduction

There is growing consensus on the need to propose targeted policies to address the ongoing depopulation of extensive rural areas of Southern Europe. However, developing such policies requires the assessment of the spatial, economic and structural conditions that explain why a local community experiences depopulation.

Rural depopulation is a demographic and territorial phenomenon reflected by a decrease in the number of inhabitants of a territory or populated place. This problem exists even in relatively urbanised regions. For example, in the Region of Valencia, the average population density is 214 inhabitants per km^2. However, a segment of the region covering 27 % of its total area is inhabited by just 0.8 % of the region's population, leading to a sparsely populated territory that belongs to the so-called *Spanish Lapland*[1].

The massive permanent reduction of the population leads to desertification, with dramatic social and environmental implications. As in other Spanish regions, the decline in absolute terms of the rural population in the Region of Valencia is a problem that affects a major part of the region. This decline in the rural population may result in the disappearance of villages, which represents a loss in ethnological, economic and environmental terms. In many cases, it is a matter not only of population loss but also of loss of structure in the territory. The modest size of villages is combined with their geographical dispersion, given the scarcity of municipalities of more than 5,000 inhabitants in inland Valencian districts.

This paper explores the determinants of population growth in municipalities of the Southern European region of Valencia, an administrative and historical area located in eastern Spain. The study's results highlight one of the most important territorial problems in rural areas: the depopulation of inland municipalities in relatively urbanised regions. The spatial methods proposed and tested in this paper can be easily applied to other regions where rural and urban districts coexist.

Assuming that population increase in one municipality entails population decline in another, we consider the differences between territories according to economic development and spatial factors. We perform exploratory spatial data analysis (ESDA) of population growth to identify hotspots of rural depopulation and find how neighbouring municipalities are correlated in the Region of Valencia. In traditional econometric models, the presence of spatial effects may lead to serious bias or inefficiency in estimated coefficients. The spatial econometric methodology deals with connexions between regions and explains the elements that cause depopulation. Thus, the key question of how spatial dependence between municipalities can affect population change can be addressed.

[1] The term "Southern Lapland" is being widely used in Spanish media and was popularized by the NGO "Asociación para el Desarrollo de la Serranía Celtibérica" in 2014. A reference is made here to sparsely populated areas in European Northern regions. See http://www.celtiberica.es/manifiesto/.

Three factors mentioned in the literature influence depopulation in a given municipality: Accessibility, economic conditions and public equipment. Qualitative comparative analysis (QCA) of Valencia's municipalities is carried out to define the presence or absence in each municipality of the conditions that lead to the presence or absence of depopulation based on predetermined thresholds. We explore whether such an approach can explain why some municipalities grow more than others.

We analyse the whole Region of Valencia, which comprises 542 municipalities. A study by the Valencian Public Administration (GVA, 2017a) has flagged a group of municipalities as 'in danger of depopulation'. The Valencian Public Administration estimates that the number of municipalities at risk of depopulation is 157, suffering a population loss of 14.5 % between 1996 and 2016 (GVA, 2017b). The same study shows that depopulation is related to accessibility, economic dynamics and public services.

In Section 2, we present a conceptual framework that justifies the spatial considerations that help explain rural depopulation processes. Next, Valencian municipalities are categorised according to risk of depopulation and the main hypothetical factors affecting rural depopulation. Section 4 describes the methodology, justifying the use of ESDA and QCA. Finally, we present the main findings followed by the main conclusions and implications for regional policies.

2. Conceptual framework

Depopulation is a complex phenomenon that can be approached from multiple perspectives. A common explanation is the presence of highly traditional employment structures in rural areas, with little economic dynamism in comparison with fast-growing territories. Regional studies have considered the impact of large cities, rural-urban migration, economic development and quality of life. Glaeser *et al.* (1995) examined the socioeconomic forces that explain the growth of U.S. cities at different times. Jedwab *et al.* (2016) focused on rural push factors and urban pull factors, considering economic factors such as income growth, differences in productivity, wage gaps and urban-biased policies to explain population movements from rural to urban areas. Graves (1979, 1983), Graves and Linneman (1979), Chi and Marcouiller (2009) and others have reported that natural amenities (landscapes, open space, climate, forests, etc.) are important resources that attract the local population and contribute to generating employment and economic activity. Cushing (1987) and Shields *et al.* (2005) illustrated how both natural amenities and economic conditions affect population movements.

By introducing spatial considerations, scholars who seek to explain depopulation can also explore municipalities' difficulties in terms of integration with other dynamic territories that benefit from social services and employment opportunities. Regional studies have started to recognise the role of accessibility or proximity to populated locations in explaining the current phenomenon. The improvement of road infrastructures has allowed certain municipalities to increase their population and change their demographic characteristics based on a population that relates to these locations for reasons of leisure, work, studies or retirements.

The choice of a territorial unit of analysis also conditions the factors explaining population dynamics. The focus on local communities reflects the specific impact of territorial problems and enables the capture of spatial relations (Boarnet, 1994), although at a higher territorial level, spatial dependence may be less significant. Recent studies along these lines have introduced spatial dependence as an additional determinant of population change (Lunberg, 2006; Delfmann, 2014; Firmino *et al.,* 2017).

Our approach does not solely focus on rurality as a major issue affecting depopulation, although we do consider a range of variables that conform to a broad definition of rurality (e.g. distance to major cities). However, unlike other studies, we do not categorise municipalities according to a rural-urban classification (Franco, 2015; Reig *et al.,* 2016) or population density (Burillo *et al.,* 2013). Instead, we consider all municipalities in the Region of Valencia and assess a set of specific factors that can explain depopulation, regardless of the eventual categorisation of the municipality as rural or urban. The data analysis used in this research do not establish predefined categories, although a territorial clustering could be deduced from the observed relationships between the conditions and the outcome of depopulation.

Our study considers material conditions such as economic dynamics and public services. We recognise that some recent works in Spain (Camarero, 2009) have shown that the sustainability of territories is the result of not only economic growth and material conditions but also social interactions. We do not deny such interdependence. However, the existence of an age group that takes charge of conditions for production, reproduction and community support is heavily constrained by a lack of material conditions (Consejo Económico y Social, 2018). Our approach tests how material conditions coupled with spatial relations affect depopulation, with a focus on accessibility and territorial dependence.

3. Sample and Data

3.1. Classifying municipalities by risk of depopulation

The Valencian Public Administration (GVA) has built a database of the region's municipalities to prioritise investments that facilitate social and economic development in struggling districts. AVANT (*Agenda Valenciana Anti-despoblación*) provides a cross-cutting plan to deal with the causes and consequences of rural depopulation. The indicators used to identify and quantify the risk of depopulation at the municipal level are shown in Table 1, together with the statistical sources used and the proposed thresholds for these indicators. These indicators, which demographically characterise the phenomenon of rural depopulation, include low population density, the continued loss of population, the fall in the birth rate, population ageing and emigration to urban areas.

TABLE 1

Indicators and thresholds to define rural depopulation

Indicator	Description	Threshold	Source
Population density	Inhabitants/km^2	≤ 20	INE (2016)
Demographic growth (1996-2016)	Growth rate between 1996 and 2016 (%)	≤ 0	INE (2016) Municipal Register (1996, 2016)
Vegetative growth	Percentage of vegetative change (1996-2015) as a percentage of total population (%)	≤ - 10	Conselleria de Economía Sostenible (2016)
Ageing rate	Population > 64 years divided by population < 16 years (%)	≥ 250	INE (2016)
Dependence index	Population < 16 years and > 64 years divided by population between 16 and 64 years (%)	≥ 60	INE (2016)
Migratory rate	Migratory balance in 2006-2016 divided by total population in 2016 (%)	≤ 0	Conselleria de Economía Sostenible (2016)

Source: List of indicators proposed by the GVA (2017a).

Depending on the value of the selected demographic indicators, the municipalities can be classified according to depopulation risk:

- *Very high risk* is used when the municipality meets the criteria for all indicators.
- *High risk* is used when the criteria are met for five indicators.
- *Moderate risk* is used when the criteria are met for four indicators or when the population of the municipality is less than or equal to 100 inhabitants.
- *Other* is the term used when a municipality meets the criteria for fewer than four indicators and the population is greater than 100 inhabitants.

Other procedures could be used to categorise municipalities. However, we selected these criteria because they are explicit and are used by a regional public administration to prioritise investment. Based on these criteria, 157 municipalities are at risk of depopulation in the Region of Valencia (See the region's location at Map 1). Of these, 43 municipalities are at very high risk of depopulation, 59 are at high risk and 55 are at moderate risk. The areas with the highest percentage of municipalities at risk are primarily in the northwest of the region, with some areas in the west and south (Map 2).

MAP 1

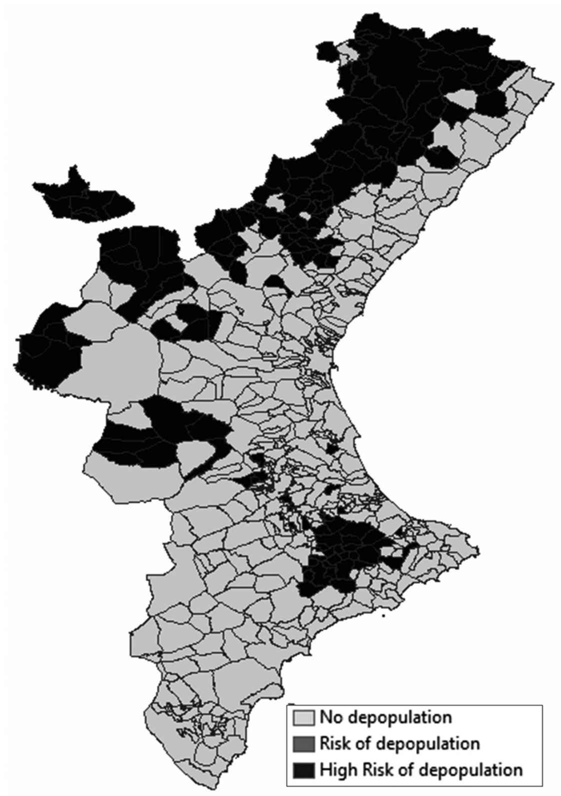
Location of Region of Valencia

Source: Authors' elaboration.

The municipalities at risk of depopulation have characteristics that are typical of the demographic decline of rural areas. They cover about one third of the surface area of the Region of Valencia but contain only 1.4 % of its population. The population density is therefore 9.2 inhabitants per km^2. Over the last 20 years, these municipalities have lost 15.5 % of their population (27 % in the case of those at very high risk of depopulation). The current age pyramid includes only one person aged under 16 years for every five people aged over 64 years. The ageing rate is more than twice the rate for the whole region.

MAP 2

Valencian municipalities at risk of depopulation



Source: AVANT classification (GVA, 2017a).

3.2. Measuring conditions explaining rural depopulation

AVANT classifies municipalities by considering indicators that capture certain variables related to three dimensions: Accessibility, public infrastructure and economic conditions. A system of local indicators was built for each dimension reflecting factors or conditions for depopulation. Table 2 shows the main indicators for each dimension proposed by AVANT, their sources and the proposed thresholds to define whether a municipality is highly influenced. Based on these indicators and their thresholds considered requirements, municipalities are classified according to the criteria in Table 3. These criteria provide a categorisation of municipalities according to the presence of problems related to the three dimensions. Table 4 summarises the situation of municipalities in the Region of Valencia in terms of the main indicators.

TABLE 2

Indicators and thresholds describing conditions for rural depopulation

Dimension/Indicator	Description	Threshold	Source
Accessibility			
Households with access to ≥ 30 Mbps network	Percentage of households with access to ≥ 30 Mbps network with respect to total households (%)	< 20	Ministry of Industry (2017)
Population with no access to new generation networks	Percentage of households with no access to new TIC networks with respect to total population	> 20	Ministry of Industry (2017)
Time to nearby cities	Estimated time of transport to cities with more than 50,000 inhabitants (minutes)	> 40	GVA (2017)
Economic dynamism			
Available income	Gross available income per capita (1,000 euro/inhabitant)	≤ 11.5	GVA (2017b)
Employment rate	Social security affiliates as a percentage of population > 16 years (%)	< 30	Ministry of Labour (2017)
Labour self-sufficiency	Social security affiliates who live in the municipality as a percentage of total employees (%)	> 140	Ministry of Labour (2017) and GVA (2017b)
Agricultural area	Agricultural area as a percentage of total municipal area (%)	> 90	GVA (2017b) and authors' elaboration
Business density	Firms per 100 inhabitants	< 6	INE (2017)
Cadastral value	Total cadastral value divided by number of properties (Euros per property)	< 40,000	Ministry of Finance (2016)
Public infrastructure and services			
Time to hospitals	Estimated time of transport to hospitals (minutes)	> 40	GVA (2017a)
Access to primary education	Admissions capacity of primary schools with respect to total population aged 3 to 12 years (%)	< 60	GVA (2017a)
Access to secondary education	Number of secondary schools in the municipality	= 0 (no school)	GVA (2017a)
Access to senior residences or assistance centres	Number of centres or residences in the municipality	= 0 (no centre)	CSIC (2017)
Protected natural areas	Percentage of protected natural area with respect to total municipal area (%)	< 65	GVA (2017a)

Source: Indicators proposed at GVA (2017a).

TABLE 3

Number of thresholds required for 'presence' of a given condition

Condition/Level of presence	Accessibility (3 indicators)	Economic dynamism (6 indicators)	Public infrastructure and services (5 indicators)
Very low presence	3	6	5
Low presence	2	5	4
Medium presence	1	4	3
Other municipalities	0	< 4	< 3

Source: Authors' elaboration from indicators proposed at GVA (2017a).

TABLE 4

Summary of indicators

Valencian municipalities at risk of depopulation					
	Very high	High[b]	Moderate[c]	Other[d]	Total
Total municipalities	43	59	55	385	542
Total population (2016) (%)	0.3	0.6	0.5	98.6	100
Total area (%)	10.2	13.4	92	67.2	100
Population growth (1996-2016) (%)	-27	-14	-7	25	24
Population density (inhabitants/km^2)	6.2	9.1	12.7	312.7	213.3
Municipalities with low and very low accessibility (%)	83	79	84	25	41
Time to access to locations with more than 50,000 inhabitants (minutes)	67	56	56	35	38
Municipalities with low and very low economic dynamism (%)	50	56	38	8	19
Average income (Euros per capita)	10,113	11,428	11,503	12,228	11,753
Municipalities with low and very low public equipment (%)	78	53	58	16	29
Time to access to nearest hospital (minutes)	54	41	43	23	27

Source: Indicators described in Table 2.

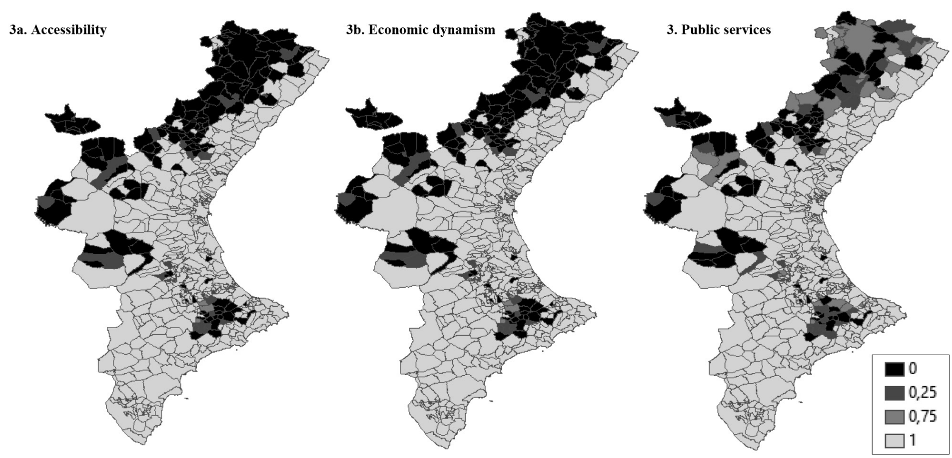
In total, 83 % of the municipalities at very high risk of depopulation have low or very low accessibility (see Map 3a). A relevant indicator of accessibility is the average time of transport to cities with more than 50,000 inhabitants. This time has been estimated at 60 minutes for this group of municipalities versus 38 minutes for the average of all the region's municipalities. The threshold for driving time to the nearest city of 50,000 or more inhabitants (used to characterise remote or peripheral areas) is 40 minutes.

A second factor relates to economic dynamism (Map 3b). Based on the indicators and thresholds, approximately half of the municipalities at risk of depopulation have low or very low economic dynamism. Only 7.5 % of municipalities with positive population growth have low or very low economic dynamism. Available income per capita in the clusters of municipalities at risk of depopulation is 10,933 Euros per person compared to 12,228 Euros per person in the most demographically dynamic cluster.

Finally, there are differences in the levels of public infrastructure in a large number of municipalities at risk of depopulation, which lack local care services for the elderly or access to secondary education (Map 3c). The average time of transfer to hospital in areas at risk of depopulation is 45 minutes, 70 % higher than the average across all the region's municipalities.

MAPS 3a, 3b and 3c

Valencian municipalities with different 'presence' of accessibility, economic dynamism and public infrastructure and services (calibrated data)



Source: Authors' elaboration from indicators proposed at GVA (2017a).

4. Methods

4.1. Exploratory spatial data analysis

Population transfer takes place because of relations between municipalities, with people working, studying or using public infrastructures in different municipalities. Territorial connexions generate spatial spillovers that should be considered in the analysis of territories and political decisions. Exploratory spatial data analysis (ESDA) can help identify the presence of these spatial correlations and the patterns of the population distribution. ESDA is a first step to confirming spatial dependence. If this is the case, any analysis of the factors leading to depopulation risk should consider the influence of neighbouring areas. One of the most common statistics to detect spatial global correlation is Moran's I (Cliff & Ord, 1981):

$$I = \frac{n}{S_o} \frac{\sum_i \sum_j w_{ij} (x_i - \mu)(x_j - \mu)}{\sum_i (x_i - \mu)^2} \qquad [1]$$

where x_i is the observation in municipality i, μ is the mean of the observations across municipalities, n is the number of municipalities and w_{ij} is the element of the spatial weight matrix W. This matrix contains the information about the relative spatial dependence between the n municipalities. The elements w_{ij} indicate the way municipality i is spatially connected to municipality j, and elements on the diagonal are set to zero. S_o is a scaling factor equal to the sum of all elements of W.

Moran's I is defined in global terms, considering the spatial dependence for the whole map, ignoring the local patterns of spatial association in certain regions. Anselin (1995) developed a general measure of local indicators of spatial association (LISA), allowing for the decomposition of Moran's I and contributing to analysing each observation associated with each region.

According to the value of the local Moran's I, LISA maps detect locations with unusual concentrations (clusters) of high or low values. The association may correspond to four types of clusters:

- High-High (HH) refers to a location with a high value surrounded by others that also have high values;
- Low-Low (LL) refers to a location with a low value surrounded by others that also have low values;
- High-Low (HL) refers to a location with a high value surrounded by others that have low values; and
- Low-High (LH) refers to a location with a low value surrounded by others that have high values.

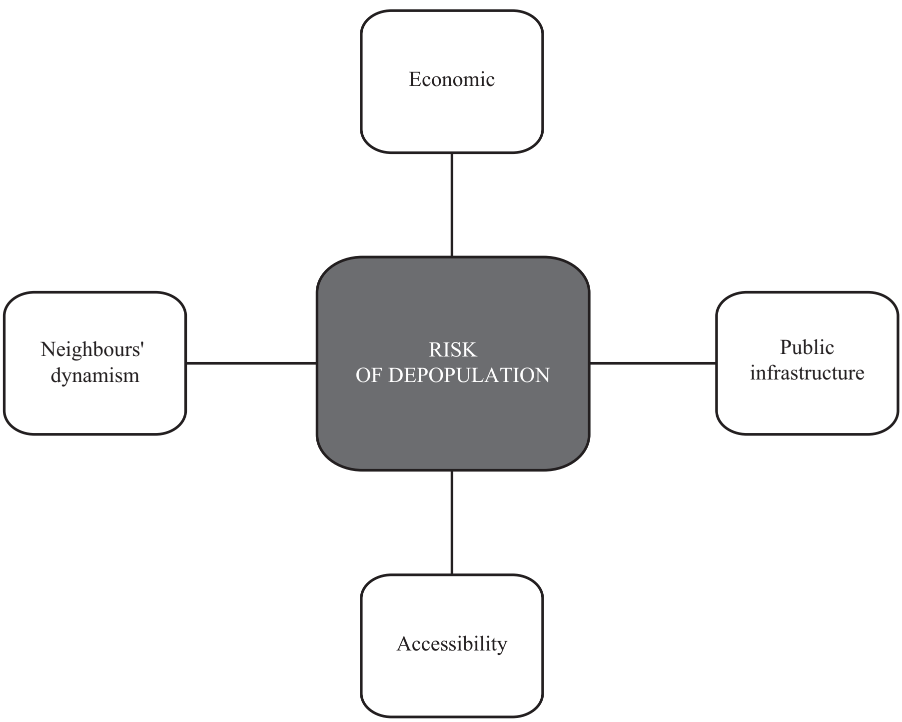
4.2. Recipes for depopulation: A qualitative comparative analysis

In QCA, the study of complex causality (in this case in relation to depopulation) has three dimensions: (i) *conjunction*, which means that the outcome is the result of interdependencies amongst various conditions; (ii) *equifinality*, which means that there is more than one path to a specific outcome; and (iii) *asymmetry*, which implies that conditions found to be causally related in one configuration may be unrelated or even inversely related in another (Ragin, 2008).

Municipal data for the Region of Valencia (542 municipalities) were used to identify the intensity of conditions or factors used for the QCA. We consider four kinds of conditions (Figure 1). Three relate to the factors discussed in the previous sections: accessibility, economic dynamism, and public equipment and services. The fourth condition relates to spatial aspects: Having an economically dynamic municipality as a neighbour.

FIGURE 1

Factors of depopulation



Source: Authors' elaboration.

QCA was developed by the social scientist Charles Ragin as a methodology to build linguistic summaries from case data. QCA is used to examine the diversity of cases and their heterogeneity in terms of different causally relevant conditions and contexts (Ragin, 2008; Fiss, 2011; García-Álvarez-Coque *et al.,* 2017). Given the complexity of real cases, which are rarely the result of a specific condition in isolation, QCA represents a useful tool to assess the interdependencies and influences of factors affecting an outcome, in our case rural depopulation. In other words, QCA can determine synergies amongst conditions to identify necessary and sufficient conditions for a given outcome (Schneider & Wagemann, 2010) and configurations of conditions (pathways) to reach that outcome.

In this study, fuzzy-set QCA (fsQCA) was applied. FsQCA can be used to explain the relationship between a combination of attributes or conditions, which may be present or absent, and a specific outcome. From a mathematical point of view, if we define an outcome set Z and attributes X and Y, fsQCA can be used to examine the possible configurations (pathways or recipes) of attributes X and Y that lead to outcome Z (i.e. X • Y, X • ~Y, ~X • Y, ~X • ~Y) for the cases under analysis. To express the degree of set membership, each set takes a value between 0 and 1. Upper-case letters reflect presence (or set membership) and the tilde ('~') reflects absence (or 1 minus set membership: 1 − A). The symbol '•' stands for the Boolean 'AND'. The QCA approach (including fsQCA) is based on a truth table that displays 'multivariate' configurations that are sufficient for the outcome (Ragin, 2008).

To conduct fsQCA, the following steps must be performed: (i) The first is *calibration* of the conditions and the outcome. This step consists of transforming the raw data into sets. Table 5 shows the membership cut-offs for each condition. (ii) The second step is to build the truth table. The truth table contains all logically possible combinations of conditions. The number of rows is equal to 2^k, where k is the number of conditions. In this case, the truth table has $2^4 = 16$ rows. (iii) The third step is minimisation. In this study, the analysis was performed using the QCA R package developed by Medzihorsky *et al.* (2018), and the minimisation algorithm was the Quine-McCluskey algorithm.

Necessary conditions are conditions that are required to produce the outcome. However, necessary conditions may not be enough by themselves. In contrast, *sufficient conditions* or *sufficient configurations* (combination of conditions) tend to lead to the outcome in most cases. A sufficient set of conditions may not be the only path to the outcome; there may be other sufficient configurations that lead to the same outcome (Nieto-Alemán *et al.*, 2018).

Consistency and *coverage* scores are the main indicators to determine sufficient conditions (Ragin, 2008). We use consistency to support or reject a hypothesis/proposition. Consistency is the proportion of cases for which the condition leads to the outcome with respect to the number of cases where that condition is present (Ragin, 2008). A condition is normally considered sufficient for an outcome when the consistency value is greater than 0.75 (Rihoux, 2006). A low consistency value reflects a weak subset relationship, indicating that the proposition is not supported. The coverage score reflects the proportion of cases where the outcome is represented by a particular configuration of attributes (Ragin, 2008). Unlike configurations with low consistency, configurations with low coverage may still be relevant.

TABLE 5

Calibration of conditions and outcome

	Degree of membership (1 = fully in; 0 = fully out)					
	0	0.25	0.75	0.9	1	
Depopulation	0	-	1	-	2-3	Raw values from AVANT
Accessibility	> 3	3	2	1	0	
Economic	> 3	3	2	1	0	
Public infrastructure	> 3	3	2	1	0	
Neighbour	A dichotomous condition that reflects whether a municipality has a neighbour that meets the 3 conditions (accessibility, economic and public infrastructure). If so, the value is 1. If the municipality does not have a dynamic neighbour, the value is 0.					

Source: Authors' elaboration.

In the present study, we seek the recipes or pathways that include necessary or sufficient conditions leading to high risk of depopulation at the municipal level. The study is based on the criteria proposed by AVANT to define depopulation as an undesirable outcome and to define certain specific conditions that, alone or combined, lead to that outcome. We also sought conditions that lead to the desirable outcome of relatively low risk of depopulation.

AVANT does not classify municipalities by degree of rurality. Therefore, as we argued earlier, rurality in itself is not the issue. AVANT categorises municipalities based on their degree of vulnerability in terms of five scales. One is the undesirable outcome: risk of depopulation. The other four scales refer to the main conditions leading to this outcome: Dynamism, public infrastructure and services, accessibility and having a dynamic municipality as a neighbour.

First, we use the AVANT database to identify municipalities that are potentially at a high risk of depopulation. More specifically, the model contains three intrinsic characteristics of municipalities (accessibility, economic conditions and public infrastructure) and one spatial dimension. This spatial condition refers to whether municipalities have a neighbouring dynamic municipality. A dynamic municipality is a municipality that is accessible, has favourable economic conditions and has good access to public infrastructure. Thus, the proposed model is as follows:

Depopulation = f (accessibility, economic, public infrastructure, neighbour)

5. Main findings and discussion

5.1. Spatial analysis of population growth

We explored population growth associations between municipalities in the Region of Valencia by estimating Moran's I (Equation 1). The significance of Moran's I was determined using a permutation test (Cliff & Ord, 1981; Good, 2005). The null hypothesis is that data are determined and then assigned to their spatial locations at random (no spatial correlation). The alternative is that the assignment to each location depends on the assignment to that location's neighbours. The distribution of any measure of spatial autocorrelation can be obtained by constructing all possible assignments. We used a sample of 1,000 to build the estimated permutation distribution of Moran's I. The value is near the higher extremes of the distribution, so we can accept that the data are produced by a mechanism that induces some autocorrelation.

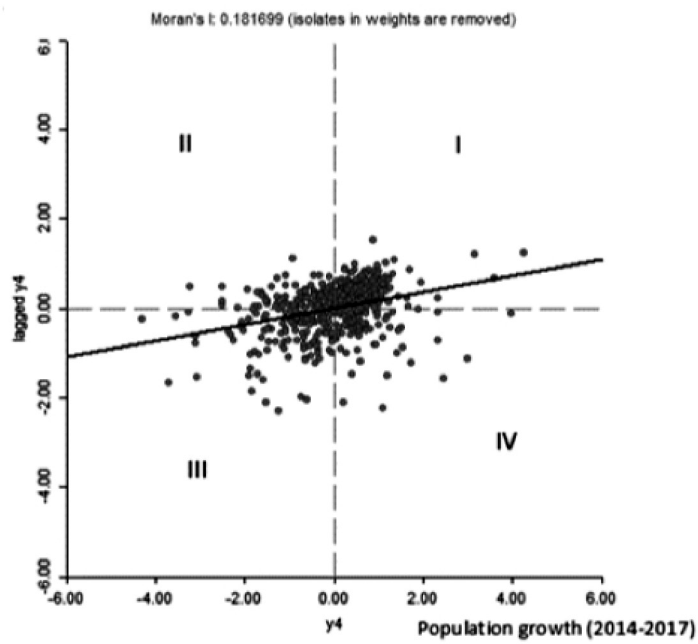
The Moran scatterplot plots the spatial lag or weighted average (Y axis) against the corresponding observation on the horizontal X axis (Figure 2). The four quadrants of the scatterplot correspond to the four types of local spatial association between a municipality and its neighbours. Quadrant I (top right) shows municipalities with high values surrounded by municipalities with high values. Quadrant II (top left) shows municipalities with low values surrounded by municipalities with high values. Quadrant III (bottom left) shows municipalities with low values surrounded by municipalities with low values. Quadrant IV (bottom right) shows municipalities with high values surrounded by municipalities with low values. Quadrants I and III refer to positive autocorrelation, indicating spatial clustering of similar values, whereas Quadrants II and IV represent negative autocorrelation, indicating spatial clustering of dissimilar values. The global spatial autocorrelation may also be observed in this graph because Moran's *I* is interpreted as the slope coefficient of the linear regression of spatial lags on original values, using a row-standardised weight matrix. Quadrant I (dynamic locations surrounded by other dynamic locations) and, to a lesser extent, Quadrants III and IV, suggest spatial autocorrelation and local associations. This finding suggests that we should study the depopulation problem from a territorial perspective that looks beyond isolated locations.

However, the Moran scatterplot provides no indications of significant spatial clustering. The LISA map suggests several clusters, which indicate population growth disparities in the region's municipalities. The LISA map enables the definition of four types of clusters.

As mentioned earlier, the Moran scatterplot gives no indication of significant spatial clustering. Map 4 reflects the LISA clustering map, showing the four types of clusters (HH, LL, HL and LH) defined above. The map illustrates HH and LL clusters, which show regional disparities between inland municipalities, particularly in the rural north and urban coastal areas of the central districts. The cluster HL is also present, which reflects municipalities in rural areas that attract the population. These municipalities are dynamic poles that partially contribute to the depopulation of the surrounding rural locations whilst potentially becoming the focus of territorial strategies of rural development. The empirical analysis of population growth reflects spatial interdependencies, which suggest that rural depopulation cannot be understood on an individual municipal basis and instead requires consideration of municipal interdependencies.

FIGURE 2

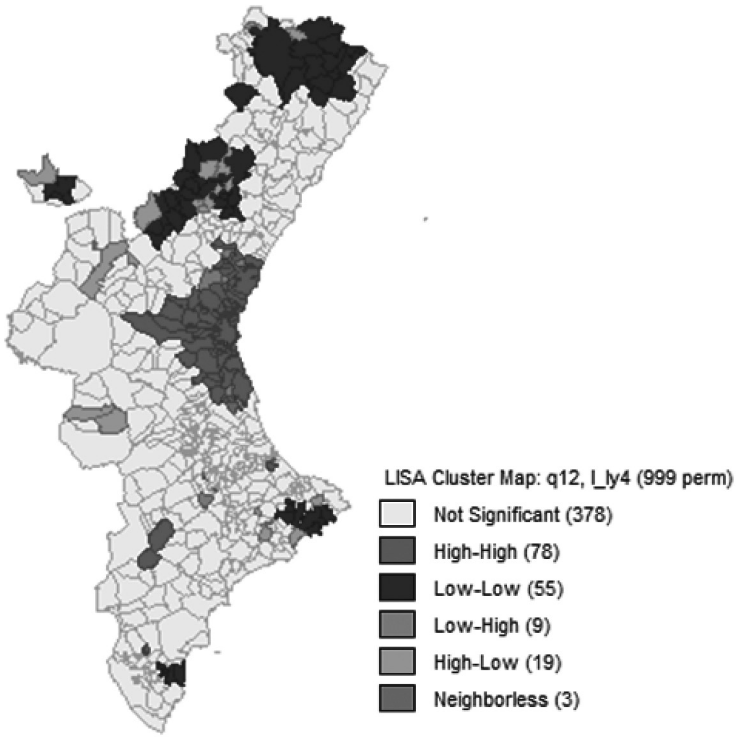
Moran scatterplot of spatial lags *vs.* original values of rural population growth (2014-2017) in Valencian municipalities



Source: Municipal data from GVA (2017a) and authors' calculations.

MAP 4

LISA cluster of population growth



Source: Authors' elaboration from GVA (2017a).

5.2. Necessary and sufficient conditions for depopulation

Table 6 shows the results of the necessity analysis. The lack of accessibility is the only necessary condition for depopulation (the consistency of necessity indicator is Cons.Nec > 0.9; Schneider *et al.,* 2010).

Table 7 complements the necessity analysis with the sufficiency analysis. The usual indicators are shown. Of the 16 (= 2^4) possible configurations, three recipes reflect municipalities in the Region of Valencia that are at high risk of depopulation. First, Recipe 1 shows that the lack of accessibility ('~' reflects the absence of a condition) is sufficient for high depopulation. Second, the lack of economic dynamism in a municipality together with having a neighbouring dynamic municipality leads to the depopulation of the first municipality (Recipe 2). Third, Recipe 3 shows that the absence of public infrastructure in a municipality with a neighbouring dynamic municipality leads to depopulation.

TABLE 6

Analysis of necessary conditions

Outcome: Depopulation			
	Cons.Nec	**Cov.Nec**	**RoN**
Accessibility	0.076	0.027	0.277
Economic	0.303	0.099	0.231
Equipment	0.182	0.062	0.258
Neighbour	0.653	0.187	0.122
~ Accessibility	**0.941**	0.895	0.962
~ Economic	0.755	0.916	0.978
~ Equipment	0.861	0.903	0.969
~ Neighbour	0.346	0.882	0.987

Note: the symbol '~' means absence of the condition.

Source: Model results

TABLE 7

Analysis of sufficient conditions

		Sufficiency inclusion score	**Proportional reduction in inconsistency Score**	**Raw coverage**	**Unique coverage**
1	~ Accessibility	0.895	0.884	0.941	0.366
2	~Economic * Neighbour	0.907	0.894	0.487	0.018
3	~ Equipment * Neighbour	0.905	0.893	0.543	0.007
	Model	**0.887**	**0.876**	**0.971**	

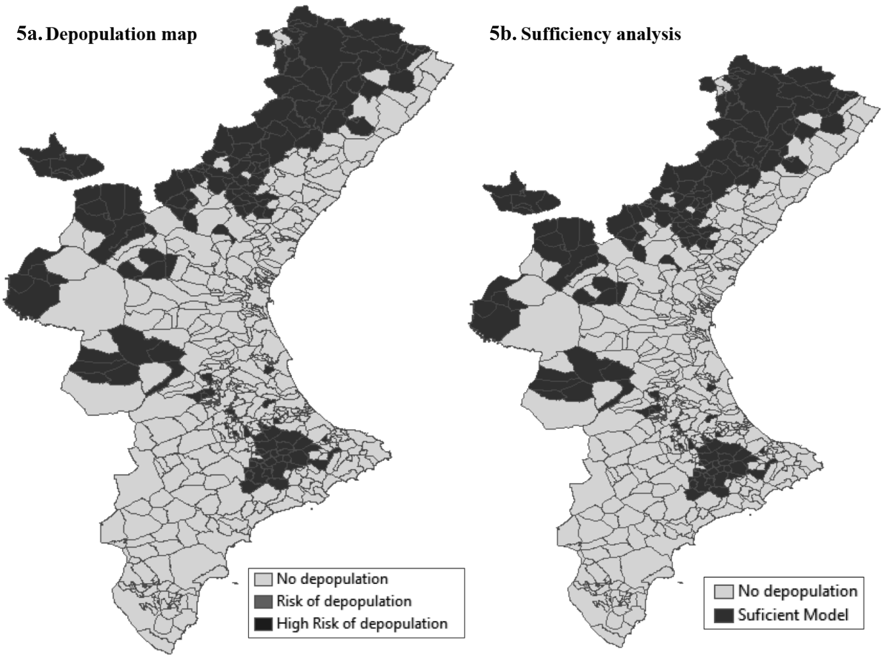
Note: the symbol '~' indicates absence of the condition. The symbol '' is the logical operator 'AND'.*

Source: Model results.

Finally, Map 5 shows, on the left, the map of the municipalities at the greatest risk of depopulation (5a) and, on the right, the municipalities that are explained by the selected recipes in the sufficiency model (5b). The categorisation of municipalities follows the proposal by AVANT.

MAP 5

Depopulation map (5a) and sufficiency analysis (5b)



*Note: (~ Accessibility + ~ Economic * Neighbour + ~ Equipment * Neighbour), where the symbol '+' is the logical operator 'OR'.*

Source: Authors' elaboration from indicators proposed at GVA (2017a) and model results.

6. Concluding remarks

Evaluating the factors that lead to depopulation is important to orient regional policies. The Valencian Public Administration is making efforts to promote policies that halt the historical and increasingly serious problem of depopulation of inland rural areas.

The present article presents a tool, based on Qualitative Comparative Analysis, to assess the conditions that for a location being potentially at high risk of depopulation. The tool was applied to the Region of Valencia, Spain, but can be easily applied to other regions of Spain. Our findings show that lack of accessibility of rural locations is significant as a sufficient condition for high depopulation risk, even within a globally urbanised region such as Valencia.

We also showed that the economic dynamism of neighbouring locations matter. Despite the exploratory nature of this research, we find that any territorial strategy will be insufficient if it underestimates the dependence between one municipality and its neighbouring municipalities. In conclusion, policies that tackle depopulation cannot be handled from the perspective of an isolated local unit. Instead, they must consider the relationships between local communities and the broader territory. In this respect, accessibility and the promotion of efficient labour systems under a supra-municipal approach are likely to become more relevant in the future.

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