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The North of Portugal and Galicia: Evidence of Agglomeration of Economic Activity[1]

O Norte de Portugal e a Galiza: Evidências de Aglomeração da Atividade Económica

Vítor João Pereira Domingues Martinho
vdmartinho@esav.ipv.pt
Agricultural School (ESAV), CERNAS-IPV Research Centre, Polytechnic Institute of Viseu (IPV), Portugal

Jesyca Salgado Barandela
j.salgado@uvigo.es
Facultad de Ciencias Empresariales y Turismo, Universidad de Vigo, España

Abstract/ Resumo

The North of Portugal and Galicia are two neighbouring regions, from different countries, with a high potential for cooperation and the creation of common synergies across their several business sectors. From this framework, it is essential to further explore the main business clusters which operate in these two neighbouring regions having a different strategic and institutional base. Considering these motivations, the main objective of this study is to identify the main socioeconomic activities that operate in these two regions and to explore the spatial interrelationships between them. For this purpose, statistical information from the official institution for Statistics of Portugal and the *Instituto Galego de Estatística*, were both considered and disaggregated at municipal level, for the number of companies that operate in each municipality of these regions. These data were previously exploited through descriptive analysis and later with spatial autocorrelation approaches. This statistical information was, also, analysed through the models related with agglomeration processes from the New Economic Geography. The results which were obtained highlight the importance of the services for these two regions,

O norte de Portugal e a Galiza são duas regiões próximas, de diferentes países, com alto potencial de cooperação e criação de sinergias comuns entre os diversos setores empresariais. Nesse contexto, é essencial explorar mais profundamente os principais grupos de negócio que operam nessas duas regiões vizinhas com uma base estratégica e institucional diferente. Considerando essas motivações, o principal objetivo deste trabalho é identificar as principais atividades socioeconómicas que operam nessas duas regiões e explorar as inter-relações espaciais entre elas. Para isso, foram considerados dados estatísticos do Instituto Português de Estatística (INE) e do Instituto Galego de Estatística, desagregados a nível municipal, para o número de empresas que atuam em cada município destas regiões. Estes dados foram explorados, primeiro, através de análise descritiva e depois com abordagens de autocorrelação espacial. Esta informação estatística foi ainda analisada através de modelos econométricos relacionados com os processos de aglomeração da Nova Geografia Económica. Os resultados obtidos destacam a importância dos serviços para estas duas regiões, mas, também, para da indústria, onde a coopera-

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but also, the industry, where the cooperation may be increased and improved, by taking advantages from spatial autocorrelation synergies.

Keywords: Number of companies; Cross-section data; Spatial autocorrelation approaches.

JEL Codes: R10; R12

ção pode ser aumentada e melhorada, aproveitando as sinergias de autocorrelação espacial.

Palavras-Chave: Número de empresas; Dados cross-section; Abordagens de autocorrelação espacial.

Códigos JEL: R10; R12

1. INTRODUCTION

This research aims to provide an additional contribution for the understanding of the contexts in the Euroregion Galicia-North of Portugal, namely in terms of economic dynamics. These new insights could be an interesting basis for policy design and a more effective implementation, specifically in the framework of current strategy instruments, such as the Interreg programmes.

There are, indeed, several affinities between the North of Portugal and Galicia (Briones et al., 1994), historic proximity (Brito, 2011) and relationships (Gonzalez et al., 2003), where the geographic interactions are real (Carvalho et al., 2010) at several levels, including environmental (Castro & Pires, 2019), which create a favourable framework for cooperation among these two Portuguese and Spanish regions. On the other hand, there are problems in these two regions having a similar pattern over the last decades (Doldán & Villasante, 2015), that call for similar approaches (Calvino-Cancela et al., 2017). It would appear that, the concentration of economic activities and the population in high poles is real in Galicia (López & Santos, 2007) and in the North of Portugal, where the littoral seems to have obtained comparative advantages (López-Rodríguez & Manso-Fernandez, 2018). These scenarios promote the regional disparities (Vieites et al., 2003), sometimes, through self-reinforced processes.

In the Portuguese context, manufacturing seems to be one of the economic sectors showing relevant evidence of concentration (Mira, 2008). There are, also relevant signs of autocorrelation in the Portuguese sectors (Monteiro & Viegas, 2014). In Galicia, the economic dynamism of municipalities such as A Coruña, Ourense, Vigo, Lugo and, Santiago de Compostela is, indeed, relevant (Patiño et al., 2000). The economic concentration in Galicia is sizeable, for example, in industries related to the automobile, transport, chemical and, electronics sectors (Villar et al., 2006). In the regional developmental dynamics, transport and communication costs have made a crucial contribution (Costa et al., 2014).

The potentialities of working together are real in, amongst others, the environmental fields (Azevedo et al., 2015), the wine sector (Cardoso et al., 2019), grapevine cultivation (Santiago et al., 2007), climate dimensions (Carvalho et al., 2016), history (Comesana Paz, 2017), culture (Conde, 2017), health (Fernandez-Garcia et al., 2016), veterinary and animal fields (Pautasso et al., 2019), genetic domains (Pereira-Lorenzo et al., 2018) and agriculture (Rodriguez et al., 2005).

In turn, the common endogenous resources and the similarities in the landscape (De Una-Alvarez, Angel Alvarez-Vazquez, et al., 2017) favour a natural cooperation between the populations of these two regions that may be exploited further with strategic plans and adjusted policies, as, in fact, already exist, but they require continuous assessment and adjustment. The several policies concerning regional impact play a relevant role for a balanced and sustainable regional development (Medín et al., 2007), including those from the Common Agricultural Policy (CAP) framework (Adán & Justo, 2008), as well as, several stakeholders and related institutions (Facal, 2000).

These aspects hold particular importance in zones where there are economic and demographic problems due to the decline of traditional economic activities, like agriculture (De Una-Alvarez, Villarino-Perez, et al., 2017), and where standardized plans are needed which are geared toward a more sustainable development. For instance, in 2017, the North of Portugal in a total of 418,082 companies, had 53,827 companies in agriculture, forestry and fishing, 35,148 in industry (including energy and water

distribution), 28,150 in the building sector and 300,957 in several other services (INE, 2019). The context in Galicia is not so different from Portugal's. Nonetheless, there are differences between these two regions, that claim for adjusted approaches, as there are between the European Union regions (del Campo et al., 2008), including those inside de Galicia region (Ocampo et al., 2013) and the North of Portugal.

Tourism is a relevant economic sector in Portugal and Spain, and an interesting example where the potentialities of cooperation are enormous (Sanchez-Fernandez et al., 2016). The traditional and new activities related to the tourism sector may bring about significant outputs for the economic performance of these two countries, in general, and for the North of Portugal and Galicia, in particular. There are, already, interesting examples of joint cooperation (Lisboa Sohn et al., 2016) which may be explored in greater depth and may be considered as benchmarks for other initiatives (de Blas & Fabeiro, 2012). Industry is another important sector for the sustainable development of both regions and where the potentialities of cooperation are, also, great (García-Arca et al., 2011).

Nonetheless, for effective cooperation, it is important to increase leadership, promote organizational capacity, reduce bureaucracy, and create more involvement from local communities and stakeholders (Lange, 2018). Of course, entrepreneurship and innovation, as well as the creation of a favourable environment is determinant (Vazquez-Rozas et al., 2012). In this interregional cooperation, the environmental impact from these socioeconomic activities should be a concern (Pérez-Lijó, 2019), as well as, the promotion of sustainable developments (Pita et al., 2018).

In this context, the main objective of this study is to identify the main clusters that operate in the North of Portugal and Galicia, their dynamics, and the potentialities of cooperation between these socioeconomic activities. We have considered data from Statistics of Portugal (INE, 2020) and Instituto Galego de Estatística (IGE, 2020) to obtain the number of companies that operate in the municipalities of these two Portuguese and Spanish regions. This statistical information was worked through descriptive analysis with the QGIS.org (2020) software and methodologies of spatial autocorrelation research with the GeoDa (2020) software and following, for instance, Anselin et al. (2006). These data were also explored through matrices of correlation and agglomeration approaches, considering Stata (2020), StataCorp. (2017a) and StataCorp. (2017b) procedures. The shapefiles used in QGIS and GeoDa were obtained in the dados.gov (2020) for the Portuguese context and in the Xunta de Galicia (2020) for the Spanish framework.

There are not many studies covering these fields for the Iberian municipalities, further proving the relevant contribution of the study being carried out, here. Furthermore, the North of Portugal and Galicia show great potential for cooperation and the creation of synergies. In this way, a study of this type provides relevant findings which allow for the identification of the pattern of industrial and socioeconomic development, and therefore giving more precise information in order to design the strategic plans for the EU region Galicia- North of Portugal.

This study will be structured into six more sections, for, data analysis, cluster analysis, local spatial autocorrelation, correlations between the number of companies from the several sectors, results for an agglomeration model and main conclusions, respectively.

2. DATA ANALYSIS

This section analyses the data for the number of companies that operate in the North of Portugal and Galicia, for the several socioeconomic sectors. These two Iberian regions are analysed separately, to capture the different dynamics and to assess the border effect in these dimensions. In turn, as the data were obtained from different databases, it is difficult to put them together. These difficulties appear, again, when an attempt is made to find a spatial unit to perform the research separately for the two regions, but in a comparable way. In this case, the municipal level was chosen, for this Euroregion, following, for instance, Martínez-Rolán, et al. (2016). The data were exploited through descriptive analysis with the QGIS software. As referred to before, the statistical information was obtained from the Statistics of Portugal (official statistical institution) and the *Instituto Galego de Estatística*.

2.1 Portuguese context

The total number of companies (for all sectors) that operate in the North of Portugal is higher in the municipalities around Porto and

Braga (figure 1), showing signs of agglomeration around these two municipalities. There are also relevant signs of a high number of companies in Vila Real and Bragança (two essential municipalities in the interior zones or the North of Portugal). These findings present that, if the North of Portugal is divided into the littoral and the interior, there are two poles of economic growth in each one of these two parts of this Portuguese region. However, the agglomeration process in the littoral is stronger than that verified for the interior of the North of Portugal. In any case, it will be interesting to design regional policies to promote economic dynamics around the municipalities of Vila Real and Bragança.

Figure 1. Total number of companies in the Northern Portuguese municipalities, in averages over the period 2014-2017

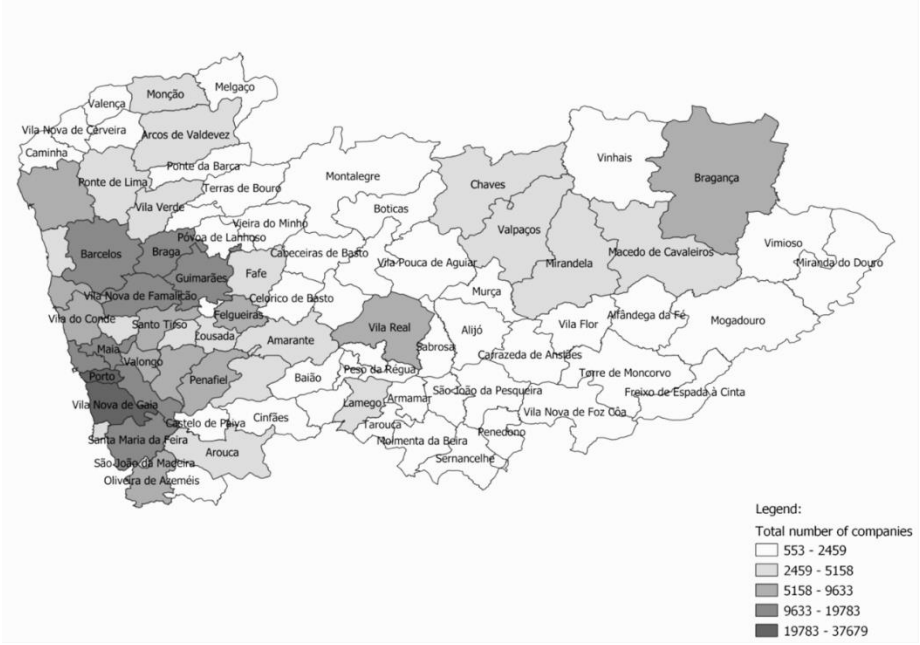
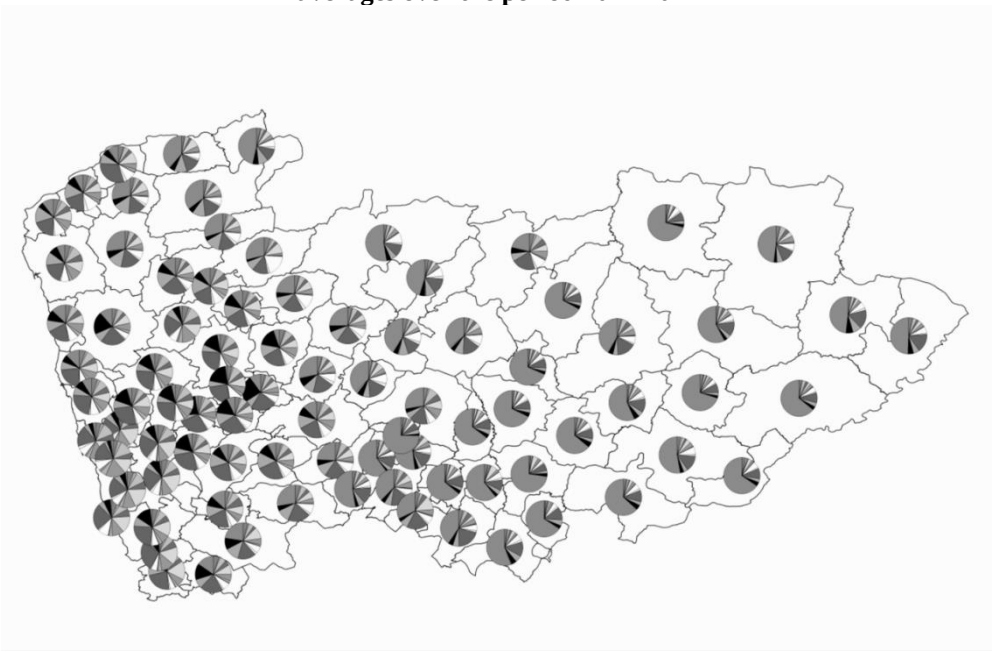


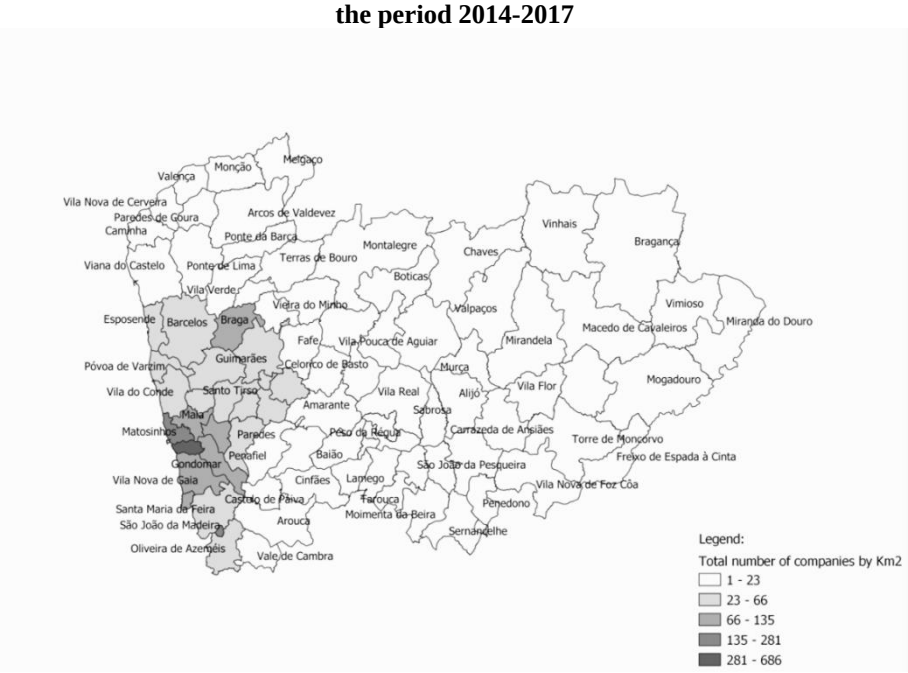
Figure 2. Proportion of the number of companies, by sector, in the Northern Portuguese municipalities, in averages over the period 2014-2017



"Agriculture, animal production, hunting, forestry, and fishing" are the sectors with more companies operating in several municipalities of the interior north of Portugal, as well as, there being signs of interesting dynamics, for example, for "Wholesale and retail trade, repair of motor vehicles and motorcycles", "Accommodation, catering and similar", "Construction" and "Manufacturing industries" (figure 2). In the coastal municipalities (around Porto and Braga, for instance), the context is different, the agricultural sector has less relative importance and gains relevance for sectors such as manufacturing, construction, and services. It is worth highlighting, for example, the relevant number of companies, for the sector "Accommodation, catering and similar", that develop their activities in municipalities such as Terras de Bouro or Vieira do Minho.

An analysis of the level of agglomeration of companies (figure 3) shows that Porto, Matosinhos, and São João da Madeira are the municipalities with a higher number of enterprises by Km2, as well as, the neighbouring municipalities (stressing the case of Braga).

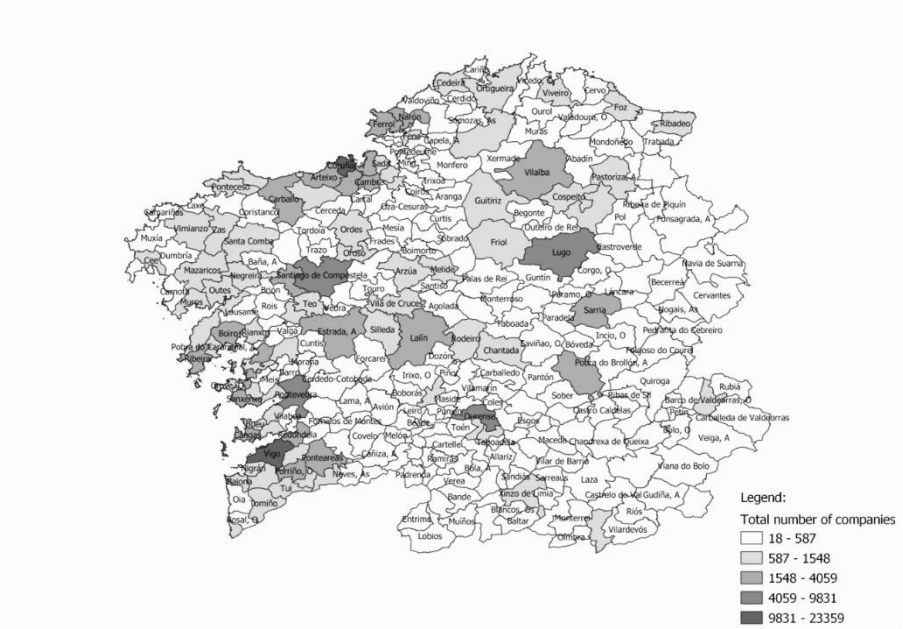
Figure 3. Total number of companies by Km2 in the Northern Portuguese municipalities, on average over the period 2014-2017



2.2. Spanish framework

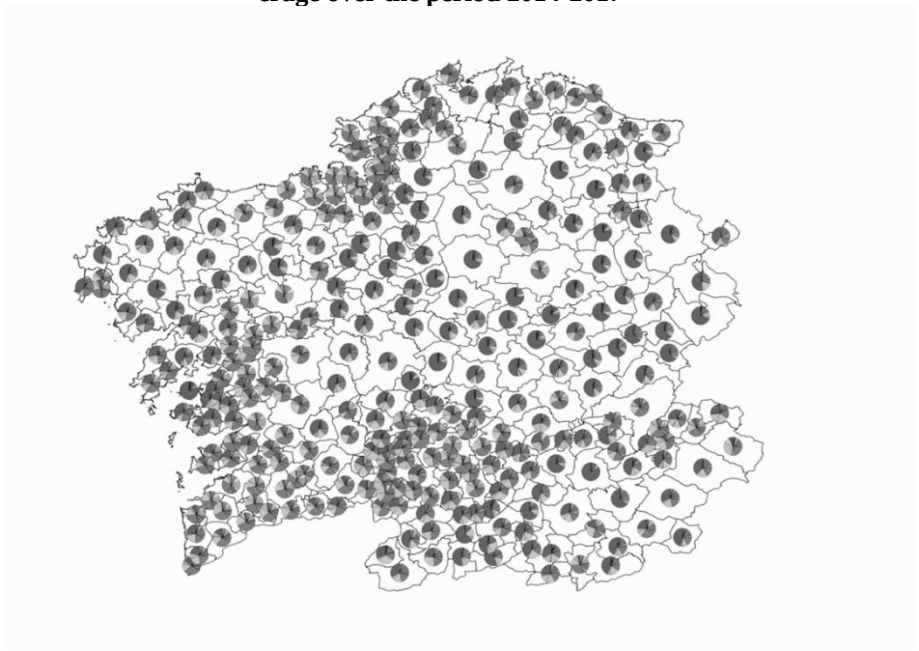
The greater number of companies in Galicia is verified in municipalities such as A Coruña, Santiago de Compostela, Lugo, Pontevedra, Vigo, and Ourense, as well as, in the neighbouring municipalities (figure 4). In the Galician context, the poles of development (poles with more socioeconomic dynamics) seem more dispersed over the entire region. In any case, the interior and the south of this region have lack of economic activity.

Figure 4. Total number of companies in the Galician municipalities, on average over the period 2014-2017



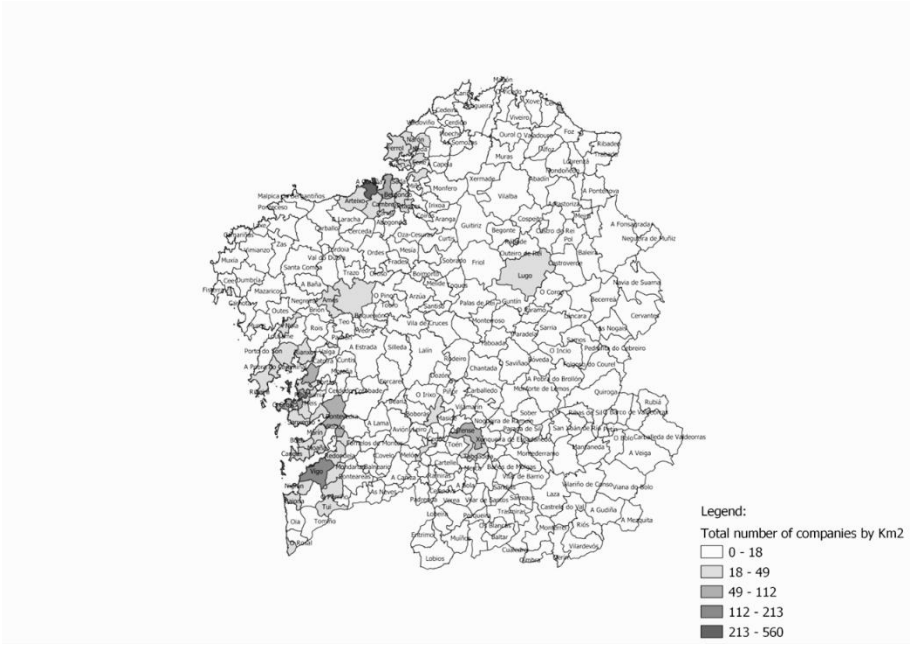
"Agriculture, animal production, hunting, forestry, and fishing" are the sectors with more companies for North of Portugal municipalities with less socioeconomic dynamics (a smaller number of companies), and the same happens in the Galician municipalities, with a similar framework (figure 5). There are also, relevant signs for the number of companies in the following sectors: "Wholesale and retail trade, repair of motor vehicles and motorcycles", "Accommodation, catering and similar", "Construction" and "Manufacturing industries". In the A Coruña-Santiago de Compostela-Pontevedra-Vigo corridor, having more socioeconomic activity, the context is different and the services, construction, and some manufacturing industries gain importance. It is pertinent to stress the relative importance of the manufacturing industries in the Orense-O Barco de Valdeorras corridor.

Figure 5. Proportion of the number of companies, by sector, within the Galician municipalities, on average over the period 2014-2017



The level of companies' agglomeration, in Galicia, is more significant in A Coruña and Vigo, but there is also evidence of this in the neighbouring municipalities, Lugo, Ourense, Santiago de Compostela, and Pontevedra (figure 6).

Figure 6. Total number of companies by Km2 in the Galician municipalities, on average over the period 2014-2017

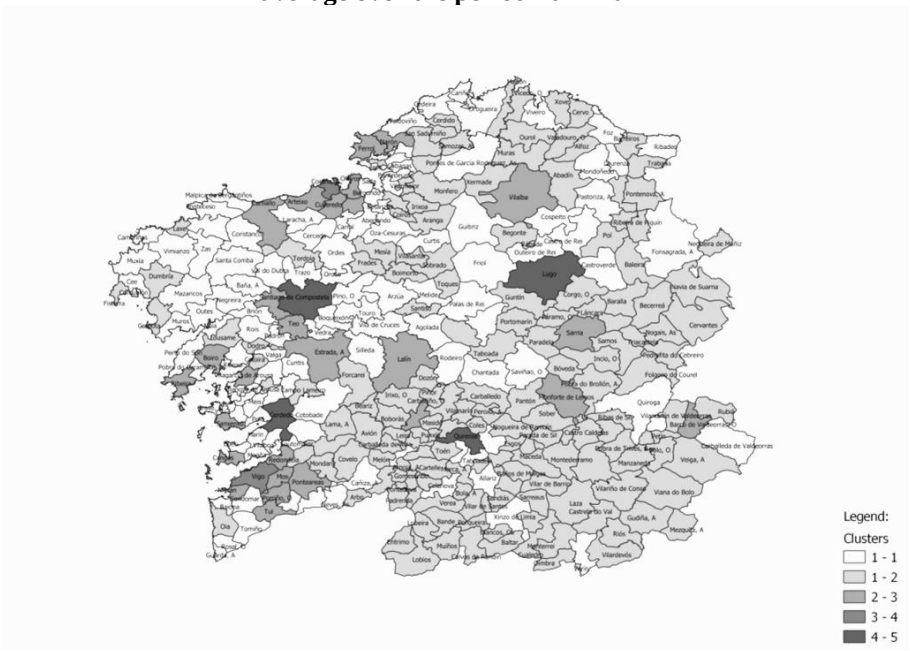


3. FACTOR AND CLUSTER ANALYSIS

For a better understanding of the cluster dynamics in the North of Portugal and Galician contexts, in this section, factor (to obtain factors without problems of collinearity) and cluster (considering the factors obtained with the factor analysis) analyses were performed, following the procedures of Torres-Reyna (n.d.). The number of companies was considered for each individual sector (from agriculture to other services) and principal component factor approaches for the factor analysis. Specifically the principal component factors method was performed first and then rotation through orthogonal varimax (Kaiser off). The factors obtained were predicted and used for the cluster analysis. For the cluster analysis, Ward´s linkage clustering and continuous Euclidean approach, complemented with dendrogram assessment, were considered. Following these approaches, we obtained 3 clusters for the North of Portugal and 5 clusters for Galicia with Stata software procedures (figures 7 and 8).

Figure 7. Clusters over the Northern Portuguese municipalities, considering the number of companies by sector, on average over the period 2014-2017

Figure 8. Clusters over the Galician municipalities, considering the number of companies by sector, on average over the period 2014-2017



Again, the results show that in the North of Portugal, the municipalities which possess more socioeconomic dynamics are those concentrated around Porto and Braga. In a different pattern, the Galician municipalities with a greater number of companies are more dispersed, creating poles of development around A Coruña, Santiago de Compostela, Lugo, Pontevedra, Vigo and Ourense. It is important to note, the cluster of companies for the Vigo-Ourense-O Barco de Valdeorras-Lugo corridor.

4. SPATIAL AUTOCORRELATION RESEARCH

Considering some of the more dynamic sectors, figures 9 and 10, for the Portuguese and Spanish contexts, respectively, present the results for the local spatial autocorrelation analysis (considering a first order matrix of

contiguity), performed with the GeoDa software and following, for example, Anselin et al. (2006). In these figures, the clusters high-high are for the municipalities with positive spatial autocorrelation for the higher values of the variables considered (in this case, the number of companies) and the clusters low-low are for the municipalities with positive spatial autocorrelation for the lower values. The clusters high-low and low-high are for the negative spatial autocorrelation. Positive spatial autocorrelation means that the values of one municipality are positively correlated with the values (of the same variable) of the neighbouring municipalities. The inverse is for the negative spatial autocorrelation (Anselin et al., 2006; GeoDa, 2020).

Figure 9. Local spatial autocorrelation analysis for the Northern Portuguese municipalities, considering the number of companies by sector, on average over the period 2014-2017

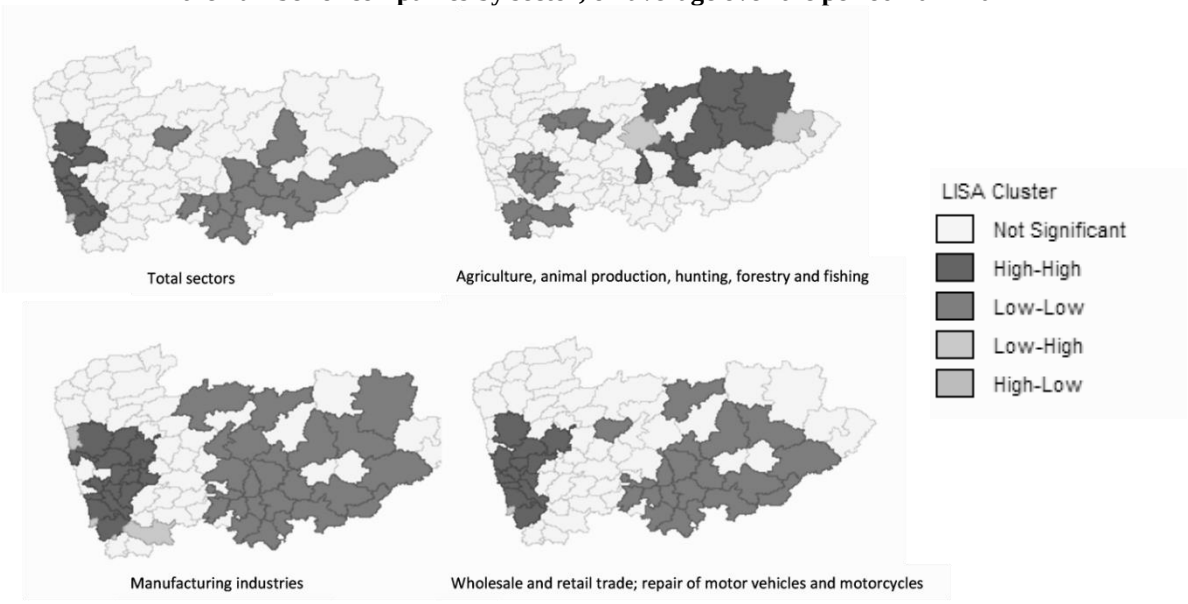


Figure 10. Local spatial autocorrelation analysis for the Galicia municipalities, considering the number of companies by sector, on average over the period 2014-2017

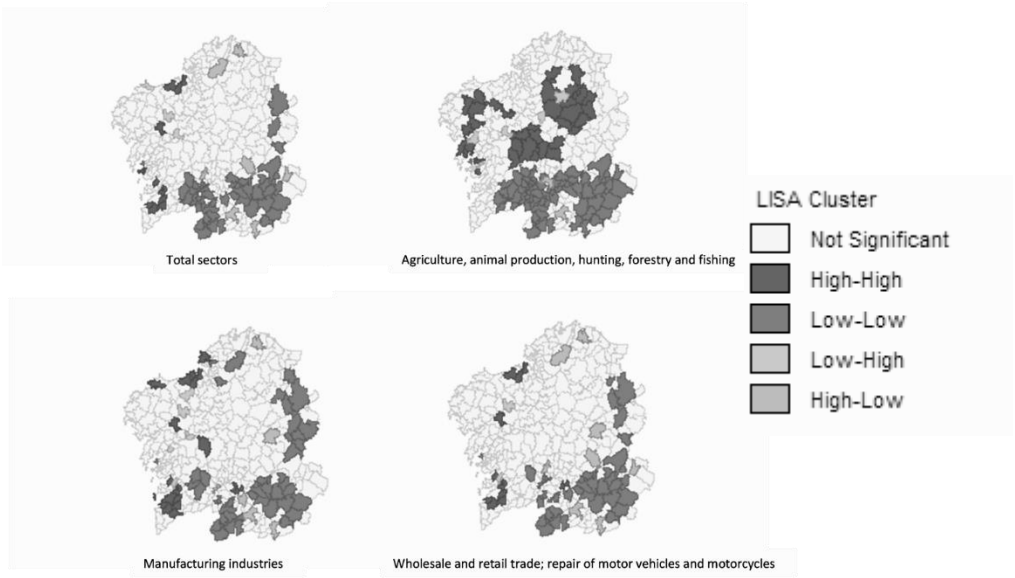


Figure 9 confirms the importance of the manufacturing and services sectors in the Northern Portuguese coastal municipalities, around Porto and Braga, and the relevance of the agricultural sector in the interior of this region. There are, however, municipalities that lose out from the proximity of dynamic neighbours, such as Espinho (low-high cluster, considering the number of companies for the entire sectors, manufacturing and services), or Arouca and Esposende (low-high clusters, considering the manufacturing sector). Figure 10 also confirms the contexts described before for the Galician region, nonetheless, highlighting that there are municipalities which benefit from the lower socioeconomic dynamics of neighbouring municipalities, such as Viveiro in the north or Verín in the south. These findings deserve special attention, namely, from the policymakers in the design of future regional policies, taking, for example, advantages from benchmark approaches.

5. EXPLORING CORRELATION BETWEEN THE NUMBER OF COMPANIES FROM THE SEVERAL SECTORS

To better highlight the framework concerning socioeconomic dynamics for the North of Portugal and Galicia, the interrelationships between the sectors that operate in these two regions were worked, through correlation matrices for the number of companies from each individual sector (obtained with the Stata software).

For the Portuguese context, table 1 reveals that the agricultural sector and the extractive industry are the least correlated with other sectors (in general, the coefficients of correlation for these two sectors have no statistical significance). The remaining sectors are strong and positively correlated. It is worth highlighting, for example, the case of the manufacturing industries that are strongly correlated with the following sectors: Electricity, gas, steam, hot and cold water and cold air; Water collection, treatment and distribution; sanitation, waste management, and remediation; Construction; Wholesale and retail trade, repair of motor vehicles and motorcycles. In turn, manufacturing is less correlated with companies from the "Information and communication activities" sectors. This situation may be an aspect that should be explored further in future research, considering the importance of the two sectors for the economy.

The Spanish context (table 2) is a little different, and despite being weak, there is a statistically significant and positive correlation between the agricultural sector and the extractive industries and the remaining sectors. The correlations between the remaining sectors are, in general, positive and robust. These correlations between, for instance, agriculture and other economic sectors is an interesting finding, showing that, in Galicia, there is a better interrelationship between the agricultural sector (a determinant sector for some regions, such as rural areas) and the remaining regional economy.

In addition, from the research performed thus far, it seems that the border effect exists in these two Iberian regions. In these contexts, it could be interesting to promote a deeper cooperation between the North of Portugal and Galicia, with benefits, for example, for manufacturing in the Portuguese littoral and for the agricultural sector in the Galician interior. Indeed, on the border, the Portuguese interior has more agricultural socioeconomic activity and the Galician littoral more industrial dynamics.

Table 1. Correlations between the number of companies from the several sectors (Northern Portugal)

	TOT	AGR	IND	MAN	ELE	WAT	CONST	WHO	TRA	ACC	INF	REA	CONSU	ADM	EDU	HUM	ART	OTH
TOT	1.000																	
AGR	0.059	1.000																
	(0.589)																	
IND	0.185	0.050	1.000															
	(0.089)	(0.646)																
MAN	0.7367*	-0.090	0.175	1.000														
	(0.000)	(0.412)	(0.108)															
ELE	0.8641*	0.100	0.200	0.7465*	1.000													
	(0.000)	(0.361)	(0.065)	(0.000)														
WAT	0.8716*	-0.095	0.2299*	0.8213*	0.7593*	1.000												
	(0.000)	(0.387)	(0.033)	(0.000)	(0.000)													
CONST	0.8528*	-0.010	0.3380*	0.8127*	0.7471*	0.8974*	1.000											
	(0.000)	(0.928)	(0.002)	(0.000)	(0.000)	(0.000)												
WHO	0.9844*	-0.030	0.200	0.8213*	0.8665*	0.9126*	0.8883*	1.000										
	(0.000)	(0.781)	(0.064)	(0.000)	(0.000)	(0.000)	(0.000)											
TRA	0.9224*	-0.006	0.135	0.5993*	0.6814*	0.7924*	0.7724*	0.8952*	1.000									
	(0.000)	(0.960)	(0.214)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)										
ACC	0.9845*	0.018	0.201	0.6812*	0.8638*	0.8181*	0.8091*	0.9652*	0.8950*	1.000								
	(0.000)	(0.870)	(0.063)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)									
INF	0.9335*	0.011	0.126	0.4973*	0.8038*	0.7258*	0.6641*	0.8788*	0.8687*	0.9470*	1.000							
	(0.000)	(0.918)	(0.250)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)								
REA	0.9472*	-0.006	0.149	0.5907*	0.8675*	0.7612*	0.7093*	0.9115*	0.8321*	0.9654*	0.9825*	1.000						
	(0.000)	(0.960)	(0.172)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)							
CONSU	0.9564*	0.016	0.141	0.5576*	0.8386*	0.7510*	0.7064*	0.9106*	0.8806*	0.9708*	0.9943*	0.9909*	1.000					
	(0.000)	(0.887)	(0.195)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)						
ADM	0.9655*	-0.042	0.113	0.6575*	0.7393*	0.8397*	0.8008*	0.9413*	0.9634*	0.9399*	0.9168*	0.8992*	0.9291*	1.000				
	(0.000)	(0.698)	(0.300)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)					
EDU	0.9825*	-0.006	0.181	0.6772*	0.8011*	0.8806*	0.8516*	0.9632*	0.9371*	0.9637*	0.9301*	0.9218*	0.9426*	0.9760*	1.000			
	(0.000)	(0.956)	(0.095)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)				
HUM	0.9746*	0.008	0.148	0.6030*	0.8410*	0.7910*	0.7491*	0.9378*	0.9113*	0.9830*	0.9848*	0.9810*	0.9945*	0.9502*	0.9652*	1.000		
	(0.000)	(0.941)	(0.175)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
ART	0.9579*	0.003	0.105	0.5720*	0.7908*	0.7537*	0.7182*	0.9136*	0.8996*	0.9718*	0.9705*	0.9694*	0.9826*	0.9520*	0.9474*	0.9826*	1.000	
	(0.000)	(0.980)	(0.339)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
OTH	0.9772*	-0.035	0.202	0.7704*	0.8132*	0.9154*	0.8965*	0.9824*	0.9120*	0.9535*	0.8750*	0.8869*	0.8993*	0.9599*	0.9839*	0.9314*	0.9103*	1.000
	(0.000)	(0.749)	(0.062)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	

Note: TOT, Total; AGR, Agriculture, animal production, hunting, forestry and fishing; IND, Extractive industries; MAN, Manufacturing industries; ELE, Electricity, gas, steam, hot and cold water and cold air; WAT, Water collection, treatment and distribution; sanitation, waste management and remediation; CONST, Construction; WHO, Wholesale and retail trade, repair of motor vehicles and motorcycles; TRA, Transport and storage; ACC, Accommodation, catering and similar; INF, Information and communication activities; REA, Real estate activities; CONSU, Consulting, scientific, technical and similar activities; ADM, Administrative and support service activities; EDU, Education; HUM, Human health and social support activities; ART, Artistic, show, sports and recreational activities; OTH, Other service activities. *, statistically significant at 5%.

Table 2. Correlations between the number of companies from the several sectors (Galicia)

	TOT	AGR	IND	MAN	ELE	WAT	CONST	WHO	TRA	ACC	INF	REA	CONSU	ADM	EDU	HUM	ART	OTH
TOT	1.000																	
AGR	0.2530*	1.000																
	(0.000)																	
IND	0.4047*	0.089	1.000															
	(0.000)	(0.114)																
MAN	0.9623*	0.2188*	0.4496*	1.000														
	(0.000)	(0.000)	(0.000)															
ELE	0.8580*	0.1911*	0.4250*	0.8018*	1.000													
	(0.000)	(0.001)	(0.000)	(0.000)														
WAT	0.9306*	0.1468*	0.4146*	0.9343*	0.7888*	1.000												
	(0.000)	(0.009)	(0.000)	(0.000)	(0.000)													
CONST	0.9865*	0.2235*	0.4208*	0.9639*	0.8515*	0.9228*	1.000											
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)												
WHO	0.9933*	0.1950*	0.4131*	0.9741*	0.8388*	0.9388*	0.9815*	1.000										
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)											
TRA	0.9838*	0.1901*	0.4155*	0.9658*	0.8263*	0.9389*	0.9686*	0.9864*	1.000									
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)										
ACC	0.9923*	0.2150*	0.3947*	0.9536*	0.8593*	0.9234*	0.9825*	0.9866*	0.9692*	1.000								
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)									
INF	0.9621*	0.095	0.3319*	0.9096*	0.8218*	0.9084*	0.9284*	0.9559*	0.9576*	0.9534*	1.000							
	(0.000)	(0.092)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)								
REA	0.9845*	0.1458*	0.3791*	0.9219*	0.8467*	0.9136*	0.9659*	0.9746*	0.9681*	0.9788*	0.9787*	1.000						
	(0.000)	(0.010)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)							
CONSU	0.9820*	0.1349*	0.3722*	0.9156*	0.8496*	0.9118*	0.9606*	0.9713*	0.9684*	0.9747*	0.9832*	0.9979*	1.000					
	(0.000)	(0.017)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)						
ADM	0.9867*	0.1428*	0.3723*	0.9405*	0.8445*	0.9258*	0.9668*	0.9797*	0.9774*	0.9805*	0.9882*	0.9933*	0.9937*	1.000				
	(0.000)	(0.012)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)					
EDU	0.9912*	0.1687*	0.3964*	0.9423*	0.8776*	0.9177*	0.9751*	0.9862*	0.9740*	0.9883*	0.9704*	0.9868*	0.9874*	0.9880*	1.000			
	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)				
HUM	0.9809*	0.1466*	0.3806*	0.9099*	0.8747*	0.8949*	0.9636*	0.9681*	0.9555*	0.9797*	0.9712*	0.9922*	0.9937*	0.9862*	0.9917*	1.000		
	(0.000)	(0.009)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
ART	0.9873*	0.1661*	0.3846*	0.9383*	0.8594*	0.9121*	0.9664*	0.9800*	0.9694*	0.9862*	0.9792*	0.9868*	0.9872*	0.9904*	0.9923*	0.9906*	1.000	
	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
OTH	0.9944*	0.1895*	0.3973*	0.9591*	0.8762*	0.9259*	0.9834*	0.9922*	0.9781*	0.9922*	0.9622*	0.9816*	0.9799*	0.9852*	0.9962*	0.9838*	0.9890*	1.000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	

Note: TOT, Total; AGR, Agriculture, animal production, hunting, forestry and fishing; IND, Extractive industries; MAN, Manufacturing industries; ELE, Electricity, gas, steam, hot and cold water and cold air; WAT, Water collection, treatment and distribution; sanitation, waste management and remediation; CONST, Construction; WHO, Wholesale and retail trade, repair of motor vehicles and motorcycles; TRA, Transport and storage; ACC, Accommodation, catering and similar; INF, Information and communication activities; REA, Real estate activities; CONSU, Consulting, scientific, technical and similar activities; ADM, Administrative and support service activities; EDU, Education; HUM, Human health and social support activities; ART, Artistic, show, sports and recreational activities; OTH, Other service activities. *, statistically significant at 5%.

6. RESULTS FROM THE AGGLOMERATION MODEL

Tables 3, 4, 5 and 6 were obtained following the procedures of the Stata software (StataCorp., 2017a, 2017b; Stata, 2020) for cross-section linear regressions with spatial autocorrelation effects. The spatial autocorrelation effects were considered in the model through a matrix of contiguity. In these regressions some of the sectors with more relevance in terms of number of companies were considered and already considered in section 4, namely the following: agriculture, animal production, hunting, forestry and fishing; manufacturing industries;and wholesale and retail trade, repair of motor vehicles and motorcycles.

The model considered follows the developments performed by Hanson (1998). This author took into account the agglomeration processes and the contributions from authors such as, Krugman (1991) or Krugman & Venables (1995).

The model considered in this section allows for spatial autocorrelation effects (with the dependent and independent variables lagged, as well as, the error term) and is presented in the following:

$$\ln\left(\frac{c_{ij}}{c_j}\right) = a_0 + a_1 ln\left(\frac{\frac{c_{ij}}{c_{ik}}}{\frac{c_j}{c_k}}\right) + a_2 W_{il} \ln\left(\frac{c_{ij}}{c_j}\right) + a_3 W_{il} ln\left(\frac{\frac{c_{ij}}{c_{ik}}}{\frac{c_j}{c_k}}\right) + a_4 W_{il}\varepsilon + \mu \qquad (1)$$

Where C is the number of companies, i represents each municipality, j represents each sector and k the total economy of each municipality, l the neighbour municipalities, W a matrix of contiguity and ε the spatially correlated error term.

In this model the relative number of companies in each municipality and sector is dependent on the relative level of agglomeration of each sector inside each municipality.

Tables 3 and 5 show that in the North of Portugal and Galicia, respectively, the internal municipal agglomeration positively influences the relative number of companies in each sector and municipalities that are greater for manufacturing industries and for the wholesale and retail trade, repair of motor vehicles and motorcycles. The reduced influence from the level of internal municipal agglomeration for the agricultural sector is expected, because this sector is described by theory as having traditionally constant returns to scale and a reduced level of companies' relocation, due to the immobility of the land. Finally, the stronger, positive and statistically significant spatial autocorrelation effects in the North of Portugal and Galicia are random. This means that the relative number of companies in each municipality and sector is positively influenced by random effects from the neighbouring municipalities. In addition, in the North of Portugal the number of companies is negatively explained by the lagged dependent variable and, maybe, manufacturing industries. In Galicia the number of companies is negatively explained by the lagged dependent variable in all sectors, but positively influenced by the lagged independent variable in the agricultural sector.

In turn, tables 4 and 6 confirm the adequacy of the model considered, comparing the values observed for the dependent variable and the predicted ones.

Table 3. Results obtained through cross-section linear regression approaches across the Northern Portuguese municipalities, with the agglomeration model and with the data on average over the period 2014-2017

Model/Sector	Agriculture, animal production, hunting, forestry and fishing	Manufacturing industries	Wholesale and retail trade, repair of motor vehicles and motorcycles
Constant	-5.666* (-27.960) [0.000]	-5.641* (-23.030) [0.000]	-5.563* (-24.030) [0.000]
Municipality agglomeration	0.530* (5.380) [0.000]	1.143* (6.390) [0.000]	1.518* (5.270) [0.000]
Lagged independent variable	-0.145 (-0.820) [0.411]	0.661 (1.180) [0.236]	-0.332 (-0.330) [0.739]
Lagged dependent variable	-0.203* (-3.460) [0.001]	-0.198** (-1.960) [0.051]	-0.108 (-0.980) [0.326]
Lagged error term	0.706* (3.810) [0.000]	0.889* (7.850) [0.000]	0.906* (9.990) [0.000]

Note: *, statistically significant at 5%; **, statistically significant at 10%.

Table 4. Summary statistics for the dependent variable observed and predicted in the cross-section linear regression approaches across the Northern Portuguses municipalities, with the agglomeration model and with the data on average over the period 2014-2017

Summary statistics/Sector	Agriculture, animal production, hunting, forestry and fishing	Manufacturing industries	Wholesale and retail trade, repair of motor vehicles and motorcycles
Observed variable			
Observations	86	86	86
Mean	-4.746	-5.421	-5.209
Standard Deviation	0.838	1.433	1.239
Min	-7.543	-7.854	-7.384
Max	-2.989	-2.572	2.476
Predicted variable			
Observations	86	86	86
Mean	-4.732	-5.404	-5.304
Standard Deviation	0.549	0.939	0.530
Min	-6.613	-6.920	-6.965
Max	-3.964	-3.303	-4.524

Table 5. Results obtained through cross-section linear regressions approaches across the Galician municipalities, with the agglomeration model and with the data on average over the period 2014-2017

Model/Sector	Agriculture, animal production, hunting, forestry and fishing	Manufacturing industries	Wholesale and retail trade, repair of motor vehicles and motorcycles
Constant	-6.869* (-46.290) [0.000]	-7.033* (-41.800) [0.000]	-6.950* (-45.010) [0.000]
Municipality agglomeration	0.298* (4.310) [0.000]	0.770* (7.210) [0.000]	1.920* (15.860) [0.000]
Lagged independent variable	0.322* (2.010) [0.044]	0.181 (0.640) [0.523]	0.588 (1.600) [0.110]
Lagged dependent variable	-0.095* (-2.760) [0.006]	-0.103* (-2.900) [0.004]	-0.157* (-3.950) [0.000]
Lagged error term	0.825* (13.900) [0.000]	0.796* (12.140) [0.000]	0.815* (14.250) [0.000]

Note: *, statistically significant at 5%; **, statistically significant at 10%.

Table 6. Summary statistics for the dependent variable observed and predicted in the cross-section linear regressions approaches across the Galician municipalities, with the agglomeration model and with the data on average over the period 2014-2017

Summary statistics/Sector	Agriculture, animal production, hunting, forestry and fishing	Manufacturing industries	Wholesale and retail trade, repair of motor vehicles and motorcycles
Observed variable			
Observations	313	313	313
Mean	-6.333	-6.581	-6.896
Standard Deviation	1.167	1.271	1.440
Min	-11.351	-10.919	-12.266
Max	-3.810	-2.447	-2.145
Predicted variable			
Observations	313	313	313
Mean	-6.203	-6.446	-6.752
Standard Deviation	0.473	0.501	0.960
Min	-7.713	-8.047	-12.902
Max	5.187	-5.270	-4.928

7. CONCLUSIONS

The main aim of this research was to identify the main clusters that operate in the North of Portugal and Galicia and to explore the spatial interrelationships between the associated socio-economic activities. The intention was to obtain a relevant basis for the several stakeholders that operate in these two Portuguese and Spanish regions, namely for the public institutions and

policymakers. For this purpose statistical information from the Portuguese official statistical institution and the *Instituto Galego de Estatística* was considered for the number of companies disaggregated by sector. These data were processed with descriptive analysis, factor-cluster analyses, spatial autocorrelation research, matrices of correlation and cross-section linear regressions.

The data analysis shows that in the North of Portugal, the companies are agglomerated in the coastal municipalities around Porto and Braga. In turn, the socioeconomic activities in the interior of this Portuguese region are mainly performed by companies from the "Agriculture, animal production, hunting, forestry and fishing" sector and by companies (albeit with a lower relative importance) from the "Wholesale and retail trade, repair of motor vehicles and motorcycle", "Accommodation, catering and similar", "Construction" and "Manufacturing industries" sectors. In Galicia, the pattern, for the relative importance of each sector inside each municipality, for the number of companies, is similar to that verified for the North of Portugal in the municipalities with more and less total number of companies. However, in this region the poles of development (with a greater total number of companies) are more dispersed around A Coruña, Santiago de Compostela, Lugo, Pontevedra, Vigo, and Ourense.

The cluster-factor analyses stress the importance of the clusters around Porto and Braga for the Northern Portuguese socioeconomic dynamics and its potential cooperation with Galicia, namely, in the Pontevedra-Vigo-Ourense-O Barco de Valdeorras corridor.

In turn, the spatial autocorrelation analysis demonstrates that there are similar patterns of development between the Portuguese municipalities around Porto and Braga and closer Galician municipalities, such as those around, for example, Vigo-Pontevedra and Ourense, where "working together" may be explored more in-depth. In the municipalities from the interior of these two regions, the Portuguese context may benefit from Spanish industrial experience, and the Galician could benefit from Portuguese agricultural dynamics.

Finally, the correlation matrices highlight the inexistence of interrelationships between the Portuguese agricultural sector and other socioeconomic sectors and the weak correlation across the "Information and communication activities" and the manufacturing industries in the North of Portugal and the agricultural sector in Galicia. This aspect should be explored deeper in future studies, considering the importance of these sectors. In addition, the cross-section linear regressions with spatial autocorrelation effects show the weaker economies of agglomeration within the agricultural sector. In turn, these economies of agglomeration are stronger in services than in manufacturing, which considering the importance of the industry for economic dynamics, deserves further attention in future work.

In terms of policy implications for this Euroregion, special attention to the industrial sector is recommended, in designing strategic plans that better and more efffectively promote the creation of better synergies, including spill over effects, for this sector, where the cooperation between Portugal and Spain could contribute to create scale and networking. The similarities between the two regions should be exploited from the logic of benchmarking. There are, also, relevant differences that could be considered for a logical use of complementary development. For future studies, work on other statistical information from other databases is recommended to highlight other possible dimensions.

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