

UNIVERSIDAD COMPLUTENSE DE MADRID

FACULTAD DE CIENCIAS ECONÓMICAS Y EMPRESARIALES



TESIS DOCTORAL

Análisis de la efectividad de la política de cohesión en la reducción de las
disparidades económicas regionales

An analysis of the cohesion policy effectiveness in reducing the regional
economic disparities

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DOCTORADO EN ECONOMÍA



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**ANÁLISIS DE LA EFECTIVIDAD DE LA POLÍTICA DE COHESIÓN EN LA
REDUCCIÓN DE LAS DISPARIDADES ECONÓMICAS REGIONALES**

**AN ANALYSIS OF THE COHESION POLICY EFFECTIVENESS IN
REDUCING THE REGIONAL ECONOMIC DISPARITIES**

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ACKNOWLEDGEMENTS

Regional disparities have been growing in the last decades, constituting a threat to the well-balanced and harmonious development of the European regions. This threat to the fundamentals of the European Union has constituted the base motivation of the current thesis, which has examined the effectiveness of the Cohesion Policy on its objective of reducing the regional inequalities, with the aim of providing with some potential insightful findings for policymakers to make the cohesion policy more effective and impactful.

First of all, I would like to thank everyone who has supported me throughout the journey of this dissertation.

Foremost, I would like to express my gratitude to my supervisor, Cristina del Campo Campos, for her invaluable guidance and encouragement. Her insightful feedback and advice have been key in shaping my research and making it possible.

I am also grateful to the referees who have reviewed the articles of this thesis for their constructive comments and suggestions, which greatly improved the quality of this work. I am grateful to the Complutense University of Madrid, its doctoral programmes and courses have helped me enhance my academic growth. I am indebted to my managers and company (Santander Global Technology and Operations) for the labour flexibility which has allowed me to conduct this thesis at partial time.

Last but not least, special thanks to my parents, family and friends for their support throughout all these years.

Thank you all for being part of this journey.

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Summary

In the last decades, regional disparities in the European Union (EU) have been a subject of a great concern for policymakers and academics alike, due to the potential threat they represent to the well-balanced and harmonious development of the European regions. This threat to the fundamentals of the EU has constituted the base motivation for the current dissertation, which examines the effectivity of the Cohesion Policy (CP), in charge of reducing the regional disparities, on the achievement of its objective.

The Cohesion Policy has constituted itself as one of the key policies within the European Union, channelling significant financial resources to promote regional cohesion and integration. Despite its considerable efforts, regional disparities have been increasing over the years, driven by factors such as the intense process of integration of the European members, the technological revolution around the ICTs and the consequent globalization, and the 2008 global financial crisis, which further aggravated the differences between the regions. Such inequalities, especially within countries, foster public discontent, leading to political and social instability that threatens the very foundations of the EU. Therefore, a strong and effective Cohesion Policy is essential to ensure the stability and future of the Union.

However, the problem is complex. Funding is supposed to boost the economic performance of the lagged regions to acquire the same economical state as the rest, levelling the existing differences. But at the same time it may also facilitate the agglomeration of the economic activities, thus enhancing the inequalities between regions.

Motivated by the importance and repercussion of this problematic situation in the EU, the present dissertation aims at assessing the effectivity of the Cohesion Policy on its objective of reducing the regional economic disparities. The first two chapters will focus on whether the NUTS 2 level is the appropriate territorial level at which to capture the Cohesion Policy effects, while the two following chapters will discuss the role of some structures financed by the CP to promote integration processes and reduce regional disparities.

Firstly, in Chapter 1, we have conducted a model-based clustering to identify the regional economic disparities in the level of economic wealth and its dynamics at NUTS 2 and NUTS 3 levels. This way, we have determined whether the NUTS 3 regions share the same behaviours as their aggregates NUTS 2 regions and therefore policies such as the Cohesion Policy are equally effective for all territories.

As we found that NUTS 2 regions are not homogeneous regions, and therefore allocating the funds at NUTS 2 level may present some inefficiencies and increase even more the regional disparities, in the second chapter we have determined whether the Cohesion Policy is indeed increasing the inequalities at the NUTS 3 level by evaluating the impact of the Structural Funds on the NUTS 3 regional economic inequalities.

Our findings reveal that the NUTS 3 regions eligible for receiving Structural Funds experience a further increase of inequalities than the ineligible ones, suggesting that the resources may be unevenly distributed within eligible NUTS 2 regions.

Combining these results with the ones obtained in the first chapter, enables us to draw the first main conclusion of this dissertation of interest for policymakers. Cohesion Policy, aimed at reducing regional disparities and defined at NUTS 2 level, should consider that NUTS 2 regions are heterogeneous territories with internal differences and therefore allocating the funds at this level may cause some inaccuracies.

Chapters 3 and 4 of this dissertation, have discussed the role of the Euroregions (structures financed by the Cohesion Policy to promote integration processes) in reducing regional disparities. It is expected that the intense cooperation relationships that occur in these particular structures (with border and non-border regions) lead to a convergence between the economic levels of the regions. However, some authors claim that integration can result from symmetries and similarities as well as from asymmetries between border regions, contradicting the previous statement. Aiming to contribute to this debate, we have explored the economic convergence processes and the evolution of the economic inequalities in the Spanish Euroregions to determine if this model could be applied more broadly to promote convergence across all member states.

More concretely, we have approached the five Spanish Euroregions, three sharing border with Portugal (EUROAAA, EUROACE and Galicia-North of Portugal) and two with France (New Aquitaine-Basque Country-Navarre and Pyrenees-Mediterranean). That way, we have observed the effect of different characteristics of these two nearby countries on the convergence with the Spanish regions. We have covered the period from 1980 to 2021 and analysed two classical concepts of convergence: σ -convergence, which refers to the reduction of inequalities over time, and β -convergence, which refers to the process by which the poorest regions catch up with the richest over time.

The results show that convergence is achieved in the Spanish Euroregions sharing border with Portugal but not in those with France, suggesting that the Spanish Euroregions convergence process depends on the country Spain shares the border with. In the case of Spain and Portugal, similarities in language and culture, along with the extensive border, likely facilitate cooperation. In the case of the Spanish Euroregions sharing border with France, the shorter border and the distance of the French internal regions from the frontier make interactions more challenging.

Stating the second main conclusion of the dissertation, the findings of these two chapters highlight the varying impact of the Euroregion model on the objective of the Cohesion Policy of reducing disparities. This impact depends on the culture, proximity, socio-economic and territorial factors -among others- of the countries which comprise the Euroregion. Specifically, it has been evidenced that Euroregions facing geographical internal obstacles and comprised of countries with very different socio-economic and cultural characteristics have to make additional efforts to achieve convergence.

Resumen

En las últimas décadas, las disparidades regionales en la Unión Europea (UE) han sido objeto de gran preocupación tanto para los responsables de políticas como para los académicos, debido a la potencial amenaza que presentan al desarrollo equilibrado y en armonía de las regiones europeas. Esta amenaza a los fundamentos de la UE ha constituido la motivación principal de la presente tesis, la cual examina la efectividad de la política de cohesión, encargada de reducir las disparidades regionales, en el logro de su objetivo.

La política de cohesión se ha constituido como una de las políticas clave dentro de la Unión de Europea, canalizando significantes recursos financieros para promover la cohesión e integración regional. A pesar de sus considerables esfuerzos, las disparidades regionales han aumentado a lo largo de los años, debido a factores como el intenso proceso de integración de los estados miembros, la revolución tecnológica de las TIC y la consecuente globalización, y la crisis financiera global de 2008, la cual agravó las diferencias entre regiones. Dichas desigualdades, especialmente dentro de los países, generan descontento público, lo que conduce a una inestabilidad política y social que amenaza los cimientos de la UE. Por tanto, una política de cohesión fuerte y eficaz es esencial para asegurar la estabilidad y el futuro de la UE.

No obstante, el problema es complejo. La financiación debería de aumentar el desempeño económico de las regiones rezagadas para que adquieran el mismo nivel económico que el resto, nivelando las diferencias existentes. Pero al mismo tiempo, puede facilitar la aglomeración de las actividades económicas, aumentando así las desigualdades entre regiones.

Motivada por la importancia y repercusión de esta problemática situación en la UE, la presente tesis tiene como objetivo analizar la efectividad de la política de cohesión en su objetivo de reducir las disparidades económicas regionales. Los dos primeros capítulos se centrarán en si el nivel NUTS 2 es el nivel territorial apropiado para capturar los efectos de la política de cohesión, mientras que los dos siguientes capítulos estudiarán el papel de algunas estructuras financiadas por la política de cohesión para promover los procesos de integración y reducir las disparidades regionales.

En el primer capítulo, hemos llevado a cabo un model-based clustering para identificar las disparidades económicas regionales en el nivel de riqueza económica y su dinámica en los niveles NUTS 2 y NUTS 3. De este modo, hemos determinado si las regiones NUTS 3 comparten los mismos comportamientos que sus agregados, las regiones NUTS 2, y si, por lo tanto, políticas como la Política de Cohesión son igualmente efectivas para todos los territorios.

Dado que encontramos que las regiones NUTS 2 no son homogéneas, y por tanto, la asignación de fondos a nivel NUTS 2 puede generar algunas ineficiencias e incluso aumentar más las disparidades regionales, en el segundo capítulo hemos determinado si la Política de Cohesión está efectivamente aumentando las desigualdades a nivel NUTS 3. Nuestros hallazgos revelan que las regiones NUTS 3 elegibles para recibir Fondos Estructurales experimentan un mayor aumento de las desigualdades en comparación con las no elegibles, lo que sugiere que los recursos podrían estar distribuidos de manera desigual dentro de las regiones NUTS 2 elegibles.

Combinando estos resultados con los obtenidos en el primer capítulo, obtenemos la primera conclusión de interés de la tesis. La política de cohesión, destinada a reducir las disparidades regionales y definida a nivel NUTS 2, debería considerar que las regiones NUTS 2 son territorios heterogéneos con diferencias internas y que, por lo tanto, asignar los fondos a este nivel puede causar deficiencias.

Los capítulos 3 y 4 de esta tesis analizan el papel de las euroregiones (estructuras financiadas por la política de cohesión para promover los procesos de integración) en la reducción de las disparidades regionales. Es de esperar que las intensas relaciones de cooperación que tienen lugar en estas particulares estructuras (con regiones fronterizas y no fronterizas) conduzcan a la convergencia entre los niveles económicos de las regiones. No obstante, algunos autores claman que la integración puede resultar tanto de simetrías como de asimetrías entre las regiones fronterizas, contradiciendo la sentencia anterior. Con el objetivo de contribuir a este debate, hemos explorado los procesos de convergencia económica y la evolución de las desigualdades económicas en las euroregiones españolas, para determinar si este modelo puede ser aplicado para promocionar la convergencia entre todos los estados miembros.

Concretamente, hemos analizado los procesos de σ -convergencia y β -convergencia en las cinco euroregiones españolas, tres compartiendo frontera con Portugal (EUROAAA, EUROACE y Galicia-Norte de Portugal) y dos con Francia (Nueva Aquitania-País Vasco-Navarra y Pirineos-Mediterráneo). De esta forma, hemos observado el efecto de las diferentes características de estos dos países en la convergencia con las regiones españolas.

Los resultados obtenidos muestran que la convergencia se consigue en las euroregiones españolas que comparten frontera con Portugal, pero no en las que comparten frontera con Francia, sugiriendo que el proceso de convergencia de las euroregiones españolas depende del país con el que España comparte frontera. En el caso de España y Portugal, similitudes en el lenguaje y cultura, junto con la larga frontera, probablemente faciliten la cooperación. En el caso de España y Francia, la frontera más corta y la gran distancia que hay entre las regiones francesas internas con la frontera hacen más difícil las interacciones.

Extrayendo la segunda conclusión principal de esta tesis, los resultados de estos dos últimos capítulos señalan el impacto variable del modelo de euroregión en el objetivo de la política de cohesión de reducir las disparidades. Este impacto depende de la cultura, proximidad, factores económicos y territoriales, entre otros, de los países que comprenden la euroregión. Específicamente, ha quedado evidenciado que las euroregiones que enfrentan obstáculos geográficos internos y que están compuestas de países con características socio-económicas y culturales muy diferentes tienen que hacer esfuerzos adicionales para conseguir la convergencia.

Introduction

In the last decades, regional disparities in the European Union (EU) have become the centre of an intense debate in which both policymakers and academics are involved, due to the potential threat they represent to the well-balanced and harmonious development of the European regions. This threat to the fundamentals of the EU has constituted the base motivation for the current dissertation, which examines the effectivity of the Cohesion Policy (CP), in charge of reducing the regional disparities, on the achievement of its objective.

The origins of the European Union date back to 1951, when the European Coal and Steel Community (ECSC) was established by the Treaty of Paris between France and Germany. This community was launched by Jean Monnet (1888-1979, France), considered the father of Europe, with the purpose of grouping the Europe states under a European entity that turned the European countries – too small to ensure the prosperity within them – into a common economic unit. In 1957, under the Treaty of Rome, it was renamed as European Economic Community (EEC) and Belgium, Italy, Luxembourg and the Netherlands became members. The European Union (EU) was renamed as such in 1993, when the Maastricht Treaty entered into force. Over the years the EU has been expanding, from 12 member states in its constitution, to the current 27 members, with the last major extension of 10 new accessions carried out in 2004 under the Treaty of Lisbon.

Ever since the ECC was created with the purpose of becoming an economic unit, as new countries were incorporated, the European model of economic integration became mandatory in order to ensure all members homogeneous development and eradicate the social and economic differences within them. European integration has been a constant process of new agreements, treaties and extensions, all geared towards strengthening and exploiting the links between the members of the Union.

In the fight for cohesion and integration of all regions, the European Commission (institution of the European Union that holds executive power and legislative initiative), under the solidarity principle, has been allocating a large amount of resources on regional policies over the years.

The first references of Community Regional Policy on integration were formulated in the preamble of the Treaty of Rome, which stated the need to reduce inequalities among

European countries and regions. However, this policy did not reach its present dimension until decades later, after the arrival of Greece (1981), Spain and Portugal (1986) into the EU. During this period, cohesion emerged as a crucial objective within the integration process, responding to the rising of interregional inequalities. Thus, to this end, the European Regional Policy, also called Cohesion Policy, was officially launched in 1988 with the aim of avoiding economic, social and territorial disparities throughout the regions of the European Union and promoting cohesion across its member states, boosting economic growth and improving EU inhabitants' quality of life (Fernández, 2007).

More concretely, the specific objective of this policy is both to promote the progress of less-developed areas (López, 2009) and to provide complementary support to social groups less favoured by the integration process (Rodríguez et al., 2014). EU regional policy addresses regional disparities and solidarity between regions, strengthening the competitiveness and attractiveness of all member states of the EU, obtains economic and social cohesion by diminishing discrepancies between the levels of regional development and by taking advantage of the common market across the European territory. To do this, regional policy is oriented towards fostering the competitiveness of regions, boosting economic growth and developing employment.

The policy has instituted itself as one of the key policies within the European Union, leveraging substantial financial resources allocated through various funds over the years. The antecedents of the Cohesion Policy funding date back to 1957, when the European Social Fund (ESF) was established under the Treaty of Rome. In 1975, the European Regional Development Fund (ERDF) was created with the strategic objective to strengthen economic, social and territorial cohesion in the EEC by correcting existing imbalances between its regions. In 1988, when the Single European Act formalized the Cohesion Policy, the European Council achieved a commitment to double their financial allocation in the period 1988-1993, by integrating them into the Cohesion Policy. The financial resources were thus strengthened and in 1994 the Cohesion Fund was created to support Member States with a GDP per capita of less than 90% of the EU average. Finally, in current policy programming period 2021-2027, Cohesion Policy is also delivered through the Just Transition Fund (JTF), from which all countries can benefit. Of all of them, the

ERDF has become the main instrument for implementing the Regional Policy within the EU with the greater budgetary contribution.

In the current policy period 2021-2027, the Cohesion Policy represents 392.000 million Euros, almost a third of the total budget of the European Union. Tens of thousands of projects have been financed with funds from the EU Regional Policy throughout years. This has benefited each region individually as well as the EU as a whole in terms of economic growth and job creation.

However, despite the huge labour and effort of the Cohesion Policy, it seems that regional disparities have been increasing over the years. Starting in the 1990s, a series of global and European events have transformed the way countries and regions interact, operate and organize, creating new differences between them (Meliciani, 2015).

First, during the 1990s and 2000s, the integration process of the European members intensified noticeably (Meliciani, 2015). The capital movements were liberalized, the cooperation between borders reinforced, the trade of goods and services boosted, and the European Monetary Union was created with the establishment of the Euro as the common currency. Additionally, the incorporation of successive entrances of new members into the European Union in those years supposed a challenge in the integration process. The European integration presented new opportunities for less prosperous regions, fostering the catching-up of lagging territories but at the same time raised new agglomeration issues which potentially increase disparities within countries (Geppert and Stephan, 2008).

Another key phenomenon which had a huge impact on the regional disparities in the 1990s and 2000s was the technological revolution around the ICTs and the consequent globalization. While technological progress and deregulations have made it possible for economic activities to be conducted virtually anywhere, it seems that at the regional scale, globalization tends to benefit certain areas while significantly lag behind in others (Meliciani, 2015).

Lastly, the global financial crisis of 2008 aggravated the differences between the regions, since the impact was not the same for all of them (Mora and Vaya, 2004; Heidenreich and Wunder, 2008; Meliciani, 2015).

Regional inequalities substantially increased as the ratio between the richest and the poorest regions was about one to five for EU15 in 2000, but one to nine for EU25 in 2004, one to 13 for EU27 in 2007, and one to 10 in 2023. As it is stated by Monfort (2020), within-country disparities accounted for one third of the total disparities in the EU in 2000, reaching 66% of the total inequalities in 2017.

In the end, current economic regional disparities are the result of two main sets of factors, each contributing to the complex landscape of economic differences across regions (Iammarino et al., 2019). The first is the long-cycle of development in the economic structure, initiated by a significant technological advancement wave characterized by innovations in technology, finance, and advanced services that thrive on economies of agglomeration. This wave has led to a decrease in employment in many traditional manufacturing sectors by introducing automation and lowering the cost of business-to-business trade within their value chains, allowing industries to spread out geographically. These technological shifts, combined with an expansion in world trade and the reduction of trade barriers, have discouraged the creation of quality employment opportunities, especially for those at the lower-skill levels, while simultaneously boosting opportunities for highly skilled workers. As a result, different skill types have become increasingly concentrated in distinct areas.

The second factor is the long-cycle of regional evolutionary features, comprising place-specific factors such as the endowments of people and skills, firms and industries, formal and informal institutions, innovation capacities, and their responses to change. The evolving economic structure's interaction with regional characteristics determines development patterns. Historically, this interaction occasionally offered substantial opportunities for lifting less-developed regions, fostering a process of inter-regional convergence. However, the trend has shifted towards divergence, since the current development wave tends to concentrate the best jobs and most innovative activities geographically provoking a slowdown in migration between regions and the emergence of various 'traps' in less-favoured regions, including low income and skill levels, low labour-force participation, development-stifling institutions, and social issues such as despair, economic disengagement, and health problems.

Together, these two forces show a picture of the multifaceted current state of regional disparities, highlighting the intricate relationship between technological progress, economic policies, regional endowments, and social conditions.

The existence of inequalities, specially within a country, generates social tension and a climate of discontent among the citizens, becoming a threat to the social cohesion, economic progress and political stability (Iammarino et al., 2019). As segments of the population feel marginalized or excluded from the benefits of economic progress, dissatisfaction may translate into political unrest. Consequently, citizens may become increasingly sceptical about the effectiveness of policies aimed at addressing inequalities, leading to a rise in the Euroscepticism. This scepticism may be directed toward the actions of the European Union, potentially undermining support for EU initiatives and policies, and fuelling the rise of nationalistic movements within member states. The combination of social tension, political instability, and the rise of nationalistic movements can pose a threat to democratic values within EU member states and to the principles of unity and cooperation upon which the European Union is built, jeopardising the democracy in the EU member states and the continuity of the European Union as such.

Hence addressing inequalities becomes not only an economic imperative but also a crucial element in safeguarding the democratic foundations and stability of the European Union. Policies aimed at reducing disparities play a pivotal role in fostering social harmony, maintaining political stability, and sustaining the overall progress of the European project.

The problem however is complex. Funding provided by the regional policies is supposed to boost the economic performance of the lagged regions to acquire the same economical state as the rest, levelling the existing differences. But at the same time it may also facilitate the agglomeration of the economic activities, thus enhancing the inequalities between regions. EU authorities are then faced with the challenge of addressing these issues and ensuring that the Cohesion Policy, responsible for reducing regional disparities, becomes impactful and effective in its implementation.

Motivated by the importance and repercussion of this problematic situation in the EU, the present dissertation aims at examining the effectivity of the Cohesion Policy on its

objective of reducing the regional economic disparities. The first two chapters will target one of its foundations subject to debate, the eligibility criterion for regions being financed, while the two following chapters will discuss the role of some structures financed by the CP to promote integration processes in reducing regional disparities.

The second level of the EU classification (NUTS 2) is the territorial level used for defining eligible regions to be financed from Structural Funds (SF), the main instrument of funding of the Cohesion Policy¹, according to their GDP level. Nomenclature of Territorial Units for Statistics (NUTS) is a hierarchical classification on regional levels from 1 to 3 that subdivides each Member State into a number of regions of level NUTS 1 (e.g. Baden-Württemberg in Germany or Isole in Italy). Each of them is then subdivided in regions of level NUTS 2 (e.g. Stuttgart and Sicilia, respectively) and these are divided, at their turn, in regions of level NUTS 3 (e.g. Böblingen and Palermo, respectively).

The decision of funding allocation at NUTS 2 level was decided according to strategic, statistical and operational reasons. Mainly, at this level, the regional government have more developed administrative capacities which may result into a more resourcefully management of the projects to be financed and a more efficient funding distribution. Moreover, the eligibility is based on solid statistical data, since at this level more data and with better quality is provided, enabling to evaluate more accurately the eligibility of each region to receive funding. Therefore, NUTS 2 level has an intermediate size suitable for designing and implementing development policies with significative impact assuring that the regions in need receive support without an excessive fragmentation.

However, the main problematic issue with this definition is that the NUTS 2 eligibility for receiving funds is defined regardless of the economic performance of their NUTS 3 regions (Gagliardi and Percoco 2017), creating, for instance, what are known as “accidental winners”, NUTS 3 regions in theory not eligible for receiving funds according to the GDP threshold, but which receive treatment because the NUTS 2 regions to which they belong to are eligible. Additionally, the effectiveness of the Cohesion Policy might not be

¹ During the policy programming periods reviewed in this analysis, SF comprised of five funds, but only three of them fell under the EU’s Cohesion Policy (ERDF, ESF and Cohesion Funds). Two of the latter three (ERDF and ESF) are the ones studied in this research, since its eligibility criterion is defined at regional level.

homogeneous within the NUTS 2 regions as it may be conditioned to some inner structural factors (Gagliardi and Percoco, 2017; Percoco, 2017) such as the structure of the public sector or the urban structure of the regions. Due to the fact that the majority of funds are directly targeted to solve problems at NUTS 2 level, the allocation of the funds within NUTS 2 regions may not be evenly transmitted throughout the NUTS 3 regions, being unsure the effect that the funding will produce on the NUTS 3 dimension, concretely on the NUTS 3 regional disparities (Butkus et al., 2019).

Consequently, the NUTS 2 level may not be the appropriate level at which to capture policy effects (Fratesi and Wishlade, 2017) since NUTS 2 regions are, in most cases, too broad regional aggregates comprised of several heterogeneous NUTS 3 sub-regions whose actual economic disparities as far as GDP is concerned might be hidden in the aggregate NUTS 2 level.

It is of high importance for policymakers to assess whether the CP, defined at NUTS 2 level, effectively reduces disparities among the NUTS 3 regions, since over the past two decades, the proportion of total inequalities within EU member states attributed to the NUTS 3 level has been on the rise (Butkus et al., 2018). This trend implies that the CP may not be adequately addressing the issues within the NUTS 2 regions, particularly at the NUTS 3 level. This oversight might stem from an inadvertence of the unique characteristics and features of NUTS 3 regions, which could influence the effectiveness of Cohesion Policy financing. In order to consider the local effects that are not visible at NUTS 2 level, we will include data at a finer level of disaggregation, the NUTS 3 level, in our assessment analysis of the eligibility criterion of the Cohesion Policy.

In the first chapter, we will identify the patterns of the economic disparities through time in the level of economic wealth and its dynamics by performing a model-based clustering over the period from 2000 to 2017. We will expose the economic disparities at both regional levels, NUTS 2 and NUTS 3, and by contrasting them, we pretend to reveal whether NUTS 2 regions are a suitable statistical level at which to implement the Cohesion Policy or on the contrary, are not homogeneous territories and present internal economic differences that may cause the implemented policy to be ineffective and increase even more the regional disparities.

Additionally, we will obtain groups of regions sharing similar economic characteristics throughout all the analysed period which can be used as a starting point in future empirical studies focussed on exploring the driving forces behind the regional economic disparities. Finally, as we found that the NUTS 2 level is indeed covering the heterogeneity of their NUTS 3 regions —i.e., at a more detailed spatial scale (NUTS 3 level) disparities flourish because of the local characteristics and specialization of the regions—, we made an approach to characterise the reasons behind the revealed NUTS 3 economic disparities.

Results from this first chapter give rise to the next one. Having obtained that NUTS 3 regions do not share the same behaviours as their aggregate NUTS 2 regions and therefore allocating the funds at NUTS 2 level may present some inefficiencies and increase even more the regional disparities, the second chapter aims at determining whether the Cohesion Policy is indeed increasing the inequalities at the NUTS 3 level.

To this end, we have calculated the inequalities of all NUTS 3 regions in terms of their GDP per capita dispersion relative to the EU average² and constructed a panel model over the period 2000-2019. By means of a simple econometric model, in which the level of inequalities for each NUTS 3 region depends on the eligibility of the region to receive Structural Funds, we will determine the relationship between regional inequality and the Structural Funds. Additionally, we will include the spatial spillovers in the model to examine how the features of the neighbouring regions can affect the inequalities of a specific region.

The results shows that the NUTS 3 regions eligible for receiving Structural Funds experience a further increase of inequalities than the ineligible ones. Thus, combining these results with the ones obtained in the first chapter, enables us to throw the first main conclusion of this dissertation. The Cohesion Policy, aimed at reducing regional disparities and defined at NUTS 2 level, should consider that NUTS 3 regions do not share the same behaviours as their aggregate NUTS 2 regions and therefore allocating the funds at NUTS 2 level presents some inefficiencies.

² The inequalities level has been calculated as the GDP per capita dispersion relative to the GDP EU average in its non-decomposed form (not separated into intra- and inter-inequalities).

Apart from the bulk of the financing which is straightforwardly dedicated to boost the development of the lagging regions and eradicate the existing differences with the rest of regions, the Cohesion Policy, within the resources of ERDF funds and under the European initiative called INTERREG, delivers a small proportion of funding destined to promote cross-border strategies, which are directly oriented to foster the integration process in the border regions. Although borders may be viewed as a barrier in the exchange of resources and a restrictor to the general mobility due to the presence of different administrative organs, institutions, culture or different idioms between the two sides of the border, they are spaces where socioeconomic exchanges of good and services take place (De Sousa, 2013), triggering the integration process. Border regions are the first ones to be benefited from these interchanges, therefore, they are considered to be the laboratories of the European integration i.e., pioneer spaces in the implementation of new measures for integration between communities (European Commission, 2021).

According to the neoclassical theories, it is expected that the removal of barriers in goods, services, labour and capital and the increase of the cooperation and interactions between borders contribute to the integration of the regions (Goecke and Hüther, 2016) by producing a more efficient distribution of labour and resources between territories and therefore an efficiency of the economy (Bonin et al., 2008; European Commission, 2010). The integration in this context, implying a reduction of the territorial disparities between borders, can be considered as a synonymous of convergence³ (De Boe et al., 1999; Ehlers et al., 2001; Alegría, 2009; Pires and Nunes, 2018).

However, the integration between regions should be interpreted in a broader sense, since it can result from symmetries and similarities as well as from asymmetries and differences between border regions (Durand, 2015).

On the one hand, intense asymmetrical flows between border regions can lead to an increase of the territorial disparities, the removal of trade barriers significantly drops the transaction costs between regions which can produce a spatial agglomeration of productive

³ Since the creation of the Cohesion Policy, the objectives of promotion of the economic convergence between regions, understanding as the catching-up of the lagging regions with the prosperous ones, and reduction of inequalities between the levels of development have been intrinsically linked together, as they are the main mechanisms to achieve the cohesion and integration of the regions.

activities in some areas (Mora and Vaya, 2004). On the other hand, cross-border integration can be produced precisely because of the existence of high economic differences (Decoville et al., 2013). Therefore, it is not implicit that increasing the cross-border actions leads to a convergence process and levelling of disparities. According to Topaloglou et al. (2005), the integration on border regions depends on the balance between policy interventions and market dynamics, highlighting that more actions than opening borders are necessary to achieve convergence in European regions.

To contribute to the current debate, in chapters 3 and 4 we intend to explore the economic convergence processes and the evolution of the economic inequalities in the so-called “Euroregions”, defined as European structures for coordination and cooperation between regions on the borders of European countries, which have proliferated thanks to the INTERREG financing instrument (Medeiros, 2013). These cross-border structures were conceived to exploit the potential synergies that may arise between the regions due to its physical proximity by boosting the relationships within them and enhancing the cooperation activities.

Our aim is to determine whether the intense cooperation relationships that occur within these particular structures, composed of (international) border and non-border NUTS 3 regions, stimulate the convergence and narrow the existing economic inequalities within the Euroregion. Due to the contribution of these mechanisms to the cohesion and integration of the regions, it is of high importance to validate the success of this new kind of cooperation model in order to replicate it in other territories to achieve the total convergence of the EU.

To establish whether inequalities are being reduced and regions are converging to the same economical levels, we will study the σ and β convergence in the Euroregions, two concepts of convergence very popular in the literature. The first one refers to the reduction of inequalities between countries or regions in time while the second one refers to the process in which poorer countries or regions catch up with the richer ones across time.

Chapter 3 will focus entirely on the Euroregion of Galicia-Norte de Portugal, in Spain-Portugal border, a Euroregion especially active in the southwestern part of Europe (Durà

et al., 2018), considered a pioneer for its long history of cooperative relations, since the early 1980s, even before both countries joined the European Union in 1986.

Chapter 4 will expand the analysis conducted in Chapter 3 to the rest of the Spanish Euroregions, two of them sharing border with Portugal (EUROAAA and EUROACE) and two with France (New Aquitaine-Basque Country-Navarre and Pyrenees-Mediterranean). The Spanish Euroregions are a case study of interest because Spain has two border areas which are quite different from each other. In the Spain-Portugal side there exists cultural, language and spatial proximity while in the Spain-France side there is a natural barrier (the Pyrenees) between both countries, and the population centres are quite separated. Also, their initial economic development is different (higher in France than in Portugal). Therefore, this scenario is perfect to analyse how the inherent differences between the border countries might determine the presence or absence of convergence in the Euroregions. Finally, apart from studying the σ and β convergence, in this chapter we will examine the spatial convergence in order not to ignore the spatial component of the data.

As for the second main conclusion of the dissertation, the results show that convergence is achieved in the Spanish Euroregions sharing border with Portugal but not in those with France, suggesting that the Spanish Euroregions convergence process depends on the country Spain shares the border with.

In summary, this dissertation examines the effectivity of the Cohesion Policy on its objective of reducing the regional disparities. The first two chapters target one of its foundations subject to debate, the eligibility criterion for regions being financed, with the purpose of stablishing if NUTS 2 level is the appropriate level at which to capture policy effects, while the two following chapters discuss the role of the Euroregions (structures financed by the CP to promote integration processes) in reducing regional disparities. Concretely, Chapter 1 pretends to determine whether NUTS 2 regions are a suitable statistical level at which to implement the Cohesion Policy or on the contrary, are not homogeneous territories and present internal economic differences that may cause the policy implemented to be ineffective and increase even more the regional disparities. Based on the non-homogeneity obtained results, Chapter 2 corroborates if the Cohesion Policy is indeed increasing the inequalities at the NUTS 3 level. Chapter 3 intends to find out

whether the intense cooperation relationships that occur within the Euroregions, concretely within the Spanish Euroregion Galicia-Nord Portugal, stimulate the convergence and narrow the existing economic inequalities while Chapter 4 extends this analysis to the rest of the Spanish Euroregions. Finally, Chapter 5 concludes the dissertation, providing with concluding remarks on the overall research and potential directions for future research.

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Chapter 1. Regional economic disparities in Europe: Time-series Clustering of NUTS 3 regions

Published as: López-Villuendas, A.M., and del Campo, C. 2023. Regional Economic Disparities in Europe: Time-Series Clustering of NUTS 3 regions. *International Regional Science Review*, 46(3), 265-298. <https://doi.org/10.1177/01600176221125703>

ABSTRACT

The aim of this research is to identify the regional economic disparities in the level of economic wealth and its dynamics in the NUTS 3 regions in EU28 over the period from 2000 to 2017. By performing a time-series clustering analysis at NUTS 3 level, we expect to uncover the economic disparities that might have been hidden in the aggregate NUTS 2 regions. Our results indicate that at a finer spatial scale (NUTS 3 level) disparities flourish, particularly in the period after the global crisis of 2008, in which different recovery rates are observed. In general, NUTS 2 regions tend to spatially cluster at the national level and, although NUTS 3 regions show slightly this tendency as well, the spatial effect is not as strong as it is for NUTS 2 level, revealing specific behaviours of the local economies and markets that remain hidden at the aggregate NUTS 2 level.

Keywords: Time-series Clustering, European NUTS 3 Regions, Cohesion Policy, regional inequalities

1.1. Introduction

Regional disparities in the European Union (EU) have led to an intense debate in the last decades due to its importance in ensuring the well-balanced and harmonious development of the regions. Reduction of disparities is one of the main priorities of the Cohesion Policy, since their presence may jeopardise the enhance of competitiveness, integration and cohesion of the EU. Article 158 of the Treaty of the European Union states “in particular, the Community aims to reduce the disparities between the levels of development of the different regions”. To that end, the Cohesion Policy dedicates a large quantity of funds, targeted specially to lagging regions. However, despite the labour of the Cohesion Policy, regional disparities have been increasing throughout the last years fostered by the enlargement of the European Union with the accession of new countries and the global financial crisis (Heidenreich and Wunder, 2008; Meliciani ,2015; Mora et al., 2004). Regional inequalities substantially increased as the ratio between the richest and the poorest regions was about one to five for EU15 in 2000, but one to nine for EU25 in 2004 and one to 13 for EU27 in 2007. As highlighted in European Commission (2003,

2004), the enlargement would produce an increase of about 30 percent of the total European area and an increase of more than 25 percent of the population, but GDP would increase by only 5 percent. There are several authors who have compared the regional disparities in the economic performance before and after the enlargement and confirmed this increase in the level of regional disparities within the EU derived from that enlargement (e.g. Ezcurra, 2019; Heidenreich and Wunder, 2008).

The study of regional disparities is essential in order to highlight the deficiencies and problematic issues in the regions and to identify the potential areas of development. In the literature different approaches and methodologies for measuring disparities can be found (Kutscherauer et al., 2010). One of them is cluster analysis, which can be employed to classify and measure the disparities since this method enables to group the regions with similar characteristics in homogeneous groups or clusters.

The evolution of disparities in the European regions are usually measured at NUTS 2 level (e.g. Ezcurra, 2019; Monfort, 2008; Tvrdoň, 2012), as the Cohesion Policy is defined and the allocation of the funds is carried out at this level. However, the allocation of the funds within NUTS 2 regions may be uneven throughout the NUTS 3 regions since the eligibility for receiving funds is defined at NUTS 2 level regardless of the economic performance of their NUTS 3 regions (Gagliardi and Percoco, 2017). By performing the analysis at a finer geographical scale, i.e., the NUTS 3 level, some local effects that are not evident at NUTS 2 level might be revealed (Fratesi and Wislade, 2017). This level enables a more efficient identification of the cohesion programme's impact as NUTS 2 regions are too broad regional aggregates, particularly in the southern countries, which may cover the specific patterns of their NUTS 3 regions. Additionally, there are some countries such as Slovakia (Leška, 2015), Czech Republic (Illner, 2010) or Hungary (Tvrdoň and Skokan, 2011), whose NUTS 3 regions are the higher-level territorial self-governing units. Actually, for these countries, the NUTS 2 regions were artificially created for the allocation of the Structural Funds as a combination of one to three NUTS 3 regions.

As stated above, the number of disparities at NUTS 3 level is rising and policies such as the Cohesion Policy are implemented at NUTS 2 level regardless of the performance at the NUTS 3 level. Due to the huge amount of funds dedicated to the Cohesion Policy, it is

necessary to determine whether the current regional level at which the funds are allocated is masking the economic inequalities of their NUTS 3 regions. However, only the evolution of the NUTS 3 economic disparities in last decades and the whole EU has been analysed in literature (Butkus et al., 2018; Goecke and Hüther, 2016), while we also incorporate the patterns of that evolution in our study.

The purpose of this research then, is to uncover the NUTS 3 economic patterns which may be hidden in their aggregates NUTS 2 level by performing a model-based clustering, which will account for the distribution of the data and will allow the inclusion of the time dimension in the clustering, thus getting an insight of the patterns of the economic disparities through time. In order to do that, we will identify the regional economic disparities in the level of economic wealth and its dynamics in all 1348 NUTS 3 regions in EU28 throughout the recent time period 2000-2017 and contrast them to the ones obtained at NUTS 2 level.

The contribution to the literature will be threefold. On one hand we will identify the economic disparities at both NUTS 2 and NUTS 3 levels, and by contrasting them, we will determine whether the NUTS 3 regions share the same behaviours as their aggregates NUTS 2 regions and therefore policies such as the Cohesion Policy are equally effective for all territories. On the other hand, we will also obtain groups of regions sharing similar economic characteristics throughout all the covered period which can be used as a starting point in future empirical studies focussed on exploring the driving forces behind the regional economic disparities. Finally, as we found that the NUTS 2 level is masking the heterogeneity of their NUTS 3 regions, we made an approach to characterise the reasons behind the revealed NUTS 3 economic disparities.

The article is organized as follows. Section *Background Literature* reviews the literature on regional disparities. Section *Methodology* describes the methodology and the data used for the analysis while section *Results and Discussion* presents and discusses the obtained results. Finally, section *Conclusions* concludes the paper.

1.2. Background Literature

Ever since the early time of the European integration process, the issue of regional inequality has always been an important concern for the EU. The Cohesion Policy aims to reduce disparities between EU regions in order to achieve balanced economic, social and territorial development.

The analysis of regional disparities in the European Union is a recurrent theme in research studies since it serves as an indicator of integration and cohesion of the European Union and it enables to assess the performance of the Cohesion Policy.

Economic disparities are the most addressed ones in inequality literature and are usually measured by several inequality indicators processed by different statistical and mathematical methods.

Many studies addressing economic disparities in the EU have examined the effect of regional inequalities on the development of the regions by performing growth regressions (De Dominicis, 2014; Lessmann, 2014; Panzera and Postiglione, 2021; Petrakos et al., 2003). Some authors have focussed on determining possible factors of regional disparities within EU countries (e.g. Ezcurra, 2019; Kyriacou and Roca-Sagalés, 2012) while the gross of the literature aims at measuring the magnitude and evolution of regional inequalities. An uniformed criterion has not been reached by researchers when measuring regional disparities and, in fact, different approaches based on statistical or mathematical methods can be found in the literature (Kutscherauer et al., 2010).

Regional economic disparities are usually calculated by some of the numerous measures of inequality existing in the literature, based on the dispersion of the GDP indicator, such as the coefficient of variation (e.g. Butkus et al., 2018; Ezcurra, 2019; Goecke and Hüther, 2016; Kokocińska and Puziak, 2020; Monfort, 2008; Postiglione et al., 2020; Smetkowski and Wójcik, 2012; Tvrdoň, 2012; Tvrdoň and Skokan, 2011), the Gini index (e.g. Butkus et al., 2018; Ezcurra, 2019; Monfort, 2008; Mora et al., 2004; Tvrdoň and Skokan, 2011), the Theil index (e.g. Butkus et al., 2018; Ezcurra, 2019; Monfort, 2008; Tvrdoň, 2012), the mean logarithmic deviation (e.g. Butkus et al., 2018; Ezcurra, 2019; Heidenreich and Wunder, 2008; Monfort, 2008) or the Atkinson index,

among others (e.g. Monfort, 2008). Other measures include the dynamics of the distribution of the data, such as the kernel density function (e.g. Mora et al., 2004; Kokocińska and Puziak, 2020), Markov chain analysis (e.g. le Gallo, 2004), non-parametric estimation of density functions, cumulative density functions and Salter graphs (e.g. Geppert and Stephan, 2008; Monfort, 2008) or the spatial component (e.g. Ertur and Koch, 2006; le Gallo, 2004; le Gallo and Ertur, 2005; Smetkowski and Wójcik, 2012). Finally, other authors have considered multivariate statistical methods, adding more indicators, such as cluster analysis and factor analysis (e.g. del Campo et al., 2008; Pavone et al., 2021; Soares et al., 2003) or multicriteria decision-making methods (e.g. Poledníková, 2014).

One widely shared result of many of these studies is that there has been a decrease in between-state inequalities while within-state inequalities have increased (e.g. Butkus et al., 2018; European Commission, 2003; Ezcurra, 2019; Heidenreich and Wunder, 2008; Meliciani, 2015; Monfort, 2008; Puga, 2002). For example, Heidenreich and Wunder (2008), measuring regional disparities with the decomposed form of mean logarithmic deviation, stated that within-states regional inequalities in the enlarged EU increased by 15 percent over the period from 1995 to 2003, while the between-state inequalities decreased by 45 percent. They determined that most of the regional economic inequalities in the EU are within-states (67 percent at the NUTS 3 level, 84 percent at the NUTS 2 level). More recently, Butkus et al. (2018), analysing economic disparities with the decomposed form of Theil index over the period 1995-2014, stated that disparities between countries are diminishing, accounting for 60.4 percent of total disparities in the EU in 2014 compared to 76.4 percent in 1995, while within-state inequalities are increasing. 23.8 percent of total inequalities were attributed to inequalities between NUTS 2 regions within the country (13.4 percent in 1995) and 15.8 percent to inequalities between NUTS 3 regions within NUTS 2 regions (10.2 percent in 1995).

Despite the publication of numerous studies on the evolution of regional disparities, the territory they usually address is the NUTS 2 level, paying less attention to NUTS 3. At this level, the studies focus generally on groups of countries (e.g. Smetkowski and Wójcik (2012) or Tvrdoň and Skokan (2011) in eastern Europe) or old members (Geppert and

Stephan, 2008; Postiglione et al., 2020). Although there are some contributions addressing the whole European Union. For example, Heidenreich and Wunder (2008), studying the evolution of regional inequalities over 1214 NUTS 3 regions in the EU25 from 1995 to 2003 using the Gini coefficient and the mean logarithmic deviation, stated that the disparities at NUTS 3 level increased by 15 percent over that period. Goecke and Hüther (2016), using the coefficient of variation as the measure of regional inequality over 1289 NUTS 3 regions in EU28, determined that the disparities declined from 2000 to 2009 but increased until 2011. More recently, Butkus et al. (2018), studying economic inequalities with the coefficient of variation over the period 1995-2014 in 1342 NUTS 3 regions in EU28, obtained that disparities at NUTS 3 level increased by 8.3 percent over the studied period. In 2014, disparities at the NUTS 3 level were bigger by 70 percent compared with the national level, while the initial difference was 41 percent. On the other hand, disparities at the NUTS 2 level increased (1.2 percent higher in 2014 than in 1995) and were 28.3 percent higher than disparities at the country level.

Measures based on the dispersion of GDP, such as the coefficient of variation, Gini index, Theil index, etc, provide relevant information regarding economic disparities, but may be considered as insufficient. Kokocińska and Puziak (2020), Quah (1993a, 1993b), or Wójcik (2016), among others, argued that dispersion indicators do not provide any information on the behaviour of the GDP distribution. By performing a model-based clustering, the grouping of the regions is carried out according to their GDP distribution. In particular, observations belonging to the same cluster, i.e., regions which similar GDP characteristics in the studied period, are generated by the same distribution. Additionally, unlike other clustering algorithms, model-based clustering allows to deal with time-series, thus including time as an essential characteristic of the analysis. Other advantage with respect to other clustering algorithms is that it selects the optimal number of clusters and the appropriate model according to which the data is distributed.

Since one of the most important descriptors of regional economic differences is the region's performance and is mainly measured by GDP, GDP per capita has been chosen as the indicator for measuring the economic disparities. Hence economic inequalities will be analysed for levels of GDP per capita, and although the level of GDP finally reflects the

cumulative rate of economic growth for the covered period, we will examine the rate of GDP growth as well, in order to account for the economic dynamism.

1.3. Methodology

1.3.1. Clustering

An uniformed criterion has not been reached by researchers when measuring regional disparities. In fact, different approaches based on statistical or mathematical methods can be found in the literature (Kutscherauer et al., 2010). Cluster analysis constitutes one of the multivariate methodologies to determine disparities by classifying regions with similar characteristics into clusters which are homogeneous within and heterogeneous between. Concretely, time-series clustering enables to identify similarities in the economic time trends of the different territories.

However, time-series present peculiar nuances, such as high dimensionality, high feature correlation or large amount of noise, so that conventional clustering algorithms do not work properly (Lin et al., 2004). In the literature, three ways of addressing clustering time-series are presented (Aghabozorgi et al., 2015): feature-based, shape-based and model-based approaches.

In the feature-based approach, the raw time-series are converted into a feature vector of lower dimension, therefore reducing the time-series dimensionality using a representation method. Later, a conventional clustering algorithm is applied to the extracted feature vectors. This approach is very common due to the high dimensionality of time-series since it reduces the effect of noise and has a low complexity of distance calculation. However, reduction of dimensionality can cause overlooking of data (Lai et al., 2010).

In the shape-based approach, clusters are generated based on similarity in shape (the time of occurrence of patterns is not important to find similar time-series in shape). This approach works directly with the raw time-series data and usually employs conventional clustering methods, whose distance measure has been adapted for time-series. Distances

such as Dynamic Time Warping (Chu et al., 2002) can calculate the similarity in shape between time-series. This approach is not usually employed in existing works since its high computational demand makes its use in large time-series datasets expensive.

Finally, in model-based methods, raw time-series are transformed into model parameters and then a conventional clustering algorithm is applied to the extracted model parameters. This approach considers that data is generated by a model or by a mixture of underlying probability distributions, each of which represents a different cluster. By fitting the assumed mixture model to observed data, observations can be classified as belonging to the cluster under which they have the greatest probability of occurring (Warren Liao, 2005). One advantage of model-based clustering is that it provides a precise framework for assessing the resulting partitions of the data and especially for choosing a relevant number of clusters (Biernacki et al., 2000).

In our study we choose to perform a model-based clustering to group the NUTS 3 European regions which have similar time tendencies according to their level of GDP per capita. This type of clustering has been proved to be useful in economics since it accounts for unobserved heterogeneity in the data (Grün, 2019). Its main benefit, with respect to the conventional clustering algorithms such as the hierarchical clustering or k-means, is the selection of the number of clusters and the appropriate model according to which the data is distributed.

The most popular model-based approach is the Gaussian mixture models (GMM) in which each component or cluster is modelled by a Gaussian distribution parametrized by its mean and covariance matrix. Even if an underlying mixture component is non-normal, it can be approximated by several Gaussian components (Fraley and Raftery, 1998). Model-based clustering provides then a soft assignment where each time-series has a probability of belonging to each cluster.

Given data \bar{y} with independent multivariate observations y_1, \dots, y_n the likelihood for a mixture model with G components is:

$$L_{mix}(\theta_1, \dots, \theta_G; \tau_1, \dots, \tau_G \vee \bar{y}) = \prod_{i=1}^n \sum_{k=1}^G \tau_k f_k(y_i \vee \theta_k) \quad (1)$$

where f_k and θ_k are, respectively, the density and parameters of the k th component in the mixture and τ_k is the probability that an observation belongs to the k th component. f_k is the multivariate normal (Gaussian) density ϕ_k , parametrized by its mean μ_k and covariance matrix Σ_k :

$$\phi_k(y_i|\mu_k, \Sigma_k) = \frac{\exp\{-1/2 (y_i - \mu_k)^T \Sigma_k^{-1} (y_i - \mu_k)\}}{\sqrt{\det (2\pi \Sigma_k)}} \quad (2)$$

The covariance matrix of Eq. 2 determines the geometric features of the clusters, that is, their shape, volume and orientation, and is computed by Expectation Maximization (EM) algorithms.

In our study, model-based clustering using Gaussian mixed models has been performed with the statistical software R version 3.6.1 and the package *mclust* (Scrucca et al., 2016). *mclust* uses an identifier for each possible parametrization of the covariance matrix. The first identifier refers to volume, the second to shape and the third to orientation and each have three possibilities identified as E for “equal”, V for “variable” and I for “coordinate axes”. There are a total of 14 combinations of volume, shape and orientation or models (see Appendix Table A1 for a detailed description of the 14 combinations).

The most appropriate models were those allowing for the most homogeneous grouping of time-series regarding their patterns of variation, selected among those with the lowest Bayesian Information Criterion (BIC). Apart from selecting the parametrization of the model, BIC selects the number of clusters as well (Fraley and Raftery, 2002).

1.3.2. Data description

The main variable in our analysis is the Gross Domestic Product in Purchasing Power Standards (GDP PPS) per capita, standard measure of the degree of prosperity, collected from the Cambridge Econometrics’ European Regional Database that is available from the new Annual Regional Database of the European Commission’s Directorate General for Regional and Urban Policy (ARDECO, 2020).

The geographical units considered in this study are all the 1348 NUTS 3 regions in EU-28 according to the NUTS 2016 classification. Nomenclature of Territorial Units for Statistics (NUTS) is a hierarchical classification on regional levels from 1 to 3 that subdivides each Member State into a number of regions of level NUTS 1 (e.g. Baden-Württemberg in Germany or Isole in Italy). Each of them is then subdivided in regions of level NUTS 2 (e.g. Stuttgart and Sicilia, respectively) and these are divided, at their turn, in regions of level NUTS 3 (e.g. Böblingen and Palermo, respectively). NUTS 1 level identifies larger socio-economic regions, NUTS 2 level indicates basic regions and NUTS 3 the smaller regions. The NUTS classification was created in order to enable the collection of harmonised regional statistics in the EU and all statistics transmitted by the Member States to the Commission should use the NUTS classification⁵ (Regulation EC No. 1059/2003 of the European Parliament and of the Council 2003).

The NUTS 3 level is an ideal unit of analysis because throughout most EU countries the boundaries of those regions were often derived from geography and industrial history. Moreover, the finer the disaggregation of the data, the more precisely EU interventions and national economic policies can be studied, implemented and evaluated. Our sample includes data of all 1348 regions at NUTS 3 level in the 28 EU countries over the period 2000-2017 (UK is included in the analysis as it had not left the EU yet).

The descriptive statistics in Table 1.1 display the asymmetries between the NUTS 3 EU regions in terms of GDP PPS per capita (GDPpc). The dispersion in this variable varies from a ratio of 1:89 for year 2000 to a ratio of 1:54 for year 2008. This fact, together with the rest of descriptive statistics proves the presence of outliers, as shown in Figure 1.1. The two extreme values correspond for all years to the same two regions, Candem and City of London, and Westminster both in UK, which have values of GDPpc much higher than the rest of the regions. However, these regions have not been removed from the analysis since model-based clustering is not significantly sensitive to outliers (Fraley and Raftery, 2002).

⁵ When an amendment to the NUTS classification occurs, the concerned Member State replaces the time-series accordingly in Eurostat, which is the main source of the ARDECO database.

Table 1.1: GDP PPS per capita descriptive statistics by year (2000-2017)

Year	Min	Max	Mean	SD	Skewness	Kurtosis
2000	2424.90	216065.64	19006.23	11363.35	6.70	98.03
2001	2941.08	219482.70	19689.56	11662.01	6.61	94.82
2002	3118.54	227189.30	20272.89	11888.53	6.82	99.76
2003	3196.35	242891.94	20565.48	12135.57	7.47	115.72
2004	3791.34	263918.02	21532.59	12749.72	7.94	127.82
2005	3654.25	284668.66	22209.95	13327.37	8.46	141.12
2006	4515.43	299139.35	23329.51	13858.58	8.48	142.78
2007	4964.68	329885.39	24528.71	14849.87	9.15	160.06
2008	5895.72	317621.44	24477.84	14556.34	9.11	155.84
2009	5541.05	313248.98	22955.96	13917.09	9.84	175.86
2010	5581.77	329119.21	23985.94	14793.20	9.64	169.25
2011	5930.31	336346.31	24794.87	15425.39	9.23	156.25
2012	5902.01	343185.39	25291.76	15799.21	9.34	157.88
2013	6048.57	346897.44	25446.90	16004.78	9.46	159.98
2014	6525.19	370808.40	26388.09	16830.60	9.92	172.63
2015	6609.63	382945.15	27523.14	17445.72	9.74	167.94
2016	6587.15	402957.26	27642.40	18013.51	10.20	178.87
2017	6995.98	400425.27	28299.72	18174.35	9.97	171.06

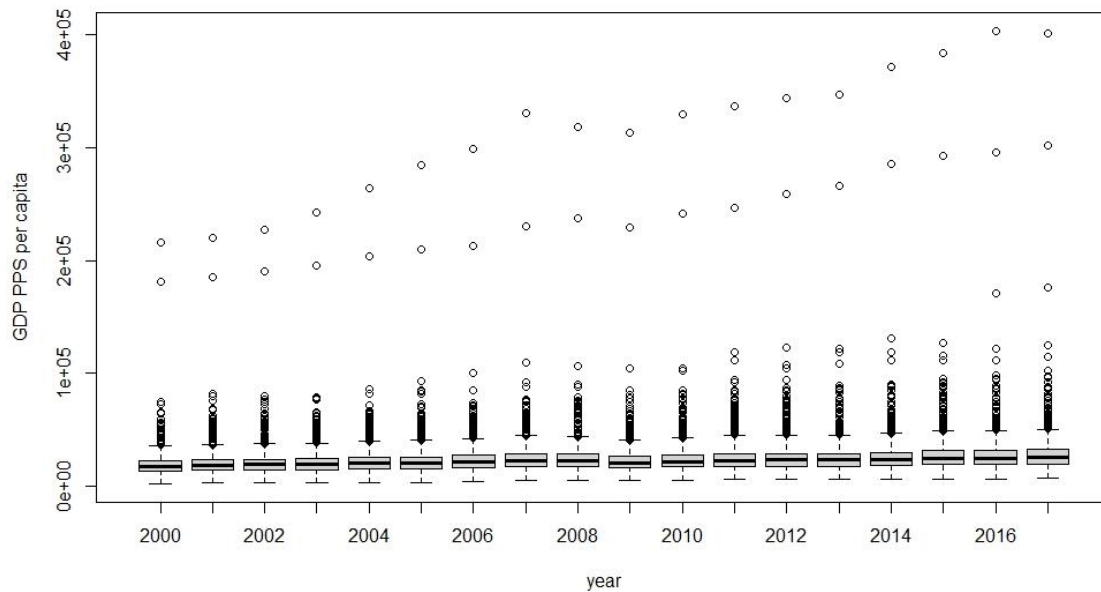


Figure 1.1: Boxplots of GDP per capita by year (2000-2017).

1.4. Results and discussion

Figures 1.2 and 1.3 show the patterns and the mapping resulted from the model-based clustering over the GDPpc values of the NUTS 2 European regions in the period 2000-2017. The best model according to Bayesian Information Criterion (BIC) is a VEE model with 4 components or clusters (See Appendix Table A2 for a specification of the best solutions).

The first cluster (in magenta in Figures 1.2 and 1.3) is composed of regions in Spain, France, Italy, Greece, Portugal, Germany, UK, Finland, Belgium, Netherlands and Czech Republic. It has values close to the mean but lower.

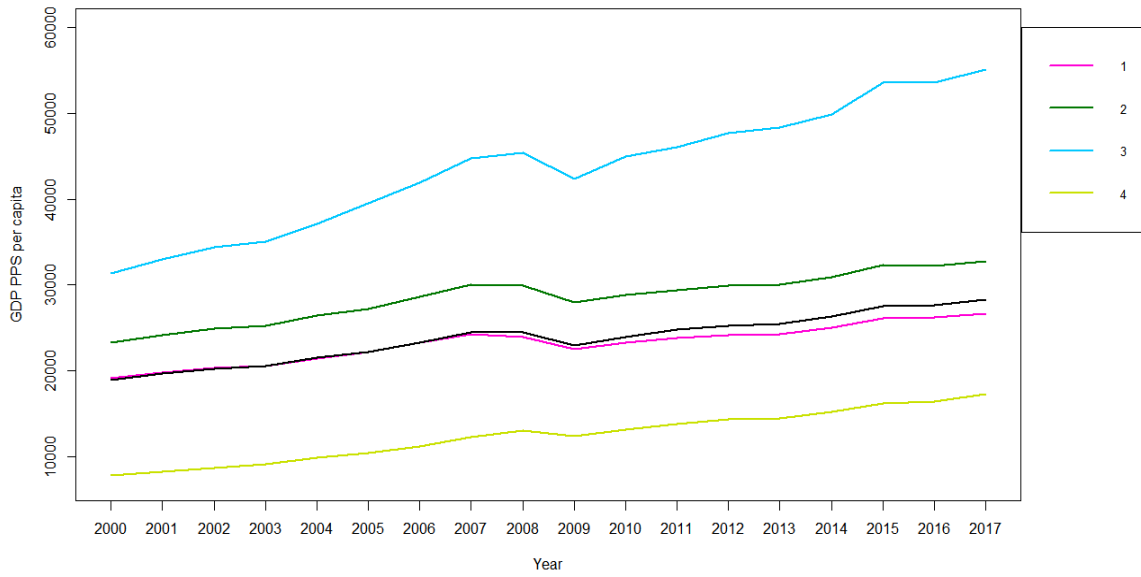


Figure 1.2. Patterns of 4-cluster solution for GDPpc of NUTS 2 regions for period 2000-2017. The mean values for each year are represented with a black line.

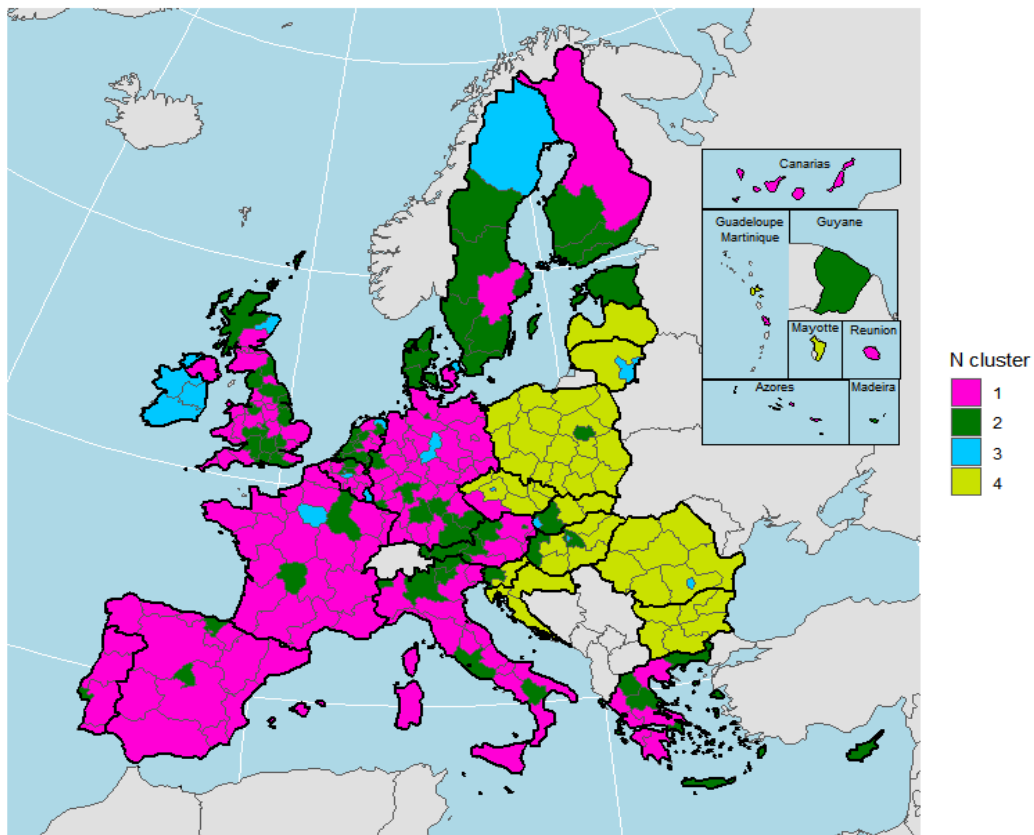


Figure 1.3. Mapping of 4-cluster solution for GDPpc of NUTS 2 regions for period 2000-2017.

The second cluster (in dark green in Figures 1.2 and 1.3) is constituted by some regions of UK, Italy, Czech Republic, Greece, Cyprus, Finland, Denmark, Sweden and Estonia, among others, and some capital regions as Lisbon in Portugal, Madrid in Spain or London in UK. It is characterized by a GDP per capita pattern superior to the mean.

The third one (in blue in Figures 1.2 and 1.3) has a value of GDP per capita much superior to the rest of the patterns and it is formed mainly by regions of Ireland.

Finally, cluster number four (in yellow in Figures 1.2 and 1.3) is mostly formed by regions of the eastern countries such as Hungary, Latvia, Lithuania, Poland, Romania, Bulgaria, Slovakia and Croatia.

In general, as shown in Figure 1.2, all the patterns are characterized by a rise in GDPpc values until year 2008, followed by a decrease in 2009, reflecting the effect of the global financial crisis of 2008, decrease that is sharper when the level of GDPpc is higher, and a rise again until 2017.

However, when we perform the model-based clustering with the same indicator at a finer level of disaggregation, the NUTS 3 level, we obtain that the number of clusters rises up to 11. This suggests that by performing the analysis at a more detailed spatial scale, more disparities flourish, since regions in a specific cluster share similar patterns of GDPpc but are dissimilar to regions not belonging to that cluster. To corroborate this statement we calculate two inequality measures, the coefficient of variation and the Gini coefficient, at NUTS 2 and NUTS 3 level for the period from 2000 to 2017 and compare them to verify whether there is more dispersion in the economic disparities between the two levels. Both measures, whose formulas appear below, are based on dispersion of GDP per capita.

$$CV = \frac{\frac{1}{N} \sqrt{\sum_{i=1}^N (y_i - \bar{y})^2}}{\bar{y}} \quad (3)$$

$$Gini = \frac{1}{2N^2\bar{y}} \sum_{i=1}^N \sum_{j=1}^N |y_i - y_j| \quad (4)$$

where y_i is the GDP per capita of the i region, \bar{y} is the mean and N is the number of regions. We use the two inequality measures in its unweighted version according to Gluschenko (2018), who claims that the weighted version might lead to inconsistent outcomes.

As we see in Figures 1.4 and 1.5, the level of disparities of NUTS 3 regions is greater than the level for NUTS 2 regions in all years and for both measures. This is in line with studies at NUTS 3 level exploring the evolution of disparities in terms of the dispersion of GDP, such as Butkus et al. (2018), who claimed that regional disparities become more evident when considering smaller territorial units.

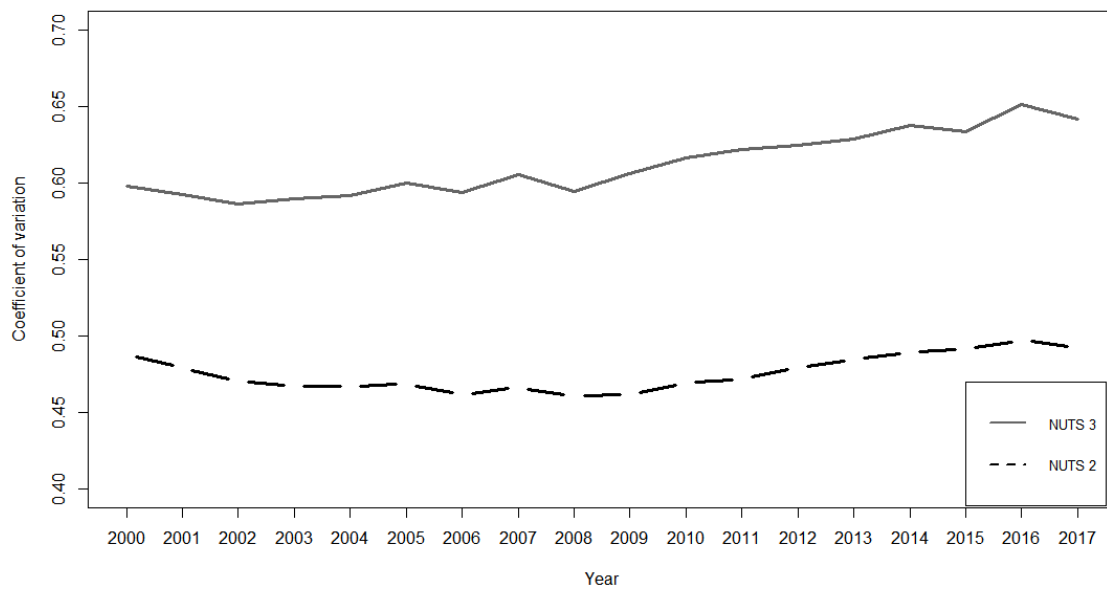


Figure 1.4. Coefficient of variation of GDPpc of NUTS 2 and NUTS 3 regions for period 2000-2017.

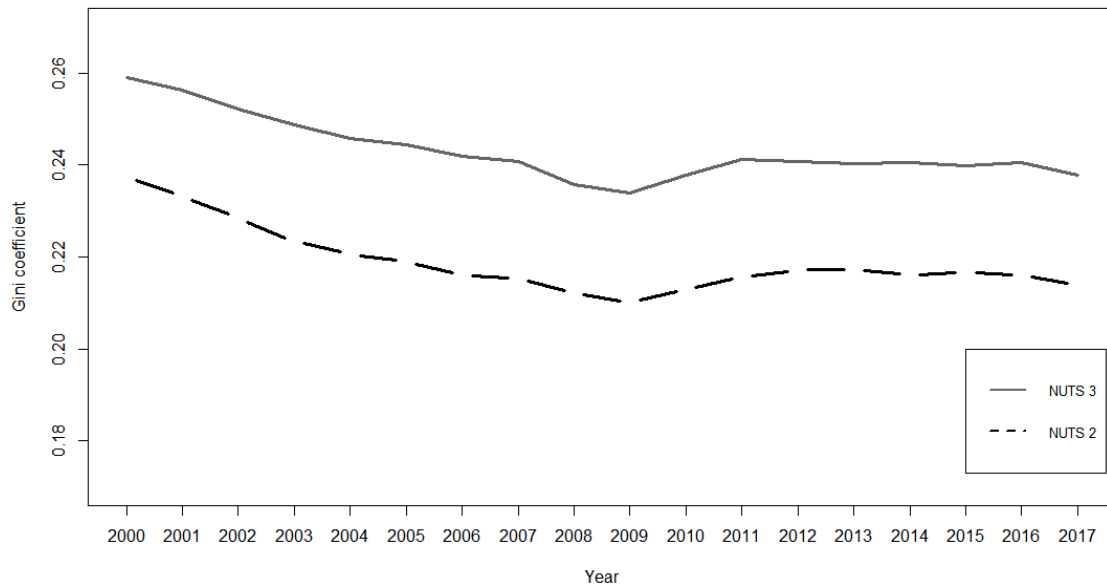


Figure 1.5. Gini coefficient of GDPpc of NUTS 2 and NUTS 3 regions for period 2000-2017.

The patterns and mapping of the 11-cluster solution for NUTS 3 regions are represented in Figures 1.6 and 1.7. In general terms, some changes arise by clustering at NUTS 3 level with respect to the previous clustering on NUTS 2 regions. The cluster which comprised the eastern countries at NUTS 2 level (cluster number 4 in Figures 1.2 and 1.3), has been divided into two clusters (cluster number 9 and 10 in Figures 1.6 and 1.7), whose patterns of GDPpc are quite similar except for its behaviour during the financial crisis (growth rates are higher for cluster 10 during the crisis). Cluster number 1 in Figures 1.2 and 1.3 has been disaggregated in several clusters at the NUTS 3 level analysis. For example, most regions of Spain and some regions of Greece now form a separate cluster (cluster number 7 in Figures 1.6 and 1.7), which presents a slow recovery from the financial crisis. Regions of South Italy, Portugal, France and some regions in UK constitute another cluster which also have a slow recovery from the crisis and a lower level of GDPpc between years 2005-2009 (cluster 11 in dark blue in Figures 1.6 and 1.7). North Italy regions represent now a separated cluster as well (cluster 6 in grey in Figures 1.6 and 1.7), which has superior levels of GDPpc than the rest of the previous clusters (clusters 7 and 11 in Figures 1.6 and 1.7).

Additionally, we see that countries in the geographic centre of EU, such as Austria, Germany, Belgium, Netherlands or Czech Republic, are very heterogeneous since they contain regions belonging to several clusters. These NUTS 3 regions are quite small geographical areas, suggesting that the geographical size of the regions also plays a role in disparities. Cluster number 5 (in magenta in Figures 1.6 and 1.7) has economic values much higher than the rest of the clusters, since it contains the outliers mentioned in section *Methodology-Data Description*.

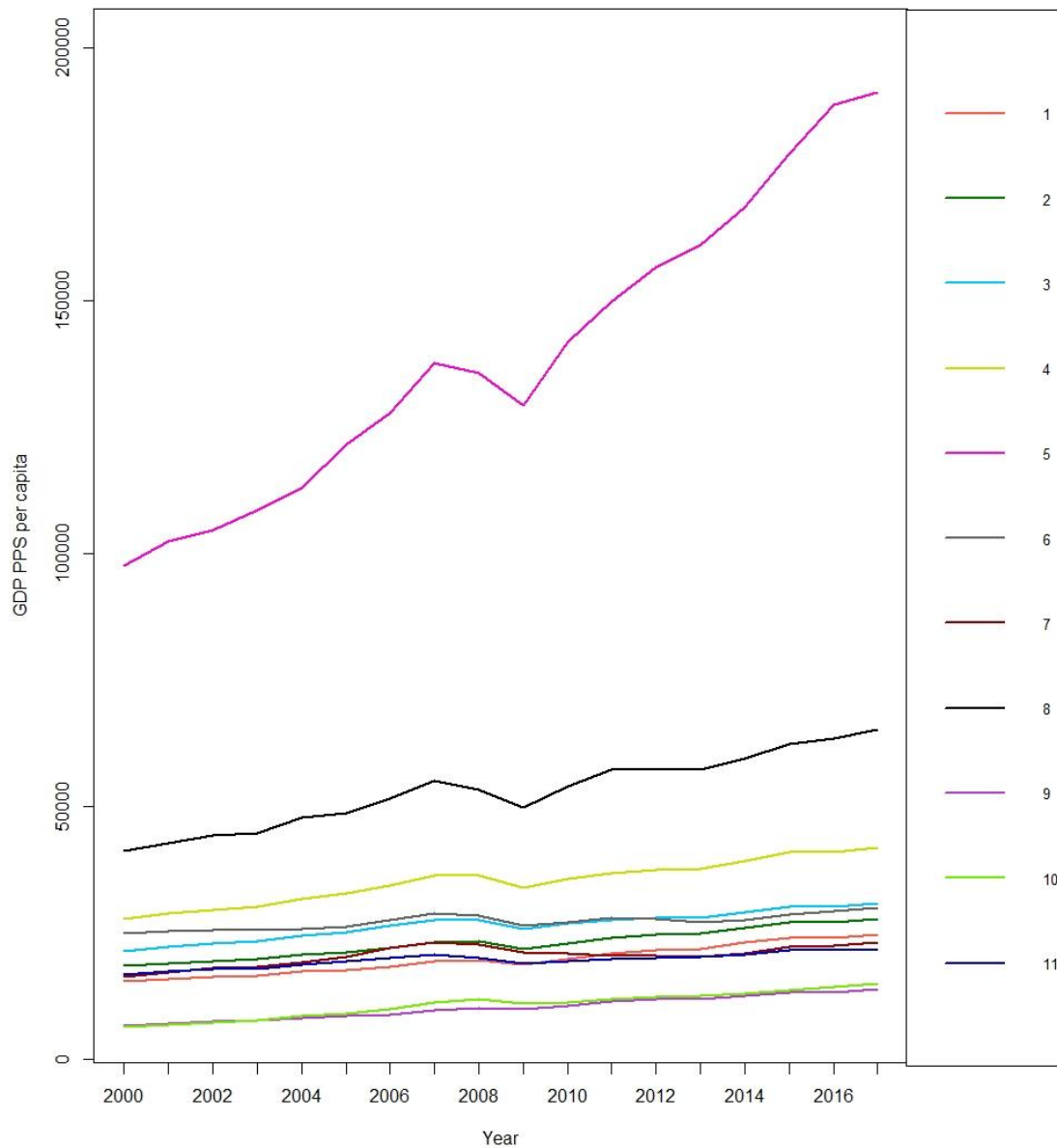


Figure 1.6. Patterns of 11-cluster solution for GDPpc of NUTS 3 regions for period 2000-2017.

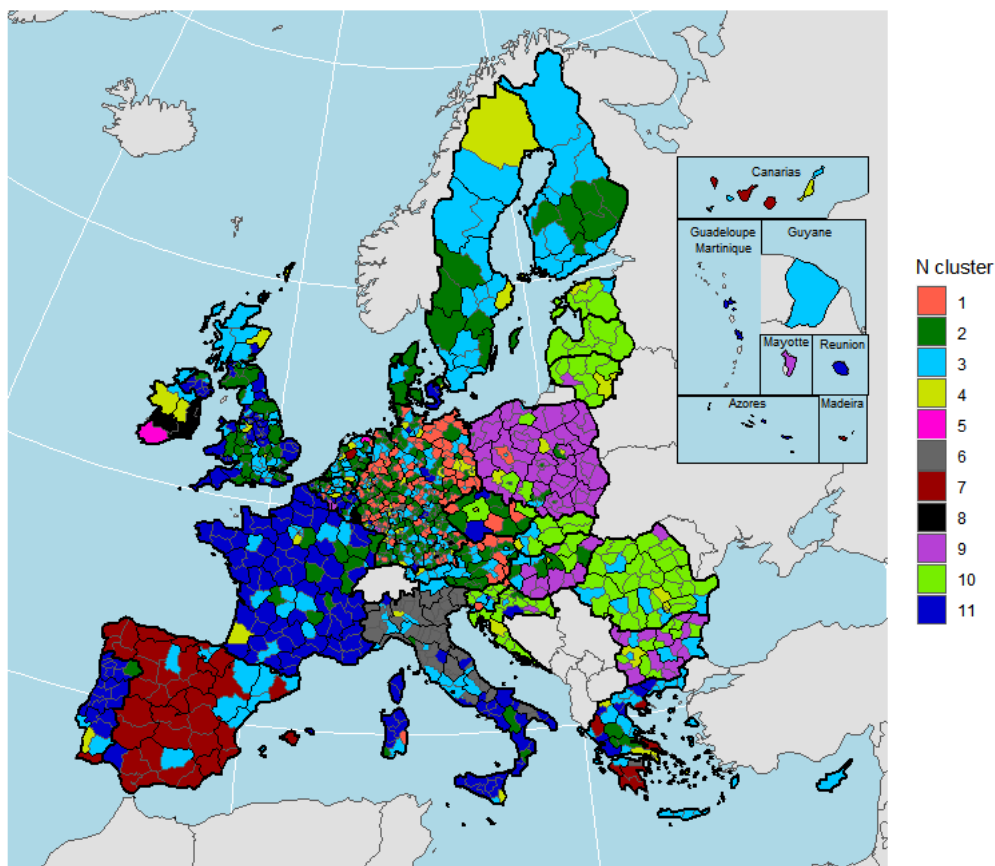


Figure 1.7. Mapping of 11-cluster solution for GDPpc of NUTS 3 regions and period 2000-2017.

Finally, it can be observed that the spatial effect is not as strong as it was for NUTS 2 clustering, in which regions belonging to the same cluster were usually spatially near (see Figure 1.3). This suggests that at a finer level of disaggregation, the local economic and market features arise and regions may share similar economic characteristics with remote regions rather than with contiguous ones. Although determining the forces behind the clustering is beyond the scope of this paper, we have performed an initial characterization of the 11 clusters obtained for the level of GDPpc at NUTS 3 level according to the variables used in Aumayr (2006) (in Table 1.2) who performed a multivariate clustering of NUTS 3 regions for year 2002 identifying 11 groupings⁶: agricultural rural peripheral

⁶ Aumayr (2006) included an additional variable in the cluster analysis, the accessibility of population, which represents the amount of people weighted by a function of distance measured as the average travel time from one region to every other region and made a distinction between urban and non-urban regions in the clustering. We have used the variable “inhabitants” as a proxy for the potential size of the urban market (See Boix et al. 2013 and Lazzeretti et al. 2009).

regions, industrialized rural peripheral regions, highly intensive touristic regions, touristic regions, industrial regions, industrialized regional centres with surroundings, tertiary regional centres with surroundings, central agglomerations, industrial cities, tertiary cities and metropolitan areas.

Table 1.2: Variables for the characterization of the 11 clusters for the GDPpc level of NUTS 3 regions

Variable	Proxy	Source	Unit(**)
Inhabitants	This variable approaches the market potential	Eurostat	Total number of people
Population density	This variable serves as an indicator of agglomeration economies	Eurostat	Number of people divided by the area
Share of employment in the primary sector	This variable accounts for agrarian regions	ARDECO(*)	Percentage of the employment in the primary sector over the total employment
Share of GVA in the secondary sector	This variable determines industrialized regions	ARDECO(*)	Percentage of the GVA in the secondary sector over the total GVA
Share of employment in the tertiary sector	This variable determines the tertiarization of a region	ARDECO(*)	Percentage of the employment in the tertiary sector over the total employment
Beds in hotels per 1000 habitants	This variable indicates tourism specialization	Eurostat	Number of beds in hotels per thousand inhabitants

Note: (*) data of UK has been extracted from the Office for National Statistics of UK

(**) The indicators are computed as the mean of the variables over the 2000-2017 period

Table 1.3: Characterization of the 11 clusters for the GDPpc level of NUTS 3 regions

Indicators	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10	Cluster 11
Inhabitants	192738.91	296458.14	337501.42	407538.64	291625.27	517115.71	803723.06	367604.07	402383.75	364796.35	440250.50
Population density	204.38	442.62	712.13	1534.96	3613.88	284.92	458.84	2208.11	103.45	74.64	472.30
Share employment primary sector	4.32	4.31	5.60	3.69	2.05	3.71	9.25	1.77	21.21	22.81	7.29
Share GVA secondary sector	23.30	23.48	22.08	22.02	39.48	24.03	16.04	31.60	23.95	28.38	16.65
Share employment tertiary sector	67.37	68.56	70.09	74.98	74.33	66.05	68.93	71.68	49.83	45.60	70.25
Beds in hotels per 1000 inhabitants	55.98	68.61	78.75	62.29	32.80	109.21	68.72	38.76	23.48	43.48	76.43

Note: Grey cells identify the indicators for which the Kruskal-Wallis test rejects the null hypothesis of similar sample means. Bold black figures identify the highest values of the means and red figures identify the lowest ones. The Kruskal-Wallis test is a non-parametric method for equality of means. It indicates the significant differences among means and it can be used to determine the between-group differences among clusters.

As seen in Table 1.3, we can characterise the regions belonging to cluster number 1 as the regions which can benefit more from the urbanization economies having the greatest potential for the urban market. Almost all regions are in central Europe with the exception of one region in the southern and six in the eastern periphery. Cluster number 4 regions, which present higher GDPpc levels than the rest, are the ones with the highest share in the tertiary sector. This cluster has the higher proportion of urban regions and it does not have totally rural regions⁷. Cluster number 5 regions, which have the highest levels of GDPpc, are the most industrialized and the ones which can benefit more from the agglomeration economies. All regions are metropolitan and are allocated in Central Europe. Cluster number 6 regions, situated in the southern periphery of EU, are the ones more specialized in tourism. Cluster number 7 regions are the least industrialized and have the lower potential for the urban market. All regions are in the southern periphery with the exception of one in the centre. Cluster number 8 regions, which have high values of GDPpc, are the least agricultural regions, not being entirely rural regions. All of them are in Central Europe except for one region in Greece. Cluster number 9 regions are the ones with less specialization in tourism, very few of them are urban, and all of them are in the eastern periphery except for four regions situated in the centre. Cluster number 10 regions, which have lowest levels of GDPpc, are the more agricultural and least specialized in the tertiary sector and agglomerated regions. Also, it is the cluster with the lowest rate of urban regions. These regions are located in the eastern periphery (except for one in Denmark, another in France and two in Belgium). Finally, clusters number 2, 3 and 11 are characterized by regions with lower shares of the primary and secondary sectors, slightly higher shares in the tertiary sector and more specialized in tourism than the rest of the clusters.

This characterization shows that factors such as the structure (urban/rural), the sectorization, the agglomeration or the specialization of the regions may be considered as potential underlying reasons for explaining the economic inequalities that arise at the NUTS 3 level.

⁷ The rural, urban and metropolitan classification of the regions has been taken from Eurostat NUTS 3 typologies (<https://ec.europa.eu/eurostat/web/nuts/tercet-territorial-typologies>).

1.4.1. Economic growth analysis

An interesting step when analysing economic patterns is to study the (spatial) evolution of the economic growth (Postiglione et al., 2020). To this end, we will explore the patterns of growth rates of GDPpc for the whole 2000-2017⁸ period performing a model-based clustering as well.

At NUTS 2 level, we obtain that the optimal number of clusters is 10 according to BIC. The patterns of this solution are represented in Figure 1.8 and mapping in Figure 1.9.

First, we notice in Figure 1.9 that regions are closely spatially clustered at national level. All regions of Spain (except Balearic Islands) represent an isolated cluster (cluster number 7 in Figures 1.8 and 1.9), nearly all regions in Italy constitute a separate cluster as well (cluster number 4 in Figures 1.8 and 1.9) and the same happens for Greece (cluster number 6 in Figures 1.8 and 1.9). The last one presents a pattern after the crisis different to the rest, since the growth rates are negative until 2013. Cluster number 9 is constituted by most regions of Poland (in purple in Figures 1.8 and 1.9) and is characterised by a high growth rate of GDPpc, although these regions belong to the cluster with the lowest level of GDPpc, as seen in Figure 1.2. Actually, mainstream economic growth theories claim that the lower the initial GDP per capita the higher the growth will be (Barro and Sala-i-Martin, 1992). Regions belonging to eastern countries, except Poland, together with Irish regions and Cyprus form cluster number 3 (in Figures 1.8 and 1.9). In this case it is worth highlighting the remoteness of Ireland and Cyprus with respect to the eastern countries, and even so, they share similar trends in growth rates of GDPpc. Concretely, Irish regions had high values of GDPpc (Figures 1.2 and 1.3) and present high growth rates of GDPpc whereas eastern countries had the lowest values of GDPpc. Regions of Austria and Belgium comprise cluster number 1 (in red in Figures 1.8 and 1.9) whereas almost all regions in Germany correspond to cluster number 5 (in magenta in Figures 1.8 and 1.9). Part of French regions belong to cluster number 8 (in black in Figures 1.8 and 1.9) while the rest, together with regions belonging to Denmark, Portugal, Netherlands, Czech Republic, Sweden, Finland and Slovenia, are included in cluster number 2 (in dark green in Figures 1.8 and

⁸ Derived from the original 2000-2017 period, the growth period we analyse is from 2001 to 2017.

1.9). Finally, most regions of UK correspond to cluster 10 (in green in Figures 1.8 and 1.9), which is characterized by the highest fall of GDPpc in the 2008 crisis.

All these clusters present different growth rate patterns (Figure 1.8) but in general, all of them present a fall in the growth rates in 2003, an abrupt drop in 2009 coinciding with the financial crisis followed by a rise in growth rates in 2010. After some fluctuations, the growth rates reach a positive peak in 2015 and fall again in 2016.

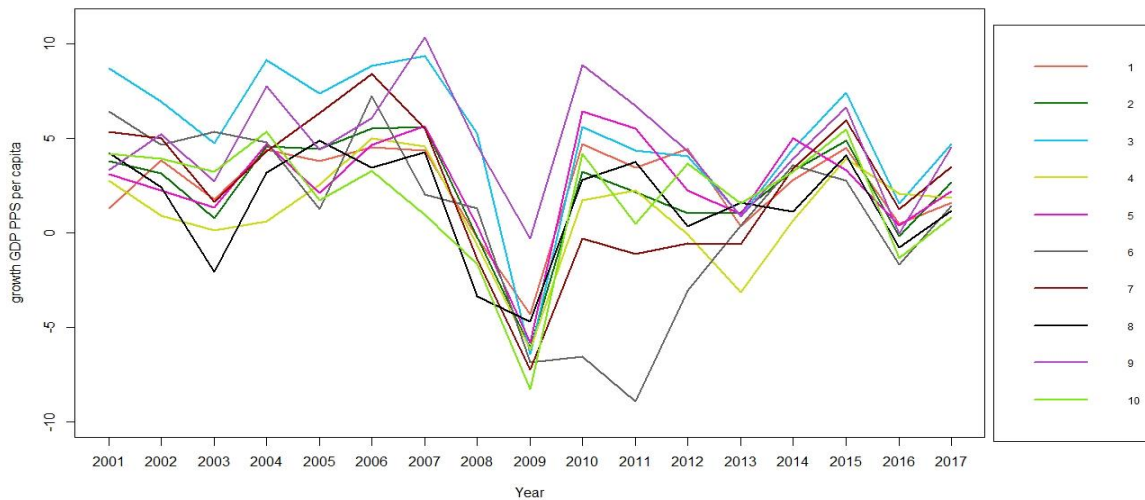


Figure 1.8. Patterns of 10-cluster solution for average GDP pc growth rates of NUTS 2 regions for period 2001-2017.

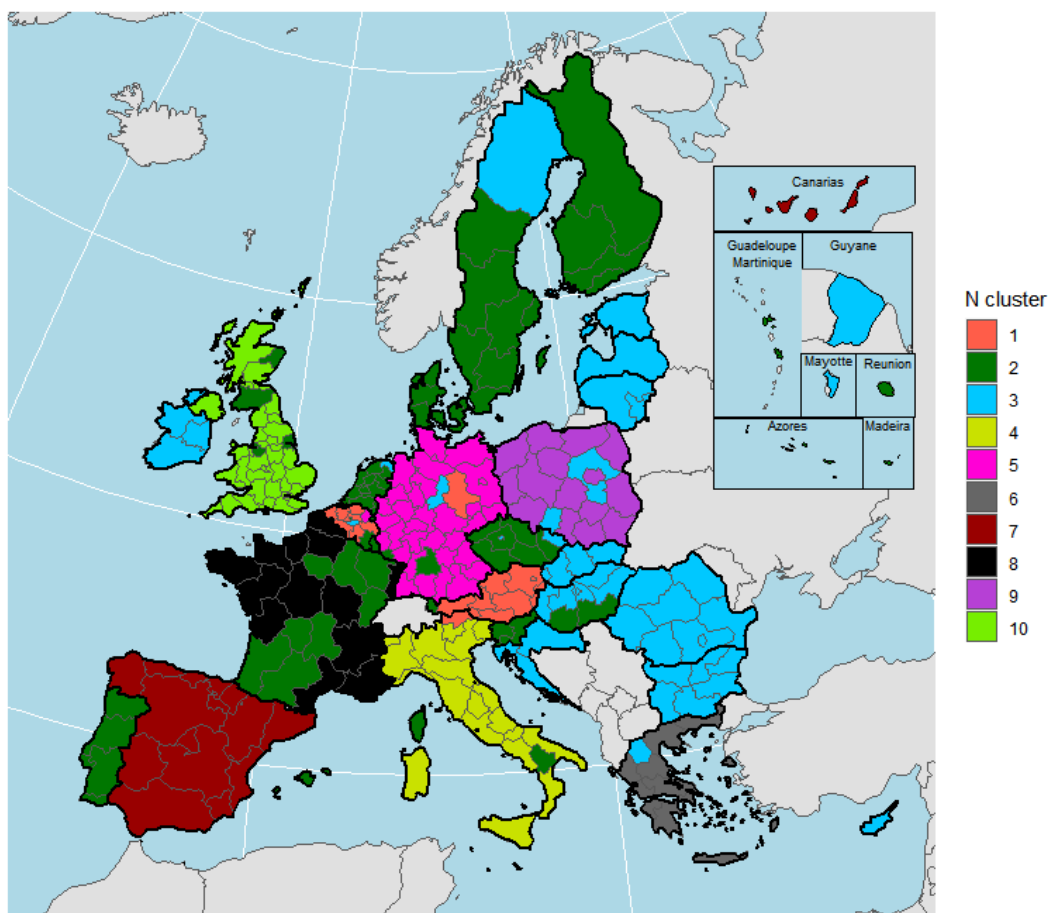


Figure 1.9. Mapping of 10-cluster solution for GDPpc growth rates of NUTS 2 regions for period 2001-2017.

By performing the model-based clustering for GDPpc growth rates at NUTS 3 level we obtain 15 clusters. Again, we see that at this level the number of clusters increases with respect to the NUTS 2 clustering. Although the spatial effect is not as strong as it is for NUTS 2 level, the regions also show a tendency to spatially cluster at the national level, except for some cases, such as Germany, whose regions belong to several clusters while at NUTS 2 level almost all regions belonged to the same cluster (cluster number 5 in Figures 1.8 and 1.9). This indicates that at finer level of disaggregation, the specialization of the regions becomes more visible and is not masked in the aggregate NUTS 2 level. In this case it is also worth noticing that the size of the NUTS 3 regions is quite small, enhancing this specialization effect. Performing the analysis at NUTS 3 level also reveals, for example, that regions of Latvia, Lithuania and Estonia belong to the same cluster on their own (cluster number 6 in Figures 1.10 and 1.11), whereas at NUTS 2 level they shared similar growth rates with Irish, eastern regions and Cyprus. Their pattern in the years before

the crisis seems to be reversed with respect to other cluster patterns, as when they present a rise in growth, the rest present a decrease and vice versa. Most regions of Greece, Spain, Italy, UK and Poland are classified in individual clusters, similarly to NUTS 2 level (clusters 9, 14, 11, 7 and 13 in Figure 1.11, respectively). However, now the regions of Portugal and Romania form individual clusters (cluster number 15 and 12 in Figure 1.11, respectively). Regions of Austria, Belgium and some from Germany, belong to cluster number 2 (in dark green in Figures 1.10 and 1.11). Some eastern regions belong to the same cluster as Irish regions (number 10 in Figures 1.10 and 1.11) while the others, together with some regions of the Baltic countries, the north of UK and Cyprus, form a cluster (number 3 in Figures 1.10 and 1.11). Finally, it should be noticed that the patterns of growth of GDPpc at NUTS 3 level exhibit the same key features as at NUTS 2 level.

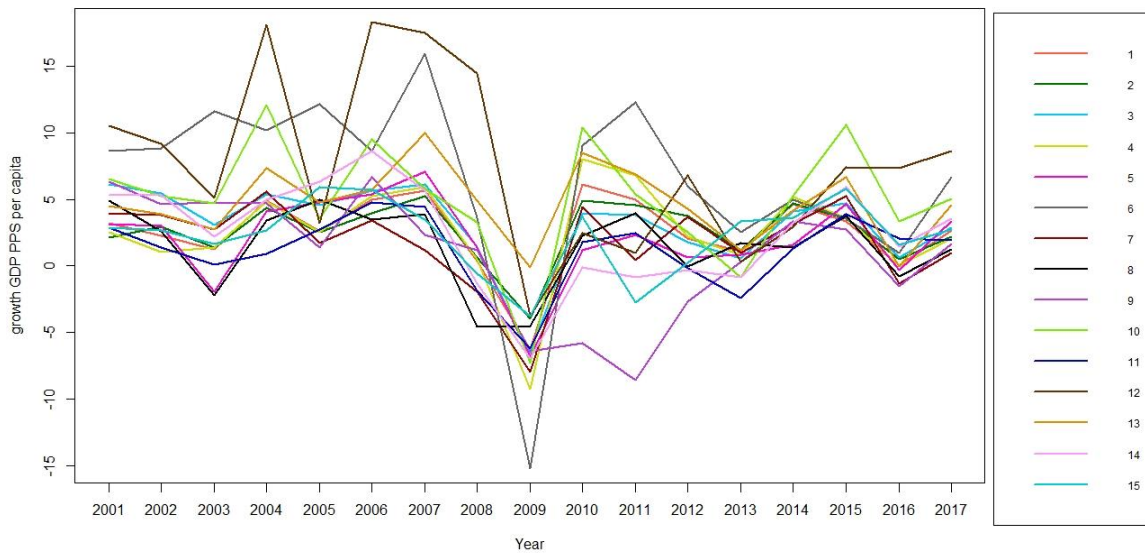


Figure 1.10. Patterns of 15-cluster solution for average GDP pc growth rates of NUTS 3 regions for period 2001-2017.

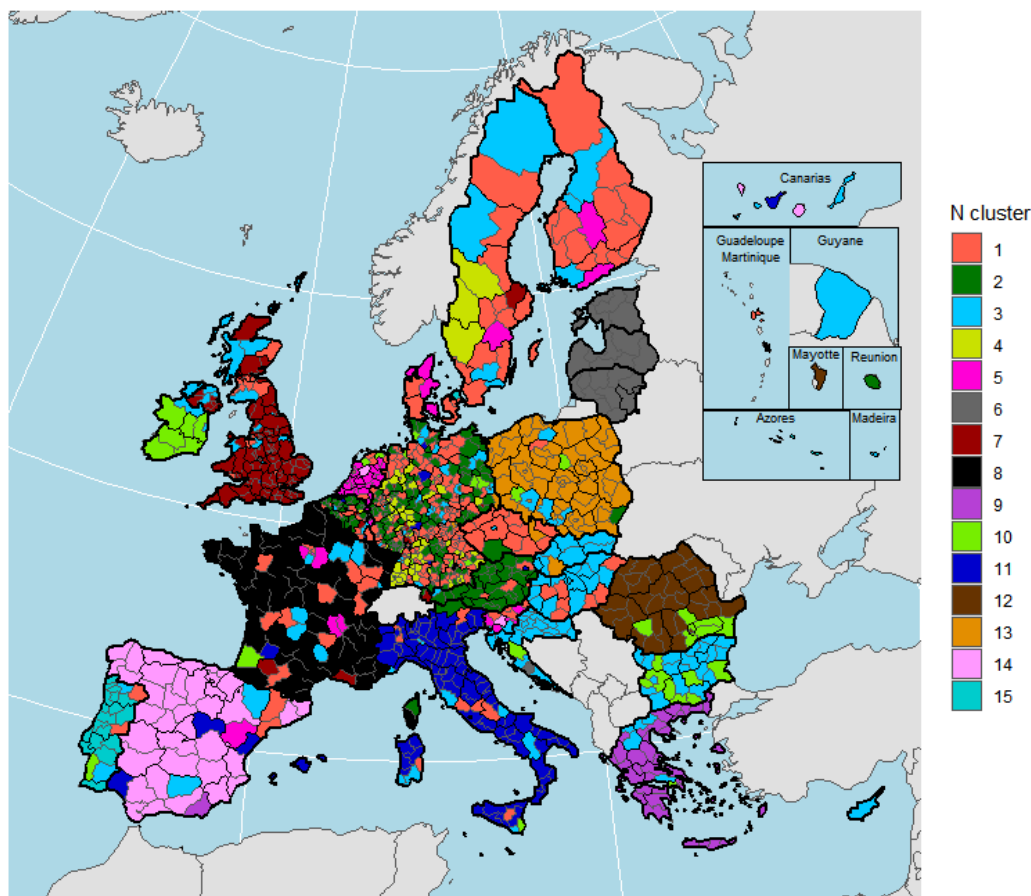


Figure 1.11. Mapping of 15-cluster solution for GDPpc growth rates of NUTS 3 regions for period 2001-2017.

1.4.2. Pre- and post-2008 financial crisis analysis

Studies of the evolution of disparities highlight that after years of reduction in regional disparities, the financial crisis of 2008 led to an increase of inequalities (Butkus et al. 2018; Postiglione, Cartone, and Panzera 2020). Aiming to observe the effect of the financial crisis on the regional economic growth we split the growth period 2001-2017 into two time spans, one from 2001 to 2008 (pre-crisis period) and the other from 2009 to 2017 (post-crisis period).

Clustering the NUTS 2 regions for the pre-crisis period, gives us a grouping of 8 components. Similarly to the entire period, many regions are spatially clustered together at national level. Some regions are individually clustered at national level as it is the case of Spanish regions (cluster number 8 in Figures 1.12 and 1.13), French regions (cluster

number 4 in Figures 1.12 and 1.13), Italian regions (cluster number 5 in Figures 1.12 and 1.13) and UK regions (cluster number 1 in Figures 1.12 and 1.13). Central EU countries, Portugal and part of the Baltic countries constitute cluster number 2 (in dark green in Figures 1.12 and 1.13). Some eastern countries, some regions of Greece and Ireland form cluster 7 (in dark red in Figures 1.12 and 1.13). Regions of Poland, Slovenia, Cyprus and most of Finland form cluster number 3 (in blue in Figures 1.12 and 1.13). Finally, Romania, Slovakia, Latvia, Lithuania and Estonia belong to cluster number 6 (in grey in Figures 1.12 and 1.13), which has the highest growth rates of GDPpc.

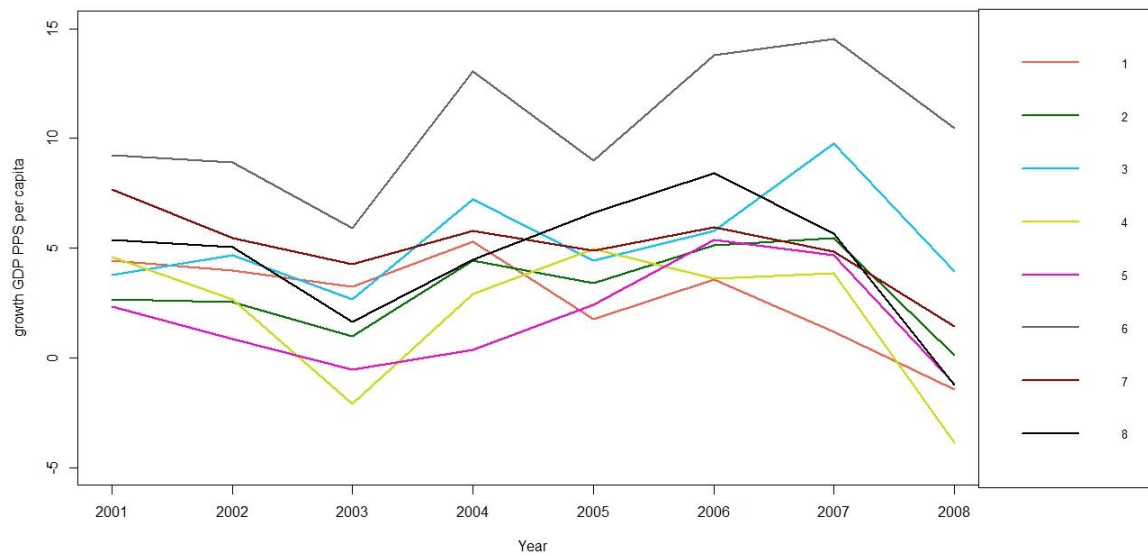


Figure 1.12. Patterns of 8-cluster solution for average GDP pc growth rates of NUTS 2 regions and pre-crisis period.

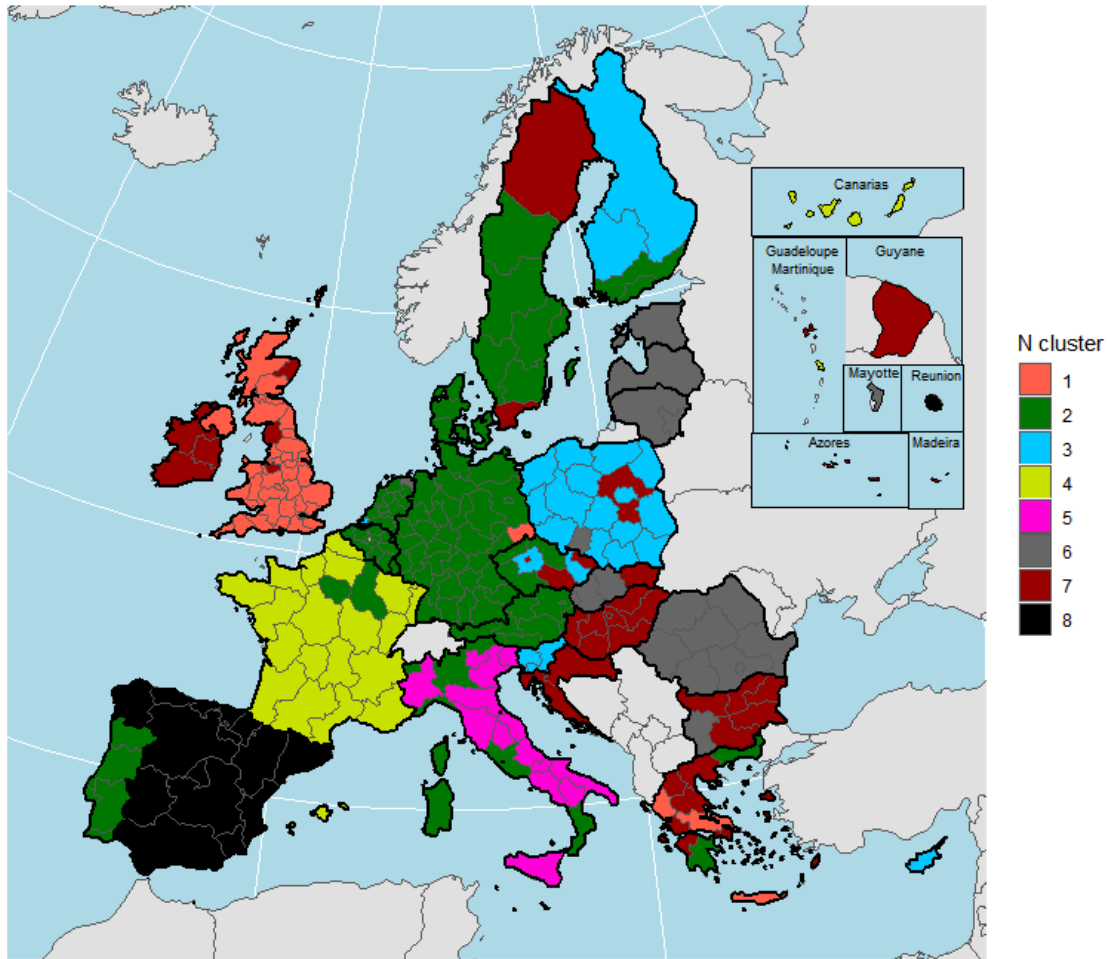


Figure 1.13. Mapping of 8-cluster solution for GDPpc growth rates of NUTS 2 regions and pre-crisis period.

By performing the clustering at NUTS 3 level (Figures 1.14 and 1.15), we obtain the same number of components (eight) as for NUTS 2 clustering, indicating that in the years preceding the crisis, the overall disparities are not greater at NUTS 3 level than at NUTS 2. However, as shown in Figure 1.15, we see that the spatial relationship seems not to be as strong as it was for NUTS 2 level, i.e., the growth rates of GDPpc of NUTS 3 regions seem not to be so influenced by the values of the contiguous regions, but by regions that are not close in space, evidencing the presence of within-countries or within-NUTS 2 regions disparities. According to Butkus et al. (2018), disparities in the EU during 2000–2009 decreased mainly because of the reduction of disparities between countries, but the part of disparities that can be attributed to within-country and within-region disparities increased. Since the contrast of the spatial effect is so clear as we have obtained the same

number of clusters at both NUTS 2 and NUTS 3 levels of analysis, we will test for spatial autocorrelation in order to validate what was perceived. To that end, we have calculated the Global Moran's I index, which indicates the presence of spatial autocorrelation. In order to be comparable at NUTS 2 and NUTS 3 level, we calculate the index in both cases at territorial NUTS 3 level. That is, in the case of the growth rates given at the NUTS 2 level, NUTS 3 regions get the value of the growth rates of GDPpc of the NUTS 2 region they belong to.

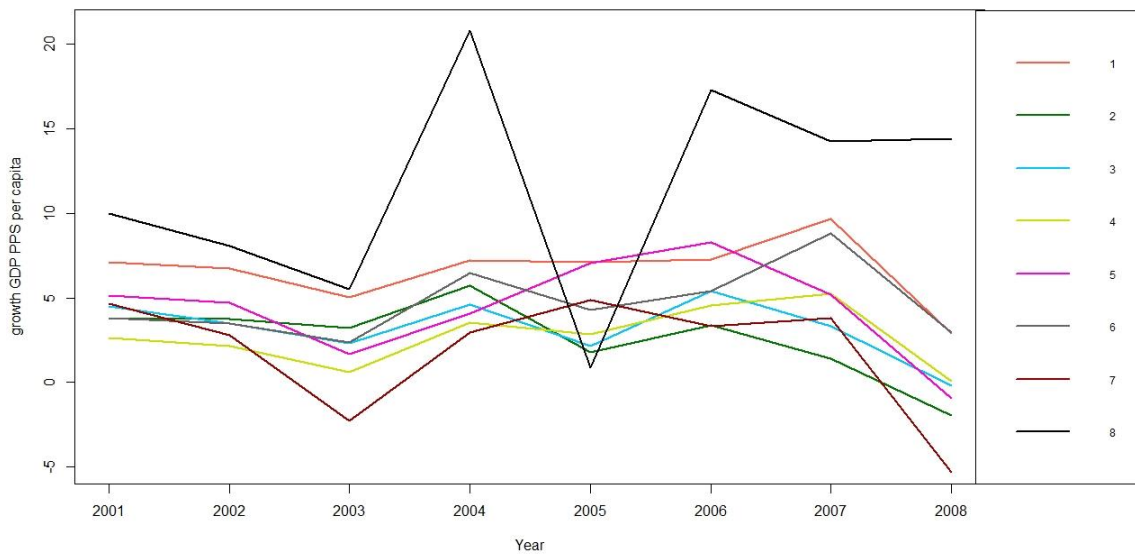


Figure 1.14. Patterns of 8-cluster solution for average GDP pc growth rates of NUTS 3 regions and pre-crisis period.

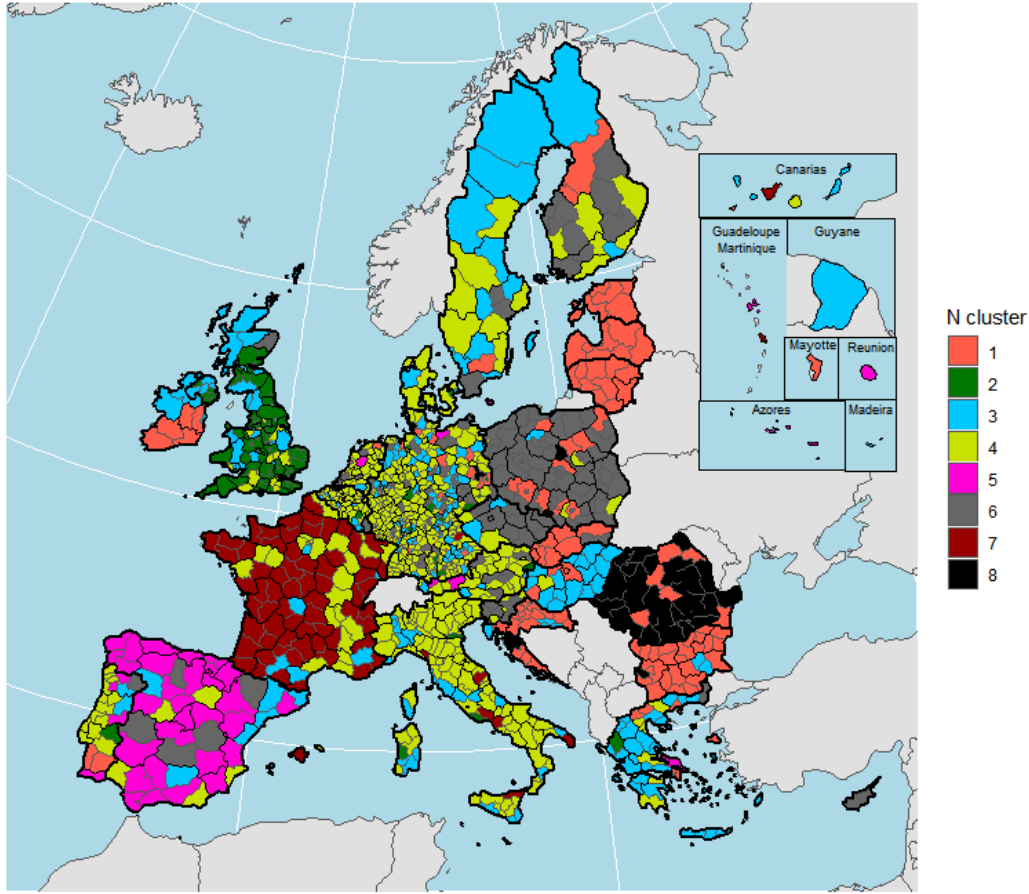


Figure 1.15. Mapping of 8-cluster solution for GDPpc growth rates of NUTS 3 regions and pre-crisis period.

Global Moran's I index is formulated as:

$$I_t = \frac{n}{s_0} \frac{\sum_{i=1}^n \sum_{j=1}^n z_{i,t} w_{ij} z_{j,t}}{\sum_{i=1}^n z_{i,t}^2} \quad (5)$$

where $z_{i,t}$ is the deviation from the mean of the growth rate of GDPpc ($z_{i,t} = x_i - \bar{x}$ with \bar{x} the mean of the variable x) in region i and period t . n is the number of NUTS 3 regions and w_{ij} is the ij element of the spatial weight matrix, which indicates the neighbours of each region. It is constructed by the K nearest neighbour's criterion, with $k = 7$. The outermost regions (Canary Islands, Guadeloupe, Martinique, Guyane, Mayotte, Reunion, Azores and Madeira) have been removed from the calculation since the K nearest neighbour's criterion is not suitable in these cases. $s_0 = \sum_i \sum_j w_{ij}$ is the sum of all weights. The inference is based on a random permutation approach with 999 permutations.

Table 1.4 displays the Moran's I index calculated for the annual growth rates of GDP per capita for each year of the pre-crisis period 2001-2008 for NUTS 3 and NUTS 2 regions. The values reveal a positive significant spatial autocorrelation for all years (p-values smaller than 0.05), i.e., regions with similar values of GDPpc growth rates tend to cluster together in space.

Table 1.4. Moran's I index for the annual growth rate of GDPpc and pre-crisis period. E(I) is the theoretical expected value, which equals $-1/(n-1)$.

Year	Moran's I		E(I)		Standard Deviation		p-value	
	NUTS 3	NUTS 2	NUTS 3	NUTS 2	NUTS 3	NUTS 2	NUTS 3	NUTS 2
2001	0.2826	0.7170	-0.0008	-0.0008	0.0136	0.0141	0.001	0.001
2002	0.2711	0.6925	-0.0008	-0.0008	0.0133	0.0141	0.001	0.001
2003	0.3409	0.7310	-0.0008	-0.0008	0.0141	0.0135	0.001	0.001
2004	0.4332	0.7893	-0.0008	-0.0008	0.0137	0.0137	0.001	0.001
2005	0.2489	0.7246	-0.0008	-0.0008	0.0136	0.0139	0.001	0.001
2006	0.3331	0.6938	-0.0008	-0.0008	0.0139	0.0010	0.001	0.001
2007	0.5160	0.8122	-0.0008	-0.0008	0.0135	0.0137	0.001	0.001
2008	0.4869	0.8177	-0.0008	-0.0008	0.0139	0.0137	0.001	0.001

Figure 1.16 displays the comparison between the evolution of the Index for growth rates at NUTS 2 and NUTS 3 level. We observe that the spatial effect is stronger for the NUTS 2 regions as we expected by visual inspection of Figures 1.13 and 1.15, indicating that NUTS 2 regions with similar GDPpc growth rates tend to be more spatially clustered than NUTS 3 regions with similar GDPpc growth rates. This evidences that at NUTS 2 level the behaviour of the NUTS 2 regions is more similar to that of its neighbours. However, at NUTS 3 level, the specialization becomes more visible and is not masked in the aggregate NUTS 2 level, revealing differences of the NUTS 3 regions with respect to their neighbours.

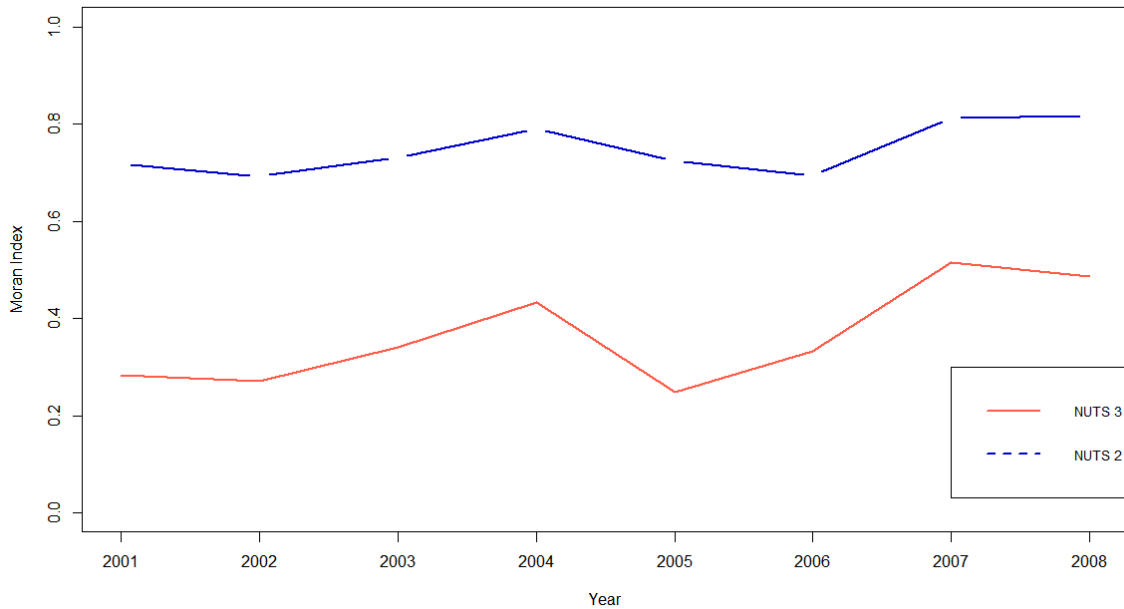


Figure 1.16. Moran's I index for GDPpc growth rates of NUTS 2 and NUTS 3 regions and pre-crisis period.

In the post-crisis period, at NUTS 2 level we obtain a grouping of 9 clusters, only one more than for the pre-crisis period. The differences with the pre-crisis period are basically that now regions of Italy and Finland belong to the same cluster (number 5 in magenta in Figures 1.17 and 1.18), German regions form now a separate cluster from the rest of the central countries (number 3 in blue in Figures 1.17 and 1.18), Greek regions form a separate cluster (number 8 in black in Figures 1.17 and 1.18), and the same happens for Polish regions (cluster number 9 in purple in Figures 1.17 and 1.18).

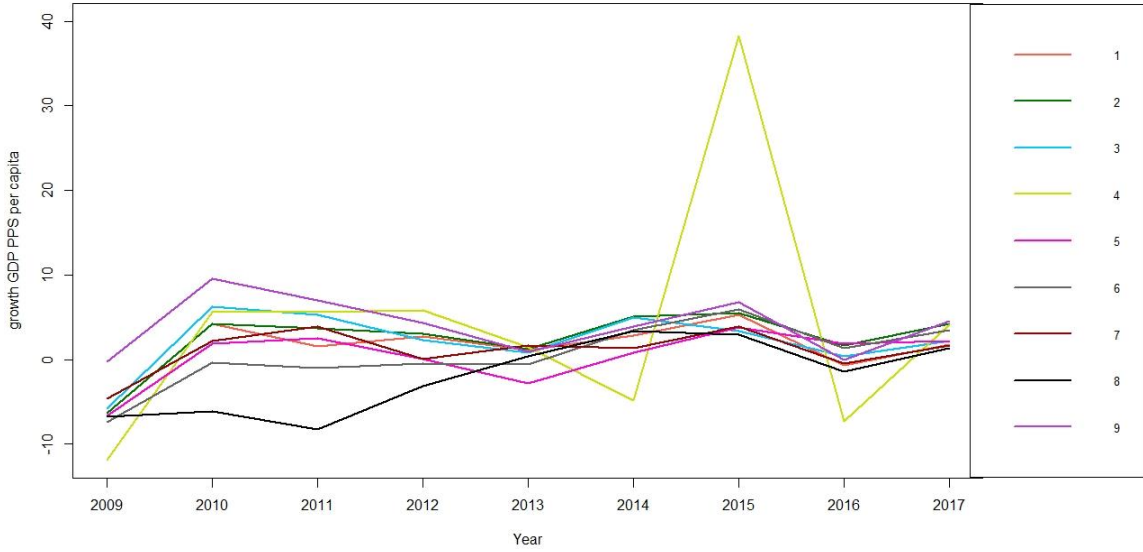


Figure 1.17. Patterns of 9-cluster solution for average GDP pc growth rates of NUTS 2 regions and post-crisis period.

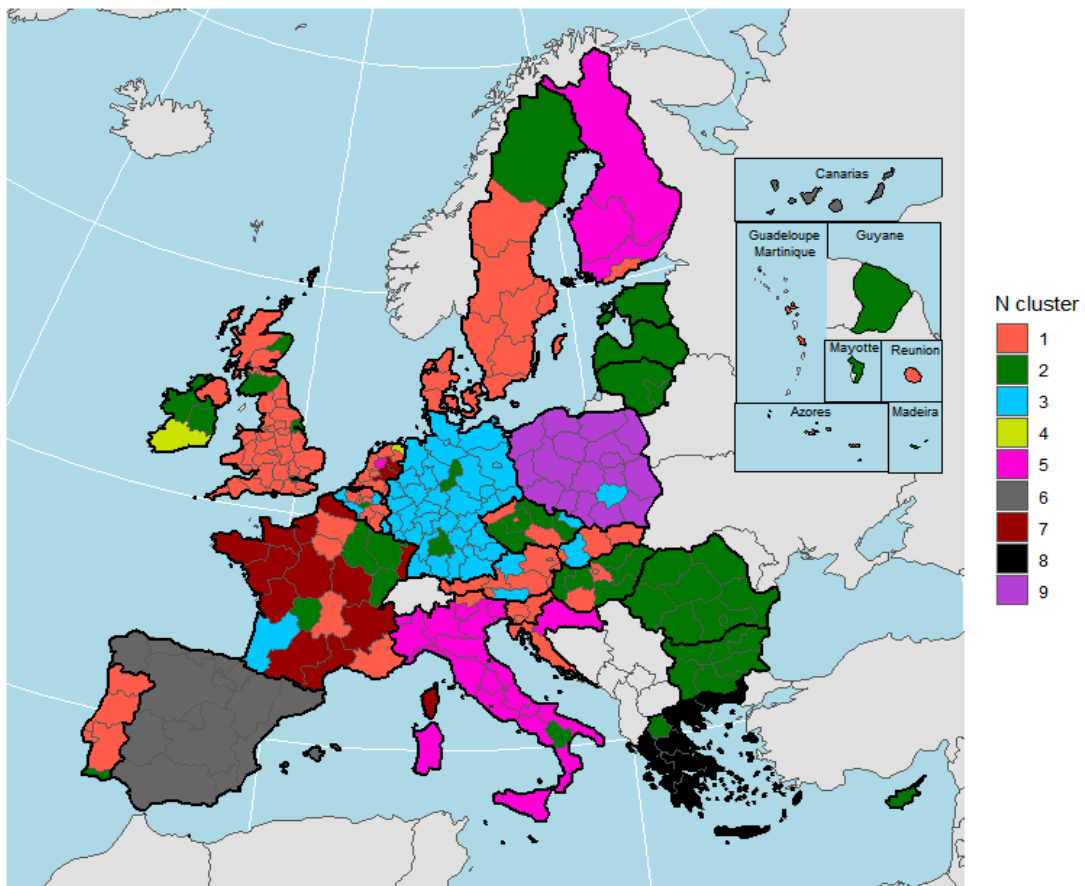


Figure 1.18. Mapping of 9-cluster solution for GDPpc growth rates of NUTS 2 regions and post-crisis period.

At NUTS 3 level, the clustering groups the regions in 15 clusters with similar tendencies of GDP per capita growth (Figures 1.19 and 1.20). This result indicates two things: that we obtain more clusters at NUTS 3 level than at NUTS 2, and that we obtain more clusters at NUTS 3 level in the post-crisis period than in the pre-crisis one. The NUTS 3 level seems to reveal the different behaviours and capacities of the regions when facing the financial crisis and the different recovery rates, behaviours that at NUTS 2 level are hidden. For example, Spain was a single cluster at NUTS 2 level, but when performing the cluster at NUTS 3 level, it has disaggregated in different clusters with different recovery patterns. Or all regions of Estonia, which belonged to a single cluster when the analysis was performed at NUTS 2 level, at NUTS 3 level one region has been revealed to belong to a different cluster with lower values of growth than the rest of the country regions.

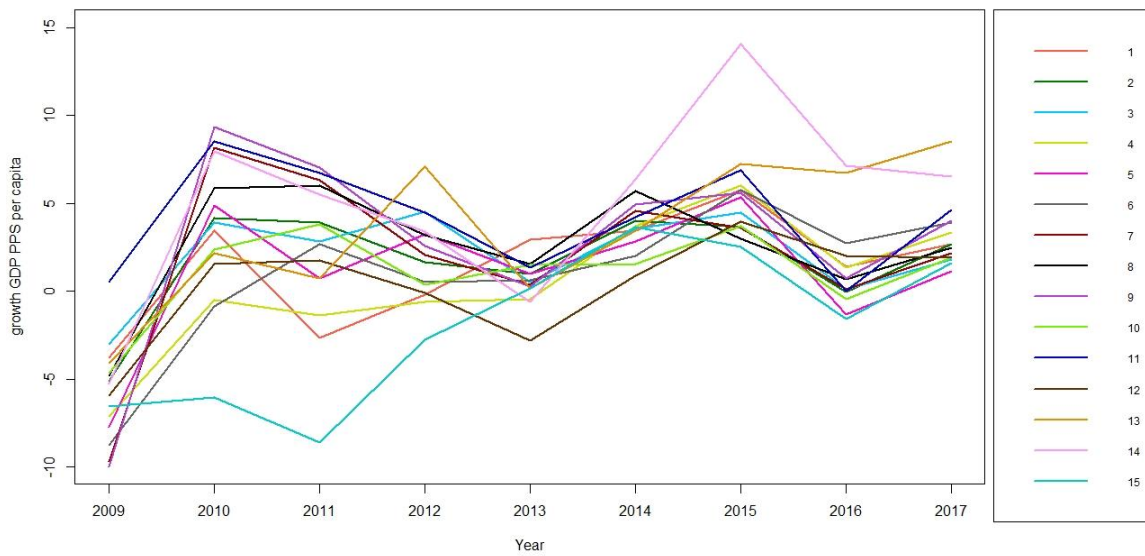


Figure 1.19. Patterns of 15-cluster solution for average GDP pc growth rates of NUTS 3 regions and post-crisis period.

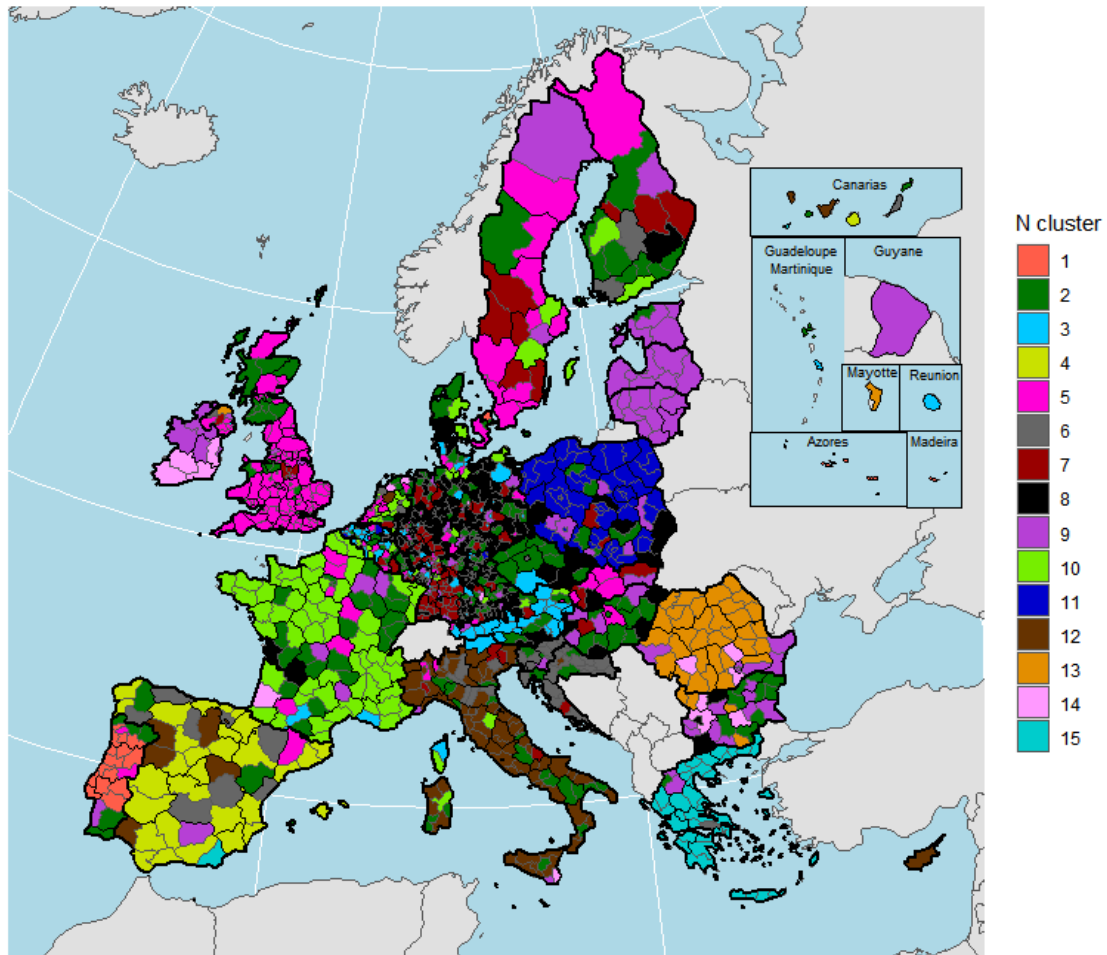


Figure 1.20. Mapping of 15-cluster solution for GDPpc growth rates NUTS 3 regions and post-crisis period.

1.5. Conclusions

This study has explored the regional economic disparities in the level of economic wealth and growth in the NUTS 3 regions in EU28 over the period from 2000 to 2017 by applying time-series clustering.

Our results suggest that by performing the analysis of both the level and growth rates of GDPpc at a more detailed spatial scale (NUTS 3 level) more disparities flourish. In general, NUTS 2 regions tend to spatially cluster at the national level and, although NUTS 3 regions show a slight tendency to cluster together in space at national level as well, the spatial effect is not as strong as it is for NUTS 2 level, indicating that NUTS 2 regions with

similar economic characteristics tend to be more spatially clustered than NUTS 3 regions. This suggests that at a finer level of disaggregation, the local economic and market features arise and regions may share similar economic characteristics with remote regions rather than with contiguous regions. Hence it seems that a process of expanding stratification, or differentiation, in the GDPpc growth rates is occurring, implying that the current Cohesion Policy at NUTS 2 level might no longer be an effective antidote for the increasing disparities within the EU.

Aiming to observe the effect of the financial crisis on the regional economic growth we split the period 2000-2017 into two-time spans, the pre-crisis and post-crisis periods. For the pre-crisis period, we have obtained the same number of components for the NUTS 3 and NUTS 2 clustering. However, again, we noticed that the spatial relationship at NUTS 3 level is not as strong as it was for NUTS 2 level. As for the post-crisis period, we obtained more clusters at NUTS 3 level than at NUTS 2, and more clusters at NUTS 3 level in the post-crisis period than in the pre-crisis one. The NUTS 3 level seems to reveal the different behaviours and capacities of the regions when facing the financial crisis and the different recovery rates that remain concealed at the NUTS 2 level.

Post-crisis policies were applied both at European and national level, and the clustering at NUTS 2 level seems to reflect the result, since most regions are clustered together in space at national level. However, when the clustering is performed at NUTS 3 level, we discovered that countries are very heterogeneous with regions belonging to several clusters which are not clustered together in space, revealing specific behaviours of the local economies and markets that are masked in the aggregate NUTS 2 level. Hence some less developed NUTS 3 regions might have been left behind in the general recovery with subdued GDP growth rates compared with those seen in the few years before the crisis.

All these findings evidence that at a more detailed spatial scale disparities flourish because of the local characteristics and specialization of the regions. Certainly, part of this effect arises because of the well-known Modifiable Areal Unit Problem (MAUP) that deals with the indeterminacy of any statistical measure as a response to changes in the level of aggregation of data (GDPpc and NUTS 2 and 3 level in this case) provoking a higher dispersion in the lower NUTS 3 level. However, this fact only reinforces our results that

the NUTS 2 level is masking the heterogeneity of the EU regional economic disparities. The main consequence is that some relatively rich NUTS 3 regions may receive Structural Funds because their NUTS 2 region is eligible, while other less prosperous NUTS 3 regions may not receive Structural Funds because they are within an ineligible NUTS 2 region. Hence the Cohesion Policy, aimed at reducing regional disparities and defined at NUTS 2 level, should consider that NUTS 3 regions do not share the same behaviours as their aggregate NUTS 2 regions and therefore it may not have the expected effect in all the territories.

Although as evidenced, factors such as the structure (urban/rural), the sectorization, the agglomeration or the specialization of the regions may be considered as potential underlying reasons for explaining the economic inequalities that arise at the NUTS 3 level, the obtained groupings of regions which share the same economic characteristics throughout all the covered period can be used as a starting point in future empirical studies. These studies can focus on exploring deeper the driving forces behind the economic regional disparities and the unlinking of the economic wealth to geographic location, since the topic would be of great interest to scholars and policy makers alike.

Finally, we have to highlight that there are some limitations in our research that should be considered when studying the economic disparities using the GDP per capita as the economic indicator. At NUTS 3 level, some part of the GDP per capita may correspond to commuters and may cause some inaccuracies in this indicator when measuring the economic wealth and growth.

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Chapter 2. The impact of European Regional Cohesion Policy on NUTS 3 disparities

Published as: López-Villuendas, A.M., and del Campo, C. 2024. The impact of European regional cohesion policy on NUTS 3 disparities. *The Annals of Regional Science*, 73, 1297-1319. <https://doi.org/10.1007/s00168-024-01291-0>

ABSTRACT

The impact of the European Union's Cohesion Policy is still controversial. Now more than ever, there is a particular demand for the Regional Cohesion Policy to be impactful and effective. In this context, the paper aims to determine the effect of the regional Cohesion Policy on the NUTS 3 economic disparities. Although the regions eligible to receive Structural Funds, the main financial instrument of the Regional Cohesion Policy, are defined at NUTS 2 level, some local effects that remain hidden at this level and affect disparities might be revealed by performing the analysis at a finer level of disaggregation, the NUTS 3 level. Our results show that the impact of Structural Funds on regional disparities is not as expected, as eligible regions experience a larger increase in disparities than non-eligible ones.

Keywords: Inequalities, Regional Cohesion Policy, Convergence, European Union, NUTS 3 regions

JEL classification codes: C23, R58, F02

2.1. Introduction

The study of regional disparities in the European Union (EU) has attracted considerable attention in the last decades mainly due to their inclusion in the Article 158 of the Treaty of the EU, which states “in particular, the Community aims to reduce the disparities between the levels of development of the different regions”. The presence of disparities is considered to be detrimental for the competitiveness, integration and cohesion of the European Union. To that end, the Cohesion Policy, which is the main EU's policy instrument committed to reduce regional disparities, dedicates a large quantity of funds, targeted specially to lagging regions, to give them the chance to converge with the more prosperous ones.

According to the literature, there has been a reduction tendency in the inequalities among EU's member states in the last decades (Bourdin, 2015; Duro, 2004; Hegerty, 2016; Monfort, 2020; Monfort, 2008; Petrakos et al., 2005); hence, the European Union has been

considered as a “convergence machine”, at least until the global financial crisis in 2008 (Monfort, 2020). However, despite the efforts of the Cohesion Policy, inequalities between regions within the same country have been growing in the last years, strengthened by the 2008 crisis and the accession of new countries to the European Union (Heidenreich and Wunder, 2008; Meliciani, 2015; Mora et al., 2004). As it is stated by Monfort (2020), within-country disparities accounted for one-third of the total disparities in the EU in 2000, reaching 66% of the total inequalities in 2017. Indeed, in most EU’s member states, due to the uneven spatial distribution and agglomeration of the economic activities (Geppert and Stephan, 2008; Tvrdoň, 2012), within-country disparities have been growing at both NUTS 2 and NUTS 3 levels, questioning the efficiency of the Cohesion Policy (Butkus et al., 2018).

The rising of inequalities, specially within a country, generates a climate of discontent between the population and increases the Euroscepticism towards the EU’s actions and policies dedicated to combat those. Consequently, some citizens are questioning the contribution of the EU as the ‘project’ capable of eradicating the differences between the European regions and achieving economic cohesion to create a solid community capable of facing the uncertainties and problematic issues in which they are increasingly involved. The rise of nationalistic movements is reflecting this sentiment, which is a potential threat to democracy in the EU’s member states and a threat to the continuity of the European Union as such. This context of political tensions and increasing inequalities between the levels of development and well-being of the citizens jeopardize the European Union project by placing it in a risky situation where its legitimacy is challenged. Therefore, now more than ever, the Cohesion Policy is requested to be impactful and effective.

The core hypothesis is that the Structural Funds, the main instrument of funding of the Cohesion Policy, decrease the cross-country inequalities but increase regional inequalities (Jovančević et al., 2015). During the policy programming periods reviewed in this analysis, Structural Funds comprised of five funds, but only three of them fell under the EU’s Cohesion Policy. Two of the latter three (the European Regional Development Fund and the European Social Fund) are the ones studied in this research, since its eligibility criterion is defined at regional level.

Yet, essentially all existing work on the assessment of the Cohesion Policy at regional level mainly uses regional data at the NUTS 2 level. This may be problematic because, although the second level of the EU's classification (NUTS 2) is used for defining eligible regions to be benefited from the Cohesion Policy funding, "...the NUTS-2 level, at which eligibility and financial allocations are largely determined, may not be the appropriate level at which to capture policy effects..." as it was stated by Fratesi and Wislade (2017, p. 819). Indeed, the allocation of the funds within NUTS 2 regions may be uneven throughout the NUTS 3 regions since the eligibility for receiving funds is defined at NUTS 2 level regardless of the economic performance of their NUTS 3 regions (Gagliardi and Percoco, 2017). It is what these authors define as "accidental winners", NUTS 3 regions in theory not eligible for receiving funds according to the GDP threshold, but which end up being treated because they belong to eligible NUTS 2 regions. Additionally, the effectiveness of the Cohesion Policy is not homogeneous within the NUTS 2 regions, as it may be conditioned to some structural factors (Gagliardi and Percoco, 2017; Percoco, 2017) such as the structure of the public sector or the urban structure of the regions. These aspects could cause an increase of the differences in the level of economic development of the NUTS 3 regions belonging to the same NUTS 2 region, reversing the purpose of the Cohesion Policy.

Therefore, the consideration of these effects is essential in order to assure a more effective assessment of the policy impact on the regional economic inequalities, which is covered by using data at a finer level of disaggregation, the NUTS 3 level. By performing the analysis at a finer geographical scale, some local effects that are not evident at NUTS 2 level and remain hidden in the aggregated NUTS 2 regions might be revealed, since NUTS 2 level may be masking the heterogeneity of the EU's regional economic disparities (López-Villuendas and del Campo, 2023). Also, taking a NUTS 3 perspective has the additional benefits of yielding a larger estimation sample, enriching the robustness of the analysis.

In order to fill this scale gap in the current literature, we will approach the NUTS 3 dimension in the present study by evaluating the impact of the Structural Funds on the NUTS 3 regional economic inequalities, covering all 1348 NUTS 3 regions during a wide

time span of almost three fully policy programming periods. Year 2000 was selected as the starting point of the analysis as that was the year all ten countries officially joining the European Union in 2004 (Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia) started to participate of the Cohesion Funds.

Hence, the contribution of the present study to the literature will be to offer a richer assessment of the Cohesion Policy impact on the regional economic inequalities by focusing on the NUTS 3 level which exposes the heterogeneity within the aggregates NUTS 2 regions. This heterogeneity could reverse the purpose of the Cohesion Policy and could cause an important bias in the proper evaluation of the Cohesion Policy. Additionally, this analysis considers all NUTS 3 regions and covers almost three complete policy programming periods, which is rather scarce in literature since studies usually focus on a specific programming period. Hence this paper provides a deeper assessment of the Cohesion Policy.

The remainder of the paper is structured as follows. In the following section a brief review of the literature on this topic is presented. The methodology is described in section 2.3 while section 2.4 presents the results and their policy implications are discussed. Concluding remarks and limitations of the study are then presented in section 2.5.

2.2. Background literature

The effectiveness of the Cohesion Policy has been broadly approached by studying the effect of the Structural Funds on, particularly, the economic growth and the regional and national convergence (understood as the catching up of the lagging regions with the prosperous ones), during the last decades employing a wide range of methodologies. Despite the vast literature addressing this issue, the effect of Cohesion Policy on economic growth and convergence is not clear, and it depends on the selected policy period and the employed methodologies. Some studies observed a positive effect of the structural spending on economic growth (e.g., Becker et al., 2010; Cappelen et al., 2003; Crescenzi and Giua, 2020). However, most of the studies determined that the positive effect is

conditioned to some specificities such as the intensity of transfers (Di Cataldo, 2017), the geography (Giordano, 2017), the expenditure category and intervention area (Pontarollo, 2017), the absorptive capacity of regions (Becker et al., 2013), the institutional quality (Becker 2012; Kyriacou and Roca-Sagalés 2014), or the quality of government (e.g., Rodríguez-Pose and Garcilazo, 2015). On the other hand, some authors find that the Cohesion Policy improves national economic convergence (e.g., Beugelsdijk and Eijffinger, 2005; European Commission, 2017) and regional convergence (Dall'erba, 2005), while others find no effects on regional convergence (e.g., Esposti and Bussoletti, 2008; Dall'erba and Le Gallo, 2008) or even a negative impact (e.g., Breindenbach et al., 2016). See Fidrmuc et al. (2024) for a thorough review of the impact of Cohesion Policy in the current literature.

Unlike the impact of Cohesion Policy on inter-country convergence, understood as the catching up of the lagging regions with the prosperous ones, the literature on the effects of Cohesion Policy on intra-country sigma convergence (understood as the reduction of inequalities) is rather scarce and inconclusive (Mogila et al., 2022).

Kyriacou and Roca-Sagalés (2012) studied the effect of the Structural Funds on NUTS 2 regional disparities in 15 EU's countries over period 1995-2006, determining that Structural Funding reduced disparities but this effect was reversed above some level of transfer intensity (approximately 1.6% of country GDP). Védrine and Le Gallo (2021), determined for period 2000-2014 that the regional within disparities of EU-15 NUTS 2 regions are negatively impacted by an increase of Structural Funds without incurring on any effect on economic growth, but the regions of the new member states, whose growth is positively affected by the Structural Funds, present an increase of their within disparities. Arcalean et al. (2007) found that Structural Funds slightly reduce the NUTS 2 regional disparities in Portugal over the period 1977-2002. Mogila et al. (2022) revealed that the Cohesion Policy will have a relatively small impact on reducing the within-country disparities (at NUTS 2 level) in the 2021-2027 period in some eastern countries, concluding that the Cohesion Policy will fail in terms of reducing within-country inequalities in the long run.

Beugelsdijk and Eijffinger (2005), testing convergence for the period 1995-2001 concluded that Structural funds appear to have a positive impact on interregional disparities. Eggert et al. (2007), who investigated EU's intervention in 16 German NUTS 1 regions from 1989 to 1999, stated that the Cohesion Policy stimulates intra-country convergence. Boldrin and Canova (2001), tested whether EU's policies had any impact on the regional per capita income for the period 1980-96 confirming no significant impact of Cohesion Policy on within-country regional disparities. The same conclusions of no significance are obtained in Ederveen et al. (2002) for period 1981-96.

Lastly, Butkus et al. (2020a) assessing the effect of regional financial support for period 2000-2006 on NUTS 3 regions (except regions of Romania, Bulgaria and Croatia) concluded that even though the effect of Structural Funds payments is positive, there is a need for a minimum threshold level of institutional quality in the region for this effect to become statistically significant. Additionally, it takes time for the positive and statistically significant effect to manifest, i.e. the estimated effect of Structural Funds' payments is significant just over the post- financial support period.

To the best of our knowledge there are only three studies focussed on the impact of Cohesion Policy on the NUTS 3 convergence (Butkus et al., 2020a, Butkus et al., 2021, and Védrine and Le Gallo, 2021 -being the last one the only one studying sigma convergence). However, Butkus et al. (2020a) only studies the policy programming period from 2000 to 2006, while Butkus et al. (2021) studies 2000 to 2006 and 2007 to 2013 programming periods and Védrine and Le Gallo (2021) only focusses on within NUTS 2 disparities (at NUTS 3 level) but estimating them with indicators at NUTS 2 level. Therefore, we intend to extend the literature determining the impact of the Structural Funds on the NUTS 3 inequalities (sigma convergence) by studying the disparities in both components (within and also between NUTS 3 regions) and estimating them using NUTS 3 level own characteristics for almost three complete programming periods.

It is of high importance for policymakers to determine whether the Cohesion Policy, defined at NUTS 2 level reduces disparities among the NUTS 3 regions, since the decomposition of disparities across the EU indicates that over the past 20 years the share of the total inequalities of the member states attributed to the NUTS 3 level has been

increasing (Butkus et al., 2018), implying that the Cohesion Policy does not deal sufficiently enough with the problems within the NUTS 2 regions, i.e. on the NUTS 3 level, neglecting the specific characteristics and features of the NUTS 3 regions that can affect the effectiveness of the Cohesion Policy financing. Going to a finer level of disaggregation (NUTS 3 level) when estimating the effect of the Cohesion Policy will allow for a more accurate assessment of the compliance of its objective, which is to decrease the regional (economic) disparities. Indeed the level of disparities is an important indicator, calculated by the dispersion of per capita GDP, which reflects the differences of the regions' economic development as well as their potential economic problems.

2.3. Methodology and data

2.3.1. Regional inequality

Aiming to estimate the effect of Cohesion Policy on regional disparities, we study whether the NUTS 3 regions receiving Structural Funds experience a further increase of disparities than regions which are not eligible to receive Structural Funds. The eligibility criterion is stated at NUTS 2 level; therefore, if a NUTS 2 region is eligible for receiving Structural Funds, all their NUTS 3 regions are considered eligible. Structural Funds are the policy instrument most intensively used by the European Union to promote economic growth and to speed up the process of convergence among its member states.

In the context of the European integration process, convergence has become a long-lived field of study. It integrates neoclassical theories which state that as long as markets are not intervened, the levels of development of different regions (usually approximated through the per capita income) will be levelled over time. This theory has been conceptualized in specially two formulations proposed by Barro and Sala-i-Martin (1991, 1992, 2004), frequently used in literature, and called β - and σ -convergence. The first one refers to the catching up of the poorest economies with the richer ones, while the later refers to the reduction of the per capita income gap over time, so it can be seen as a way of looking at income inequality (Villaverde and Maza, 2009). Therefore, in the present analysis, we will be dealing with σ -convergence, as it directly addresses the inequalities.

Several measures exist in the literature to quantify the inequality and there is not a unique criterion for selecting an appropriate inequality measure. In fact, the evolution of disparities over time may be different regarding the used measure, so it is recommendable to address several measures to corroborate the veracity of the obtained results (Ezcurra and Rodríguez-Pose, 2009). In order to quantify the economic inequalities of the EU's NUTS 3 regions we will use the Theil index and the Mean Logarithmic Deviation (MLD) measures.

The Theil index (Theil, 1967) has become a very popular measure for quantifying regional inequalities. It is scale and mean independent and not excessively affected by outliers. The Theil index is a particular case of the Generalised Entropy Index with coefficient 1. Following Rey and Janikas (2005), the Theil index is given by:

$$T = \sum_i^n s_i \log(ns_i) \quad (1)$$

where n is the number of regions and

$$s_i = y_i / \sum_i^n y_i \quad (2)$$

being y_i the per capita GDP in region i .

The Theil index can be interpreted as the logarithm of a weighted geometric mean of the regional per capita incomes, the weights being represented by the income shares. A dual form also exists, in which the income shares are changed by population shares. According to Gluschenko (2018), who claims that this weighted approach is conceptually inconsistent, we use the Theil index without weighting by population (Eq. 1).

The Mean Logarithmic Deviation is also a member of the generalised entropy family of inequality measures, corresponding to the Generalised Entropy Index with coefficient 0. MLD, compared to the Theil index, is more sensitive to the inequality that appears at the bottom of the income distribution. It is given by:

$$L = \sum_i^n 1/n \log (1/n/s_i) \quad (3)$$

Bourguignon (1979), Shorrocks (1980) and Cowell (1995) showed that the Generalized Entropy Indices satisfy all the axioms of inequality measures¹⁰.

The income variable used in the Entropy measures in the present paper is the per capita Gross Domestic Product in Purchasing Power Standards (GDP PPS), collected from the Cambridge Econometrics' European Regional Database that is available from the new Annual Regional Database of the European Commission's Directorate General for Regional and Urban Policy (ARDECO, 2020).

The entropy measures have been calculated throughout the period from 2000 to 2019, which basically covers the three most recent EU's budgetary periods, and for all 1348 NUTS 3 regions in the EU28 (UK is included in the analysis as it was still a EU member throughout that period).

The eligibility criterion for receiving the Cohesion Policy funding is stated at NUTS 2 level. Eligible regions have been defined in all three studied funding periods as regions with a per capita GDP less than the 75% of the EU's average, receiving Structural Funds from the European Regional Development Fund and the European Social Fund. These are:

- Regions under the Objective 1 for policy period 2000-2006. Regions belonging to the ten countries which joined the European Union in 2004 (Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia) have been also considered under Objective 1 from 2000 to 2004 since they were receiving pre-accession funds in that period. Regions belonging to Bulgaria and Romania, which joined the EU in 2007, have been considered, as well, under Objective 1 from 2000 to 2006 since they were receiving pre-accession funds in that period.

¹⁰ Properties of inequality measures: mean or income scale Independence, Population Independence, Symmetry, The Pigou-Dalton Transfer principle, Decomposability.

- Convergence regions for policy period 2007-2013. Regions belonging to Croatia, which joined the EU in 2014, have been considered also as convergence regions from 2007 to 2013 since they were receiving pre-accession funds in that period.
- Less developed regions for period from 2014 to 2019 in our case (the whole policy period is from 2014 to 2021).

We confine our study to this funding because it has the specific objective of increasing the level of development in regions that are lagging behind the EU's average and entail the largest part of the overall Structural Funds.

The n+2 rule, which states the obligation to spend the funds allocated annually by the second year following the end of the programming period has not been taken into account in order to avoid overlaps in the different policy periods. However, it does not represent an issue in the analysis since only about 17% of regions changed their eligibility status over the three different programming periods and only about one third of these regions belong to countries with low absorption rates. Therefore, although a region might have not spent all the funds at the end of one period, it usually is still eligible and receives funds in the following programming period.

2.3.2. The model

Authors in the aforementioned literature have applied different methods when studying the effect of Cohesion Policy on intra-country convergence. Among them, Butkus et al. (2020a), applied a Difference-in-Difference model for a single policy programming period (2000-2006), Mogila et al. (2022) performed a macroeconomic approach while other studies used reduced-form single-equation econometric models (e.g. Kyriacou and Roca-Sagalés, 2012; Védrine and Le Gallo, 2021; Giua, 2017) based on the Williamson hypothesis, which allows to model the dynamics and estimate the main determinants of the regional disparities. Following this last line of methodology, and since our aim is to test the impact of Cohesion Policy on disparities in NUTS 3 regions throughout different programming periods, we formulate a simple econometric model in which the level of inequalities for each NUTS 3 region, quantified by the inequality measures of Eqs. 1 and 3, depends on the eligibility of the region to receive Structural Funds.

We have therefore limited ourselves to establish the simplest connection between the Structural Funds and the economic inequality across European regions, by conducting a panel regression model in which regional economic inequality during the period 2000-2019 is regressed on the eligibility of the region to be financed from Structural Funds (Eq. 4):

$$Inequality_{it} = \beta_1 Eligibility_{it} + \beta_2 X_{it} + u_{it} \quad (4)$$

Where $Inequality_{it}$ is the inequality measure of each NUTS 3 region i in time t covering period 2000-2019, X stands for a set of control variables which account for additional factors that may have an influence on regional disparities and u is the corresponding disturbance term. $Eligibility$ is a dummy variable which has a value of 1 when the i NUTS 3 region in year t is eligible for receiving Structural Funds and 0 otherwise. This variable only captures the policy status of the regions and does not account for the effective expenditure they benefit from. However, it captures the intention to treat effect and it is in line with many studies in the literature analysing the effect of Structural Funds on socio-economic variables (e.g. Giua, 2017).

Using this dummy variable instead of the real intensity of the Structural Funds treatment may consider eligible regions as treated when they have actually received less funding than initially budgeted. Structural Funds are delivered to local stakeholders which apply for policy support by submitting projects to be financed. However, they may not result elected to be financed since they might not meet the policy requirements implying the return of funds to the European Union as there are not enough projects to absorb the funding. Additionally, the absorption of the EU's funds depends to a high degree on the abilities of institutions to effectively implement policies so the lack of administrative capacity of the regions may jeopardise the absorption of the funds.

Unfortunately, the effective expenditure of the regions, which would have enabled us to estimate more accurately the effect of the Structural Funds on the inequality by confirming that each region considered eligible has received and spent funds, is not available at NUTS 3 level. Nevertheless, coefficients estimated by considering the eligibility dummy capture the intention to treat effect that is the lower bound for the average treatment effect that a continuous policy variable would have captured (Giua, 2017). Additionally, it indicates the eligibility criterion for each year, since a region could move

from eligible to non-eligible and vice versa through the different programming periods (although it is not the usual).

When selecting our control variables we take into account characteristics which may affect both regional inequalities and Structural Funds and, therefore, its omission might bias the estimated impact of Structural Funds on regional inequalities. These variables have been selected from the literature that studies the effect of Cohesion Policy on inequalities as well as the literature that studies the determinants of regional inequalities.

Hence, our choice of control variables includes the level of economic development measured by per capita GDP, together with the population density, the area of the regions, the employment rate and the initial level of inequalities. The level of economic development is quite relevant when explaining regional disparities, as it has been broadly discussed in inequality literature (e.g. Petrakos et al., 2005). The per capita GDP is the criterion used to determine the eligibility of a region for receiving Structural Funds, however, GDP can also influence the regional disparities for independent causes (Kyriacou and Roca-Sagalés, 2012; Védrine and Le Gallo, 2021). Its effect on regional disparities is controversial, as one can argue distinct theoretical points of view particularly when considering growth of economic development. As it is stated in Petrakos et al. (2005), some scholars following Solow (1956) claim that disparities are bound to diminish with growth, because of diminishing returns to capital. However, other schools following Myrdal (1957), agree that growth is a cumulative process, which is likely to increase inequalities.

As we have not weighted the measures of regional inequality by population according to Gluschenko (2018), who claims that this practice might lead to inconsistent outcomes, we control it by including the population density in the model. This variable might be a factor explaining regional inequalities and furthermore, it will enable us to control agglomeration effects (Crescenzi et al., 2017) and the region's size. It will be expected that disparities are affected by agglomeration effects. Other authors have included the population growth (Védrine and Le Gallo, 2021) in their models.

Additionally, to control the differences in population size across regions, we control for the size of the regions as it is done in the inequality literature (e.g. Lessmann, 2014; Védrine and Le Gallo, 2021). Since larger regions are often more heterogeneous than

smaller regions, a positive relationship with inequalities will be expected (Williamson, 1965). We also add the employment rate as a further control variable (authors as Védrine and Le Gallo (2021) included the employment density or the sectoral composition of employment), and we expect that more employment opportunities reduce the development disparities (Lessmann, 2014).

Finally, we are going to control for the initial level of inequalities at the beginning of the study period in order to verify whether the regions with more initial inequalities continue to have more inequalities than the rest of the regions. The desired outcome will be that regions with high initial disparities have reduced them over time, implying a negative relationship with the dependent variable. However, it is highly likely that regions with high initial disparities continue to have high disparities, seen the evolution of the European regional disparities over the last decades.

The variables have been collected from the Cambridge Econometrics' European Regional Database that is available from the new Annual Regional Database of the European Commission's Directorate General for Regional and Urban Policy (ARDECO, 2020) and Eurostat (See Table 2.1 for the exact source), except the initial level of disparities, which has been calculated from Eq. 1.

Table 2.1. Data sources

Variable	Source
Per capita GDP	Cambridge Econometrics' European Regional Database (ARDECO 2020)
Population	Cambridge Econometrics' European Regional Database (ARDECO 2020)
Area	Eurostat
Eligibility	European Commission
Employment rate	Cambridge Econometrics' European Regional Database (ARDECO, 2020)

Other studies in the inequality literature studying the driving forces behind inequality include control for ethnic groups, imports and exports, government quality, trade openness,

etc (Kyriacou and Roca-Sagalés, 2012; Védrine and Le Gallo, 2021). Unfortunately, this kind of variables are not available at this regional NUTS 3 level. Nevertheless, the variables included in the model have turned out to have a good performance in the estimations and explain a high percentage of the variation of the dependent variable as we would see below.

The model (Eq. 4) will be first estimated by OLS. Authors often consider panel data models with fixed effects (typically individual effects) to estimate regional equations, claiming that unobservable factors driving inequality may exist and cause omitted variable bias, and therefore including fixed effects in the models takes account of this unobserved regional heterogeneity (Ederveen, et al. 2002; Lessmann, 2014). Individual fixed effects models rely on the time variation within each cross-sectional unit and are frequently utilized in regional growth equations, being their use scarcer when dealing with disparities due to a small individual variation. In fact, in our analysis, most of the variation registered by the dependent variable is between NUTS 3 regions, rather than over time (the within standard deviation of the regional inequality main measure is $1.27 \cdot 10^{-4}$ while the between and overall standard deviations are $9.64 \cdot 10^{-4}$ and $9.04 \cdot 10^{-4}$, respectively).

Hence, it will be more appropriated to include time fixed effects in our model to corroborate the results obtained by OLS. From Eq. 4, the error term includes the time fixed effect λ_t (Eq. 5):

$$u_{it} = \lambda_t + \varepsilon_{it} \quad (5)$$

Resulting in Eq. 6:

$$Inequality_{it} = \beta_1 Eligibility_{it} + \beta_2 X_{it} + \lambda_t + \varepsilon_{it} \quad (6)$$

Nevertheless, there might be unobserved regional characteristics, invariant over time, which can affect both the Structural Funds' allocation and the regional inequalities, and may bias the estimation of the model. Therefore, we have considered as well individual fixed effects in the estimations by performing a two way fixed effects ($Inequality_{it} = \beta_1 Eligibility_{it} + \beta_2 X_{it} + \lambda_t + \mu_i + \varepsilon_{it}$ being μ_i the individual error component). However, by removing the variables invariant over time, the percentage of the dependent variable explained by the independent variables was drastically reduced, hence we have not included this model in the paper. Furthermore, as previously mentioned, controlling for

individual fixed effects is not recommendable in our case, as the time variation within each cross-sectional unit is limited in our dependent variable. As pointed out by Ezcurra and Rodríguez-Pose (2013), in this case individual fixed effects models leave unexplained what is most important in the data and the results may be biased (Kyriacou et al., 2015).

Additionally, if a region receives funds and affects its regional disparities or other characteristics, it may cause an influence on the features of the neighbouring regions. Therefore, there might be some slight bias in the previous estimations by the omission of this spatial spillover effect. As a robustness test, we will include the spatial spillovers by conducting a spatial autoregressive combined model (SARAR), which includes a spatial lag of the dependent variable and a spatial autoregressive disturbance (Eq. 7). The spatial dependence on the dependent variable implies that the values of the dependent variable, at each location, are correlated with the observations of the dependent variable at other locations. The spatial dependence on the disturbance term implies that the values of the disturbance term, at each location, are correlated with the disturbance terms at other locations.

$$Inequality_{it} = \beta_1 Eligibility_{it} + \beta_2 X_{it} + \eta \sum_{i \neq j} w_{ij} Inequality_{jt} + u_{it} \quad (7)$$

Where W is the spatial weights matrix, $WInequality_{jt}$ is the spatial lag term of the dependent variable and η is the spatial autoregressive coefficient. The disturbance term u_{it} includes the time specific effect λ_t not spatially autocorrelated (Eq. 8):

$$u_{it} = \lambda_t + \varepsilon_{it} \quad (8)$$

Being ε a vector of spatially autocorrelated innovations that follows a spatial autoregressive process of the form:

$$\varepsilon_{it} = \rho \sum_{i \neq j} w_{ij} \varepsilon_{jt} + v_{it} \quad (9)$$

Where $W\varepsilon_{jt}$ is the spatial lag of the error term and ρ is the autoregressive coefficient associated to the spatial lag $W\varepsilon_{jt}$.

2.4. Results, discussion and policy implications

The evolution of inequalities of NUTS 3 regions for the period 2000-2019 is displayed in Figure 2.1, using the Theil index and MLD measures respectively (Eqs. 1 and 3). Both measures start in 2000 from very similar values (0.1328 for Theil measure and 0.1339 for MLD), but although their trends diverge, they show similar patterns, with smoother features for MLD case, throughout years. Both measures show a clear decline in NUTS 3 inequalities until 2008, when the financial crisis took place, followed by a rise until 2016. From this year, inequalities slightly decrease again, to reach a value of 0.119 for Theil measure and 0.097 for MLD in 2019. Overall, NUTS 3 inequalities have decreased in the studied period considered as a whole.

The evolution of the NUTS 3 disparities does not seem to be linked to the policy programming periods, but it seems extremely affected by the global financial crisis of 2008, year from which the reduction tendency seen in the previous years is reversed. In order to observe the policy effects on NUTS 3 inequalities, we perform a regression over the model (Eq. 4).

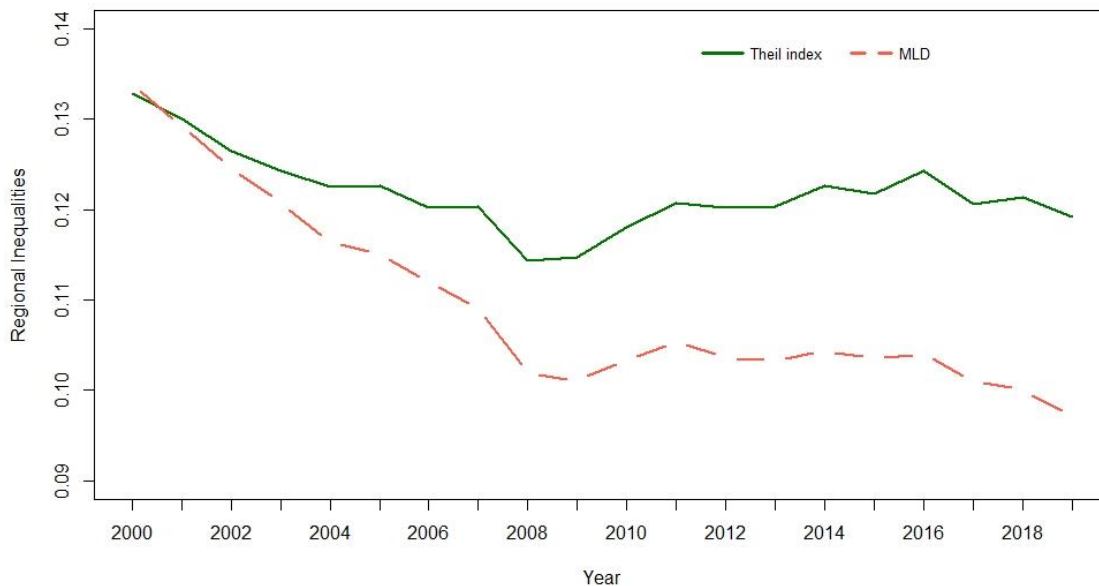


Figure 2.1. Evolution of NUTS 3 inequalities during period 2000-2019 using Theil index (in green) and Mean Logarithmic Deviation (MLD, in red).

Table 2.2 reports the estimates of the model (Eq. 4) via OLS with heteroskedasticity and autocorrelation consistent errors, using Theil index (Eq. 1) as the inequality measure and the dependent variable. As indicated in Table 2.2 (column 1), the model presents relatively good values in terms of goodness-of-fit (adjusted $R^2 = 0.97$).

Table 2.2. The impact of eligibility of regions on NUTS 3 regional inequality. Period 2000-2019

	(1) OLS	(2) Time fixed effects	(3) Spatial effects
Intercept	-2.625e-04*** (5.798e-06)	-3.176e-04*** (5.741e-06)	-2.471e-04*** (5.306e-06)
Per capita GDP	1.434e-08*** (1.850e-10)	1.862e-08*** (2.033e-10)	2.306e-08*** (2.109e-10)
Population density	-2.304e-08*** (8.060e-10)	-2.545e-08*** (7.809e-10)	-2.982e-08*** (8.986e-10)
Area	1.080e-10 (1.680e-10)	1.284e-10 (1.627e-10)	-5.286e-10** (1.884e-10)
Employment rate	-2.624e-06*** (1.420e-07)	-3.638e-06*** (1.396e-07)	-7.299e-06*** (1.416e-07)
Initial inequality	9.444e-01*** (2.798e-03)	8.944e-01*** (2.932e-03)	8.887e-01*** (2.951e-03)
Eligibility	1.642e-04*** (2.540e-06)	1.802e-04*** (2.480e-06)	1.715e-04*** (3.271e-06)
Observations	26960	26960	26960
NUTS 3 regions	1348	1348	1348
F-test	154495***	165939***	
Adj. R^2	0.97	0.97	
LM lag test			115.96***
LM error test			967.89***
Robust LM lag test			240.88***
Robust LM error test			822.8***
ρ			0.413*** (0.006)
η			-0.032*** (0.001)

Notes: *Significant at 10%, ** significant at 5%, *** significant at 1%. Theil index as measure of inequality. *Eligibility* is the dummy variable taking a value of 1 when regions are eligible for receiving Structural Funds and 0 otherwise.

Focussing on our coefficient of interest (β_1 in Eq. 4), we obtain that regions which are eligible to receive structural funds experience, on average, an increase of $1.642e-04$ on the disparities with respect to those regions which do not receive funds. The difference in the increase of disparities of the eligible regions with respect to non-eligible ones might seem to be quite small, but one should take into account that the values of the dependent variable are around of 10^{-5} .

The area of the NUTS 3 regions, used to control the size of the regions, shows a positive relationship with the inequality measure, meaning that the bigger the region area the higher the inequalities, in line with what is reported in inequality literature (e.g. Lessmann, 2014). However, this variable is not significant. The employment rate is negative, as we expected, implying that more employment opportunities reduce disparities. The relationship between inequalities and population density is also negative, suggesting that disparities are not affected by agglomeration effects, which is contrary to what was expected. The level of initial inequalities coefficient has a positive sign, denoting that regions with more initial inequalities continue to have high disparities. As previously mentioned, the desired outcome would have been the opposite, i.e., that regions with high initial disparities would have had them reduced over time.

Finally, we have obtained a positive impact of the level of economic development, measured by per capita GDP, on the level of disparities of NUTS 3 regions. This is in line with several empirical works in inequality literature. However, one can argue distinct theoretical points of view particularly when considering growth of economic development. As it is stated in Petrakos et al. (2005), some scholars following Solow (1956) argue that disparities are bound to diminish with growth, because of diminishing returns to capital. However, other schools following Myrdal (1957), agree that growth is a cumulative process, which is likely to increase inequalities. Williamson (1965) suggested an inverted-U-shaped relationship between inequality and economic development, based on the ideas of Kuznets (1955). Anyway, obtaining a positive relationship between economic development and regional inequalities indicates an ambiguous implication, since the objective of the Cohesion Policy is to reduce inequalities among its members and promote their economic development at the same time. Thus, this relationship is critical for

Cohesion Policy (Petraikos et al., 2005). Nevertheless, the impact of the level of economic development should be interpreted cautiously since it may be also affected by regional inequalities (Lessmann, 2014). The presence of this effect may cause endogeneity bias in the estimations. In order to provide robustness to our findings, we will perform some additional regressions.

In order to account for the unobserved regional heterogeneity in the model, we have included estimations with time fixed effects (Table 2.2, column 2). Time fixed effects' estimations present the same signs, significances and performance as the ones obtained by OLS, confirming the robustness of the model. Also, we include in the model the presence of spillover effects (Eq. 7), obtaining the same signs and significances as previously. As shown in Table 2.2 column (3), there is spatial autocorrelation in the data both in the error and in the dependent variable, implying that the inequalities of a region are affected by the inequalities of the neighboring regions and suggesting a non-spatial concentration of regional disparities values.

Continuing with robustness tests, we employ a Feasible General Least Squares (FGLS) estimator for the model. This is used instead of pooled OLS estimator when the series exhibit heteroskedasticity and serial correlation (Wooldridge 2006), which are present in our sample. As seen in Table 2.3 (column 1), we obtain again similar results, the same signs and similar goodness-of fit (adjusted $R^2 = 0.95$). However, in this case, the area is now significant.

As it has been previously indicated (section 2.3.1.), disparities over time may be different regarding the measure used to calculate the inequality index, since each index differently aggregates the information contained in the distribution (Ezcurra and Rodríguez-Pose, 2009). For this reason, we perform the model (Eq. 4) but using MLD inequality measure (Eq. 3) as the dependent variable with OLS, FGLS methods and time fixed effects. As it can be seen in Table 2.3 (OLS, FGLS and Time fixed effects with MLD, columns 2, 3 and 4), the signs are reversed for per capita GDP variable. When the relationship between the regression variables and the inequality variable measured by MLD or Theil index is complex or not lineal, as it might be the case (explained previously in section 2.4), differences in the signs of the regression coefficients could arise. In any case,

the main result holds, as regions eligible to receive structural funds, experience a further increase on disparities with respect to regions which do not receive funds. Note that with MLD inequality measure the performance of the model decreases (adjusted $R^2 = 0.76, 0.72$ and 0.83 respectively).

Table 2.3. Robustness analysis: alternative measures of inequality and FGLS estimation. Period 2000-2019

	(1) FGLS with Theil index	(2) OLS with MLD	(3) FGLS with MLD	(4) Time fixed effects with MLD
Intercept	-5.065e-04*** (6.838e-06)	6.944e-04*** (5.845e-06)	6.726e-04*** (4.963e-06)	8.101e-04*** (5.041e-06)
Per capita GDP	2.742e-08*** (1.806e-10)	-2.196e-08*** (1.863e-10)	-2.245e-08*** (1.027e-10)	-3.090e-08*** (1.785e-10)
Population density	-2.807e-08*** (1.829e-09)	-1.426e-08*** (8.130e-10)	-1.339e-08*** (1.822e-09)	-9.238e-09*** (6.856e-10)
Area	1.629e-09*** (3.734e-10)	1.295e-10 (1.698e-10)	8.827e-10* (4.031e-10)	5.980e-11 (1.428e-10)
Employment rate	-1.604e-06*** (1.363e-07)	-3.864e-06*** (1.436e-07)	-1.808e-06*** (7.987e-08)	-1.789e-06*** (1.225e-07)
Initial inequality	7.069e-01*** (3.924e-03)	2.246e-01*** (2.821e-03)	1.842e-01*** (3.533e-03)	3.295e-01*** (2.575e-03)
Eligibility	7.646e-05*** (2.861e-06)	2.242e-04*** (2.559e-06)	7.305e-05*** (3.269e-06)	1.930e-04*** (2.178e-06)
Observations	26960	26960	26960	26960
NUTS 2 regions	1348	1348	1348	1348
F-test		14689.5***		22600.3***
Adj. R2	0.95	0.76	0.72	0.83

Notes: *Significant at 10%, ** significant at 5%, *** significant at 1%. *Eligibility* is a dummy variable taking a value of 1 when regions are eligible for receiving Structural Funds and 0 otherwise.

As an additional test, we check whether the obtained results separately hold for the three different policy periods included in our 2000-2019 study period. Therefore, we run separated OLS and time fixed effects estimations for the Theil index inequality measure for the three included policy periods (2000-2006, 2007-2013, and 2014-2019). In Table 2.4 we see that we reach the same findings of the coefficient for eligibility being significant

and positive, pointing out that the effect (eligible regions experience further increase of disparities than ineligible ones) has been produced in the three policy periods, suggesting that the operational measures implemented to reduce the regional disparities have been similar in the different programming periods.

Additionally, we address potential bias due to cycle and policy periods effects, repeating the estimations for different subperiods of the whole 2000-2019 period. Table 2.5 reports the obtained results when subperiods of five years are considered, supporting earlier findings as well. The results indicate that all robustness tests for different periods and inequality measures performed with the time fixed effect model maintain the results obtained by OLS.

Hence, based on the findings revealed when performing the panel regression in Eq. 4 and corroborated by the robustness tests, we have determined that NUTS 3 regions eligible for receiving cohesion funds experience a greater increase of disparities than ineligible ones.

Although Kyriacou and Roca-Sagalés (2012) determined that the structural funding reduced within-country disparities until certain threshold, it seems that the effect is reversed when tackling the NUTS 3 regional inequalities. Our results are in line with the ones reported by Butkus et al. (2020b) over the policy period 2000-2006, which concluded that structural funds are enlarging imbalances within NUTS 2 regions, at NUTS 3 level.

Table 2.4: Robustness analysis: policy periods

	OLS			Time fixed effects		
	(1) 1st policy period 2000-2006	(2) 2nd policy period 2007-2013	(3) 3rd policy period 2014-2019	(4) 1st policy period 2000-2006	(5) 2nd policy period 2007-2013	(6) 3rd policy period 2014-2019
Intercept	-7.473e-05*** (5.859e-06)	-2.636e-04*** (9.619e-06)	-4.168e-04*** (1.301e-05)	-8.654e-05*** (5.905e-06)	-2.675e-04*** (9.629e-06)	-4.358e-04*** (1.302e-05)
Per capita GDP	5.099e-09*** (2.247e-10)	1.443e-08*** (3.844e-10)	2.184e-08*** (4.458e-10)	6.060e-09*** (2.374e-10)	1.485e-08*** (3.902e-10)	2.287e-08*** (4.513e-10)
Population density	-5.080e-09*** (7.733e-10)	-2.360e-08*** (1.269e-09)	-3.747e-08*** (1.739e-09)	-5.758e-09*** (7.700e-10)	-2.381e-08*** (1.268e-09)	-3.784e-08*** (1.726e-09)
Area	-1.308e-10 (1.548e-10)	9.374e-10*** (2.629e-10)	5.141e-10 (3.789e-10)	-1.657e-10 (1.537e-10)	9.291e-10*** (2.625e-10)	5.202e-10 (3.759e-10)
Employment rate	-1.074e-06*** (1.313e-07)	-2.933e-06*** (2.330e-07)	-4.808e-06*** (3.248e-07)	-1.261e-06*** (1.313e-07)	-3.075e-06*** (2.340e-07)	-5.006e-06*** (3.228e-07)
Initial inequality	9.694e-01*** (2.787e-03)	9.515e-01*** (5.253e-03)	9.056e-01*** (7.331e-03)	9.606e-01*** (2.866e-03)	9.473e-01*** (5.292e-03)	8.900e-01*** (7.403e-03)
Eligibility	5.492e-05*** (2.358e-06)	1.682e-04*** (4.142e-06)	2.524e-04*** (6.190e-06)	6.030e-05*** (2.385e-06)	1.706e-04*** (4.155e-06)	2.591e-04*** (6.169e-06)
Observations	9436	9436	8088	9436	9436	8088
NUTS 2 regions	1348	1348	1348	1348	1348	1348
F-test	157982***	62904.2***	36335.1***	160260***	63115.1***	36929.3***
Adj. R2	0.99	0.98	0.96	0.99	0.98	0.96

Notes: *Significant at 10%, ** significant at 5%, *** significant at 1%. Theil index as measure of inequality. *Eligibility* is the dummy variable taking a value of 1 when regions are eligible for receiving Structural Funds and 0 otherwise. Columns 1, 2 and 3 performed by OLS; columns 4, 5 and 6 are estimations with time fixed effects.

Table 2.5: Robustness analysis: different subperiods

	(1) 2000-2004	(2) 2005-2009	(3) 2010-2014	(4) 2015-2019	(5) 2000-2004	(6) 2005-2009	(7) 2010-2014	(8) 2015-2019
Intercept	-6.813e-05*** (5.009e-06)	-1.289e-04*** (1.079e-05)	-3.372e-04*** (1.172e-05)	-4.276e-04*** (1.445e-05)	-7.282e-05*** (5.017e-06)	-1.342e-04*** (1.086e-05)	-3.391e-04*** (1.173e-05)	-4.419e-04*** (1.445e-05)
Per capita GDP	3.547e-09*** (2.027e-10)	9.550e-09*** (4.296e-10)	1.691e-08*** (4.731e-10)	2.307e-08*** (4.869e-10)	3.978e-09*** (2.083e-10)	9.833e-09*** (4.354e-10)	1.708e-08*** (4.760e-10)	2.379e-08*** (4.905e-10)
Population density	-1.976e-09*** (6.548e-10)	-1.563e-08*** (1.395e-09)	-2.844e-08*** (1.576e-09)	-3.843e-08*** (1.920e-09)	-2.272e-09*** (6.527e-10)	-1.583e-08*** (1.395e-09)	-2.852e-08*** (1.576e-09)	-3.868e-08*** (1.910e-09)
Area	-1.297e-10 (1.302e-10)	6.074e-10* (2.815e-10)	6.657e-10* (3.330e-10)	5.521e-10 (4.197e-10)	-1.444e-10 (1.296e-10)	6.089e-10* (2.813e-10)	6.643e-10* (3.328e-10)	5.305e-10 (4.172e-10)
Employment rate	-2.751e-07* (1.101e-07)	-2.981e-06*** (2.504e-07)	-2.827e-06*** (2.956e-07)	-5.474e-06*** (3.605e-07)	-3.670e-07*** (1.101e-07)	-3.004e-06*** (2.502e-07)	-2.879e-06*** (2.956e-07)	-5.595e-06*** (3.587e-07)
Initial inequality	9.595e-01*** (2.391e-03)	9.922e-01*** (5.627e-03)	9.353e-01*** (6.603e-03)	8.905e-01*** (8.127e-03)	9.595e-01*** (2.418e-03)	9.886e-01*** (5.701e-03)	9.334e-01*** (6.632e-03)	8.790e-01*** (8.179e-03)
Eligibility	3.444e-05*** (2.032e-06)	1.230e-04*** (4.467e-06)	1.918e-04*** (5.237e-06)	2.620e-04*** (6.832e-06)	3.688e-05*** (2.044e-06)	1.241e-04*** (4.474e-06)	1.927e-04*** (5.243e-06)	2.666e-04*** (6.812e-06)
Observations	6740	6740	6740	6740	6740	6740	6740	6740
NUTS 2 regions	1348	1348	1348	1348	1348	1348	1348	1348
F-test	215886***	51763.7***	41761.8***	29775.3***	217978***	51858***	41810.8***	30135.7***
Adj. R2	0.99	0.98	0.97	0.96	0.99	0.98	0.97	0.96

Notes: *Significant at 10%, ** significant at 5%, *** significant at 1%. Theil index as measure of inequality. (1) and (5) Period from 2000 to 2004, (2) and (6) period 2005-2009, (3) and (7) period 2010-2014, (4) and (8) period 2015-2019. *Eligibility* is the dummy variable taking a value of 1 when regions are eligible for receiving Structural Funds and 0 otherwise.

Our findings seem to suggest that the allocation of the funds at NUTS 2 level only accentuates the NUTS 3 inequalities. As stated by Butkus et al. (2020b), the distribution at this level does not ensure that the financial support arrives at the NUTS 3 regions really needing it. On the one hand, this may be caused by the fact that the effectiveness of the Cohesion Policy is not homogeneous within the NUTS 2 regions, as it may depend on factors such as the structure of the public sector or the urban structure of the regions (Gagliardi and Percoco, 2017; Percoco, 2017). On the other hand, the resources may be unevenly distributed among the NUTS 3 regions mainly due to the fact that the absorption of the EU's funds depends to a high degree on the abilities of institutions to effectively implement policies (Leonardi, 2006; Tiginasu et al., 2018). This is especially the case in the new member states, which have a lack of administrative capacity in the regions and centralize the resources mostly in the capitals. The increasing spatial centralization in the distribution of funds was in the centre of the debate about the implementation of the 2021-2027 EU's Multiannual Financial Framework (Farole et al., 2018). However, almost the same operational programs are implemented the present programming period running the risk of a further concentration of EU's funds in the capitals and in some other more developed parts of the countries (Hadjinikolov, 2020).

We are aware that the assessment of the Cohesion Policy has been done using the eligibility of the NUTS 2 regions and not the actual expenditure the NUTS 3 regions benefit from. Also, there are certain aspects when dealing with treatments (differences between treated and non-treated regions, staggered treatment or pre-treatment trends) which have not been analysed in the estimations and could affect the interpretation of the results. Regardless, the results of this analysis could be useful for policymakers since they indicate that the actual distribution of the funds within NUTS 3 regions does not seem to have the desired effect, as NUTS 3 regions which are supposed to be receiving funds, do not see their disparities to be reduced. The 'one fits all' logic should give way to a more flexible approach that considers the huge differences in all ambits of the European regions and maximizes the effect of the policy. Recent approaches suggest that place-based policies may be more effective in reducing regional disparities (Iammarino et al., 2019; Rodríguez-Pose, 2020). Concretely, new approaches suggest that regional disparities in the European Union could be reduced by a twofold approach: reinforcing the strongest regions, and, at the same time, as it is currently done, boosting lagging regions, leading to a new "place-sensitive distributed development policy" (Iammarino et al., 2019).

In the long run, rising inequalities could affect the growth of all EU's regions (Brülhart and Sbergami, 2009; De Dominicis, 2014). However, member states have diverse preferences in terms of regional policy objectives. Some members do not see the reduction and eradication of regional disparities as a priority objective to implement, giving more importance to their aggregate economic performance (Crescenzi et al., 2020).

Furthermore, some recent events such as the Covid-19 pandemic put aside the addressing of specific regional structural problems by being more focused on meeting EU's wide objectives to ensure the economic recovery of their member states. While these policies and initiatives are of great importance for the long-term development of the European Union as a whole, they do not necessarily align with reducing regional disparities (Mogila et al., 2022). Probably, the Covid-19 crisis broadened the regional inequalities since "regions will disproportionately suffer from the impacts of the economic down-turn, making Cohesion Policy an important recovery tool, in a period where the feeling of being 'left behind' in the 'geographies of discontent' may actually grow in the short to medium term" (Sielker et al., 2021, p. 9). Therefore, in order to meet the objective of reducing the regional inequalities while assuring the economic performance of the regions, it is essential the EU-wide alignment of initiatives with national and regional programmes.

2.5. Conclusions

In this article we have examined the impact of the Structural Funds on the NUTS 3 regional inequalities with the purpose of determining whether NUTS 3 regions receiving those Structural Funds experience a further increase of disparities than regions which are not eligible to receive Structural Funds. To this end, we calculated the inequalities at NUTS 3 level and we constructed a panel model over the period 2000-2019 to study the relationship between regional inequality and the Structural Funds.

According to the Cohesion Policy purpose to reduce the disparities between the different regions' levels of development, our findings reveal that the Structural Funds impact on regional disparities does not seem to be the expected one. We have obtained that the NUTS 3 regions eligible for receiving Structural Funds experience a further increase of disparities than the ineligible ones.

This result suggests that the resources may be unevenly distributed within eligible NUTS 2 regions. Therefore, the spatial scale at which the Cohesion Policy allocates the funds could be debatable or consider tailored specific approaches devoting more attention to the particular characteristics of the NUTS 3 dimension, such as the economic and geographical structure. Thus, the existence of “accidental winners” which may trigger an enlargement of the economic differences of this kind of regions with respect to the others, could be avoided. The increase of inequalities as a result of the heterogeneous effectiveness of the Cohesion Policy within the NUTS 2 regions and the centralization of the allocation of the resources, could also be prevented. Regarding the latter, policymakers should implement measures boosting the effectiveness of the absorption of the Cohesion Policy funds at the NUTS 3 dimension. But all of these suggestions will be successful only if an alignment of EU-wide initiatives with national and regional programmes is produced so that the aggregate economic performance of the member state’s objective and the reduction of regional inequalities objective are aligned.

Future research revealing the driving forces behind the economic inequalities at the NUTS 3 level and performing further analysis regarding the effectiveness of the funding at this level will be useful to apply tailored policies in order to achieve the Cohesion Policy main objective. Moreover, the actual expenditure the NUTS 3 regions benefit from was not available, hence the Cohesion Policy assessment has been done using the NUTS 2 regions eligibility. Should we in the future be able to obtain the actual expenditure the NUTS 3 regions benefit from, we might be able to provide more specific recommendations for improving the EU’s policy.

Finally, we have to highlight that there are some limitations in our research that should be considered when studying the Cohesion Policy impact. We have not contemplated the n+2 rule when indicating the eligibility of a region to receive Structural Funds, for which there are two additional years to spend the funds after the end of the policy period. Furthermore, we have not included the post-policy period effects in our study, which may affect the disparities although regions might no longer be receiving funds. It is also likely that, at NUTS 3 level, some part of the per capita GDP corresponds to commuters, causing some small inaccuracies in this indicator.

2.6. References

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Chapter 3. Análisis de la Convergencia económica en la Eurorregión Galicia- Norte de Portugal en el periodo 1980-2019

RESUMEN

La existencia de intensas relaciones de cooperación entre las regiones Galicia y Norte de Portugal desde principios de la década de 1980 han conducido a la creación de una eurorregión para coordinar acciones conjuntas en busca de su mutuo desarrollo. La cuestión de si la existencia de estas fuertes acciones de cooperación entre regiones transfronterizas contribuye a la reducción de desigualdades entre ambos lados de la frontera y a una convergencia permanece sin esclarecerse. Por ello, el objetivo del presente análisis es contribuir a esta discusión explorando el fenómeno de convergencia en la eurorregión Galicia-Norte de Portugal durante el periodo de 1980 a 2019. Los resultados muestran una reducción en dichas desigualdades económicas a lo largo de todo el periodo y una convergencia absoluta al mismo nivel económico, demostrándose que la cooperación entre las regiones de la eurorregión ha conducido a un proceso de cohesión.

ABSTRACT

The existence of intense cooperative relations between Galicia and Norte-de-Portugal regions since the early 1980's have led to the creation of a Euroregion to coordinate joint actions in pursuit of their mutual development. The question of whether the existence of these strong cooperative actions between cross-border regions contributes to the reduction of inequalities between the two sides of the border and a convergence of the regions remains unclear. Therefore, the objective of this analysis is to contribute to this discussion by exploring the phenomenon of convergence in the Euroregion Galicia-Norte-de-Portugal during the 1980-2019 period. The results show a reduction in economic inequalities throughout the entire period and an absolute convergence at the same economic level, proving that the cooperation between the regions of the Euroregion has led to a cohesion process.

Palabras clave: Convergencia; Eurorregión Galicia-Norte de Portugal; Desigualdades económicas.

Keywords: Convergence; Galicia-Norte-de-Portugal Euroregion; Economic Inequality.

Códigos JEL: C21, R58, F02, O47

3.1. Introducción

La creación de la Unión Europea (UE) y la consecuente eliminación de las barreras en la movilidad, comercio e inversión entre los estados miembros, ha contribuido a un proceso de intensa interacción y cooperación entre territorios transfronterizos. En las últimas décadas, las regiones transfronterizas han ido ganando relevancia tanto en el mundo académico como en el político por su contribución al proceso de integración europea, al ser consideradas como “laboratorios de la integración europea”, es decir, espacios pioneros en la implantación de nuevas medidas para la integración entre comunidades (Comisión Europea, 2021).

La existencia de amplias relaciones transfronterizas y la financiación económica proporcionada esencialmente por la iniciativa europea INTERREG para reforzar los procesos de cooperación transfronteriza en la UE han conducido a la proliferación de diversas asociaciones transfronterizas (Medeiros, 2013), entre ellas las llamadas “eurorregiones”. Una eurorregión puede ser definida como una estructura europea para la coordinación y la cooperación transfronteriza de los países europeos. Estos espacios establecen intervenciones y medidas conjuntas para solucionar problemas comunes en las fronteras, explotar su potencial crecimiento y aumentar los procesos de cooperación.

La eliminación de las barreras transfronterizas en la movilidad, mercado de trabajo, comercio, etc, revela las amplias desigualdades económicas, sociales y territoriales que existen a ambos lados de la frontera. Estos territorios se caracterizan por tener distintos niveles económicos y una amplia diversidad social y cultural, derivada principalmente por el diferente lenguaje, distintos sistemas administrativos y legales, sistemas educativos y de salud, mercados de trabajo, etc. No obstante, se espera que con la apertura de las fronteras, aumente la movilidad de trabajo y personas, así como la creación de flujos de capital y bienes entre ellas, provocando una nivelación de las desigualdades que puedan existir, al producirse una redistribución más eficaz del trabajo y los recursos y un incremento en la eficiencia de la economía (Pires y Nunes, 2018; Comisión Europea, 2010; Bonin *et al.*, 2008). Esto es, se espera que se produzca un proceso de integración espacial en los territorios que comparten una frontera y consecuentemente una convergencia entre los mismos (Pires y Nunes, 2018).

Sin embargo, se ha demostrado que la existencia de fuertes interacciones y acciones de cooperación entre las regiones transfronterizas no implica un proceso de convergencia

en sus características territoriales (Alegría, 2009; Topaloglou *et al.*, 2005; De Boe *et al.*, 1999). Es decir, el desarrollo de relaciones económicas transfronterizas no necesariamente conlleva una reducción en las disparidades o un incremento en la cohesión territorial (Decoville *et al.*, 2013).

En base a estos argumentos, en el presente estudio se pretende explorar la convergencia económica y la evolución de las disparidades en la eurorregión Galicia-Norte de Portugal, una eurorregión especialmente activa en la zona sudoeste de Europa (Durá *et al.*, 2018). La convergencia es uno de los mecanismos fundamentales para conseguir cohesión entre las regiones, el cual es uno de los principales objetivos de la política de cohesión europea.

El resto del artículo está estructurado de la siguiente forma. En el apartado 3.2 se presenta una revisión de los antecedentes sobre convergencia y cohesión, así como de la eurorregión objeto de estudio. La metodología usada para realizar el análisis se describe en el apartado 3.3 mientras que los resultados se presentan y discuten en el apartado 3.4. El apartado 3.5 presenta las conclusiones del estudio.

3.2. La importancia de la cohesión económica en Europa: el nivel eurorregional y la eurorregión Galicia-Norte de Portugal

Las regiones transfronterizas, primeras beneficiadas por la apertura de las fronteras, se han convertido en espacios de intercambios socioeconómicos de bienes y servicios (de Sousa, 2013), generando un proceso de integración. Se ha demostrado que el proceso de integración transfronteriza varía a lo largo de las fronteras dependiendo de la intensidad de la cooperación entre las regiones, el nivel de la confianza social entre las poblaciones y la participación en proyectos de cooperación (Durand y Decoville, 2020). Algunos autores alegan que la integración espacial puede conllevar una reducción de las diferencias entre regiones (Pires y Nunes, 2018; Ehlers *et al.*, 2001), al producirse una distribución más eficaz del trabajo y los recursos y un incremento en la eficiencia de la economía (Pires y Nunes, 2018; Comisión Europea 2010; Bonin *et al.*, 2008). En este sentido, la integración espacial puede ser considerada como un sinónimo de convergencia.

Por otro lado, hay autores que claman que la integración transfronteriza (especialmente en términos del mercado laboral) se produce debido a la existencia de

altas diferencias económicas, lo cual contradice que la integración conlleve un proceso de convergencia (Decoville *et al.*, 2013; Topaloglou *et al.*, 2005). De esta forma, aunque cabría esperar que la cooperación entre las regiones transfronterizas nivele las desigualdades regionales, la existencia de interacciones entre territorios transfronterizos no es indicativo de convergencia.

Adicionalmente, es más probable que la convergencia se cumpla para un grupo homogéneo de regiones con características socioeconómicas y estructuras institucionales y legales similares, como pueden ser las regiones de un mismo país (Viegas y Antunes, 2013). Concretamente, en la península ibérica, estos autores observaron un fuerte efecto de club convergencia nacional, constatando la incapacidad de las regiones portuguesas transfronterizas a converger con las regiones españolas más prósperas.

Hay otros factores que también pueden influir en la convergencia y cohesión territorial de las regiones transfronterizas, como por ejemplo, las infraestructuras de conexión, cuyo papel es fundamental para promover la cohesión social y territorial de las regiones. No obstante, de acuerdo con Gutiérrez *et al.* (2015), la implantación de nuevas líneas ferroviarias -una de las infraestructuras clave para mejorar la cohesión- cumple solo parcialmente su objetivo, ya que pueden existir municipios atrasados en los que dicha implantación empeoraría la cohesión. Otras infraestructuras que tienen un gran impacto en la cohesión son las universidades y hospitales, cuya dispersión, de acuerdo con García (2014), ha incrementado la cohesión territorial y social en Galicia en las últimas décadas.

Las políticas económicas europeas también juegan un papel esencial en la convergencia y cohesión de las regiones transfronterizas. En concreto, a partir del periodo 2007-2013 se produjo una reorientación del tipo de programas y de actuaciones priorizadas (Sande Veiga y Vence Deza, 2021) y una reducción de financiación que afectó desfavorablemente a la integración de la eurorregión Galicia-Norte de Portugal (Faíña *et al.*, 2015). Adicionalmente, la gestión centralizada de los fondos europeos dificulta la distribución correcta hacia los territorios y la absorción de los recursos (Sande Veiga y Vence Deza, 2019) constatando que la periféricidad de la eurorregión penaliza el desarrollo económico y convergencia de la misma, así como su integración con el resto de núcleos y redes europeas.

En vista de este debate, con este estudio se pretende contribuir a la discusión estableciendo si para las eurorregiones, espacios con intensas relaciones de cooperación

facilitadas por una financiación específica dentro de la política de cohesión, se dan procesos de convergencia y de reducción de las disparidades regionales, cubriendo así la brecha que existe para este tipo de estructuras híbridas, que contienen regiones transfronterizas y no transfronterizas.

Para ello, vamos a estudiar la convergencia económica y la evolución de las disparidades regionales en la eurorregión Galicia-Norte de Portugal, una eurorregión especialmente activa de la zona sudoeste de la Unión Europea (Durá *et al.*, 2018), durante un periodo de casi 40 años (1980-2019).

El estudio de la convergencia económica ha sido ampliamente abordado en las últimas décadas, debido a su importancia como método de evaluación de la efectividad de la política de cohesión europea. Los conceptos de convergencia clásica más ampliamente estudiados son la β -convergencia, propuesto por Barro y Sala-i-Martin (1991, 1992), el cual se refiere al proceso por el que países o regiones más pobres alcanzan a los más ricos a lo largo del tiempo, mientras que la σ -convergencia, propuesta también por Barro y Sala-i-Martin (2004), se refiere a la reducción de las disparidades entre los países o regiones en el tiempo.

Este análisis se puede aplicar a otras eurorregiones de la UE para explicar la evolución de las desigualdades existentes y entender el proceso de convergencia en estructuras que tienen una frontera común, lo cual puede ser útil a la hora de establecer políticas y mecanismos de cooperación entre regiones transfronterizas.

3.2.1. La eurorregión Galicia-Norte de Portugal

Este estudio se ha centrado en la eurorregión Galicia-Norte de Portugal, en la zona sudoeste de la Unión Europea, la cual es especialmente activa (Durá *et al.*, 2018). Es considerada una pionera por su larga trayectoria en relaciones de cooperación, desde principios de la década de 1980, incluso antes de que ambos países entraran en la Unión Europea en 1986. Estas relaciones condujeron a la constitución de una comunidad de trabajo en 1991 y a la creación de la eurorregión en 2008. Su línea de trabajo está dirigida al apoyo de uniones público-privadas reforzando la interacción entre ambos lados de la frontera en diferentes sectores (Durá *et al.*, 2018).

La eurrregión de Galicia-Norte de Portugal fue la primera en crearse entre la frontera de España y Portugal. Está compuesta por territorios extensos con áreas metropolitanas y ciudades de tamaño medio separadas por áreas rurales o escasamente pobladas, y largas líneas costeras (Durá *et al.*, 2018). La eurrregión tiene una población de 6.3 millones de habitantes. Su dinámica de actividad y empleo se concentra principalmente en el sector servicios (64,6%), en la industria y construcción (29,6%) y, en menor medida, en el sector primario (5,8%). En general, las provincias españolas tienen un nivel más alto del PIBpc que las portuguesas (a excepción de la subregión portuguesa Área Metropolitana do Porto).

Tabla 3.1. Indicadores para la eurrregión.

Región	Población	Empleo Sector primario	Empleo Industria y Construcción	Empleo Servicios	PIBpc (1980)	PIBpc (2019)
Norte de Portugal	3.6 millones	5.5%	33.1%	61.4%	3163.27 PPSpc	21081.75 PPSpc
Galicia	2.7 millones	6.4%	24.0%	69.6%	5033 PPSpc	25612.78 PPSpc

Fuente: observatorio transfronterizo Galicia-Norte de Portugal (<http://www.observatoriognp.eu>), 2019. Datos PIBpc: cálculos propios sobre la base de datos “Annual Regional Database of the European Commission’s Directorate General for Regional and Urban Policy” (ARDECO, 2021).

Utilizando la nomenclatura estadística de unidades territoriales de la UE, la eurrregión Galicia-Norte de Portugal englobaba doce regiones NUTS 3 en el momento de su creación: las provincias de A Coruña, Lugo, Ourense y Pontevedra en Galicia (España), y las subregiones de Minho-Lima, Cávado, Ave, Grande Porto, Tâmega, Entre Douro e Vouga, Douro y Trás-os-Montes y Alto Douro en Norte de Portugal. En la Tabla 3.2 y Figura 3.1 se muestran las regiones que comprenden dicho territorio según la clasificación actual NUTS 2021.

Tabla 3.2. Regiones NUTS 3 de la eurrregión Galicia-Norte de Portugal (clasificación NUTS 2021).

Región	Código
A Coruña	ES111
Lugo	ES112

Ourense	ES113
Pontevedra	ES114
Alto Minho	PT111
Cávado	PT112
Ave	PT119
Área Metropolitana do Porto	PT11A
Alto Tâmega	PT11B
Tâmega e Sousa	PT11C
Douro	PT11D
Terras de Trás-os-Montes	PT11E

Fuente: <https://ec.europa.eu/eurostat/web/nuts/history>.



Figura 3.1. Mapa de las regiones NUTS 3 de la eurorregión Galicia-Norte de Portugal. Fuente: elaboración propia.

3.3. Metodología

3.3.1. Descripción de los datos

El indicador utilizado para medir la evolución de las desigualdades económicas y evaluar la convergencia es el PIB PPS per cápita, extraído de la base de datos “Annual Regional Database of the European Commission’s Directorate General for Regional and Urban Policy” (ARDECO, 2021). El análisis se ha llevado a cabo a nivel NUTS 3, un

requisito a la hora de crear eurorregiones con fronteras interiores (Reglamento (CE) 1638/2006 del Parlamento Europeo y del Consejo, 2006).

Las estadísticas descriptivas de la Tabla 3.3 muestran las asimetrías entre las regiones pertenecientes a la eurorregión en términos del PIB PPS per cápita (PIBpc de ahora en adelante). La dispersión (CV) en esta variable varía desde un valor de 0.38 en el año 1980 hasta 0.18 en 1999 y 2013. El nivel del PIBpc ha aumentado a lo largo del periodo, quintuplicándose.

Tabla 3.3. Estadísticas descriptivas anuales del PIBpc (1980-2019).

Año	Min	Max	Media	Mediana	Des.Std	CV	Asimetría	Curtosis
1980	2052.33	5447.22	3386.00	2832.01	1276.90	0.38	0.39	-1.68
1981	2352.78	5950.32	3815.85	3241.83	1361.12	0.36	0.35	-1.73
1982	2555.08	6759.60	4167.57	3520.95	1509.08	0.36	0.42	-1.59
1983	2730.79	6997.63	4433.19	3751.77	1591.95	0.36	0.45	-1.54
1984	2905.40	7749.37	4782.27	3991.70	1757.34	0.37	0.44	-1.56
1985	2870.09	7143.79	4668.35	3957.45	1617.45	0.35	0.32	-1.78
1986	3472.14	7703.44	5310.93	4822.21	1516.29	0.29	0.22	-1.79
1987	3634.79	8164.05	5586.59	5083.46	1608.43	0.29	0.23	-1.76
1988	4147.44	8822.82	6353.27	5843.55	1772.63	0.28	0.16	-1.86
1989	4692.99	10001.97	7058.40	6646.59	1856.45	0.26	0.18	-1.74
1990	5377.02	10412.63	7843.65	7657.23	1825.37	0.23	0.11	-1.74
1991	5901.92	11303.20	8547.30	8442.24	1916.84	0.22	0.08	-1.70
1992	6546.85	12358.14	9187.95	9268.87	1900.71	0.21	0.15	-1.48
1993	6593.14	12238.44	9201.73	9232.17	1887.55	0.21	0.12	-1.55
1994	6955.45	12666.92	9564.02	9607.04	1890.38	0.20	0.12	-1.53
1995	6938.33	12438.86	9434.06	9481.05	1819.32	0.19	0.15	-1.49
1996	7421.45	13069.40	9925.18	10007.33	1845.33	0.19	0.18	-1.44
1997	7664.56	13294.11	10151.34	10125.37	1888.93	0.19	0.21	-1.48
1998	8050.73	13777.63	10568.69	10456.02	1977.71	0.19	0.26	-1.50
1999	8593.05	14514.85	11123.06	11068.26	2003.14	0.18	0.29	-1.42
2000	8206.06	15307.90	11578.02	11722.74	2444.80	0.21	0.01	-1.60

2001	8605.52	15877.26	12220.22	12266.82	2612.54	0.21	-0.02	-1.70
2002	8824.77	16394.30	12704.84	12690.99	2811.32	0.22	-0.04	-1.76
2003	9119.05	17125.01	13051.87	12684.56	2954.92	0.23	0.02	-1.77
2004	9321.25	18124.97	13520.73	12849.37	3188.34	0.24	0.10	-1.74
2005	10065.55	19555.17	14584.57	13496.12	3414.40	0.23	0.15	-1.76
2006	10950.22	21298.71	15681.05	14126.22	3817.65	0.24	0.24	-1.75
2007	11544.80	22965.86	16470.06	14772.12	4211.15	0.26	0.30	-1.71
2008	11731.96	23616.88	17027.94	15432.27	4190.32	0.25	0.29	-1.67
2009	11526.94	22711.88	16437.93	15233.62	3655.25	0.22	0.32	-1.51
2010	12072.56	22754.27	16951.55	15827.09	3407.86	0.20	0.23	-1.50
2011	11808.79	22287.73	16646.87	15463.00	3445.72	0.21	0.24	-1.58
2012	11754.88	21822.27	16518.48	15203.76	3419.60	0.21	0.22	-1.62
2013	12320.57	21995.69	17098.47	15926.62	3152.34	0.18	0.19	-1.51
2014	12738.11	22482.72	17592.11	16631.47	3268.90	0.19	0.11	-1.50
2015	13229.43	23839.71	18272.55	17450.73	3620.25	0.20	0.15	-1.49
2016	13605.04	24149.02	18938.41	18235.61	3655.35	0.19	0.08	-1.55
2017	13799.19	24971.59	19466.92	18841.20	4030.20	0.21	0.05	-1.70
2018	14406.88	25551.37	20362.13	19886.78	3863.10	0.19	-0.10	-1.56
2019	14996.82	26383.39	21099.35	20735.10	3961.80	0.19	-0.11	-1.57

Fuente: cálculos propios sobre la base de datos “Annual Regional Database of the European Commission’s Directorate General for Regional and Urban Policy” (ARDECO, 2021).

3.3.2. Convergencia

Con el propósito de estudiar los fenómenos de convergencia entre las regiones NUTS 3 pertenecientes a la euroregión Galicia-Norte de Portugal, nos centraremos en el concepto de convergencia real, la cual se mide por el PIB per cápita, y se refiere a la reducción de las diferencias económicas entre regiones, a través de un proceso por el cual los niveles de renta de las economías de renta más bajas se aproximan de forma permanente a los de las economías de renta más altas. Esta aproximación viene dada por el aumento de los niveles de rendimiento per cápita de las regiones menos desarrolladas hasta alcanzar los niveles de las más prósperas. La convergencia real se mide principalmente con dos conceptos frecuentemente usados en literatura: σ -convergencia y

β -convergencia absoluta, ambos propuestos por Barro y Sala-i-Martin (2004, 1991, 1992).

Para obtener un proceso de σ -convergencia se tiene que observar una reducción de la dispersión del PIB per cápita de las regiones a lo largo del tiempo, mientras que para que se dé la existencia de β -convergencia absoluta, las regiones más pobres deben experimentar un crecimiento más rápido que las regiones más ricas, las cuales crecen con tasas menores, hasta que ambas alcanzan el mismo nivel económico. Que exista β -convergencia es una condición necesaria pero no implica que se obtenga σ -convergencia (Chatterji, 1992). Ambos tipos de convergencia se explican en detalle a continuación.

3.3.2.1. σ -Convergencia

La σ -convergencia, propuesta por Barro y Sala-i-Martin (2004) hace referencia a la reducción de las disparidades entre regiones a lo largo del tiempo, y es evaluada midiendo la dispersión del PIB per cápita entre ellas. Una reducción de la dispersión del PIBpc implica la existencia de un proceso de σ -convergencia.

Las medidas más comúnmente usadas para evaluar este tipo de convergencia son la desviación estándar o el coeficiente de variación. No obstante, existen más medidas como el coeficiente de Gini, el índice de Theil o la desviación logarítmica media (MLD). En la literatura, no hay un método único a la hora de seleccionar la medida apropiada. De hecho, diferentes medidas pueden arrojar resultados distintos en la evolución de las disparidades, por lo que es recomendable aplicar varias de ellas para comprobar la validez de los resultados obtenidos (Ezcurra y Rodríguez-Pose, 2009). En nuestro estudio vamos a estudiar la evolución de las desigualdades con las siguientes medidas: el coeficiente de variación, el coeficiente de Gini, el índice de Theil y la desviación logarítmica media, a través de las siguientes ecuaciones:

$$CV = \frac{\frac{1}{N} \sqrt{\sum_{i=1}^N (y_i - \bar{y})^2}}{\bar{y}} \quad (\text{Ec. 1})$$

$$Gini = \frac{1}{2N^2\bar{y}} \sum_{i=1}^N \sum_{j=1}^N |y_i - y_j| \quad (\text{Ec. 2})$$

$$T = \frac{1}{N} \sum_i^N \frac{y_i}{\bar{y}} \log \left(\frac{y_i}{\bar{y}} \right) \quad (\text{Ec. 3})$$

$$L = \frac{1}{N} \sum_i^N \log \left(\frac{\bar{y}}{y_i} \right) \quad (\text{Ec. 4})$$

donde y_i es el PIB per cápita de la región i , \bar{y} es la media y N es el número de regiones.

El coeficiente de variación expresa la relación entre la desviación típica y la media, mientras que el coeficiente de Gini se calcula como la media aritmética del valor absoluto de las diferencias entre todos los pares de valores del PIB, dividido por la media, el cual es más sensible cuando las variaciones en las desigualdades aparecen alrededor de la mediana. El índice de Theil (Theil, 1967) es independiente de la escala y de la media y no está afectado excesivamente por valores atípicos. Es un caso particular del índice de entropía generalizada con coeficiente 1, mientras que la desviación logarítmica media corresponde al coeficiente 0. Esta última medida es más sensible a las desigualdades que aparecen en el extremo inferior de la distribución, comparado con el índice de Theil. Todas las medidas de desigualdad son independientes de la media, del tamaño de la población, simétricas y satisfacen el principio Pigou-Dalton (Cowell, 1995). Las usaremos sin ponderar de acuerdo con Gluschenko (2018), quien alega que la ponderación puede dar lugar a resultados inconsistentes.

3.3.2.2. β -Convergencia

El concepto de β -convergencia, propuesto por Barro y Sala-i-Martin (1991, 1992) alude al proceso por el cual las regiones más pobres alcanzan a las más ricas en el tiempo y es evaluado mediante regresiones del crecimiento del PIBpc sobre su nivel inicial.

Según la teoría neoclásica de Solow (Solow, 1956), las regiones con unos niveles iniciales más bajos del PIBpc crecen más rápido que el resto de las regiones en la primera etapa del proceso de convergencia, para luego converger a largo plazo a tasas de crecimiento similares a las del resto de las regiones. La razón subyacente es que una región con valores económicos más bajos tiene más posibilidades de aumentar su productividad marginal, por lo que la tasa de crecimiento de una región es mayor cuanto más lejos está de converger. De esta forma, la divergencia es un fenómeno transitorio a corto plazo hasta que se alcanza la convergencia en los niveles económicos. Al final del

proceso, las regiones inicialmente más pobres alcanzan a las más ricas, convergiendo al mismo estado estable en el nivel del PIBpc. Una relación inversa y estadísticamente significativa entre los niveles iniciales del PIBpc de las regiones y sus tasas de crecimiento implica la existencia de este fenómeno.

No obstante, puede que el proceso de convergencia no se produzca debido a las externalidades y el aumento del rendimiento, según los modelos de crecimiento endógeno propuestos por Romer (1986) y Lucas (1988) y la nueva teoría de comercio internacional propulsada por Krugman (1991). Las economías de escala y los efectos externos limitados regionalmente pueden desencadenar la concentración de la actividad económica en regiones donde el capital ya es elevado, aumentando así las desigualdades económicas regionales.

La convergencia absoluta implica que todas las regiones poseen los mismos parámetros estructurales a excepción de su nivel inicial del PIBpc, por lo que el estado estable al que converjan será el mismo para todas las regiones. Es más probable que esta condición se cumpla para un grupo de regiones homogéneas con parámetros económicos, legales, etc, similares, tal y como ocurre para las regiones de un mismo país (Viegas y Antunes, 2013). Aunque Portugal y España no comparten las mismas características económicas y administrativas, las intensas relaciones de cooperación que ha habido entre ambos países a lo largo de los años y la creación de la eurorregión tienen como propósito aumentar la movilidad y las relaciones económicas a ambos lados de la frontera, contando con una financiación específica común para ello, por lo que es probable que las regiones de esta eurorregión converjan al mismo nivel económico. Por otro lado, la convergencia condicional considera que las regiones tienen distintas condiciones de crecimiento y convergen a distintos estados estables determinados por sus propios parámetros estructurales como el nivel de tecnología, las tasas de ahorro, la depreciación del capital, etc, por lo que estas variables adicionales se deben incluir en el modelo a fin de controlar este fenómeno.

La ecuación tradicional de la β -convergencia absoluta es la siguiente:

$$\frac{1}{T} \log \frac{y_{i,T}}{y_{i,0}} = \alpha + \beta \log(y_{i,0}) + \varepsilon_i \quad (\text{Ec. 5})$$

Donde el término de la izquierda es la tasa de crecimiento media anual del PIBpc en la región i durante el periodo T , $y_{i,0}$ es el PIBpc de la región i al inicio del periodo, α es

el término constante a determinar, ε es el término de error y β es el parámetro a estimar el cual indica la relación entre el crecimiento del PIBpc y su valor inicial. Cuando este parámetro tiene signo negativo implica la existencia de β -convergencia absoluta. Con la estimación de $\beta = (1 - e^{-bT})/T$ obtenemos la velocidad de convergencia b a partir de la siguiente expresión:

$$b = -\frac{1}{T} \log(1 - \beta T) \quad (\text{Ec. 6})$$

Y la vida media, que se define como el tiempo necesario para alcanzar la mitad del estado estable de convergencia, se obtiene con la siguiente fórmula:

$$\tau = \frac{\ln 2}{b} \quad (\text{Ec. 7})$$

Con el objetivo de comparar los resultados de la convergencia con distintos estudios, estimaremos la ecuación 5 mediante regresión por mínimos cuadrados (OLS), asumiendo que la convergencia entre regiones que tienen niveles altos en el PIB y entre regiones con niveles bajos tiene el mismo efecto en la convergencia total.

3.4. Resultados y discusión

3.4.1. σ -Convergencia

En primer lugar, se ha estudiado el fenómeno de la σ -convergencia durante el periodo de 1980 a 2019 en la eurorregión Galicia-Norte de Portugal, usando varias medidas de desigualdad, entre ellas el coeficiente de variación, el coeficiente de Gini, el índice de Theil y la desviación logarítmica media. Tal y como se puede observar en la Figura 3.2, las disparidades económicas para la eurorregión han ido decreciendo desde el año 1980. Partiendo de un valor de 0.36 en el año 1980 (medido con el coeficiente de variación), han disminuido hasta un valor de 0.18, es decir, se muestra una convergencia general a lo largo del periodo estudiado, en la que las disparidades han decrecido en un 50%. Aunque a lo largo de todo el proceso se aprecian fluctuaciones que pueden deberse a influencias en las disparidades de los ciclos temporales económicos, se notan claramente tres tramos con tendencias distintas. Se puede apreciar una fuerte convergencia durante el periodo 1980-1999, en el cual las disparidades disminuyeron desde un valor de 0.36 en el año 1980 a un valor de 0.17 en el año 1999. A partir de este año, coincidiendo con la

implementación de la Unión Monetaria, las disparidades empezaron a crecer hasta alcanzar un valor de 0.24 en el 2007, dando lugar a un periodo de divergencia. Seguidamente, coincidiendo con el inicio de la crisis global de 2008, las desigualdades volvieron a decrecer hasta un valor de 0.18 en el año 2019, implicando convergencia.

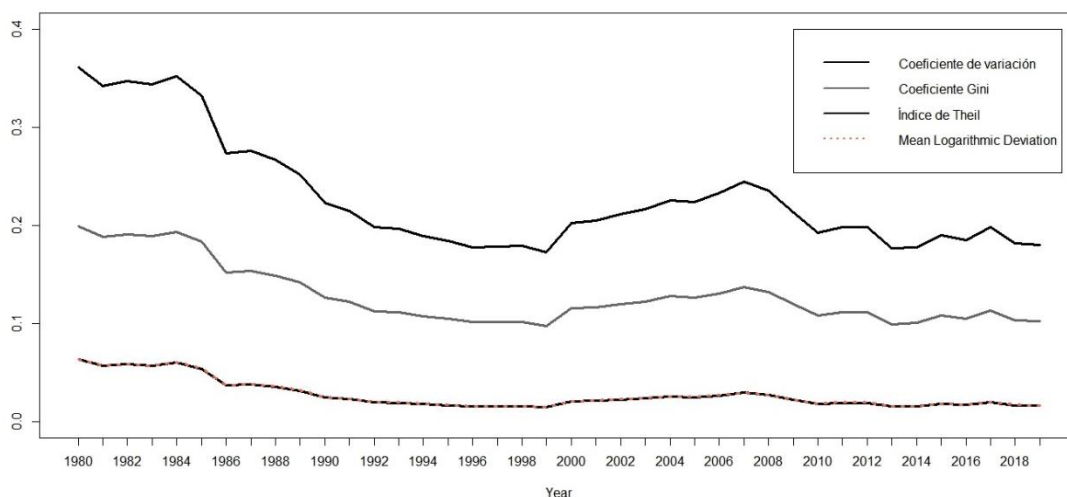


Figura 3.2. Evolución de las disparidades económicas en la eurrregión de 1980 a 2019. Fuente: cálculos propios sobre la base de datos “Annual Regional Database of the European Commission’s Directorate General for Regional and Urban Policy” (ARDECO, 2021).

Aunque las medidas de desigualdad usadas son sensibles a los cambios en distintas partes de la distribución y ello puede dar lugar a diferentes resultados, las cuatro muestran las mismas tendencias de convergencia o divergencia para los mismos años. Con el coeficiente de Gini obtenemos un valor de 0.2 en el año 1980, el cual disminuye hasta 0.13 en el año 1990, aumenta hasta 0.14 en el año 2007 y vuelve a decrecer hasta alcanzar un valor de 0.1 en el último año del periodo, disminuyéndose en total las disparidades en un 51%. Según el índice de Theil, las disparidades tenían un valor de 0.0636 en 1980, las cuales van decreciendo hasta alcanzar un valor 0.0249 en 1990, aumentan hasta 0.02957 en 2007 y vuelven a disminuir hasta 0.01644 en 2019, reduciéndose un 26% en total. Por último, con la desviación logarítmica media se parte de un valor de 0.0639 en 1980, el cual disminuye hasta 0.0253 en 1990, aumenta hasta 0.02959 en 2007 y decrece hasta alcanzar un valor de 0.1 en 2019, obteniéndose una disminución de un 26.5% en las disparidades a lo largo de todo el periodo.

Las tendencias obtenidas en el análisis de la σ -convergencia contrastan con las reportadas en la literatura para la Unión Europea. Butkus *et al.* (2018) obtuvo un aumento de las disparidades económicas de las regiones NUTS 3 europeas hasta el año 2001 (desde

el año 1995), seguido de un periodo de convergencia hasta el año 2008 y un periodo de divergencia hasta el año 2013. No obstante, los resultados obtenidos parecen estar en línea con las evidencias reportadas a nivel nacional para Portugal y España. Villaverde y Maza (2009), analizando diferentes medidas de desigualdades, obtuvieron que las disparidades económicas en las provincias españolas se redujeron un 17% según el índice de Theil durante el periodo comprendido entre 1985 y 2005, señalando un proceso de convergencia. Por su parte, Viegas y Antunes (2013), estudiando los procesos de convergencia en la península ibérica en el periodo 1985-2008, obtuvieron un proceso de convergencia nacional tanto para España como para Portugal. Sin embargo, analizando la península ibérica en conjunto, constataron un proceso de divergencia. En concreto, la dispersión regional decreció hasta el año 2001, año a partir del cual aumentó alcanzando un nivel superior al del inicio del periodo.

En base a estas evidencias, aunque existe un fenómeno de divergencia entre Portugal y España y las disparidades económicas entre ambos países han aumentado a lo largo de los años, se ha puesto de manifiesto que las intensas acciones de cooperación bajo el amparo del establecimiento de la eurorregión Galicia-Norte de Portugal, han conducido a una reducción de las desigualdades económicas existentes a ambos lados de la frontera, a pesar de que se trata de territorios diferentes en términos socio-económicos, culturales y administrativos.

3.4.2. β -Convergencia

Una vez analizada la σ -convergencia, se ha estimado la ecuación 5 para determinar la presencia de β -convergencia. En la Tabla 3.4 se muestran los parámetros obtenidos para el periodo completo 1980-2019 y para tres subperiodos con la intención de captar con más detalle los cambios ocurridos durante el proceso. Estos subperiodos van desde el año 1980, coincidiendo con el inicio de las relaciones de cooperación a ambos lados de la frontera de la eurorregión, a 1990; de 1991, año en el que se constituyó la comunidad de trabajo, a 2007; y de 2008, año en el cual se creó la eurorregión, hasta 2019.

Las estimaciones revelan la existencia de un proceso de convergencia absoluta para el periodo completo con una velocidad de convergencia anual del 1.9%, indicando que el tiempo necesario para llegar a la mitad del nivel del estado estable de convergencia es de 36 años.

En la Unión Europea Butkus *et al.* (2018) obtuvo β -convergencia absoluta en las regiones NUTS 3 europeas con una velocidad del 0.74% en el periodo 1995-2014. Más concretamente, en la península ibérica, Viegas y Antunes (2013) determinaron un proceso de divergencia entre ambos países para el periodo 1985-2008 (sin dependencia espacial). Al igual que en el análisis de la σ -convergencia, aunque exista divergencia entre ambos países, en la eurorregión parece que se ha conseguido un proceso de convergencia económica, y los resultados están en línea con las tendencias reportadas a nivel nacional para los países individuales. Villaverde y Maza (2009) obtuvieron convergencia absoluta en el periodo 1985-2005 con una velocidad de 1.48% para las regiones españolas. Viegas y Antunes (2013) también obtuvieron evidencia de β -convergencia absoluta tanto en España como en Portugal, con una velocidad del 1.2% anual, en el periodo 1985-2008.

Separando por tramos con el objetivo de observar el proceso de convergencia en más detalle, en el primer tramo de 1980 a 1990 se ha obtenido convergencia absoluta con una velocidad anual del 5%. Vemos por tanto que en este primer tramo ha habido una fuerte convergencia, con una velocidad mucho más alta que para el periodo completo. En el segundo tramo de 1991 a 2007 se ha obtenido divergencia, aunque no significativa. De acuerdo con Pires y Nunes (2018), el PIB de Galicia en 1995 era un 10% mayor que el de Norte de Portugal, mientras que en el 2007 era un 20% mayor, concluyendo que la integración económica y la movilidad laboral de la eurorregión no habían contribuido a una convergencia económica. Según la teoría, este periodo de divergencia puede tratarse de un fenómeno transitorio a corto plazo hasta que se alcanza la convergencia en los niveles económicos. Efectivamente, en el último tramo de 2008 a 2019 también se obtiene convergencia con una velocidad del 2.4%, más alta que la del periodo completo pero el doble de lenta que la del primer tramo. Observamos que la crisis económica de 2008 no ha alterado el proceso de convergencia, si no que más bien ha contribuido a ello.

Según la literatura de convergencia, las regiones están estrechamente relacionadas con el comportamiento económico de sus respectivos países (Lopez-Rodriguez y Faiña, 2009), por lo que cabe esperar que las regiones portuguesas y españolas no hayan convergido al mismo ritmo y se observen clubs de convergencia nacional. Para ello, se ha representado la convergencia del periodo completo (Figura 3.3) y de los diferentes subperiodos (Figuras 3.4, 3.5 y 3.6) diferenciando entre las regiones españolas y portuguesas. La línea negra mostrada en las figuras representa la regresión, indicando la

presencia de β -convergencia absoluta si la pendiente de la línea es negativa y β -divergencia absoluta si es positiva.

Tabla 3.4. β -convergencia en la euroregión Galicia-Norte de Portugal

	(1) 1980-2019	(2) 1980-1990	(3) 1991-2007	(4) 2008-2019
Constante	0.157*** (0.015)	0.413*** (0.057)	0.024 (0.074)	0.227** (0.060)
GDPpc inicial	-0.013*** (0.002)	-0.040*** (0.007)	0.002 (0.008)	-0.021** (0.006)
Velocidad de convergencia	0.019	0.051		0.024
Vida media	36.2	13.44		28.62
Observaciones	12	12	12	12
F-test	55.13***	32.99***	0.05	11.85**
Adj. R2	0.83	0.74	0	0.50

Notas: estimación de la ecuación (1) mediante OLS. *Significativo al 5%, ** significativo al 1%, *** significativo al 0.1%. (1) Periodo 1980-2019, (2) periodo 1980-1990, (3) periodo 1991-2007, (4) periodo 2008-2019. Fuente: cálculos propios sobre la base de datos “Annual Regional Database of the European Commission’s Directorate General for Regional and Urban Policy” (ARDECO, 2021).

En general se observan dos clústeres de convergencia (ver Figura 3.3), uno comprendido por las regiones españolas y otro por las portuguesas (a excepción de la subregión portuguesa Área Metropolitana do Porto (PT11A) cuyo comportamiento se asemeja más al de las regiones españolas). Según la figura, las regiones portuguesas presentan los niveles más bajos del PIBpc (a excepción de la subregión portuguesa Área Metropolitana do Porto, la cual contiene uno de los principales centros urbanos y complejos empresariales de la euroregión) y, por tanto, tal y como predice la teoría, son las que han tenido mayores tasas de crecimiento anual y una velocidad de convergencia más alta. Mientras que las regiones españolas, con niveles más altos del PIBpc, experimentan una velocidad de convergencia menor y tienen tasas de crecimiento más pequeñas. La subregión portuguesa Cávado (PT112) es la que más ha crecido, mientras que la provincia española A Coruña (ES111), con el valor más alto del PIBpc, es la que menos ha crecido.

En el periodo de 1980 a 1990, las tasas anuales de crecimiento son mayores que las existentes en el periodo de 2008 a 2019, y sus niveles de iniciales del PIBpc, menores (según se ha visto en la Tabla 3.3, los valores del PIBpc han ido aumentando conforme el paso de los años). Se observa (ver Figura 3.6) que la subregión portuguesa Área Metropolitana do Porto se acerca todavía más a las regiones españolas en el nivel inicial

del PIBpc en el último periodo de 2008 a 2019. En este último tramo, las provincias españolas Pontevedra (ES114) y A Coruña son las que menor crecimiento han tenido, mientras que las otras dos (Lugo -ES112- y Ourense -ES113) han aumentado su crecimiento, hasta alcanzar a las regiones portuguesas que menos han crecido. En el periodo intermedio de 1991 a 2007 se da un proceso de divergencia (ver Figura 3.5), aunque como se ha obtenido en la Tabla 3.4, no es significativo.

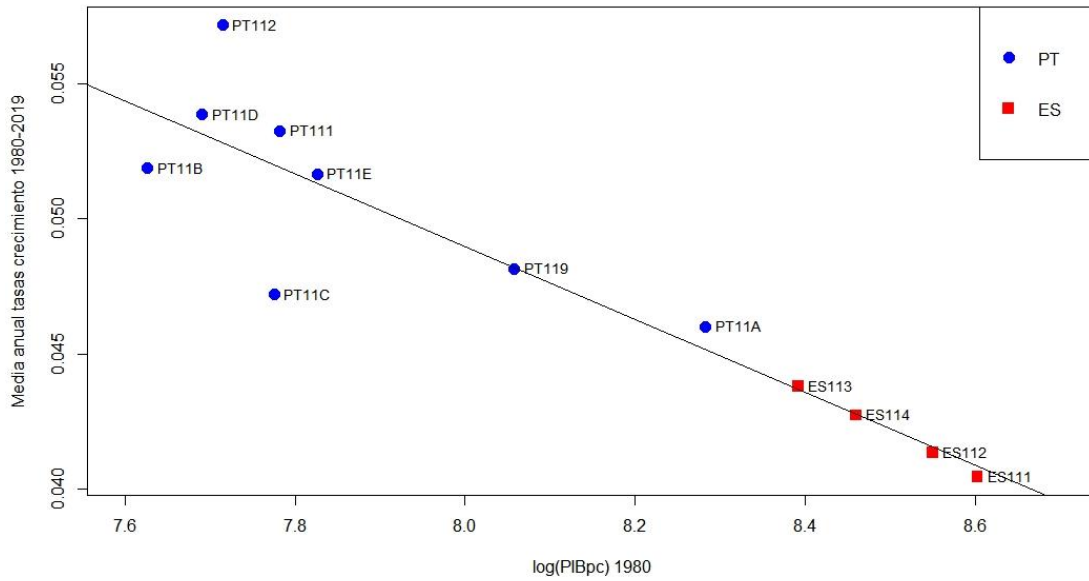


Figura 3.3. β -convergencia absoluta en la eurorregión en el periodo 1980-2019. Fuente: cálculos propios sobre la base de datos “Annual Regional Database of the European Commission’s Directorate General for Regional and Urban Policy” (ARDECO, 2021).

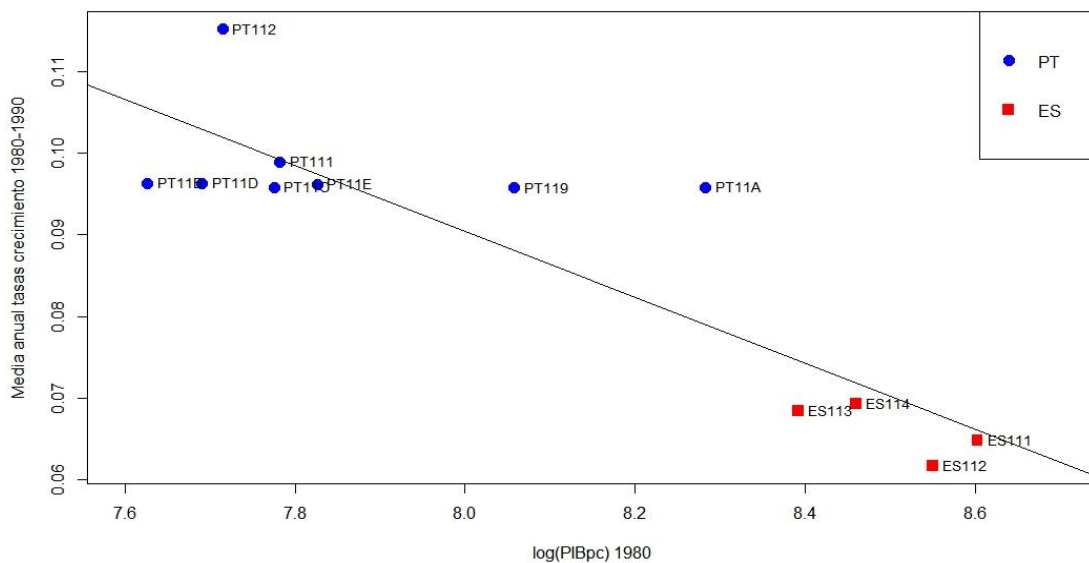


Figura 3.4. β -convergencia absoluta en la eurorregión en el periodo 1980-1990. Fuente: cálculos propios sobre la base de datos “Annual Regional Database of the European Commission’s Directorate General for Regional and Urban Policy” (ARDECO, 2021).

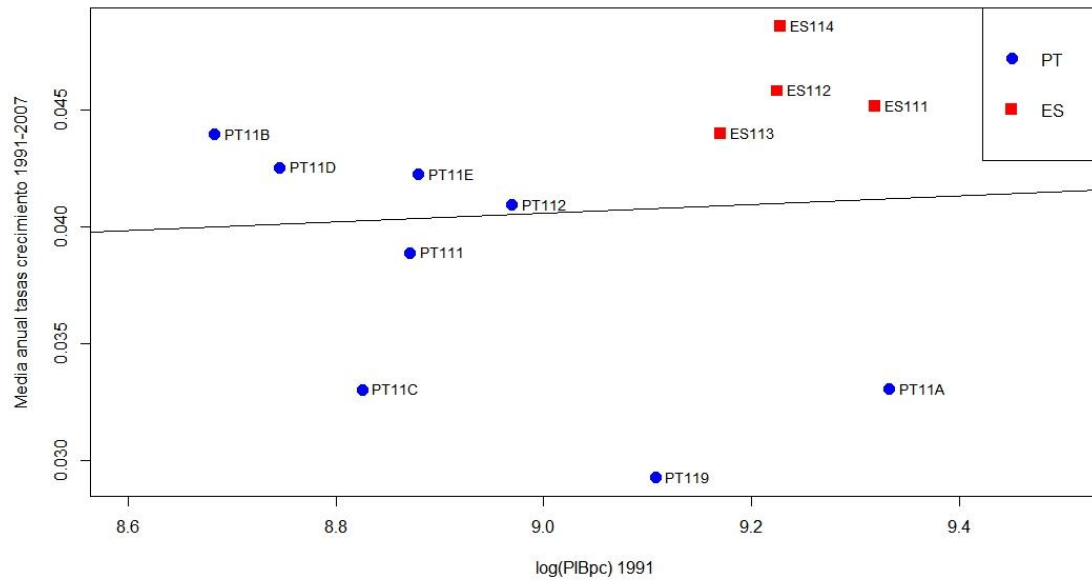


Figura 3.5. β -divergencia absoluta en la eurorregión en el periodo 1991-2007. Fuente: cálculos propios sobre la base de datos “Annual Regional Database of the European Commission’s Directorate General for Regional and Urban Policy” (ARDECO, 2021).

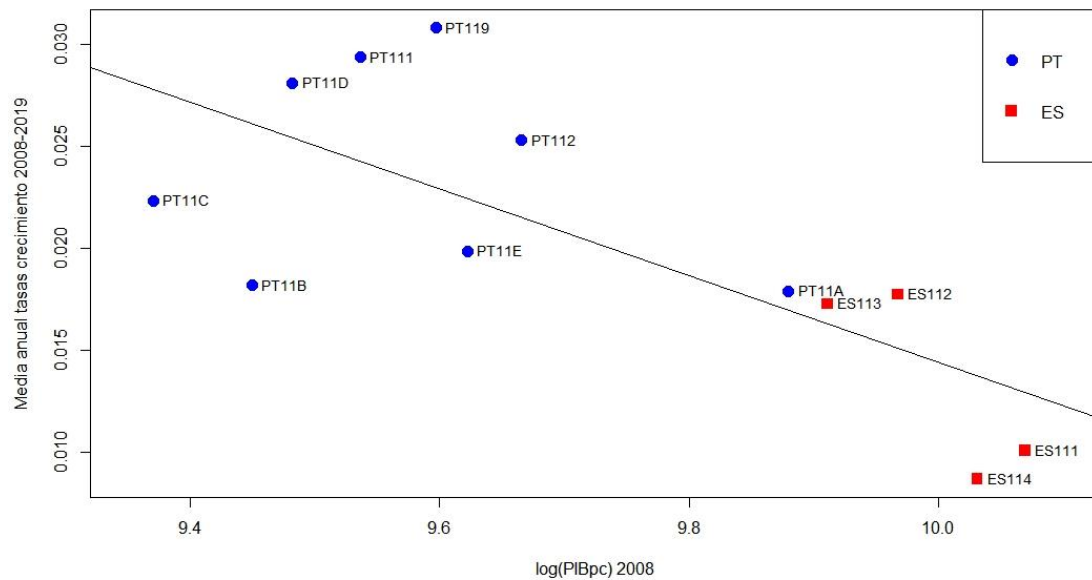


Figura 3.6. β -convergencia absoluta en la eurorregión en el periodo 2008-2019. Fuente: cálculos propios sobre la base de datos “Annual Regional Database of the European Commission’s Directorate General for Regional and Urban Policy” (ARDECO, 2021).

En definitiva, ambos análisis de β - y σ -convergencia han verificado que existe un proceso de convergencia durante el periodo 1980-2019 en la eurorregión Galicia-Norte de Portugal. Estudiar el proceso de convergencia durante un periodo amplio, de casi 40

años, nos ha permitido observar la convergencia en esta eurorregión. El uso de subperiodos puede mostrar procesos parciales de convergencia o divergencia debido a características específicas de los mismos, como es el caso del subperiodo de 1991 a 2007, el cual puede tratarse de un fenómeno de divergencia transitoria a corto plazo hasta que se ha alcanzado la convergencia.

De esta forma, aunque se ha demostrado en la literatura que la presencia de fuertes interacciones entre territorios transfronterizos no implica la existencia de un proceso de convergencia entre ellos (Durand y Decoville, 2020; Decoville *et al.*, 2013; Alegría, 2009; Topaloglou *et al.*, 2005) y aunque Viegas y Antunes (2013), analizando la convergencia en la península ibérica, constataran la incapacidad de las regiones portuguesas a convergir con las españolas, en el caso concreto de esta eurorregión se ha demostrado que las intensas relaciones de cooperación han conducido a un proceso de convergencia económica entre ambos lados de la frontera, a pesar de que se trata de territorios con características socio-económicas, culturales y administrativas diferentes.

Esto pone de manifiesto que la cooperación transfronteriza entre territorios con distintas propiedades, y en concreto, la creación de espacios dedicados a fortalecer esa cooperación, como las eurorregiones, puede ser beneficioso para ellos ya que nivela las desigualdades económicas existentes entre los mismos y mejora el desarrollo económico de las regiones menos desarrolladas.

3.5. Conclusiones

La cuestión de si el proceso de integración derivado de la apertura de fronteras produce una reducción de las desigualdades económicas y una convergencia permanece sin esclarecerse. Por ello, en este artículo hemos examinado la convergencia en la eurorregión Galicia-Norte de Portugal en el periodo 1980-2019. A este fin, se han estudiado dos conceptos clásicos de convergencia, la σ - y la β -convergencia.

En este caso en concreto para la eurorregión Galicia-Norte de Portugal, hemos obtenido que se ha producido una reducción en las desigualdades económicas a lo largo de todo el periodo, y se ha producido una convergencia absoluta al mismo nivel económico. Por lo que, en este caso, se ha demostrado que la existencia de fuertes acciones de cooperación entre las regiones NUTS 3 pertenecientes a la eurorregión, ha

contribuido a un proceso de cohesión entre los dos países miembros. En concreto, las regiones portuguesas, con menores niveles de PIBpc han experimentado tasas de crecimiento anuales más altas para converger al nivel de las regiones españolas.

Los resultados obtenidos en este análisis se pueden aplicar a otras eurorregiones de la UE para explicar la evolución de las desigualdades existentes y entender el proceso de convergencia en estructuras que tienen una frontera común, lo cual puede ser útil a la hora de establecer políticas y mecanismos de cooperación entre regiones transfronterizas.

La creación de eurorregiones puede ser un instrumento muy eficaz para conseguir la cohesión europea, debido al papel de las regiones transfronterizas como “laboratorios de integración”. Por tanto, la política de Cohesión europea debería seguir promoviendo el establecimiento de estos espacios de cooperación y facilitando la financiación para desarrollar los proyectos conjuntos que se lleven a cabo en ellos. Así, se pueden reforzar los procesos de colaboración transfronteriza, aumentando la movilidad de trabajo y de personas, con el objetivo de seguir reduciendo las desigualdades económicas que puedan existir en la eurorregión. Asimismo, para promover la convergencia y cohesión, es necesario incentivar las reformas en las regiones que se queden atrás con un menor nivel económico, y aumentar el peso de las infraestructuras o mejorar las ya existentes.

Por último, en el estudio de la β -convergencia, hemos supuesto que todas las regiones poseen los mismos parámetros estructurales a excepción de su nivel inicial del PIBpc. Es más probable que esta condición se cumpla para un grupo de regiones homogéneas, por lo que, al tratarse las eurorregiones de una composición de regiones heterogéneas, también habría que explorar en futuros análisis la convergencia condicional, incluyendo variables adicionales en la regresión, ya que las regiones pueden tener diferentes condiciones iniciales de crecimiento y converger a distintos estados estables. Adicionalmente, no hemos considerado un deflactor para corregir los precios en el tiempo, por lo que sería interesante comparar las tasas de convergencia resultantes al estimar dicho efecto con las obtenidas en este análisis, determinando cómo afecta la evolución de los precios en el tiempo en las velocidades de convergencia.

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Chapter 4. Convergence in European cross-border structures: the case of Spanish Euroregions

ABSTRACT

European border regions are considered to be laboratories of the European integration. However, it is not clear whether that integration is an indicator of convergence between the regions, since it can result from similarities as well as from existing differences between border regions. This paper studies the processes of σ , β and spatial convergence in the particular case of the Euroregions, mixed territories with (international) border and non-border regions, with the aim of determining whether the intense cooperation relationships that occur in these particular structures stimulate the convergence as well as contribute to the levelling of the economic inequalities within the Euroregion. Specifically, we focus on the Spanish Euroregions, to analyze how the inherent differences between the border countries could determine the presence or absence of convergence in the Euroregions. The results show that convergence is achieved in the Spanish Euroregions that share border with Portugal but not those bordering France.

Key Words: Convergence; Euroregion; Economic inequalities; Regional disparities; Spatial analysis.

JEL codes: C21; R58; F02; O47

4.1. Introduction

The European Union (EU) funding provided by interregional programmes and policies such as the INTERREG program and the Cohesion Policy seeks to boost the cohesion between regions and member states. These programs have proliferated the creation of some cross-border structures as the so called “Euroregions” (Medeiros, 2013). In these structures, joint interventions are established to solve common problems regarding the border and to increase the prosperity and development level of the regions on both sides of the border.

Borders can represent a barrier in the mobility and exchange of resources due to the different administrative governments, institutions, culture and languages at the two sides of the border. However, the creation of these cross-border structures seeks to exploit the potential synergies that can arise from the proximity of those regions by increasing the cooperation and the socio-economic relationships within them.

According to the neoclassical theories, the removal of barriers in trading, labour markets, mobility, or capital, promotes the convergence and levels the inequalities between regions. Therefore, it is expected that the increase of cross-border interactions will contribute to the integration of the regions by a more efficient distribution of the resources and the labour market. The integration in this context, causing a reduction of the territorial inequalities between both sides of the borders, can be seen as an indicative of convergence between regions (Alegria, 2009; De Boe et al., 1999; Ehlers et al., 2001; Pires and Nunes, 2018).

However, the integration between regions should be considered in a broader sense, since it can result from symmetries and similarities as well as from asymmetries and differences between border regions (Durand, 2015). On the one hand, intense asymmetrical flows between border regions can lead to an increase of the territorial disparities. On the other hand, cross-border integration can be produced precisely because of the existence of high economic differences, contradicting the previous statement that claimed that augmenting the cross-border interactions leads to a convergence process and levelling of disparities (Decoville et al., 2013). According to Topaloglou et al. (2005), the integration on border regions depends on the balance between policy interventions and market dynamics, highlighting that more actions than opening borders are necessary to achieve convergence in European regions.

In view of these discrepancies in literature, in the present study we intend to explore the economic convergence processes and the evolution of the economic inequalities precisely in the Euroregions. These regions, which are composed of (international) border and non-border regions of different countries, are spaces where intense cooperation relationships take place. To the best of our knowledge, there are not studies in literature focussing on the total convergence in this kind of regions, hence our research will contribute to fill this gap. Our aim is to determine whether the intense cooperation relationships that occur within these particular structures (with border and non-border areas) stimulate the convergence and contribute to the levelling of the economic inequalities within the Euroregion. Convergence and reduction of inequalities are among the main objectives of the European Cohesion Policy, hence the importance of verifying whether this new kind of cooperation model is successful and can accordingly be implemented in other areas to contribute to the total convergence of all the member states. To achieve this goal, we will study the beta and sigma convergence in the Euroregions,

two concepts of convergence widely used in the literature, which can indicate if the inequalities are diminishing and regions are converging to the same economical levels. Also, we will study the spatial convergence to include the spatial component of the data.

More concretely, we will focus on the convergence processes in the Spanish Euroregions since Spain has two border areas which are quite different from each other. On the Spain-Portugal side there exists cultural, language and spatial proximity, while in the Spain-France side there is a natural barrier (the Pyrenees) between the two countries, and the population centres are quite separated. Also, their initial economic development is different (higher in France than in Portugal). Therefore, this scenario is ideal to analyze how the inherent differences between the border countries might determine the presence or absence of convergence in the Euroregions.

The rest of the article is structured as follows. In section 4.2 a review of the literature about integration and convergence is presented. In section 4.3 the territorial and economic characteristics of the Euroregions are described and the methodology used to perform the analysis is described. The results are evidenced and discussed in section 4.4 while section 4.5 concludes the study.

4.2. Literature Review

The opening of the European borders encompassed under the frame of the European integration policy has largely increased the mobility, the flow of goods and services, social exchanges and interactions between regions. The most sensitive territories to that opening and direct beneficiaries are the border regions, which have become “laboratories of the European integration” (European Commission, 2021). These regions have attracted the attention of researchers who seek to examine the effects of the cross-border interactions on their convergence and structural inequalities.

Some authors claim that cross-border cooperation between two economically imbalanced regions may level the disparities between them (Chiriac, 2013). Hippe et al. (2024), studying the gross domestic product (GDP) per capita disparities in NUTS 0 and NUTS 3 (Nomenclature of territorial units for statistics) European regions over the 2000-2019 period, determined that the convergence trends were more positive in border regions than in non-border regions, reflecting a general catching-up process due to border

liberalization and Cohesion Policy actions. The removal of barriers in goods, services, labor and capital and the increase of the cooperation and interactions between border regions are expected to contribute to the integration of the regions (Goecke and Hüther, 2016) by producing a more efficient distribution of labour and resources between territories and therefore an efficiency of the economy (Bonin et al., 2008; European Commission, 2010). The integration in this context, implying a reduction of the territorial disparities between borders, can be considered synonymous with convergence (Alegría, 2009; De Boe et al., 1999; Ehlers et al., 2001; Pires and Nunes, 2018).

Decoville et al. (2013), analyzing the spatial integration process in 10 European cross-border metropolitan regions over cross-border commuters, GDP and the housing market, determined three models of integration. In one of them, the disparities between regions were levelled, suggesting that, in this case, spatial integration can be viewed as a process of convergence. However, the other two models were based on high differentials across the border, i.e., cross-border integration (specially in the labour market dimension) takes place due to the existence of high economic differences, which contradicts the previous statement that integration can be considered a synonym of convergence.

In this line, there are some authors who concur that cross-border interactions do not necessarily lead to territorial convergence. One of the reasons is that the functional specialization over the space can raise the socio-economic disparities over time between border regions (Durand, 2015; ESPON, 2014). Another reason, stated by Topaloglou et al. (2005), is that if the interactions are very asymmetrical, they may increase the territorial disparities instead of reducing them. In fact, the homogenization between territories may result from internal dynamics instead of from the exchange of flows across the borders. Another example of a paper supporting this view is for example Naz et al. (2017), who, covering 203 NUTS 2 regions from 1996 to 2006, found wage convergence for internal regions (regions within the same country) but not for border regions (neighbouring regions across international borders). Kallioras et al. (2011), covering NUTS 3 border regions in the 1995-2005 period, determined that the majority of the EU border regions tended to form one broad convergence club indicating that the process of integration in Europe was still associated with significant differentiations along border areas. Niebuhr and Stiller (2006), studying income and unemployment on NUTS 3 European regions in the period 1995-2000, determined that on average unemployment and per capita income differed more among adjacent foreign regions than between

adjacent regions in the same country. Goecke and Hüther (2016), studying convergence on NUTS 3 regions over the period 2000-2011, concluded that international borders did not influence on the overall convergence.

Furthermore, Kallioras et al. (2010), concluded that convergence between border regions depends on their initial economic level. They studied conditional convergence in 349 NUTS 3 EU border regions during the 2000-2006 period and found that convergence forces dominated among EU border regions having a low initial development level, but border regions beyond a threshold level of initial development displayed divergence forces.

In view of the difference in opinions between authors, the present study will contribute to the existing literature by establishing whether in the Euroregions, which are mixed spaces containing border and non-border regions where strong interactions and cooperation relationships are established, a convergence and reduction of inequalities is produced. Specifically, it will expand the study by López-Villuendas and del Campo (2022) of Galicia-North Portugal Euroregion to the other four Spanish Euroregions, two of them sharing border with Portugal (EUROAAA-Alentejo-Algarve-Andalucía Euroregion- and EUROACE -Alentejo-Centro-Extremadura Euroregion) and two with France (New Aquitaine-Basque Country-Navarre and Pyrenees-Mediterranean), in order to contrast the effect on the regional convergence of the different countries (different national and regional policies, administrative institutions, etc.) with which Spain shares a border. In this study, a process of convergence was obtained within the Euroregion for period 1980-2019.

4.3. Euroregions' background

The study covers four Spanish Euroregions, two sharing border with Portugal, EUROACE and EUROAAA, and two with France, New Aquitaine-Basque Country-Navarre and Pyrenees-Mediterranean Euroregion. There is a fifth Spanish Euroregion, Galicia-North Portugal, already studied in López-Villuendas and del Campo (2022). However, we have included the initial characteristics of the Euroregion and the obtained results to present the complete analysis for all five Spanish Euroregions. The Spanish Euroregions will enable us to observe the effect of the different economic, social, and

administrative characteristics of the two border countries on the convergence with the corresponding Spanish regions.

Although some of these Euroregions are of recent creation, they have maintained long cooperation relationships for several decades. All five Euroregions are characterized for being mixed territories (urban with significative metropolitan areas and rural areas) and for their main economic activity being based on the service sector.

4.3.1. New Aquitaine-Basque Country-Navarre

Created in 1982 between French and Spanish regions (Figure 4.1(a)), it is the oldest Euroregion considered in this study. It is the result from a long cooperation between the Basque government (Spain) and the French NUTS 2 region of Aquitaine. In 2017 the Community of Navarra joined the Euroregion¹³. This Euroregion supports projects of regional and local cooperation focussed on concepts such as the territorial and environmental sustainability or the mobility integration (Durá et al., 2018). Its economic activity is mainly based on the service sector and the Spanish Communities have a higher level of GDPpc (Gross Domestic Product per capita) than the French region (see Table B1 in Appendix B).

4.3.2. Pyrenees-Mediterranean

Created in 2004, the Pyrenees-Mediterranean Euroregion is composed by the Autonomous Communities of Cataluña and Balearic Islands in Spain and the former French regions of Languedoc-Roussillon and Midi-Pyrénées, currently Occitania (Figure 4.1(b))¹⁴. One of its priorities is to create an environment of sustainable development based on innovation and social and economic territorial integration, increasing the relationships between the scientific, technological and cultural hubs (Durà et al., 2018).

¹³ Navarra (Spain) has been included in the analysis although it was incorporated into the Euroregion in 2017.

¹⁴ The autonomous community of Aragon (Spain) has not belonged to the Euroregion since 2006 and has not been included in the analysis.

Its main economic activity is also in the service sector and the incomes are similar for all regions, except for the French region Languedoc-Roussillon, which presents a lower per capita economic level (see Table B2 in Appendix B).

4.3.3. EUROAAA

The EUROAAA Euroregion is composed by the regions of Alentejo and Algarve in Portugal and Andalusia in Spain (Figure 4.1(c)). They have maintained cooperative relations for more than 20 years, which allowed to create the Euroregion in 2010.

The economy is oriented towards the service sector, the most important in terms of employment, with a very significant weight of the tourism sector. It is followed by the industry and construction sector thanks to the strong construction of public facilities and the residential edification. In the last position appears the primary sector, which is characterized by the farm employment linked to seasonal crops.

In terms of income, the initial GDPpc (in 1980) was higher for Andalusia in Spain, but currently the Portuguese regions have higher per capita economic levels (see Table B3 in Appendix B).

4.3.4. EUROACE

Regions of Alentejo and Portugal-centre in Portugal and Extremadura in Spain had been working together for 20 years thanks to the European program INTERREG until the EUROACE Euroregion was established in 2009 (Figure 4.1(d)). The Euroregion is endowed with an agile and open work structure which allows joint development of useful projects for citizens, companies and society.

The Portuguese regions are characterized by a lower service activity than the Spanish region and the other Euroregions in general. Currently, Portuguese regions have higher per capita economic levels than the Spanish region (see Table B4 in Appendix B).

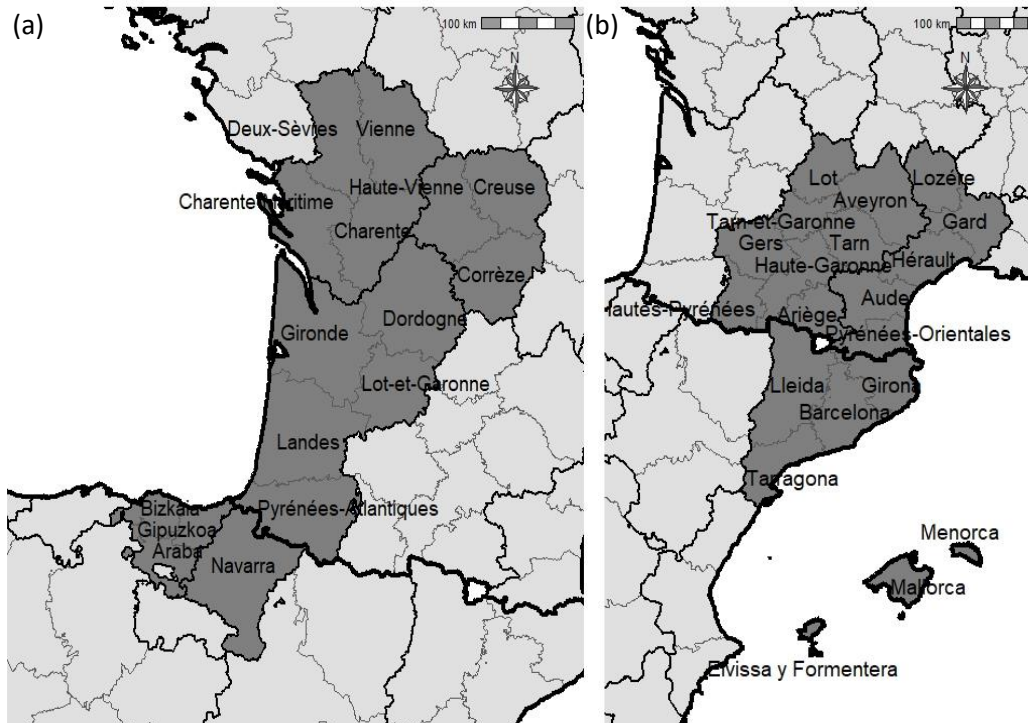
As noticed, Alentejo belongs to both EUROAAA and EUROACE Euroregions, which may affect the convergence with the Spanish regions. However, the region presents high initial GDPpc levels in both Euroregions, therefore it will set the pace of convergence of the rest of the regions.

4.3.5. Galicia-North Portugal

The Galicia-North Portugal Euroregion, composed by the Autonomous Community of Galicia (Spain) and Portuguese region North-Portugal (Figure 4.1(e)), the first to be created between the Spain-Portugal border, had maintained intense cooperation relationships from the beginning of the 1980s, until the Euroregion was created in 2008.

It is composed by vast territories with metropolitan areas separated by rural areas and large costal lines (Durà et al., 2018). The Euroregion has a population of 6.3 million of inhabitants. Its dynamic of activity and employment is focussed mainly in the service sector, in industry and construction. The Spanish region had higher initial levels of GDPpc than the Portuguese region (see Table B5 in Appendix B).

López-Villuendas and del Campo (2022) observed a process of convergence over the 1980-2019 period in this Euroregion. The Portuguese regions had higher annual growth rates and a higher convergence speed while the Spanish ones, with higher initial GDPpc levels, had lower convergence speeds and lower growth rates.



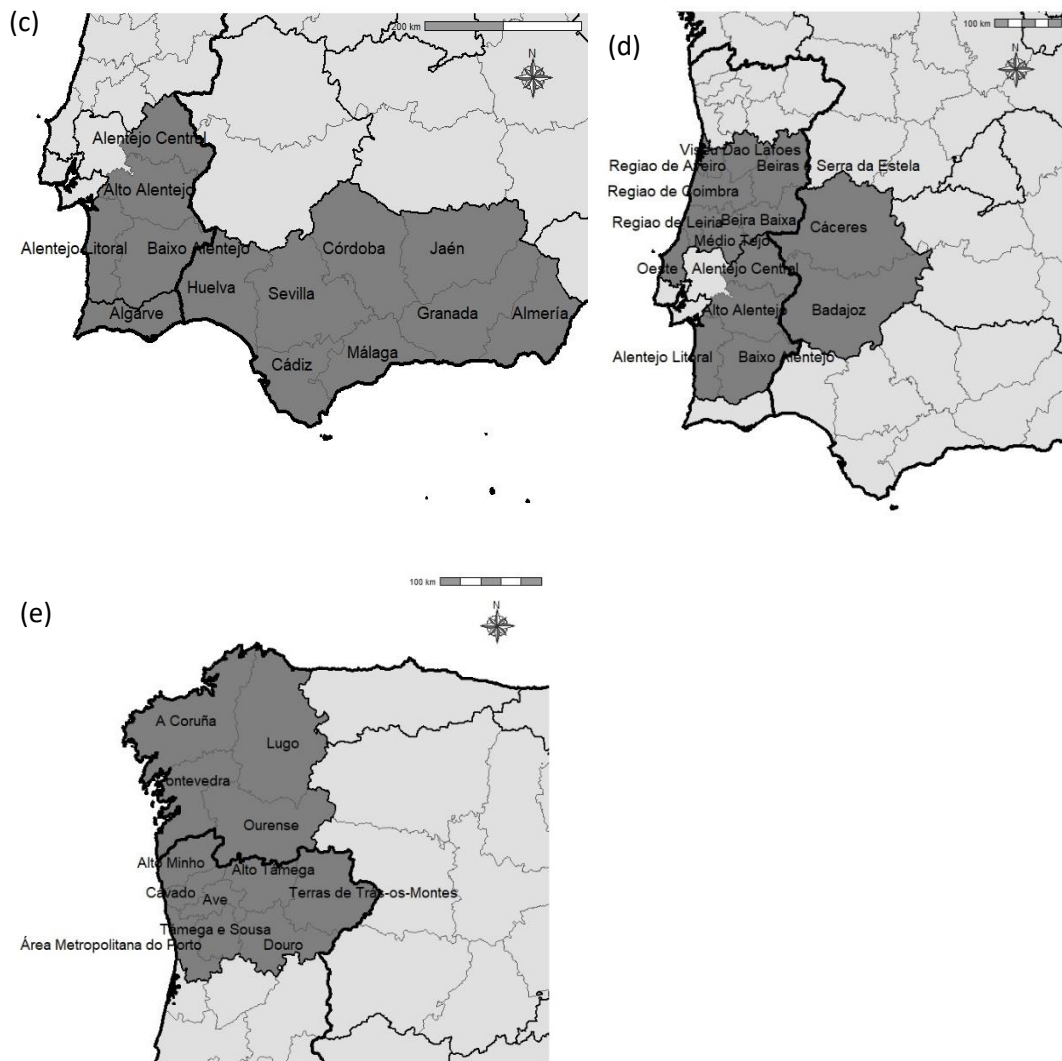


Figure 4.1. Own elaboration (a) New Aquitaine-Basque Country-Navarre Euroregion's map. Scale bar: 100km. Source: <https://www.euroregion-naen.eu/es/la-euroregion/que-es-la-euroregion/> (b) Pyrenees-Mediterranean Euroregion's map. Scale bar: 100km. Source: <https://euroregio.eu/es/euroregion> (c) EUROAAA Euroregion's map. Scale bar: 200km. Source: <https://www.euroaaa.eu/site/es> (d) EUROACE Euroregion's map. Scale bar: 100km. Source: <https://www.euro-ace.eu/territorio-euroace> (e) Galicia-North Portugal Euroregion's map. Scale bar: 100km. Source <https://galicia-nortep.t.xunta.es/es/euroregi%C3%B3n>.

4.4. Methodology

4.4.1. Data description

The indicator used to measure the evolution of the economic inequalities and assess the convergence is the GPD per capita, extracted from the database “Annual Regional Database of the European Commission’s Directorate General for Regional and Urban Policy” (ARDECO 2021). The analysis has been performed at NUTS 3 level, since cross-border cooperation programmes with inner borders may cover all territorial units

corresponding to NUTS 3 level (REGULATION (EC) No 1638/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, 2006). The studied period goes from 1980, the beginning of the decade when the Euroregions started to establish cooperative relationships, to 2021, the most recent year for which data is available.

4.4.2. Convergence

Studying the convergence processes within the Euroregions will enable us to determine the extent of the integration -in its structural dimension- of the transborder regions. Convergence has been broadly examined in the literature in the last decades due to its importance as a method for assessing the effectiveness of the Cohesion Policy. We will analyze two of the most popular concepts of convergence in literature, specifically σ -convergence and β -convergence, both proposed by Barro and Sala-i-Martin (1991, 1992, 2004), as well as spatial convergence, to incorporate the effect of the spatial spillovers (Abreu et al., 2005).

4.4.2.1. σ -Convergence

In the process of σ -convergence, a reduction of the GDPpc dispersion of the regions throughout time is observed. Hence, it is assessed by measuring the GDPpc dispersion among regions. A reduction of GDPpc dispersion implies σ -convergence.

It is well known that the results can be different depending on dispersion measure used; therefore, it is recommended to test various measures to gain robustness (Ezcurra and Rodríguez-Pose 2009). The measures used in this study have been the coefficient of variation (CV), the Gini coefficient (Gini), the Theil index (T) and the mean logarithmic deviation (L). The equations are the following ones respectively:

$$CV = \frac{\frac{1}{N} \sqrt{\sum_{i=1}^N (y_i - \bar{y})^2}}{\bar{y}} \quad (1)$$

$$Gini = \frac{1}{2N^2\bar{y}} \sum_{i=1}^N \sum_{j=1}^N |y_i - y_j| \quad (2)$$

$$T = \frac{1}{N} \sum_i^N \frac{y_i}{\bar{y}} \log\left(\frac{y_i}{\bar{y}}\right) \quad (3)$$

$$L = \frac{1}{N} \sum_i^N \log\left(\frac{\bar{y}}{y_i}\right) \quad (4)$$

where y_i is the GDPpc of region i , \bar{y} is the mean and N is the number of regions.

We will use these unweighted versions of these measures as, according to Gluschenko (2018), the weighted version could cause some bias in the results.

4.4.2.2. β -Convergence

The β -convergence concept refers to the process for which a poorer region catches up to a richer one in time, converging to the same steady state in terms of GDPpc. It is evaluated with the GDPpc growth regressions over their initial level, as shown in Equation (5). According to Solow's neoclassic theory (Solow, 1956), the regions with lower initial levels of GDPpc grow faster than the other regions in the initial steps of the convergence process, until they catch up the richer regions, converging to similar growth rates. An inverse and significant relationship between the initial GDPpc of a region and its growth rates implies a process of absolute β -convergence. The existence of β -convergence is a necessary condition but does not imply σ -convergence (Chatterji, 1992).

The equation of absolute β -convergence is:

$$\frac{1}{T} \log \frac{y_{i,T}}{y_{i,0}} = \alpha + \beta \log(y_{i,0}) + \varepsilon_i \quad (5)$$

where the left term is the annual average growth rate of GDPpc in region i over period T . $y_{i,0}$ is the initial level of GDPpc of region i , α is the constant term to determine, ε is the error term and β is the coefficient to estimate, which indicates the relationship between the GDPpc growth and its initial level. When this coefficient is negative a process of β -convergence occurs. The speed of convergence b is estimated with Equation (6) from the estimation of the β coefficient $\beta = (1 - e^{-bT})/T$

$$b = \frac{-1}{T} \log(1 - \beta T) \quad (6)$$

Finally, the half-life, which is defined as the necessary time to reach half of the convergence steady-state, can be estimated with the following equation:

$$\tau = \frac{\ln 2}{b} \quad (7)$$

4.4.2.3. Spatial Convergence

We will study the absolute β -convergence process by estimating Equation (5) by ordinary least squares (OLS). However, the estimation of absolute β -convergence by OLS may be inaccurate if the spatial component is ignored.

Two types of spatial effects can be present in our data, spatial autocorrelation and spatial heterogeneity. Spatial autocorrelation indicates that the values of a region may be affected by the values of the neighbouring regions, whereas the spatial heterogeneity indicates an instability in the space: parameters such as the mean and the variance vary and they are not homogeneous in the studied space.

Heterogeneity can be manifested as heteroskedasticity, which occurs when the disturbance term lacks constant variance across the observations. If this is present, the heteroskedastic error model will be used. In this model, the variance of the random disturbance is no longer constant but varies with each observation. In order to verify the presence of heteroskedasticity, we will use the Breusch-Pagan test.

The spatial autocorrelation can be of two kinds, spatial dependence on the dependent variable (spatial lag model) or in the disturbance term (spatial error model) depending on whether the values of the dependent variable or the disturbance term, at each location, are correlated, respectively, with the observations of the dependent variable or the disturbance term at other locations.

To determine whether there is spatial autocorrelation in the model of absolute β -convergence we calculate the Moran's Index, represented by:

$$I_t = \frac{n}{s_0} \frac{\sum_{i=1}^n \sum_{j=1}^n z_{i,t} w_{ij} z_{j,t}}{\sum_{i=1}^n z_{i,t}^2} \quad (Eq. 8)$$

Where $z_{i,t}$ is the mean deviation of the GDPpc level ($z_{i,t} = x_i - \bar{x}$ with \bar{x} the mean of variable x) in region i and period t . n is the number of NUTS 3 regions and w_{ij} is the ij

element of the spatial weights matrix, which indicates the neighbours of each region. $s_0 = \sum_i \sum_j w_{ij}$ is the total sum of weights.

Afterwards, following the classic strategic, if there is spatial autocorrelation, we will determine the type of spatial effects with the robust Lagrange Multiplier (LM) test for error dependence (LM_ERR), which determines the use of the spatial error model, and the LM test for a missing spatially lagged dependent variable (LM_LAG), which determines the use of the spatial lag model.

The spatial error model is determined by the following equation:

$$\frac{1}{T} \log \frac{y_{i,T}}{y_{i,0}} = \alpha + \beta \log(y_{i,0}) + u_i \quad (9)$$

being $u_i = \lambda Wu + \varepsilon_i$, where Wu is the spatial lag of the error term and λ is the autoregressive coefficient associated to the spatial lag Wu .

The spatial lag model is determined by the following equation:

$$\frac{1}{T} \log \frac{y_{i,T}}{y_{i,0}} = \alpha + \rho W \left(\frac{1}{T} \log \frac{y_T}{y_0} \right) + \beta \log(y_{i,0}) + u_i \quad (\text{Eq. 10})$$

where $W \left(\frac{1}{T} \log \frac{y_T}{y_0} \right)$ is the spatial lag term of the dependent variable and ρ is the autoregressive spatial coefficient.

4.5. Results and discussion

4.5.1. σ -Convergence

We have studied the σ -convergence phenomenon in the Spanish Euroregions from 1980, the beginning of the decade when the Euroregions started to stablish cooperative relationships, until 2021, using several inequalities measures, specifically the coefficient of variation, the Gini coefficient, the Theil index and the mean logarithmic deviation.

As can be seen in Figures 4.2-4.5, even though the inequality measures used are sensitive to the changes in different parts of the distribution and that can lead to different results, the four measures show the same convergence or divergence tendencies (for all Euroregions).

More concretely, the economic inequalities for the EUROACE Euroregion have been declining since the 1980s (see Figure 4.2). Starting from a value of 0.34 in 1980 (measured with the coefficient of variation), the inequalities have decreased to reach a value of 0.14 in 2021 - that is, a general convergence has been produced throughout the studied period, with inequalities decreasing a 40%. Although throughout the entire convergence process some fluctuations can be observed, these may be due to influences of temporal economic cycles on the inequalities.

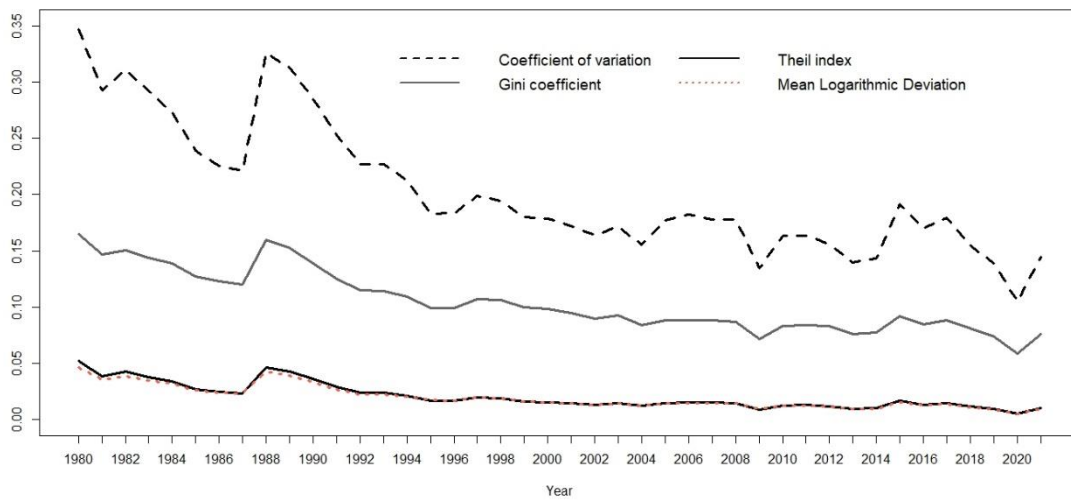


Figure 4.2. Evolution of the economic inequalities in the EUROACE Euroregion from 1980 to 2021 using as inequalities measures the coefficient of variation, the Gini coefficient, the Theil index and the mean logarithmic deviation.

Similarly to EUROACE, for EUROAAA Euroregion (Figure 4.3) we start from a value of the coefficient of variation of 0.24 in 1980 until a value of 0.15 in 2021; therefore a process of reduction of economic inequalities and σ -convergence is produced. The minimum value is obtained in 2009 with 0.1.

As in López-Villuendas and del Campo (2022), who identified a σ -convergence process over the 1980-2019 period in the Galicia-North Portugal Euroregion, we have obtained a reduction of inequalities in the studied period for both Euroregions sharing border with Portugal, EUROAAA and EUROACE.

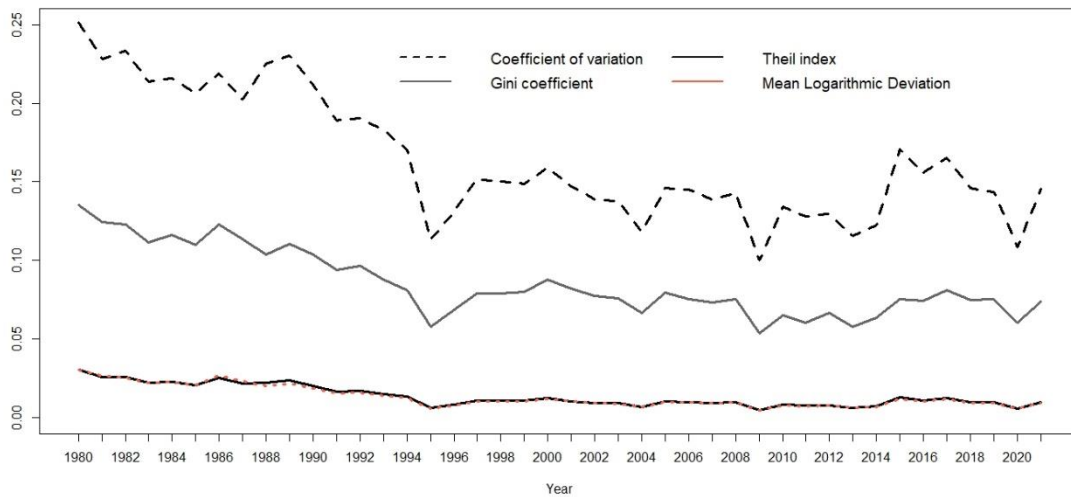


Figure 4.3. Evolution of the economic inequalities in the EUROAAA Euroregion from 1980 to 2021 using as inequalities measures the coefficient of variation, the Gini coefficient, the Theil index and the mean logarithmic deviation.

Moving on to the Spanish-French Euroregions, the New Aquitaine-Basque Country-Navarre Euroregion (Figure 4.4) starts from a coefficient of variation of 0.13 in 1980 and ends with a CV of 0.18 in 2021; therefore, here we identified a process of σ -divergence, since the inequalities have increased a 40% over the considered period, with a peak value of 0.25 coinciding with the 2008 global financial crisis.

In the Pyrenees-Mediterranean Euroregion (Figure 4.5), a σ -convergence process has been observed, since the coefficient of variation goes from 0.185 in 1980 to 0.17 in 2021. However, the tendency is mostly flat, with the inequalities only decreasing by 10%.

The divergence process obtained for New Aquitaine-Basque Country-Navarre Euroregion seems to be more aligned with the general tendency reported in the literature for the European Union, according to which the regional inequalities (at NUTS 3 level) have increased in the last decades. For example, Butkus et al. (2018) found an increase of economic inequalities of the NUTS 3 European regions between 1995 and 2001, followed by a convergence period until 2008 and a later divergence period until 2013.

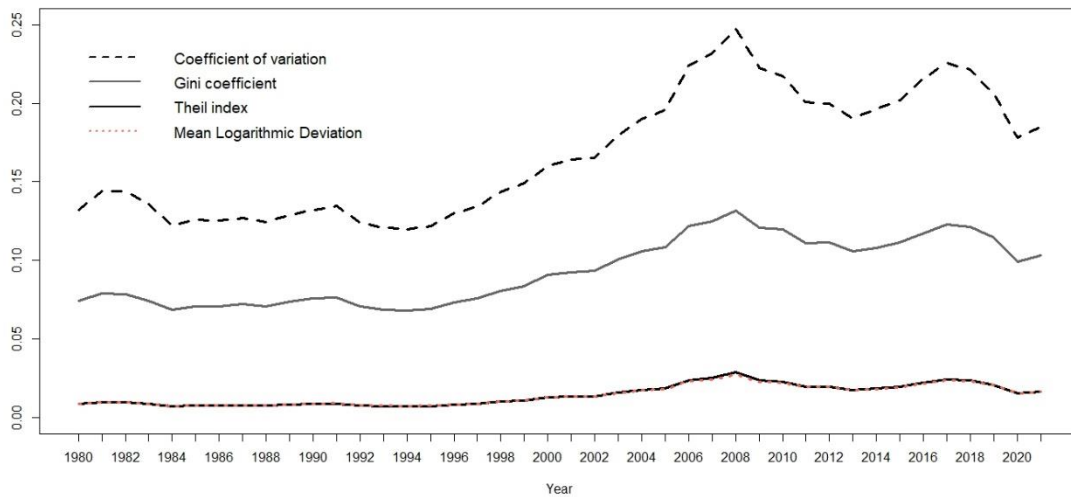


Figure 4.4. Evolution of the economic inequalities in the New Aquitaine-Basque Country-Navarre Euroregion from 1980 to 2021 using as inequalities measures the coefficient of variation, the Gini coefficient, the Theil index and the mean logarithmic deviation.

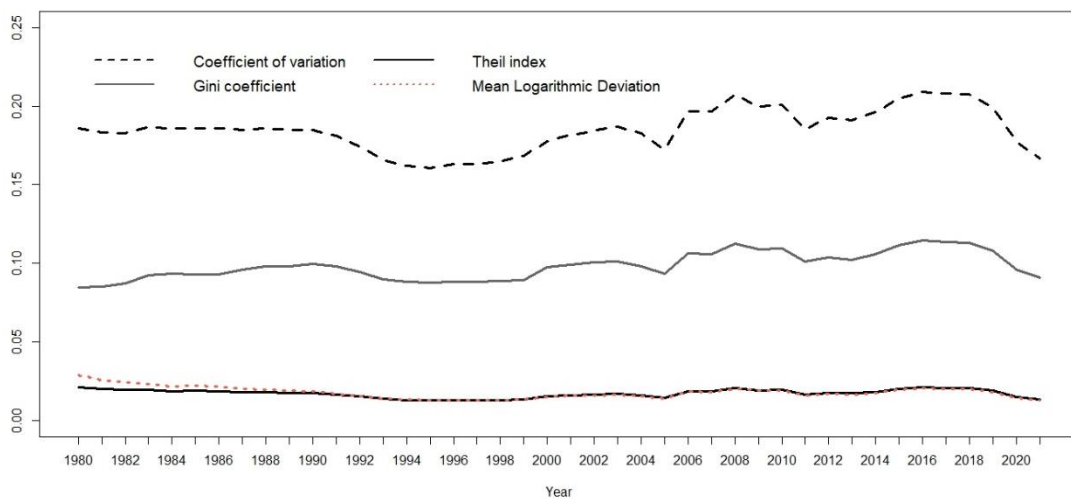


Figure 4.5. Evolution of the economic inequalities in the Pyrenees-Mediterranean Euroregion from 1980 to 2021 using as inequalities measures the coefficient of variation, the Gini coefficient, the Theil index and the mean logarithmic deviation.

4.5.2. β -Convergence and Spatial convergence

After assessing σ -convergence, we will now use a spatial econometric methodology to estimate the model of absolute β -convergence for the Spanish Euroregions in the 1980-2021 period. First, we will estimate the model of absolute β -convergence (Equation 5) by OLS. Then, we will test for the presence of spatial effects in the data with the robust LM tests which will enable us to determine which model is appropriated to be considered in the estimation, the spatial lag model or the spatial error model.

Table 4.1 shows the results of the estimation of the absolute β -convergence for the Spanish Euroregions which share border with Portugal, EUROACE and EUROAAA, and also the convergence between Spain and Portugal. For the first one, we have obtained by OLS (column a) a process of β -convergence for the whole period with an annual convergence speed of 2.1%, implying that the necessary time to reach the half of the convergence steady-state level is 32.6 years. This β -convergence process is in line with the σ -convergence observed in the Euroregion (Figure 4.2). In this case there is no sign of spatial autocorrelation or heteroskedasticity, as indicated by the non-significance of the Moran I index and Breusch-Pagan tests, respectively.

Table 4.1. β -convergence by OLS for period 1980-2021.

	(a) EUROACE	(b) EUROAAA	(c) Spain-Portugal
Constant	0.160 ^{***} (0.013)	0.173 ^{***} (0.026)	0.135 ^{***} (0.009)
Initial GDPpc	-0.014 ^{***} (0.001)	-0.016 ^{***} (0.003)	-0.011 ^{***} (0.001)
Convergence speed	0.021	0.026	0.015
Half life	32.6	26.6	45.3
Observations	15	13	70
F-test	75.43 ^{***}	26.99 ^{***}	115.1 ^{***}
Adj. R2	0.85	0.68	0.62
Moran I	-0.261	0.487 ^{**}	0.288 ^{***}
LM lag	0.012	0.926	4.216 ^{**}
LM lag (robust)	1.340	0.464	0.127
LM error	1.375	4.22 ^{**}	7.509 ^{***}
LM error (robust)	2.702	3.758 [*]	3.412 [*]
Breusch-Pagan test	0.271	0.47	1.184

Note: *Significative at 10%, ** significative at 5%, *** significative at 1%.

In case of the EUROAAA Euroregion, we also obtain a process of absolute significative β -convergence by OLS (Table 4.1 column b), as we have deduced from the σ -convergence process (Figure 4.3). Although there is spatial autocorrelation in the data, the LM robust tests are not significant (at 5%) therefore we keep the OLS estimation results. It has a convergence speed of 2.6% and a half-life of nearly 27 years.

Finally, we have also calculated the convergence between Spain and Portugal (Table 4.1 column c), obtaining a process of absolute β -convergence by OLS, with a convergence

speed of 1.5%, lower than the determined for the Euroregions, and a half-life of 45.3 years, significantly higher than those of the Euroregions.

According to convergence literature, the economic behaviour of a given region is related to the economic behaviour of the country more generally (Lopez-Rodriguez and Faiña, 2009); hence, it is possible that the Portuguese and Spanish regions do not follow the same convergence rates and convergence clusters can be observed. In order to observe this effect, we have plotted the regression differentiating by colours and shape the Spanish (red squares) and Portuguese (blue circles) regions (see Figures 4.6 and 4.7).

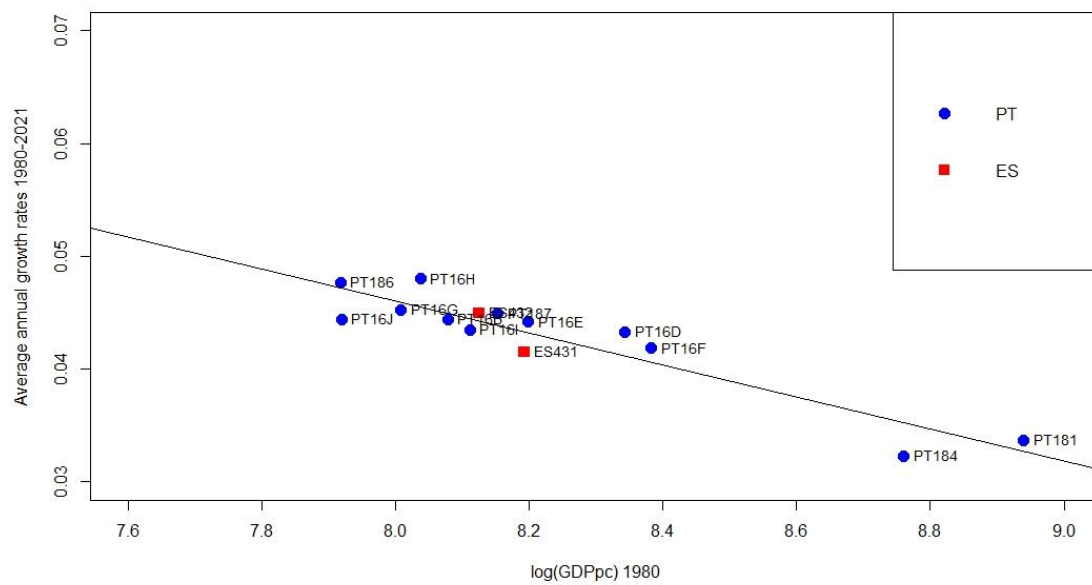


Figure 4.6. Absolute β -convergence in EUROACE Euroregion in period 1980-2021. The negative slope indicates an absolute β -convergence process.

In EUROACE Euroregion (Figure 4.6), the regions with higher initial GDPpc levels are Baixo Alentejo (border region, PT184) and Alentejo Litoral (non-border region, PT181), which belong to the NUTS 2 Portuguese region of Alentejo, and are the ones that have lower growth rates and experiment a lower convergence speed according to theory. These regions show the same tendency in next Figure 4.7, since they belong to both EUROACE and EUROAAA Euroregions. It is worth noticing that despite the fact that Alentejo regions benefit from the cooperation activities of two Euroregions, two of their regions (Baixo Alentejo and Alentejo Litoral) have the lowest convergence speeds. Therefore, we can say that its rate of growth has been reduced for the benefit of the others.

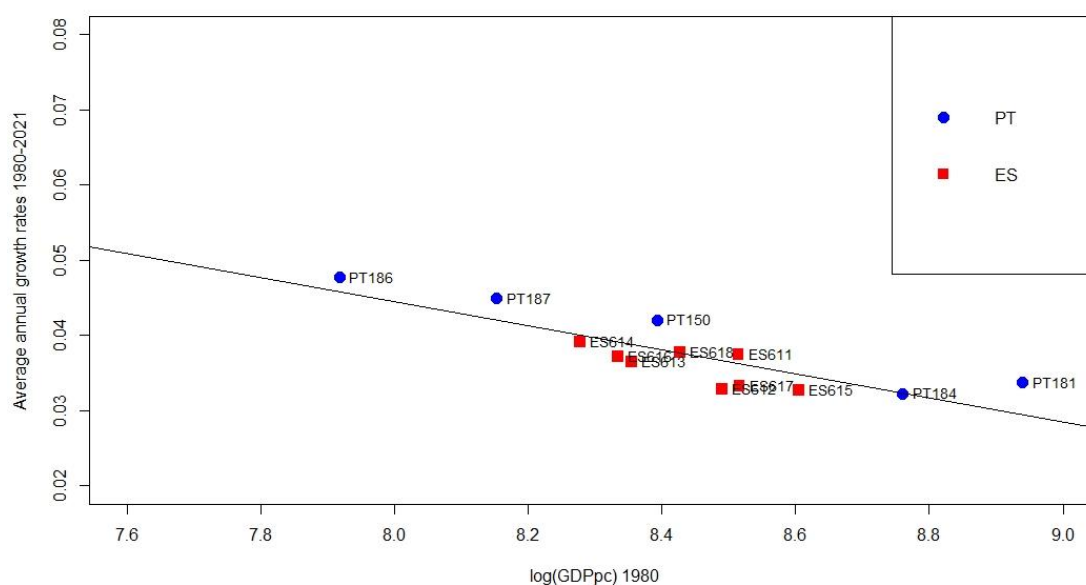


Figure 4.7. Absolute β -convergence in EUROAAA Euroregion in period 1980-2021. The negative slope indicates an absolute β -convergence process.

In Figure 4.7 we can observe that the Spanish regions in EUROAAA Euroregion are clustered together, suggesting that Spanish Euroregions have similar convergence rates. Regarding the Portuguese regions, there is one cluster of regions with the lowest GDPpc levels and the highest growth rates and another with the highest GDPpc levels. The cluster with the highest GDPpc levels corresponds to the regions of Alto Alentejo (PT186) and Alentejo Central (PT187), both border regions. According to theory, the regions with lower GDPpc levels are the ones with the higher growth rates and a higher convergence speed. This will be the case of the first Portuguese regions cluster (PT 181 and PT 184), as in Figure 4.6, Baixo Alentejo (border region) and Alentejo Litoral (non-border region). In light of this figure, we cannot establish that the border regions are the ones with higher convergence speeds, as would have been expected due to their spatial closeness that should allow for easier cooperation and catching up.

Table 4.2 displays the results of the estimation of the absolute β -convergence for the Spanish Euroregions sharing a border with France, i.e. the New Aquitaine-Basque Country-Navarre and Pyrenees-Mediterranean Euroregions, and also between Spain and France. For the first one, a process of absolute beta-convergence is obtained by OLS (column a) but it is not significant. The results of the three spatial autocorrelation tests indicate that there is a presence of spatial effects; specifically, the significance of the LM robust error test indicates the presence of spatial correlation in the residuals of the

regression model. The error term dependency establishes the effect of non-observed variables that may have contributed to the economic development of adjacent regions. Therefore, in this case, the spatial error model is more appropriate to estimate the spatial dependence (Equation 9). Table 4.2 column b shows the obtained results for the spatial error model estimation, where λ represents the spatial autoregressive parameter in the error term.

Table 4.2. β -convergence in New Aquitaine-Basque Country-Navarre Euroregion by OLS (a), SEM (b), in Pyrenees-Mediterranean Euroregion by OLS (c)^{15, (d)} and between Spain and France by OLS (e) for period 1980-2021.

	(a) OLS	(b) SEM	(c) OLS	(d) OLS without Ibiza (ES 531)	(e) OLS
Constant	0.045 (0.058)	0.074* (0.040)	0.210*** (0.027)	0.021 (0.07)	0.075*** (0.011)
Initial GDPpc	-0.001 (0.006)	-0.004 (0.004)	-0.020*** (0.003)	0.002 (0.008)	-0.004*** (0.001)
λ		0.617** (0.180)			
Convergence speed	0.001		0.041	0.002	0.005
Half life	538		16.6	408	138
Observations	16	16	20	19	143
F-test	0.04		40.89***	0.04	12***
Adj. R2	0		0.69	0	0.07
Moran I	0.466***		-0.039	0.08	0.368***
LM lag	5.303**		0.046	0.11	26.486***
LM lag (robust)	3.366*		0.362	2.9*	0.131
LM error	5.569**		0.055	0.16	26.849***
LM error (robust)	3.632**		0.371	2.96*	0.494
Breusch- Pagan test	2.6e-04		0.458	0.184	25.076***

Note: *Significative at 10%, ** significant at 5%, *** significant at 1%.

¹⁵ There is no SEM model for Pyrenees-Mediterranean Euroregion as there is not spatial autocorrelation.

With the spatial error dependence model (column b), the slight beta-convergence process estimated by the OLS model is still not significant. This excludes the presence of a catching-up effect among the poorest regions, as predicted by the σ -divergence process observed in Figure 4.4.

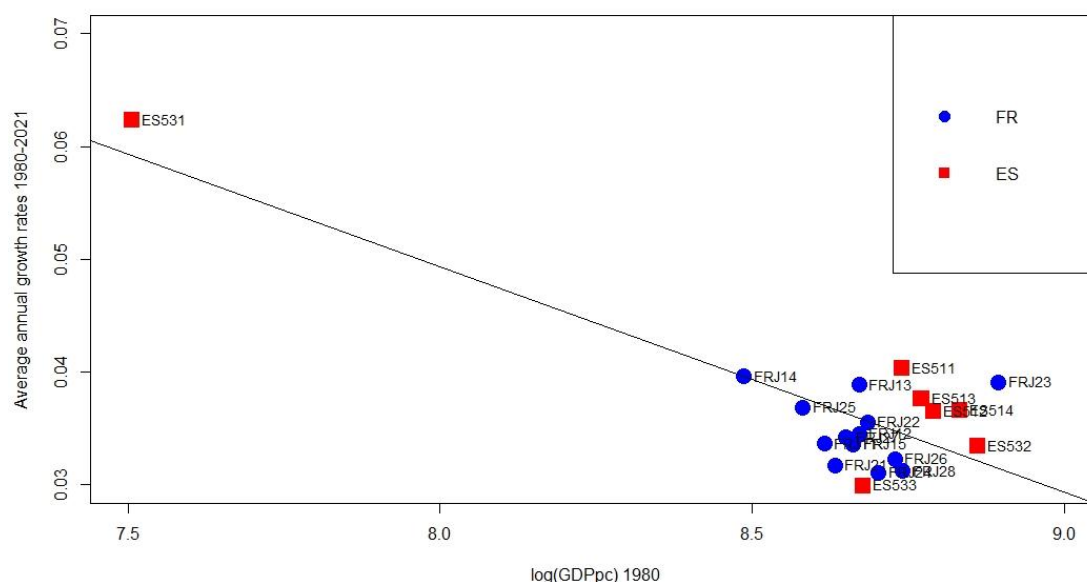


Figure 4.8. Absolute β -convergence in Pyrenees-Mediterranean Euroregion in period 1980-2021. The negative slope indicates an absolute β -convergence process.

In the Pyrenees-Mediterranean Euroregion, a process of absolute beta-convergence is obtained by OLS for the whole period with a convergence speed of 4.1% and a half-life of 16.6 years (Table 4.2, column c). However, when we represent the regression (Figure 4.8), we observe that there is a clear outlier in the data, corresponding to the region of Ibiza (ES 531). This region has, by far, the lowest initial level of GDPpc and the highest growth rate of the Euroregion. This region has had a tremendous economic growth in the last few decades due to an explosion in international luxury tourism. In fact, if we remove this region from the regression, no absolute beta-convergence is obtained (Table 4.2 column d), and no spatial autocorrelation. If we remove this region as well from the σ -convergence analysis, we find that there is a 75% increase of the inequalities throughout the studied period - that is, we obtain divergence, since the inclusion of Ibiza raised the dispersion coefficients at the initial year of the period (having by far the lowest economic level).

Finally, we have also calculated the convergence between Spain and France, obtaining in this case a process of absolute beta-convergence by OLS, with a convergence speed of 0.5% (Table 4.2, column e).

Overall, as predicted before by observing sigma convergence, beta convergence has been produced for EUROAAA and EUROACE regions in the analyzed period. This effect was also obtained in the Galicia-North Portugal Euroregion by López-Villuendas and del Campo (2022), indicating that for Spanish Euroregions sharing border with Portugal, convergence between cross-border regions has taken place. We have also identified a process of beta-convergence between Spain and Portugal, therefore we can conclude that the convergence produced in these Euroregions is contributing to the total convergence between Spain and Portugal, and the intense cooperation relationships that are developed within the Euroregions frame results in a convergence speed higher in the Euroregions than in the Iberian Peninsula. However, for the other two Spanish Euroregions sharing a border with France, sigma and beta divergence processes were found, despite obtaining beta-convergence between Spain and France, meaning that if differences between these Euroregions continue to grow, the total convergence between the two countries could be jeopardized.

Therefore, for Spanish Euroregions, the convergence process seems to depend on the country with which Spain shares the border. In the first case, it may be due to the similarities in language and culture between Spain and Portugal, and the long border which can facilitate the cooperation between countries (especially in the case of EUROACE). In the case of the Spanish Euroregions sharing border with France, especially for the New Aquitaine-Basque Country-Navarre Euroregion, the border they share is quite short and the French internal regions are far from the frontier, making interactions more difficult. Agreeing with Medeiros (2013), the convergence in this last case could be improved by reducing the French area of the Euroregion, since it would enable the implementation of dedicated policy measures, incrementing their effectiveness.

This raises the question of how differences in the grade of development, social factors, economic structure, culture, or proximity, among others, between the countries could promote or slow convergence. Also, the execution organs of the policies, the kind of cooperation projects that are established within the Euroregions, or their interests,

among other factors, could be important in explaining the driving forces behind the processes of convergence or divergence. Knowing these factors, which call for a deeper analysis, would provide a significant advance for policymakers to establish tailored measures to boost the convergence between the member states.

Finally, a point to highlight is that the same general results (convergence in Euroregions sharing border with Portugal and divergence in Euroregions sharing border with France) are maintained for period 2000-2019 - that is, without taking into consideration the effect of COVID-19 (untabulated results). The COVID-19 lockdown entailed a drastic fall in GDPpc in European regions. Nevertheless, the influence of the COVID-19 on the convergence and divergence processes lies in the slowing of the convergence and the rise of inequalities in year 2021, since regions have disproportionately suffered from the impacts of the economic downturn.

4.6. Conclusions

Convergence in European cross-border regions is a controversial topic in the literature. On the one hand, some authors claim that the increase in the number of interactions between regions can lead to an integration in their structural characteristics, and this can be considered as an indication of convergence. On the other hand, some authors agree that integration should be viewed in a broader sense, since it can result from symmetries and similarities as well as from asymmetries and differentials between border regions, contradicting the previous statement.

With the present analysis, we contribute to the literature by studying the convergence in the Euroregions, aiming to determine whether the intense cooperation relationships that occur in these particular structures (with border and non-border areas) boost their convergence. If this cooperation model is successful it could be implemented in other areas to contribute to the total convergence of all the member states, hence the importance of this analysis. Specifically, we have studied four Spanish Euroregions, two sharing a border with Portugal (EUROAAA and EUROACE) and two with France (New Aquitaine-Basque Country-Navarre and Pyrenees-Mediterranean). In this way, we have observed the effect of different socio-economic, cultural and administrative characteristics of these two countries on the convergence with the Spanish regions. We covered the period from 1980 to 2021 and analyzed two classical concepts of convergence: σ -convergence, which

refers to the reduction of inequalities over time, and β -convergence, which refers to the process by which the poorest regions catch up with the richest over time. Furthermore, we have also studied the spatial convergence.

We identified sigma and beta convergence processes for EUROACE and EUROAAA in the 1980-2021 period, similarly to the results obtained in López-Villuendas and del Campo (2022) for the Galicia-North of Portugal Euroregion. That is, for all three Spanish Euroregions that share a border with Portugal, there has been a reduction in economic disparities over time and a process of catching up between regions with disparate economic levels. Mainly, the Portuguese regions, with lower levels of GDPpc, have experienced higher annual growth rates to converge to the level of the Spanish regions.

This shows that, in the case of the Iberian Peninsula, cross-border cooperation between countries with different socio-economic, cultural and administrative characteristics, and specifically, the creation of spaces dedicated to strengthening this cooperation, such as the Euroregions, can be beneficial since it levels the economic disparities and improves the economic development of the less developed NUTS 3 regions.

In the case of the two Euroregions that share a border with France, Pyrenees-Mediterranean Euroregion and New Aquitaine-Basque Country-Navarre Euroregion, we found sigma and beta divergence; that is, economic disparities have increased over the years and there has not been a catching-up process between poorer and richer NUTS 3 regions, confirming that there is still a long way to go to increase cooperation between the Spanish-French border.

Therefore, it seems that the Spanish Euroregions' convergence process depends on the country Spain shares the border with. Hence, it could be useful in future research to include in the model the region-specific structural parameters and study the conditional convergence. Factors such as the cultural heritage, the territory, the qualifications and employment structure, the institutions, or the cooperation models, among others, could explain the presence or absence of convergence. Knowing the factors behind the processes of convergence and divergence could be of importance for policymakers in order to foster tailored actions to improve the convergence. Also, in future research, Euroregions of other countries could be included to further analyze the country-specific

structural parameters - for example, Germany, the country with the highest number of Euroregions, which shares a border with several countries.

Euroregions can be a useful resource to study the processes of convergence, integration and cohesion in the European Union, since they are territories in where major efforts are made to increase the cooperation and socio-economic interactions between the two sides of the border and hence reduce the barriers in mobility, culture, markets, etc. Border regions are considered to be laboratories of the Europeanization process (Kramsch and Hooper 2004). Therefore, actions carried out in these structures can be replicated by others and can be useful for policymakers to establish policies and cooperation mechanisms between transborder regions, since cross-border convergence contributes to the total convergence of the EU. In the current context of Euroskepticism and other challenges that the European Union is facing, convergence between European member states is essential. Moreover, national and regional policies should further contribute to the development of these structures development as well, since most of the competences required to support more convergence between border regions remain at national or regional level, and most Euroregions face barriers to the development of cross-border cooperation by being peripheral regions, distant from national and regional decision centres (Kurowska-Pysz et al. 2018).

Finally, we must highlight a limitation in our research that should be considered when studying the disparities at the NUTS 3 level: some part of the per capita GDP might correspond to commuters, causing some small inaccuracies in this indicator.

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Chapter 5. Global findings, discussion and conclusions

This final chapter presents the conclusions drawn from the main findings of chapters 1, 2, 3 and 4, and suggests potential directions for future research.

In the last decades, regional disparities in the European Union (EU) have sparked controversy due to the potential threat they pose to the well-balanced and harmonious development of the European regions. Given the significance and impact of this issue on the EU's foundations, the present dissertation has examined the effectivity of the Cohesion Policy (CP) in achieving its goal of reducing these disparities.

The first two chapters have addressed the eligibility criterion for European regions being financed, concretely focussing on whether the NUTS 2 level is the appropriate territorial level at which to capture the Cohesion Policy effects. Over the past 20 years, the share of the total inequalities of the member states attributed to the NUTS 3 level has been increasing (e.g. Butkus et al., 2018), implying that the Cohesion Policy neglects the problems within the NUTS 2 regions, by not taking into consideration the specific characteristics and features of the NUTS 3 level that can affect the overall effectiveness of the Cohesion Policy funding. Therefore, we consider it is of great interest for policymakers to determine the effect of the Cohesion Policy on the disparities of the NUTS 3 regions.

Firstly, in Chapter 1, we have conducted a model-based clustering to identify the regional economic disparities in the level of economic wealth and its dynamics at NUTS 2 and NUTS 3 levels. This way, we have determined whether the NUTS 3 regions share the same economic behaviours as their aggregates NUTS 2 regions and therefore policies such as the Cohesion Policy are equally effective for all territories.

Our results show that NUTS 2 regions tend to spatially cluster at the national level and, although NUTS 3 regions show a slight tendency to cluster together in space at national level as well, the spatial effect is not as strong as it is for NUTS 2 level. This suggests that when the analysis is conducted at a more granular spatial level (NUTS 3), additional disparities emerge, revealing local economic and market characteristics, and regions may display economic similarities with distant regions rather than neighbouring ones. As a result, it appears that a process of increasing stratification, or differentiation, in GDP per capita growth rates is taking place, implying that the current Cohesion Policy at the NUTS 2 level may no longer be effectively addressing the growing disparities within the EU.

Part of this effect can be attributed to the Modifiable Areal Unit Problem (MAUP), which refers to the variability in statistical measures when data (such as GDP per capita) is aggregated at different levels, in this case, NUTS 2 and NUTS 3. This leads to greater dispersion at the more granular NUTS 3 level. However, this issue actually strengthens our findings that the NUTS 2 level is concealing the heterogeneity of economic disparities across EU regions. As a result, some relatively rich NUTS 3 regions might receive Structural Funds simply because their NUTS 2 region is eligible -these are the so-called “accidental winners”- while less prosperous NUTS 3 regions might miss out on funding because their NUTS 2 region is ineligible. Therefore, the Cohesion Policy, which is designed to reduce regional disparities and is defined at the NUTS 2 level, should consider that NUTS 2 regions are not homogeneous territories presenting internal economic differences which could render the policy ineffective and potentially exacerbate regional disparities even further.

Having obtained that the NUTS 2 level is masking the heterogeneity of their NUTS 3 regions, we made an approach to characterise the reasons behind the revealed NUTS 3 economic disparities in order to be used as a starting point in future empirical studies to discover the driving forces behind the regional economic disparities. Factors such as the structure (urban/rural), the sectorization, the agglomeration or the specialization of the regions may be considered as potential underlying aspects for explaining the economic inequalities that arise at the NUTS 3 level. Also, exploring the unlinking of the economic wealth to geographic location could provide with further insights on the behaviour of economic inequalities. Revealing the mechanisms behind these will enable to discovery and directly address the potential problems arising at the NUTS 3 dimension, facilitating policymakers to effectively design policies to reduce regional disparities.

Results from this first chapter gave rise to the next one. As we found that NUTS 2 regions are not homogeneous regions, and therefore allocating the funds at NUTS 2 level may present some inefficiencies and increase even more the regional disparities, in the second chapter we have determined whether the Cohesion Policy is indeed increasing the inequalities at the NUTS 3 level by evaluating the impact of the Structural Funds on the NUTS 3 regional economic inequalities.

Our findings reveal that the NUTS 3 regions eligible for receiving Structural Funds experience a further increase of inequalities than the ineligible ones, suggesting that the resources may be unevenly distributed within eligible NUTS 2 regions.

As stated by Butkus et al. (2020), the allocation of funds at this level does not guarantee that financial support reaches the NUTS 3 regions that truly need it. On the one hand, the Cohesion Policy's effectiveness might vary within NUTS 2 regions, depending on factors such as public sector structure or urbanization levels (Gagliardi and Percoco, 2017; Percoco, 2017). On the other hand, the resources may be unevenly distributed across NUTS 3 regions due to the fact that the absorption of EU funds heavily relies on the institutional capacity to implement policies effectively (Tiginasu et al., 2018). This issue is particularly prevalent in newer member states, where regional administrative capacity is often lacking, leading to a concentration of resources in capital cities.

Combining these results with the ones obtained in the first chapter, enables us to draw the first main conclusion of this dissertation of interest for policymakers. Cohesion Policy, aimed at reducing regional disparities and defined at NUTS 2 level, should consider that NUTS 2 regions are heterogeneous territories with internal differences and therefore allocating the funds at this level may cause some inaccuracies.

Ultimately, the spatial scale at which the Cohesion Policy allocates the funds could be debatable. One-size-fits-all policies may not be longer the solution, but a more tailored, region-specific approach may be necessary. Recognizing the diversity of the NUTS 3 regions, devoting more attention to the particular characteristics of this dimension, such as the economic or geographical structure, is essential to offer more targeted and effective policies.

It has to be noted that we are not suggesting that the solution to consider the NUTS 3 particular characteristics is to distribute the funding at NUTS 3 level, because it would suppose higher administrative complexity, hence significantly enlarging the coordination challenges which could slow down the fund disbursement and increase inefficiencies. Moreover, some countries do not even have well-established regional governments at NUTS 2 level, so they centralize the funds at national level. However, the eligibility criterion of financing NUTS 2 regions according to its GDP level should be reviewed in order to offer a more tailored solution which contemplates the internal characteristics of the NUTS 2 regions, at NUTS 3 level. For example, the eligibility criterion could

incorporate socioeconomic indicators at NUTS 3 level. Thus, the existence of “accidental winners” which may cause an enlargement of the economic differences of these regions with respect to the others, could be avoided.

Additionally, the assignation of funds at NUTS 2 level could be complemented with intra-regional assignation mechanisms which consider the inequalities at NUTS 3 level, enabling a more homogeneous distribution of the funding within NUTS 2 regions, and ensuring that the funds arrive to the territories in need. Specific programs under the Structural Funds framework could be created to reduce the internal inequalities within NUTS 2 regions, enhancing the internal convergence and boosting the integration of the lagging NUTS 3 regions. Assessment methods of the policies could also be implemented by disaggregating the results at NUTS 3 level, enabling to detect the potential problems within the NUTS 2 regions and adapt the policies accordingly. Finally, the inclusion of the local government administrations in the funds management could avoid centralization in the resources allocation and boost the absorption of the Cohesion Policy funds at the NUTS 3 level, enhancing the efficiency and the legitimacy of the assignation and distributions processes.

However, all these suggestions will be fruitful if the aggregate economic performance of the member state’s objective is aligned with the objective of reducing their regional inequalities. By addressing these considerations, EU authorities can work towards making the Cohesion Policy more impactful and effective in its mission to reduce regional disparities.

Future research revealing the underlying factors driving the economic inequalities at the NUTS 3 level, along with further analysis of the effectiveness of funding at this level, will be valuable for developing more targeted policies to achieve the main objective of the Cohesion Policy. Additionally, analysis conducted to prove the presence of the “accidental winners” at NUTS 3 level could be beneficial for policymakers to identify the misallocation of resources and therefore to improve the funding allocation criterion. An analysis distinguishing between intra- and inter-inequalities could also be helpful to offer a better understanding of the inequalities situation and contribute to its reduction.

It has to be noted that the actual expenditure received by NUTS 3 regions was not available for this study, so the assessment of the Cohesion Policy was based on NUTS 2 regions eligibility. Should we in the future be able to obtain the actual expenditure data

for NUTS 3 regions, we could perform more accurate studies and offer more precise recommendations for enhancing the EU's policy. Research such as conducting multilevel analysis to evaluate the impact of the funds at different territorial levels, capturing effects at both NUTS 2 and NUTS 3 levels, or carrying out spatial analysis to identify patterns in the concentration of the funds assignment and in the economic results.

Continuing with chapters 3 and 4 of this dissertation, these have discussed the role of the Euroregions (structures financed by the Cohesion Policy to promote integration processes) in reducing regional disparities. It is expected that the intense cooperation relationships that occur within these particular structures (with border and non-border regions) lead to an integration in their structural characteristics and this can be considered as an indication of convergence between the economic levels of the regions. However, some authors claim that integration should be considered in a broader sense, since it can result from symmetries and similarities as well as from asymmetries and differences between border regions, contradicting the previous statement. Aiming to contribute to this debate, we have explored the economic convergence processes and the evolution of the economic inequalities in the Spanish Euroregions, in order to find out whether the intense cooperation relationships that occur within these structures, stimulate the convergence and narrow the existing economic inequalities among its regions. Should this cooperation model be successful, it could be implemented in other areas to contribute to the total convergence of all member states, hence the importance of this analysis.

More concretely, we have approached the five Spanish Euroregions, three sharing border with Portugal (EUROAAA, EUROACE and Galicia-North of Portugal) and two with France (New Aquitaine-Basque Country-Navarre and Pyrenees-Mediterranean). That way, we have observed the effect of different socio-economic, cultural and administrative characteristics of these two nearby countries on the convergence with the Spanish regions. We have covered the period from 1980 to 2021 and analysed two classical concepts of convergence: σ -convergence, which refers to the reduction of inequalities over time, and β -convergence, which refers to the process by which the poorest regions catch up with the richest over time.

Our findings show that the three Portuguese Euroregions, EUROACE, EUROAAA and Galicia-North of Portugal, have experimented a reduction in its economic disparities over the studied period and the regions with lower economic levels have caught-up

regions with higher economic levels, achieving σ and β convergence. Mainly, the Portuguese regions, which are the ones with initial lower economic levels, have reached the economic levels of the Spanish regions by showing higher annual growth rates than the last ones. Additionally, we also have verified that Spain and Portugal have experienced a β -convergence process during that period, implying that the convergence which has been achieved in those Euroregions is contributing to the total convergence between Spain and Portugal. Concretely, the strong cooperative relationships fostered within the Euroregions framework lead to a faster pace of convergence in these areas compared to the rest of the Iberian Peninsula. This indicates that, in the context of the Iberian Peninsula, cross-border cooperation between countries with differing socio-economic, cultural and structural features, and specifically, the establishment of spaces like Euroregions dedicated to enhancing such cooperation can be advantageous since it helps to reduce economic disparities and promotes the economic development of the less developed NUTS 3 regions.

However, in the case of the two Spanish Euroregions sharing border with France - Pyrenees-Mediterranean Euroregion and the New Aquitaine-Basque Country-Navarre Euroregion-, processes of σ and β divergence have been observed. This means that economic disparities have widened over the years, and there has been no catching-up between the poorer and richer NUTS 3 regions, despite the existence of a process of β -convergence in Spain and France. Consequently, the overall convergence between the two countries could be at risk if the differences within these Euroregions continue to widen.

We can conclude then from the results of these two chapters that the convergence process in the Spanish Euroregions appears to be influenced by the country with which Spain shares its border. In the case of Spain and Portugal, similarities in language and culture, along with the extensive border, likely facilitate cooperation. In the case of the Spanish Euroregions sharing border with France, the shorter border (the Pyrenees) and the wide distance of the French internal regions from the frontier make interactions more challenging. As Medeiros (2013) suggests, convergence in this last case could be improved by reducing the French area within the Euroregion, which would allow for more targeted policy measures, incrementing their effectiveness.

This raises the question of how differences in development levels, social factors, economic structures, culture, proximity, and other factors between countries might either

promote or slow down convergence. Also, the execution organs of the policies, the kind of cooperation projects that are established within the Euroregions, and their specific interests, among others, could be important features when explaining the forces driving convergence or divergence. Determining these factors, which require more in-depth analysis, would suppose a significant step forward for policymakers in designing targeted measures to enhance convergence between member states. Future research could benefit from incorporating region-specific structural parameters into the model to examine conditional convergence or expand the analysis to include Euroregions from other countries to further explore country-specific structural parameters.

Stating the second main conclusion of the dissertation, the findings of these two chapters highlight the varying impact of the Euroregion model on the objective of the Cohesion Policy of reducing disparities. This impact depends on the culture, proximity, socio-economic and territorial factors -among others- of the countries which comprise the Euroregion. Specifically, it has been evidenced that Euroregions facing geographical internal obstacles and comprised of countries with very different socio-economic and cultural characteristics have to make additional efforts to achieve convergence.

Euroregions can be a valuable resource for studying the processes of convergence, integration and cohesion within the European Union. These regions are areas where significant efforts are made to enhance cooperation and socio-economic interactions across borders, helping to reduce barriers related to mobility, culture, markets, etc. Border regions are considered to be laboratories of the Europeanisation process (Kramsch and Hooper, 2004). Therefore, successful initiatives in these areas can be replicated elsewhere, providing policymakers with effective models for establishing policies and cooperation mechanisms between cross-border regions, since cross-border convergence contributes to the overall convergence of the EU. In the current climate of Euroscepticism and other challenges that the EU is facing, fostering convergence among member states is essential. National and regional policies should further support the development of the Euroregions, as most of the competences required to enhance convergence between border regions reside at the national or regional level, and some Euroregions face obstacles to cross-border cooperation due to their peripheral locations, far from national and regional decision-making centers (Kurowska-Pysz et al., 2018).

Overall, we are aware of the difficulty that implies to perform a proper assessment of the effectiveness of the Cohesion Policy on its objective of reducing the economic disparities, as this policy encompasses several dimensions, extends to many territories and involves a diverse range of stakeholders and administrations, therefore affecting numerous socio-economic and territorial factors.

Throughout the thesis, potential factors contributing to regional inequalities have been identified and suggested. These include structural, sectoral, agglomeration, and specialization factors of the regions (identified in the first part of the study, corresponding to the first two chapters), as well as administrative, socio-economic, cultural, and territorial characteristics of the regions (suggested in the second part of the thesis, covering Chapters 3 and 4). Unveiling these factors related to the intrinsic characteristics of the regions can help identify regional deficiencies, and addressing them can contribute to eradicate regional disparities.

However, as indicated in the introduction, in recent years, regions have been exposed to general factors at both the European and global levels, such as globalization, the technological revolution, the integration process of newly admitted EU members, the global financial crisis of 2008, and the introduction of the Euro (whose effect on the inequalities has not been explicitly analysed in the research -except for the global financial crisis of 2008-), which might have created new disparities, adding an extra inequality component for Cohesion Policy to address.

The literature on the assessment of the Cohesion Policy reveals a variety of results, which differ depending on the methods employed in the analysis, the analysed period, the used measures, the made assumptions, and the interpretations of the authors, making it difficult to draw definitive conclusions which would help to better design the future Cohesion Policy. Nonetheless, we hope the findings of this dissertation will be valuable to policymakers and academics alike, and based on the citations from the studies who have referenced our published articles, we believe that our outcomes have contributed to the literature by providing with impactful results and solid conclusions regarding the economic inequalities in European regions.

Finally, we have to highlight that this dissertation is not without limitations. A common one throughout the research relates to the use of the GDP per capita as the economic indicator when studying the economic disparities. First, at NUTS 3 level, some

part of the per capita GDP may correspond to commuters and may cause some inaccuracies in this indicator. Secondly, the use of national PPS (as regional ones are not available) overstates the GDP per capita in PPS in regions with prices above the national average prices within any given member states, while understates the values for regions with prices below the national average prices. Additionally, as indicated in Chapter 2, we have not contemplated the n+2 rule when stating the eligibility of a region to receive Structural Funds, for which there are two additional years to spend the funds after the end of the policy period. Similarly, we have not included the post-policy period effects in our study, which may affect the disparities although regions might no longer be receiving funds.

Due to the multifaceted and complex landscape of the current state of regional disparities, and given the threat that regional disparities represent to the well-being of the EU citizens, it is essential to keep researching on the effectiveness of the Cohesion Policy. By continuously assessing and enhancing policy instruments, the European Union can ensure that the Cohesion Policy remains an effective tool for fostering balanced and sustainable regional development, ultimately improving the quality of life for all citizens and strengthening the resilience of the European project.

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Annexes

Appendix A. Regional economic disparities in Europe: Time-series Clustering of NUTS 3 regions

In order to select the number of clusters, the BIC is a popular choice in the context of GMMs. In the *mclust* package, BIC is used by default for model selection and allows to obtain a matrix of BIC values for all the available models and number of components in order to determine the optimal number of clusters.

Table A1: Possible models in clustering

Model	Distribution	Volume	Shape	Orientation
EII	Spherical	Equal	Equal	-
VII	Spherical	Variable	Equal	-
EEI	Diagonal	Equal	Equal	Coordinate axes
VEI	Diagonal	Variable	Equal	Coordinate axes
EVI	Diagonal	Equal	Variable	Coordinate axes
VVI	Diagonal	Variable	Variable	Coordinate axes
EEE	Ellipsoidal	Equal	Equal	Equal
EVE	Ellipsoidal	Equal	Variable	Equal
VEE	Ellipsoidal	Variable	Equal	Equal
VVE	Ellipsoidal	Variable	Variable	Equal
EEV	Ellipsoidal	Equal	Equal	Variable
VEV	Ellipsoidal	Variable	Equal	Variable
EVV	Ellipsoidal	Equal	Variable	Variable
VVV	Ellipsoidal	Variable	Variable	Variable

Table A2: Best BIC values for each clustering solution

Clustering		1st best BIC value	2nd best BIC value	3rd best BIC value
Level of GDP of NUTS 2 regions in period 2000-2017	BIC	-80259.07	-80366.15	-80546.90
	Model	VEE	VEE	VEE
	Clusters	4	3	2
Level of GDP of NUTS 3 regions in period 2000-2017	BIC	-392951.3	-392967.93	-393227.54
	Model	VEE	VEE	VEE
	Clusters	11	10	9
Growth rates of GDP of NUTS 2 regions in period 2001-2017	BIC	-22138.4	-22155.93	-22256.11
	Model	VEI	VEI	VEI
	Clusters	10	9	8
Growth rates of GDP of NUTS 3 regions in period 2001-2017	BIC	-119064.7	-119108.74	-119132.55
	Model	VEI	VEI	VEI
	Clusters	15	14	16
Growth rates of GDP of NUTS 2 regions in pre-crisis period	BIC	-10762.27	-10779.74	-10790.81
	Model	VII	VII	VEI
	Clusters	8	9	8
Growth rates of GDP of NUTS 3 regions in pre-crisis period	BIC	-58517.89	-58534.82	-58547.77
	Model	VEI	VII	VEI
	Clusters	8	8	7
Growth rates of GDP of NUTS 2 regions in post-crisis period	BIC	-11789.31	-11814.95	-11830.12
	Model	VEI	VEI	VEI
	Clusters	9	10	13
Growth rates of GDP of NUTS 3 regions in post-crisis period	BIC	-62277.34	-62293.51	-62329.46
	Model	VEI	VEI	VEI
	Clusters	15	16	19

Appendix B. Convergence in European cross-border structures: the case of Spanish Euroregions

Table B1. New Aquitaine-Basque Country-Navarre Euroregion's indicators

Region	Population (2021)	Employment Primary Sector (2021)	Employment Industry and Construction (2021)	Employment Services (2021)	GDPpc (1980)	GDPpc (2021)
Euskadi (ES)	2.2 mill. people	0.9%	24.1%	75.0%	7196.5 PPSpc	35185.05 PPSpc
Navarra (ES)	657654 people	3.8%	29.3%	66.9%	7424.01 PPSpc	33151.70 PPSpc
Nouvelle-Aquitaine (FR)	6 mill. people	5.1%	17.3%	77.6%	6876.48 PPSpc	28482.77 PPSpc

Source: authors from ARDECO (2021)

Table B2. Pyrenees-Mediterranean Euroregion's indicators

Region	Population (2021)	Employment Primary Sector (2021)	Employment Industry and Construction (2021)	Employment Services (2021)	GDPpc (1980)	GDPpc (2021)
Cataluña (ES)	7.7 mill. people	1.4%	19.3%	79.3%	6341.21 PPSpc	31997.42 PPSpc
Illes Balears (ES)	1.2 mill. people	0.9%	15.7%	83.4%	6192.19 PPSpc	26572.90 PPSpc
Languedoc-Roussillon (FR)	2.9 mill. people	3.9%	13.7%	82.4%	5738.95 PPSpc	25545.41 PPSpc
Midi-Pyrénées (FR)	3 mill. people	3.6%	17.9%	78.5%	6375.91 PPSpc	29190.64 PPSpc

Source: authors from ARDECO (2021)

Table B3. EUROAAA Euroregion's indicators

Region	Population (2021)	Employment Primary Sector (2021)	Employment Industry and Construction (2021)	Employment Services (2021)	GDPpc (1980)	GDPpc (2019)
Andalucía (ES)	8.5 mill. people	8.1%	14.5%	77.4%	4611.99 PPSpc	21204.09 PPSpc
Algarve (PT)	437970 people	9.6% (2020)	13.0% (2020)	77.4% (2020)	4414.53 PPSpc	24719.26 PPSpc
Alentejo (PT)	699420 people	21.6% (2020)	18.6% (2020)	59.8% (2020)	4576.84 PPSpc	22853.64 PPSpc

Source: authors from ARDECO (2021)

Table B4. EUROACE Euroregion's indicators

Region	Population (2021)	Employment Primary Sector (2021)	Employment Industry and Construction (2021)	Employment Services (2021)	GDPpc (1980)	GDPpc (2021)
Extremadura (ES)	1 mill. people	9.7%	15.9%	74.4%	3519.74 PPSpc	20381.49 PPSpc
Centro Portugal (PT)	2.2 mill. people	11.9% (2020)	28.3% (2020)	59.8% (2020)	3504.79 PPSpc	21449.50 PPSpc
Alentejo (PT)	699420 people	21.6% (2020)	18.6% (2020)	59.8% (2020)	4576.84 PPSpc	22853.64 PPSpc

Source: authors from ARDECO (2021)

Table B5. Galicia-North Portugal Euroregion's indicators

Region	Population	Employment Primary Sector (2021)	Employment Industry and Construction (2021)	Employment Services (2021)	GDPpc (1980)	GDPpc (2021)
Norte de Portugal (PT)	3.6 mill. people	7.8% (2020)	32.8% (2020)	59.4% (2020)	3593.37 PPSpc	21208.33 PPSpc
Galicia (ES)	2.7 mill. people	6.1%	20.0%	73.9%	5033.12 PPSpc	25111.47 PPSpc

Source: authors from ARDECO (2021)

Table B6. NUTS 3 regions of New Aquitaine-Basque Country-Navarre Euroregions (NUTS 2021 classification).

Region	Code
Dordogne	FRI11
Gironde	FRI12
Landes	FRI13
Lot-et-Garonne	FRI14
Pyrénées-Atlantiques	FRI15
Corrèze	FRI21
Creuse	FRI22
Haute-Vienne	FRI23
Charente	FRI31
Charente-Maritime	FRI32
Deux-Sèvres	FRI33
Vienne	FRI34
Araba/Álava	ES211
Gipuzkoa	ES212
Bizkaia	ES213
Navarra	ES220

Table B7. NUTS 3 regions of Pyrenees-Mediterranean Euroregions (NUTS 2021 classification).

Region	Code
Aude	FRJ11
Gard	FRJ12
Hérault	FRJ13
Lozère	FRJ14
Pyrénées-Orientales	FRJ15
Ariège	FRJ21
Aveyron	FRJ22
Haute-Garonne	FRJ23
Gers	FRJ24
Lot	FRJ25
Hautes-Pyrénées	FRJ26
Tarn	FRJ27
Tarn-et-Garonne	FRJ28
Barcelona	ES511
Girona	ES512
Lleida	ES513
Tarragona	ES514
Eivissa y Formentera	ES531
Mallorca	ES532
Menorca	ES533

Table B8. NUTS 3 regions of EUROAAA Euroregion (NUTS 2021 classification).

Region	Code
Algarve	PT150
Alentejo Litoral	PT181
Baixo Alentejo	PT184
Alto Alentejo	PT186
Alentejo Central	PT187
Almería	ES611
Cádiz	ES612
Córdoba	ES613
Granada	ES614
Huelva	ES615
Jaén	ES616
Málaga	ES617
Sevilla	ES618

Table B9. NUTS 3 regions of EUROACE Euroregion (NUTS 2021 classification).

Region	Code
Alentejo Litoral	PT181
Baixo Alentejo	PT184
Alto Alentejo	PT186
Alentejo Central	PT187
Oeste	PT16B
Região de Aveiro	PT16D
Região de Coimbra	PT16E
Região de Leiria	PT16F
Viseu Dão Lafões	PT16G
Beira Baixa	PT16H
Médio Tejo	PT16I
Beiras e Serra da Estrela	PT16J
Badajoz	ES431
Cáceres	ES432

Table B10. NUTS 3 regions of Galicia-North Portugal Euroregion (NUTS 2021 classification).

Region	Code
A Coruña	ES111
Lugo	ES112
Ourense	ES113
Pontevedra	ES114
Alto Minho	PT111
Cávado	PT112
Ave	PT119
Área Metropolitana do Porto	PT11A
Alto Tâmega	PT11B
Tâmega e Sousa	PT11C
Douro	PT11D
Terras de Trás-os-Montes	PT11E