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Section Empirical contributions

A Spatial analysis on the relation between accessibility and spatial development for Cross-border regions

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ABSTRACT: Cross-border regional development is one of the EU current major concerns. These regions are usually less dynamic socio-economically. Some of them have recently benefited from new roads, which have mainly been funded through the European financial program of Transnational Transport Networks, TEN-T. Using socioeconomic data from the Portugal/Spain cross-border area a model able to measure the relation between accessibility and development in this region is being calibrated. This paper reflects an initial study using Portuguese and Spanish geographical units in the border area for the period 1991-2001 and giving special efforts to the building of similar spatial units in both countries.

JEL Classification: R15, R42, R58, O18, C31.

Keywords: Regional Development, Cross-border Areas, Spatial Regression.

Un análisis espacial de la relación entre la accesibilidad y el desarrollo territorial de las regiones transfronterizas

RESUMEN: El desarrollo regional transfronterizo es, en la actualidad, una de las principales preocupaciones de la UE. Normalmente, estas regiones tienen menos dinámica socio-económica. Algunas de ellas se han beneficiado recientemente de nuevas carreteras, que han sido principalmente financiadas por el programa europeo TEN-T. Utilizando los datos socioeconómicos del área transfronteriza entre Portugal / España, se ha calibrado un modelo para medir la relación entre la accesibilidad y el desarrollo en esta región. Este documento refleja un estudio inicial con unidades geográficas en la zona fronteriza para el periodo 1991-2001. Se destaca también el esfuerzo complementario para la construcción de unidades homogéneas a ambos lados de la frontera.

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1. Introduction

The spatial distribution of activities is the result of opportunities and localization strategies outlined in terms of specific objectives. If we take into account that most human activities involve using and sharing limited resources it is easy to see that the decision processes are complex and involve an important economic component. The acceleration of regional development, particularly in peripheral and border regions —as in our case— seems generally to be associated with substantial capital investment, the allocation of sophisticated technical and scientific resources to production systems, and a thorough renovation of the economy. Building new infrastructure in these areas also leads to significant public investment to make private capital more productive, and it is hoped, therefore, that the expansion of networks and systems will, in the first place, enable firms to operate at lower costs and achieve better performance and, second, mean that the resulting productivity gains will increase the range of regional economic activity. Our geographical working area is considered a peripheral region; it is facing a sharp population decline, weak business dynamics, and its transport infrastructure is referred to as *being little in line with the local development needs*.

Two characteristics of this type of territory can help us better understand these local needs. First, based on census data, there is a significant trend for the number of young people to fall and the elderly population to increase, with particularly disturbing future implications. In fact, although this is *only* a reduction in the younger population, it necessarily implies a future reduction in workforce; this trend means that an increasingly small active population will have *to* support a growing number of elderly people. The region can realistically only establish a trend towards population stabilization if people come from outside, that is, if the territories are attractive, because there is no credible prospect of a change in the sign (negative) of natural increase. And a young potentially active population is essential for regional development. Second, the topography and water courses (as well as political decisions) have always conditioned the structure of the main road network of the area. This situation has changed very little in recent years. Apart from the delay that has been systematically observed in improving some of the main roads crossing the region - essential to both the permeation of the national territory and to penetrating either side of the border - the capillary network has not been properly addressed by the authorities. These networks are doubly important for the integrated development of the region. From an inside point of view it represents more direct links between Portuguese towns. From a wider strategic point of view, it represents links to neighboring Spanish settlements. This latter issue is fundamental to a cross-border cooperation (CBC) pattern which age-old tradition needs to preserve and enhance in order to improve local economic dynamics.

Accessibility in general and the transport infrastructure in particular are fundamental to the integrated development of any region. To achieve this target it is necessary they exist and act as such. However, although some components have not yet gone beyond the virtual planning stage, the region —on both sides of the border— is already endowed with an interesting range of transport infrastructure. One issue here is that not all of these new or improved roads operate at full use of their capacity (or else they do not do so in network). While infrastructure construction and the implementation of transport systems in these regions, which are simultaneously remote and border areas, may be guided by the principle of territorial equity, we are also aware that logic should prevail in local claims; any requests for investment of generic utility should be replaced by more selective interests that are easier to support technically and economically. Whilst it is not possible to eliminate the effects of the past it is nonetheless legitimate to balance any development opportunities in this region with scenarios of more and/or improved accessibility at national, interregional and cross border levels.

These background considerations demonstrate the importance of this subject, although it has not been treated in any depth in the literature. In fact, recent examination of the most prestigious science databases shows that specific papers devoted to this issue are quite rare, and even fewer have focused on cross-border accessibility, and most of these are qualitative in nature. This paper thus aims to provide some new scientific knowledge about the impact of accessibility on sustainable development. A specific cross-border region between Portugal and Spain has been chosen as a case study.

First, and for better understanding of this area dynamics some autocorrelation studies were taken within the Iberian Peninsula. Then, a group of 15 cross-border municipalities was selected. Through a classical regression analysis the above relationship was evaluated, considering only these municipalities' access connections within Portugal. Then the process was repeated but adding information concerning access connections with Spain for those 15 municipalities. Finally some information was included about Spanish municipalities directly connected to the other side of the border, next to the Portuguese municipalities. In a fourth stage this work will be extended to all municipalities on both sides of the entire Portugal/Spain border. This later stage will be developed within a spatial regression framework, with the addition of the «location» variable as an explanatory variable for development.

2. 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 work of Vickerman (1995), Button (1995), Forslund and Johansson (1995) and Gutiérrez and Urbano (1996) and, more recently, of Lopez and Gutierrez (2008) related to important new European transport infrastructures and consolidating the concept of «potential accessibility». However, the calculation of accessibility is not enough to measure the way it acts as a development factor. Antonio Páez makes some important advances by using the same type of accessibility indicators as variables in a spatial regression analysis framework (Páez, 2004), supported by the spatial econometrics work of Anselin (1988). Besides Paez, the work of Anselin has inspired great number of contributions since the beginning of the millennium, e.g. Mur (2009). The same methodology is now used in recent Portuguese work (Ribeiro, 2009). The number of kilometers 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). Overall, cross-border areas have become increasingly important in the context of European integration, particularly since the recent enlargement. Usually, but not always, peripheral to the main city centers within their country's spatial structure, these regions suffer from chronic development problems (many of them related to centuries of history and changing boundaries). Among other similar programs, the European Commission approved recently (2007) a European program for cross-border cooperation between Spain and Portugal for the period 2007-2013 (*http://www.poctep.eu*). The efforts are now concentrating on improving connectivity and basic infrastructures in the border areas in a new approach aimed at improving competitiveness, promoting employment and enhancing socio-economic and institutional integration in the border regions. Therefore, it is fundamental to analyze how the existing transport infrastructures can do better to meet those objectives. 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, several articles have examined the same type of issues. For example, 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 analyze 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.

This paper initiates a process of spatial regression analysis, starting to build up a model to be applied to the entire Portugal/Spain cross-border region that is able to quantify this impact. In fact, the spatial nature of this impact suggests that the use of regression techniques can include the space factor, which is particularly important in the analysis of cross-border territories. Nevertheless these techniques will be fully applied only in further developments of this paper. For now, we hope that this research approach will contribute quite significantly to the scientific information available about the important connection between transport infrastructure and development in cross-border regions. As currently underlined by the European Commission these regions' development represents a strategic factor for the future strengthening of European cohesion, since multi-spatial cooperation is now one of the three main European Union objectives.

3. Study area, data and methodology

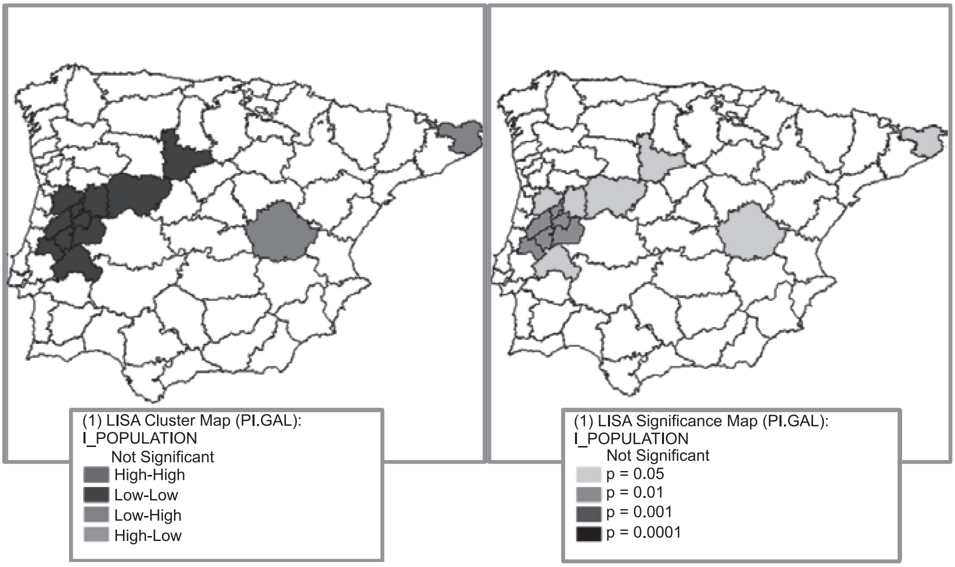
This study is developed in two phases. One at the level of NUT III (including all the Iberian Peninsula) and other at the level of municipalities. The first one, while using Iberian Peninsula NUTIII is developed in order to give focus to the cross border region under appreciation. The second one, at the municipality level for a restrict cross border area is developed in order to give some insight on spatial correlations for this area.

3.1. Iberian Peninsula Autocorrelation Study for NUT III level

Bellow there is a simple spatial autocorrelation analysis for all the Iberian Peninsula (that includes both countries, Portugal and Spain) using NUT III (bigger than the municipalities).

In Figure 1 it is possible to observe the results for population in 2001. Note that the significance map indicates the level of significance of the areas identified either as «clusters» («high-high», «low-low») or «outliers» («high-low», «low-high») (16). The NUT III identified within the group «low-low» (in dark blue), are all contiguous and locate in both sides of the border. From the Portuguese side 9 NUT III are included, and from Spanish side 2 NUT III are included. This is an area where, in the Iberian Peninsula context, it is quite significant (statistically) the low population values and correlated with population values in the neighbors. This autocorrelation occurs precisely where our cross-border region is located.

Figure 1. Lisa cluster and significance maps for population in 2001 in the Iberian Peninsula

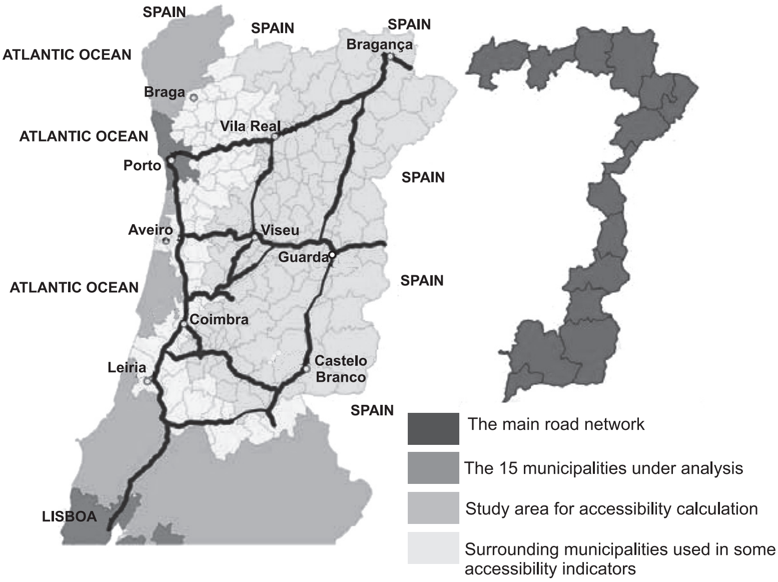


3.2. Cross Border Analysis for 9 NUT III at the municipality level

At this stage a group of 15 Portuguese cross-border municipalities was selected (Figure 2) for the evaluation of the above relationship, considering these municipalities' accessibility connections within the Portuguese territory, using a classical regression analysis. In future stages we will include data from both sides of the border, always taking the municipality as the unit.

Two sets of variables are needed for the regression: those that could reflect development and those that could induce development. The variables that could reflect spatial development are socio-economic (e.g. population variation, if taken as a good proxy for product data, since there is no reliable information on product at municipality level). The variables that could induce development (or not) include population literacy (School Background) and/or accessibility levels (Accessibility); the later one potentially inducing development and closer to transport infrastructure investment. In a previous study (with 86 Portuguese municipalities including the 15 now under analysis), a set of control variables were choose such as unemployment, population

Figure 2. The set of 15 municipalities under study within Portugal mainland



evolution in the previous decade. Only some prove to be the significant. Therefore only some variables were tested in the present study. Variables like population variation and population literacy will be collected from current Census data and/or correlated databases (of particular interest is the Census Data Collection expected within Portuguese territory for 2011, which means an excellent opportunity to enhance the accuracy of our results). The accessibility variables (potential accessibility) are calculated using population and time/distance (calculated from digitalized transport networks). So potential accessibility of a municipality is the total activity (population, product, etc.) reachable within a certain time/distance from that municipality to the others that are part of a certain study area. These transport networks are those appropriate to serve the spatial structure formed by the spatial units selected.

All measures of accessibility used time-distance in minutes. In the case of the variable Acessibility Pt 1991-2001, firstly we calculate the values using the expression $Ai = \sum j\ (Pj/tij\ 0{,}5)$ and data for 1991 [*Ai* (1991)] and 2001 [*Ai* (2001)]. In the expression, 0,5 is the impedance factor, a value adapted from other traffic studies in Portugal and for similar areas. Then we calculate the «variation of potential accessibility from 1991 to 2001» for each municipality. The network used was the road and the mode was the car. The influence of congestion on travel time was not considered because we are dealing with interregional accessibility and therefore congestion is not an issue (particularly in those deprived, ultra peripheral areas). The travel times are calculated upon a digitalized network (on a GIS framework) that was built in detail for this specific work area in order to have accessibility variables that indentify local differences. Then we repeated the process but adding information on access connections with Spain for those 15 municipalities. For this a new variable was included to add a specific classification to each of the 15 municipalities, according to the number and type of its connections with the Spanish side of the border. Table 1 describes the number and type of all those connections. It also shows a classification we imposed on each type of connection, i.e., from Motorway ($T = 7$) —on the left, to Railway ($T = 1$)— on the right. Although a railway is not a road access it still exists and adds real connection between both opposite sides of the border. For road infrastructures the authors used the Michelin Maps Ranking, 2010 Edition; for the railway they choose the lowest priority because, based on official statistics, quite there is no local/regional use of this infrastructure, either for passengers or goods purposes.

Table 1. Number and type of cross-border connections of each municipality

Units (from North to South)	*Motorways (T = 7)*	*Internat. Road (T = 6)*	*Interreg. Road (T = 5)*	*Surfaced Road (T = 4)*	*Unsurfaced Road (T = 3)*	*Road Subject to Restriction (T = 2)*	*Railway (T = 1)*
Montalegre	–	–	–	3	–	–	–
Chaves	–	1	–	–	–	–	–
Vinhais	–	–	–	1	–	–	–
Bragança	–	1	1	1	–	–	–
Vimioso	–	–	–	1	–	–	–
Miranda do Douro	–	–	1	2	1	–	–
Mogadouro	–	–	1	–	–	–	–
Freixo de Espada à Cinta	–	–	–	1	–	–	–
Figueira de Castelo Rodrigo	–	–	1	–	–	–	–
Almeida	1	–	–	1	–	–	1
Sabugal	–	–	–	–	–	–	–
Penamacor	–	–	1	–	–	–	–
Idanha-a-Nova	–	–	1	2	–	–	–
Castelo Branco	–	–	–	–	–	–	–
Vila Velha de Rodão	–	–	–	–	–	1	–

Using all these data a new variable might then be built, arranging the municipalities in order of their importance in terms of the number and type of cross-border connections with Spain, as in Equation 1:

*Connection 2010i = (n.º of Motorwaysi * 7) + (n.º of International Roadsi * 6) + (n.º of Interregional Roadsi * 5) + (n.º of Surfaced Roadsi * 4) + (n.º of UnSurfaced Roadsi * 3) + (n.º of Roads Subject to Restrictionsi * 2) + (n.º of Railwaysi * 1)* (1)

This variable, called Connection 2010, led to the following classification (Table 2):

Table 2. Municipalities in *Connection 2010* order

Municipalities	*Connection 2010 (classification)*
Sabugal	0
Castelo Branco	0
Vila Velha de Rodão	2
Vinhais	4
Vimioso	4
Freixo de Espada à Cinta	4
Mogadouro	5
Figueira de Castelo Rodrigo	5
Penamacor	5
Chaves	6
Montalegre	12
Almeida	12
Idanha-a-Nova	13
Bragança	15
Miranda do Douro	16

This variable represents «actual» connections and a special note must be made on that. How can we compare present connections with population evolution between 1991 and 2010? The answer relies on the fact that all the new connections are part of a National Road Plan known since 1985 and therefore able to produce changes associated with the expectations of the local development it generates. In a final analysis for this stage, we developed the same type of analysis but considering socio economic data from the other side of the border. Within that purpose, Spanish population growth was considered for the same period (1991-2001), and for the geographical areas in the border with the 15 Portuguese municipalities. In this point we needed to develop a previous geographical analysis aggregating Spanish municipality's data into artificial geographical areas (that can be compared in size with the Portuguese ones, because Spanish municipalities are generally much smaller). Besides the variable Connection 2010 (which is naturally the same for the two sides of the border), we do not had at this stage information about population literacy or detailed accessibility variables for Spain, to develop the exact same type of regression for the Spanish side. Therefore, a simple accessibility variable (time distance to the national capital - DistCap) was calculated for both sides of the border, which could be used as a control variable in the Spanish regressions (this variable is taken as «actual» accessibility, in 2010, because it is assumed that the new roads were built during the decade 1991-2001, therefore inducing development during this period).

There will be one more stage in the near future, as mentioned earlier: to extend this work to all municipalities located in both sides along the entire Portugal/Spain border, adding new variables.

4. Analisys

Within the framework of regression analysis and using all data selected for the Portuguese cross-border municipalities under analysis, the modeled relations (between the variables that reflect development and the ones with the potential to induce development) will hopefully add scientific weight to knowledge on significant spatial development tendencies for the region. Accessibility variables enter in the regression as independent ones, therefore as variables potentially able to induce development. The program used was the GeoDa which assumes that firstly we run an OLS regression and secondly, if spatial autocorrelation is present on residuals, we run a SLM (Spatial Lag Model) or a SEM (Spatial Error Model), both using a Maximum Likelihood Estimation. In this paper, because of the above explanation about the lack of data and the particularities of the geographical units, only the OLS was run. This OLS model results include a Lagrange test for spatial autocorrelation on the residuals. Nevertheless these results must be taken with special care since a set of 15 municipalities is not enough to produce sufficiently robust results. Therefore, and once the complete data base is built (gathering data from Portugal and from Spain) new and more significant analysis will be taken.

So, as previously mentioned, next points refer: *a)* to the use of Portuguese socio-economic and accessibility data, *b)* to the inclusion of variable Connection 2010 in the previous analysis, and *c)* to the use of some available Spanish socio-economic and accessibility data, keeping *Connection 2010* as a common variable. In this later analysis, the Spanish regression was also compared with the Portuguese identical regression, i.e.:

Assuming a relationship in which nothing exists beyond the border:

Population Pt 1991-2001 = f (Acessibility Pt 1991-2001; School Background Pt 1991) (2)

Where: Population Pt 1991-2001 and Acessibility Pt 1991-2001 respectively represent population variation and potential accessibility variation between 1991 and 2001; and the School Background Pt 1991 represents the highest education level achieved by the population in 1991 (proportion of population with an University level/degree).

The following results were obtained (Table 3).

Table 3 shows that when high education level increase 1%, population increases too by around 6.02%; but when potential accessibility level increases 1%, the population decreases 0.18%. Which means that besides the fact that all variables are significant, population with higher education in 1991 seems to have more impact on population increase than variations in potential accessibility between 1991 and 2001. Of course a figure of 0.18% is too low, but even so it has a negative sign which it is

Table 3. Relationship in which *nothing* exists beyond the border

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Probability*
CONSTANT	–22.4829	2.0010	–11.2350	0.0000
School Background Pt 1991	6.0230	0.8488	7.0970	0.0001
Acessibility Pt 1991-2001	–0.1790	0.0838	–2.1357	0.0540

$R^2 = 0.81$.

not a good prognosis for this group of municipalities. In addition, taking into account its socio-economic characteristics, this result was expected: if the territory does not have enough infrastructures to ensure welfare the population will try to leave the territory as soon as appears accessibility increases and/or improves.

While testing for spatial autocorrelation, it was possible to find out that there is some evidence on autocorrelation on the residuals, indicating that a spatial error model should be estimated (Table 4).

Table 4. Relationship in which *nothing* exists beyond the border - Spatial Analysis

Test	*Value*	*Probability*
Moran's I (error)	–2.0700	0.0380
Lagrange Multiplier (lag)	1.0540	0.3045
Robust LM (lag)	0.0145	0.6990
Lagrange Multiplier (error)	4.4520	0.0349
Robust LM (error)	3.5470	0.0597
Lagrange Multiplier (SARMA)	4.6010	0.1002

Adding data concerning the above mentioned cross-border connections:

Population Pt 1991-2001 = f (Acessibility Pt 1991-2001; School Background Pt 1991; Connection Pt Sp 2010) (3)

Where: the new variable Connection PtS p 2010, represents the importance of cross-border connections with Spain, in 2010, as mentioned in Table 2.

The following results were obtained (Table 5):

Table 5. Relationship including cross-border connections

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Probability*
CONSTANT	–21.2265	2.2248	–9.5409	0.0000
School Background Pt 1991	6.3370	0.8731	7.2584	0.0000
Acessibility Pt 1991-2001	–0.2083	0.0858	–2.4270	0.0336
Connection Pt Sp 2010	–0.2518	0.2092	–1.2037	0.2540

$R^2 = 0.84$.

The results from Table 5 are similar to the previous case. But, besides the fact that the new variable (Connection 2010) is not significant, we may add to the general conclusion that when the cross-border connections are improved by 1%, the population decreases 0.25%. Anyway, we can again see that enhanced accessibility within the Portuguese territory and more cross-border connections will combine to contribute to a decrease of population. Again, it was possible to find some evidence on the existence of autocorrelation in the residuals (Table 6):

Table 6. Relationship including cross-border connections - Spatial Analysis

Test	*Value*	*Probability*
Moran's I (error)	–2.3730	0.0176
Lagrange Multiplier (lag)	0.5876	0.4433
Robust LM (lag)	0.5826	0.4453
Lagrange Multiplier (error)	5.3230	0.0210
Robust LM (error)	5.3180	0.0211
Lagrange Multiplier (SARMA)	5.9056	0.0522

Adding data concerning Spanish population and accessibility to the capital:

Population Sp 1991-2001 = f (Dist Cap Sp 2010; Connection Pt Sp 2010) (4)

Where: the new variable Dist Cap Sp 2010, represents the time distance to the Spanish Capital, Madrid, in 2010.

The following results were obtained (Table 7):

Table 7. Relationship including Spanish population growth, accessibility to the Spanish capital and cross-border connections

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Probability*
CONSTANT	0.0429	0.1568	0.2734	0.7892
Dist Cap Sp 2010	–0.0008	0.0006	–1.1855	0.2588
Connection Pt Sp 2010	–0.0001	0.0033	–0.0293	0.9771

$R^2 = 0.12$

From this analysis we can conclude that neither of the variables used as independent is significant. Accounting for the fact that they are both accessibility related variables, this means that population growth in the Spanish side is both independent from the existence of connections with Portugal and from the distance to the national capital, Madrid.

Again, it was possible to find some evidence on the existence of autocorrelation in the residuals but without robustness (Table 8):

Table 8. Relationship including Spanish population growth, accessibility to the Spanish capital and cross-border connections - Spatial Analysis

Test	*Value*	*Probability*
Moran's I (error)	–1.6957	0.0899
Lagrange Multiplier (lag)	3.6177	0.0572
Robust LM (lag)	0.3212	0.5709
Lagrange Multiplier (error)	3.3087	0.0689
Robust LM (error)	0.0121	0.9123
Lagrange Multiplier (SARMA)	3.6298	0.1629

In order to further confirm this result, the analysis was repeated but for Portuguese data:

Population Pt 1991-2001 = f (Dist Cap Pt 2010; Connection Pt Sp 2010) (5)

Where: the new variable Dist Cap Pt 2010, represents the time distance to the Portuguese Capital, Lisbon, in 2010.

So the following results were obtained (Table 9):

Table 9. Relationship including Portuguese population growth, accessibility to the Portuguese capital and cross-border connections

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Probability*
CONSTANT	–12.0262	9.9643	–1.2069	0.2507
Dist Cap Pt 2010	0.0024	0.0365	0.0655	0.9488
Connection Pt Sp 2010	0.1415	0.4934	0.2946	0.7733

$R^2 = 0.009953$.

As in the previous analysis, population growth in the Portuguese side is both independent from the existence of connections with Portugal and from the distance to the national capital, Lisbon. These results are in line with previous ones. In fact Connection 2010 never was significant, potential Accessibility was significant but with a inverse relation (the bigger the accessibility the smaller the population growth), and the only determinant variable in Population growth was the School Background of resident population.

Again, it was possible to find some evidence on the existence of autocorrelation in the residuals but without robustness (Table 10).

Further analyses should investigate deeply these conclusions, measuring more precisely the «perverse» accessibility effect for cross border regions. For these future analyses, a more accurate definition of comparable geographical areas in both sides of the border is desirable, a work absolutely needed for investigation and for cross-border cooperation projects. This is the first and main objective of further steps.

Table 10. Relationship including Portuguese population growth, accessibility to the Portuguese capital and cross-border connections - Spatial Analysis

Test	*Value*	*Probability*
Moran's I (error)	–1.9743	0.0483
Lagrange Multiplier (lag)	5.1258	0.0236
Robust LM (lag)	1.3724	0.2414
Lagrange Multiplier (error)	5.3035	0.0213
Robust LM (error)	1.5502	0.2131
Lagrange Multiplier (SARMA)	6.6760	0.0355

5. Conclusions

This work's main objective is to build a model able to measure the relation between accessibility and development for all the municipalities in the Portugal/Spain cross-border area. This scientific opportunity results from the observation of huge road infrastructure investment, often indicated as being little in line with the local development needs in peripheral regions that are currently facing sharp population decline and weak business dynamics.

At the same time, and since this subject is of so much importance, it is surprising that very few studies have focused on quantitatively measuring the complex relationship between accessibility and development.

This study has selected the particular case of cross-border regions, since these are usually the most depressed areas in both countries. It will be developed in four main stages and this paper deals with the first two. First a group of 15 cross-border municipalities was selected (developing a study on autocorrelation with the identification of autocorrelation behaviors for some variables within the Iberian Peninsula at the NUT III level). Through a classical regression the above relationship was evaluated, considering only these municipalities' access connections within Portugal. Then the process was repeated but adding information concerning access connections with Spain for those 15 municipalities.

In the third stage we intend to add data from the Spanish municipalities directly connected to the other side of the border, next to the Portuguese municipalities. In a fourth stage this work will be extended to all municipalities on both sides of the entire Portugal/Spain border.

For neither of the countries, neither of the accessibility variables seemed to have influence or be related with population evolution. Since these network modifications occurred in the last 20 years it would be expected that population evolution (somehow reflecting more accessible and attractive territory) would have grow. But this relation does not seem to be relevant.

So far, the results suggest that increased accessibility within the countries and good connections with Portugal/Spain, respectively, are less relevant for local development than school background, or are insignificant. Moreover, an increase in national potential accessibility or in connection seems to have a negative influence on population increase.

These results show that locally, and particularly for cross-border municipalities, accessibility seems to be an irrelevant factor in development. The fourth stage of this analysis (see above) will help to consolidate the conclusions that have been drawn in this paper as the launching pad for this important analysis.

The spatial trend under these processes will also be further analyzed using a complete Spatial Regression process and identifying the local differences in the relation between accessibility and development.

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