HAROKOPIO UNIVERSITY

ENVIRONMENT, GEOGRAPHY AND APPLIED ECONOMICS

GEOGRAPHY

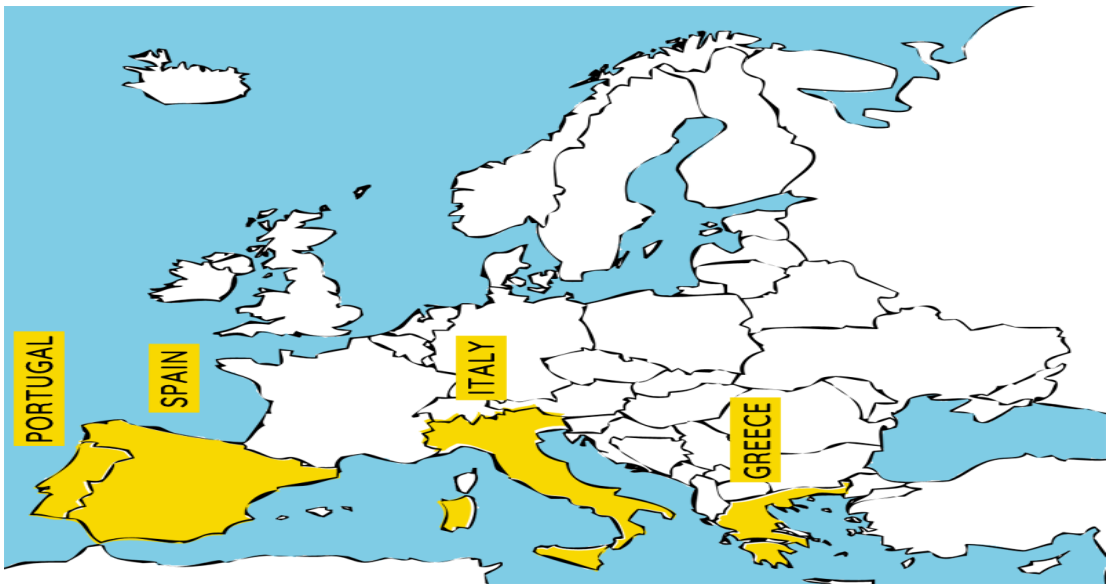
APPLIED GEOGRAPHY AND SPATIAL PLANNING

SPATIAL POLICIES AND DEVELOPMENT IN EUROPE

Main Title : The impact of the 2008 economic crisis on the regions of Southern Europe: the case of Greece, Spain, Italy and Portugal. Building a composite indicator to explore regional economic resilience

Master Thesis

Georgia Pagiavla



Athens, 2021

HAROKOPIO UNIVERSITY

ENVIRONMENT, GEOGRAPHY AND APPLIED ECONOMICS

GEOGRAPHY

APPLIED GEOGRAPHY AND SPATIAL PLANNING

SPATIAL POLICIES AND DEVELOPMENT IN EUROPE

Examining Committee

[Artelaris, Panagiotis] (Supervisor)
Assistant Professr, Geography, Harokopio University

[Skordili, Sophia] (Examiner)
Professor, Geography, Harokopio University

[Mavrommatis, George] (Examiner)
Assistant Professor, Geography, Harokopio University

Ethics and Copyright Statement (Required)

I, Georgia Pagiavla, hereby declare that:

1) I am the owner of the intellectual rights of this original work and to the best of my knowledge, my work does not insult persons, nor does it offend the intellectual rights of third parties.

2) I accept that Library and Information Centre of Harokopio University may, without changing the content of my work, make it available in electronic form through its Digital Library, copy it in any medium and / or any format and hold more than one copy for maintenance and safety purposes.

Quote page

Απ' το χωριό σου κυλά το νερό στο χωριό μου
(Water flows from your village to my village)

Hoy por ti, mañana por mí.
(Today for you, tomorrow for me.)

Noi Non Potremo Avere Perfetta Vita Senza Amici
(We Couldn't Have a Perfect Life Without Friends)

A caridade começa em casa
(Charity begins at home)

ACKNOWLEDGEMENTS

I would like to say a special thank you to my supervisor, Artelaris Panagiotis. His support, guidance and overall insights in this field have made this an inspiring experience for me.

Also, I would like to thank my mother and father for supporting me during the compilation of this dissertation.

TABLE OF CONTENTS

Abstract in Greek

Το ζήτημα των περιφερειακών ανισοτήτων είναι στη κορυφή της οικονομικής και Ατζέντας της Ευρωπαϊκής Ένωσης. Η οικονομική κρίση του 2008 φαίνεται να έχει επηρεάσει το μέγεθος και την ανάπτυξη τους, δημιουργώντας ένα ισχυρό ερευνητικό ενδιαφέρον. Αυτή η εργασία εξερεύνησε την επίδραση της οικονομικής κρίσης σε τέσσερις χώρες του ευρωπαϊκού Νότου (Ελλάδα, Ισπανία, Ιταλία, Πορτογαλία) σε επίπεδο NUTS2. Σε θεωρητικό πλαίσιο, αξιοποιήσαμε την έννοια της ανθεκτικότητας, η οποία εστιάζει στο πώς τα συστήματα αντιδρούν και ανακάμπτουν μετά από μια διαταραχή. Σε αντίθεση με την αντίληψη της Νεοκλασσικής σχολής, η οποία θεωρεί ότι η περιφερειακή οικονομία προσαρμόζεται σε ισορροπία, η σχολή της εξελικτική οικονομική γεωγραφίας υποστηρίζει ότι η περιφερειακή οικονομία διαρκώς αλλάζει και έτσι βρίσκεται σε μια διαρκή εξελικτική διαδικασία. Σε εμπειρικό επίπεδο, χρησιμοποιήσαμε τη θεωρία των σύνθετων δεικτών ώστε να κατασκευάσουμε ένα σύνθετο δείκτη που συμπεριλαμβάνει κρίσιμες πτυχές της ανάπτυξης όπως οικονομικές, κοινωνικές και δημογραφικές μεταβλητές (π.χ. περιφερειακό εισόδημα κατά κεφαλήν, χάσμα γυναικείας απασχόλησης, αυτοκτονίες, εκπαίδευση, απασχόληση και αποχή). Το πρώτο ερευνητικό ερώτημα μελετά αν η οικονομική κρίση επηρέασε ή άλλαξε σημαντικά το γεωγραφικό μοτίβο της ανάπτυξης στις τέσσερις οικονομίες της Νότιας Ευρώπης. Στη συνέχεια, παρατηρήσαμε τα διαφορετικά επίπεδα ανθεκτικότητας και προσπαθήσαμε να κατανοήσουμε το φαινόμενο. Αυτό οδήγησε την μελέτη στο δεύτερο ερευνητικό ερώτημα το οποίο αφορά τα διαρθρωτικά χαρακτηριστικά των περιφερειών. Πραγματοποιήσαμε μια ανάλυση συσχέτισης ανάμεσα στο δείκτη μας και σε 12 διαρθρωτικές μεταβλητές. Τα αποτελέσματα της έρευνας έδειξαν ότι οι περιφέρειες που είχαν καλύτερη οικονομική επίδοση έχουν κοινά οικονομικά, κοινωνικά και δημογραφικά χαρακτηριστικά, και είχαν διαφορετική εικόνα σε σχέση με το ρυθμό μεγέθυνσης του ΑΕΠ και το ρυθμό ανεργίας. Επίσης, οι μητροπόλεις δεν φάνηκαν να είναι οι πιο ανθεκτικές περιφέρειες.

Λέξεις κλειδιά: Περιφερειακή οικονομική ανθεκτικότητα, σύνθετος δείκτης, ανάλυση συσχέτισης, Νότια Ευρώπη, οικονομική κρίση.

Abstract in English

The context of regional disparities is at the top of the European Union's economic and political agenda. The economic crisis of 2008 seems to have affected their size and development, creating a strong research interest. This study explored the impact of the economic crisis on four southern European countries (Greece, Spain, Italy Portugal) at NUTS2 level. At the theoretical level, we used the concept of resilience, which focuses on how systems react and recover after a disorder. Contrary to the Neoclassical notion that the regional economy adapts to equilibrium, evolutionary economic geography argues that the regional economy is constantly changing and therefore in a constant evolutionary process. At the empirical level, we used the composite indicators framework to construct a complex indicator that incorporates critical aspects of development such as economic, social and demographic variables (eg regional income per capital, gender employment gap, suicides, education, employment and voter turnout). The first research question of this study examined whether the economic crisis has affected or significantly changed the geographical patterns of growth and development in the four economies of Southern Europe. Then, after observing the different levels of resilience we tried to understand that phenomenon. That lead the study to the second research question which dealt with the structural features of the regions. We performed a correlation analysis between our composite indicator and 12 structural variables. The findings of that study showed that regions that performed better share economical, societal and demographical characteristics and their performance is different if compared to GDP growth and unemployment rate. Also, we found that capital regions did not appear the most resilient.

Keywords: Regional economic resilience, Composite indicator, correlation analysis, Southern Europe, economic crisis.

LIST OF FIGURES

LIST OF TABLES

LIST OF MAPS

ABBREVIATIONS

GDP	Gross Domestic Product
RER	Regional Economic Resilience
CI	Composite Indicator

Chapter 1: Introduction

1.1. Global insecurity and Regional Resilience

We live in a global community and it is more than possible that events that take place in long geographical distances affecting us. The most recent example is the COVID-19 crisis, where it started in China and now the whole world is under social distancing measures and most of the countries will face economic recessions (World Bank, 2020). Another example is the financial market collapse in 2008 in the USA and its economic and social aftermath were felt across the world (Huwart & Verdier, 2013). The economic and political instability in the Middle East has been felt in the EU through the Migration/Refugee crisis, where 1 million people came to its borders (UNHCR, 2015). On top of all that, there is climate change which is influencing the extreme weather phenomena (National Geographic, 2015). In other words, globalization raises health, economic, political, and environmental challenges, which bring new kinds of insecurity. As Moqhaddam (2010) mentions, globalization may promise a more secure world, with open borders and open flourishing societies, but it is actually translated into interconnected insecurity, due to greater economic and political instability.

However, not all regions experience a shock in the same way, as the resistance and the recovery process vary greatly. Regional science, to explore those differences, examines the resilience of the regions. In other words, it analyzes the way regions, individuals and institutions respond, adapt, and demonstrate resilience during an extraordinary event. A region that is characterized by higher resilience is more likely to absorb the disturbances, either because it had more efficient assessment criteria or was more ready to absorb the crisis, or because it had better endowments or structure, like infrastructure, human capital, networks, which resulted to a more effective reaction (Foster, 2006). The higher the degree of resilience the lower the degree of vulnerability (Müller, 2011).

In the Neoliberal Era, which is characterized by the deregulation of the flow of goods, capital and people, local economies have decreased levels of protection and increased competitiveness pressures (Eraydin, 2013). Dani Rodrik names this state of

globalization as hyper-globalization, pointing out that unlimited economic integration has become impractical. Regions are forced to identify their assets that increase their competitiveness and facilitate their integration into the global economy. But, these asset effects may differ from place to place and competitiveness can be eroded. Also, the reliance of a region on global conditions increases its economic vulnerability, where economic crises being the most common example. As a result, competitiveness at the territorial level becomes the new priority for governance and follows an entrepreneurial logic, which decreases the opportunity for public concerns and long-term strategies and makes proactive measures to shocks difficult (Eraydin, 2013). To sum up, the neoliberal agenda does not seem able to address the increasing vulnerabilities and resilience thinking can be perceived as a new planning paradigm (Eraydin & Taşan-Kok, 2013)

1.2. The notion of Resilience in Regional Science

We may encounter a shifting discourse from "planning optimism" towards preparing for the unexpected and uncertain, where the concept of resilience can provide new lenses to regional science to examine and understand the ability of a region to cope with disturbances and uncertainty (Giacometti & Teräs, 2019). However, the use of the word *resilience* has a long history and replete with diverse meanings.

According to Alexander (2013), the etymology of resilience is unknown, however, it was probably a part of standard Latin, where the most popular meaning was "to leap", among others like "to shrink or contract", "to avoid". The word passed into French in which it came to mean "to retract" or "to cancel" and then migrated into English in the sense of "retract", "return to a former position" or "desist", where Francis Bacon in 1625 he firstly makes scientific use in English of the word "resilience". Later on, the word was used as a means of expressing emotion and in the sense of the ability to withstand the effects of an earthquake, but until the 20th century the main notion of resilience was "to bounce back". Figure 1 illustrates the trend of the word resilient according to Collins Dictionary the period 1768-2008. It is obvious that after WWII, the term is getting some popularity and since the beginning of the 21st century, its recorded usage is growing at an exponential rate.

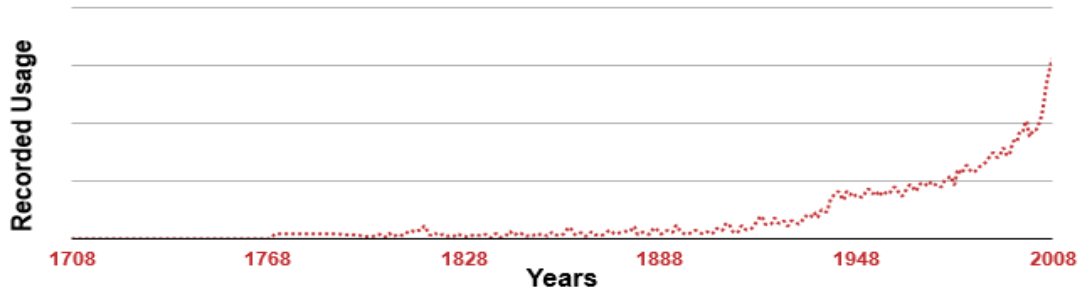


Figure 1: Trends of the word resilience the period 1768-2008. Source: Collins Dictionary

Consequently, resilience does not derive from the natural and physical sciences, as it is widely believed, but the regional literature agrees that it was adopted by Holling (1973), whose study explores the preventions of disasters and the qualitative capacity of ecological systems to absorb and accommodate future events. It is important to mention that in the 1950s psychology was already using the term resilience and in the 1980s gained greater popularity. The innovation of Holling and other ecologists is that they began to utilize and adapt management in resilience studies and the interest was around the survival of ecological systems. In other words, the term resilience transited from ecological to socio-ecological work (Alexander, 2013). Figure 2, presents the evolution of the term resilience and the most important linkages are included.

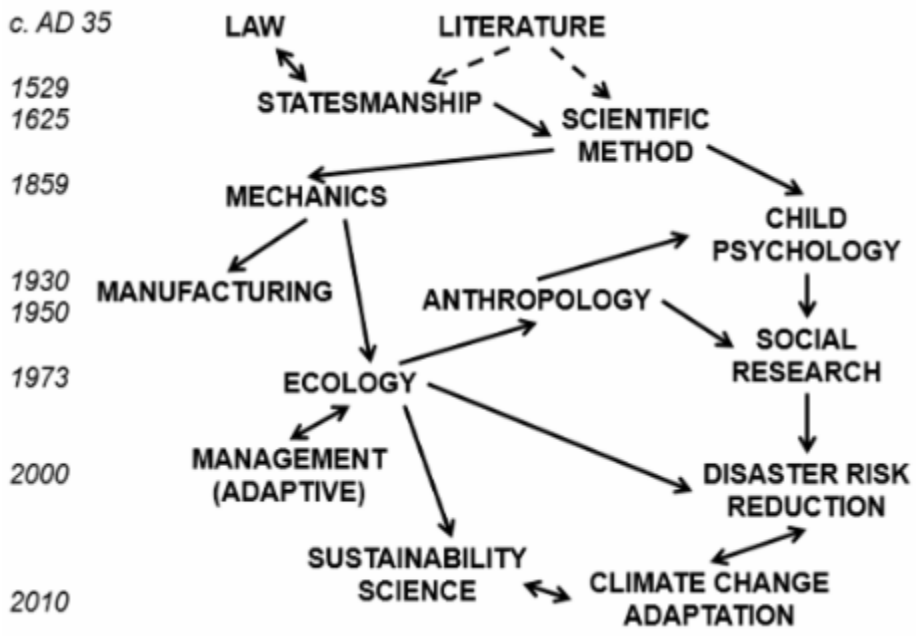


Figure 2: Schematic diagram of the evolution of the term "resilience". Source: Alexander (2013)

Since then, the literature discusses the role of resilience, panarchy, adaptive capacity and adaptive management in social-ecological systems (Müller, 2011). We have already mentioned that vulnerability is one of the key terms of resilience along with the ability of a region to recover from disturbances, but those points are not exclusively related to natural hazards and climate change. In other words, resilience has migrated into the social sciences in general; management, planning and anthropology among others (Foster, 2006).

Recently, a more systemic view is getting attention from researchers and they include social, economic and environmental aspects to encapsulate the entire production process of social well-being (Sensier et al., 2016). As a result, many authors transferred the notion of resilience to regional economic development. It seems that regional economic science has moved from the analysis of economic growth to a broader and more holistic concept: *regional economic resilience*. The catalyst for that shift was the uneven geographical impact of the 2008 economic crisis, where is this context economists tried to revive the concept of economic resilience (Oprea *et al.*, 2020). The geography of recessions, as mention by Martin (2012), is very important, because it tries to explore the way regions respond to major recessionary shock, which may be closely related to regional growth patterns and even more to the existence, persistence and evolutions of long-run regional inequalities in terms of economic prosperity.

Figure 3, illustrates the number of publications on regional resilience on the special issue in the Cambridge Journal of Regions, Economy and Society.

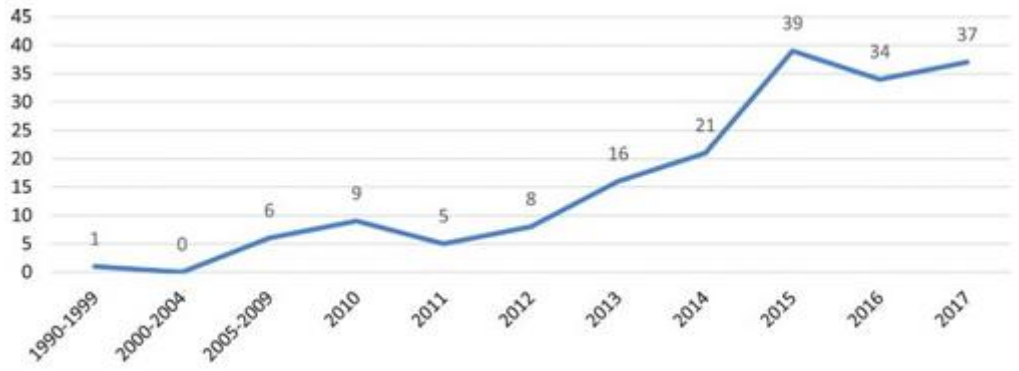


Figure 3: Timeline of publication on regional science. Source: Fröhlich & Hassink (2018)

European Committee (2017, p.2) highlights, that regions should be empowered to face globalization by strengthening territorial resilience and suggests to stop promoting "space-blind structural reforms":

> *"The designing of EU strategy to harness globalisation should be built around three main axes: a clear pro-active strategy on improving skills, knowledge, infrastructure, and thus regional competitiveness so as to help all EU territories to harness the opportunities of globalisation, a mitigation strategy including the European Globalisation Adjustment Fund (EGAF) and other social policy instruments, and a participative strategy built on democratic accountability at European, national, regional and local level to better involve citizens in EU policy making"*

So, it seems that resilience has become a very attractive concept and many researchers are reviewing the notion and its key concepts to explore its value and many others are using it to explain the regional heterogeneity effect of a shock. The literature starts to recognize that ensuring regional economic sustainable development solutions and sustainable thinking is not enough, so there is a need for resilient thinking (Tóth, 2015). Nevertheless, sustainability and resilience have a strong connection, as sustainability relates to the aspiration for persistent and equitable well-being in the long run and resilience summarizes that through its dimension of persistence and adaptability (Rizzi, et al., 2018). Meanwhile, Reid (2013), wonders whether the doctorine of sustainable development, which deploys ecological reason to argue for the need to secure the life for the biosphere, can be retrived from the grip which neoliberalism has fastened upon it, which prescribes economy as the very means of that security, and if it is to escape its appropriation how it engages with the concept of resilience.

The fact that regional resilience is a highly influential and quickly adopted concept, doesn't quarantine its profundity and asides from its answers it raises many questions (Martin, 2018). There are also critical voices, which point out that there is no distinct theory of resilience and it a fuzzy concept, and the debates over conceptual definitions, research methodology, theoretical significance and practical unity are inevitable as the concept of regional resilience is still in the infancy stages (Cho, 2014). The common ground among regional scientists is its analytical potential, but

the combination of adaptation (dynamic) with resistance (static) in one framing concept has created arguments.

Olsson et al. (2015), claim that there is a wide gap between natural and social sciences because the resilience discourse is mostly present in ecology and environmental studies, as compared with economics, political science sociology, anthropology and geography, as illustrated in Figure 4, meaning that dispite its usage potential it is not widely taken up by the 10 most influential journals.

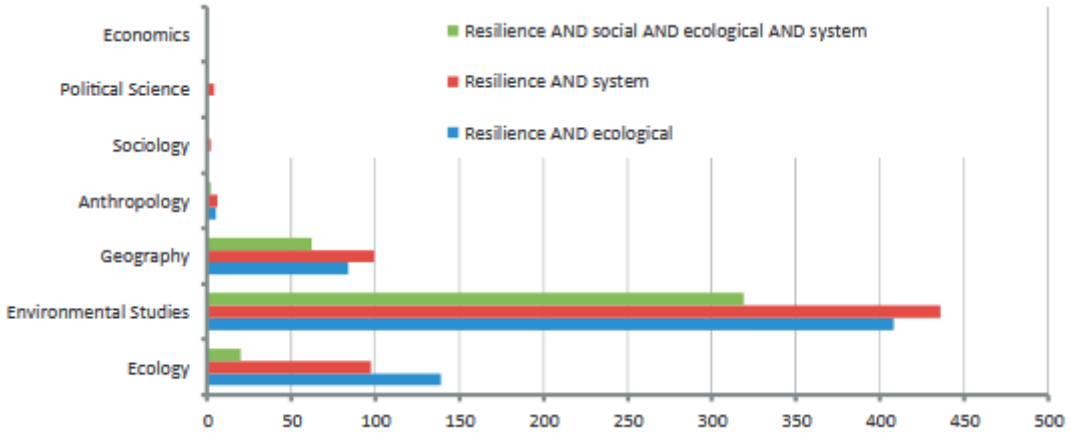


Figure 4: Number of articles, 2001–2013, containing "resilience" and (Boolean"AND") combinations of "ecological" and "system" in the 10 highest-ranked journals (ISI) in seven relevant scientific dis-ciplines or fields. Source: Olsson (2015).

Olsson et al. (2015, p.7), offer three reasons for why resilience is not easily integrated with social thinking: *"(i) the ontological presupposition to see reality as a system with equilibria, feedbacks, and thresholds; (ii) the principle of self-organization overshadowing agency, conflict, and power; and (iii) the notion of function as foundational to resilience theory while having lost its centrality in the social sciences".* They underlined that within ecology and environmental studies, resilience appears as a unifying concept, but a unification ambition in social science may result in scientific imperialism.

One point that stands out in the critical literature is that social change may be depoliticized by resilience theory (Reid, 2013). Moreover, Humbert & Joseph (2019), considered the different key ideas that interpret the notion of resilience, which are all problematised as political issues; threat, continuity, transformation, the local and most importantly the relationship between resilience and neoliberalism, resilience and

indigeneity, resilience and the local and the relationship resilience has to power inequalities within societies and between societies. They highlighted that resilience seems to fit with the Foucault's notions of "governing from a distance" and responsibilised governance of the self and pointed out Joseph' work (2018) where he states that resilience is seen as matching with contemporary neoliberal governance, particularly in terms of its individualistic approach, its shifting of responsibility onto individuals and communities and its promotion of reflexive self-governance through strategies of awareness, risk management and adaptability.

Fröhlich & Hassink (2018), aim to answer whether the concept of resilience mean different things for different authors, by performing a bibliometric analysis, containing a two step approach; citation network analysis and evaluation id the searched term is used in different discipline. Their results demonstrate that the concept of resilience is rooted in ecology and especially at Holling's (1973) paper and also they identified three groups of research on regional resilience: urban ecology and policy, economic dynamics and regional revolutionary perspectives and crisis managements and engineering. They conclude that the concept of resilience is not so stretched as they would have expected given the critique regarding the fuzziness of the term. Some other critiques mention that resilience it gives emphasis on the holistic ontology and ignores micro-level agency, it is determined endogenously and adds little to existing notions of sustainability or competiveness (Martin, 2015).

According to Müller (2011), there are at least three weaknesses when we attempt to extent the resilience concept to regions. First, there is a lack of a concise and well founded theoretical concept. Second, there is no concise understanding of the mechanisms that make some regions more resilient. Third, there is lack of operationalization, meaning that there is not a well established linkage between resilience and regional policy.

1.3. Research Questions, Goals, and Scope of this research

The focus of this study is to investigate the regional resilience across selected EU Mediterranean countries; Greece, Spain, Italy and Portugal, because they have experienced an economic and political crisis. These two parallel crises are of a different type, but they have to be examined in combination because the institutional

response of the first one has provoked the second one (Zamora-Kapoor & Coller, 2014). The austerity agenda that has been implemented, in exchange for financial assistance, has reduced the participation of the State in the economy and has increased the unemployment rate. In addition to that, the monetary policy that aimed at maintaining high euro-U.S. dollar parity affected the primary and secondary of Southern Europe. These four Southern European countries faced low economic activity, high unemployment, low disposable income, increasing inequality, rising social unrest, rising poverty, weakening public institutions and growing political dissatisfaction at a national level. However, the effects seem to have been different in the regional level.

Most of the studies focus on the national level, so the spatial impact of the crisis is relatively under-examined. The notion of resilience brought the regional level of analysis to the forefront of the empirical studies. Questions regarding how different regions have been affected by the crisis and what explains that different pattern, and which regions were the hardest hit needs further research.

This research will explore the regional economic resilience of Greece, Spain, Italy, Portugal during the crisis (2009-2015 for the former country and 2009-2013 for the rest ones, because their national economies have not exited crisis the same year) by constructing a Composite Index, which holistically measures economic resilience and seeks to highlight whether there is a common geographical pattern evident. Also, this study aims to understand whether there is a relationship between regional economic resilience and a broad range of structural factors – preconditions, which have been identified by the literature as key drivers.

In other words this study sought to answer the following research questions

I. Has the economic crisis affected or significantly changed the geographical patterns of growth and development in the four economies of the European South (Greece, Spain, Italy and Portugal)?

II. Are there structural factors that indicate a relationship between the phenomenon?

This study explores the notion of resilience in different ways. First, by analyzing regional economic resilience holistically through a Composite Indicator (including 8 variables with economic, societal, and demographic dimensions), more meaningful information about why some regions were able to resist are provided, than focusing on outcomes alone (GDP or/and employment). Second, to our best knowledge we are the first to look at regional economic resilience for the four selected countries (Greece, Spain, Italy and Portugal).

Our main conclusion is three fold. First, the regions of the four selected Southern European countries (Greece, Spain, Italy and Portugal) show a high degree of heterogeneity, as far as their resilience to the recessionary shock of 2009. Even though the most severely hit regions during the crisis are located in the southern parts of the countries and the Central-North parts indicated the highest resilience, capital regions did not appear to be resilient. Second, the comparison of the rankings of our CI between the rankings of the most two common single indicators (GDP per habitat growth rate and unemployment rate) provided different results. Third, we made a first attempt to detect the drivers of regional economic resilience through a correlation analysis and probably these four countries have something in common; Intramural R&D expenditures, Tertiary education and Employment in technology and knowledge-intensive sectors, as these variables may be important indicators for regional resilience.

The rest of this study is organized as follows: chapter 2 sets the theoretical framework and gives an overview of the related empirical literature; chapter 3 presents study area chapter 4 presents the method and the selected data, describing the variables that were used in the Composite Index and the measures of the preconditions; chapter 5 presents the results and discussion of the composite index and the correlation analysis; chapter chapter 6 presents the conclusions.

Chapter 2: The Conceptual Framework of Regional Economic Resilience

The debate around regional economic resilience includes the interpretation of resilience; what it means, the indicators of reference, how it might be assessed or measured and its implication for policy development (Cooke et al, 2011). In more detail, the literature identifies the variables that shape the system of regional economic resilience, the nature of shocks and the observable outcomes of the phenomenon. We will examine each one of the prementioned aspects of resilience in this section.

2.1. The Interpretations of Resilience

According to (Martin, 2012), there are three different interpretations of resilience. First, there is engineering resilience, which is mainly found in physical sciences and focuses on the ability of a system to return to, or resume to its equilibrium state. The faster the system returns to equilibrium the more resilient it is and it explores the system's elasticity (Cooke, et al, 2011). Although economists do not use this notion of resilience, it resembles the Neoclassical Economics assumption of self-correcting forces, where the system is always in equilibrium and if a shock intervenes to its stability, there are adjustment forces that bring the system back to equilibrium.

Second, there is ecological resilience, which can be considered as an extension of engineering resilience, as it enriches the assumption of a single equilibrium state to a multiple equilibrium system. In other words, the system may move to a different state, if the shock pushes the system beyond its elasticity threshold. According to that interpretation, the larger the shock that the system absorbs, the more resilient it is.

But, the regional economy may never be in equilibrium, so the concept of hysteresis, may provide a more suitable interpretation of resilience, that of adaptive resilience (Martin, 2012, p.14), which leads the author to highlight the following:

> *"Regional economic resilience can be viewed as having to do with the capacity of a regional economy to configure, that is adapt, its structure (firms,*

industries, technologies and institutions), so as to maintain an acceptable growth and in output employment and wealth over time"

The theoretical framework of this view of resilience derives from evolutionary geography, which in contrast to Neoclassical economics, has history and geography in its core as to give explanations for broader spatial patterns it emphasizes the importance of place-specific elements and processes (Hassink, 2010). Evolutionary thinking is an alternative and fuller conceptualization because it perceives resilience as a dynamic process and not as a short-term outcome or an unchanged situation (Dawley, et al., 2010).

After all, it appears that there are two main theories of resilience. On the one hand, there is engineering and ecological resilience which are based on adjustment thinking and assume the existence of equilibrium, either single or multiple. On the other hand, there is adaptation resilience, which is based on adaptation thinking and includes heterodox notions like path dependence, lock-in and co-evolution (Hassink, 2010). However, all of these interpretations suggest that in order to gain a full understanding of the different respond of the regions to shocks there are needed four interrelated dimensions: resistance, recovery, re-orientation and renewal (Martin, 2012).

Figure 5, illustrates the possible reactions of a regional economy to a shock. The e line represents the engineering resilience, where the system bounces back to pre-shock growth path and bcd part indicates the resilience of the system. Lines h and f represent the ecological resilience, where the system bounces forward to raised growth path or has lowered growth path of pre-shock growth rate and b to t2 time distance indicates the resilience of the system. Lines j and g, represent the adaptive resilience, either to a raised growth path and raised growth rate or lowered growth path and lower growth rate of pre-shock rate.

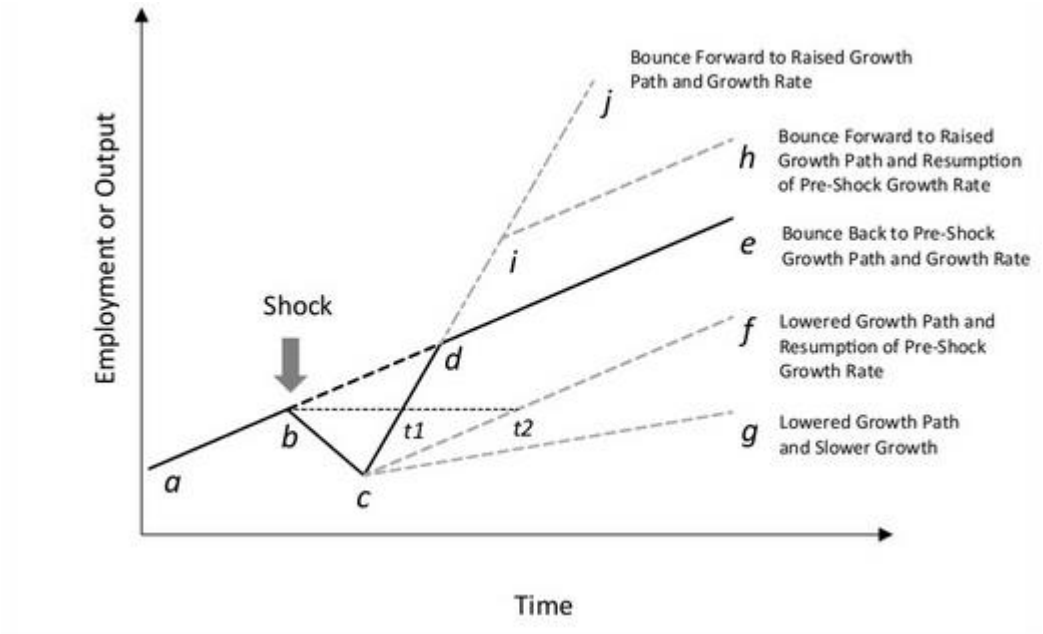


Figure 5: Stylized possible reactions of a regional economy shock. Martin, 2018

In conclusion, a region can be identified as shock-resistant, resilient, or non-resilient by examining its economic performance over a period of time. A shock-resistant region is the one whose growth path is not affected by the shock. A resilient region is the one whose post-shock growth rate is at least as high as the pre-shock growth rate. On the contrary, a non-resilient region is the one whose post-shock growth rate is lower than the pre-shock growth rate (Hill *et al.*, 2012). Figure 6, summarizes the resilience concept.

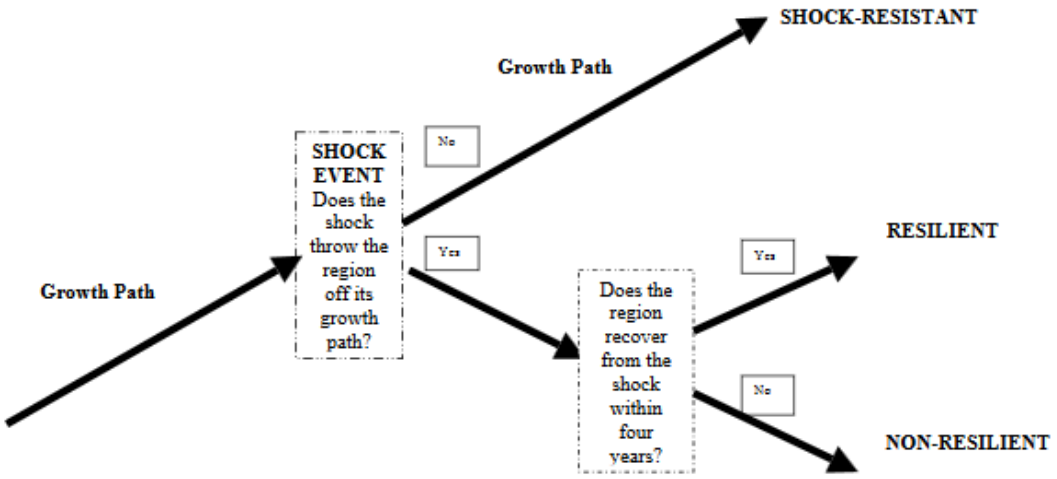


Figure 6: Resilience concept. Source: Hill et al. (2012)

2.1.1. Indicator of reference

Disturbances and shocks are varying according to their type, time and spatial scale and by including these specifications in the analysis we are referring to the "resilience to what" (Müller, 2011). First, a disturbance may be natural (earthquake), economic (recession), biomedical(diseases), social (demographics), technological (industrial accidents) and political (change of government, wars). It should be noted that disturbances are not only negative, because a regions' development strategy may be reconsidered after a major new investment or a mega-event, meaning that there is a positive side also. Second, disturbances may vary in temporal scale, as they may occur for a few minutes (traffic jam), for a few hours (floods), weeks (stock market crashes), months (epidemics), or even decades (climate change, gentrification). In addition to that, disturbances may be characterized as slow burn (de-industrialization) or system shocks (recession, disasters). Third, a disturbance may vary in spatial scale, as it can occur at the household, neighborhood, local, regional, national and global level.

2.1.2. Measuring resilience

Resilience can be measured by focusing, firstly on the ability of a region to address shocks, in other words, the ability to recover quicly or withstand or avoid shock, or secondly on the specific outcomes of these efforts, which may have weakened its ability to address future shocks. This means that regional resilience entails two dimensions; revealed resilience and resilient capacities, where the first dimension can be measured either concerning a region's own reference indicators or in comparison with other regions, while the second dimension requires a deeper understanding of the capacities and adaptive mechanism ot the region's resilience (Sensier et al, 2016).

The empirical literature is mainly using macroeconomic aggregates, as they capture the economic well-being of a state in a comprehensive manner and they facilitate the comparability between countries and regions. For a deeper understanding of long-term economic resilience, studies examine structural indices and their evolution over time. Even though qualitative measures may seem more meaningful as they provide quantified estimates of performance, time and effort (cost), a qualitative assessment is also useful to understand how bad things are (Proag, 2014). In other words, the

analysis of the mechanism of regional economic resilience and the incorporation of path-dependence and longer-term institutional concepts demand large N quantitative analysis, case studies and interviews (Hill, Wial and Wolman, 2008). In more details, the empirical literature which uses qualitative methods, like Bristow and Healy (2015), interview regional agents and give insight on territorial resilience through complex adaptive systems. Other researchers use quantitative methodologies, where the most common macroeconomic indicator for the calculation of economic resilience is GDP and employment. Oprea et al. (2020), study economic resilience by using an econometric approach with GDP being the dependent variable because they claim that it is reflecting better the economic impact of a shock.

However, using single indicators that measure outputs alone, such as GDP or and employment to examine a multidimensional phenomenon like economic resilience, may not provide meaningful information in contrast to a Composite Indicator which includes multiple dimensions. That is the reason, that in this study we compose an index with 8 variables to capture holistically the resilience of regions. It is important to mention, that this study is aware of the criticism that economic resilience indicators may confuse resilience capacities with resilience outcomes, which may lead to autocorrelation problems. More details concerning the rationale behind the composite index are provided in chapter 3.

2.2. Regional Economic Resilience and the Economic Crisis of 2009

This research aims to explore the geographical impact of the 2008 economic crisis, where local and regional economies have reacted differently to the economic shock. The empirical literature is trying to investigates what determines those different regional reactions and regional economic resilience can contribute to that understanding. EU regions indicate a highly heterogeneous pattern of resilience and empirical literature is trying to identify which regions had resilient outcomes and why some regions are more resilient than others. A proper understanding of recession impact is necessary for future regional policies.

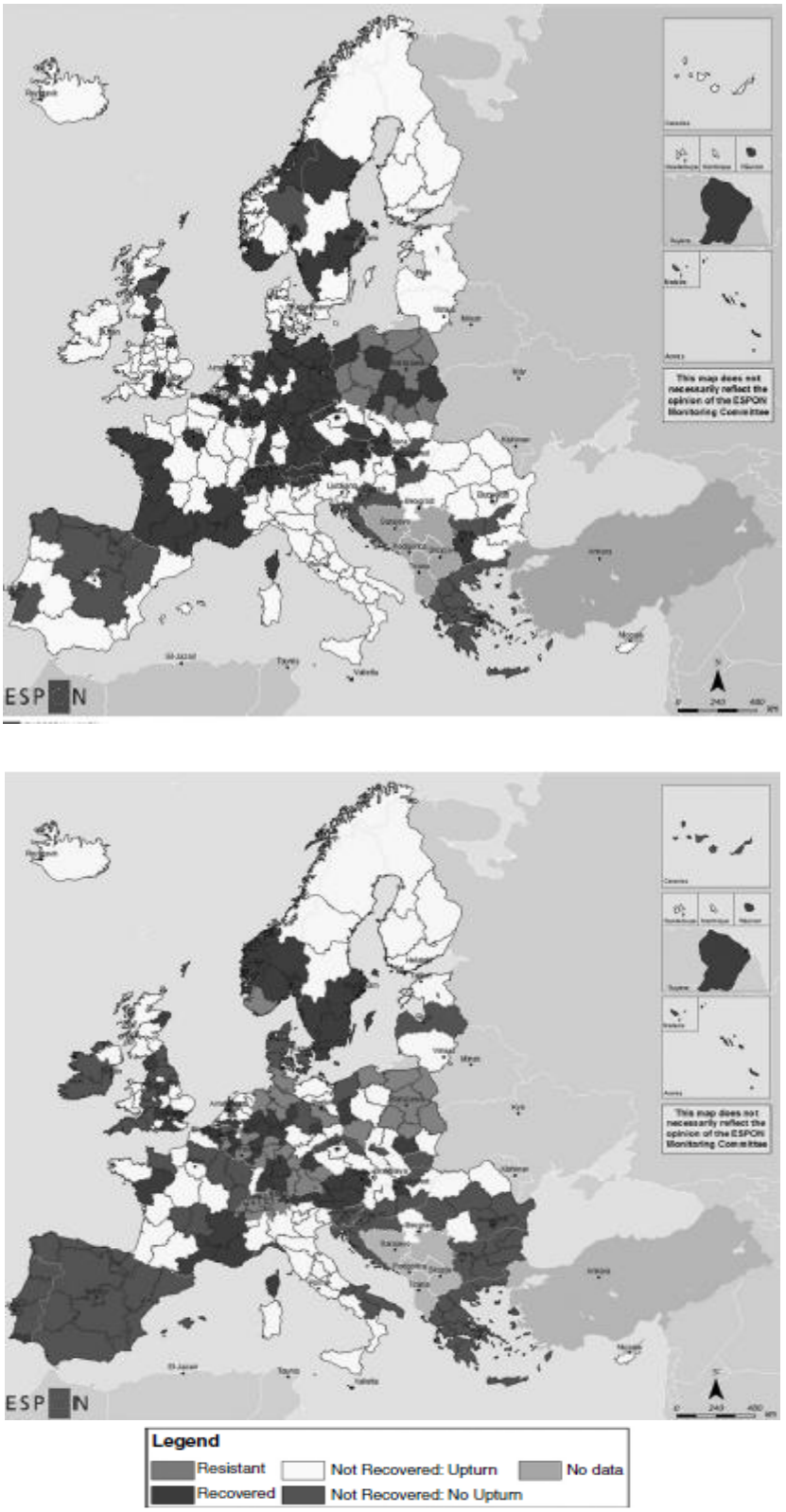
2.2.1. The origins of the 2008-09 crisis

The most popular answer to what triggered the economic crisis is the credit crunch, which emerged in July of 2007 in the USA. The credit crisis began when the USA housing bubble burst, leading to the crushing down the global financial structure in 2008, which drove the developed world into recession. The IMF (2009), published a report predicting that the recession for advanced economies will be probably much worse than the 1930's Great Recession. The shadow banking system along with the interconnection of the global financial markets resulted in a rapid exposure of the economies of individual countries and they also began to publish pessimistic economical prospects. However, the different integration of national and regional economies, into these globalised financial markets and supply chains, influenced the form of the crisis. In other words, the local conditions and the form of economic and political integration of each country and region into global financial markets and the international division of labour, had a great influence on the particular form that the crisis took (Hadjimichalis and Hudson, 2014). Specifically, Spain's real estate sector was one of the first signs of the crisis in Europe and right after the rest of Southern Europe followed. In 2010, the banking crisis was transformed into a sovereign debt crisis, due to the mutated private debts to the public sectors and the fears of the inability of these governments to repay the debt. As a result, the interest rates regarding the public debt rose, leading South Europe to a deeper crisis, as extremely austerity measures began to be implemented in Greece, Portugal and Ireland.

2.2.2. Which regions are resilient in crisis of 2009?

The effects of the crisis of 2008 were unevenly distributed, with significant variations observed between regions and nations. The analysis of Bristow & Healy (2018), revealed that at the national level only four economies (Germany, Luxembourg, Poland and Switzerand) were sock-resistant and maintained or increased the level of employment and only one economy (Poland) was able to resist a decline of it GDP, while Greece has not recovered and no upturn was experienced by 2011 both in employment (like Portugal and Spain) and GDP, though Italy has not recovered but experienced by 2011 increase in employment and GDP (like Spain and Portugal). On the regional level one-third of EU regions were shock-resilient, while two-third were

still to recover by 2011. Map 1, illustrates the Distribution of regional output resilience

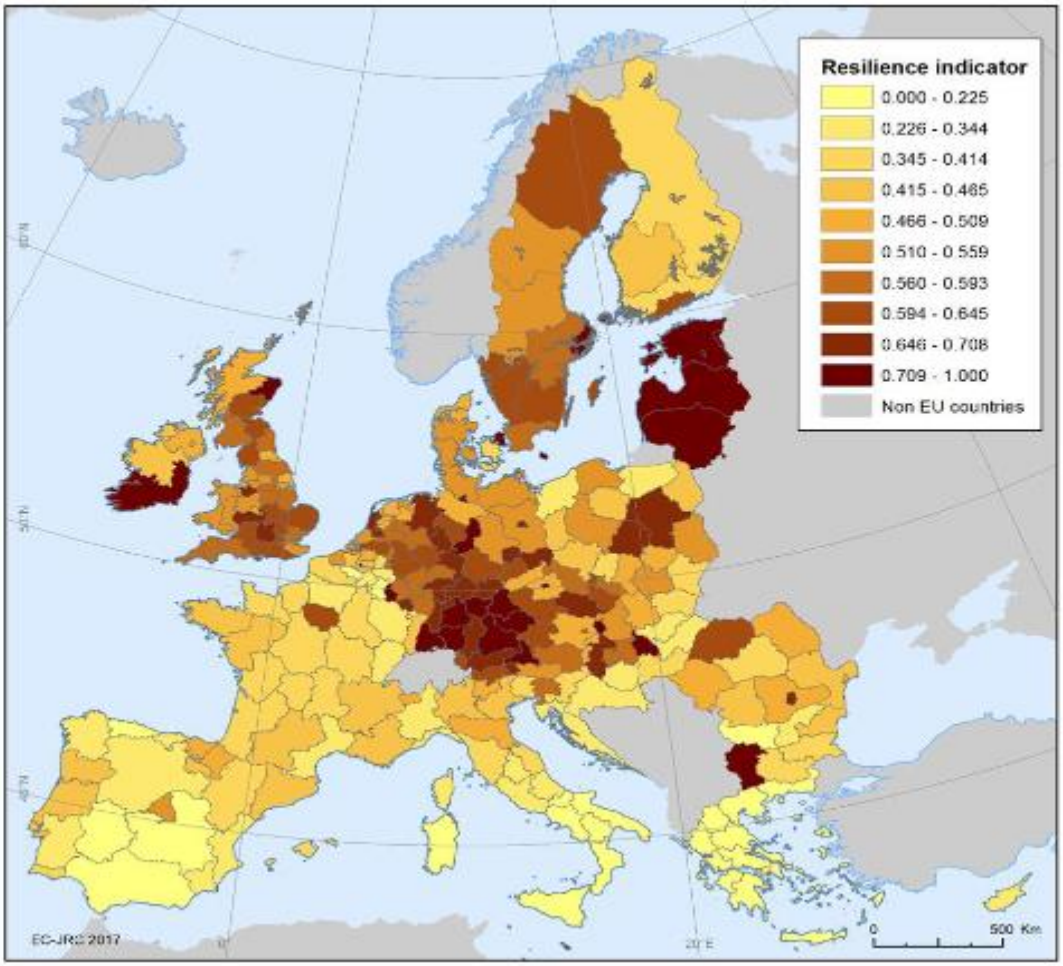


Map 1: Distribution of regional output resilience GDP (up) and employment (down) peak year 2011. Source: Bristow & Healy (2018)

Crescenzi, et al (2016), also conclude that Polish regions recorded the most positive performance during crisis (2008-2010), while Spain, Iraland, Greece and Baltic countries were among the most severely hit. Their research highlight also that the majority of countries experienced a trend of national convergence towards more similar unemployment levels, meaning that the crisis (2008-2012) had an equalizing effect with countries, something that is not observed in the regional level where a process of divergence took place across EU.

The fact that some economies reacted differently to the crisis, and the scale of analysis (NUTS1 or NUTS2) does play a role, means that a more detailed understanding is essential when examining the economic resilience of regions. Pontarollo and Serpieri (2020)(a), observe that nations have common trends. More specifically, the selected indicators of Mediterranean countries are characterized by slow growth. On the contrary, the same indicators for Germany and Northern countries are characterized by high growth. In other words, there are resilient capacities observable. Also, Italy, Spain and Belgium have a north-south divide. While pre-crisis regional development trajectories are highly heterogeneous in terms of economic growth and employment after the economic crisis emerges a center-periphery spatial pattern, which goes beyond the simple North-South divide as it is more relevant a divide between old-new Europe (Crescenzi, et al., 2016). The spatial distribution is also evident in the analysis of Giannakis & Bruggeman (2017), where the researchers draw two main conclusions. First, the national patterns are influencing the regional geography of resilience and the continental southern periphery is once again indicated as non-resilient. Second, there is a highly heterogeneous pattern of resilience within countries. However, regardless of which spatial regime a region belongs, spatial effects are important for any region, meaning that location matters (Annoni, et al., 2019).

Map 2 presents the spatial distribution of the Regional Resilience Indicator by decile, which has been normalized and varies between 0 (smaller values – lighter color) and 1 (higher values – darker color). This composite Regional Resilient Indicator incorporates two dimensions, one measuring the intrinsic capacity of a region (slow-burn) and the other the reaction capacity to an unexpected shock (shock wave).



Map 2: Regional Resilience Indicator over the period 2000-2015 by NUTS 2. Source: Pontarollo and Serpieri (2020)(a)

The research of Pontarollo and Serpieri (2020)(a), highlighted that capital metro regions, in Germany, Great Britain, Belgium, Hungary and Austria, have higher resilience than the surrounding regions agreeing with Capello, et al., (2014), where after using a scenario approach and a new version of macroeconometric regional growth forecasting model (MASST), found that cities are a source of resilience. Rural regions which are close to big cities have shown more resilience than the less connected regions, meaning that urban centers can foster resilience in their surrounding areas (ESPON, 2014). However, Artelaris (2017), after studying Greece at NUTS2 level and incorporating dimensions of well-being, concludes that less urbanized and developed regions have a better performance during the crisis. So, regions that host significant cities seemed to be more exposed to the crisis. The different results can be imputed to the analysis technique, as Artelaris (2017) takes into account the societal dimension.

Alessi et al. (2020), used the European Commission Joint Research Centre (JRC) conceptual framework, where society is resilient if it retains the ability to deliver social well-being in a sustainable way, so that it is not compromising the future generations. In other words, this research adopts a multidimensional approach and emphasis the notion of societal resilience. The main results of the empirical analysis show that European countries have substantial differences between countries in each of the resilient capacities considered, with Cyprus, Greece and Italy being the bad performers. However, the indicator of reference (Short-term, Medium-term and Long-term resilience) influences the resilience performance. Also, the relative resilience to other countries does not imply resilience in absolute terms as medium term and bound forward rakings differ. So, there is a dichotomy between recovery and renewal (Pontarollo and Serpieri, 2020b). Finally, resilient countries tend to perform better in all parts and dimensions of the system, meaning that no single characteristic can explain resilience alone. This research is on the country level and extending the analysis at the regional level is major ongoing research.

2.3. Why some regions are more resilient than others?

The second strain of the puzzle refers to the drivers of regional resilience. (Alessi et al., 2020b), having tested more than 200 characteristics that are associated with resilience, conclude that the stronger determinants for regional economic resilience on the absorption phase are high government expenditures on social protection, on the medium-run performance is the political stability and on the bounce forward phase is the favorable business environment. However, according to the selection criteria, the used method and theoretical framework, researchers reach to different conclusion. It is evident from the following table, which presents the basic drivers as have been examined by the literature (Rizzi, et al., 2018), there is no agreement on the key factor that explains the patchwork of resilient outcomes.

Pillar	Theme	Pillar	Theme
Economic dimension		*Environmental dimension*	
Resources availability (+)	Size of local economy	Resources Availability (+)	Biodiversity
	Accessibility to credit		Wood Land and Green Areas
	Human capital		Multifunctional agriculture
	Territorial capital		
Vulnerability (−)	Openness of the economy	Vulnerability (−)	Climate change and natural hazards
	Dependence on imports and export		Ecosystem degradation
	Production specialization		
	Enterprises state of difficulty		Built-up area and Landscape fragmentation
Strategic adaptation (+)	Creativity and Innovation		Anthropic pressure
	Collective learning		Air, Soil, Water Pollution
	Strategic Planning		
Social dimension		Strategic adaptation (+)	Sustainable Production and Consumption
Resources Availability (+)	Health and Social Infrastructures		Protected areas
	Social capital		Renewable Energ
	Community Culture		Separate Waste collection
Vulnerability (−)	Demographic dependency		
	Unemployment		
	Inequality, poverty		
	Crime		
Strategic adaptation (+)	Collective knowledge, skills coping		
	Welfare policies		
	Social Innovation		

Table 1: Basic drivers of regional economic resilience. Source Rizzi, et al. (2018)

It is obvious that economic, social and environmental dimensions seem to be responsible for the resilience of a region. Capello, et al. (2014), support that the type of city, not only its size, is responsible for how regions react to the crisis, indicating that agglomeration economies in combination with the quality of activities and the productions factors, give greater economic resilience to the cities and to the regions that host them. Brakman, Garretsen and Van Marrewijk (2015), draw similar conclusions, as they claim that the level of urbanization and the share of output in medium and high tech industries have a positive relationship with regional resilience because a larger share of a population in a commuting area has positive implications for the initial impact of the crisis and negative implications on unemployment. In other words, the spatial allocation of the population is relevant to economic outcomes, so economic geography and spatial economic provide the necessary tools to incorporate with those findings.

Giannakis and Bruggeman (2017), find that regions with a larger share of workforce with upper secondary and tertiary education are more resistant to the impact of the

shock than regions with poor educational attainment, because education improves human capital and leads to increased productivity and an innovation-prone environment. Education is also important because it can spur economic outcomes in neighboring regions, due to the existence of spillover effects (Annoni et al., 2019). Once again, spatial econometrics can probably analyze more efficient the main determinants of resilience, because they take into consideration the spatial interactions among regions.

So far it has been underlined that the rural-urban divide, the population density and the human capital are the most mentioned determinants of regional economic resilience. Another factor that underpins regional economic resilience is sectoral composition, as it can explain a large part of the differences in the severity of the crisis. The real estate sector declined dramatically after the crisis, affecting negatively the construction sector, where the biggest reduction was evident in Greece (European Commission, 2013). Also, the manufacturing sector appears to be more sensitive to business cycles than service sectors (Groot, et al., 2011), while it seems that there is a positive relationship between manufacturing specialization and better economic performance (Milio et al., 2014). Studies suggest that strong concentrations of construction and agricultural activity are associated with less resilient regions, while service-based activities are associated with more resilient regions, but the effect of the manufacturing industry is less clear (Bristow, G., & Healy, 2018). Petrakos & Psycharis (2016), conclude that less advanced rural which are partly subsidized agriculture were not as strongly affected by the crisis as the more developed regions which were strongly affected by the decline of the industry and service. The above suggests that sectors may have a relationship with the region's resilience.

European Commission highlighted in its proposal for the programming budget for the EU the importance of innovation in building long-term recovery and resilience (European Commission, 2021). The study of Bristow and Healy (2018 b) explores the relationship between innovation and regional resilience, under the theoretical framework of Schumpeter, where technological innovation is one of the key drivers of adaptive processes and thus resilience. They found that even there is no simple relationship between regions with strong innovation performance and their observed resilience, however the most resilient regions were positively associated with a

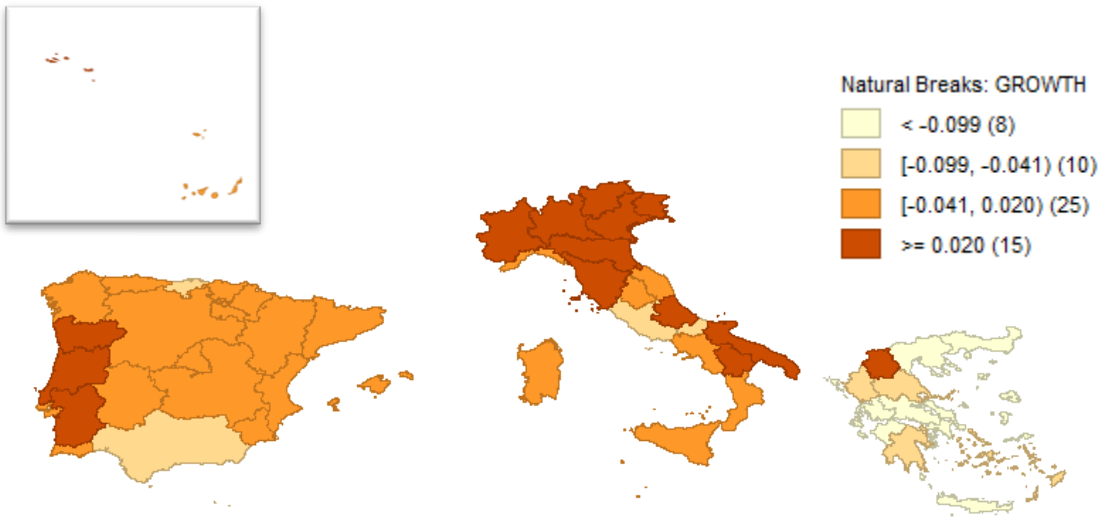
stronger level of innovation. Filippetti et al. (2020) established a theoretical link between resilience and innovation, where they perceived innovation as the result of long-term process which provides regions with a stock of capabilities, and found that less innovative regions were outperformed by more innovative ones in term of employment. In other words, literature suggests that innovation does increase resilience.

Chapter 3: Case study

3.1. Southern Europe during the crisis of 2009: Greece, Spain, Italy and Portugal

The financial crisis has turned into a deep a prolonged economic and social crisis in southern Europe, as it documents a steadily rising large section of low and middle-income groups who fall into the ranks of the "new poor" (Forster et al., 2017), rising poverty (Keaveny, 2016) and rising unemployment (Guerrieri, 2013). In Spain, public deficit and public debt were comparatively at low levels in 2007, but after the eruption of the crisis, the levels of private indebtedness were as large as twice the national GDP. The construction bubble burst and intensified the construction, putting an end to the economic and employment growth which has started in the 2000s. In Italy and Portugal, the crisis triggered the public debt and deficit, while in Greece the vulnerability of the economy due to high levels of borrowing and current account deficits, resulted in the greatest downfall. Although Italy and Spain avoided the austerity path and only Greece and Portugal signed the "Memoranda of Understanding", the whole southern European continent has been hit the hardest and longest by the 2008 economic crisis.

Map 3, illustrates the growth rate of the four selected countries for the period 2009-2015. Greek growth rates are mostly negative except Dytiki Makedonia. This indicates that the rest 3 countries had recovered while Greece was still in recession. In order to correct that different timing of exiting crisis among national countries, Greece is examined for the period 2009-2015, while Spain, Italy and Portugal are examined for the period 2009-2013.



Map 3: Growth rates of Greece, Spain, Italy and Portugal the period 2009-2015. Source: Eurostat -Own creation.

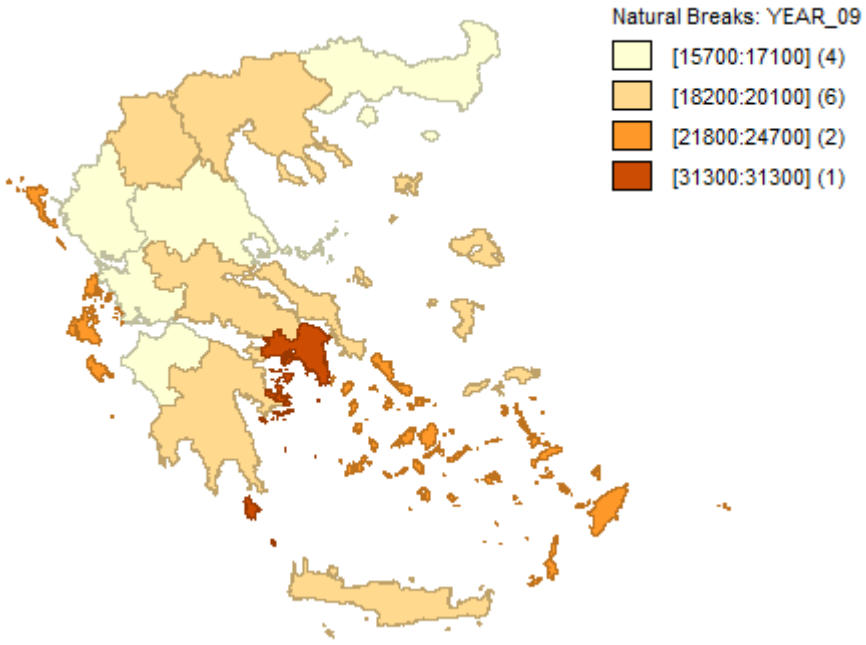
The following sections present the regional economies of Greece, Spain, Italy and Portugal.

3.1.1. Greece

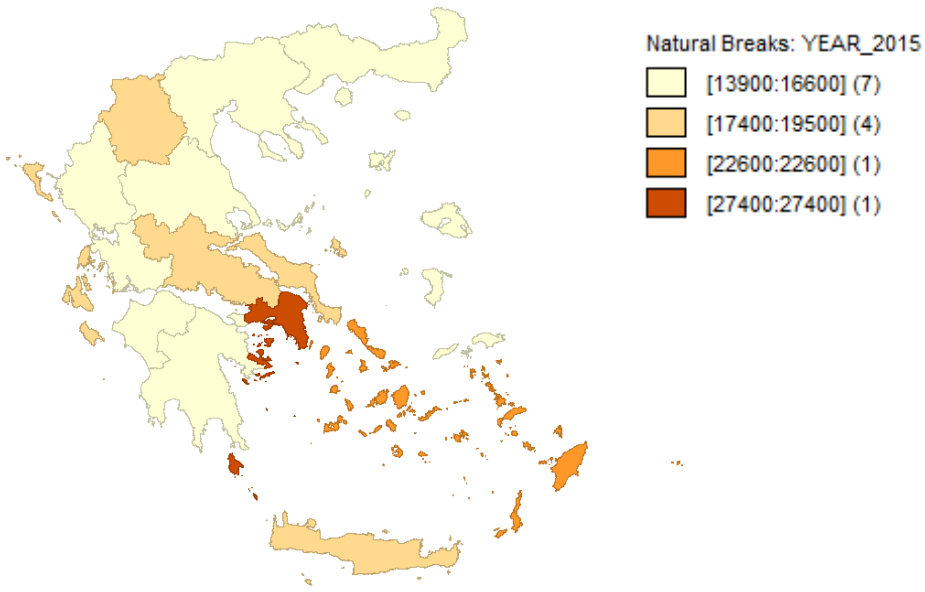
The structure of the Greek economy is characterized by its traditional structure, with high levels of agriculture employment, low levels of heavy industry and business services and domination of small and family-owned businesses (Monastiriotis, 2008). Attica and Kentriki Makedonia include the two metropolitan cities, which are responsible for 49% and 14% of the total GDP (2009) and host 36% and 17% of the total population (2009). Most of the Greek regions are specialized in agriculture (Western Greece, Epirus, Thessaly, Center Greece, Peloponnese and Crete), while few can be characterized as industrial clusters (Central Western Makedonia and Attica) and only Attica has a weak business service sector and South Aigaio tourism.

The following map (4&5) illustrate the spatial "model" of Greek development. In 2009, Attica's Regional Domestic Product per habitat (RDPperhab) was 31.300 euros, being the only region in the highest category. The second category, which is almost 10.000 euros les than the first one, contains only two regions (Ionian Islands and South Aigaio). The third category contains 6 regions which have RDPperhab between 18.200 and 20.100 euros. The last category contains 4 regions which have RDPperhab between 15.700 and 17.100 euros. The crisis has not altered the spatial pattern of

development, because Attica remains the wealthiest region, even though it seems to suffer the most negative impact of the economic crisis. However, most of the regions are now present in the last category, with RDPperhab between 13.300 and 16.600 euros. In other words, there is an evident reduction of RDPperhab in all regions, but the dominance of Attica at national level is still persistent.



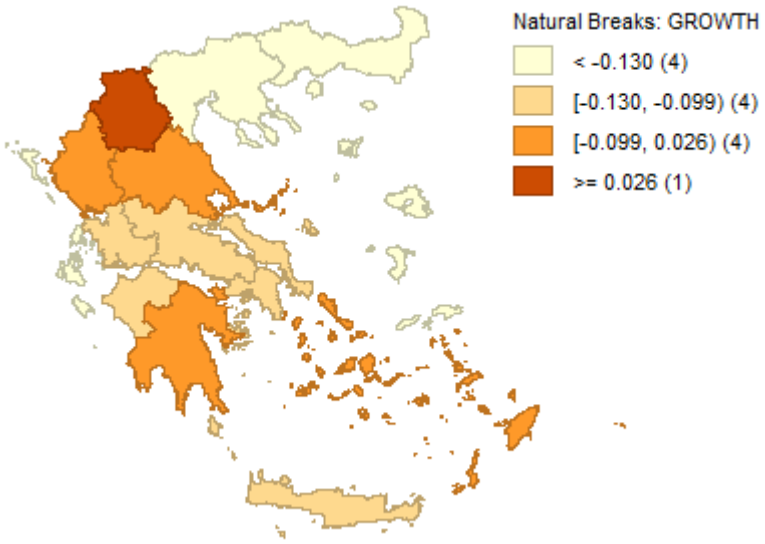
Map 4: Regional Domestic Product (per hab) in Greece, year 2009. Source: Eurostat - Own creation.



Map 5: Regional Domestic Product (per hab) in Greece, year 2015. Own creation.

Psycharis, et al. (2012), conclude that after assessing the resilience and development of Greek regions the spatial pattern remains rather unaltered because the pre-crisis poles of development seem to hold their top positions. Artelaris (2021) investigated regional inequality in Greece during 1981-2015 using spatial research methods in NUTS 3 level and found that since 2000 interregional inequality is the dominant source of inequality in Greek regions and not intraregional inequality. In other words, the more developed regions in terms of income, includes all the spatial entities of Attiki along its main satellite region, while the poorest regions are generally geographically clustered at the periphery.

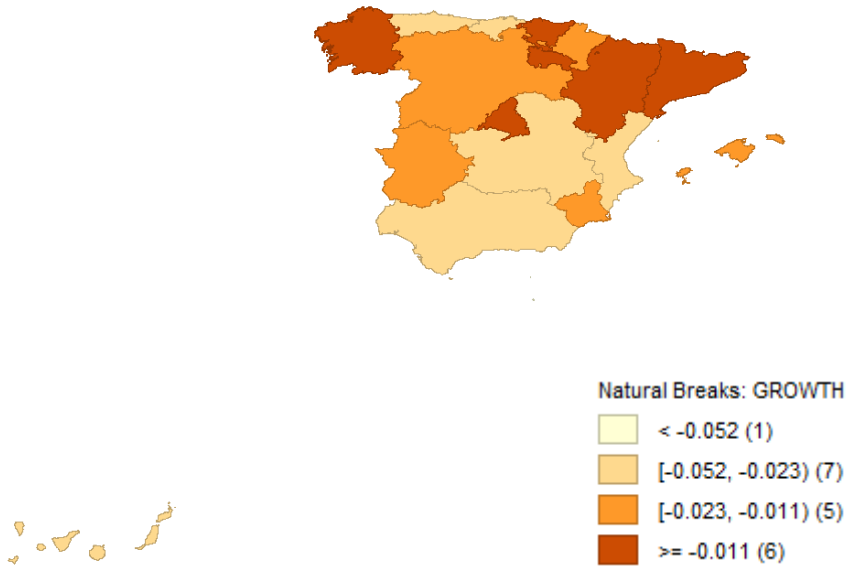
What is important though is the regional performance during crisis that can be obtained by looking at the growth rate. Map 6 illustrates the growth rate from 2009 to 2015, where only Dytiki Makedonia retained a modest positive growth rate (0,026), while the rest of the regions witnessed a negative growth rate.



Map 6: Growth rate in Greece, period 2009-2015. Source: Eurostat - Own creation.

3.1.2. Spain

The real GDP growth profile of the cross section of Spanish regions in the past three decades has been relatively similar to the aggregate of the country, even though some dispersion is apparent across regions. Although studies comparing Spain with other EU countries show that Spain's economy presents quite a high within-country homogeneity despite its large size (Gómez-Loscos, et al., 2020), when focusing on its structural issues appear four broad region groups. First, the richest regions are Madrid and the Basque Country, next are the regions in the North-East (Navarre, La Rioja, Aragon and Catalonia), the third cluster includes regions include regions in the North-West and the Valencian Community and Murcia, and the regions in the South (Andalusia, Extremadura and Castilla-La Mancha) are the poorest ones (Artola, et al., 2018). The above pattern it is obvious in map 7, which indicates the growth rates from 2009 to 2013.



Map 7: Growth rate of Spain, period 2009-2013. Source: Eurostat - Own calculation.

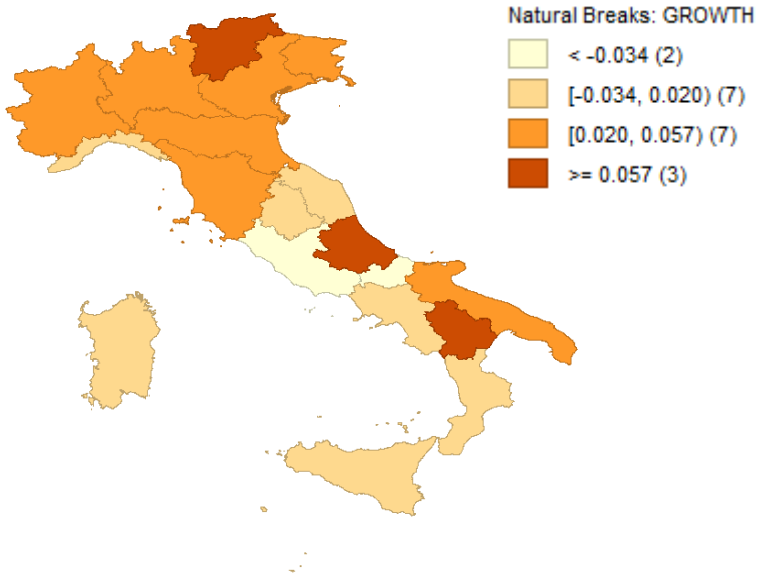
3.1.3. Italy

The North-South divide, especially the long-lasting divide between the Mezzogiorno and Central-Northern Italy, has characterized the socioeconomic landscape of Italy since 1900s and is probably the most known and most persistent characteristic of the Italian economic geography (Musolino, 2018). Northern Italy's GDP per capita is almost double that of the South, while economic activity is geographically concentrated in few regions and about 40 percent of the national GDP growth was driven by three regions during 2000–2007 (IMF, 2011). According to the Bank of Italy (2019), the gap between the South and the rest of the country remains wide, as between 2007 and 2018 GDP per capita fell by about 7 percentage points in the Centre and North and by 10 points in the South.

Central-Northern Italy and the Mezzogiorno are not two internally homogeneous macro-areas, two 'blocks' racing against each other, as both within Central-Northern Italy and within the Mezzogiorno, the level and dynamism of economic development differs (Musolino, 2018). In Central-Northern Italy, some areas have been the core of Italian economic development; the case of the industrial triangle (Turin – Milan – Genova) and the case of 'Third Italy' (i.e. 'Terza Italia'), an area roughly covering Veneto, Friuli, East Lombardy, Emilia-Romagna, Northern Tuscany and Marche,

characterised since the end of 1960s by the emergence of the well-known 'industrial district model' which shifted Italian economy south-eastward. Even though, the spatial patterns in the economy of the Mezzogiorno have appeared to be less changeable in recent decades, the economic growth rates are not evenly distributed. Calabria, Campania, and Sicily are the regions that historically have always had the lowest level of development and the slowest rates of growth.

The 2008 crisis increased regional disparities further, as the recovery was much weaker in Southern regions, although some regions showed GDP growth levels above average, as is illustrated in map 8. The period 2009-2013 almost half of Italy's regions witnessed negative growth rates and the vast majority of them are located at the South part of the country, which experienced the lowest employment gains in 2004-2007, but suffered the highest employment losses during the crisis (IMF, 2011).



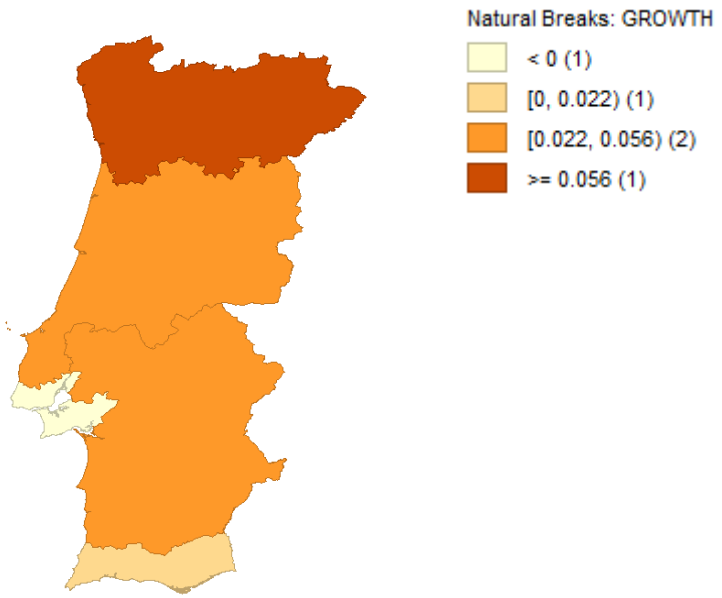
Map 8: Growth rate of Italy, period 2009-2013. Source: Eurostat - Own calculation.

3.1.4. Portugal

Portugal is not a homogenous economy as it has for a long time faced an issue of regionalisation along with an increasing urban-rural divide (Rodrigues, 2019). In more details, the majority of the population and wealth tends to be concentrated in coastal regions - along the Lisbon-Porto axis, as well as the Algarve on the southern coast- which has caused the peripheralisation of inland regions. Even though Portugal

has an issue with urban-rural disparities, this doesn't mean that the rural regions of Portugal should be seen as homogenous neither, because they have very diverse and experience very different economic realities (Hennebry, 2020).

Portugal's economy was hard hit by the economic crisis and due to the difficulties with rising public deficit and debt, in 2011 applied for financial assistance and obtained a bailout worth EUR 78 billion from the EU and the International Monetary Fund (IMF). Map 9, illustrates the growth rate during 2009-2013 in Portuguese regions.



Map 9: Growth rate of Portugal, period 2009-2013. Source: Eurostat - Own calculation.

Chapter 4: Methods

The purpose of this chapter is to introduce the research method for this empirical study regarding the geographical pattern of the economic crisis 2009-2015 in Southern Europe (Greece, Spain, Italy and Portugal) at the NUTS2 level. In order to have a deeper understanding of the crisis footprint, we construct a Composite Indicator to track signals of change in the economy from a short-term perspective.

4.1. Methods of Composite Indicator (CI)

A composite indicator is appropriate when the goal of the research is to compare economic outcomes between countries (or regions in our case). The main advantages of using composite indicators are that the indicators provide the summary of complex and multi-dimensional concepts, it becomes easier to compare regions performance over a period of time and it is possible to make predictions for the present economic development in a convenient way (OECD, 2008). However, the process of constructing a composite indicator has challenges and high levels of competence in statistics, while the choices of components and the measurement process may be largely subjective. Nardo et al. (2005) point out that despite their controversy, composite indicators should not be seen as a goal per se, but as the starting point for initiating discussion and attracting public interest and concern.

A composite indicator is a mathematical combination (or aggregation) of a set of indicators and is constructed by compiling individual indicators into a single index, based on an underlying model of the multi-dimensional concept that is being measured. In other words, the logic behind the selected indicators is a theoretical framework, which reflects the dimensions or structure of the phenomenon being measured.

The technical definition of a composite index is

$$I_c = \sum_{j=1}^{m} W_j X_{cj} \qquad [1]$$

Where I_c, is a weighted (linear) aggregation of a number of variables, where w_j is a weight, with $0 \leq w_j \leq 1$ and $\sum w_j = 1$; X_{cj} is the variable of country c in dimension j; and, for any country c the number of policy variables are equal to j=1,...,m.

WHO (2002) mentions that indicators classification varies according to whether they are concerned with impacts, process or outcomes or whether they are quantitative (involving numerical measurements) or qualitative (for example involving people's opinions or perceptions). Primarily descriptive indicators can be useful when the aim is to obtain baseline information on the phenomenon under investigation, which will lead to the formulation of policy options and plans and asses trends Indicators are distinct from their primary data which they are based, because they convert the data into information which is helping to shed light on a phenomenon, at the global, national, local, neighborhood or sectoral level.

The reason for constructing a composite indicator (CI from now on) is mainly to fill gaps in existing statistics and highlight underlying economic phenomena. However, the theoretical framework must be clearly defined on what it measures and its sub-components. To construct a leading indicator for economic resilience, it is important to define what the scope of the measure is.

Despite their extensive use, CIs have received critical arguments regarding their conceptual and methodological measurement approach (Nardo et al., 2005) Despite their easy interpretation, as they summarize complex or multi-dimensional phenomena, they may send misleading policy messages if their construction is poorly implemented or their message is poorly interpreted. Also, there is a possibility to draw over-simplistic conclusions. Another critique is that if the various stages of the construction indexing process are not transparent and are not based on sound statistical or conceptual principles, they may be built to support a desired policy, in other words, CI's may lend themselves to instrumental use. Moreover, if some dimensions of the phenomenon are not well pointed out and represented, then there is an increased difficulty in identifying the proper policy action, or even worst the wrong policies may be implemented.

4.2. A Decalogue for constructing a CI

Integrating individual indicators in a manner that accurately reflects economic reality is very difficult because the researcher should firstly have an understanding and a definition of what it is that is being measured. The proper conceptual and methodological choices to construct a CI are presumed to be an art and not just

science. The building of a CI is a 10-step process and the rest of this section presents the decision making process during these steps. The starting point in constructing a CI is the theoretical framework (step 1), which according to OECD (2008, p.22):

> *"Provides the basis for the selection and combination of variables into a meaningful composite indicator under a fitness-for-purpose principle"*

The theoretical framework guides the choice of indicators, but the data selection (step 2) is quite a subjective process. In other words, data selection is based on the relevance, analytical soundness, timeliness, accessibility and other features of the variables. so, data quality relates to the strengths and limitations of CI.

Missing regional data (step 3) is the biggest trouble for regional scientist, as many variables are not measured at smaller scale than national, or the data is not up to date. In general, missing data are present in almost all composite indicators and there are three approaches for dealing with it; case deletion, single imputation or multiple imputations (Nardo et al., 2005). When data is missing for a country or a region, then either the observation or the indicator is deleted from the analysis. The main disadvantage of deletion is that it ignores possible dimensions of the indicator. The other two approaches see the missing data as part of the analysis and therefore try to impute values through either Single Imputation (e.g. Mean/Median/Mode substitution, Regression Imputation, Expectation-Maximisation Imputation, etc.) or Multiple Imputation (e.g. Markov Chain Monte Carlo algorithm).

Multivariate analysis (step 4) is used to check the underling the structure of the data.

After the database is constructed and there are no longer missing values, the indicators are not measured in the same units, thus the indicators are transformed and converted into either percentage or per 100.000 units. The next step is to normalize (step 5) the indicators between the range 0-100 through the following formula (Farrugia, 2007)

$$XS_{ij} = \frac{(X_{ij} - MinX_j)}{(MaxX_j - MinX_j)} \qquad [2]$$

XS_{ij} is the value of the normalised observation for country i of component j, Xij is the actual value of the same observation, $MinX_j$ and $MaxX_j$ are the minimum and maximum values of the same observations for component j. Yet, if a high distortion

between minimum and maximum is evitable, the index values are calculated by dividing the actual values of the particular variable by its maximum value only.

This is the conventional linear scaling transformation (LST) method, where aims to point out the relation among the values of the certain variable, how far apart they are and in what direction they lie relative to each other (Booysen, 2002). This method aids to scale the variables from 0 to 100.

The second instance in composite indexing is converting them to a common scale with a mean of zero and standard deviations as the following formula indicates

$$XS_{ij} = \frac{(X_{ij} - \bar{X}_{ij})}{(\sigma)} \qquad [3]$$

Where $\bar{X}_{ij}$ is the average and σ_j is the observation across regions.

In more details, raw scores are first adjusted for directionality by multiplying each with either +1 or –1, then these raw scores are transformed into standard scores, and z scores use. But, t scores are also popular for indexing purposes, because they have a mean of zero and a standard deviation of one.

There are also two more options for scaling/normalizing CI. First, there is the option of transforming variables into ordinal response scales and second there the option of not scaling and this last option is viable only when the variables are already scaled, but in most cases, unscaled variables are not useful, because aggregation cannot be performed (Booysen, 2002).

Another step in constructing a CI is weighting (step 6), where is the process of assigning importance ("weight") to each variable in an index's conceptual framework to facilitate aggregation (Skeith & Gallagher, 2019). The most important point that we need to have in mind is that weights usually have an important impact on the results of the composite indicator especially whenever higher weight is assigned to indicators on which some countries excel or fail. This is why weighting models need to be made explicit and transparent.

OECD (2003) claims that the common practice in attaching weights is to give greater weights to components that are considered to be more significant in the context of the

CI. Munda & Nardo (2005), highlight that weights have always the meaning of trade off ratio because the substitution rates of the weighted linear aggregation equal the weights of the variables up to a multiplicative coefficient, which implies the possibility of offsetting a disadvantage on some variables by a sufficiently large advantage on another variable.

However, the decision on the weighting model is central to the construction of a composite index and there are two main classification methods; equal and unequal weighting (Lindén, 2018). The first classification is self-explanatory, as it implies that all indicators are assigned with the same weight a priori, either because all indicators are considered equally important or because there is not an adequate statistical knowledge or theoretical framework to justify the different weighting. The second classification, unequal weighting implies that different weights may be assigned to indicators to reflect their significance, statistical adequacy, cyclical conformity, speed of available data, etc, while the available techniques are weighting schemes based on statistical models (factor analysis, data envelopment analysis, unobserved components models), or on participatory methods (budget allocation, analytic hierarchy processes). The statistical quality of the data could also be reflected by weights, thus higher weights could be assigned to statistically reliable data (data with low percentages of missing values, large coverage, sound values). In other words, sub-indicators that are easy to measure and readily available are rewarded, while the problematic indicators are punished. Indicators could also be weighted based on experts' opinions, who know policy priorities and theoretical backgrounds, to reflect the multiplicity of stakeholders' viewpoints (Nardo et al., 2005).

Sensitivity analysis (step 7) intends to ease down the controversy around CIs. The most frequent argument surrounding CIs is that they are too subjective, so the message can be heavily influenced. as a result, a combination of uncertainly and sensitivity analysis can help to gauge the robustness of the CI. In other words, sensitivity analysis increases the transparency of the CI.

Back to data (step 8) is an important step and is needed to reveal the main drivers for an overall good or bad performance. This step is responsible for exploring if the CI results are overly dominated by few indicator results. Also, the correlation between other relevant measures should be made to explore links to other indicators (step 9).

The last step concern the visualization of the results (step 10) and present the CI results in a clear and accurate manner.

4.3. Evaluation of our Regional Economic Resilience Indicator

Booysen (2002) addressed 7 dimensions that present a useful framework for evaluating a developmental indicator and we adapted them to the "regional economic resilience – RER framework" and we provide the answers below.

I. Content: *What aspects or facets of regional economic resilience does the indicator measure?*

As it has been mentioned by Artelaris (2017), most of the studies investigate the economic dimension of economic crisis, while the social dimension is under investigated. In addition to that, regional resilience is usually measured by macroeconomic indicators, which measure region's performance with output and employment rates (Giannakis & Bruggeman, 2017), while other dimensions are not included. In order to fill that gap, our CI measures the economical, societal, educational and demographical aspect of RER. In other words, our CI is based on Sen (1980) and his theory of capability approach, where capabilities go beyond the notion of equal distribution and give emphasis on the quality of life

II. Technique and method: *Does the indicator measure RER in a quantitative (qualitative), objective (subjective), cardinal (ordinal), or uni-dimensional (multi dimensional) manner?*

Our indicator measures RER in a quantitative, subjective, cardinal and multidimensional manner. Pontarollo & Serpieri (2018) perform a Principal Component Analysis, as a mean to reduce dimensionality but despite the complexity of empirical techniques, composite indexing remains a subjective exercise. Although our variable selection is based on the theoretical and empirical literature, the proxies for each dimension were chosen according to the availability of the data and to our judgment on what variable seems most suitable for a proxy. In other words, another researcher could have chosen different variables, or even include other dimensions

III. Comparative application: *Does the indicator compare the level of RER (a) across space ('cross-section') or time ('time-series'), and (b) in an absolute or relative manner?*

Our aim is to make comparisons between Greece, Spain, Italy and Portugal performance during crisis, so the indicator compares the level of RER across space. In other words, we perform a cross-sectional empirical analysis of the crisis phenomenon which is useful in identifying shared components in RER. We made 4 CI for each country separately.

IV. Focus: *Does the indicator measure RER in terms of input ('means') or output ('ends')?*

Literature hasn't agreed on that also, as some claim that CI should include either input (means) or output (ends) variables, while other studies claim that CI should include only outputs and exclude negative indices (Booysen, 2002). We followed the paradigm of UNDP's Human Development Index (HDI), which includes both means and ends.

V. Clarity and simplicity: *How clear and simple is the indicator in its content, purpose, method, comparative application and focus?*

In order to make very clear what our variables measure and how are measured, we present the following table which summarizes all the contents of our indicator. CI's purpose is to measure the RER of 4 Southern European countries in a multidimensional way to investigate whether there is a geographical pattern of crisis.

Dimensions of concern	Indicators	Source
Economic	Gross Domestic Product per Head of Population (ppp Thousand Euro)	AMECO
Education	Early leavers from education and training (18-24) (%)	Eurostat
Empoyment	Employment rates (%) Long-term unemployment (12 months and more)	Eurostat
Social equality	Gender employment gap (%)	Eurostat
Social Capital	Suicides (per 100.000 inhabitans)	National Statistical Authorities (EL.STAT, INE, Istat, PorData)
Civil Engagment	Voter turnout in national elections (%)	Election Resources on the Internet
Demographic	Population on 1 January	Eurostat

Table 2: Description of the indicators used to measure regional economic resilience. Own creation.

VI. Availability: *How readily available are data on the particular indicator across time and space?*

The data sets that we included in our CI are easily reachable and are freely available so everyone can replicate our analysis and validate our results. The aforementioned table includes the resources of the data sets that we have used.

VII. Flexibility: *How relatively flexible is the indicator in allowing for changes in content, purpose, method, comparative application and focus?*

In respect of method and technique, the construction of CI is a relativly complex issue, however, as we have mentioned in previous sections CIs have the advantage

that present in a simple way multidimensional phenomena. We chose to make our methodology as simple as possible, without undermining its validity. We based our CI on ad hoc selection, traditional 0-100 scaling, equal weighting and additive aggregation, because are simpler than those employing multivariate techniques in selection and weighting standard scores in scaling of composite indexing and functional aggregation (Booysen, 2002)

4.4. Building our Composite Indicator

As we have mentioned in the previous section we aim to study the geographical impact of the crisis on the regional level. So, we focus on the Greek, Spanish, Italian and Portuguese NUTS 2 regions and we want to measure their regional economic resilience (step 1) through a CI. Our variable selection (step 2) is based on the theoretical and empirical literature, the proxies for each dimension were chosen according to the availability of the data and to our judgment on what variable seems most suitable for a proxy. We tried to construct our index with variables that will prevent us from dealing with missing data. Whenever we came across with missing data with more than 2 regions we didn't include that indicator. However, whenever we came across with that problem, we include the most recent available value (step 3).

It is important to mention that, some variables have a negative sign, meaning that the higher the value is the worst performance has the region (like unemployment), but other variables have a positive sign, meaning the higher the value is the better performance has the region. For that reason, we transformed all of our variables to have a positive sign, so 0 is the worst value while 100 is the best (step 51). We judged that our indicators should receive equal weighting because we include many dimensions of the RER phenomenon and our indicators have no missing values so weights will not provide any further explanatory power (step 6). For sensitivity analysis (step 7) we utilized the second instance in normalizing the CI with the standard deviation method and we used z scores.

We present four regional tables in the appendix with all the variables of the CI. Thus, we go back to our data (step 8) to explore the main drivers for regional performance.

1 This research used Excel to construct the CI

We also performed a correlation between our CI and the two most popular indicators when measuring RER, GDP and unemployment and we identify the links to the indicators (step 9). Finally, we visualize the results (step 102).

4.4.1. Variable selection

The individual variables that we selected, intend to explain the resilience phenomenon. The period under examination for Greek regions is 2009-2015, while for the rest regions of Spain, Italy and Portugal is 2009-2013.

Some words of caution are warranted at this stage because the choice of variables as components of the index is somewhat subjective, so in order to incorporate that the indicators are selected on the basis of their analytical, soundness, measurability, regional coverage, relevance to the phenomenon being measured and the relationship to each other.

Briguglio et al. (2006) state, a resilience index that tries to capture the shock-absorbing and shock-counteracting elements should include indicators from the following areas; macroeconomic stability, microeconomic market efficiency, good governance and social development. The fact that we are trying to construct a resilience index at the regional level makes it difficult to find available regional (and comparable) data for all of these areas. As a result, our CI is consisted of 8 variables which include indicators from the economic and social area and the rationale behind their selection is described below.

- Regional Domestic Product

One of the most widely used measures of resilience is the level of Gross Domestic Product (GDP), because it reacts fast to economic shocks. In other words, it reflects the economic impact of the shocks very well, while other variables like unemployment depend on GDP (Oprea et al., 2020). However, we are aware that GDP measures economic activity and it does not reflect very well the economic resources of the households (Stiglitz, Sen, Fitoussi 2009). Stanickova & Melecký (2018) defined a set of set indicators for resilience, which link the concept of resilience with competitiveness, and gross domestic product was one of them. We

2 GeoDa software was used to visualize the data

wanted to have a better perspective when tracking the well-being over a period of time we choose the variable *regional domestic product per habitat in PPP*.

- Early leavers from education and training

Studies suggest that education is one main determinant of economic resilience (Annoni et al., 2019 & Oprea et al., 2020). Stanickova & Melecký (2018) include in their resilience index both population aged 25–64 years with higher education and lifelong learning. We could have also used one of these indicators, but we wanted to include an indicator, which reflects social vulnerability. *Early leavers from education and training* are more likely to face considerable difficulties in the labor market, due to their limited education (Joint Research Center, 2020). So, we chose this variable as a proxy for human capital.

- Gender employment gap

Despite improvements in education and skills, gender disparities in labor market opportunities and outcomes are still relevant in Europe (Eurostat, 2020). Labor force participation rates among women remain well below those for men and that difference between the employment rates of men and women aged 20-64, is defined gender employment gap. Gender employment gap, are strong predictors of resilient regional behavior after the crisis and capture a social dimension of the production process of well-being (Benczur, et al., 2020). Joint Research Center (2020) points out that in countries where women and men are equally empowered, inequalities are smaller, and that influences the impact and recovery phases of the crisis. As a result, we included the parameter of gender equality in our CI though *Gender employment gap* indicator.

- Employment

The second most popular measure of regional resilience is the number of people employed in a region. *Employment,* along with regional output, are two of the most used variables when measuring RER, as it is assumed to have a societal value, because the possession of a job is a strong indication of well-being of an economy. Pontarollo & Serpieri (2020) construct a CI to measure regional resilience and employment is one of the indicators that they use.

- Long-term unemployment

Long-term unemployment, especially among young people and over 50's, increased after 2010, mainly due to the economic crisis. Unemployment and long-term unemployment are also used in CI which measures RER (Stanickova & Melecký, 2018), because they are two of the most standard labor market outcome indicators (Martin, 2015). We chose this variable, for its societal and economic dimension both to individuals and society.

- Suicides

There is an increasing concern over the effect on health of the economic crisis and studies conclude that during economic downturn suicide rates increase, due to increasing unemployment, poverty, financial problems etc (De Vogli, 2013). Reeves, et al. (2015) findings show that rises in male unemployment have contributed to the recent recession-related increases in suicide rates in Europe and the study points out the need to respond to the suicide risks faced by newly unemployed groups in Europe, particularly, in countries facing austerity policies like Greece, Ireland, Portugal, Spain and Italy. We include this variable to grasp social capital as Artelaris (2017) did.

- Voter Turnout

Voter Turnout is a way of people expressing their disbelief or ignorance on how they are governed. This indicator measures civic and political participation and is calculated based on national elections. In other words, it can be assumed as a proxy for social capital (Martin, 2015). Scherzer et al. (2019), are using 47 indicators in order to describe the resilience capacities of Norwegian municipalities and voter turnout is one of them. Also, Artelaris (2017) uses this indicator to measure civil engagement in his CI.

- Population

This variable captures the demographic dimension of the CI. In other words, it describes the demographic dynamics, which intends to capture the general demographic characteristics of the regions. Artelaris (2017) uses this indicator and we follow this rationale to our CI also. Martin (2015) also states that demographic

indicators, especially population growth, reflect the pressure of demographic changes on public finances (old-age support ratio).

4.4.2. Risks related to data

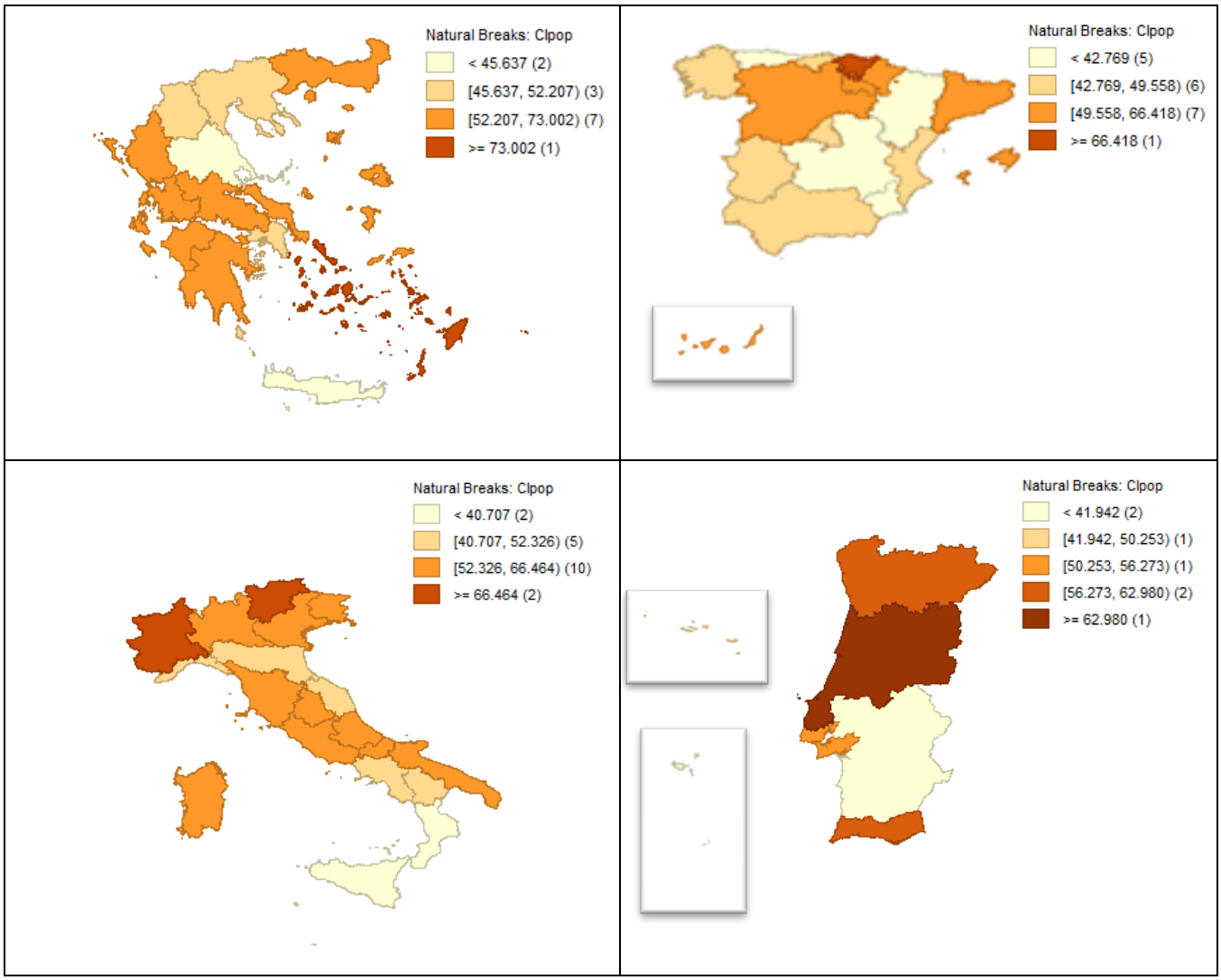
Some economies entered the crisis earlier and other later and this creates a problem of choosing a single reference year for the whole data set. In order to include that troublesome, we assume that all regions entered crisis on 2009. We also assume that the regions of Italy, Portugal and Spain exited the crisis in 2013, while Greek regions were still in crisis until 2015, which is the finish year of our analysis. We are aware that this assumption has also limitations, because not all regions entered and exited the crisis as the national average suggests. However, for that stage of the analysis it can provided us a good picture of the resistance of the regions.

Also, there is a risk in choosing to use an absolute measure of resilience rather than one that is relative, as the regional performance may be better than the average across the country. When considering a more widespread analysis, like ours, is problematic, for example in the case of regions in countries such as Greece, Portugal or Spain (Sensier, 2018), it could suggest that a region that experiences a major reduction in the CI is more resilient than another simply because of its performance against the national average in their respective countries. In order to account for that, we will construct four CI's, one for each country.

5. *Results and Discussion*

5.1. Resilience in South Europe

Southern Europe (Greece, Spain, Italy and Portugal) experienced the impact of the crisis of 2009 differently. These differences in the impact of the crisis reflect the fundamental heterogeneity in the capabilities of various regions to respond and absorb economic disturbances. Table 4 illustrates the results of our Composite Indicator (CIpop3) on Regional Economic Resilience (RER) for the selected Mediterranean countries. Despite these differences, a geographical pattern is evident when the maps are compared. The most severely hit regions during the crisis are located in the southern parts of the countries. We can also identify a North-South divide and the Central-North part is the most resilient for the whole country set.



3 CIpop indicates that our CI includes population dynamics – however CIpop is equivalent to CI.

Table 3: Composite Indicator (CI) of Regional Economic Resilience (RER) –Left without population dynamics. Right with population dynamics. Own construction.

In the Appendix, we present 4 graphs that illustrate the normalized individual indicators for Greek regions during 2009-2015, for Spanish, Italian and Portuguese regions during 2009-2013. The following 4 tables represent the ranked regions for Greece, Spain, Italy and Portugal according to our CI and we indicate with bolt lettering the capital region. Also, we present 4 graphs were we compare our CI with single variable indicators, GDP and Unemployment to make comparisons and links with the data.

5.1.1. Greece

In the case of Greece, the most resilient region is Notio Aigaio (73,00179), while the least resilient is Thessalia (34,05219) and they have a difference of 38,9496 points (Table 5). The capital region, Attika, is ranked 11th. In terms of GDP/hab Attica is the wealthier one and ranks 1st and Ipeiros is the poorest ranking in the 13th place. Although Anatoliki Makedonia, Thraki and Ipeiros are among the 3 poorest regions, in terms of resilience they are among the top 5.

Regions	CI Value	CI Ranking	GDP/hab Ranking
Notio Aigaio	73,0	1	2
Sterea Ellada	60,7	2	4
Peloponnisos	58,6	3	9
Anatoliki Makedonia, Thraki	55,8	4	12
Ipeiros	54,6	5	13
Ionia Nisia	53,6	6	3
Voreio Aigaio	52,8	7	8
Dytiki Ellada	52,2	8	11
Dytiki Makedonia	48,5	9	6

Attiki	**47,0**	**10**	1
Kentriki Makedonia	45,6	11	7
Kriti	37,3	12	5
Thessalia	34,0	13	10

Table 4: Ranking Greek regions in terms of CI and GDP/hab level 2009 (Eurostat). Own calculation

The Greek land area has been developed since ancient times with a focus on the Aegean and continued in recent history with the S axis of development, which for the most part coincides with the PATHE highway and a number of other infrastructures (Skagiannis, 2009). Growth along the S is maintained and polarized the country, while its key element is the internal polarization with a focus on Athens and secondarily Thessaloniki. So, the spatial organization of the country is a well known problem. At the macro level are the international links and interregional cohesion (including the connection the western with eastern regions) in addition to the relative isolation of some central areas, as well as the consistency of the insular system. It is also well known the significant role of Athens and its overwhelming size in relation to other cities and regions. To sum up, the so-called S-axis from Patras to Kavala has been discussed for several years.

Our CI ranking agrees with the GDP/hab in the case of South Aigaio, as it has the 1st and 2nd place accordingly. However, for the rest of the regions it seems that GDP and CI have a lot of differences. GDP probably is not the most appropriate indicator to measure the development or socioeconomic state of the regions and studies that focus only on GDP measure they do not penetrate the regional inequalities as they are but they underestimate them (Petrakos & Psycharis, 2004). Attica is the most dominant regions in terms of GDP and according to the developmental composite indicators of Petrakos & Psycharis (2004) ranks first in every case, but according to our CI the metropolitan regions did not appear to be resilient during the period of 2009-2015.

5.1.2. Spain

In the Spanish case the most resilient region is País Vasco (66,41845), while the least resilient is Aragón(36,69704) and they have a difference of 29,7214 points (Table 6).

The capital region, Comunidad de Madrid, is ranked 14th, while in terms of GDP is the wealthiest ranking 1st. We also observe that some of the poorest regions, like Ciudad Autónoma de Melilla (ES) and Canarias (ES) are among the top resilient regions.

Region	CI	Rank	GDP/hab Ranking
País Vasco	66,4	1	2
Ciudad Autónoma de Melilla (ES)	57,2	2	16
Canarias (ES)	55,1	3	14
Castilla y León	51,2	4	9
Comunidad Foral de Navarra	50,5	5	3
Illes Balears	49,9	6	7
Cataluña	49,7	7	4
La Rioja	49,5	8	6
Extremadura	46,2	9	19
Cantabria	46,0	10	8
Galicia	45,6	11	11
Andalucía	44,3	12	18
Comunidad Valenciana	43,2	13	12
Comunidad de Madrid	**42,7**	**14**	**1**
Principado de Asturias	41,4	15	10
Ciudad Autónoma de Ceuta (ES)	39,2	16	13
Región de Murcia	38,9	17	15
Castilla-la Mancha	37,8	18	17

Aragón	36,6	19	5

Table 5: Ranking Spanish regions in terms of CI and GDP/hab level 2009 (Eurostat). Own calculation

Spain is also a heterogeneous country. According to Cuadrado-Roura (2009), the historical evolution explains at a large extent the persistent regional inequalities. The Spanish regions are not the result of recent political and administrative decision, but have historical roots which go back centuries. This phenomenon is not common in the European and non-European context and deserves a good historical understanding to grasp that heterogeneity pattern. The Spanish regional question is understood as something more than the mere existence of economic inequalities among the country's regions, as the most known phenomenon involves the claims for self-governance.

Despite all that, it is obvious that our CI ranking and GDP ranking do not match, leading us once again to the conclusion that measuring development in GDP term may not provide the whole picture, as the most wealthy regions do not appear to be the most resilient.

5.1.3. Italy

In the Italian case the most resilient region is Provincia Bolzano + Trento (69,76494) , while the least resilient is Calabria (34,74289) and they have a difference of 35,02205 points (Table 7). Lazio is the capital region and is ranked in the 12th position.

Regions	CI	Rank	GDP/hab Ranking
Provincia Bolzano + Trento	69,7	1	1
Piemonte + Valle d'Aosta	66,4	2	4
Lombardia	60,7	3	2
Abruzzo	58,3	4	12

Puglia	57,2	5	18
Molise	56,1	6	13
Sardegna	55,8	7	14
Veneto	54,2	8	7
Friuli-Venezia Giulia	54,1	9	9
Toscana	53,4	10	8
Umbria	52,4	11	11
Lazio	**52,3**	12	**3**
Marche	46,0	13	10
Basilicata	43,9	14	15
Liguria	43,3	15	6
Campania	43,1	16	16
Emilia-Romagna	40,7	17	5
Sicilia	37,2	18	17
Calabria	34,7	19	19

Table 6: Ranking Italian regions in terms of CI and GDP/hab level 2009 (Eurostat). Own calculation

In Italy we observe a different situation as most regions CI ranking seem to coincide with the GDP ranking. Probably this may indicate a stronger North-South divide. However, some regions even though are below the national average in term of GDP appear to have high resilience like Abruzzo, Puglio, Molise and Sardegna.

5.1.4. Portugal

In the Portuguese case the most resilient region is Centro (PT) (62,97964), while the least resilient and poorest is Região Autónoma da Madeira (PT) (35,23254) and they

have a difference of 35,23254 points (Table 8). The capital region, Área Metropolitana de Lisboa, is ranked 4th, while is the most wealthy region.

Regions	CI	Rank	GDP/hab Ranking
Centro (PT)	62,9	1	6
Algarve	57,4	2	2
Norte	56,2	3	7
Área Metropolitana de Lisboa	50,2	4	1
Região Autónoma dos Açores (PT)	41,9	5	4
Alentejo	38,4	6	5
Região Autónoma da Madeira (PT)	35,2	7	3

Table 7: Ranking Portuguese regions in terms of CI. and GDP/hab level 2009 (Eurostat) Own calculation

In the Portuguese case two of the poorest regions in terms of GDP appear to have withstand the crisis very well as they are ranked among the top 3 resilient regions. Once again, the rankings of our composite indicator and the singe indicator of GDP appear to have different results.

5.2. Comparison of our CI with GDP growth and Unemployment growth

In the previous section it was more than obvious that the rankings between our CI and GDP per habitat (2009 levels) do not coincide. In other words, the most wealthy regions in the beginning of the crisis were not the ones with the highest resilient. In order to investigate more that phenomenon we performed a comparison of our CIs between GDP growth and unemployment growth rate. In other words we compare our CIs with the two of the most common single indicators – Gross Domestic Product and unemployment rate – in the literature when investigating regional economic resilience

Figure 7, illustrates the comparison of the Greek region's rankings. A lower ranking means a better performance regarding the period 2009-2015. After performing a correlation analysis of rankings between CI and single indicators we found that there is a very weak correlation between CI and GDP (0,18), while there is a strong correlation between CI and Unemployment rates (0,55). Anatolikh Makedonia and Thraki occupies the last position in terms of GDP growth but it occupies 3rd position in term of Unemployment and 4th in terms of CI. Attiki occupies a better position in terms of GDP growth (8th) but ranks 2 positions lower in terms of unemployment and CI. Notio Agaio seems to have performed better as it occupies the 1st position in terms of unemployment and CI and 2nd in term of GDP growth. Among the worst performance in three indexes are Kentriki Makedonia, Kriti and Attiki. Attiki and Kentriki Makedonia are the two metropolitan regions, and Kriti is also an important urban center of Greece and the biggest island.

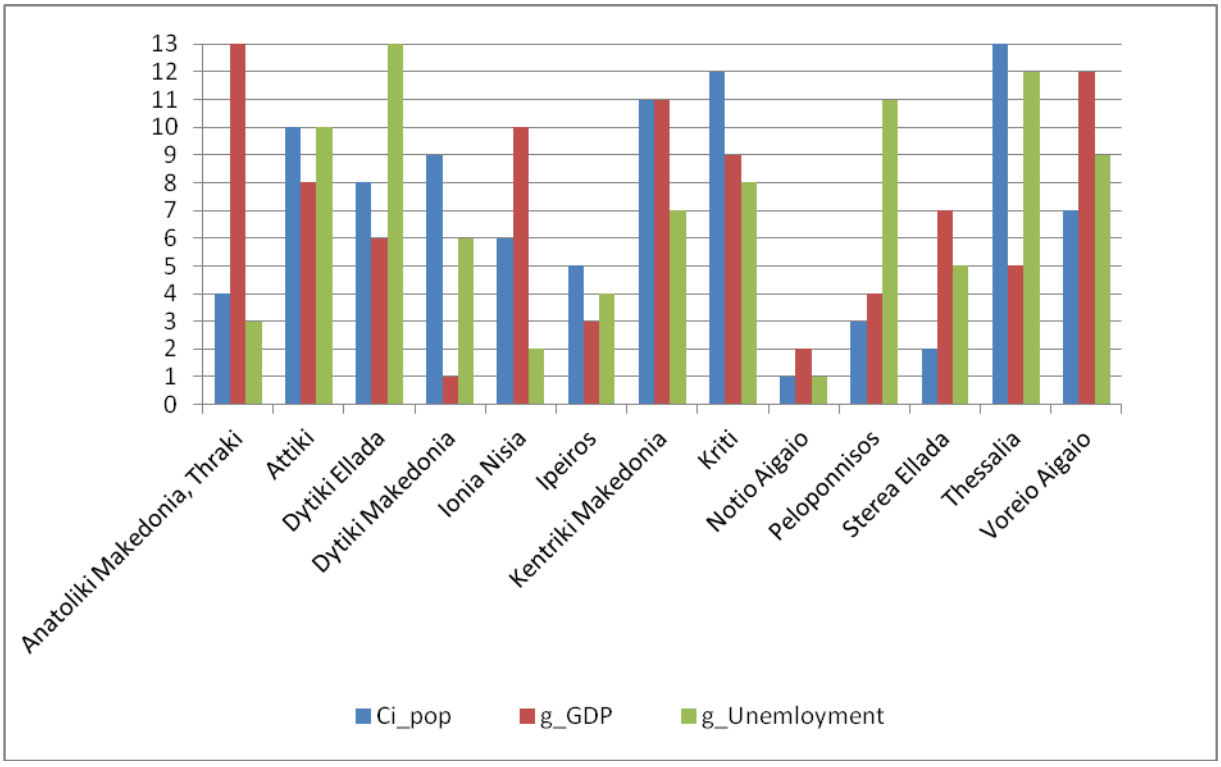
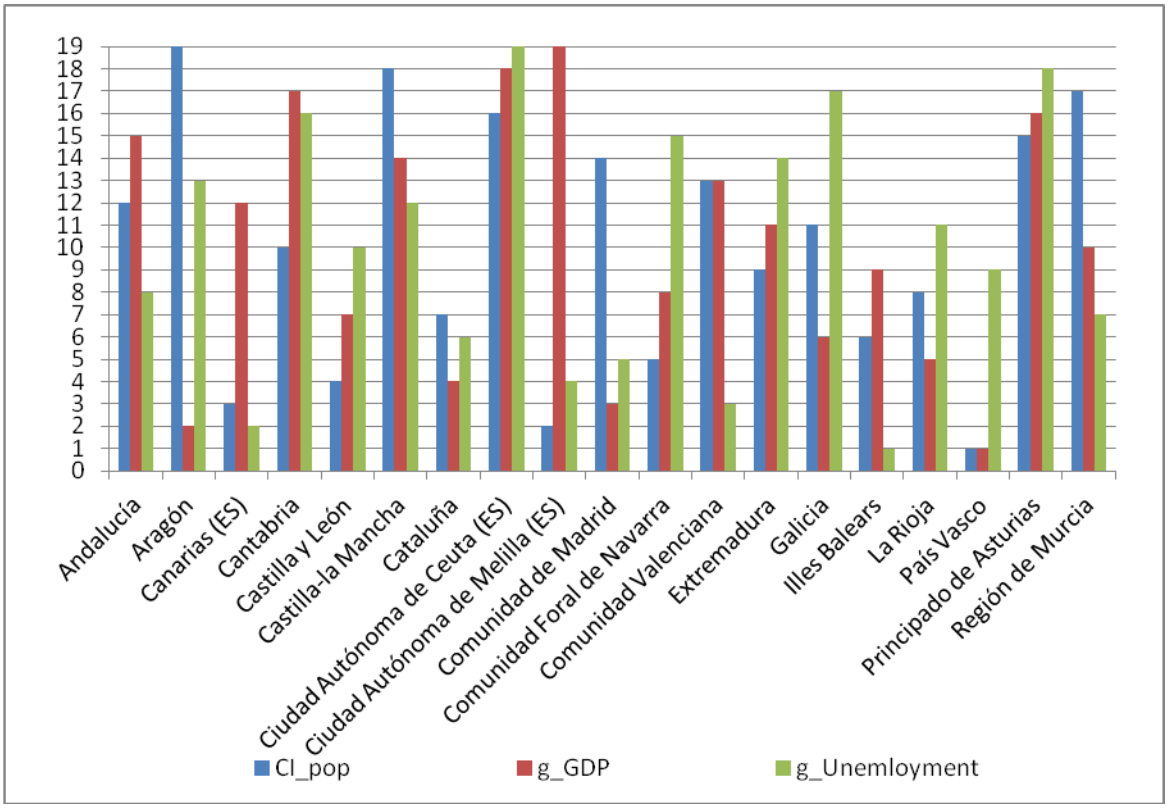


Figure 7: Rankings of economic crisis' impact, Composite indicator, GDP per capita and unemployment rate in Greece. Note: A lower ranking means a better performance regarding the crisis. Own calculations.

Figure 8, illustrates the comparison of Spanish region's rankings between Gross Domestic Product and unemployment rate n terms of growth with the rankings of our

CI. A lower ranking means a better performance regarding the period 2009-2013. After performing a correlation analysis of rankings between CI and single indicators we found that there is a very weak correlation between CI and GDP (0,13), while there is a moderate correlation between CI and Unemployment rates (0,36). Pais Vasco occupies the first position in terms of CI and GDP growth, while it occupies the 9th position in terms of unemployment. Aragon occupies the last position in term of CI but occupies the 2nd position in terms of GDP growth. Ciudad Autonoma de Melila occupies the last position in terms of GDP, while it occupies the 2nd in terms of CI. The worst performing regions according to the three indexes are Ciudad Autonoma de Ceuta and Prinicipado de Asturias and Castila-la Mancha.



Graph 8: Rankings of economic crisis' impact, Composite indicator, GDP per capita and unemployment rate in Spain. Note: A lower ranking means a better performance regarding the crisis. Own calculations.

Figure 9, illustrates the comparison of the Italian region's rankings between the two most common single indicators – Gross Domestic Product and unemployment rate – in terms of growth with the rankings of our CI. A lower ranking means a better performance regarding the period 2009-2013. After performing a correlation analysis

of rankings between CI and single indicators we found that there is a moderate correlation between CI and GDP (0,38), while there is a weak correlation between CI and Unemployment rates (0,20). Abruzzo appears to have performed better, as it occupies 4th position in terms of CI and 3rd position in terms of GDP and Unemploment. Provincia Bolzano + Trento occupies 1st position in terms both of GDP and CI, while it occupies the 15th position in terms of unemployment. Basilicata occupies a very good position in terms of CI, 14th, while it occupies the 2nd position in terms of GDP and unemployment. Among the worst performers in 3 indexes are Calabria, Campania and Marche.

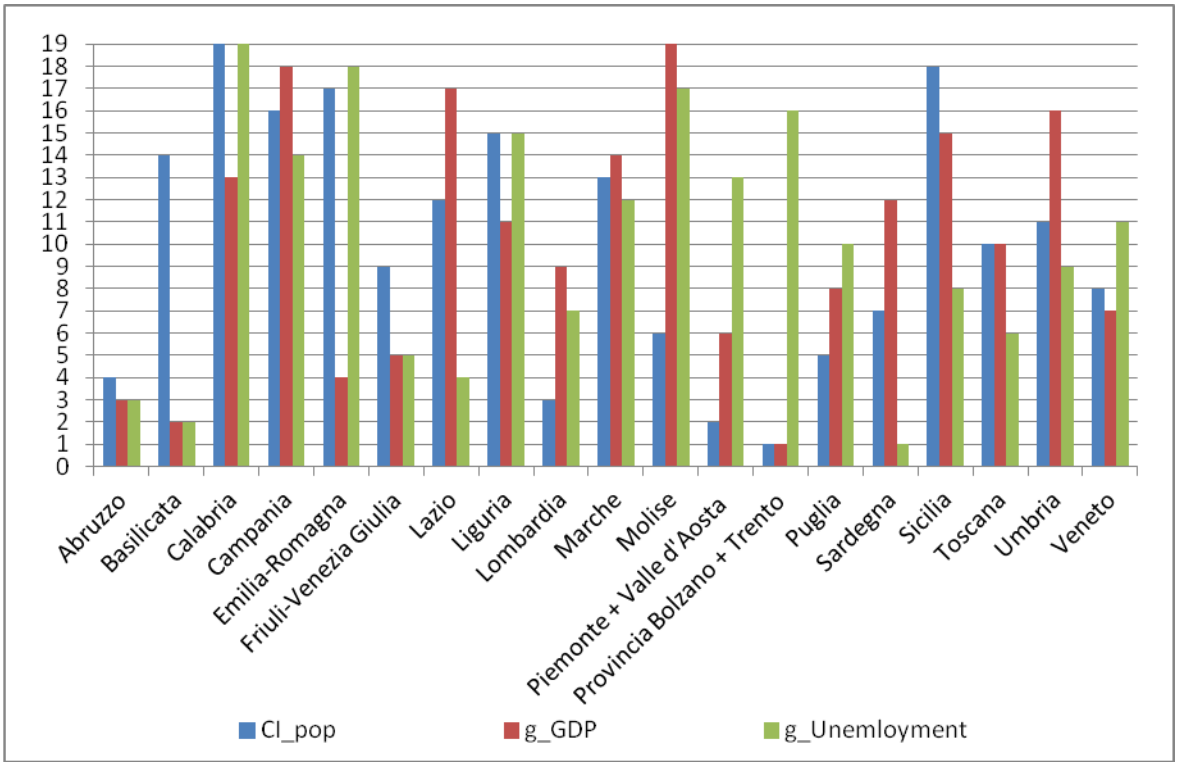
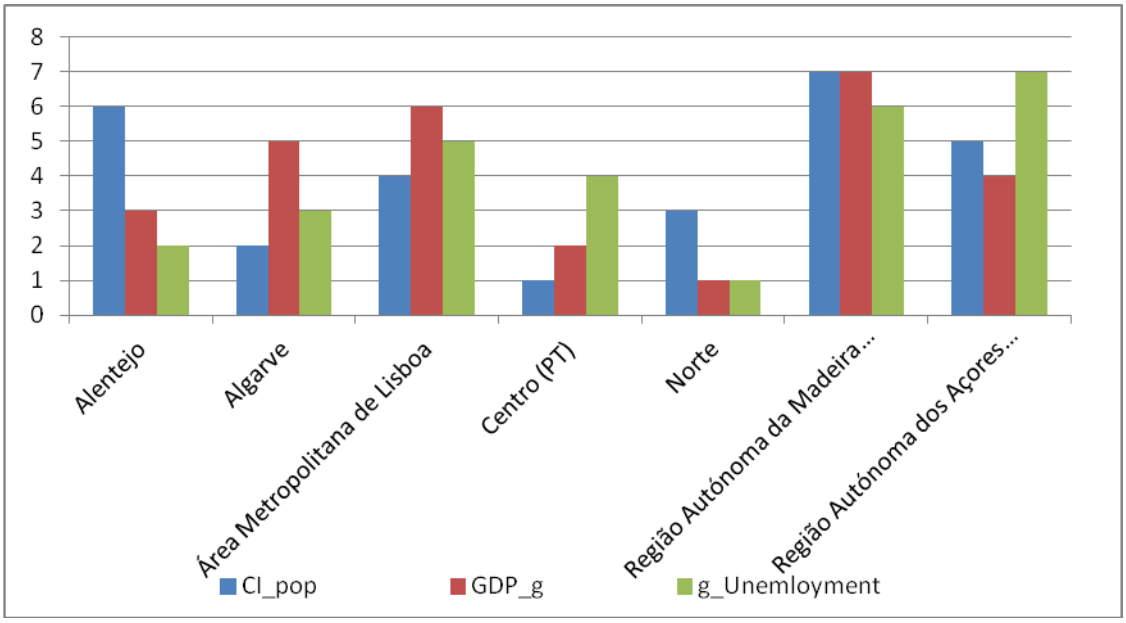


Figure 9: Rankings of economic crisis' impact, Composite indicator, GDP per capita and unemployment rate in Italy. Note: A lower ranking means a better performance regarding the crisis. Own calculations

Figure 10, illustrates the comparison of Spanish region's rankings between the two most common single indicators – Gross Domestic Product and unemployment rate – in terms of growth with the rankings of our CI. A lower ranking means a better performance regarding the period 2009-2013. After performing a correlation analysis

of rankings between CI and single indicators we found that there is a strong correlation between CI and GDP (0,50), while there is a moderate correlation between CI and Unemployment rates (0,35). Norte occupies first position in terms of GDP growth and unemployment, while it occupies the 3rd position in terms of CI. The worst performing region in 3 indexes is Madeira. Alentejo occupies the 6th position in terms of CI, while it occupies the 2nd position in terms of growth and the 3rh in terms of unemployment.



Graph 10: Rankings of economic crisis' impact, Composite indicator, GDP per capita and unemployment rate in Portugal. Note: A lower ranking means a better performance regarding the crisis. Own calculations.

Our analysis tries to investigate these four countries together to capture a geographical pattern. That's why we present bellow the comparison of these 3 indexes for the 58 regions. We recalculated the CI and the lower the value the lower the resilience and the higher the value the higher the resilience. The diagram is based on the decreasing ranking of our CI. Thessalia is the least resilience region, while Notio Agaio is the most resilient. We observe that the last and first position is occupied by Greek regions. Also the Greek regions had the greater dispersion, relevant to the other countries, meaning that Greece showed the higher degree of heterogeneity, as far as the resilience to the recessionary shock of 2009. Most of the Spanish regions occupy position below the median, while most of the Italian regions occupy positions above

the median. Portugal in terms of CI the picture resembles the Greek picture, as its regions showed a high degree of heterogeneity.

In terms of GDP growth and unemployment growth rate Greek regions occupy the bottom positions, with the only exceptions Dytiki Makedonia which occupies the 10th position in terms of GDP and Notio Aigaio which occupies the 1st position. Italian regions appeared resilient both in terms of our CI and of GDP growth, while Spanish regions appeared resilient in terms of unemployment. Portuguese regions appeared resilient in term of growth rate as they occupy the top positions.

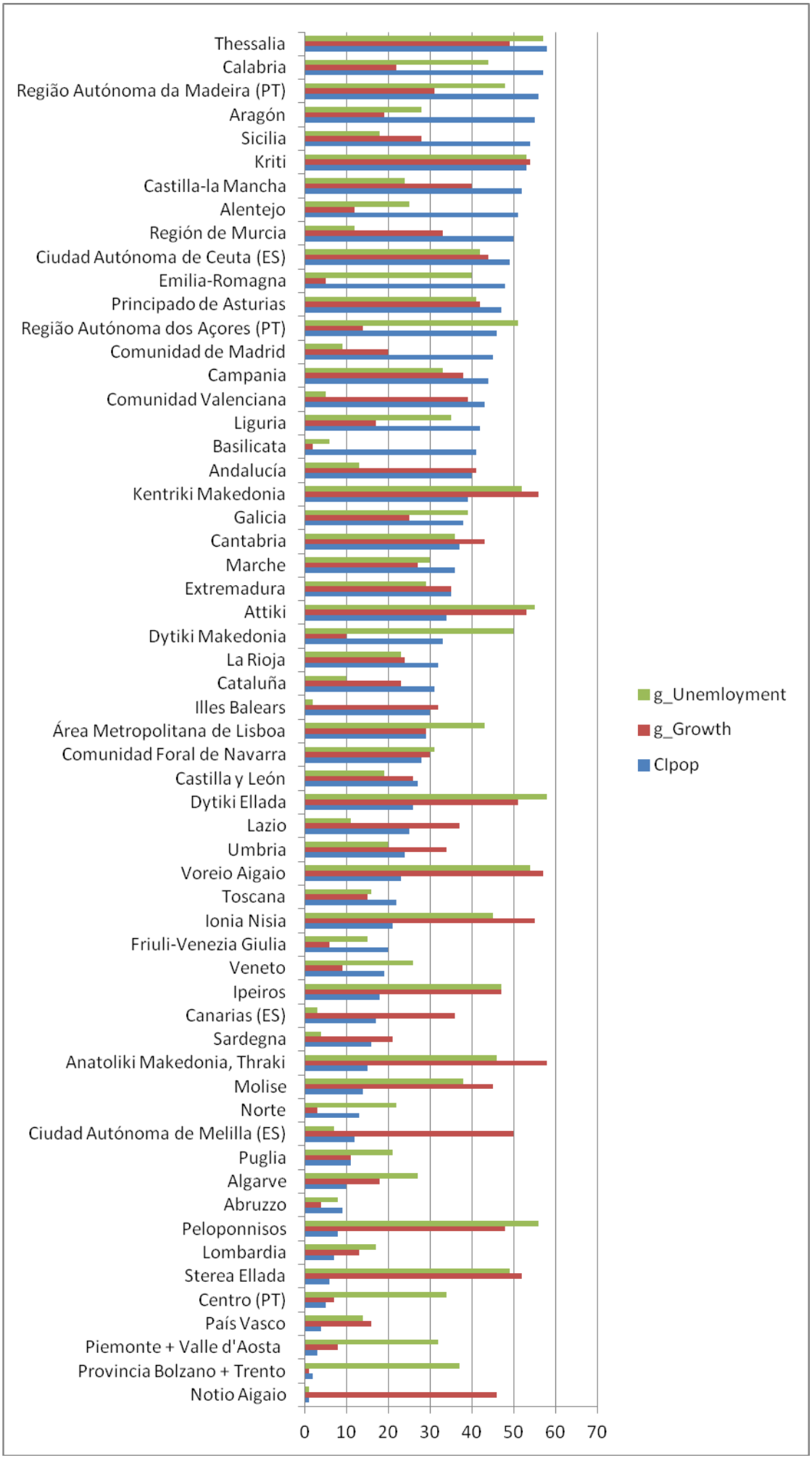

Thessalia
Calabria
Região Autónoma da Madeira (PT)
Aragón
Sicilia
Kriti
Castilla-la Mancha
Alentejo
Región de Murcia
Ciudad Autónoma de Ceuta (ES)
Emilia-Romagna
Principado de Asturias
Região Autónoma dos Açores (PT)
Comunidad de Madrid
Campania
Comunidad Valenciana
Liguria
Basilicata
Andalucía
Kentriki Makedonia
Galicia
Cantabria
Marche
Extremadura
Attiki
Dytiki Makedonia
La Rioja
Cataluña
Illes Balears
Área Metropolitana de Lisboa
Comunidad Foral de Navarra
Castilla y León
Dytiki Ellada
Lazio
Umbria
Voreio Aigaio
Toscana
Ionia Nisia
Friuli-Venezia Giulia
Veneto
Ipeiros
Canarias (ES)
Sardegna
Anatoliki Makedonia, Thraki
Molise
Norte
Ciudad Autónoma de Melilla (ES)
Puglia
Algarve
Abruzzo
Peloponnisos
Lombardia
Sterea Ellada
Centro (PT)
País Vasco
Piemonte + Valle d'Aosta
Provincia Bolzano + Trento
Notio Aigaio
0
10
20
30
40
50
60
70
g_Unemloyment
g_Growth
Clpop

Figure 11: Ranking of CI, GDP growth and unemployment growth. Own construction.

The main point that can be drawn is that metropolitan regions did not appear to be resilient terms of CI as Lazio occupies the 25th position, Área Metropolitana de Lisboa occupies the 29th position, Attiki occupies the 34th position and Comunidad de Madrid occupies the 45th. In terms of GDP, again metropolitan regions occupy position below the median and Attiki holds the 53rd position and in terms of unemployment holds the 55th position while Spanish and Italian metropolitans occupy the 9th and 11th position accordingly.

5.3. Is there a relationship between the structural variables and our CI?

In this section we try to investigate the drivers of resilience. This primary stage of identification is conducted through a correlation analysis, where quantifies the association between two continuous variables, for example between an independent and a dependent variable or between two independent variables.

Our analysis explores the linear relationship between our CI on regional economic resilience of 58 Southern European regions (dependent variable) between selected variables on 2009 levels (independent variable). In other words, we want to investigate what seems to drive regional resilience. We performed individual correlation analyses for each country's regions with the following variables:

- Population density

  According to UNU (2015) in 1950 two-thirds of the world's population lived in rural areas, but by 2050, that proportion will be reversed as is forecasted that cities will be home to some 6.3 billion people, 2.4 billion more urban inhabitants than today. This urban growth leads to the question "Are cities driver of Risk or Resilience?" and UN tries to answer that by setting the Sustainable Development Goal 11 which aspires to "Make cities and human settlements inclusive, safe, resilient and sustainable.

  It is important to mention that the concept of resilience in SDG is perceived under to framework of vulnerability to the impacts of natural disasters, however,

economic resilience tries to adapt that logic of adaptability to economic shocks and studies show that cities can be a factor of resilience and perform better during a recession, because they are entailed with better human capital, networks and technology which leads to higher productivity and innovation, so a greater preventing and adapting mechanisms (Drobniak, 2012). Pavel et al. (2020) found striking differences between urban and rural communities in the way Romanian regions responded to the financial crisis of 2008-2011 and their results indicated that rural communities were more resilient. Artelaris (2017) examined the social well-being of greek regions and concluded that less urbanized regions responded better during crisis years.

We performed a correlation analysis of population density with our CI and if the results show a strong correlation it means that geography matters and if it is positive (negative) then the more (less) urbanized a region the higher the resilience.

- Gross domestic product per habitat (PPP)

The theory of path dependence points out that most of the determinants of regional economic resilience are a product of history, meaning that previous economic patterns influence the underlying strengths of a region's economy and its prospects for recovery from disruptions (Martin & Sunley, 2015). Kitsos and Bishop (2018), suggested that initial conditions did explain the regional resilience of the UK.

So, by exploring the correlation between 2009 levels of Gross domestic product per habitat (PPP) and our CI, we may suggest whether the initial economic conditions influence the resilience.

- Intramural R&D expenditure (GERD) by sectors of performance

According to United Nations (2017, p.1) "Research and experimental development (R&D) comprise creative and systematic work undertaken to increase the stock of knowledge –including knowledge of humankind, culture and society –and to devise new applications of available knowledge". Svoboda & Klementova (2014) perform a correlation analysis to indicate the main determinants of regional economic resilience

and they claim that Intramural R&D expenditure is an important factor to indicate Innovation and Research Activity.

According to European Commission 2014, the composition of the Regional Innovation Scoreboard includes the enables of innovation, the innovation activity and innovation output. The enables of innovation consider the human resources, R&D expenditures and knowledge-intensive sectors. We correlate Intramural R&D expenditure with our CI and if the results indicate a significant coefficient then higher (lower) regional resilience indicates higher (lower) R&D expenditures.

- Employment in technology and knowledge-intensive sectors

Sirimanne (2020) claims that Science, technology and innovation (STI) have a critical role to play in building resilience to multiple shocks, as they empower the economy to absorb and adapt to (the) shock(s). Bristow and Healey (2018), suggested that regional socio-economic resilience is strongly related to its capacity for innovation, as the most resistant region in Europe were the ones with the highest levels of innovation capacity and performance. In other words, regional economic resilience is highly dependent on learning processes associated with knowledge.

In order to capture that relationship, we performed correlation analysis with the variable Employment in technology and knowledge-intensive sectors and our CI.

- GVA for 6 sectors according to NACE categorization

The role of economic sectoral structure in regional development is widely acknowledged and for that reason, empirical bibliography tries to investigate whether the specialization sector of a region influences economic resilience. Groot et al. (2011), investigate the explanations for spatial heterogeneity in the severity of the crisis of 2008 and conclude that differences in the sectoral composition is one of the main contributions to the variations in the (national and regional) effects of the crisis. Kitsos & Bishop (2018) mention that for the 2008 crisis, the initial expectation was that there would be a severe impact on places with high shares of financial services activities, however, their results highlight that all of the sectoral variables failed to provide statistically significant results, providing no evidence that particular sectors were the source of greater vulnerability for UK's local authority districts. Petrakos &

Psycharis (2016), found that regions specializing in manufacturing were hit harder due to reduced demand and cut bank credit among others, while regions relative dependent on agriculture were the least affected ones.

By exploring the correlation of our CI with the GVA of 6 sectors we contribute to that dialogue.

- Education

Literature suggests that regions with higher levels of human capital have a greater ability to mitigate the impact of the crisis, meaning that geographical variations in levels of education may be translated into variations in regional patterns of adjustment (Martin & Sunley, 2015). Oprea et al. (2020) find that tertiary education had a positive influence on the regional resilience of Eastern European regions.

We also use tertiary attainment and correlate that with our CI.

- Internet Access

European Commission (2020), highlighted in the most recent report which monitors Europe's overall digital performance and tracks the progress of EU countries concerning their digital competitiveness, the so-called 2020 Digital Economy and Society Index, the importance of digital resilience in times of crisis. Internet connectivity is one of the 5 principal policy areas (the other 4 are digital skills, internet usage by individuals, integration of digital technologies by businesses and digital public services). Chakravorti et al. (2020) mentioned the importance of digital capabilities for ensuring a country's growth and economic resilience. We perform a correlation analysis between CI and internet access because the internet is crucial for regional resilience.

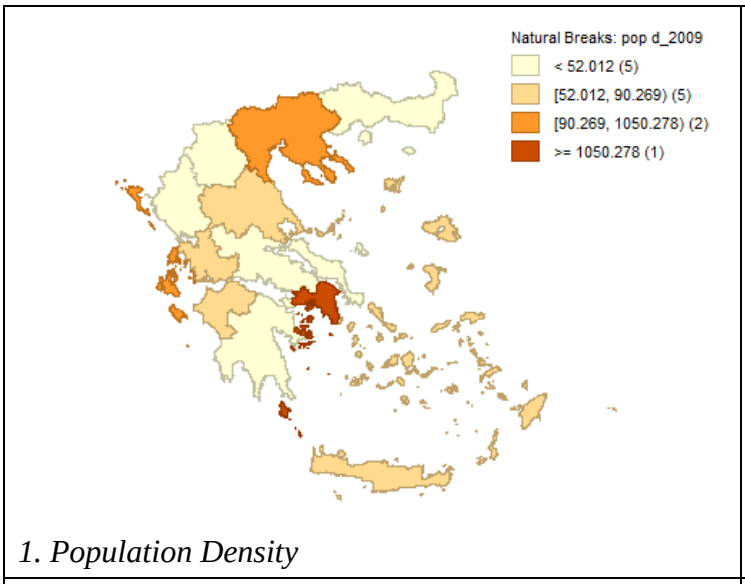
5.3.1. Map Analysis

The following table illustrate the maps of the levels from the 7 structural variables for Greece, Spain, Italy and Portugal, which appear to have a correlation coefficient r>0,3 with our CI which is also presented in the table.

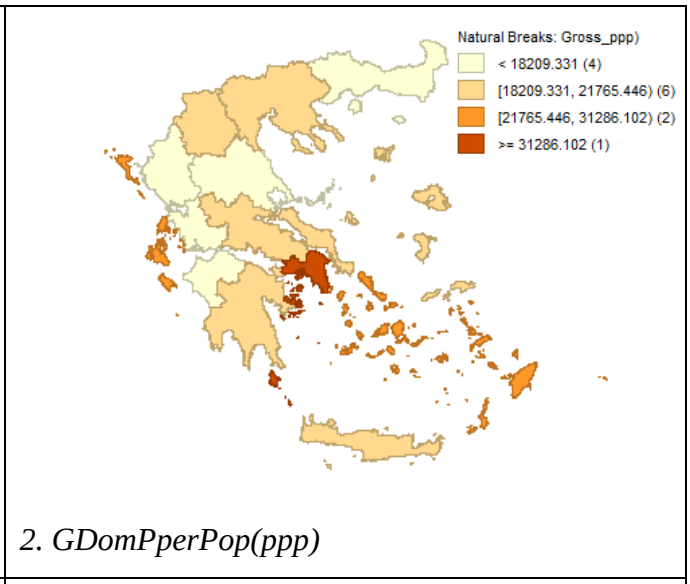
In the case of Greece, Attica, which is the capital region, concentrates the highest values for all structural variables, except Agricultural activity as expected due to its

high urban level. In general, North Greece seems to have higher values in all structural values. Kriti is located in the southern part of Greece and can be identified as an exception, as it has high R&D expenses, employment in Technology and Internet Access. The university of Kriti and its research institute is responsible for that trend.

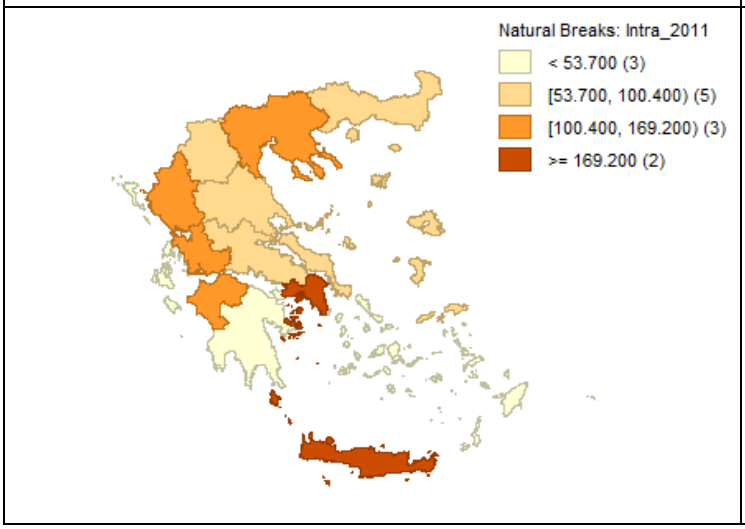
The two metropolitan regions Attiki and Kentriki Madekonia eventhough they have among the highest values of the structural variables they do not appear to have high values in our CI. However, Notio Aigaio which is characterized by a high GDP/hab level appears the most resilient region. Peloponnisos has among the lowest values in all the structural variables, but in terms of resilience, it has relatively to Attica greater values. This negative relationship between structural variables and resilience is more obvious through the negative sign of the correlation in the coefficient of the Greek results.

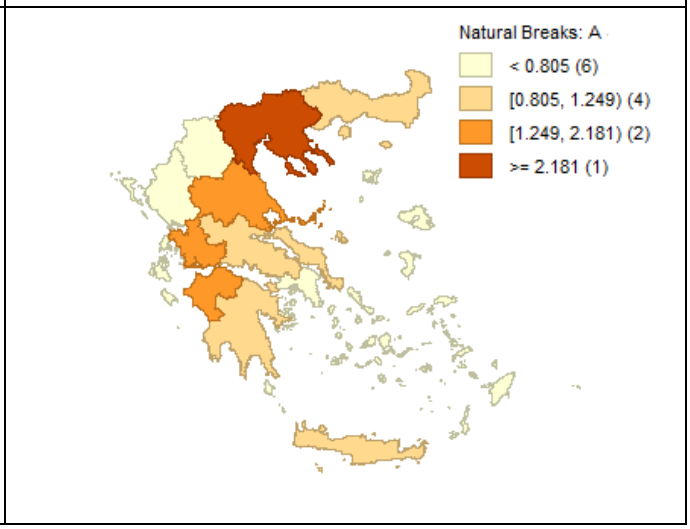


1. Population Density



2. GDomPperPop(ppp)





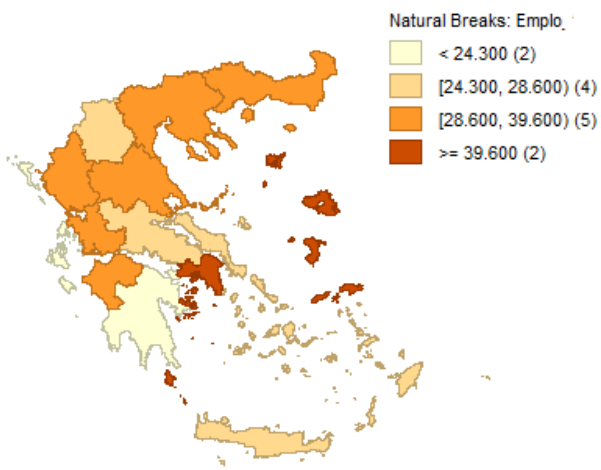
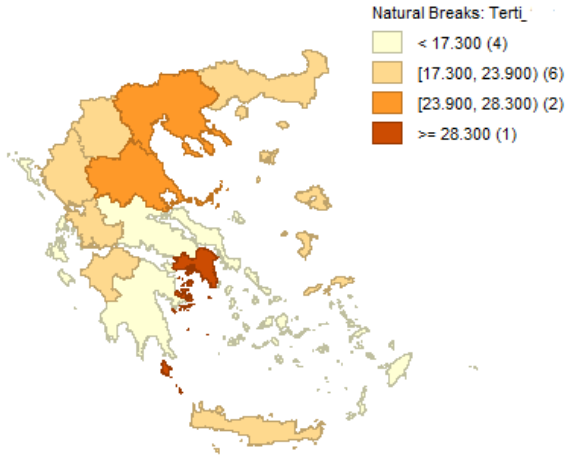
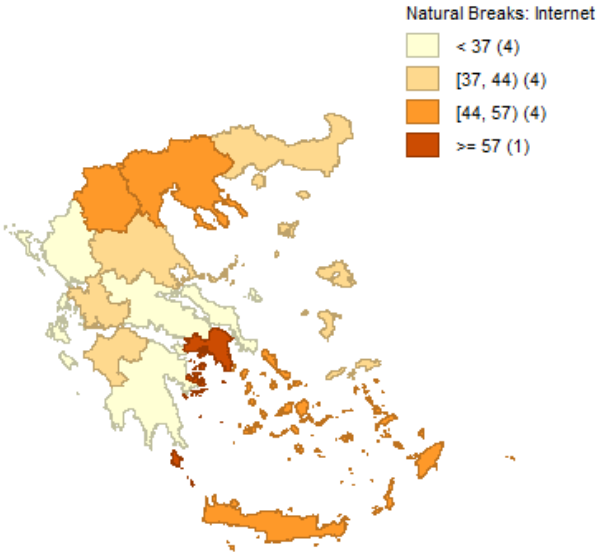
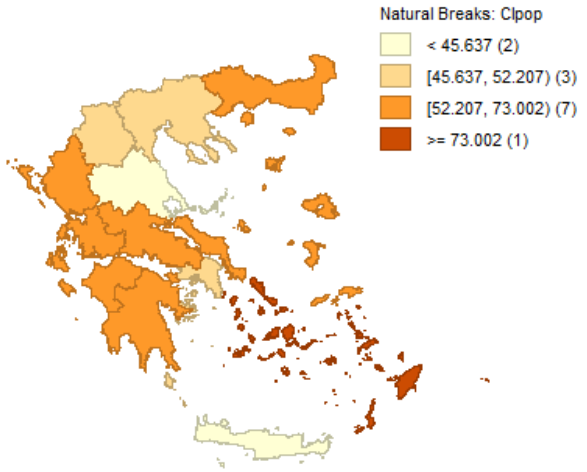
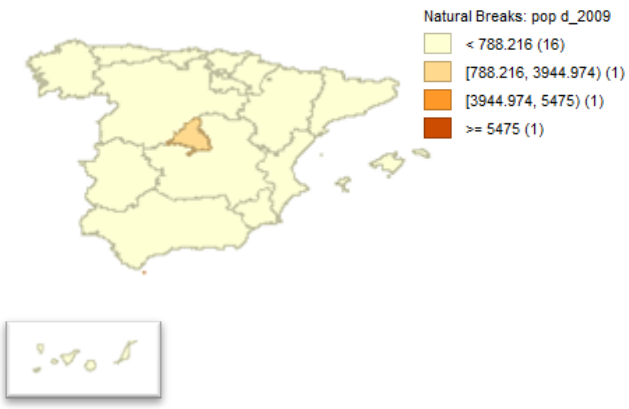
3. Intramural R&D expenditure	*4. A Sector (Agriculture, forestry & fishing)*
 *5. Employment in technology & knowledge-intensive*	 *6. Tertiary Education*
 *7. Internet access*	 *Our Composite Indicator*

Table 8: Levels of structural variables (Greece). Own creation.

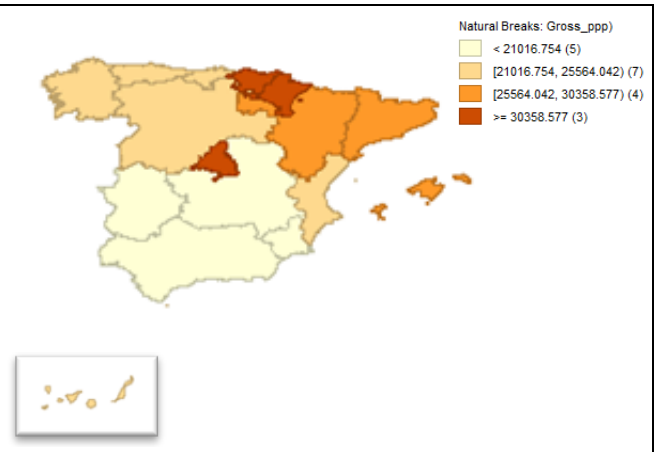
Spain territory also seems to be divided between North and South, were the Northern part concentrates the highest values of all the structural variables, except Agriculture activity which is dominant in the Southern part. The most wealthier regions are Pais Vasco and Communidad de Madrid and they concentrate among the highest values of R&D expenditure, Tertiary education and Internet access. Communidad de Madrid is the capital region, but it does not appear resilient, while Pais Vasco is the most resilient region. Catalonia also demonstrates high resilience.

Historically, the growing dynamism of the country and the economic changes that have taken place the recent centuries resulted to the highly industrialized Catalonia and Pais Vasco, which appear to lead the industrialization process. Probably, the positive relationship between structural variables and CI in the case of Pais Vasco and Catalonia explains the significant positive sign in the correlation analysis.

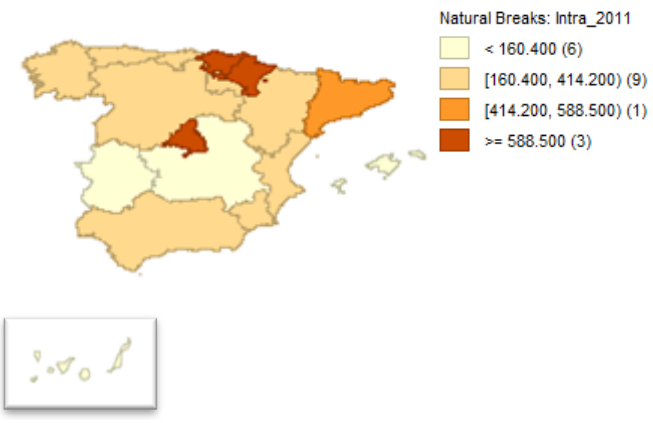
Castilla y León appears resilient, even though it is a highly agricultural oriented region and has very low values in the other structural values. However, other agricultural regions, like Andalucia, which is among the poorest and with very low R&D expenditures and tertiary education is not among the least resilient.



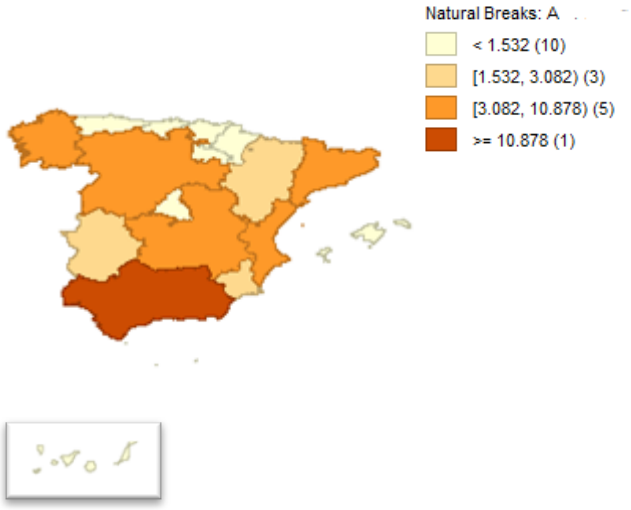
1. Population Density



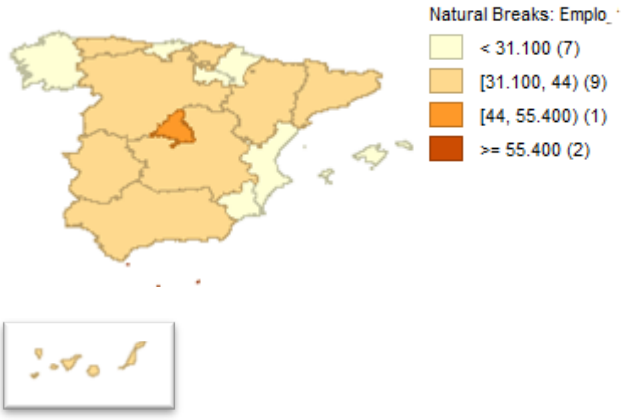
2. GDomPperPop(ppp)



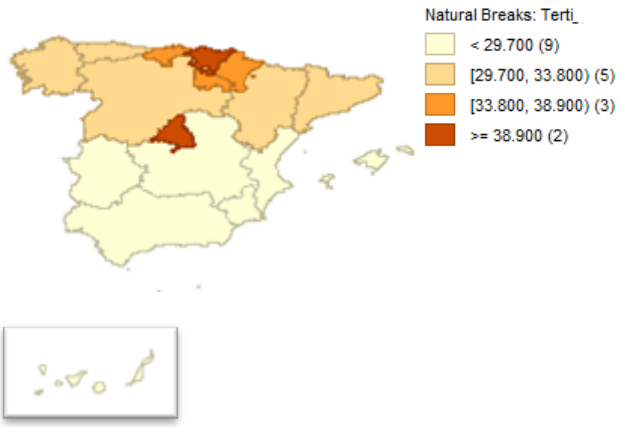
3. Intramural R&D expenditure



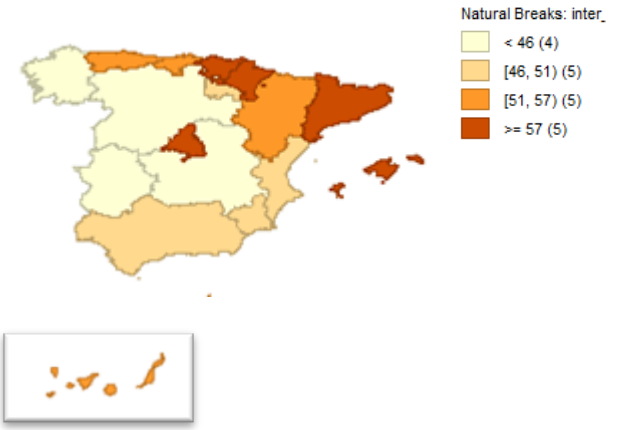
4. A Sector (Agriculture, forestry & fishing)



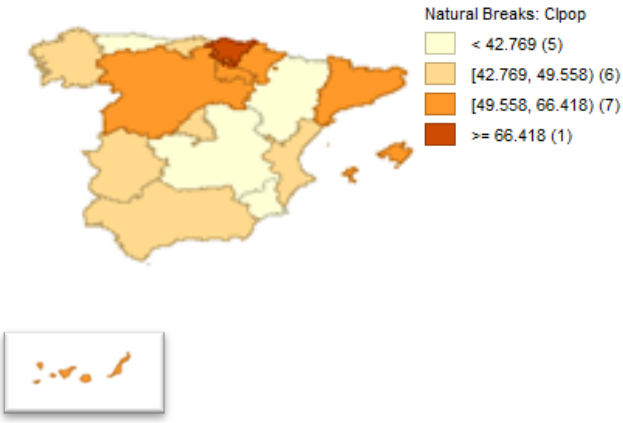
5. Employment in technology & knowledge-intensive



6. Tertiary Education



7. Internet access



Our Composite Indicator

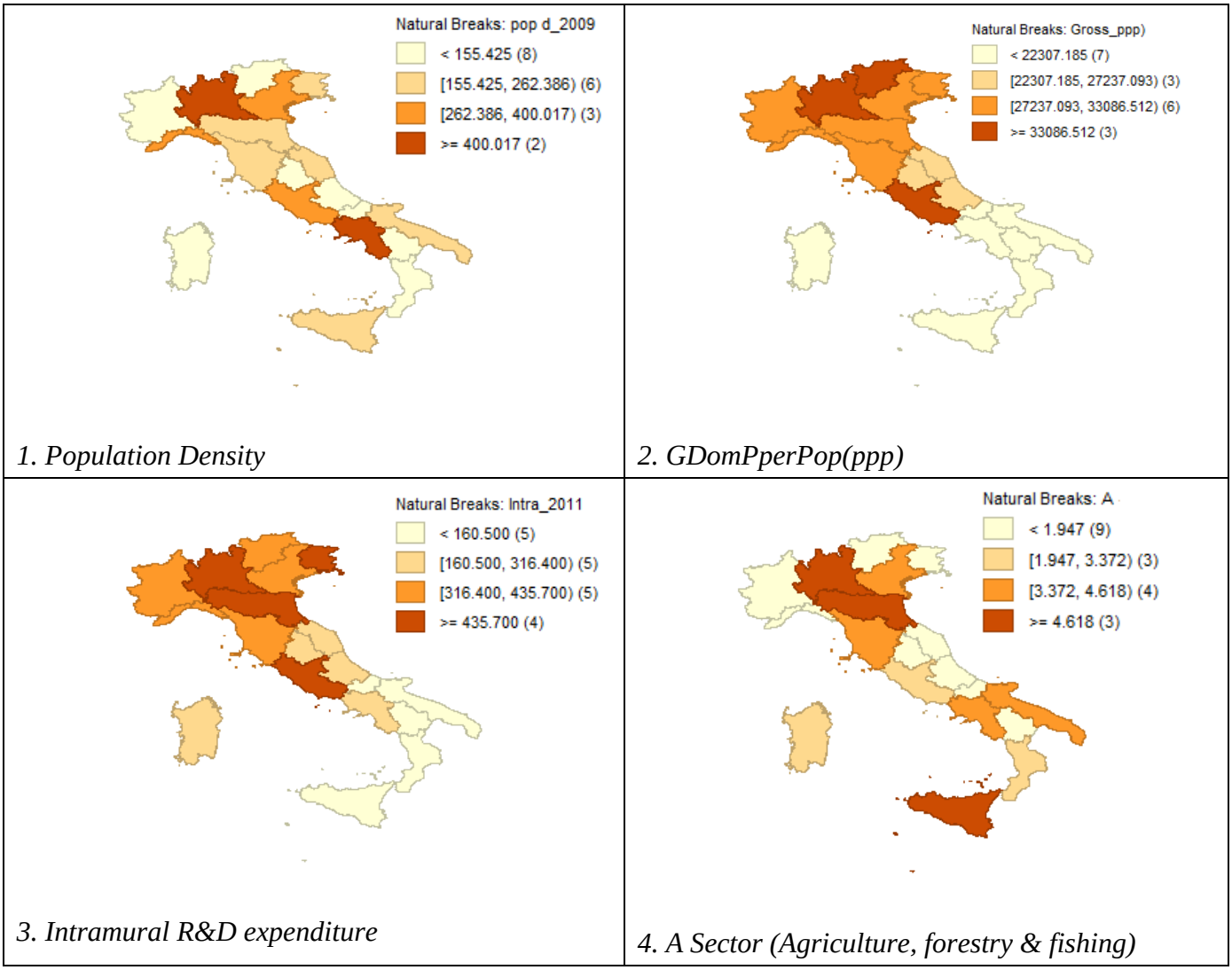
Table 9: Levels of structural variables (Spain). Own creation.

In the one hand, Italy seems to have a more mixed picture, as Population density, Agriculture and Employment in technology , do not appear to be concentrated only in the Northern part of the country. On the other hand, the rest of the structural variables, GDP, R&D, Tertiary Education and Internet access are dominant in the Central-North part of Italy.

The fact that the wealthiest regions, which are located in the North, coincide with the regions that demonstrate the highest resilience, explains the positive relationship between GDP and CI. Both in Spanish and Italian regions the wealthiest regions appear to have a positive and significant relationship with our CI. This probably indicates that the initial conditions are closely related with the resilient pattern. In

other words, the resilience of Spanish and Italian regions may be explained by their historical pattern.

Sicilia is among the poorest regions and least resilient, even though it has along with Lazio very high employment in technology and knowledge-intensive sectors. Sicilia is also characterized for its agriculture sector intensity, along with Emilia Romagna, which has low resilient and Lombardia which has not so high resilient, and the negative sign (but not significant) presents this negative relationship between agriculture and CI. However, we need to have in mind, that the correlation between CI and A sector (agriculture, forestry and fishing) investigates whether the primary sector correlates with resilient. In other words, this particular relationship indicates nothing about the rural communities and self-reliance.

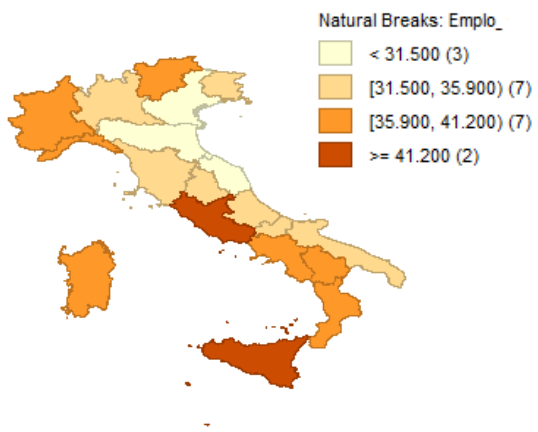


1. Population Density

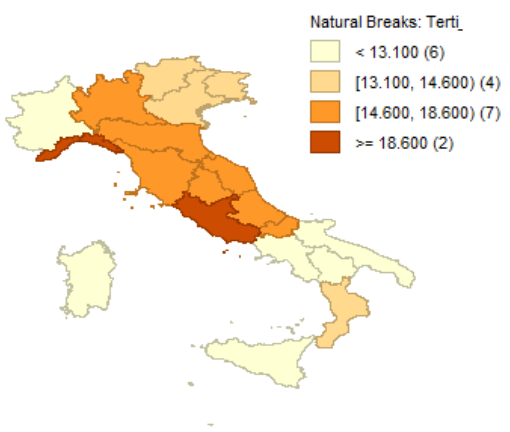
2. GDomPperPop(ppp)

3. Intramural R&D expenditure

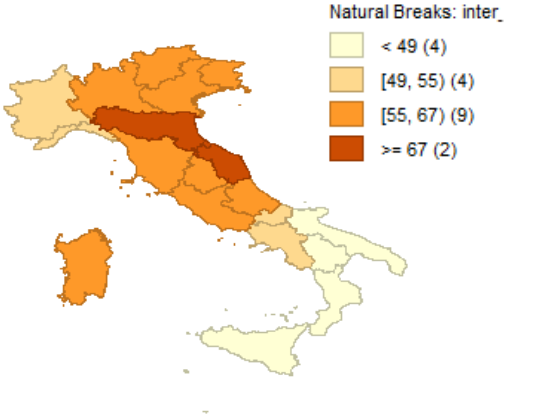
4. A Sector (Agriculture, forestry & fishing)



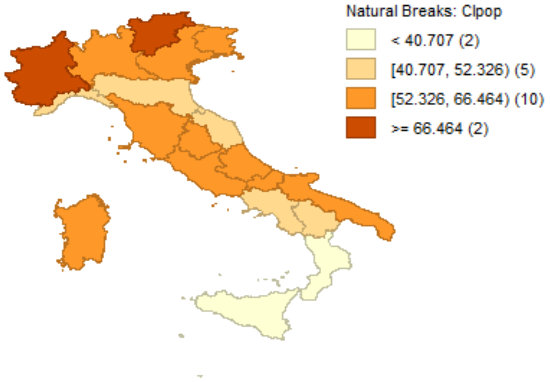
5. Employment in technology & knowledge-intensive



6. Tertiary Education



7. Internet access

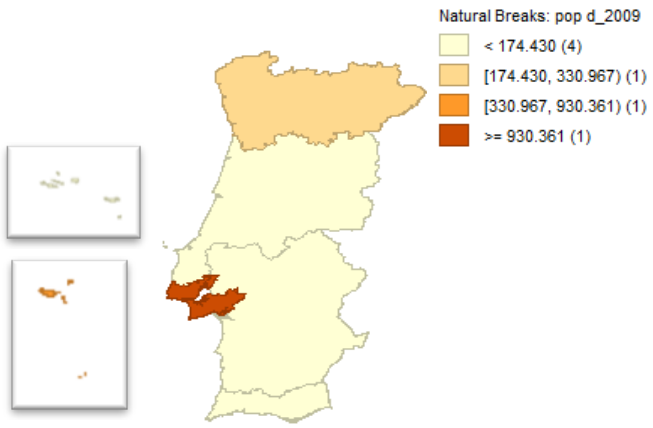


Our composite Indicator

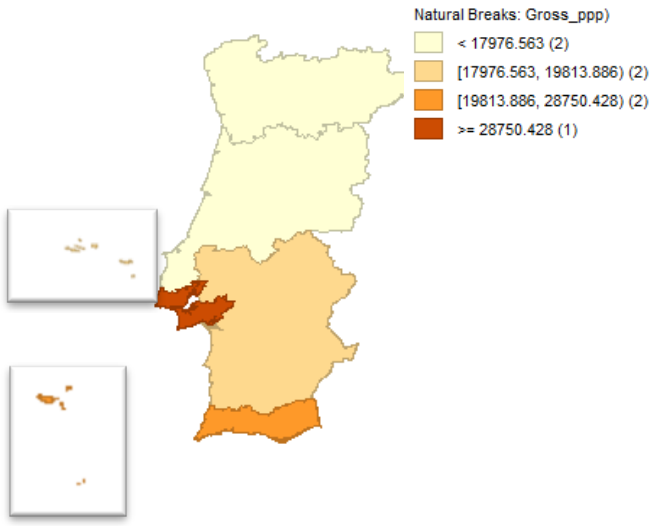
Table 10: Levels of structural variables (Italy). Own creation.

In the case of Portugal is harder to identify a pattern as there are much fewer regions. Capital region once again has the highest values in all the structural variables. Coastal areas seem to concentrate most of the GDP, Employment in Technology, and Internet access.

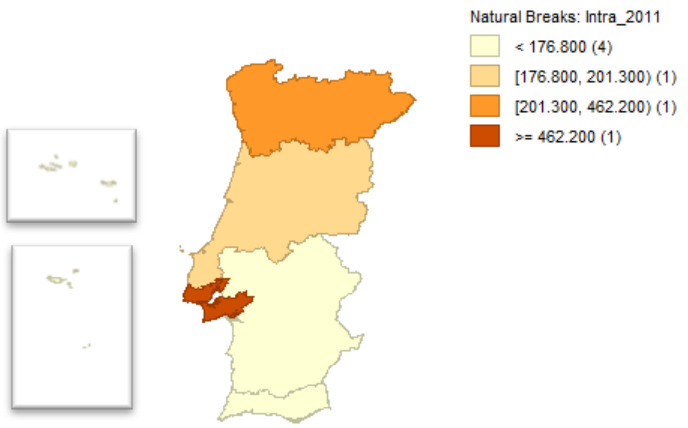
For a reminder, the majority of the population and wealth tends to be concentrated in coastal regions and as a result Portugal indicates a strong rural-urban divide. However, the capital region once again, is not among the highest resilient regions. All 6 Portuguese sectors appear to have a positive and significant relationship with our CI, in contrast to Spanish and Italian case where none of the sectors appear to demonstrate significant correlation.



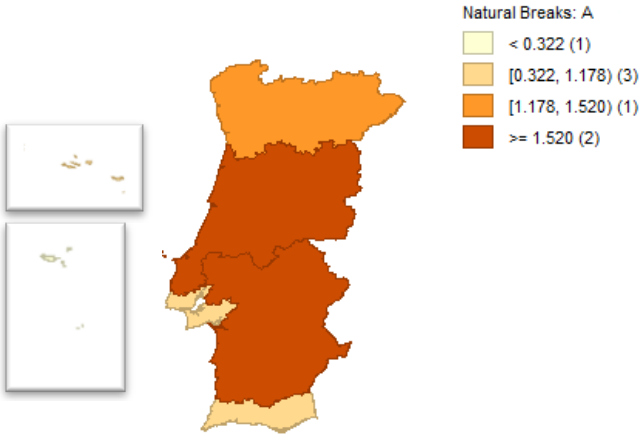
1. Population Density



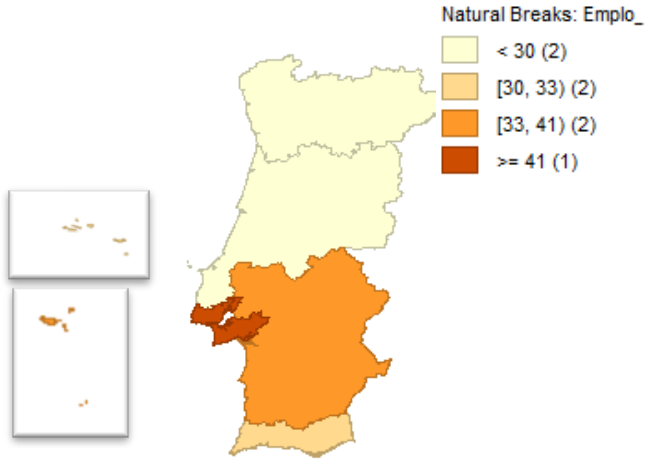
2. GDomPperPop(ppp)



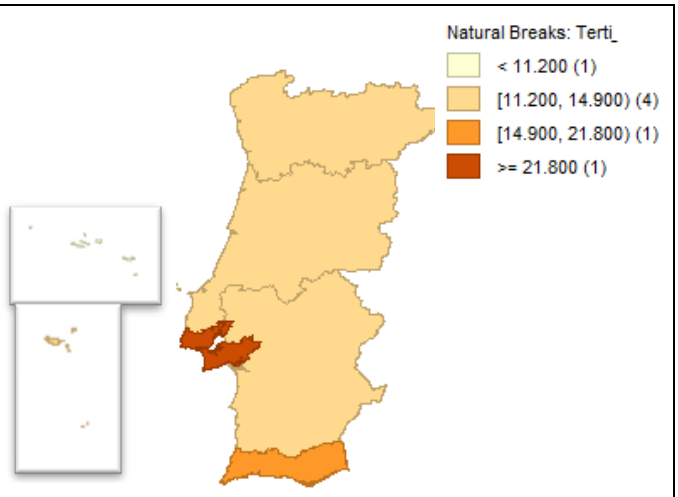
3. Intramural R&D expenditure



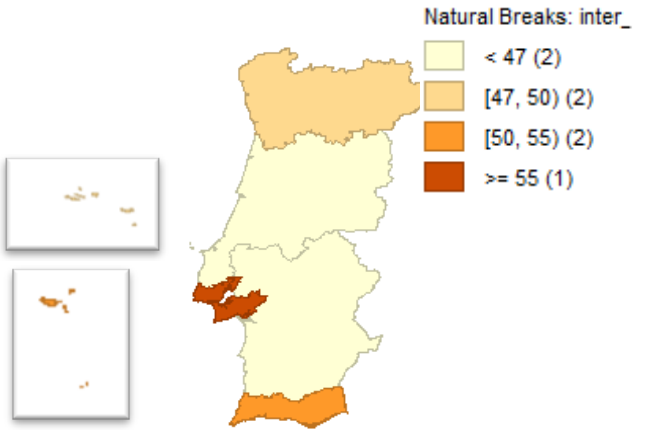
4. A Sector (Agriculture, forestry & fishing)



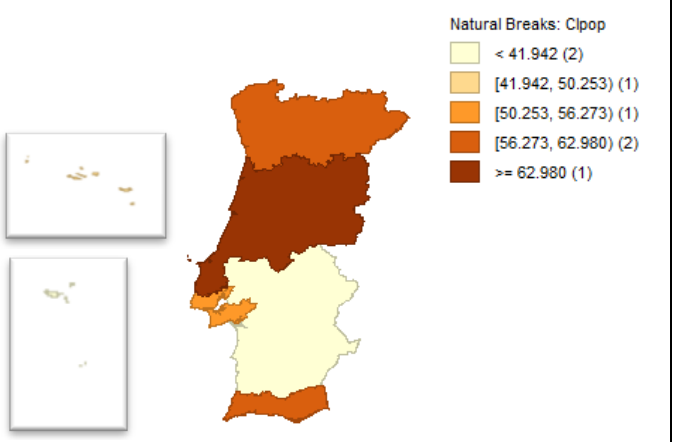
5. Employment in technology & knowledge-intensive



6. Tertiary Education



7. Internet access



Our composite indicator

Table 11: Levels of structural variables (Portugal). Own creation.

5.3.2. Correlation analysis

In that subsection, we present Table 13 which summarizes the results of our correlation analysis. We have performed a correlation between the CI and each of the 12 structural variables. We have indicated with bolt the values of coefficient correlation that are greater than 0,3 (r>0,3) . It should be mentioned that correlation does not imply causation. Correlation and causality should not be confused with each other, in order to avoid causal fallacy (= *two events which appear together of follow one another are presumed to a causal relationship, rather than just appear before or next to the other*) (Sassower, 2017).

The variable *GDP per hab (ppp)* is correlated with three out of four countries; moderate correlation is identified in Spanish, Italian and Portuguese regions. The variable *Intramural R&D expenditure (GERD) by sectors of performance* 2011 is correlated with the CI of the four countries, while the variable *Employment in technology and knowledge-intensive sectors* is weakly correlated with Greek CI and is strongly correlated with Portuguese CI. *Tertiary education* is correlated with two out of four countries; a strong correlation is identified in Greek and moderate Spanish regions. Also, *A(Agricultural) sector* is correlated with two out of four countries CI; moderate correlation is evident in Greek and Portuguese regions. Portugal's CI is correlated with the 6 sectors, especially Manufacturing (B-E Sectors) and Construction (F Sectors) indicate a strong correlation, while the rest 3 sectors indicate a moderate correlation. Population density has no significance and Internet access is moderatly correlated with Spanish CI and weakly with Greek CI.

	Greek Regions	Spanish Regions	Italian Regions	Portuguese Regions
pop density = total and land area/pop 2009	-0,162	0,146	-0,189	-0,055
GDP per hab (ppp)	0,145	**0,306**	**0,485**	-0,070
Intramural R&D expenditure (GERD) by sectors of performance 2011	**-0,462**	**0,341**	**0,326**	**0,356**
Employment in technology and knowledge-intensive sectors	**-0,293**	0,034	-0,147	**-0,572**
A Sectors	**-0,436**	-0,195	-0,213	**0,357**
B - E Sectors	-0,212	0,097	0,155	**0,616**
F Sectors	-0,242	-0,058	0,061	**0,600**
G - J Sectors	-0,186	-0,026	0,076	**0,432**
K - N Sectors	-0,186	-0,039	0,109	**0,356**
O - U Sectors	-0,241	-0,050	-0,092	**0,469**
Tertiary Education	**-0,694**	**0,377**	-0,147	0,203
internet access	**-0,294**	**0,352**	0,212	0,008

Table 12: Correlation analysis CI and structural variables. Own creation.

The regions of the four selected Southern European countries (Greece, Spain, Italy and Portugal) show a high degree of heterogeneity, as far as their resilience to the recessionary shock of 2009. Very limited regions appear to have high resilience, as only 7 regions (out of a total 58) have a value greater than 60/100, while 10 have a value lower than 40/100. In other words, the economic shock did not have the same impact on the regions.

The societal aspect of the crisis should not be ignored, because economic effects are insufficient to capture the effects of the crisis (Artelaris, 2017). Central Greece appeared to be more resilient, along with the Island regions, while the more urbanized regions performed worse. In the case of Spain and Italy, a North-South divide is more evident, where the North appeared more resilient. However, the combination of social and economic factors, knowledge sharing and human skills can explain the resilience of the Italian regions (Di Caro, 2015). The resilience of Spanish regions varies according to their socio-economic characteristics, where the higher resilient regions and the lower regions share common features (Ubago Martinez, et al., 2019) In the case of Portugal, coastal regions didn't perform very well and more rural areas indicated higher resilience. Finally, different characteristics of Portuguese regions explain the different resilience realities (Hennebry, 2020). In fewer words, by looking the Appendix, that presents the normalized individual indicators for Greek regions during 2009-2015 and for Spanish, Italian and Portuguese regions during 2009-2013 where all variables have a positive meaning (the higher the value the better), it is obvious that the most resilient regions share economical, societal and demographical characteristics.

Our study compared the rankings obtained using the most two common single indicators (GDP per habitat growth rate and unemployment rate) with the ranking of the CI and as we showed those three indexes do not provide the same results. This indicates the limitations of GDP, as the most economically successful countries are not the most resilient, meaning that this indicator is missing the real well-being of the regions, which are captured from other indicators (economical, societal, demographical, among others). The failures to account for those, some studies choose unemployment over GDP because it captures a societal aspect of the economic phenomenon under investigation. Our CI correlates with the unemployment growth

rate at a more significant level than GDP growth per habitat. However, composite indices have the advantage to explore an economic phenomenon, like regional economic resilience holistically.

The puzzle of regional economic resilience is not only solved by indicating that the impacts of the crisis are not homogeneously distributed, but it is also crucial to identify what may explain that asymmetry. Giannakis and Brugmann (2015) indicated the important role of agriculture in the Greek countryside, which forms a safety net against the current economic downturn, providing a possible explanation for the higher resilience of Greek rural regions. They also stated the resilience of the island regions compared to continental regions was mainly attributed to the positive industry-mix and regional shift effects of the tourism sector. In other words, the resilience of island regions could be attributed to the resilience of the tourism industry (Karoulia et al, 2016). Di Caro (2015) assumes that manufacturing and industrialization activities, explain the high resilience of the Northern Italian regions. Ubago Martinez (2020), found that industry-oriented economies, with higher-quality public and human capital, appear to be the most resilient. Hennebry (2020) highlights that agriculture and manufacture were among the determinants of the Portugal region's resilience. So, the second scale of our study explored the relationship among the CI and the levels of 12 structural variables, which include human capital, level of economic product, innovation and sectoral composition.

Focusing on Greece's structural variables and the results from the correlation analysis with the CI, Employment in Technology has a weak negative correlation, R&D expenditure and Agriculture have moderate negative correlation and Tertiary Education has a strong negative correlation. It is obvious that the region of Attica, which contains the capital of the country, has the higher values in all variables, except Agriculture. Notio Agaio, Sterea Ellada and Peloponnisos are the top 3 resilient regions. However, they have among the lowest values on structural variables. This negative relationship is indicated in the negative sign of the correlation analysis, which means the higher (lower) the value of the structural variable the lowest (highest) is the resilience of the region. R&D expenditure, Employment in technology and knowledge-intensive sectors and tertiary education are not translated into resilience.

A mainstream explanation for that is (a) the limited progress that has been made in extramural research funding, as between 2005 to 2011 there was a statistically significant decrease of 4 per cent, (b) the attraction of large multinational technologies companies is relative low (c) the underperfomance of Greek Universities, as between 2005 and 2011 academic researchers increased by 12.7 per cent, while R&D expenditure increased by only 2.1 per cent. (Arzimanoglou & Ikonomidou, 2014). Komninos & Tsamis (2008), examined the research, and technology and innovation policies implemented in Greece over the period 1990-2008 and claimed that the Greek system of innovation is problematic, due to important asymmetries and failure of innovation policy to properly address them and also due to limited innovation measures at a regional scale in the Cohesion Structural Funds regional operational programmes.

The above can also be relevant for the Spanish case, as most of the regions do not have a powerful ICT (Information and Communication Technologies) and only the region of Madrid is a significant contribution, also the TFP contribution has been negative, due to the higher contribution of tourism, wholesale and construction (Mas et al., 2009). Even though, the correlation is not significant the sign is negative indicating that all sectors except manufacturing have a negative relationship with our CI.

Only two structural variables correlate positively with the CI of Italian regions GDP per habitat levels and R&D expenditure. Probably the highly polarized economy may explain why there is a relationship between local cognitive capital and growth (Capello et al., 2009), indicating that the resilience depends strongly on the regional effect, such as the competitive regional advantages in terms of natural resources, human capital, entrepreneurial abilities (Martini, 2020).

Portugal's results should be examined with more caution because the number of the regions is very small, so the correlation may overestimate these values and that is why Portuguese regions appear to have the most significant correlation values. Agriculture, as expected, appears to have a positive relationship with CI. Employment in Technology has a very strong negative correlation, so the explanation of the Greek case may be relevant for Portuguese too.

The aim of this study is not only to identify whether there is a national geographical pattern of economic resilience and what is the explanation on the national level, but aims also to identify whether these four countries have something in common. Intramural R&D expenditures, Tertiary education and Employment in technology and knowledge-intensive sectors, may be important indicators for regional resilience, agreeing with the results of Svodova & Klementova (2014), while population density do not seem to correlate and although the value is not significant, it may worth to mention that the sign is negative. In other words, urban areas did not perform better during the 2009 crisis, probably due to their higher exposure to international and EU competition.

Despite that the most innovative regions do not seem to be rewarded in term of CI, this doesn't seem that crisis is an opportunity for lagging regions. Filippetti et al. (2020), underlined that most of the opportunity that is has been created during crisis was grasped by those regions which had already a strong regional system of innovation. Thus, economic turbulence didn't enable the reshaping of the power relations. That's why the asymmetry at the national level didn't alter before and after the crisis.

Papadopoulos et al. (2019), after conducting a qualitative analysis in two Greek islands (Syros and Andros), revealed that it may be more accurate to speak about "resilience in rural locales" rather than the "resilience of rural locales", meaning that rural resilience should be seen as a capacity to be resilient through living and being active and cannot be seen as an inherent characteristic of rural areas. This could probably link to the theory of "self-relience" economy, where self-consumption acts as a safety net to the households (Panagiatopoulou, 2011). In other words, self-consumption in rural regions is not a pre-capitalistic characteristic of the production, but rather a vital characteristic for every social transformation, where households are both economical and social units with ressistance power from the full dependence of the economic market.

6. Conclusions

The question of why regions did not perform the same during the economic crisis of 2009 provides compelling motivation for analysis of the regional resilience concept. In chapter 2, the theoretical framework of resilience was presented, along with the critical arguments. Although there is theoretical literature that investigates regional resilience, there is no a coherent theory of regional economic resilience. However, the notion of economic resilience is getting a lot of attention and has entered not only academic but policy discussions also. Regional resilience is a multidimensional phenomenon, with no generally accepted methodology on how to measure and evaluate regional economic resilience. In chapter 3 we presented our study area. In chapter 4 we presented the method of composite indicator. Our aim was to explore this phenomenon holistically, so we constructed a composite index for the regions of four selected southern European countries (Greece, Spain, Italy and Portugal) for the period 2009-2015. In section 4 we presented our results. According to our findings, the resilience of regions was not homogenous in terms of our composite indicator, as some regions indicated higher resilience values than others. In general, the most urbanized regions, the metropolitans, were not the ones with the higher resilience scores. Also, our analysis found that the regional rankings in terms of our composite indicator were different from rankings in terms of GDP growth and unemployment rate, highlighting that socioeconomic characteristics are essential when we try to understand the impacts of an economic disturbance. We also wanted to investigate whether there is a relationship between out composite indicator and 12 structural variables, so we performed a correlation analysis to identify the drivers of regional economic resilience. We are aware that correlation do not indicate causation, and those result are a primary stage for further research. Intramural R&D expenditures, Tertiary education and Employment in technology and knowledge-intensive sectors, may be important indicators for regional resilience as they had the stronger correlation with our CI.

This study has explored regional economic resilience literature by constructing a composite indicator. The potential policy implications worth considering include its

possible use to support decision-making of regional policy-makers, especially during the after COVID-19 period, where cities metropolitan regions appeared the less resilient.

Other aspects like cohesion policy and social welfare require further analysis when studying the regional economic resilience. Also, this study focused only on resilience and not on recovery, so we suggest that also for a next research.

References

Alessi, L. *et al.* (2020) 'The Resilience of EU Member States to the Financial and Economic Crisis', *Social Indicators Research*. Springer Netherlands, 148(2), pp. 569–598.

Alexander, D. E. (2013). Resilience and disaster risk reduction: an etymological journey. *Natural hazards and earth system sciences*, *13*(11), 2707-2716.

Annoni, P., de Dominicis, L. and Khabirpour, N. (2019) 'Location matters: A spatial econometric analysis of regional resilience in the European Union', *Growth and Change*.

Annoni, P., De Dominicis, L., & Prognos, N. K. (2019). *The great recession: main determinants of regional economic resilience in the EU*. EU Working Paper.

Artelaris, P. (2021). Regional economic growth and inequality in Greece. *Regional Science Policy & Practice*, *13*(1), 141-158.

Artelaris, P. (2017) 'Geographies of crisis in Greece: A social well-being approach', *Geoforum*.

Artola, C., Gil, M., Pérez, J. J., Urtasun, A., Fiorito, A., & Vila, D. (2018). Monitoring the Spanish economy from a regional perspective: main elements of analysis. *Banco de Espana Occasional papers*.

Arzimanoglou, I. & Ikonomidou A. (2014). Impact of the economic crisis on R&D in Greece may not be as bad as feared. Science Business. Available online **here**. Last accessed on 18/02/2021.

Bank f Italy (2019). The economy of the Italian regions: Short-term dynamics and structural features. Available online **here**. Last accessed on 03/02/2021.

Benczur, P., Joossens, E., Manca, A. R., Menyhert, B., & Zec, S. (2020). *How resilient are the European regions? Evidence from the societal response to the 2008 financial crisis* (No. JRC121554). Joint Research Centre (Seville site).

Booysen, F. (2002). An overview and evaluation of composite indices of development. *Social indicators research*, *59*(2), 115-151.

Brakman, S., Garretsen, H. and Van Marrewijk, C. (2015) 'Regional resilience across Europe: On urbanisation and the initial impact of the Great Recession', *Cambridge Journal of Regions, Economy and Society*.

Briguglio, L., Cordina, G., Farrugia, N., & Vella, S. (2006). Conceptualizing and measuring economic resilience. *Building the economic resilience of small states, Malta: Islands and Small States Institute of the University of Malta and London: Commonwealth Secretariat*, 265-288.

Bristow, G. and Healy, A. (2015) 'Crisis response, choice and resilience: Insights from complexity thinking', *Cambridge Journal of Regions, Economy and Society*.

Bristow, G., & Healy, A. (2018 b). Innovation and regional economic resilience: an exploratory analysis. *The annals of regional science*, *60*(2), 265-284.

Bristow, G., & Healy, A. (Eds.). (2018). *Economic crisis and the resilience of regions: A European study*. Edward Elgar Publishing.

Bristow, G., Healy, A. (2018 c). Innovation and regional economic resilience: an exploratory analysis.Annals in Regional Science,60(2), 265–284

Capello, R., Caragliuy, A. and Fratesi, U. (2014) 'Spatial heterogeneity in the costs of the economic crisis in Europe: Are cities sources of regional resilience?', *Journal of Economic Geography*.

Chakravorti, B., Bhalla, A. and Chaturvedi R.S. (2020). Which Economies Showed the Most Digital Progress in 2020?. Available online **here**. Last accessed on 16/02/2021

Cho, C. J. (2014). A Workable Framework or a Fuzzy Concept? The Regional Resilience Approach to the Evolution and Adaptability of Regional Economies. *World Technopolis Review*, *3*(2), 66-77.

Cooke, P., Bristow, G., & Porter, J. (2011). Regional resilience literature review. *Bordeaux, France*.

Crescenzi, R., Luca, D. and Milio, S. (2016) 'The geography of the economic crisis in Europe: National macroeconomic conditions, regional structural factors and short-term economic performance', *Cambridge Journal of Regions, Economy and Society*.

Cuadrado-Roura, J. R. (2009). Spain as a Case-Study: Regional Problems and Policies. In *Regional Policy, Economic Growth and Convergence* (pp. 3-18). Springer, Berlin, Heidelberg.

Dawley, S., Pike, A. and Tomaney, J. (2010) 'Towards the resilient region?', *Local Economy*.

De Vogli, R., Marmot, M., & Stuckler, D. (2013). Strong evidence that the economic crisis caused a rise in suicides in Europe: the need for social protection. *J Epidemiol Community Health*, *67*(4), 298-298.

Di Caro, P. (2015). Recessions, recoveries and regional resilience: evidence on Italy. *Cambridge Journal of Regions, Economy and Society*, *8*(2), 273-291.

Drobniak, A. (2012). The urban resilience–economic perspective. *Journal of Economics and Management*, *10*, 5-20.

Eraydin, A. (2013). "Resilience Thinking" for Planning. In *Resilience thinking in urban planning* (pp. 17-37). Springer, Dordrecht.

Eraydin, A., & Taşan-Kok, T. (2013). The Evaluation of Findings and Future of Resilience Thinking in Planning. In *Resilience Thinking in Urban Planning* (pp. 229-239). Springer, Dordrecht.

European Commission (2020). New Commission report shows the importance of digital resilience in times of crisis. Available online **here**. Last accessed on 16/02/2021

European Commission (2021). Recovery plan for Europe. Available online **here**. Last accessed on 22/02/2021.

European Commission. (2013). *The Urban and Regional Dimension of the Crisis: Eighth Progress Report on Economic, Social and Territorial Cohesion*. Publications Office of the European Union.

European Committee of the Regions (2017). 'Opinion of the European Committee of the Regions — Strengthening territorial resilience: empowering regions and cities to face globalisation'. *Official Journal of the European Union.* Available online **here**. Last accessed on 12/09/2020.

Eurostat (2020). Gender pay gap statistics. Available online **here**. Last accessed on 12/02/2021.

Farrugia, N. (2007). Conceptual issues in constructing composite indices. Occasional Papers on Islands and Small States

Filippetti, A., Gkotsis, P., Vezzani, A., & Zinilli, A. (2020). Are innovative regions more resilient? Evidence from Europe in 2008–2016. *Economia Politica*, *37*(3), 807-832.

Forster, M., Llena Nozal, A., & Thévenot, C. (2017). Understanding the socioeconomic divide in Europe. *Organization for Economic Cooperation and Development—COPE Centre for Opportunity and Equality*.

Foster, K. (2006) 'A Case Study Approach to Understanding Regional Resilience', *Annual Conference of the Association of Collegiate Schools of Planning*.

Fröhlich, K., & Hassink, R. (2018). Regional resilience: a stretched concept?. *European Planning Studies, 26*(9), 1763-1778.

Giacometti, A., & Teräs, J. (2019). *Regional economic and social resilience: An exploratory in-depth study in the Nordic Countries*. Nordregio.

Giannakis, E. and Bruggeman, A. (2017) 'Determinants of regional resilience to economic crisis: a European perspective', *European Planning Studies*.

Gómez-Loscos, A., Gadea, M. D., & Bandres, E. (2020). Business cycle patterns in European regions. *Empirical Economics*, *59*(6), 2639-2661.

Groot, S. P., Möhlmann, J. L., Garretsen, J. H., & de Groot, H. L. (2011). The crisis sensitivity of European countries and regions: stylized facts and spatial heterogeneity. *Cambridge Journal of Regions, Economy and Society*, *4*(3), 437-456.

Guerrieri, P. (2013). The Rise of Unemployment in the Eurozone: The Worst of the Crisis is Not Over. *The G-20 and Central Banks in the New World of Unconventional Monetary Policy*, *51*.

Hassink, R. (2010) 'Regional resilience: A promising concept to explain differences in regional economic adaptability?', *Cambridge Journal of Regions, Economy and Society*.

Hennebry, B. (2020). The determinants of economic resilience in rural regions. An examination of the Portuguese case. *Miscellanea Geographica*, *1*(ahead-of-print).

Hill, E. *et al.* (2012) 'Economic shocks and regional economic resilience', in *Urban and Regional Policy and Its Effects: Building Resilient Regions*.

Hill, E., Wial, H. and Wolman, H. (2008) 'Exploring regional economic resilience', *Working Paper, Berkley IURD*.

Holling, C. S. (1973). 'Resilience and stability of ecological systems'. *Annual review of ecology and systematics*, *4*(1), 1-23.

Humbert, C., & Joseph, J. (2019). Introduction: the politics of resilience: problematising current approaches. *Resilience*, *7*(3), 215-223.

Huwart, J. Y., & Verdier, L. (2013). 'The 2008 financial crisis–a crisis of globalization'. *Economic globalisation: origins and consequences*, 126-143.

IMF (2011). Italy: Selected Issues. Available online **here**. Last accessed on 03/02/2021.

Joint Research Centre, Prototype dashboard for monitoring the social and economic dimension of resilience, 2020, JRC121729.

Karoulia, S., Gaki, E., Kostopoulou, S., & Lagos, D. (2016). Greek tourism sector and signs of resilience.

Keaveny, P. (2016) 'How poverty has radically shifted across Europe in the last decade'. Available online **here**. Last accessed on 13/01/2021.

Kitsos, A., & Bishop, P. (2018). Economic resilience in Great Britain: the crisis impact and its determining factors for local authority districts. *The Annals of Regional Science*, *60*(2), 329-347.

Komninos, N., & Tsamis, A. (2008). The system of innovation in Greece: structural asymmetries and policy failure. *International Journal of Innovation and Regional Development*, *1*(1), 1-23.

Lindén, D. (2018). Exploration of implicit weights in composite indicators: the case of resilience assessment of countries' electricity supply. In Degree Project

Environmental Engineering,Second Cycle. Available **here**. Last accessed on 12/02/2021.

Martin, N. (2015). Building Resilience Through Greater Adaptability To Long-Term Challenges.

Martin, R. (2012) 'Regional economic resilience, hysteresis and recessionary shocks', *Journal of Economic Geography*.

Martin, R., & Sunley, P. (2015). On the notion of regional economic resilience: conceptualization and explanation. *Journal of Economic Geography, 15*(1), 1-42.

Mas, M., Pérez, F., & Quesada, J. (2009). The sources of Spanish regional growth. In *Regional Policy, Economic Growth and Convergence* (pp. 125-148). Springer, Berlin, Heidelberg.

Milio, S., Durazzi, N., Garnizova, E., Janowski, P., Olechnicka, A., & Wojtowicz, D. (2014). Impact of the economic crisis on social, economic and territorial cohesion of the European Union.

Moghaddam. Santa Barbara, Calif.: Praeger Security International.

Monastiriotis, V. (2008). Greece: Country report. *Economy (Greece) in Central and South-eastern Europe. Europa regional surveys of the world series*.

Moqhaddam, F. (2010). *The New Global Insecurity: How Terrorism, Environmental Collapse, Economic Inequalities, and Resource Shortages are Changing our World*/Fathali M.

Moreira, S. B., & Crespo, N. (2017). Composite Indicators of Development: Some Recent Contributions. In *Emerging Trends in the Development and Application of Composite Indicators* (pp. 140-162). IGI Global.

Müller, B. (2011) 'Urban and Regional Resilience – A New Catchword or a Consistent Concept for Research and Practice?'

Munda, G., & Nardo, M. (2005). Constructing consistent composite indicators: the issue of weights. *EUR 21834 EN*, 1-11.

Musolino, D. (2018). The north-south divide in Italy: reality or perception?. *European Spatial Research and Policy*, *25*(1), 29-53.

Nardo, M., Saisana, M., Saltelli, A., & Tarantola, S. (2005). Tools for composite indicators building. *European Comission, Ispra*.

National Geographic (2015).' Wild Weather'. Available online **here**. Last accessed on 10/09/2020.

OECD (2008). *Handbook on constructing composite indicators: methodology and user guide*.

Oprea, F., Onofrei, M., Lupu, D., Vintila, G., & Paraschiv, G. (2020). The Determinants of Economic Resilience. The Case of Eastern European Regions. *Sustainability*, *12*(10), 4228.

Panagiatopoulou, R. (2011). The evolution of self-consumption of rural households. *In Economy and Policy in Contemporary Greece. Dionikos.* [In Greek].

Papadopoulos, A. G., Fratsea, L. M., Karanikolas, P., & Zografakis, S. (2019). Reassembling the Rural: Socio-Economic Dynamics, Inequalities and Resilience in Crisis-Stricken Rural Greece. *Sociologia Ruralis*, *59*(3), 474-493.

Pavel, A., Moldovan, B. A., Kourtit, K., & Nijkamp, P. (2020). Urban or Rural: Does It Make A Difference for Economic Resilience? A Modelling Study on Economic and Cultural Geography in Romania. *Sustainability*, *12*(9), 3776.

Petrakos, G., & Psycharis, Y. (2004). *Regional Development in Greece*. Kritiki. [In Greek]

Petrakos, G., & Psycharis, Y. (2016). The spatial aspects of economic crisis in Greece. *Cambridge Journal of Regions, Economy and Society*, *9*(1), 137-152.

Pontarollo, N. and Serpieri, C. (2020a) 'A composite policy tool to measure territorial resilience capacity', *Socio-Economic Planning Sciences*.

Pontarollo, N. and Serpieri, C. (2020b) 'Towards regional renewal: a multilevel perspective for the EU', *Regional Studies*. Taylor & Francis, 54(6), pp. 754–764.

Proag, V. (2014). Assessing and measuring resilience. *Procedia Economics and Finance*, *18*, 222-229.

Psycharis, Y., et al. (2012). The Spatial Footprint of the Ongoing Economic Crisis (2009-…) in Greece: Assessing the Resilience and Development of the Greek Regions. In *ERSA Conference Papers, Bratislava*.

Reeves, A., McKee, M., Gunnell, D., Chang, S. S., Basu, S., Barr, B., & Stuckler, D. (2015). Economic shocks, resilience, and male suicides in the Great Recession: cross-national analysis of 20 EU countries. *The European Journal of Public Health*, *25*(3), 404-409.

Reid, J. (2013). Interrogating the neoliberal biopolitics of the sustainable development-resilience nexus. *International Political Sociology*, *7*(4), 353-367.

Rizzi, P., Graziano, P. and Dallara, A. (2018) 'A capacity approach to territorial resilience: the case of European regions', *Annals of Regional Science*. Springer Berlin Heidelberg, 60(2), pp. 285–328.

Rodrigues, C. F. (2019). Inequality and poverty in Portugal: Does location matter?. *Sociologia On Line*, 15.

Sassower, R. (2017). Causality and Correlation. *The Wiley-Blackwell Encyclopedia of Social Theory*, 1-4.

Scherzer, S., Lujala, P., & Rød, J. K. (2019). A community resilience index for Norway: An adaptation of the Baseline Resilience Indicators for Communities (BRIC). *International Journal of Disaster Risk Reduction*, *36*, 101107.

Sen, A.K. (1980) 'Equality of What?' in S. McMurrin (ed.) Tanner Lectures on HumanValues, Cambridge: Cambridge University Press

Sensier, M. (2018). Measuring resilience across European regions. In *Economic Crisis and the Resilience of Regions*. Edward Elgar Publishing.

Sensier, M. and Devine, F. (2020) 'Understanding Regional Economic Performance and Resilience in the UK: Trends since the Global Financial Crisis', *National Institute Economic Review*.

Sensier, M., Bristow, G. and Healy, A. (2016) 'Measuring Regional Economic Resilience across Europe: Operationalizing a complex concept', *Spatial Economic Analysis*, 11(2), pp. 128–151

Sirimanne, S.N. (2020). How science, technology and innovation can help build resilience to multiple shocks. Available online **here**. Last accessed on 16/02/2021

Skagiannis, P. (2009). From S to sigma: towards a new development of greek territory?. In book: 25 essays for Planning and Developing Space. Publisher: University of Thessaly Press. In Greek

Skeith. M & Gallagher, J. (2019). Composite Indicators: An introduction to their development and use. USAID presentation. Available **here**. Last accessed on 12/02/2021.

Stanickova, M., & Melecký, L. (2018). Understanding of resilience in the context of regional development using composite index approach: the case of European Union NUTS-2 regions. *Regional Studies, Regional Science*, *5*(1), 231-254.

Stiglitz, J., Sen, A. K., & Fitoussi, J. P. (2009). The measurement of economic performance and social progress revisited: reflections and overview. Sciences Po publications 2009-33, Sciences Po.

Stockwell, I. (2008). Introduction to Correlation and Regression analysis. In *Statistics and Data Analysis. SAS Global Forum*. Available online **here**. Last accessed on 02/02/2021.

Svoboda, O. & Klementova, T. (2014). Correlation analysis and model of the regional economic resilience. *WSEAS Transactions on Business and Economics*, *11*, 765-777.

Tóth, B. I. (2015) 'Regional economic resilience: Concepts, empirics and a critical review', *Miscellanea Geographica*

Ubago Martinez, Y., García-Lautre, I., Iraizoz, B., & Pascual, P. (2019). Why are some Spanish regions more resilient than others?. *Papers in Regional Science*, *98*(6), 2211-2231.

UNHCR (2015). Over one million sea arrivals reach Europe in 2015. Available online **here**. Last accessed on 27/02/2021.

United Nations (2017). Indicator 9.5.1: Research and development expenditure as a proportion of GDP (percent). Available online **here**. Last accessed on 16/02/2021

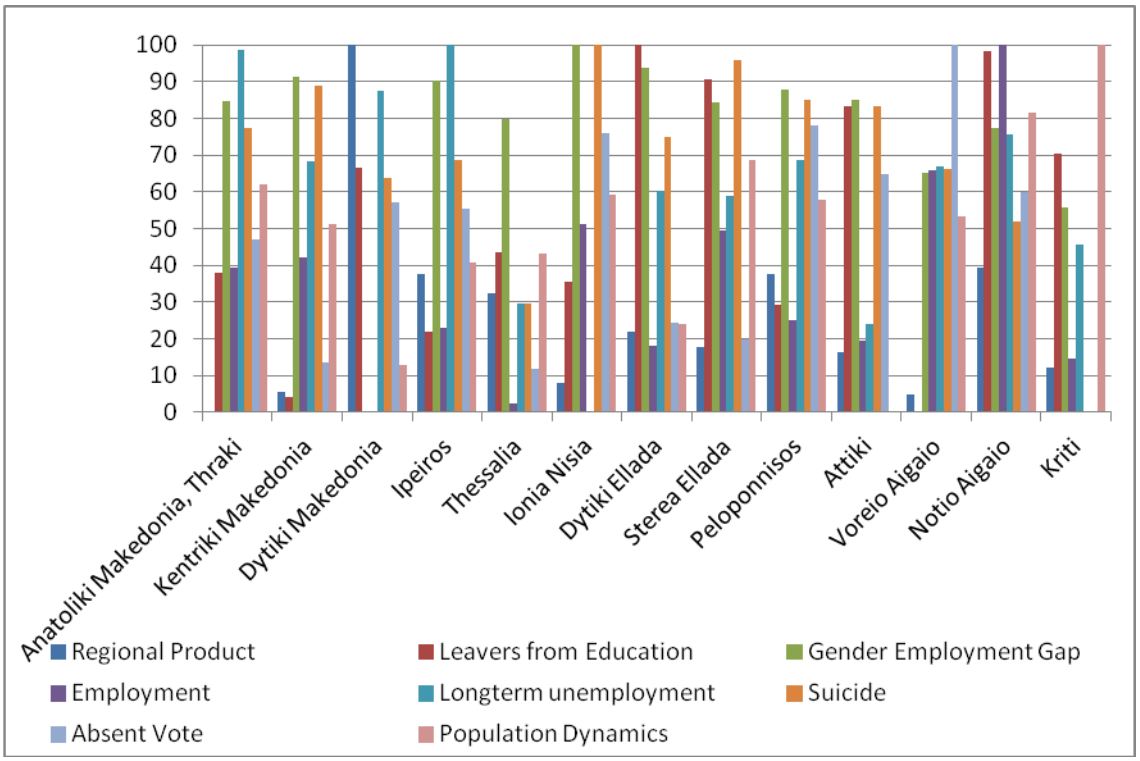
UNU (2015). Cities: Drivers of Risk or Resilience?. Available online **here**. Last accessed on 13/02/2021.

World Bank (2020). 'The Global Economic Outlook During the COVID-19 Pandemic: A Changed World'. Available online **here**. Last accessed on 10/09/2020.

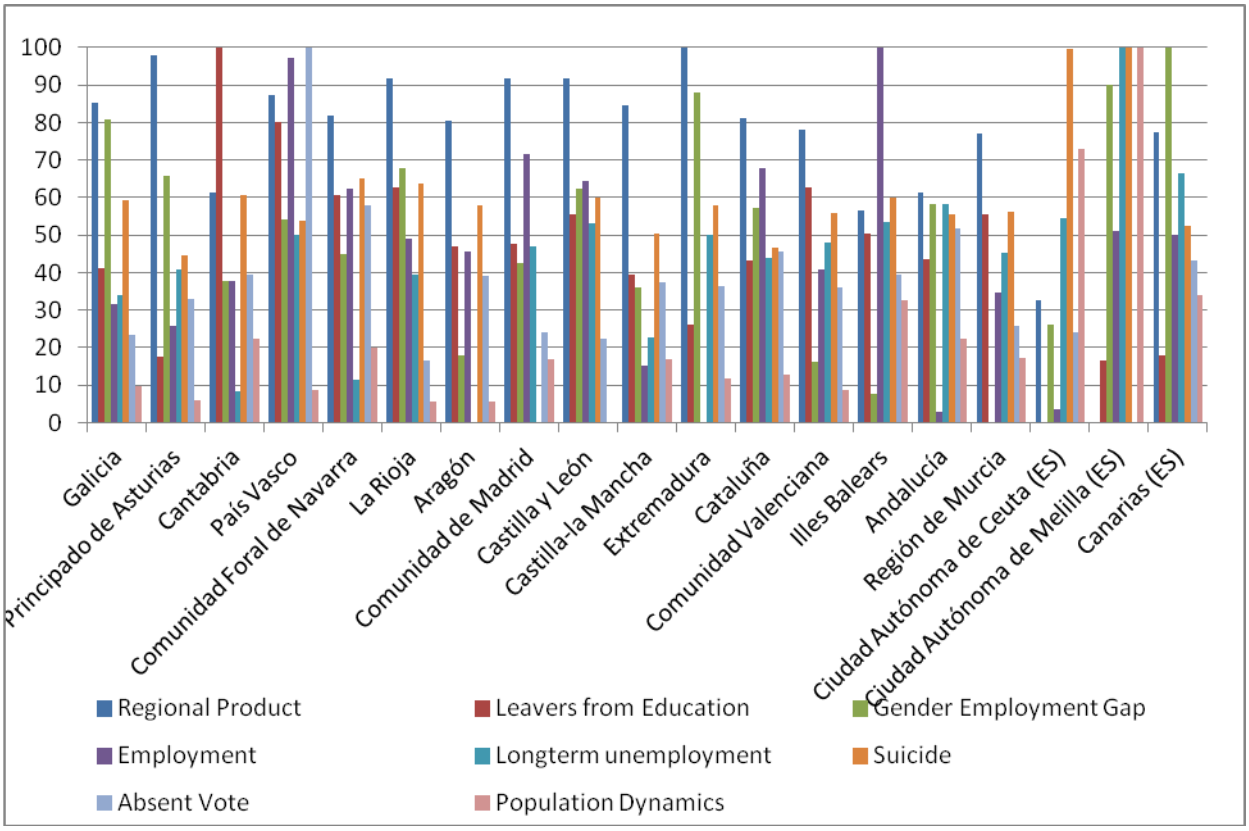
World Health Organization. (2002). The nature and use of Indicators. In *Health in sustainable development planning: the role of indicators*. World Health Organization.

Zamora-Kapoor, A., & Coller, X. (2014). The effects of the crisis: Why Southern Europe?. American Behavioral Scientist, Vol. 58(12) 1511 –1516

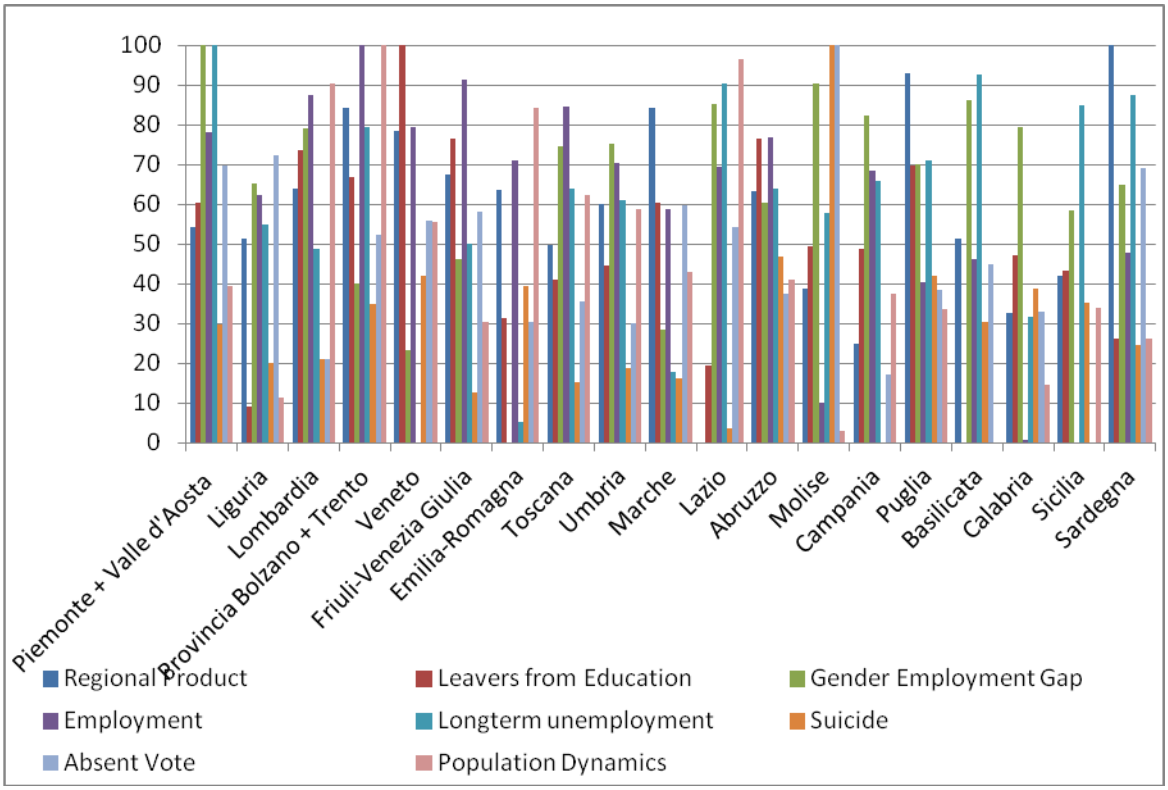
Appendix



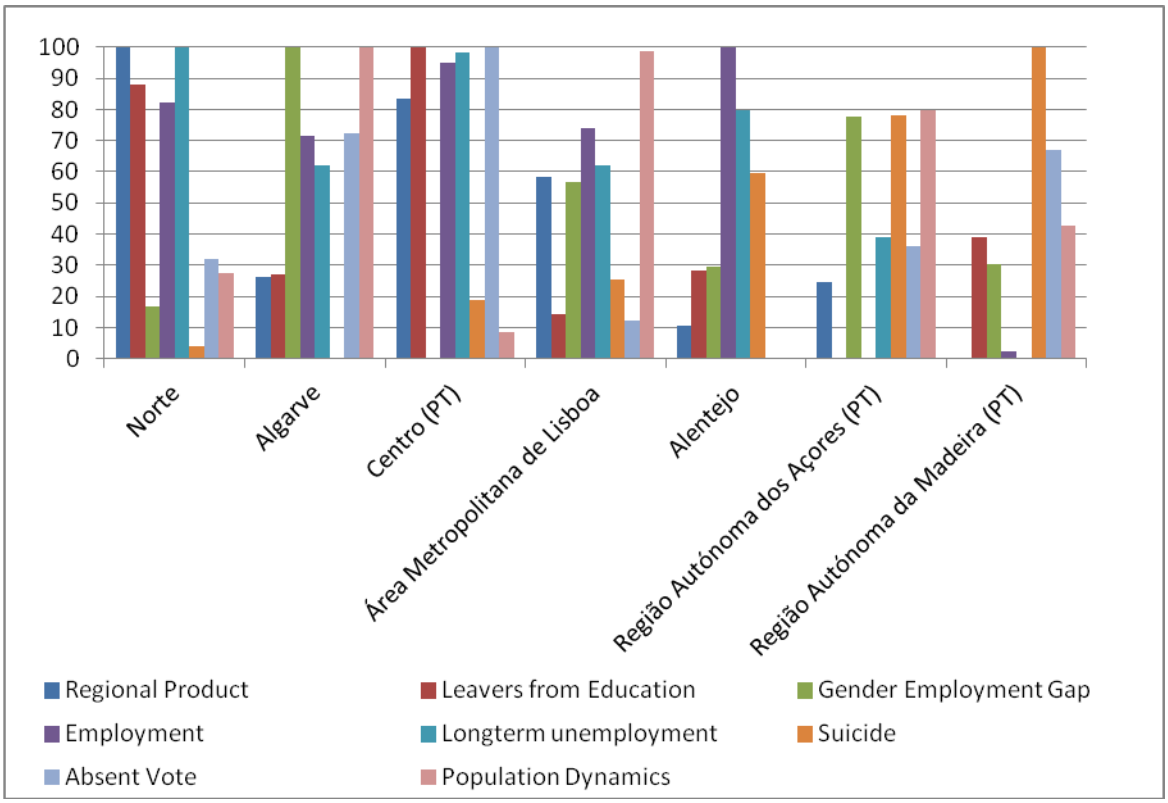
Graph A1: Greece - Normalized Individual Indicators (0-100) for the period 2009-2015. Own creation



Graph A2: Spain - Normalized Individual Indicators (0-100) for the period 2009-2013. Own creation



Graph A3: Italy - Normalized Individual Indicators (0-100) for the period 2009-2013. Own creation.



Graph A4: Portugal - Normalized Individual Indicators (0-100) for the period 2009-2013