CROSS-BORDER ACESSIBILITY AND LOCAL DEVELOPMENT IN PORTUGAL AND SPAIN

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ABSTRACT

One of de EU current major concerns is cross-border regional development, for obvious cohesion purposes. These regions are usually less dynamic socio-economically acting as bottlenecks, especially in European peripheral territories. Obviously, this is not an exclusive problem of the EU. The paper focuses on both sides of the Portuguese-Spanish border, using socio-economic data and accessibility data from both countries to study the development of this border area. It considers a Spatial Econometric Analysis, to produce statistical evidence on the relation between accessibility and development at a local scale. This type of analysis allows identifying territorial differences in the relationship between accessibility and cross border development. These differences must be taken into account in regional development strategies. Due to the size difference of Spanish municipalities, these were aggregated in 'Comarcas', similar to the Portuguese municipalities. All the units are included in statistical units (NUTIII) that are defined in the program for the Spanish-Portuguese Cross-Border area (INTERREG). A pilot study on the region of Raia Ibérica (one of the main Cross-Border Areas between Portugal and Spain) using a set of variables on population age, graduation characteristics, migrations, unemployment and accessibility (daily accessibility to main towns), is being analysed. This study will be applied to the entire Cross Border area between Portugal and Spain. After defining the database, a regression analysis to assess regional relationship between accessibility and development in cross border areas will be undertaken. A first step in the development of this study is the evaluation of some of the variables for a selected area, exploring the possibility of some autocorrelated variables. This exploratory analysis allows for the identification of local tendencies, in the behaviour of these variables, with statistical significance. A first group of results shows some of the main differences along the portuguese-spanish cross border region.

***Keywords**: Cross border regions; spatial autocorrelation*

INTRODUCTION

The implementation of the main road transport infrastructures in Europe is based on the EU Trans-European Transport Networks (TEN-T). As mentioned in the EU site for Transport and Mobility, transport infrastructure is essential for several reasons: the smooth operation of the internal market, the mobility of persons and goods, and the economic, social and territorial cohesion of the EU. The implementation of this infrastructure in Portugal followed the European guidelines, and some regional development improvements were not as expected, namely in those regions close to Spain and traditionally less developed. This development did not happen with the expected magnitude and extension, and those regions had been losing competitiveness and population. In border areas between Portugal and Spain, a new (road) infrastructure was built in the last decades, changing completely the accessibility panorama, but the development variables seem to get worst in most of the cross border regions. Some road links are still missing, but some already exist and are not having the expected development impact. Specific programs like INTERREG are focused on solving development issues in border areas. In Figure 1 it is possible to see the above mentioned cross-border area between Portugal and Spain. This is one of the key areas in the European Union that needs specific policies, in general materialized in cooperation projects between both countries. So that in future the development of these regions can be promoted and is essential to realize how the investment in transport infrastructure may help in the permeability of these regions.

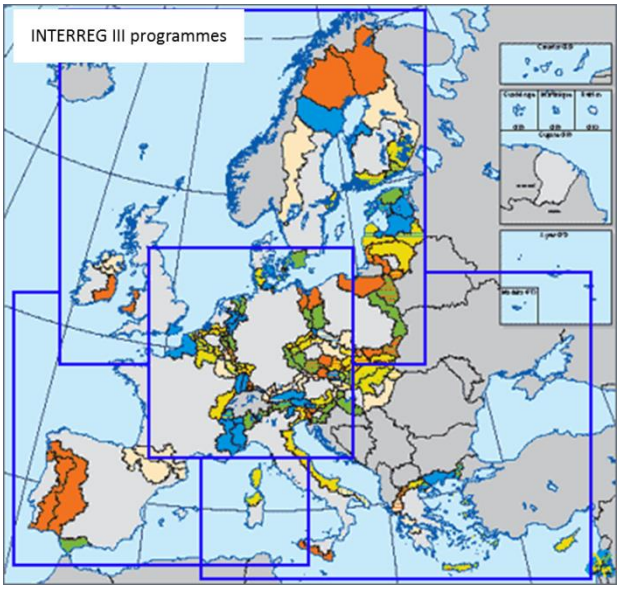


Figure 1 – INTERREG III main action areas

Therefore accessibility is a concept related with transport and communications that come closer to the population and that may have a facilitating role and act as catalyst for development. The main objective in this work is to understand road infrastructure's impact in the development, through the effects of accessibility on cross-border areas between Portugal and Spain, using spatial analysis methods, such as autocorrelation studies and spatial regression. Therefore, this initial exploratory study grabs some accessibility variables and some variables that might reflect development and explores its tendency for autocorrelation.

This step it is essential to analyse, at a municipal level, the spatial behaviour with statistical significance of relevant variables, including accessibility.

LITERATURE REVIEW

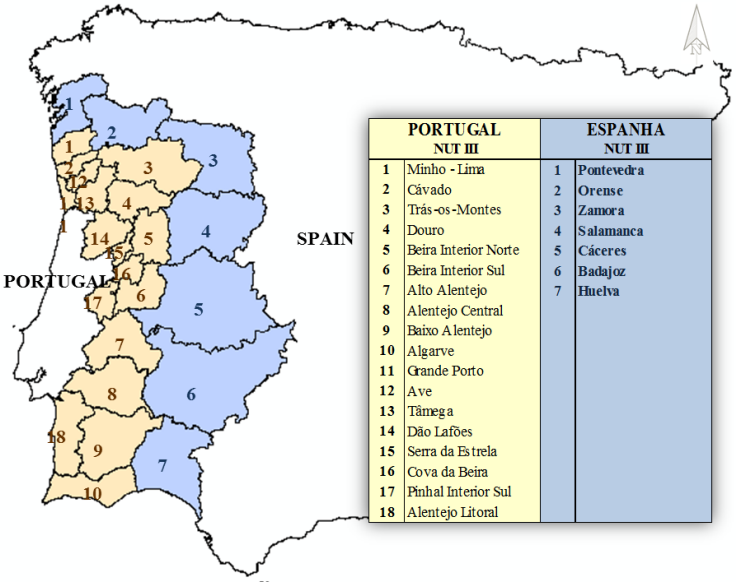
Considerable investment has been made in new road infrastructure in recent decades. This investment has mainly been supported by the argument that road links are important tools in improving social and economic cohesion. In Europe the related policies and actions aim to consolidate the Trans-European Transport Networks (TEN-T) and provide closer links between core and peripheral countries (European Commission, 2007). The positive influence of transport infrastructure (through improved accessibility) in development is a widely accepted concept. But the full validity of this concept has not yet been established. The great majority of studies about how accessibility impacts on development apply on a spatially aggregated basis and use methodologies and models such as cost benefit analysis with production functions (Aschauer, 1989), among others. Rietveld and Bruinsma (1998) and Banister and Berechman (2000) report a wide range of approaches. Research in Portugal uses the same aggregated approaches to show that new transport infrastructure positively affects the global Portuguese economic performance (Pereira and Andraz, 2005). The growing complexity of spatial socio-economic interactions has recently called for the use of more disaggregated spatial units and the inclusion of the «location» factor, arguing that the positive effects are weaker when looking at it on a local basis (Mas et al, 1996; Guild, 2000). The use of accessibility indicators is an important step forward, as seen in the works of Vickerman (1995), Button (1995), Forslund and Johansson (1995) and Gutiérrez and Urbano (1996). More recently, Lopez et al (2008) related to important new European transport infrastructures consolidating the concept of «potential accessibility». However, the calculation of accessibility is not enough to measure the way it acts as a development factor. Páez (2004) makes some important advances by using the same type of accessibility indicators as variables in a spatial regression analysis framework, supported by the spatial econometrics work of Anselin (1988). Besides Paez (2004), the work of Anselin (1988) has inspired great number of contributions since the beginning of the millennium, e.g. Mur et al (2009). The same methodology is now used in recent portuguese work (Ribeiro, 2009). The number of kilometres of Portugal's network of major roads has increased substantially in the last twenty years (through the TEN-T program), as has happened in many European countries (Santos et al, 2009). Consequently, most of the country felt a huge increase in accessibility but the corresponding improvement in development has not matched expectations, since in many areas population continues to decline (Gaspar et al, 2002). These negative effects are more pronounced in cross-border areas, where a spatial regression analysis is used to explain to what extent the new accessibility achieved by the new roads has affected population growth at municipality level (Ribeiro et al, 2010). The scientific background (to the relation between accessibility and development) does not go much further than the literature mentioned above, and on cross-border issues it is extremely recent, largely resulting from recent European funded projects (and mainly qualitative). And there is no article on the application of spatial regression analysis to this subject. In fact, the most prestigious relevant database contains very few articles about cross-border regions, development and accessibility (or transport), (Mesarec and Lep, 2009; Johnson, 2009; Lopez et al, 2009). As Portuguese examples, some

articles have examined the same type of issues: Silva (2005) and Cavaleiro et al (2009). But again, these important studies consider the availability of direct transport infrastructure as the indicator for development and do not analyse the significance of that potential impact. Globally, there seems to be a lack of scientific research on transport infrastructure impact as a spatial development factor for cross-border regions.

METHODOLOGY

Case Study

The analysis proposed in this study represents a first step on the spatial regression for evaluating the relation between accessibility and development. This step it is essential to analyse, at a municipal level, the spatial behaviour with statistical significance of relevant variables, including accessibility. It is to be developed at the municipality level in order to evaluate the regional development differences at a local scale within the cross border area, which is not possible at a higher level such as NUTIII.A central constraint in this study is the fact that it is difficult to obtain comparable data from both sides of the border and to compare municipalities from Portugal and Spain since they are so different (Spanish municipalities are much smaller than Portuguese municipalities and census data from each country do not always match). Therefore the first important step already developed is the construction of a Cross-Border Data Base, with comparable geographical units. The geographical area of analysis of this work is formed by NUTIII of Portugal and Spain, which are identified as areas for action in the INTERREG program: eighteen NUT III from Portugal and seven NUT III from Spain (Figure 2).



PORTUGAL NUT III		ESPANHA NUT III	
1	Minho - Lima	1	Pontevedra
2	Cávado	2	Orense
3	Trás-os-Montes	3	Zamora
4	Douro	4	Salamanca
5	Beira Interior Norte	5	Cáceres
6	Beira Interior Sul	6	Badajoz
7	Alto Alentejo	7	Huelva
8	Alentejo Central		
9	Baixo Alentejo		
10	Algarve		
11	Grande Porto		
12	Ave		
13	Tâmega		
14	Dão Lafões		
15	Serra da Estrela		
16	Cova da Beira		
17	Pinhal Interior Sul		
18	Alentejo Litoral		

Figure 2 – Study area

This cross border map is entailing some of the ongoing projects which are divided into zones. These zones are: Norte/Galicia, Centro/Castilla y Leon, Alentejo/Extremadura, and Algarve/Andalucia, and can imply more than one of these regions each time. At the local level, it is important to have the same type of geographical unit in both sides of the border. The study area consists of a set of geographical units on both sides of the border forming the cross-border region under analysis. The geographical unit of analysis is primarily the municipality. But since municipalities have different sizes within each country and between countries (Figure 3) some aggregations of municipalities are being performed. These aggregations are done considering the "Comarcas" criteria from the Spanish side.

Figure 3 – Differentiation between Portuguese and Spanish municipalities

Using this area as the starting point for analysis, a new database with the municipalities must to be built, considering the existence of a geographically variable analysis of common and uncommon areas treated with the use of Geographic Information Systems (GIS).
This data base will have a geographical expression and can therefore be treated in platforms such as GeoDa, where the autocorrelation analysis developed in this study and the spatial regressions developed in further studies can be taken undertaken.

Based on variables needed for the ongoing analysis and available at the municipal level, we had to build new geographic areas on both sides of the border, comparable in size and characteristics, and that can be easily related to the road network. In this context, data will be aggregated to Spanish "municipalities" called "Comarcas", units whose dimensions and characteristics are similar to the Portuguese municipalities.

In Table 1 it is possible to see the correspondence between NUT III and NUT II between both countries.

Table I – NUT II and NUT III in the cross-border between Portugal and Spain

PORTUGAL		**ESPANHA**	
NUTII	**NUTIII**	**NUTIII**	**NUTII**
NORTE	Minho Lima Cávado Alto Trás os Montes Douro	Pontevedra Ourense	**GALICIA**
CENTRO	Beira Interior Norte Beira Interior Sul	Zamora Salamanca	**CASTILLA y LÉON**
ALENTEJO	Alto Alentejo Alentejo Central Baixo Alentejo	Cáceres Badajoz	**EXTREMADURA**
ALGARVE	Algarve	Huelva	**ANDALUCIA**

This way, we obtained an expected database of 183 Portuguese municipalities plus 63 Spanish comarcas, a total of 246 units.

Data Collection

In the first phase of this study, data collection was of great importance. Thus, for both Portugal and Spain data, the necessary variables were obtained from the National Statistical Offices of both countries. The study considered data from 1991, 2001 and 2011, in terms of population census. In addition, data on road maps, for the calculation of accessibility variables, were also collected in both countries (Spain through Centro Nacional de Información Geográfica - www.cnig.es, and Portugal through Instituto de Infra-Estruturas Rodoviárias IP – www.inir.pt).

As previously stated, the analysis proposed in this study represents a first step on the spatial regression for evaluating the relation between accessibility and development. This step is essential and is called an autocorrelation study or exploratory study, to analyse, at a municipal level, the spatial behaviour with statistical significance of relevant variables, including accessibility. The group of variables compromises a large set of different variables on socio economic characteristics of population and on accessibility variables.

For this set of 246 Cross-Border geographical units, 46 variables were choose and collected from both portuguese and spanish census. These variables were submitted to several filters in order to avoid future problems, such as endogeneity and collinearity.

Taken from the initial 46 variables, a first group of six plus three (nine) variables (Table 2) was used for the first exploratory studies. These studies are related with the evaluation of spatial autocorrelation for each variable.

The accessibility variables considered, **for each municipality/comarca** are:

1. Relative accessibility (time by road) at the National level (NUTI): ARIL, ARIM - meaning, respectively, relative accessibility (time) to Lisbon and Madrid.
2. Relative accessibility at the regional level (NUTII): ARIIa, ARIIb - meaning, respectively, relative accessibility (time) to the regional capital (a) and to the closest (by road) regional capital of the neighbour country (b).
3. Relative accessibility at the sub-regional level (NUTIII): ARIIIa, ARIIIb - meaning respectively, relative accessibility (time) to the sub-regional capital (a) and to the closest (by road) sub-regional capital of the neighbour country (b).

In the spatial analysis studies to be considered in the next phase, some dependent variables must be taken in account and autocorrelation will also be tested:

1. VPOP9111 – Population variation between 1991 and 2011.

2. VIE9101 – Ageing index variation between 1991 and 2001.

3. VTXD9101 – Unemployment rate variation rate between 1991 and 2001 (there is no data for 2011 yet).

This group of six variables will be considered for the autocorrelation studies described in the next section. From the initial group of 246 geographical units some of them were choose as the map of this pilot study area includes only the Centre and the North (South is out for now), (Figure 4).

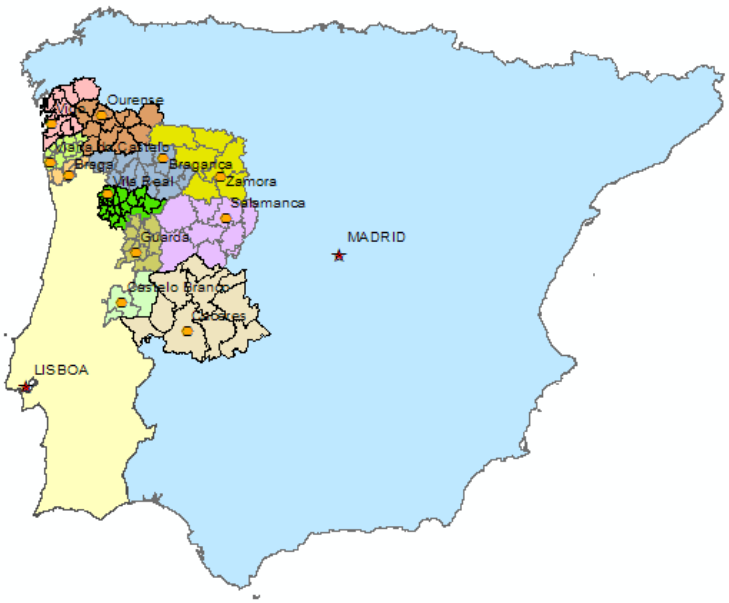


Figure 4 – Analysed areas

Methods

In a first phase the definition of autocorrelation significance for some variables in the selected area is fundamental for a better understanding of further spatial regression studies results. This paper will be focused on the above selected area and on the autocorrelation studies for the three variables that will be tested as dependents, and for the accessibility variables.

Autocorrelation studies

There are two types of autocorrelation: global autocorrelation (degree of autocorrelation of a variable, considering all the territory under study) and local autocorrelation (autocorrelation of a variable space for each unit). In case of global autocorrelation the most widely index in use is the Moran I.

RESULTS AN DISCUSSION

Autocorrelation for accessibility variables

The autocorrelation exploratory studies, in this case the Local Indexes for Spatial Analysis (LISA) maps and correspondent significance maps, were performed for relative accessibility variables. The relation between the municipalities with each NUTII, with its capitals from the NUTII level and the higher levels NUTII and NUTI are expressed in the Table 2, in accordance with the explanations in the previous section, about data collection.

Table II – Relations between the municipalities/comarcas with each NUT

Country	NUTIII	ARI	ARIIa	ARIIb	ARIIIa	ARIIIb
E	Pontevedra	L/M	Santiago Compostela	Porto	Vigo	Viana do Castelo
E	Ourense	L/M	Santiago Compostela	Porto	Ourense	Vila Real
E	Zamora	L/M	Valladolid	Porto	Zamora	Bragança
E	Salamanca	L/M	Valladolid	Coimbra	Salamanca	Guarda
E	Cáceres	L/M	Merida	Coimbra	Caceres	Castelo Branco
P	Minho Lima	L/M	Porto	Santiago Compostela	Viana do Castelo	Vigo
P	Cavado	L/M	Porto	Santiago Compostela	Braga	Vigo
P	Alto Tras os Montes	L/M	Porto	Santiago Compostela	Bragança	Zamora
P	Douro	L/M	Porto	Santiago Compostela	Vila Real	Ourense
P	Beira I. Norte	L/M	Coimbra	Valladolid	Guarda	Salamanca
P	Beira I. Sul	L/M	Coimbra	Valladolid	Castelo Branco	Caceres

Relative accessibility at the National level (NUTI): ARIL, ARIM, meaning respectively relative accessibility (time) to Lisbon and Madrid.

The first case (Figure 5) is the relative accessibility to both capitals, Lisbon and Madrid (ARIL and ARIM, respectively).

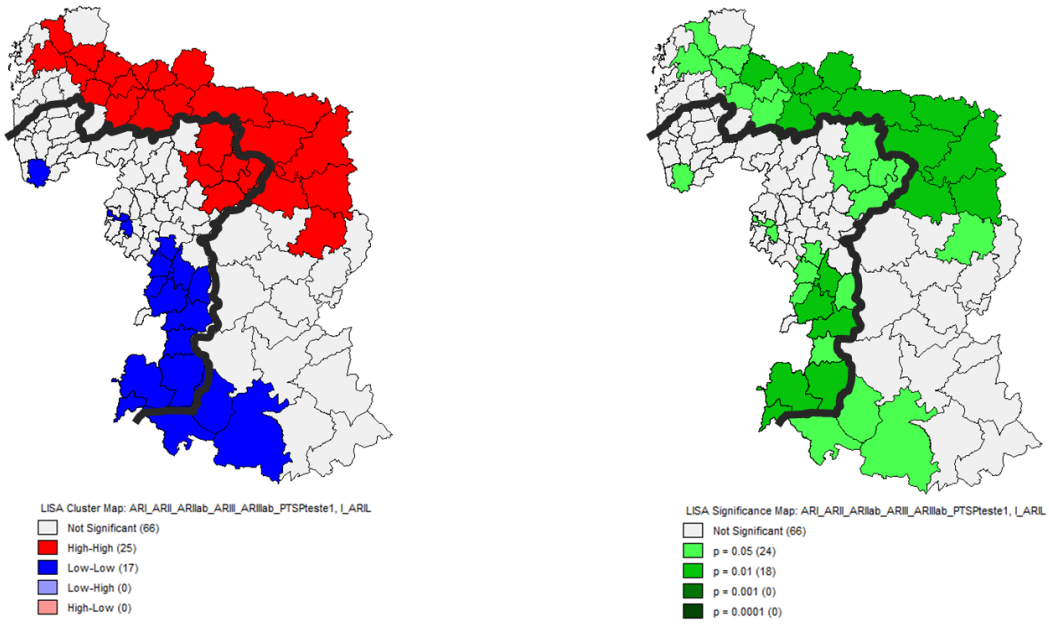


Figure 5 – Lisa and significance maps for relative accessibility to capital of NUT I – Portugal (Lisbon)

In the case of time-distance of all municipalities to the city of Lisbon, it is possible to observe that in this case the border effect is not influent especially for the two clusters, high-high and low-low. In fact the existence of good connection with Lisbon, relatively influences positively a group of municipalities from both sides of the border, near Castelo Branco and Cáceres. On the other end, it clearly has the opposite effect for a group of cross-border municipalities, up in the North because of the bad connection North-South directly in the direction of Lisbon on that area (please note that 'high' means a bigger time-distance and therefore less accessibility). Among the highlighted municipalities, it is clear that some municipalities have a higher level of significance. Taking this significance level into account, the cross-border effect appears. It is possible to see, on the correspondent significance maps, that expressive levels of significance occur.

Considering the time-distance of all municipalities to Madrid (Figure 6), the border effect appears quite clearly, that is to say on the cross border Portugal-Spain.

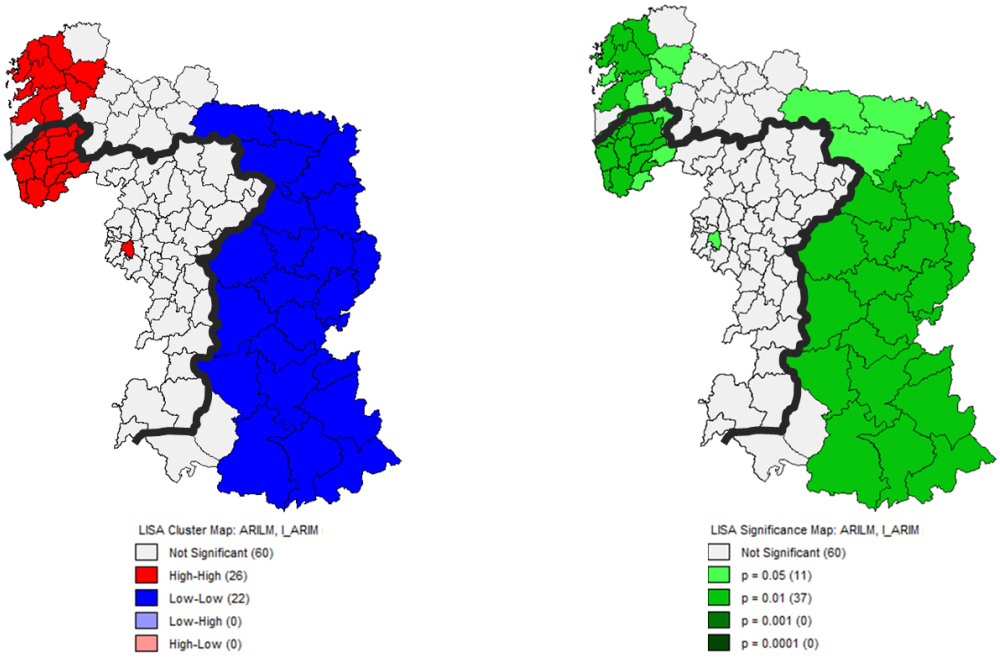


Figure 6 – Lisa and significance maps for relative accessibility to capital of NUT I – Spain (Madrid)

The Spanish municipalities are better connected with Lisbon than the Portuguese municipalities are with Madrid. Of course distances are different, and that implies that on further research this should be taken into account. However the cross-border bottleneck on the Raia area is evident and it has statistical significance.

Relative accessibility at the regional level (NUTII): ARIIa, ARIIb - meaning respectively, relative accessibility (time) to the national/regional capital (a) and to the closest (by road) national/regional capital of the neighbour country (b).

Considering the accessibility to the 'own regional capital' (ARIIa), (Figure 7), which means the time distance from each municipality to its regional capital within its own country, it is interesting to observe that the ones 'best connected' form a 'high-high' cluster in Minho-Galicia and in terms of 'low-low' we have the north-east zone of Portugal. The remaining area is not significant.

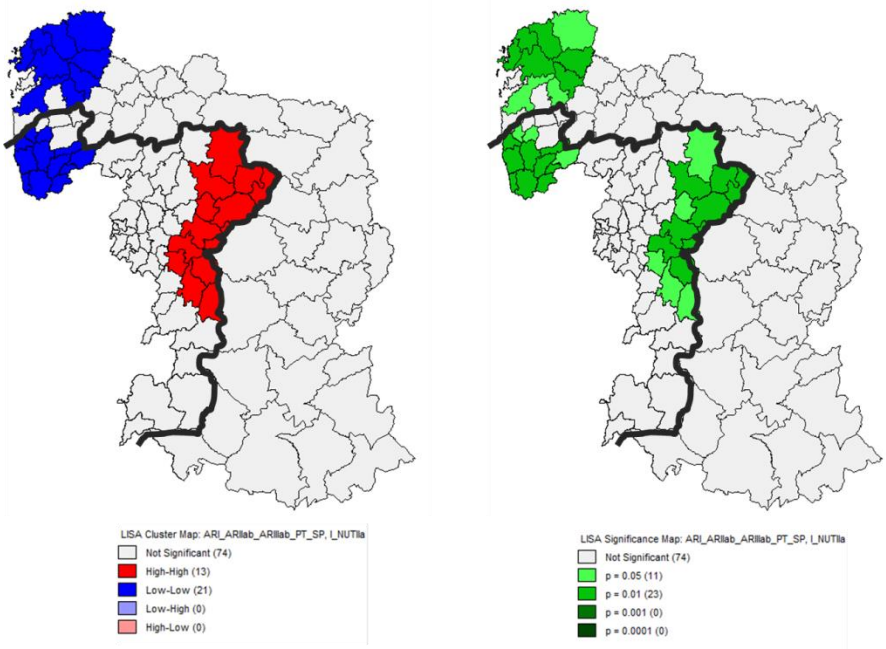


Figure 7 – Lisa and significance maps for relative accessibility to the regional capital of NUTII (ARIIa)

When we consider for each municipality the distance to the Portuguese/Spanish neighbour that is closer (Figure 8), other interesting observations are possible.

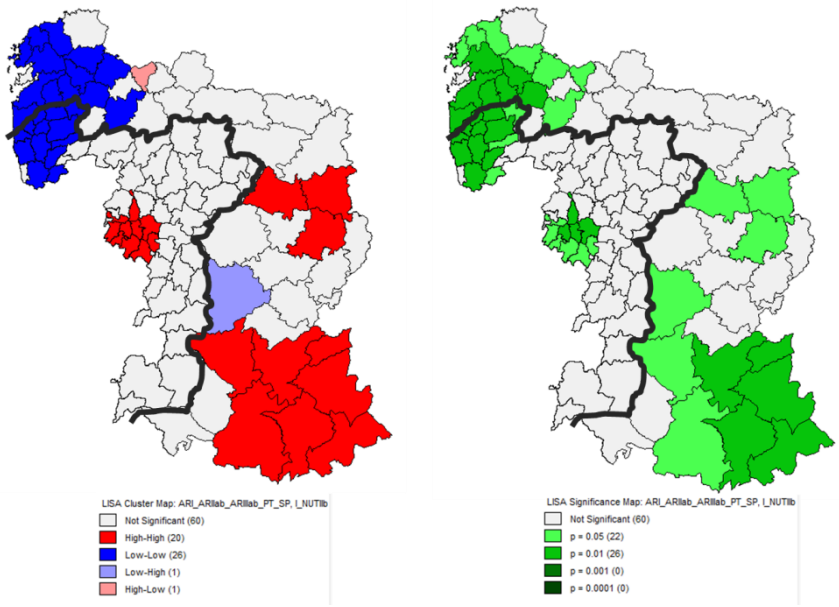


Figure 8 – Lisa and significance maps for relative accessibility to the closest (by road) regional capital of the neighbour country (ARIIb)

Again, the cross-border region Minho-Galicia is well connected, and several areas in Spain are badly connected with Portugal. However, the group of municipalities in Portugal also form a cluster badly connected with Spain.

Relative accessibility at the sub-regional level (NUTIII): ARIIIa, ARIII - meaning respectively, relative accessibility (time) to the sub-regional capital (a) and to the closest (by road) sub-regional capital of the neighbour country (b).

Considering the accessibility to the 'own sub-regional capital' (ARIIIa), (Figure 9), which means the time distance from each municipality to its sub-regional capital within its own country, it is interesting to observe that now smaller clusters appear, both well/bad connected with its own sub-regional capital.

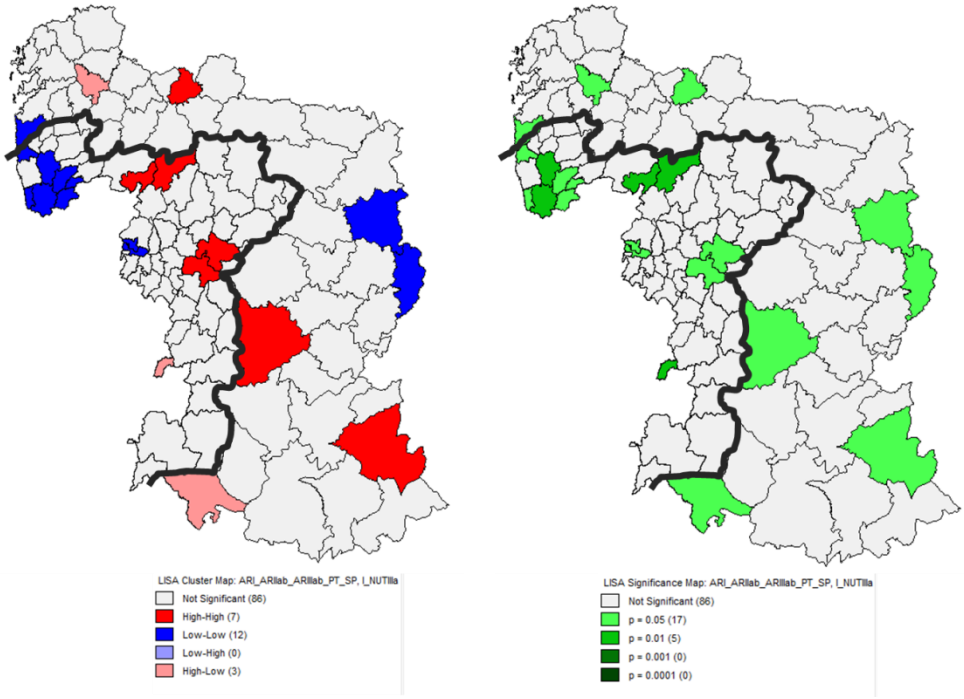


Figure 9 – Lisa and significance maps for relative accessibility to the sub-regional capital of NUTIII (ARIIIa)

When we take for each municipality the distance to the Portuguese/Spanish sub-regional neighbour (Figure 10) the clusters are not so disperse and tend to form more aggregated areas with good/bad connections with its neighbours.

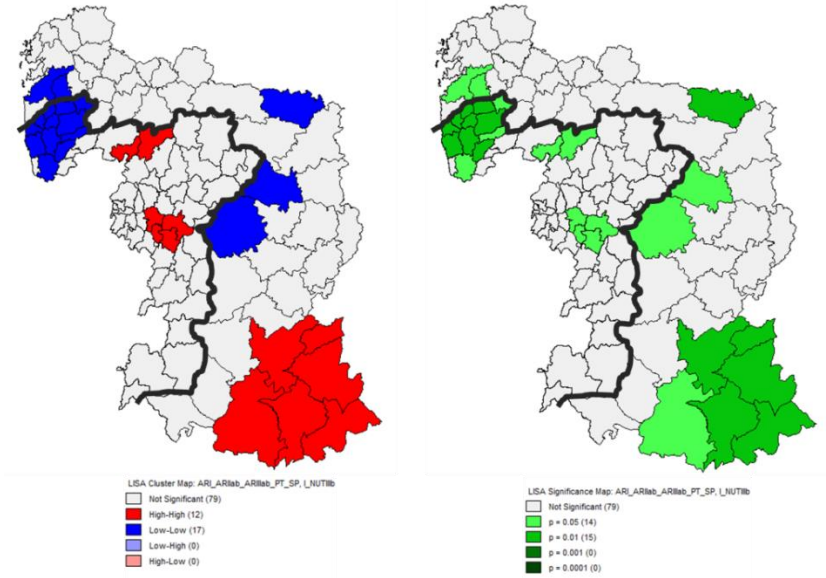


Figure 10 – Lisa and significance maps for relative accessibility to the closest (by road) sub-regional capital of the neighbour country (ARIIIb)

Autocorrelation for development variables

It is rather curious to verify that there is no significant tendency for population evolution either for a high or a low cluster. Exception made to a group of high-high in the region of Braga (on the Portuguese side), and a group of low-low near Vilar Formoso (but on the Spanish side), (Figure 11).

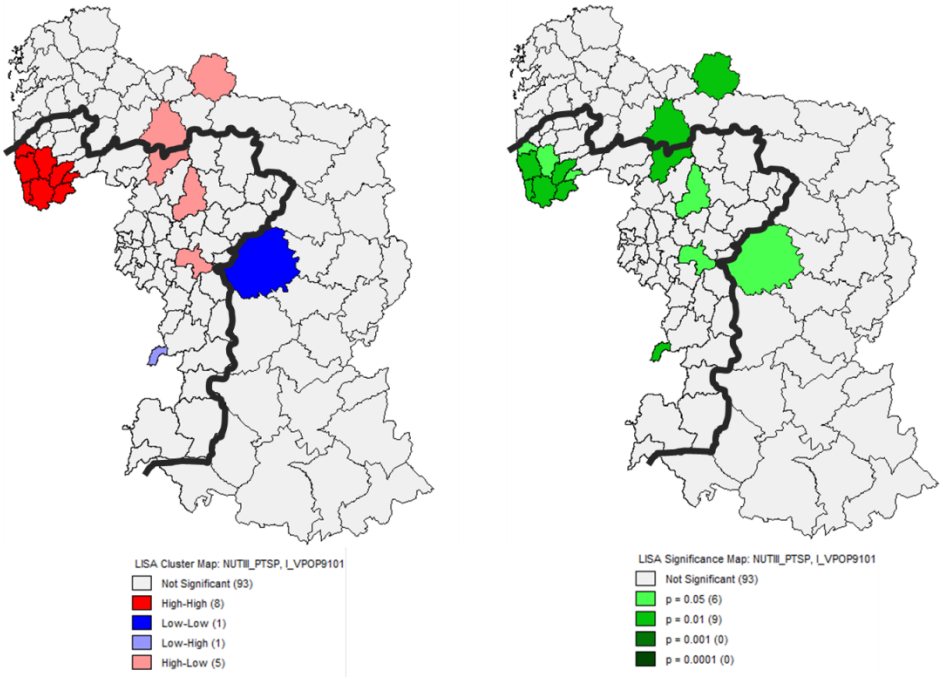


Figure 11 – VPOP9101

In the case of the ageing index, in most of the municipalities in the Spanish side there is no significant evolution in this index in spatial terms, exception for a cluster where the index has increased a lot (between Orense and Vigo), (Figure 12).

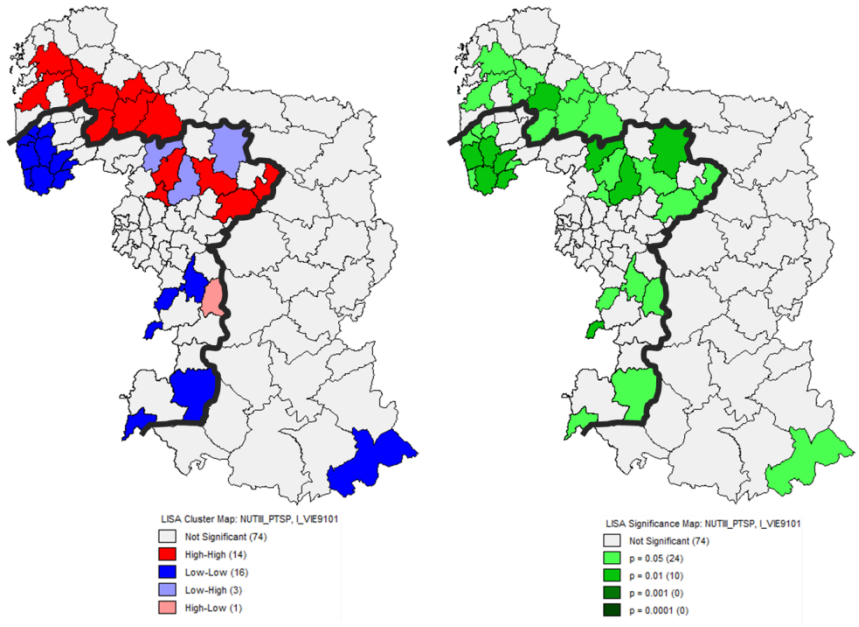
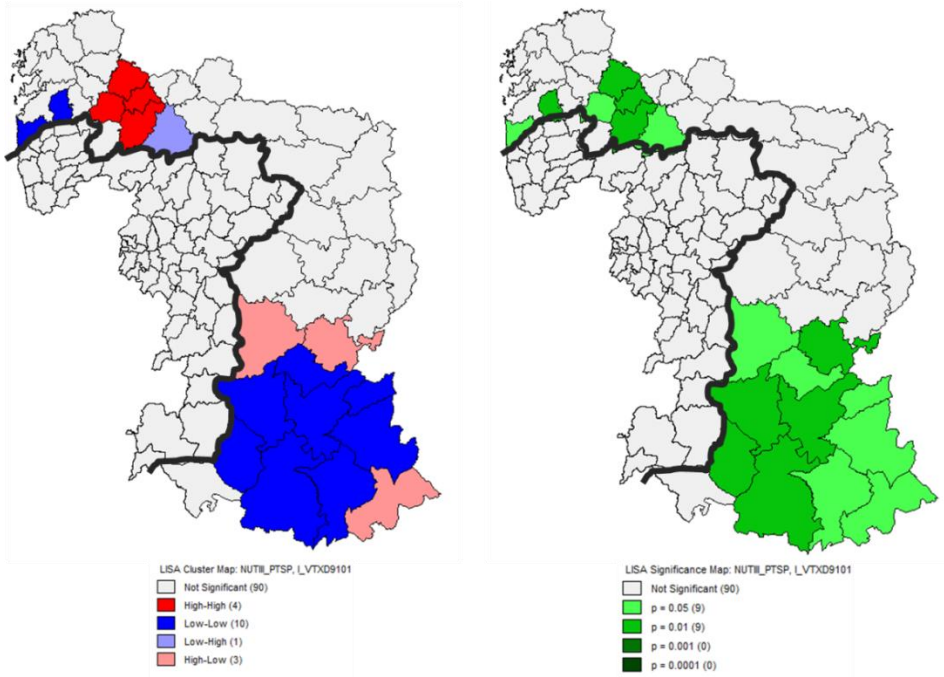


Figure 12 – VIE9101

The unemployment rate (Figure 13) shows a curious behaviour with a big cluster where it did not increases so much, and another cluster, partly coincident with the ageing index (as somehow expected), that have a behaviour high-high.



CONCLUSIONS

The main objective of this study is a first step on a broader spatial regression analysis for evaluating the relation between accessibility and development. This step it is essential and it is called an autocorrelation study or exploratory study, to analyse, at a municipal level, the spatial behaviour with statistical significance of relevant variables, including accessibility Therefore, this initial study, with some accessibility variables and some variables that might reflect development, explores its autocorrelation potential tendencies. The statistical significance of autocorrelation for these variables, indicates that most probably, some significant regional differences in the relation between transports and development are to be found, even if latter some other control variables are included in spatial regressions. In fact, the identification of the spatial autocorrelation characteristics for each variable will be quite helpful in explaining some differences obtained in the spatial regressions, to be developed in further steps of this research. To accomplish this objective, a pilot area was choose, with six accessibility variables, and three variables that might reflect development on further spatial regressions. This first exploratory study on autocorrelation for this group of variables shows very interesting results. In fact, for the accessibility variables it is possible to identify the better and the worst connection clusters, both inside the country and with the neighbours from the other country. For the socio-economic variables considered, since all three are to be tested as dependents, we see that they do not show significant autocorrelation, but the clusters/outliers identified will help further research, namely in terms of interpretation of spatial regressions, as already stated.

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