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Master Thesis - MSc Urban Port and Transport Economics

THE EU COHESION POLICY

Capturing the Impact of Cohesion Policy Funding on Regional

Economic Growth and Convergence

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STATEMENT OF ORIGINALITY

I, Maarten Kroon, herewith declare to have written this master thesis and that I am responsible for the content of it. I declare that the presented text and work in this thesis is original and that no sources other than those mentioned throughout the text and in its references have been used in creating it.

To the best of my knowledge, this thesis contains no materials that were previously published or written by another person, or substantial proportions of material which have been accepted for the award of any other degree at Erasmus University Rotterdam School of Economics or any other educational institution. Any contribution made to the presented research by others, with whom I have worked at Erasmus University Rotterdam or elsewhere, is explicitly acknowledged.

I declare that all intellectual content of this master thesis is the product of my own work. Erasmus University Rotterdam School of Economics is responsible solely for the supervision of the completion of this thesis, not for the content of it.

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ABSTRACT

This study assesses the effectiveness of the regional cohesion policy of the European Union and the accompanied funding mechanisms in terms of regional economic development and convergence. In particular, the impact of cohesion policy funding on regional economic performance, productivity and employment is estimated on the basis of regression analysis. Furthermore, spatial heterogeneity in its impacts and regional economic spillovers of the policy are investigated, as well as spatial heterogeneity in those regional economic spillovers.

Based on a sample consisting of panel data on 279 European NUTS-2 regions over the period 2000-2018, using fixed effects modelling to disentangle time-invariant country specific and time-variant aggregate effects, it is found that the cohesion policy and the accompanied regional funding mechanisms have indeed significantly increased regional economic growth and convergence.

Moreover, empirical evidence shows that the impact of cohesion policy funding on regional economic growth and convergence is heterogeneous across space and that spatial regimes exist. Also, empirical evidence shows that cohesion policy funding is not limited to the targeted region and that economic spillovers to adjacent regions exist. Finally, it is shown that these economic spillovers are heterogeneous across space as well.

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I. INTRODUCTION

The regional policy of the European Union (EU), often referred to as cohesion policy, is one of the main funding programmes in the history of the Union. The policy refers to the EU's strategy of promoting and supporting overall harmonious development throughout its member states and regions, by aiming for inter-regional convergence, regional employment and competitiveness, and inter-regional cooperation.

As a consequence, the main aim of the cohesion policy relies on improving overall economic well-being throughout European regions and to avoid inter-regional disparities, by particularly supporting regional job creation, stimulating regional economic growth, improving sustainable development, and increasing regional convergence.

The policy is operationalized through redistributive financial transfers on the basis of a number of funding mechanisms, of which the European Regional Development Fund is the oldest. Over the years, the European Social Fund, the European Agricultural Fund for Rural Development, and the Cohesion Fund were established, making up the European Structural and Investment Funds.

Nowadays, approximately one third of the EU's budget is devoted to the funding mechanisms that support the cohesion policy. In the current programming period, lasting from 2014 to 2020, total regional funding on the basis of cohesion policy adds up to over €350 billion. In total, since the cohesion policy was founded and installed, over €900 billion has been regionally redistributed on the basis of the policy (European Commission, 2020).

Resulting from this, the cohesion policy is the EU's most intensively used financial instrument to promote economic growth throughout the regions of its member states and to stimulate and accelerate the process of convergence with respect to these regions. Consequently, it is both interesting and important to empirically validate whether these regional investments actually serve their purpose.

Building on findings in existing literature and based on a sample consisting of panel data on 279 European NUTS-2 regions over the period 2000-2018, this research aims to quantify the effectiveness of cohesion policy funding in terms of regional economic growth and convergence. Furthermore, this research aims to identify whether the impact of cohesion policy funding is heterogeneous across space, to quantify economic spillovers of cohesion policy funding to adjacent regions, and to evaluate spatial heterogeneity in these economic spillovers.

II. THEORETICAL FRAMEWORK

This section identifies, discusses and synthesises previously established literature regarding the EU's cohesion policy in general, and its effectiveness in particular. First, an overview of historic events regarding the establishment of the cohesion policy is presented, in order to create a general frame of reference. Next, characteristics of the current cohesion policy and the accompanied funding mechanisms are discussed to create an overview of the policy's current measures and goals. Finally, established literature on the effectiveness of the cohesion policy in general, and the funding on the basis of the policy in particular, is discussed to serve as guidance with regard to determining and defining the regression specifications and explanatory variables taken into consideration, when quantifying the effectiveness of cohesion policy funding in the empirical component of this research.

A. History of Regional Policy in the European Union

As said, a historic overview regarding the establishment of the cohesion policy is presented first. Starting with a description of important events regarding European international and regional cooperation, the fundamentals of the regional policy of the EU are set out. Next, the establishments of the respective funding mechanisms that make up the cohesion policy are discussed. The section evolves into a description of the early establishment of what today is referred to as the EU's cohesion policy and the several reforms the policy has gone through over the years.

European International and Regional Cooperation

In 1951, for the first time in history, European national governments agreed to transfer a part of their sovereignty to a newly founded international institution (Petzina, Stolper & Hudson, 1981; Toepke, 1981; Dinan, 2004). Captured in the Treaty of Paris, executive authorities regarding the production of coal and steel were directed to a supranational European authority, the European Coal and Steel Community (ECSC; Petzina et al., 1981; Dinan, 2004). Six years later, in order to extent the economic cooperation between the member states of the ECSC (Belgium, Germany, France, Italy, Luxembourg and the Netherlands), the European Economic Community (EEC) was established by the Treaty of Rome (1957), further strengthening political stability and common economic development (Toepke, 1981;

Steinherr, 1985; Fligstein & Stone Sweet, 2001; Cruz, 2009; European Commission, 2020).

Following the establishment of the EEC, a number of supranational institutions were created, including the European Commission (Toepke, 1981; Fligstein & Stone Sweet, 2001; Dinan, 2004; Nugent & Rhinard, 2015). The Treaty of Rome set out promoting harmonious development of common economic activities throughout the EEC as one of the main tasks of the Commission (Wilson, 1980; Steinherr, 1985; European Commission, 2007; Nugent & Rhinard, 2015). Following the Treaty of Brussels in 1967, the ECSC and the EEC, together with the European Atomic Energy Community (Euratom), were merged into the European Community (EC; Dinan, 2004). One year later, the expressed need for a communal centrally coordinated solution to regional problems and interregional disparities was acknowledged by the EC by the creation of the Directorate-General for Regional Policy in 1968 (European Commission, 2007; European Commission, 2020).

Establishing the European Regional Development Fund

In 1972, after the EC's first enlargement in the form of the accession of Ireland, Denmark and the United Kingdom, the European Commission set the objective to create a regionally integrated economic and monetary union (Toepke, 1981; Nugent & Rhinard, 2015). Consequently, in combination with the creation of the Directorate-General for Regional Policy, the EC countries decided to establish a European Regional Development Fund (ERDF; Wilson, 1980; Vanhove, 2018). Two years later the EC countries unanimously agreed upon the first regulations regarding the ERDF, which came into force in 1975, resulting in the first tangible form of a Common Regional Policy (CRP; Wilson, 1980; European Commission, 2007; Nugent & Rhinard, 2015; Vanhove, 2018; European Commission, 2020).

In general, the first ERDF regulations mainly consisted of budgetary redistribution, operationalized mostly in the form of quotas and subsidies meant to pursuit the European Commission's goal of promoting harmonious development of economic activities in European regions (Wilson, 1980; Steinherr, 1985; European Commission, 2007; Nugent & Rhinard, 2015). More specific, the first ERDF regulations were designed to establish a finance mechanism for investments in regional industrial and service activities. In addition, the fund was meant to cover infrastructure investments relating those activities as well as general infrastructure

investments in relatively underdeveloped European regions (Wilson, 1980; Martins & Mawson, 1981).

At the time, potentially receiving funding from the ERDF was only applicable to specific investment projects, rather than programs, which had to be located in designated areas eligible for regional policy assistance (Martins & Mawson, 1981; Bachtler & Michie, 1995). Funding could only be requested through an application process which involved the submission of these specific investment projects by national governments. In addition, funding was granted subject to a system of fixed national quotas. Consequently, all EEC member states received financial assistance to some extent, without regard to their relative economic situations (Martins & Mawson, 1981; European Commission, 2007).

Establishing the European Structural and Investment Funds

Following the operationalization of the first ERDF regulations, both the CRP and particularly the ERDF itself increasingly became subject to criticism. First, critiques regarding the system of fixed national quotas arose, while it was also argued that the ERDF budget was too small and the area covered by the fund too large. Also, in the first years after the installation of the fund, it became clear that national governments partially used the fund to reimburse previously made regional investments, rather than engaging in additional investments on regional policy (Martins & Mawson, 1981; Bache, 2010).

Furthermore, there was a lack of systematic evaluation regarding the impact of ERDF aided investment projects and correspondingly implemented regional policy. One reason for this relies on the fact that within the Directorate-General for Regional Policy there was a central coordination deficiency, which resulted in a situation in which several operating units of the Directorate-General had their own priorities and methodologies. Additionally, there was a great variety in evaluation techniques regarding regional development policies and structural operations among the different EEC member states (Bachtler & Michie, 1995; Vanhove, 2018).

In 1986, after a major revision of the Treaty of Rome, the Single European Act (SEA) was signed by the EC members states, stating the ambition to create a common market in the EC by 1992 and promoting further European integration (Bieber, Pantalis & Schoo, 1986; Dinan, 2004; Cruz, 2009; Nugent & Rhinard, 2015). Following this ambition, in combination with the context of enlargement of the EC

with the accession of Greece (1981) and both Portugal and Spain (1986), the European funding mechanisms were also majorly revised (Bachtler & Gorzelak, 2007; Bache, 2010; European Commission, 2020). Resulting from this revision, the ERDF was integrated into an overarching regional cohesion policy together with the European Social Fund (ESF) and the Common Agricultural Policy (CAP), establishing the European Structural and Investment Funds (ESIFs; Bache, 2010; European Commission, 2020).

Before the creation of the ESIFs, the ESF and the CAP were operating as separate financial and policy mechanisms. The ESF was initially created by the signing of the Treaty of Rome in order to protect workers that would potentially be affected by the establishment of a common market (Tome & Tracs-Krupa, 2019; European Commission 2020). In general, it aimed to support employment-related projects throughout the EC and was engaged in investments in European human capital (European Commission, 2020). Several years after the creation of the ESF, the CAP was introduced as a system mainly consisting of agricultural subsidies to ensure a sustainable food supply and to improve agricultural productivity (Cruz, 2009; European Commission 2020). Nowadays, the funding instrument of the CAP is referred to as the European Agricultural Fund for Rural Development (EAFRD; European Commission 2020).

The Inauguration of Cohesion Policy

Merging the ERDF, ESF and the EAFRD, the cohesion policy and the corresponding establishment of the ESIFs, by the reform of the European funding mechanisms, revolutionized procedures regarding the allocation of regional funding and regional policy implementation (Bailey & De Propis, 2002). Furthermore, the established cohesion policy introduced some key principles regarding future regional policy implementation.

First, regarding the programming principle, the application process involving the submission of specific investment projects by national governments was replaced by a multi-annual programming scheme, based on scientific analysis, strategic planning and structural evaluation. Second, the principle of additionality was introduced to ensure that regional investments previously made by national governments were not reimbursed by European funding. Third, the principle of partnership was introduced, which related to collaboration in the design and

implementation of the regional investment programmes to ensure transparency, coordination and policy effectiveness (Bailey & De Propis, 2002; European Communities, 2008; Allen, 2010; Bache, 2010; Vanhove, 2018; European Commission, 2020).

Finally, regarding the principle of concentration, it was decided that the cohesion policy should be focussed on a limited number of general objectives (Bailey & De Propis, 2002; European Communities, 2008; Vanhove, 2018). These objectives included the promotion of development of the least developed European regions, converting industries in regions significantly affected by industrial decline, tackling long-term unemployment, the facilitation of social and occupational integration, accelerating the adjustment of agricultural structures and promoting development in rural regions (Bailey & De Propis, 2002; European Commission, 2007; European Communities, 2008; Vanhove, 2018; European Commission, 2020).

In 1992, the Treaty of Maastricht was signed, formally establishing the European Union and setting out a programme to move towards a monetary and economic union in the future (Dinan, 2004; European Communities, 2008). In addition, it established a new institution, the Committee of the Regions (CoR). The establishment of the CoR was the result of a widely supported need for a consultative body to represent regional interests in the EU and contained the promise that local and regional governments would be increasingly directly involved in the creation and implementation of local and regional policy (Loughlin, 1996; Christiansen, 1996; Jones, 1997; Allen, 2010). Simultaneously, another principle was introduced, being the principle of subsidiarity, which stated that decision making regarding policies in the EU should take place at the closest practical level to the citizen (Jones, 1997; Bailey & De Propis, 2002; Allen, 2010).

When the Treaty of Maastricht came into force, it also established a new financial mechanism, the Cohesion Fund (CF). This fund was meant for countries with a gross national income (GNI) per capita of less than 90 percent of the EU average, conditional on the fact that these countries had a policy programme promoting and aiming for economic convergence. Evidently, the CF was integrated into the overarching European cohesion policy, further emphasizing the policy's aim to reduce economic and social disparities and to promote sustainable economic development. In addition, following the accession of Finland, Austria and Sweden to the EU, another objective was added to the policy's goals, referring to the support of

sparsely-populated European regions (Christophersen, 1994; European Communities, 2008; Allen, 2010).

Reforming Cohesion Policy

At the end of the twentieth century, the European Commission presented the Agenda 2000. The agenda described the prospects for the EU's development, outlining the shape of the EU's financial framework after future enlargements, and introducing new rules and regulations regarding future regional policy creation and implementation. With regard to the latter, the Agenda 2000 outlined a reform of the EU's cohesion policy, mainly in the form of new regulations on the ESIFs and CF. Resulting from this reform, the number of general objectives of the policy was reduced to three (Hall & Rosenstock, 1998; Bailey & De Propis, 2002; Bachtler & Mendez, 2007; European Communities, 2008; Allen, 2010)..

As set out by the reformed cohesion policy, the first objective was related to the promotion of economic development and structural industrial adjustment of European regions whose economic development is lagging behind. Next, the second objective included the support of economic and social conversion of European regions that were facing structural difficulties. Finally, the third objective referred to the support of adaption and modernisation of policies and systems related to education, training and employment (Hall & Rosenstock, 1998; Bachtler & Mendez, 2007; European Communities, 2008; Allen, 2010).

After Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia, Slovakia and the Czech Republic joined the European Union in 2004, increasing the EU's population with 20 per cent, but only increasing the EU's GDP with 5 per cent, the cohesion policy was reformed again (European Communities, 2008). As a result of this reform, the first general priority objective was slightly transformed into the objective of convergence. In addition, the second and the third objective were merged into a new single objective of regional competitiveness and employment. Also, a new third objective of European territorial cooperation was created on the basis of the Interreg Community Initiative (European Communities, 2008; Allen, 2010; Dhèret, 2011).

The objective of convergence stated to aim at accelerating the process of convergence of the relatively underdeveloped regions and member states of the EU, where the relatively underdeveloped regions covered were defined by a gross

domestic (or regional) product (GDP/GRP) per capita of less than 75 per cent of the EU's average. In contrast, the regional competitiveness and employment priority objective would cover all European regions that were not covered by this first priority objective, aiming to strengthen regional competitiveness, attractiveness and increasing regional employment. Finally, the objective of European territorial cooperation was stated to create a support for cross-border, transnational and interregional European cooperation and enhancing European (regional) networks (Bachtler & Mendez, 2007; European Community, 2008; Allen, 2010).

After Bulgaria and Romania joined the EU in 2007, the Treaty of Lisbon was signed, amending both the Treaty of Rome and the Treaty of Maastricht, thereby changing the functioning of the EU. Explicitly acknowledging the principle of regional self-government within the EU, the Lisbon Treaty further emphasized the importance of regional levels in the principle of subsidiarity (Allen, 2010; Committee of the Regions, 2015). In addition, the Treaty of Lisbon increased the political power of the CoR through different stages of legislative processes, by giving the EU assembly of regional and local representatives more legal and political tools. These included the right to challenge regional and local aspects of EU legislation through the European Court of Justice, with specific regard to the subsidiarity principle and regional and local competences (Mendez, 2011; Committee of the Regions, 2015; Bachtler & Mendez, 2016).

In the following years, rules and regulations regarding the cohesion policy were further simplified and improved, with a strong emphasis on transparency in the process of policy creation and an additional accent on interregional communication with respect to policy implementation. Also, research and innovation, as well as working towards a low-carbon economy, became key investment areas within the EU's cohesion policy. Furthermore, similar to earlier periods of cohesion policy reforms, a stronger focus on job creation and economic development was a major element of the reform. (Mancha-Navarro & Garrido-Yserte, 2008; Allen, 2010; Committee of the Regions, 2015; Bachtler & Mendez, 2016; European Commission, 2020).

B. The Cohesion Policy

The historic events regarding cohesion policy discussed in the previous section, and in particular the reforms, are the fundamentals of the currently existing cohesion policy. Throughout the following section, characteristics of the current cohesion policy are discussed. In addition, characteristics of the funding mechanisms of the policy are evaluated and presented. This includes a description of the particular focus of each of the funds and their overall goal of supporting harmonious development throughout the EU.

The Current Cohesion Policy

Nowadays, the European Commission still defines the cohesion policy as the EU's strategy to promote and support the overall harmonious economic development of its member states and regions. Consequently, the cohesion policy aims to continue the strengthening of both social and economic cohesion throughout the EU by addressing and reducing regional disparities in economic development, while strongly focussing on and thereby mainly targeting less developed European regions (Becker, 2019; Darvas, Mazza & Midoes, 2019; European Commission, 2020). More specifically, being the EU's main investment policy, cohesion policy targets all regions in the EU to financially support economic developments such as job creation, local business competitiveness, sustainable development and economic growth, and improve the quality of life of European citizens (European Commission, 2014; Becker, 2019; Darvas et al.; European Commission, 2020).

Cohesion policy is still widely supported throughout the entire EU as a result of a number of political and economic arguments. First, with regard to the concept of social cohesion, equality is argued to be important, as a relatively socially cohesive union creates the possibility for increased political cohesion as well. Second, a similar reasoning applies to the concept of economic cohesion, as smaller regional disparities could further improve political cohesion and stability (Borz, Brandenburg & Mendez, 2018; Darvas et al., 2019).

On the national level, cohesion policy can be seen as a part of a political bargain regarding the accession of less developed southern and eastern European member states in more recent years. As these countries became part of the European internal market, they effectively opened up their respective national markets to goods and services provided by firms established in the more developed EU member states. Consequently, the more developed member states that joined the EU earlier accepted the migration of labour from these countries and directed cohesion policy related financial transfers to these countries, in order to support their political and economic

transformation and to encourage overall economic social and economic convergence throughout the union (Leonardi, 2006; Darvas et al., 2019; European Commission, 2020).

However, it is important to note that international financial transfers resulting from the cohesion policy should not be seen as compensation for economically less developed member states. There is an economic rationale behind the policy, as it is argued that if economic activities increasingly concentrate in the more developed regions, this could be at the extent of economic activities in the less developed regions. Cohesion policy related financial transfers and investments in infrastructure, technological innovation and research and development, can then help to establish the conditions necessary for advancing economic development in these less developed regions (Darvas et al., 2019; European Commission, 2020).

In addition to financially supporting job creation, sustainable economic development and improving the EU citizens' quality of life, investments resulting from the cohesion policy also have strong impacts in other fields. EU policies aiming to improve education and stimulate employment, as well as EU policies related to the environment, the common market and research and innovation are increasingly complemented by financial transfers resulting from the cohesion policy. In fact, the cohesion policy provides the financial framework regarding the investments involved with the modern European growth goals, as set out in the Europe 2020 strategy (European Commission, 2014; Medeiros, 2017; Becker, 2019; Marin, 2019; European Commission, 2020).

Overall, the Europe 2020 strategy is set out to stimulate smart, sustainable and inclusive growth in the EU. Altogether, it consists of five particular targets. The first target is related to employment, as the EU particularly aims 75 per cent of Europeans between the ages of 20 and 64 to be employed. The second target is related to innovation and has a rather financial nature, stating that three per cent of the EU's GDP is to be invested in research and development activities. For the third target, which is related to climate change and energy sustainability, the EU aims to reduce greenhouse gas emissions, increase the share of energy created from renewables and increase overall energy efficiency. With regard to the fourth target, concerning education, the EU aims to reduce the rate of early school leavers to below ten per cent. Finally, the fifth target is related to social inclusion, as the EU aims to reduce the amount of people in or at risk of social exclusion and poverty with twenty

million (European Commission, 2014; Liobikienė & Butkus, 2017; Pagliacci, 2017; Marin, 2019; European Commission, 2020).

Furthermore, next to the fact that cohesion policy is significantly contributing to achieving these goals and addressing the diverse necessities for economic development throughout European regions, the policy is acting as a catalyst for further private and public funding. This is not only because cohesion policy is an impetus for EU member states to co-finance cohesion policy related projects and programmes with national budget funding, but also because the policy improves investor confidence, also for external private investors (Marin, 2019; European Commission, 2020).

The Current European Structural and Investment Funds

Today, cohesion policy funding is mainly delivered through the ERDF and the CF. Together with the ESF and the EAFRD, the ERDF and the CF make up the ESIFs. In addition, the European Maritime and Fisheries Fund (EMFF) is part of the ESIFs (European Commission, 2020). However, given that the EMFF targets countries rather than regions, it will not be taken into account throughout the analysis of the regional cohesion policy.

The ESIFs mainly focus on five separate investment areas. These include strategically investing in research and innovation, financing the development of digital technologies, funding sustainable management of natural resources, supporting the low-carbon economy and supporting small and medium-sized enterprises (SMEs). Furthermore, the ESIFs aim to mobilize investment, to support structural reforms, to increase the attractiveness of European regions in terms of private sector financing and improve the investment climate. Overall, the ESIFs directly contribute to the EU's objectives of economic growth and employment. Consequently, the general purpose of the funds incorporated in the ESIFs is to invest in the creation of jobs and a harmonized and sustainable European economy (Dapkus & Streimikeine, 2016; Marin, 2019; European Commission, 2020).

The ERDF's general aim is to strengthen both social and economic cohesion in the EU by correcting imbalances between European regions. Its main objectives include the strengthening of research, innovation and technological development, the enhancement of the accessibility of information and communication technologies, improving the competitiveness of SMEs and support the shift towards a low-carbon European economy (European Commission, 2014). The ERDF is generally involved with stimulating growth and development in the less developed European regions. However, it also applies to relatively more developed regions, further improving their competitiveness and employment (European Commission, 2014; Dapkus & Streimikeine, 2016; European Commission, 2020).

In addition, the ERDF particularly focuses on growth and development in European regions with certain territorial characteristics. These include urban areas and areas with specific geographical disadvantages. In urban areas, the ERDF's main actions are concerned with the reduction of economic, environmental and social problems, thereby stimulating sustainable urban development. In European regions that have natural disadvantages in terms of their geographical situation, the ERDF is mainly involved with offering specific assistance in order to stimulate economic growth and development to allow for overall economic and social convergence in the EU. As a result, both urban areas, as well as the most remote, mountainous and sparsely populated regions receive special attention from the ERDF (European Commission, 2014; European Commission, 2020).

Next, the ESF is mainly involved with supporting investment projects and programmes that are related to employment and European human capital. It engages in investments that improve employment and education opportunities across the EU. In addition, the ESF aims to improve the situation of European citizens that are at risk of social exclusion and poverty. Particularly, the main objectives of the ESF relate to the promotion of sustainable employment and increased labour mobility, the promotion of social inclusion in the form of the combat of poverty and discrimination, improving education and training by strategically targeted investments and improving public administration efficiency (European Commission, 2014; Dapkus & Streimikeine, 2016; Tomé & Tracz-Krupa, 2019; European Commission, 2020).

Nowadays, the CF is still targeted at member states of the EU of which the gross national income (GNI) per capita is less than 90 percent of the average GNI in the EU. Equivalent to the ERDF, one of the main priorities of the CF is to support the shift towards a low-carbon economy. In addition, the CF has some more objectives related to environmental issues. These include the promotion of climate change adaption, risk management and prevention, preserving the environment and promoting resource efficiency. Also, the CF aims to promote sustainable transport

and network infrastructures. The latter mainly refers to trans-European transport networks, which are projects of European interest that are given special priority by the EU. Overall, the CF aims to reduce social and economic disparities and is involved with the promotion of sustainable development (European Commission, 2014; Darvas et al., 2019 European Commission, 2020).

Finally, the EAFRD supports rural development strategies and projects. As mentioned earlier, it can be seen as the financing mechanism behind the CAP. EAFRD funding is generally meant to strengthen the EU's agricultural and forestry sectors, support environmental sustainability and improve the well-being of rural areas in the EU. The general objectives of the EAFRD include the fostering of agricultural sector competitiveness, ensuring that natural resources are managed in a sustainable way and working towards a balanced territorial development of rural communities and economies, including the creation of employment opportunities (Darvas et al., 2019; European Commission, 2020).

Altogether, the funds that make up the ESIFs are all supporting the overall cohesion policy's goal of promoting and supporting overall harmonious development of EU member states and regions. The aim of strengthening both social and economic cohesion throughout the EU by addressing and reducing regional disparities in economic development and employment is clearly underwritten by each of the individual funds. Also, especially with regard to the CF, it is clear that there is a strong focus on the less developed regions, aiming to provide these regions with the conditions necessary to catch-up with more developed regions, both in a social and an economic context (European Commission, 2014; Dapkus & Streimikeine, 2016; Darvas et al., 2019; Marin, 2019; European Commission, 2020).

C. Cohesion Policy Effectiveness

Before quantitatively analysing the effectiveness of cohesion policy funding, it is important to obtain and discuss findings on the policy's effectiveness in existing literature. Established research on the effectiveness of the policy is rather extensive and reports mixed results. Some established literature indeed finds positive significant impacts of cohesion policy funding on regional employment and regional economic growth and convergence (Dall'erba, 2005; Bouvet, 2005; Puigcerver-Peñalver, 2007; Ramajo, Márquez, Hewings & Salinas, 2008; Falk & Sinabell, 2008;

Esposti & Bussoletti, 2008; Pellegrini, Terribile, Tarola, Muccigrosso & Busilli, 2013; Rogge, 2019; Bachtrögler, Fratesi & Perucca, 2020).

Other studies resulted in a variation in estimated impacts among different countries and regions, generally distinguishing between less developed regions and the remaining, as well as comparing significant impacts on the longer term to shorter term impacts that became insignificant after some time (Rodriguez-Pose & Fratesi, 2004; Percoco, 2005; Soukiazis & Antunes, 2005; Bachtler, Begg, Charles & Polverari, 2017; Crescenzi & Guia, 2020).

Also, some studies resulted in the estimation of insignificant or marginally significant impacts on regional employment, productivity growth and economic convergence or find that estimated results are largely dependent on the assumptions made with regard to the econometric modelling (Garcia-Milá & McGuire, 2001; Ederveen, de Groot & Nahuis, 2002; de Freitas, Pereira & Torres, 2003; Dall'erba & Le Gallo, 2008; Psycharis, Tselios & Pantazis, 2020).

First, Dall'erba (2005) found empirical evidence for a statistically significant positive relationship between cohesion policy funding and regional economic growth. Conducting an exploratory investigation on regional funding on the basis of cohesion policy, in the form of ERDF funding, and the spatial distribution of regional per capita income over the period 1989-1999, this statistical relationship was identified. In addition, spatial autocorrelation in the distribution of the regional incomes per capita was found. Bouvet (2005, as cited in Mohl & Hagen, 2010) found similar results. Studying ERDF per capita funding of fewer EU member states, but over a substantially extended time frame (1975-1999), a modest significantly positive relationship was found with respect to regional economic growth rates and regional convergence.

Investigating cohesion policy funding impacts in a more recent period (2000-2011), Rogge (2019) also established empirical evidence of a positive impact on regional growth. Though, regardless of an increased focus on competitiveness and productivity during this period following the Treaty of Lisbon, it is argued that this growth is relatively limited for the EU as a whole. It is shown that there are high interregional differences in economic growth rates. Nonetheless, the results of the study hand evidence for a limited convergence trend among EU regions over the period assessed.

Bachtrögler et al. (2020) analysed the 2007-2013 cohesion policy programming period increasingly focussing on regional growth in terms of firm activity and the creation of employment. Their findings show that cohesion policy funding contributes significantly to the creation of employment and promotes firms to grow in terms of value added and employment more than in terms of productivity. Though, they state that there is a great variation in effectiveness of cohesion policy funding among and within countries and regions.

In contrast, Ederveen et al. (2006) found the on-average effect of cohesion policy funding on regional growth to be insignificant. They argue that regional funding is only effective for regions in countries that have a well-functioning institutional framework regarding the implementation of policies induced by the funding. For regions in countries without the appropriate institutions, they find cohesion policy funding to be ineffective, both in terms of regional economic growth and regional convergence, further stressing the importance of assessment of regional economic asymmetries.

Bachtler et al. (2017) also find that there is a lack of evidence regarding the effectiveness of cohesion policy funding on the longer term. According to them, this is mainly explained by significant absence of conceptual thinking and strategic justification with respect to the instalment of investment programmes. However, they argue that there is improvement over time, also with regard to establishing appropriate institutions. Additionally, the study also shows that territorial factors and characteristics significantly influence the impact and effectiveness of cohesion policy funding.

Studying particularly the regions that were lagging behind over the period 1989-2000, Puigcerver-Peñalver (2007) found empirical evidence for a significant positive statistical relationship between regional growth rates and total regional cohesion policy funding. Equivalent results were found with respect to per capita cohesion policy funding and in terms of regional funding relative to total funding received by all regions. However, the study shows that the positive influences of regional funding on the growth process in the less developed regions were stronger during the first program period studied (1989-1993) compared to the latter (1994-1999). The research by Esposti and Bussoletti (2008) also focussed on the less developed EU regions. Assessing per capita cohesion policy funding in these regions

on the basis of an augmented conditional convergence model, they find a significant but limited impact on regional growth.

Assessing the less developed regions in a more recent period (1995-2004), Falk and Sinabell (2008) equivalently find significant positive effects of cohesion policy funding on regional growth. Though, instead of incorporating the total amount of funding in these regions in their econometric model, they compare regions eligible for funding to ineligible regions. They argue that the growth rate of the less developed regions relative to other regions is largely explained by regional characteristics, rather than by asymmetries in estimated coefficients. Pelligrini et al. (2013) identified a similar relationship by also comparing eligible regions to regions ineligible for cohesion policy funding over the period 1994-2006. Their results show a significant positive impact of cohesion policy funding on regional economic growth.

Focussing on effects of the cohesion policy funding on regional growth in terms of the creation of employment, more asymmetric effects were found when comparing the less developed regions with the remaining by Crescenzi and Guia (2020). They show that cohesion policy overall has exerted a significantly positive impact on regional employment in the EU as a whole. Though, they argue that these positive effects are unevenly distributed both across and within the different EU member states. Generally, for most northern European countries Crescenzi and Guia find significant impacts on regional employment, while for most of the southern European member states the estimated impacts of the cohesion policy on employment were insignificant or non-existent.

Rodriguez-Pose and Fratesi (2004) address further limitations to the impact of cohesion policy funding on regional growth in the less developed regions. Analysing the 1989-1999 period, they find that cohesion policy funding regarding infrastructure and business support did not lead to significant results. In terms of agricultural related investments, they only find short term effects that fade out rather quickly. In fact, only the investments related to improvement of education opportunities and human capital were found to lead to significant returns in terms of economic and social cohesion in the less developed regions.

De Freitas et al. (2003) also distinguished between the less developed regions and the remaining in assessing the impact of cohesion policy funding on regional convergence. The results of their research do support that convergence is present among EU regions and that a well-functioning institutional framework strengthens

this. However, they find no statistically significant evidence that convergence is increasingly taking place in the less developed regions when comparing these to the remaining regions.

Ramajo et al. (2008) made further distinguishes between regions with different characteristics. Creating separate regressions for regions at different stages of development over the period 1981-1996, they found that convergence levels of relative regional incomes were higher in less developed regions. In addition, they further identified the role of spatial effects in economic convergence by showing clear evidence of separate spatial convergence groups of regions within the EU, implying spatially concentrated spillover effects.

Dall'erba and Le Gallo (2008) support the claim that significant convergence is taking place in EU regions. Though, when taking into account potential endogeneity problems in the estimation of the impact of cohesion policy funding, they find that the observed convergence is not attributable to the funding. Also, they raise several objections regarding the spillover effects to other regions as a result of funding in a particular region.

Several case studies, carried out on a national scale, also made distinguishes with respect to asymmetries in regional characteristics. For instance, Soukiazis and Antunes (2005) investigated the convergence process related to cohesion policy funding in Portuguese regions, distinguishing between coastal and inland regions. Their results show that the distinction between these coastal and inland regions is important in assessing the effects of cohesion policy funding, as convergence processes are increasingly experienced in the inland regions. Though, overall regional growth is higher in the coastal regions as a result of the cohesion policy funding. Another example relies on the assessment of southern regions in Italy. In this study, Percoco (2005) finds significant asymmetries among regions in terms of cohesion policy funding induced growth rates, as a result of regional characteristics. Additionally, the study shows that the levels of growth rates in the less developed regions became highly volatile as a result of cohesion policy funding.

Though, other case studies show opposing results. For instance, Garcia-Milà and McGuire (2001) focussed on the impact of cohesion policy funding on the less developed regional economies of Spain. They found that the policy has been ineffective in improving the less developed regional economies. In addition, they

argue that cohesion policy funding has not been effective at stimulating private investment in the case of Spain.

Also Psycharis et al. (2020) find no evidence that investment projects cofinanced by cohesion policy funding led to increased regional growth in their case study of Greece, over the period 2000-2014. Their results question the coordination and additionality between cohesion policy funding and domestic regional policies with respect to the stimulation of regional growth, especially in the less developed regions. Though, the results are sensitive to the time period and geographical level assessed.

Altogether, it is clear that there is no consensus in the established literature regarding the effectiveness of cohesion policy funding with respect to regional growth and convergence. Although many studies find significant overall impacts of cohesion policy funding on a significant set of development and economic growth variables, the established literature shows that the impacts of cohesion policy funding are rather asymmetrical across and within different countries. Also, there are several studies that find no significant impacts of cohesion policy funding on regional growth variables. It is argued that the differences in direction and significance of estimated impacts is attributable to a variation in research methodologies. Also, most studies are limited to a set of selected EU member states, a selection of cohesion policy funding components, or a restricted time frame.

III. METHODOLOGY

Building on findings in existing literature, the remainder of this research aims to quantify the effectiveness of cohesion policy funding. Effectiveness of the policy is assessed in terms of regional economic growth and convergence. In order to obtain whether the EU's cohesion policy and the accompanied regional funding mechanisms have indeed significantly increased regional economic growth and convergence, data on the policy's funding and regional economic growth variables is quantitatively analysed. The analysis is performed by means of statistical modelling in general and regression analysis in particular.

In the regression analysis, statistical relationships between cohesion policy funding and regional economic growth and convergence variables are empirically investigated on the basis of a sample consisting of panel data on 279 NUTS-2 regions

over the period 2000-2018. The regression coefficients are estimated on the basis of a fixed effects regression model.

Furthermore, it is explicitly assessed whether regional economic convergence took place among the regions included in the analysis over the period 2000-2018. Additionally, spatial heterogeneity in the relationships between cohesion policy funding and regional economic growth and convergence variables are investigated among two subsets of regions, eastern European regions and southern European regions, in order to empirically assess the existence of spatial regimes. Finally, the data analysis is extended by assessing potential regional economic spillovers of cohesion policy funding to adjacent regions and the evaluation of spatial heterogeneity with respect to those spillovers.

This section provides details on the collection of the data resulting in the panel dataset subject to research, a description of the variables included in this dataset, and an explanation and theoretical justification of the quantitative research methodologies used. Furthermore, it presents the specifications of the regression models that are eventually estimated to assess the cohesion policy's effectiveness, to explicitly test overall regional convergence, empirically validate the existence of spatial heterogeneity in the effects of the cohesion policy, and assess the potential regional economic spillovers of the policy as well as the extent to which these are heterogeneous across space.

A. Cohesion Policy Funding

The core of the dataset subject to research exists of the total amount of annual funding to EU and UK regions on the basis of the funds that are part of the EU's regional cohesion policy. These funds include the ERDF, the ESF, the CF and the EAFRD. The dataset covers the four most recent programming periods in the history of the cohesion policy over the 2000-2018 period. Consequently, the main independent variable in the regression analysis component of this research consists of the historic annual payments from the EU by the ESIFs to EU and UK regions.

The data on the historic annual payments is obtained from the harmonised presentation of annualised payments to NUTS-2 regions as provided by the European Commission. For every individual fund, the data on annual EU payments to these regions is collected on the NUTS-2 level, which is the second most precise level of the EU's coding system for referencing subdivisions of its member states for statistical

purposes. It was compiled by the Commission by extracting annual EU payments regarding individual investment programmes from the Commission's accounting system.

When information on the geographical scope of these payments in terms of the NUTS-2 level was unavailable, the Commission regionalised these payments by estimating the regional distribution on the basis of population size. Furthermore, the regionalized payments were subject to various modelling techniques to develop estimates of the moment the actual investment expenditures related to the programming payments took place (European Commission, 2020).

The dataset provided by the European Commission is then modified by aggregating the annual EU payments to EU and UK regions made with regard to the funds previously described. As a consequence, all other funds included in the data provided by the Commission are dropped. This results in the described dataset consisting of the total annual cohesion policy funding granted to EU and UK regions on the NUTS-2 level over the 2000-2018 period.

B. Regional Economic Growth & Convergence

As said, the effectiveness of the cohesion policy funding to EU and UK NUTS-2 regions is assessed in terms of regional economic growth and convergence. In turn, regional economic growth and convergence are operationalized in the form of three separate dependent variables in the regression analysis component of this research. These include the Gross Regional Product (GRP) to measure the size of the region's economy, the GRP per capita as a measurement approach to regional productivity and the creation of jobs as estimated by total regional employment. Data on these dependent variables are obtained from the European statistical office Eurostat.

First, the GRP reflects the total value of all goods and services that are produced in a region less the value of all intermediate goods and services. It therefore reflects the total output of a region's economy, or equivalently, the total utilized productive capacity of a region's economy. As a result, in the panel data setting of this research, GRP can be seen as an indicator for regional economic growth. The data on the NUTS-2 regions' GRP is presented at current market prices. As a consequence, variation in GRP resulting from fluctuations in price levels over time is eliminated.

Second, the GRP per capita is indirectly obtained by dividing a region's GRP in a given year by its population on January 1 in the same year. Resulting from this, the

GRP per capita eliminates variation due to fluctuations in price levels over time in a similar way. As GRP per capita corrects the total utilized productive capacity of a region's economy for the population of that region, it can be seen as an indicator for productivity. That is, in the panel data setting of this research, GRP per capita indicates productivity growth.

The third dependent variable in the regression analysis component of this research is regional employment. More specifically, it consists of the amount of people between the ages 15 and 64 employed in a particular region. Data on regional employment is collected at the NUTS-3 level and then aggregated to the NUTS-2 level in order to comply with the structure of the dataset. In the panel data setting of this research, this variable represents regional employment growth, which can be seen as an alternative measure of regional economic growth. Next to that, the creation of employment is one of the main targets of Europe's 2020 strategy of supporting smart, sustainable and inclusive growth.

Whether it is obtained that cohesion policy funding has significantly increased regional economic growth and convergence throughout EU and UK regions depends on the size and significance of the estimated regression coefficients of the cohesion policy funding variable in preliminary regression equations 1-3,

$$GRP_{it} = \beta_0 + \beta_1 CPF_{it} + \varepsilon_{it}$$
 (1)

$$GRP/Capita_{it} = \beta_o + \beta_1 CPF_{it} + \varepsilon_{it}$$
 (2)

$$Employment_{it} = \beta_0 + \beta_1 CPF_{it} + \varepsilon_{it}$$
 (3)

where GRP_{it} represents the GRP of region i in year t; $GRP/Capita_{it}$ represents the GRP per capita of region i in year t; $Employment_{it}$ represents the regional employment of region i in year t; CPF_{it} represents the total amount of cohesion policy funding to region i in year t; and β_0 and ε_{it} represent the intercept and error term, respectively. Additionally, for both interpretation purposes and in order to linearize the statistical relationships, the dependent variables and the cohesion policy funding variable are transformed to their respective natural logarithms.

C. The Fixed Effects Model

In assessing the effectiveness of cohesion policy funding on the GRP, GRP per capita and regional employment, it is important to take into account other factors that could influence the estimation of the respective regression coefficients. When these factors are accounted for in the regression models, they can be held constant throughout the course of the research, improving the extent to which the relationship between cohesion policy funding and regional economic growth and convergence can be successfully assessed and understood.

Throughout the regression analysis in this research, the majority of these factors is accounted for in the regression models by assessing the relationship between cohesion policy funding and the respective dependent variables on the basis of a fixed effects regression model. This is a statistical model in which the parameters of the model are treated as fixed (non-random) quantities. Within the regression models included in this research, fixed effects are applied both in terms of region fixed effects and year fixed effects.

The application of region fixed effects controls for unobserved time-invariant region-specific characteristics that are potentially correlated with the observed independent variables included in the model. That is, including region fixed effects in the regression models controls for differences between regions that do not change over time, though might influence the size and significance of the estimated coefficients of the independent variable cohesion policy funding.

In addition to controlling for time-invariant regional differences, the regression models include year fixed effects. In turn, the application of year fixed effects controls for unobserved time-variant general characteristics that are potentially correlated with the observed independent variables included in the models. In other words, the application of year fixed effects controls for characteristics that do not differ among different regions, but do change over time, and therefore also might influence the size and significance of the estimated coefficients of the independent variable cohesion policy funding.

Incorporating both region fixed effects and year fixed effects in regression equations 1-3, results in regression equations 4-6,

$$GRP_{it} = \beta_o + \beta_t CPF_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$$
 (4)

$$GRP/Capita_{it} = \beta_0 + \beta_1 CPF_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$$
 (5)

$$Employment_{it} = \beta_0 + \beta_1 CPF_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$$
 (6)

where GRP_{it} represents the GRP of region i in year t; $GRP/Capita_{it}$ represents the GRP per capita of region i in year t; $Employment_{it}$ represents the regional employment of region i in year t; CPF_{it} represents the total amount of cohesion policy funding to region i in year t; α_i represents all unobserved time-invariant region-specific characteristics; α_t represents all unobserved time-variant general characteristics; and β_0 and ε_{it} represent the intercept and error term, respectively. Again, the dependent variables and the cohesion policy funding variable are transformed to their respective natural logarithms.

D. Controlling for Additional Influences

After the inclusion of fixed effects, there are still some factors that could potentially influence the estimation of the regression coefficients and could therefore have an impact on the conclusions drawn from the regression models. These include variables describing characteristics that are both region-specific and time-variant.

Consequently, data on a number of control variables are collected. The control variables that are eventually incorporated in the regression equations include the size of a region's population, the regional education level and regional expenses in research and development.

By including these control variables in the regression equations, they can be held constant throughout the course of the research, further reducing the possibility of omitted variable bias. As a result, the extent to which the relationship between cohesion policy funding and regional economic growth and convergence can be successfully assessed and understood is further improved. Data on these variables are also collected or indirectly obtained from Eurostat.

First, regional population sizes are controlled for in the regression models. Including the regional population in the fixed effects models effectively controls for annual changes in the regional population, or alternatively, regional population growth. The effect of population growth on economic development is extensively researched in existing literature. Several recent studies find a statistically significant

relationship between population growth and economic development (E.g. Nyoni & Bonga, 2017; Lawton, 2018; Koduru & Tatavarthi, 2019; Simon, 2019). Given the empirical evidence in existing literature for a statistical relationship between population growth and economic growth, the regional population size is included in the regression models. The data on the regional population sizes are already collected for the construction of the GRP per capita.

Second, the regional education level is controlled for in the regression models. Similar to the regional population size, including the regional education level in the fixed effects models effectively controls for annual changes in the regional education level. Recent literature shows extensive evidence for a statistically significant relationship between the education level and economic growth, mainly with respect to tertiary education (E.g. Astakhova et al., 2016; Pinheiro & Pillay, 2016; Saviotti, Pyka & Jun, 2016; Seetanah & Teeroovengadum, 2019; Hussaini, 2020). Given the empirical evidence for a statistical relationship between the education level and economic growth in existing literature, the regional education level is included in the regression models. In the regression model, the education level is expressed by the total amount of people with tertiary education. It is constructed by multiplying regional population by the share of the regional population with education level 5 or higher, corresponding to the definition of tertiary education from the International Standard Classification of Education (ISCED).

Lastly, regional intramural expenses in research and development are controlled for in the regression models. Similar to the regional population size and the regional education level, including the regional expenditure on research and development in the fixed effects models effectively controls for annual changes in regional research and development expenses. Throughout existing literature there is extensive empirical evidence for a statistically significant relationship between expenditure in research and development and economic growth (E.g. Blanco, Gu & Prieger, 2016; Freimane & Balina, 2016; Hafeez, Syed & Qureshi, 2019; Mandel & Darcy, 2019). As existing literature shows extensive empirical evidence for a statistical relationship between expenditure in research and development and economic growth, the regional expenditure in research and development is included in the regression models. The data on intramural research and development expenditure are directly obtained from Eurostat.

Incorporating the additional control variables discussed in regression equations 4-6, results in regression equations 7-9,

$$GRP_{it} = \beta_0 + \beta_1 CPF_{it} + \beta_2 POP_{it} + \beta_3 EDU_{it}$$

$$+ \beta_4 RDE_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$$
(7)

$$GRP/Capita_{it} = \beta_0 + \beta_1 CPF_{it} + \beta_2 POP_{it} + \beta_3 EDU_{it}$$

$$+ \beta_4 RDE_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$$
(8)

Employment_{it} =
$$\beta_0 + \beta_1 CPF_{it} + \beta_2 POP_{it} + \beta_3 EDU_{it}$$
 (9)
+ $\beta_4 RDE_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$

where GRP_{it} represents the GRP of region i in year t; $GRP/Capita_{it}$ represents the GRP per capita of region i in year t; $Employment_{it}$ represents the regional employment of region i in year t; CPF_{it} represents the total amount of cohesion policy funding to region i in year t; POP_{it} measures the population size of region i in year t; EDU_{it} measures the education level of region i in year t; RDE_{it} measures the intramural expenditure in research and development of region i in year t; α_i represents all time-invariant region-specific characteristics; α_t represents all time-variant general characteristics; and β_0 and ε_{it} represent the intercept and error term, respectively. Again, the dependent variables and the cohesion policy funding variable are transformed to their respective natural logarithms.

Conclusions regarding the effectiveness of cohesion policy funding in terms of regional economic growth and convergence rely on the estimated regression coefficients of the cohesion policy funding variable in the regression models corresponding to regression equations 7-9. When the estimated regression coefficients are significantly positive, it can be concluded that there are positive statistically significant relationships between cohesion policy funding and GRP, GRP per capita and regional employment. If so, this implies a positive statistically significant relationship between cohesion policy funding and regional economic growth and convergence.

E. Regional Convergence

The statistical implications from the regression models described are relatively clear with respect to the relationship between cohesion policy funding and regional economic growth. When the effect of cohesion policy funding is estimated to be significantly positive with respect to GRP, GRP per capita and regional employment, conclusions can evidently be drawn in terms of the relationship between cohesion policy funding and regional economic growth. Though, concluding on a relationship between cohesion policy funding and regional economic convergence might seem less straightforward on the basis of the regression models corresponding to the regression specifications previously described.

The main intuition behind implications regarding the described regression models in terms of regional economic convergence relies on the fact that, in general, relatively less developed regions are particularly targeted by the cohesion policy. Hence, cohesion policy funding in these regions generally involves the allocation of relatively more funding. As a result, when the effect of cohesion policy funding is estimated to be significantly positive in terms of GRP, GRP per capita and regional employment, this implies that those relatively less developed regions are catching up with relatively more developed regions, which in turn receive relatively less funding.

Nevertheless, the estimated regression models corresponding to the described specifications will not provide hard statistical evidence for regional economic convergence. Therefore, it is valuable to explicitly assess whether regional economic convergence is significantly present among the regions included in the analysis, over the period covered in this research.

In order to empirically validate the presence of regional economic convergence, a cross-sectional model setting is created, in which the growth rates of each of the dependent variables, GRP, GRP per capita and regional employment over the 2000-2018 period are regressed on their own respective initial values. Additionally, the initial values of the control variables previously described are controlled for in these cross-sectional regression models.

Whether it is obtained that significant regional economic convergence took place among EU and UK regions over the 2000-2018 period depends on the size and significance of the estimated regression coefficients of the respective growth rates of the related dependent variables in regression equations 10-12,

$$\Delta GRP_{i} = \beta_{o} + \beta_{1}GRP_{i} + \beta_{2}POP_{i} + \beta_{3}EDU_{i} + \beta_{4}RDE_{i} + \varepsilon_{i}$$
(10)

$$\Delta GRP/Capita_{i} = \beta_{o} + \beta_{1}GRP/Capita_{i} + \beta_{2}POP_{i} + \beta_{3}EDU_{i} + \beta_{4}RDE_{i} + \varepsilon_{i}$$
(11)

$$\Delta Employment_{i} = \beta_{o} + \beta_{1} Employment_{i} + \beta_{2} POP_{i} + \beta_{3} EDU_{i} + \beta_{4} RDE_{i} + \varepsilon_{i} \tag{12}$$

where $\triangle GRP_i$ represents the percentage change in the GRP over the 2000-2018 period in region i; $\triangle GRP/Capita_i$ represents the percentage change in the GRP per capita over the 2000-2018 period in region i; $\triangle Employment_i$ represents the percentage change in the regional employment over the 2000-2018 period in region i; GRP_i measures the natural logarithm of the GRP of region i in the year 2000; $GRP/Capita_i$ measures the natural logarithm of the GRP per capita of region i in the year 2000; $Employment_i$ measures the natural logarithm of the regional employment of region i in the year 2000; EDU_i measures the education level of region i in the year 2000; EDU_i measures the education level of region i in the year 2000; EDU_i measures the intramural expenditure in research and development of region i in the year 2000; and e_{it} represent the intercept and error term, respectively.

Conclusions regarding the significance of regional economic convergence among the regions included in the analysis over the 2000-2018 period rely on the estimated regression coefficients of the stock variables related to the respective dependent variables in the regression models corresponding to regression equations 10-12. When the estimated regression coefficients are significantly negative, it can be concluded that there are negative statistically significant relationships between the initial values of GRP, GRP per capita and regional employment and their respective growth rates. Hence, this provides statistical evidence for significant regional economic convergence among the regions included in the analysis over the 2000-2018 period.

F. Spatial Heterogeneity

After assessing the effectiveness of cohesion policy funding on regional economic growth and convergence and empirically validating whether regional convergence significantly took place among the regions in the analysis over the time period covered, the research is extended by assessing whether the impact of cohesion policy funding on regional economic growth and convergence has been asymmetrical among different groups of regions. That is, the research aims to empirically validate whether the effect of cohesion policy funding on regional economic growth and convergence is spatially heterogeneous and so-called spatial regimes exist.

Several studies discussed in the theoretical framework put the effectiveness of cohesion policy funding into perspective by presenting a variation in estimated impacts among different countries and regions, generally distinguishing between less developed regions and the remaining. As a consequence, in existing literature, grouping regions together to test for spatial regimes is usually carried out on the basis of common historical background, level of development and geographical location.

On the basis of these grouping techniques, this research aims to empirically validate the existence of two particular spatial regimes with respect to the impact of cohesion policy funding on regional economic growth and convergence. First, eastern European regions are grouped together and compared to the remaining regions in the analysis. Next, the same empirical analysis is carried out with respect to a group of southern European regions. Effectively, it will be empirically tested whether the impact of cohesion policy funding is significantly different in each of these two subgroups, when comparing them both to all remaining regions included in the analysis.

First, in order to distinguish between eastern European regions and the remaining, a dummy variable is created, taking on a value of one when a region is identified as an eastern European region, zero otherwise. The identification of regions is based on the United Nations geoscheme, as devised by the United Nations Statistics Division (UNSD). The same procedure is carried out for southern European regions.

Resulting from this, in order of EU accession, the group of eastern European regions exists of all regions that are part of Czechia, Hungary, Poland, Slovakia, Bulgaria and Romania. In turn, the group of southern European regions exists of all regions belonging to Italy, Greece, Portugal, Spain, Cyprus, Malta, Slovenia and

Croatia. Consequently, the regions part of Belgium, France, Germany, Luxembourg, the Netherlands, Denmark, Ireland, United Kingdom, Austria, Finland, Sweden, Estonia, Latvia and Lithuania make up the remaining group of regions. Though, it is important to note that in the assessment of the existence of an eastern European regime, southern European regions are included in the group of reference, and vice versa.

In order to test whether the cohesion policy funding has significantly different impacts in each of the subgroups, compared to the group including all remaining regions, the dummy variable indicating the specific subgroup is interacted with all the explanatory variables included in regression equations 7-9. The dummy variable itself will not be included in the regression models, however. Since it is time-invariant, the dummy variable is already controlled for by the incorporation of region fixed effects. Including the resulting interaction terms for the eastern European subgroup of regions in these equations, results in regression equations 13-15,

$$GRP_{it} = \beta_{o} + \beta_{t}CPF_{it} + \beta_{2}East_{i}*CPF_{it}$$

$$+ \beta_{3}POP_{it} + \beta_{4}East_{i}*POP_{it}$$

$$+ \beta_{5}EDU_{it} + \beta_{6}East_{i}*EDU_{it} + \beta_{7}RDE_{it}$$

$$+ \beta_{8}East_{i}*RDE_{it} + \alpha_{i} + \alpha_{t} + \varepsilon_{it}$$

$$GRP/Capita_{it} = \beta_{o} + \beta_{t}CPF_{it} + \beta_{2}East_{i}*CPF_{it}$$

$$+ \beta_{3}POP_{it} + \beta_{4}East_{i}*POP_{it}$$

$$+ \beta_{5}EDU_{it} + \beta_{6}East_{i}*EDU_{it} + \beta_{7}RDE_{it}$$

$$+ \beta_{8}East_{i}*RDE_{it} + \alpha_{i} + \alpha_{t} + \varepsilon_{it}$$

$$Employment_{it} = \beta_{o} + \beta_{t}CPF_{it} + \beta_{2}East_{i}*CPF_{it}$$

$$+ \beta_{5}EDU_{it} + \beta_{6}East_{i}*EDU_{it} + \beta_{7}RDE_{it}$$

$$+ \beta_{5}EDU_{it} + \beta_{6}East_{i}*EDU_{it} + \beta_{7}RDE_{it}$$

$$+ \beta_{8}East_{i}*RDE_{it} + \alpha_{i} + \alpha_{t} + \varepsilon_{it}$$

where GRP_{it} represents the GRP of region i in year t; $GRP/Capita_{it}$ represents the GRP per capita of region i in year t; $Employment_{it}$ represents the regional employment of region i in year t; CPF_{it} represents the total amount of cohesion policy funding to region i in year t; $East_i*CPF_{it}$ represents the total amount of cohesion

policy funding to eastern European region i in year t; POP_{it} measures the population size of region i in year t; $East_i*POP_{it}$ measures the population size of eastern European region i in year t; EDU_{it} measures the education level of region i in year t; $East_i*EDU_{it}$ measures the education level of eastern European region i in year t; RDE_{it} measures the intramural expenditure in research and development of region i in year t; $East_i*RDE_{it}$ measures the intramural expenditure in research and development of eastern European region i in year t; α_i represents all time-invariant region-specific characteristics; α_t represents all time-variant general characteristics; and β_o and ε_{it} represent the intercept and error term, respectively. Again, the dependent variables and the cohesion policy funding variable (including the interaction term) are transformed to their respective natural logarithms.

Equivalently, including the resulting interaction terms for the southern European subgroup of regions in the same regression equations, results in regression specifications 16-18,

$$GRP_{it} = \beta_{o} + \beta_{i}CPF_{it} + \beta_{2}South_{i}*CPF_{it}$$

$$+ \beta_{3}POP_{it} + \beta_{4}South_{i}*POP_{it}$$

$$+ \beta_{5}EDU_{it} + \beta_{6}South_{i}*EDU_{it} + \beta_{7}RDE_{it}$$

$$+ \beta_{8}South_{i}*RDE_{it} + \alpha_{i} + \alpha_{t} + \varepsilon_{it}$$

$$GRP/Capita_{it} = \beta_{o} + \beta_{i}CPF_{it} + \beta_{2}South_{i}*CPF_{it}$$

$$+ \beta_{3}POP_{it} + \beta_{4}South_{i}*POP_{it}$$

$$+ \beta_{5}EDU_{it} + \beta_{6}South_{i}*EDU_{it} + \beta_{7}RDE_{it}$$

$$+ \beta_{8}South_{i}*RDE_{it} + \alpha_{i} + \alpha_{t} + \varepsilon_{it}$$

$$Employment_{it} = \beta_{o} + \beta_{i}CPF_{it} + \beta_{2}South_{i}*CPF_{it}$$

$$+ \beta_{3}POP_{it} + \beta_{4}South_{i}*POP_{it}$$

$$+ \beta_{5}EDU_{it} + \beta_{6}South_{i}*EDU_{it} + \beta_{7}RDE_{it}$$

$$+ \beta_{8}South_{i}*RDE_{it} + \alpha_{i} + \alpha_{t} + \varepsilon_{it}$$

$$(18)$$

where GRP_{it} represents the GRP of region i in year t; $GRP/Capita_{it}$ represents the GRP per capita of region i in year t; $Employment_{it}$ represents the regional employment of region i in year t; CPF_{it} represents the total amount of cohesion policy

funding to region i in year t; $South_i*CPF_{it}$ represents the total amount of cohesion policy funding to southern European region i in year t; POP_{it} measures the population size of region i in year t; POP_{it} measures the population size of southern European region i in year t; POP_{it} measures the education level of region i in year t; POP_{it} measures the education level of southern European region i in year t; POP_{it} measures the intramural expenditure in research and development of region i in year i; POP_{it} measures the intramural expenditure in research and development of region i in year i; POP_{it} measures the intramural expenditure in research and development of southern European region i in year i; i represents all time-invariant region-specific characteristics; i represents all time-variant general characteristics; and i and i represent the intercept and error term, respectively. Again, the dependent variables and the cohesion policy funding variable (including the interaction term) are transformed to their respective natural logarithms.

Whether it can be concluded that spatial regimes exist, with respect to both the groups of eastern European and southern European regions, depends on the joint significance of the estimated regression coefficients of all the interaction terms included in the regression models. Therefore, a joint significance test on these estimated regression coefficients is executed. When it is found that the estimated regression coefficients of all the interaction terms are jointly significant, it can be concluded that the impact of cohesion policy funding is spatially heterogeneous.

Alternatively, for both groups of regions, joint significance of the respective interaction terms leads to the conclusion that the independent variables in the models have significantly different impacts on the dependent variables, when comparing the particular subgroup to the group including all remaining regions. Hence, if this is the case, spatial regimes exist.

G. Regional Spillovers

After assessing the effectiveness of cohesion policy funding on regional economic growth and convergence, empirically validating whether regional convergence actually took place among the regions in the analysis over the time period covered, and assessing spatial heterogeneity across different groups of regions included in the analysis, the regression equations 7-9 will be further extended by the introduction of another spatial component. Throughout the literature discussed in the theoretical

framework, there is a debate about whether economic effects associated with cohesion policy funding are limited to the area within the geographical boundaries of the funded region. It is often argued that these effects in fact are not limited to these bounded areas and, hence, so-called regional economic spillovers exist.

As a consequence, it is argued that cohesion policy funding is not only statistically related to regional economic growth and convergence in the funded region, but also to regional economic growth and convergence in adjacent regions. Or, alternatively, it is argued that there is a statistically significant relationship between economic growth and convergence in one particular region and cohesion policy funding in adjacent regions. Therefore, the regression analysis component of this research is extended by assessing the relationship between the average of cohesion policy funding in adjacent regions and regional economic growth and convergence.

In order to empirically validate the relationship between the average of cohesion policy funding in adjacent regions and regional economic growth and convergence, a new variable is created and incorporated in regression equations 7-9. This variable measures the average annual cohesion policy funding to adjacent regions, for every region. To create this variable, a contiguity spatial weighting matrix is created.

The matrix is normalized spectrally. Resulting from this, all region-pairs that are adjacent to each other are assigned a nonzero eigenvalue, zero otherwise. The size of this nonzero eigenvalue is irrelevant. It is only important that it is equal among all adjacent region-pairs. With only two values in the matrix, the zero value and the nonzero value, the matrix is fully described as containing values such that regions are adjacent or regions are not adjacent.

Multiplying the original cohesion policy funding variable by this adjacency matrix results in a variable measuring the average annual cohesion policy funding to adjacent regions, for every region. In other words, the resulting variable is the spatial lag of the total annual cohesion policy funding granted to EU and UK regions on the NUTS-2 level over the 2000-2018 period.

Incorporating the spatial lag of the cohesion policy funding variable in regression equations 7-9, results in regression equations 19-21,

$$GRP_{it} = \beta_0 + \beta_1 CPF_{it} + \beta_2 CPF_{2it} + \beta_3 POP_{it}$$

$$+ \beta_4 EDU_{it} + \beta_5 RDE_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$$
(19)

$$GRP/Capita_{it} = \beta_0 + \beta_1 CPF_{it} + \beta_2 CPF_{2it} + \beta_3 POP_{it}$$

$$+ \beta_4 EDU_{it} + \beta_5 RDE_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$$
(20)

Employment_{it} =
$$\beta_0 + \beta_1 CPF_{it} + \beta_2 CPF_{2it} + \beta_3 POP_{it}$$
 (21)
+ $\beta_4 EDU_{it} + \beta_5 RDE_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$

where GRP_{it} represents the GRP of region i in year t; $GRP/Capita_{it}$ represents the GRP per capita of region i in year t; $Employment_{it}$ represents the regional employment of region i in year t; CPF_{it} represents the total amount of cohesion policy funding to region i in year t; CPF_{2it} represents the average amount of cohesion policy funding to all regions adjacent to region i in year t; POP_{it} measures the population size of region i in year t; EDU_{it} measures the education level of region i in year t; RDE_{it} measures the intramural expenditure in research and development of region i in year t; α_i represents all time-invariant region-specific characteristics; α_t represents all time-variant general characteristics; and β_0 and ε_{it} represent the intercept and error term, respectively.

Again, the dependent variables and the cohesion policy funding variable are transformed to their respective natural logarithms. In contrast, the spatial lag of total annual cohesion policy funding (CPF2i) is presented in its linear form, as including its logarithmic transformation causes multicollinearity problems with respect to the natural logarithm of the total annual cohesion policy funding (CPFi) itself.

Conclusions regarding the existence of regional economic spillovers of cohesion policy funding in terms of regional economic growth and convergence rely on the estimated regression coefficients of the spatially lagged cohesion policy funding variable in the regression models corresponding to regression equations 19-21. When the estimated regression coefficients are significantly positive, it can be concluded that there is a statistically significant relationship between economic growth and convergence in one particular region and cohesion policy funding in adjacent regions. Hence, if this is the case, regional economic spillovers exist.

H. Spatial Heterogeneity in Regional Spillovers

After assessing spatial heterogeneity across different groups of regions included in the analysis in terms of cohesion policy funding effectiveness and determining whether the economic effects of the policy are limited to the area within the geographical boundaries of the funded region, the remainder of the regression analysis component of this research consists of a combination of the respective methodologies described. That is, the research is further extended by quantifying spatial heterogeneity in regional economic spillovers of cohesion policy funding.

Using the same method as previously described, eastern European regions are compared to the remaining regions in the analysis first, followed by a comparison of southern European regions and the remaining. As mentioned before, it is important to note that in the assessment of the existence of an eastern European regime, southern European regions are included in the group of reference, and vice versa.

In order to empirically test whether the regional economic spillovers of cohesion policy funding are significantly different for each of these two subgroups, when comparing them both to all remaining regions included in the analysis, the dummy variable indicating the specific subgroup is interacted with the spatial lag of the total annual cohesion policy funding granted to EU and UK regions on the NUTS-2 level over the 2000-2018 period. Alternatively, the cohesion policy funding variable is multiplied by the adjacency matrix described in the previous section, which is in turn multiplied by the dummy variable indicating the specific subgroup.

Combining regressions 13-15 for the eastern European subgroup of regions with spatial lag regressions 19-21, results in regression equations 22-24,

$$GRP_{it} = \beta_{o} + \beta_{1}CPF_{it} + \beta_{2}East_{i}*CPF_{it}$$

$$+ \beta_{3}CPF2_{it} + \beta_{4}East_{i}*CPF2_{it}$$

$$+ \beta_{5}POP_{it} + \beta_{6}East_{i}*POP_{it} + \beta_{7}EDU_{it}$$

$$+ \beta_{8}East_{i}*EDU_{it} + \beta_{9}RDE_{it}$$

$$+ \beta_{10}East_{i}*RDE_{it} + \alpha_{i} + \alpha_{t} + \varepsilon_{it}$$

$$GRP/Capita_{it} = \beta_{o} + \beta_{1}CPF_{it} + \beta_{2}East_{i}*CPF_{it}$$

$$+ \beta_{3}CPF2_{it} + \beta_{4}East_{i}*CPF2_{it}$$

$$+ \beta_{5}POP_{it} + \beta_{6}East_{i}*POP_{it} + \beta_{7}EDU_{it}$$

$$+ \beta_{8}East_{i}*EDU_{it} + \beta_{9}RDE_{it}$$

$$+ \beta_{10}East_{i}*RDE_{it} + \alpha_{i} + \alpha_{t} + \varepsilon_{it}$$

$$(22)$$

Employment_{it} =
$$\beta_0 + \beta_1 CPF_{it} + \beta_2 East_i *CPF_{it}$$
 (24)
 $+ \beta_3 CPF_{2it} + \beta_4 East_i *CPF_{2it}$
 $+ \beta_5 POP_{it} + \beta_6 East_i *POP_{it} + \beta_7 EDU_{it}$
 $+ \beta_8 East_i *EDU_{it} + \beta_9 RDE_{it}$
 $+ \beta_{10} East_i *RDE_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$

where GRP_{it} represents the GRP of region i in year t; $GRP/Capita_{it}$ represents the GRP per capita of region *i* in year *t*; *Employment*_{it} represents the regional employment of region i in year t; CPF_{it} represents the total amount of cohesion policy funding to region *i* in year *t*; East_i*CPF_{it} represents the total amount of cohesion policy funding to eastern European region i in year t; CPF2it represents the average amount of cohesion policy funding to all regions adjacent to region *i* in year *t*; East_i*CPF2_{it} represents the average amount of cohesion policy funding to all regions adjacent to eastern European region i in year t; POP_{it} measures the population size of region *i* in year *t*; East_i*POP_{it} measures the population size of eastern European region i in year t; EDU_{it} measures the education level of region i in year t; $East_i*EDU_{it}$ measures the education level of eastern European region i in year t; RDEit measures the intramural expenditure in research and development of region *i* in year *t*; Easti*RDEit measures the intramural expenditure in research and development of eastern European region i in year t; α_i represents all time-invariant region-specific characteristics; α_t represents all time-variant general characteristics; and β_0 and ε_{it} represent the intercept and error term, respectively.

Again, the dependent variables and the cohesion policy funding variable (including the interaction term) are transformed to their respective natural logarithms. In contrast, like regression equations 19-21, including the logarithmic transformation of the spatial lag of total annual cohesion policy funding ($CPF2_{it}$) causes multicollinearity problems with respect to the natural logarithm of the total annual cohesion policy funding (CPF_{it}) itself. Therefore, the spatial lag of total annual cohesion policy funding is included in its linear form. This also applies to the corresponding interaction term ($East_i*CPF_{it}$).

Equivalently, combining regressions 16-18 for the southern European subgroup of regions with spatial lag regressions 19-21, results in regression specifications 25-27,

$$+\beta_{3}CPF2_{it} + \beta_{4}South_{i}*CPF2_{it}$$

$$+\beta_{5}POP_{it} + \beta_{6}South_{i}*POP_{it} + \beta_{7}EDU_{it}$$

$$+\beta_{8}South_{i}*EDU_{it} + \beta_{9}RDE_{it}$$

$$+\beta_{10}South_{i}*RDE_{it} + \alpha_{i} + \alpha_{t} + \varepsilon_{it}$$

$$GRP/Capita_{it} = \beta_{0} + \beta_{1}CPF_{it} + \beta_{2}South_{i}*CPF_{it}$$

$$+\beta_{3}CPF2_{it} + \beta_{4}South_{i}*CPF2_{it}$$

$$+\beta_{5}POP_{it} + \beta_{6}South_{i}*POP_{it} + \beta_{7}EDU_{it}$$

$$+\beta_{8}South_{i}*EDU_{it} + \beta_{9}RDE_{it}$$

$$+\beta_{10}South_{i}*RDE_{it} + \alpha_{i} + \alpha_{t} + \varepsilon_{it}$$

$$Employment_{it} = \beta_{0} + \beta_{1}CPF_{it} + \beta_{2}South_{i}*CPF_{it}$$

$$+\beta_{3}CPF2_{it} + \beta_{4}South_{i}*CPF_{it}$$

$$+\beta_{5}POP_{it} + \beta_{6}South_{i}*POP_{it} + \beta_{7}EDU_{it}$$

$$+\beta_{8}South_{i}*EDU_{it} + \beta_{9}RDE_{it}$$

$$+\beta_{10}South_{i}*RDE_{it} + \alpha_{i} + \alpha_{t} + \varepsilon_{it}$$

 $\beta_0 + \beta_1 CPF_{it} + \beta_2 South_i *CPF_{it}$

 GRP_{it}

where GRP_{it} represents the GRP of region i in year t; $GRP/Capita_{it}$ represents the GRP per capita of region *i* in year *t*; *Employment*_{it} represents the regional employment of region i in year t; CPF_{it} represents the total amount of cohesion policy funding to region *i* in year *t*; South_i*CPF_{it} represents the total amount of cohesion policy funding to southern European region *i* in year *t*; *CPF2*_{it} represents the average amount of cohesion policy funding to all regions adjacent to region i in year t; South_i*CPF2_{it} represents the average amount of cohesion policy funding to all regions adjacent to southern European region i in year t; POPit measures the population size of region *i* in year *t*; South_i*POP_{it} measures the population size of southern European region *i* in year *t*; EDU_{it} measures the education level of region *i* in year *t*; $South_i$ * EDU_{it} measures the education level of southern European region i in year t; RDE_{it} measures the intramural expenditure in research and development of region i in year t; South_i*RDE_{it} measures the intramural expenditure in research and development of southern European region i in year t; α_i represents all time-invariant region-specific characteristics; α_t represents all time-variant general characteristics; and β_0 and ε_{it} represent the intercept and error term, respectively.

(25)

Again, the dependent variables and the cohesion policy funding variable (including the interaction term) are transformed to their respective natural logarithms. In contrast, like regression equations 19-21 and 22-24, including the logarithmic transformation of the spatial lag of total annual cohesion policy funding ($CPF2_{it}$) causes multicollinearity problems with respect to the natural logarithm of the total annual cohesion policy funding (CPF_{it}) itself. Therefore, also for the regressions distinguishing southern European regions from the remaining, the spatial lag of total annual cohesion policy funding is included in its linear form, as well as the corresponding interaction term ($South_i*CPF_{it}$).

Whether it can be concluded that economic spillovers of cohesion policy funding in terms of regional economic growth and convergence are heterogeneous across space depends on two separate factors. First, it is important to test whether there is still sufficient empirical evidence for the existence of spatial regimes, with respect to both the group of eastern European regions and the group of southern European regions, when the spatially lagged cohesion policy funding variable and the corresponding interaction term are included in the regression models. If this is the case, conclusions regarding the presence of spatial heterogeneity in regional economic spillovers of the policy rely on the estimated regression coefficients of the interacted spatially lagged cohesion policy funding variable.

IV. EMPIRICAL EVIDENCE

In conformity with the model specifications described in the previous section, the regression coefficients of the explanatory variables included in the respective models are estimated. The estimated regression models are used to obtain whether cohesion policy funding significantly increases regional economic growth and convergence, relative to overall regional economic growth and convergence. In addition, the estimated models explicitly test overall regional economic convergence, empirically validate the existence of spatial heterogeneity in the effects of the cohesion policy, assess the significance of potential regional economic spillovers of the policy, and evaluate spatial heterogeneity in these economic spillovers.

First, bivariate regression models 1-3 are presented. Next, these models are extended by including both region fixed effects and year fixed effects, resulting in models 4-6. Controlling for additional influences that could potentially influence the estimation of the regression coefficients results in the assessment of models 7-9. Then, to explicitly validate overall regional economic convergence, models 10-12 are presented. Furthermore, in order to empirically assess the existence of spatial heterogeneity in the effects of the cohesion policy, models 13-15 and models 16-18 are used to test for the existence of an eastern European spatial regime and a southern European spatial regime, respectively. Next, in order to assess regional economic spillovers of the cohesion policy funding, models 19-21 are examined. Finally, in order to evaluate spatial heterogeneity in these economic spillovers, models 22-24 and 25-27 are presented.

A. The Bivariate Model

When regressing the natural logarithm of cohesion policy funding on the dependent variables' logarithmic transformations, it is estimated that cohesion policy funding significantly increases regional economic growth and convergence. The estimated regression coefficients of regressions 1-3 are displayed in table 1.

Table 1. Regression Results for Bivariate Regression Models 1-3

	(1)	(2)	(3)
	GRP	GRP/Capita	Employment
Cohesion Policy Funding	0.01005***	0.00450**	0.00957***
	(0.00292)	(0.00214)	(0.00289)
Constant	23.87147***	9.89224***	13.06818***
	(0.05037)	(0.03740)	(0.05080)
Observations	4.746	4.550	4.070
o poet vacions	4,746	4,559	4,972
R-squared	0.00248	0.00096	0.00219
Region Fixed Effects	No	No	No
Year Fixed Effects	No	No	No
Adjusted R-squared	0.00227	0.00074	0.00200
F-statistic	11.81	4.405	10.94

Notes: All variables are expressed in natural logarithms. Below the estimated regression coefficients, standard errors are in parentheses. * denotes significance at the 10% level (α = 0.1), ** denotes significance at the 5% level (α = 0.05), *** denotes significance at the 1% level (α = 0.01).

First, a positive statistically significant relationship is found between cohesion policy funding and the GRP. Based on the sample subject to this research and the specific regression specification, it is estimated that a one percent increase in cohesion policy funding to a particular region increases the GRP of that region with 0.0101 percent.

Second, a positive statistically significant relationship is found in terms of cohesion policy funding and the GRP per capita. Based on the sample and the regression specification, it is estimated that a one percent increase in cohesion policy funding to a particular region increases the GRP per capita of that region with 0.0045 percent.

Third, a positive statistically significant relationship is also found with respect to cohesion policy funding and employment. Based on the sample and the regression specification, it is estimated that a one percent increase in cohesion policy funding to a particular region increases the amount of people employed in that region with 0.0096 percent.

B. The Fixed Effects Model

Including region fixed effects and year fixed effects in the models to control for unobserved time-invariant region-specific characteristics and unobserved time-variant general characteristics, respectively, results in regression models 4-6. Based on these regression models, concluding that cohesion policy funding significantly increases regional economic growth and convergence becomes slightly more complicated. The estimated regression coefficients corresponding to these models are presented in table 2.

First, there is evidence for the presence of a positive statistically significant relationship between cohesion policy funding and the GRP. Based on the sample and the regression specification, while controlling for fixed effects, it is estimated that a one percent increase in cohesion policy funding to a particular region increases the GRP of that region with 0.0294 percent.

Also, a positive statistically significant relationship is estimated with regard to cohesion policy funding and the GRP per capita. After the inclusion of fixed effects, based on the sample and the regression specification, it is estimated that a one percent increase in cohesion policy funding to a particular region increases the GRP per capita of that region with 0.0342 percent.

Table 2. Regression Results for Fixed Effects Regression Models 4-6

	(4)	(5)	(6)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.02937***	0.03420***	-0.00085**
Funding	(0.00083)	(0.00091)	(0.00042)
Constant	23.30819***	9.19045***	13.18678***
	(0.01316)	(0.01474)	(0.00679)
Observations	4,746	4,559	4,972
R-squared	0.718	0.661	0.228
Number of Regions	279	279	279
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.699	0.637	0.179
F-statistic	595.4	437.5	72.81

Notes: All variables are expressed in natural logarithms. Below the estimated regression coefficients, standard errors are in parentheses. * denotes significance at the 10% level (α = 0.1), ** denotes significance at the 5% level (α = 0.05), *** denotes significance at the 1% level (α = 0.01). Time dummies are not reported.

However, no positive statistically significant relationship is found with respect to cohesion policy funding and employment. In fact, after the inclusion of fixed effects, a negative statistically significant relationship is estimated. Based on the sample and the regression specification, it is estimated that a one percent increase in cohesion policy funding to a particular region decreases the amount of people employed in that region with 0.0009 percent, while controlling for fixed effects.

C. Controlling for Additional Influences

Including additional factors that could potentially influence the estimation of the regression coefficients in the respective regressions, results in regression models 7-9. Based on these regression models, it can again be concluded that cohesion policy funding significantly increases regional economic growth and convergence. The estimated regression coefficients corresponding to these models are presented in table 3.

In terms of the statistical relationships between cohesion policy funding and GRP and GRP per capita, relatively similar results are found when comparing the

estimated regression coefficients of regression models 7-9 with regression models 4-6. With respect to the GRP, there is statistically significant evidence for a positive relationship with cohesion policy funding. Based on the sample and the regression specification, it is estimated that a one percent increase in cohesion policy funding to a particular region increases the GRP of that region with 0.0303 percent, ceteris paribus.

Table 3. Regression Results for Fixed Effects Regression Models 7-9

• 0		O	, ,
	(7)	(8)	(9)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.03028***	0.03174***	0.00146***
Funding	(0.00118)	(0.00120)	(0.00050)
Population	-0.00033***	-0.00071***	0.00019***
Topulation	(0.0003)	(0.0003)	(0.0001)
Tertiary Education	0.00025***	0.00043***	-0.00009***
	(0.00004)	(0.00004)	(0.00001)
R&D Expenditure	0.00004***	0.00004***	0.00002***
1	(0.00001)	(0.00001)	(0.00001)
Constant	00.614=0***	10.13881***	10 9 400 4***
Constant	23.61453*** (0.05731)	(0.05804)	12.84304*** (0.02751)
	(0.03/31)	(0.03004)	(0.02/31)
Observations	2,877	2,877	3,263
R-squared	0.750	0.736	0.270
Number of Regions	249	249	271
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.725	0.708	0.199
F-statistic	373.3	345.3	52.35

Notes: All dependent variables and the cohesion policy funding variable are expressed in natural logarithms. Below the estimated regression coefficients, standard errors are in parentheses. * denotes significance at the 10% level (α = 0.1), ** denotes significance at the 5% level (α = 0.05), *** denotes significance at the 1% level (α = 0.01). Time dummies are not reported.

Also, a positive statistically significant relationship is estimated again with regard to cohesion policy funding and the GRP per capita. After the inclusion of additional

control variables, based on the sample and the regression specification, it is estimated that, ceteris paribus, a one percent increase in cohesion policy funding to a particular region increases the GRP per capita of that region with 0.0317 percent.

In contrast to previously discussed regression models 4-6, a positive statistically significant relationship is found again with respect to cohesion policy funding and employment. Based on the sample and the regression specification, it is estimated that a one percent increase in cohesion policy funding to a particular region increases the amount of people employed in that region with 0.0015 percent, ceteris paribus.

With respect to the control variables included in regression models 7-9 some of the estimated regression coefficients seem somewhat counter-intuitive. First of all, the effect of the population size on both the GRP and the GRP per capita is estimated to be significantly negative. One possible explanation of this finding relies on the fact that cohesion policy funding is allocated partially based on regional population sizes. As a consequence, it is possible that the variation in regional population sizes is already picked up by the estimated regression coefficient of the cohesion policy funding variable to some extent. With respect to regional employment however, the estimated effect of the regional population size is significantly positive.

Another remarkable finding relies on the estimated effect of the education level on regional employment, which is also estimated to be significantly negative. Again, it can be argued that the estimated coefficient of the cohesion policy funding variable might influence this result, as cohesion policy funding generally targets relatively less developed regions, in which the average education level is usually lower as well. Though, in terms of GRP and GRP per capita, as expected, the effect of the education level is estimated to be significantly positive.

Furthermore, with respect to the unexpected results regarding both the estimated negative coefficients of regional population and the regional education level, it is important to note that including stock variables in fixed effects models, as explained in the methodology section, effectively controls for periodic changes in these variables. Clearly, when a region experiences high levels of population growth, this does not necessarily mean that the population size is relatively large already. Equivalently, when a region experiences high increases in the average education level,

this does not necessarily imply that this region had a relatively high education level in the first place.

In contrast to the estimated regression coefficients of the population size and the education level, the estimated coefficients related to regional research and development expenditure are rather intuitive. The estimated effect of regional expenditure in research and development is significantly positive for each of the dependent variables.

D. Regional Convergence

Regressing the growth rates of each of the dependent variables, GRP, GRP per capita and regional employment on their own initial values, in order to explicitly test the significance of regional economic convergence among the regions included in the analysis over the 2000-2018 period, results in the estimation of models 10-12. The estimated regression coefficients corresponding to these models are presented in table 4.

The estimated regression coefficients of the dependent variables' respective initial values are all significantly negative, while controlling for the initial values of the control variables included in the regression models. Therefore, it can be concluded that there are negative statistically significant relationships between the initial values of GRP, GRP per capita and regional employment and their respective growth rates. Hence, this provides statistical evidence for significant regional economic convergence among the regions included in the analysis over the 2000-2018 period.

Nevertheless, it should be noted that the number of observations included in regressions 10-12 is rather low. This is a direct consequence of the limited data available, mainly with respect to regional research and development expenditures. Consequently, bivariate regression models for each of the dependent variables and their respective initial values are also estimated. After that, the control variables are added to these bivariate models one for one, in order to obtain the significance of regional economic convergence, while balancing between the number of regions included in the regression models and the number of theoretically relevant variables that is controlled for. The corresponding estimated regression coefficients can be found in appendix C.

Table 4. Regression Results for Regression Models 10-12

. 0	o .		
	(10)	(11)	(12)
	∆GRP	⊿GRP/Capita	∆Employment
GRP	-0.17197***		
	(0.04581)		
GRP/Capita		-0.48057***	
		(0.03910)	
Employment			-0.06439***
			(0.01998)
Population	4.34•10 ⁻⁹	-1.02•10 ⁻⁷ ***	1.15•10-8
	(3.68•10-8)	$(2.35 \cdot 10^{-8})$	(1.52•10 ⁻⁸)
Tertiary Education	5.01•10 ⁻⁷ ***	3.35•10-7 ***	1.81•10 ⁻⁷ **
	(1.74•10 ⁻⁷)	(1.15•10 ⁻⁷)	(7.73•10-8)
R&D Expenditure	-6.32•10-11	1.89•10-10 ***	-4.32•10 ⁻¹¹ **
	(9.09•10-11)	(6.64•10-11)	(1.79•10-11)
Constant	4.52961***	5.16116***	0.92018***
	(1.03204)	(0.37236)	(0.24433)
Observations	69	69	101
R-squared	0.296	0.740	0.135
Region Fixed Effects	No	No	No
Year Fixed Effects	No	No	No
Adjusted R-squared	0.252	0.724	0.099
F-statistic	6.713	45.52	3.753

Notes: The main independent variables are expressed in natural logarithms. Below the estimated regression coefficients, standard errors are in parentheses. * denotes significance at the 10% level (α = 0.1), ** denotes significance at the 5% level (α = 0.05), *** denotes significance at the 1% level (α = 0.01).

E. Spatial Heterogeneity

Including the interaction terms in regression models 7-9 in order to empirically validate the existence of spatial regimes in the effect of cohesion policy funding on regional growth and convergence, results in regression models 13-15 regarding the subgroup of eastern European regions and regression models 16-18 for the subgroup of southern European regions. From these models, it can be concluded that spatial

heterogeneity in the effects of cohesion policy funding is present and that spatial regimes exist with respect to both eastern and southern European subgroups.

First, in order to empirically validate the eastern European spatial regime, the estimated regression coefficients corresponding to regression models 16-18 are presented in table 5. With respect to the GRP, it is found that the impact of cohesion policy funding is significantly larger in eastern European regions compared to the remaining. Based on the sample and the regression specification, compared to the estimated effect on the remaining regions, it is estimated that a one percent increase in cohesion policy funding to a particular eastern European region increases the GRP of that region with an additional 0.0076 percent, ceteris paribus.

Also, it is estimated that the effect of cohesion policy funding on the GRP per capita in eastern European regions is significantly higher compared to the reference group of the remaining regions. Based on the sample and the regression specification, it is estimated that, ceteris paribus, a one percent increase in cohesion policy funding to a particular eastern European region increases the GRP per capita of that region with an additional 0.0118 percent compared to the remaining regions.

In contrast, it is found that the impact of cohesion policy funding on regional employment in eastern European regions is significantly lower when comparing to the remaining regions. Based on the sample and the regression specification, it is estimated that, relative to the remaining regions, a one percent increase in cohesion policy funding to a particular eastern European region decreases the amount of people employed in that region with 0.0075 percent, ceteris paribus.

Furthermore, several interacted control variables show interesting results. First, compared to the remaining regions, it is estimated that the impact of the regional population size is significantly lower in eastern European regions with respect to the GRP and GRP per capita. However, with respect to regional employment, its impact is significantly higher compared to the other regions. Second, with respect to the education level, the estimated impact is significantly higher for eastern European regions for each of the dependent variables, compared to the impact of the education level in the other regions. Third, with respect to the GRP and GRP per capita, the estimated effect of expenditure in research and development is

significantly higher in eastern European regions, compared to the remaining. Though, in terms of regional employment, the estimated effect is significantly lower.

Table 5. Regression Results for Fixed Effects Regression Models 13-15

	(13)	(14)	(15)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.01563***	0.01432***	0.00437***
Funding	(0.00172)	(0.00172)	(0.00091)
East x Cohesion Policy	0.00755***	0.01178***	-0.00745***
Funding	(0.00209)	(0.00209)	(0.00103)
Population	3.03•10-8	-2.99•10 ⁻⁷ ***	2.48•10 ⁻⁷ ***
	(3.71•10-8)	(3.71•10 ⁻⁸)	(1.89•10-8)
East x Population	-6.89•10 ⁻⁷ ***	-8.66•10 ⁻⁷ ***	1.84•10 ⁻⁷ ***
	(6.74•10 ⁻⁸)	(6.74•10-8)	$(3.40 \cdot 10^{-8})$
Tertiary Education	-8.44•10 ⁻⁸ **	6.67•10 ⁻⁸ *	-2.04•10 ⁻⁷ ***
·	(4.02•10-8)	(4.02•10-8)	(1.98•10-8)
East x Tertiary	1.74•10 ⁻⁶ ***	1.71•10-6 ***	5.05•10 ⁻⁷ ***
Education	(1.12•10 ⁻⁷)	(1.12•10 ⁻⁷)	$(3.58 \cdot 10^{-8})$
R&D Expenditure	5.73•10-11 ***	6.26•10-11***	2.94•10-11***
	(7.04•10 ⁻¹²)	(7.04•10-12)	$(3.52 \cdot 10^{-12})$
East x R&D	1.59•10 ⁻¹⁰ **	1.52•10 ⁻¹⁰ **	-8.78•10-11 ***
Expenditure	(6.76•10-11)	(6.76•10-11)	(3.12•10-11)
Constant	23.44708***	9.99854***	12.64161***
	(0.05570)	(0.05569)	(0.02969)
Observations	2,877	2,877	3,263
R-squared	0.803	0.797	0.343
Number of Regions	249	249	271
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.783	0.776	0.278
F-statistic (overall)	425.3	408.4	61.99
F-statistic (interactions)	174.9	196.4	82.4

Notes: All dependent variables and the cohesion policy funding variable (including the interaction term) are expressed in natural logarithms. Below the estimated regression coefficients, standard errors are in parentheses. * denotes significance at the 10% level (α = 0.1), ** denotes significance at the 5% level (α = 0.05), *** denotes significance at the 1% level (α = 0.01). Time dummies are not reported.

Overall, regardless the sign and significance of the estimated impact of the interacted individual explanatory variables, obtaining empirical evidence for the existence of a spatial regime with respect to eastern European regions depends on the joint significance of these interactions. As the F-statistic related to the joint significance test on all the interaction terms is sufficiently high, it can be concluded that a spatial regime of eastern European regions indeed exists.

Next, in order to empirically test for the existence of a southern European spatial regime, the estimated regression coefficients corresponding to regression models 16-18 are presented in table 6. With respect to cohesion policy funding, the estimated regression coefficients of the interaction terms related to southern European regions in regression models 16-18 show opposite results compared to estimated regression coefficients of the interaction terms related to the eastern European regions in regression models 13-15.

With respect to the GRP, it is estimated that the effect of cohesion policy funding is significantly lower in southern European regions compared to the remaining. Based on the sample and the regression specification, compared to the estimated effect on the remaining regions, it is estimated that a one percent increase in cohesion policy funding to a particular southern European region decreases the GRP of that region with 0.0224 percent, ceteris paribus.

In addition, it is estimated that the impact of cohesion policy funding on the GRP per capita in southern European regions is also significantly lower compared to the remaining regions. Based on the sample and the regression specification, it is estimated that a one percent increase in cohesion policy funding to a particular southern European region decreases the GRP per capita of that region with 0.0283 percent compared to the remaining regions, ceteris paribus.

In contrast, opposing results are found with respect to regional employment, as it is found that the impact of cohesion policy funding on regional employment in southern European regions is significantly higher, compared to the remaining regions. Relative to these regions, based on the sample and the regression specification, it is estimated that a one percent increase in cohesion policy funding to a particular southern European region increases the amount of people employed in that region with 0.0071 percent, ceteris paribus.

Table 6. Regression Results for Fixed Effects Regression Models 16-18

	(16)	(17)	(18)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.03050***	0.03339***	-0.00106**
Funding	(0.00125)	(0.00124)	(0.00053)
South x Cohesion Policy	-0.02234***	-0.02828***	0.00709***
Funding	(0.00246)	(0.00244)	(0.00123)
Population	-7.17•10 ⁻⁷ ***	-1.23•10 ⁻⁶ ***	2.17•10 ⁻⁷ ***
	(4.54•10-8)	(4.50•10-8)	(2.03•10-8)
South x Population	1.02•10 ⁻⁶ ***	1.23•10 ⁻⁶ ***	1.26•10 ⁻⁷ ***
	$(6.40 \cdot 10^{-8})$	$(6.34 \cdot 10^{-8})$	(3.11•10-8)
Tertiary Education	7.71•10 ⁻⁷ ***	8.69•10-7 ***	7.42•10 ⁻⁸ ***
	(5.15•10 ⁻⁸)	$(5.10 \cdot 10^{-8})$	(1.90•10 ⁻⁸)
South x Tertiary	-1.09•10 ⁻⁶ ***	-1.07•10 ⁻⁶ ***	-4.04•10 ⁻⁷ ***
Education	$(6.32 \cdot 10^{-8})$	$(6.26 \cdot 10^{-8})$	(2.91•10-8)
R&D Expenditure	1.95•10-11 **	2.74•10-11***	4.61•10-12
	(7.75•10 ⁻¹²)	(7.69•10-12)	(3.74•10-12)
South x R&D	1.23•10-12	2.91•10-11	1.56•10-11
Expenditure	$(2.58 \cdot 10^{-11})$	$(2.56 \cdot 10^{-11})$	(1.33•10-11)
Constant	23.66241***	10.31698***	12.70916***
	(0.05741)	(0.05691)	(0.02864)
Observations	2,877	2,877	3,263
R-squared	0.790	0.787	0.342
Number of Regions	249	249	271
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.768	0.765	0.277
F-statistic (overall)	392.4	384.8	61.80
F-statistic (interactions)	161.6	209.7	78.8

Notes: All dependent variables and the cohesion policy funding variable (including the interaction term) are expressed in natural logarithms. Below the estimated regression coefficients, standard errors are in parentheses. * denotes significance at the 10% level (α = 0.1), ** denotes significance at the 5% level (α = 0.05), *** denotes significance at the 1% level (α = 0.01). Time dummies are not reported.

With respect to the other interaction terms, first, compared to the remaining regions, it is estimated that the impact of the regional population size is significantly larger for southern European regions for each of the dependent variables. In contrast, with regard to the education level, the estimated impact is significantly lower for southern

European regions for each of the dependent variables, compared to the remaining regions. Finally, with respect to expenditure in research and development no significant results are found. Hence, the impact of research and development expenditure in southern European regions is not significantly different from its impact in the remaining regions.

Nevertheless, again, regardless the sign and significance of the estimated impact of the interacted individual explanatory variables, obtaining empirical evidence for the existence of a spatial regime depends on the joint significance of the interaction terms. Also for southern European regions, the F-statistic related to the joint significance test on all the interaction terms is sufficiently high. Consequently, it can be concluded that a spatial regime of southern European regions exists as well.

Given the empirical evidence for the existence of both a spatial regime of eastern European regions and a spatial regime of southern European regions, regression models 7-9 are also estimated separately for the respective subgroups, as well as for their corresponding reference groups. These regression models are presented in Appendix D.

F. Regional Spillovers

In order to empirically validate regional economic spillovers of cohesion policy funding, the statistical relationships between economic growth and convergence in one particular region and the average of cohesion policy funding in adjacent regions are assessed. Including the spatially lagged cohesion policy funding variable in regression models 7-9 results in regression models 19-21. Throughout these models, the positive statistically significant relationships between cohesion policy funding and regional economic growth and convergence hold. The estimated regression coefficients corresponding to these models are presented in table 7.

In terms of the spatially lagged cohesion policy funding variable, based on these regression models, it can overall be concluded that cohesion policy funding indeed significantly increases regional economic growth and convergence in adjacent regions. As described before, resulting from multicollinearity problems with respect to the cohesion policy funding variable, the spatially lagged cohesion policy funding variable is incorporated in the model in its linear form. As a consequence, the economic interpretation of the estimated regression coefficient becomes slightly different compared to previous interpretations of estimated regression coefficients.

Table 7. Regression Results for Fixed Effects Models 19-21

	(19)	(20)	(21)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.02510***	0.02558***	0.00114**
Funding	(0.00123)	(0.00123)	(0.00054)
Cohesion Policy	0.00032***	0.00038***	0.00002*
Funding in Adjacent Regions	(0.00002)	(0.00002)	(0.00001)
Population	-0.00026***	-0.00063***	0.00019***
	(0.00003)	(0.00003)	(0.00001)
Tertiary Education	0.00022***	0.00041***	-0.00009***
	(0.00004)	(0.00004)	(0.00002)
R&D	0.00004***	0.00004***	0.00002***
Expenditure	(0.00001)	(0.00001)	(0.00001)
Constant	23.56120***	10.07545***	12.83679***
	(0.05598)	(0.05609)	(0.02776)
Observations	2,877	2,877	3,263
R-squared	0.764	0.755	0.271
Number of Regions	249	249	271
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.739	0.729	0.199
F-statistic	382.5	364.2	50.13

Notes: All dependent variables and the cohesion policy funding variable are expressed in natural logarithms. Below the estimated regression coefficients, standard errors are in parentheses. * denotes significance at the 10% level (α = 0.1), ** denotes significance at the 5% level (α = 0.05), *** denotes significance at the 1% level (α = 0.01). Time dummies are not reported.

First, there is statistical evidence for the presence of a positive statistically significant relationship between the average amount of cohesion policy funding in adjacent regions and a region's GRP. Based on the sample and the regression specification, it is estimated that a one million Euro increase in the average cohesion policy funding to adjacent regions, increases the GRP of a region with 0.0320 percent, ceteris paribus.

Also, a positive statistically significant relationship is estimated with regard to the average amount of cohesion policy funding in adjacent regions and the GRP per capita. Based on the sample and the regression specification, it is estimated that, ceteris paribus, a one million Euro increase in the average cohesion policy funding to adjacent regions, increases the GRP per capita of a region with 0.0380 percent.

With respect to the average cohesion policy funding to adjacent regions and regional employment a statistically significant relationship is found as well. Based on the sample and the regression specification, it is estimated that a one million Euro increase in the average cohesion policy funding to adjacent regions increases the amount of people employed in a region with 0.0020 percent, ceteris paribus. Though, it is important to note that this result only holds at the 10 percent significance level.

G. Spatial Heterogeneity in Regional Spillovers

In order to empirically validate whether the regional economic spillovers of cohesion policy funding are spatially heterogeneous, the statistical relationships between economic growth and convergence in one particular region and the average of cohesion policy funding in adjacent regions, interacted with the dummy variable indicating the specific subgroup, are assessed. Combining regression models 13-15 and 19-21 for the subgroup of eastern European regions results in regression models 22-24, whereas combining regression models 16-18 and 19-21 for the subgroup of southern European regions results in regression models 25-27.

From these models, it can be concluded that spatial heterogeneity in the effect of cohesion policy funding in adjacent regions on regional economic growth and convergence is present. In addition, it can be concluded that, when the spatially lagged cohesion policy variable and the corresponding interaction term are included in the regression models, empirical evidence is still sufficient with respect to the existence of spatial regimes in terms of both the subgroup of eastern European regions and the subgroup of southern European regions.

First, in order to empirically validate whether regional economic spillovers of cohesion policy funding are significantly different for the subgroup of eastern European regions, compared to the remaining, regression models 22-24 are presented in table 8. In terms of both the GRP and the GRP per capita, the estimated regression coefficients of the interacted spatially lagged cohesion policy funding variable are insignificant. That is, it is found that the statistical relationships between the average amount of cohesion policy funding in adjacent regions and the GRP and the GRP per capita in eastern European regions are not significantly different from the equivalent statistical relationships in the remaining regions.

Table 8. Regression Results for Fixed Effects Models 22-24

	(22)	(23)	(24)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.01517***	0.01359***	0.00460***
Funding	(0.00172)	(0.00172)	(0.00092)
1 unumg	(0.001/2)	(0.001/2)	(0.00092)
East x Cohesion Policy	0.00685***	0.01072***	-0.00770***
Funding	(0.00217)	(0.00216)	(0.00105)
Cohesion Policy	8.55•10-11 ***	1.36•10 ⁻¹⁰ ***	-3.63•10-11**
Funding in	(3.10•10-11)	(3.09•10-11)	$(1.56 \cdot 10^{-11})$
Adjacent Regions			
East x Cohesion Policy	-3.68•10 ⁻¹⁴	-2.84•10 ⁻¹²	3.19•10-11**
Funding in	(3.13•10-11)	(3.12•10-11)	(1.56•10-11)
Adjacent Regions			
Population	2.72•10 ⁻⁸	-3.04•10 ⁻⁷ ***	2.48•10 ⁻⁷ ***
Topulation	$(3.70 \cdot 10^{-8})$	(3.69•10-8)	(1.89•10-8)
	(0-7	(0/-) -)	
East x Population	-6.42•10 ⁻⁷ ***	-7.94•10 ⁻⁷ ***	1.88•10-7 ***
	(7.10•10-8)	(7.07•10-8)	$(3.55 \cdot 10^{-8})$
Tertiary Education	-7.22•10 ⁻⁸ *	8.58•10 ⁻⁸ **	-2.07•10 ⁻⁷ ***
	(4.03•10-8)	(4.02•10-8)	(1.99•10-8)
East x Tertiary	1.66•10-6***	1.59•10 ⁻⁶ ***	4.90•10 ⁻⁷ ***
Education	(1.15•10-7)	(1.14•10-7)	$(3.89 \cdot 10^{-8})$
D0 D E Ji	- (4 4 0 11 ***	(10 10-11***	0.00.10-11***
R&D Expenditure	5.64•10 ⁻¹¹ *** (7.04•10 ⁻¹²)	6.13•10 ⁻¹¹ *** (7.02•10 ⁻¹²)	2.98•10 ^{-11***} (3.52•10 ⁻¹²)
	(/.04•10)	(/.02•10)	(3.52•10)
East x R&D	1.48•10-10 **	1.35•10 ⁻¹⁰ **	-8.97•10 ⁻¹¹ ***
Expenditure	(6.84•10-11)	$(6.82 \cdot 10^{-11})$	(3.15•10-11)
Constant	23.43774***	9.98431***	12.63960***
00110tm110	(0.05596)	(0.05578)	(0.02983)
Observations	2,877	0.955	0.060
R-squared	0.804	2,877 0.799	3,263 0.345
Number of Regions	249	249	0.345 271
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.783	0.778	0.279
F-statistic (overall)	395.4	382.6	57.72
F-statistic (interactions)	107.76	114.42	73.19

Notes: All dependent variables and the cohesion policy funding variable (including the interaction term) are expressed in natural logarithms. Below the estimated regression coefficients, standard errors are in parentheses. * denotes significance at the 10% level (α = 0.1), ** denotes significance at the 5% level (α = 0.05), *** denotes significance at the 1% level (α = 0.01). Time dummies are not reported.

In contrast, a positive statistically significant effect is estimated in terms of regional employment. Hence, it is estimated that the effect of the average amount of cohesion policy funding in adjacent regions is significantly larger for the subgroup of eastern European regions, compared to all other regions included in the analysis. Relative to the subgroup of remaining regions, based on the sample and the regression specification, it is estimated that a one million Euro increase in the average cohesion policy funding to adjacent regions increases the regional employment in an eastern European region with 3.19•10-9 percent, ceteris paribus.

However, it stands out that the overall effect of the average amount of cohesion policy funding in adjacent regions is estimated to be significantly negative in terms of regional employment. In fact, the negative size of the estimated regression coefficient of spatially lagged cohesion policy funding is larger than the positive size of the estimated regression coefficient of the corresponding interaction term. Therefore, it should be noted that the net effect of the average amount of cohesion policy funding in adjacent regions for the subgroup of eastern European regions is negative after all.

With respect to the cohesion policy funding variable, as well as for the corresponding interaction term, no surprising results are found when the spatially lagged cohesion policy funding variable and the corresponding interaction term are included. The estimated regression coefficients have the same sign and significance as the estimated regression coefficients in regression models 19-21. This also applies to all control variables, as well as for the corresponding interaction terms, when comparing these to the estimated regression coefficients in regression models 13-15.

Overall, regardless the sign and significance of the estimated impact of the interacted individual explanatory variables, empirical evidence for the existence of a spatial regime with respect to eastern European regions is still sufficient when including the spatially lagged cohesion policy variable and the corresponding interaction term in the regression models. As the F-statistic related to the joint significance test on all the interaction terms is sufficiently high, it can be concluded that a spatial regime of eastern European regions exists.

Next, in order to obtain if regional economic spillovers of cohesion policy funding are significantly different for the subgroup of southern European regions, compared to the remaining, regression models 25-27 are presented in table 9. In terms of the GRP, the estimated regression coefficients of the interacted spatially

lagged cohesion policy funding variable is significantly negative. That is, it is found that the effect of the average amount of cohesion policy funding in adjacent regions is significantly larger for the subgroup of southern European regions, compared to the remaining. Relative to the subgroup of remaining regions, based on the sample and the regression specification, it is estimated that a one million Euro increase in the average cohesion policy funding to adjacent regions decreases the GRP of a southern European region with 5.26•10-9 percent, ceteris paribus.

Similar results are found with respect to the GRP per capita. For the subgroup of southern European regions, the effect of the average amount of cohesion policy funding in adjacent regions is significantly smaller compared to the group of reference. Based on the sample and the regression specification, it is estimated that a one million Euro increase in the average cohesion policy funding to adjacent regions decreases the GRP of a southern European region with 4.69•10-9 percent, ceteris paribus.

In terms of the regional employment, the effect of the average amount of cohesion policy funding in adjacent regions is also significantly smaller compared to the remaining regions. Relative to the subgroup of remaining regions, based on the sample and the regression specification, it is estimated that a one million Euro increase in the average cohesion policy funding to adjacent regions decreases the regional employment in a southern European region with 4.72•10-9 percent, ceteris paribus.

With respect to the cohesion policy funding variable, as well as for the corresponding interaction term, no surprising results are found when the spatially lagged cohesion policy funding variable and the corresponding interaction term are included. The estimated regression coefficients have the same sign and significance as the estimated regression coefficients in regression models 19-21. This also applies to all control variables, as well as for the corresponding interaction terms, when comparing these to the estimated regression coefficients in regression models 16-18, apart from the estimated regression coefficients for the interacted expenditure in research and development. Based on the regression specifications of regression models 25-27, it is estimated that the regional economic spillovers of R&D expenditure are not significantly different for the subgroup of southern European regions, compared to the remaining.

Table 9. Regression Results for Fixed Effects Models 22-24

	(25)	(26)	(27)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.02688***	0.02905***	-0.00121**
Funding	(0.00131)	(0.00130)	(0.00057)
South x Cohesion Policy	-0.01826***	-0.02387***	0.00858***
Funding	(0.00254)	(0.00250)	(0.00128)
Cohesion Policy	2.09•10-10 ***	2.52•10 ⁻¹⁰ ***	5.88•10-12
Funding in Adjacent Regions	(2.64•10 ⁻¹¹)	(2.60•10-11)	(1.30•10-11)
South x Cohesion Policy	-5.26•10-11 ***	-4.69•10 ⁻¹¹ **	-4.72•10 ⁻¹¹ ***
Funding in Adjacent Regions	(2.02•10-11)	(2.00•10-11)	(1.06•10-11)
Population	-6.35•10 ⁻⁷ ***	-1.13•10 ⁻⁶ ***	2.18•10 ⁻⁷ ***
	(4.60•10 ⁻⁸)	$(4.54 \cdot 10^{-8})$	(2.09•10-8)
South x Population	9.19•10 ⁻⁷ ***	1.11•10-6 ***	1.21•10 ⁻⁷ ***
	$(6.44 \cdot 10^{-8})$	$(6.35 \cdot 10^{-8})$	$(3.16 \cdot 10^{-8})$
Tertiary Education	7.19•10 ⁻⁷ ***	8.05•10-7 ***	7.29•10 ⁻⁸ ***
	$(5.13 \cdot 10^{-8})$	$(5.06 \cdot 10^{-8})$	$(1.93 \cdot 10^{-8})$
South x Tertiary	-1.01•10 ⁻⁶ ***	-9.67•10 ⁻⁷ ***	-4.09•10 ⁻⁷ ***
Education	$(6.35 \cdot 10^{-8})$	$(6.26 \cdot 10^{-8})$	$(2.97 \cdot 10^{-8})$
R&D Expenditure	2.16•10-11 ***	2.98•10-11 ***	4.81•10-12
	$(7.67 \cdot 10^{-12})$	$(7.56 \cdot 10^{-12})$	$(3.74 \cdot 10^{-12})$
South x R&D	-6.99•10 ⁻¹³	2.57•10-11	1.87•10-11
Expenditure	$(2.55 \cdot 10^{-11})$	$(2.52 \cdot 10^{-11})$	(1.33•10-11)
Constant	23.61347***	10.25871***	12.70660***
	(0.05707)	(0.05625)	(0.02886)
Observations	2,877	2,877	3,263
R-squared	0.795	0.795	0.347
Number of Regions	249	249	271
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.774	0.773	0.281
F-statistic (overall)	374.3	372.4	58.31
F-statistic (interactions)	122.48	156.80	83.39

Notes: All dependent variables and the cohesion policy funding variable (including the interaction term) are expressed in natural logarithms. Below the estimated regression coefficients, standard errors are in parentheses. * denotes significance at the 10% level (α = 0.1), ** denotes significance at the 5% level (α = 0.05), *** denotes significance at the 1% level (α = 0.01). Time dummies are not reported.

Overall, regardless the sign and significance of the estimated impact of the interacted individual explanatory variables, empirical evidence for the existence of a spatial regime with respect to southern European regions is still sufficient when including the spatially lagged cohesion policy variable and the corresponding interaction term in the regression models. As the F-statistic related to the joint significance test on all the interaction terms is sufficiently high, it can be concluded that a spatial regime of eastern European regions exists.

The empirical evidence for the existence of both a spatial regime of eastern European regions and a spatial regime of southern European regions is still sufficient, when including the spatially lagged cohesion policy funding variable. Therefore, regression models 19-21 are also estimated separately for the respective subgroups, as well as for their corresponding reference groups. These regression models are presented in Appendix E.

V. DISCUSSION

Building on discussed findings in existing literature, this research quantified the effectiveness of cohesion policy funding in terms of regional economic growth and convergence. Throughout this research it has become clear that the EU's cohesion policy has been effective in pursuing the overall goals it has been designed for. That is, the EU's cohesion policy and the accompanied regional funding mechanisms have indeed significantly increased regional economic growth and convergence, based on the regression analysis executed in this research.

On the basis of a variation of regression model specifications discussed in the previous sections, it is estimated that cohesion policy funding has significantly increased regional economic performance, as measured by the GRP, and regional productivity, as measured by the GRP per capita. Although relatively more sensitive to alternative model specifications, similar results were found with respect to the impact of cohesion policy funding on the creation of jobs, as measured by regional employment.

Throughout this research it is argued that these measures are good indicators for the assessment of the overall goals of the cohesion policy. However, it is important to note that these indicators do not cover the overall goals completely. For example, the GRP of a region does not literally translate to regional economic performance, as

the composition of the regional GRP can significantly differ among different regions. Equivalently, the GRP per capita does not completely describe regional productivity.

With respect to regional employment, the main limitation relies on the fact that sectoral composition of employment is basically neglected. Although the European commission describes the goal of the creation of jobs in a very broad manner, it is clear that employment in certain sectors might be more valuable for regional economies compared to employment in other sectors.

It is important to stress that the overall goals of cohesion policy are rather general. Consequently, different empirical results might be obtained when the impact of the policy is assessed on the basis of its narrower, more detailed goals. That is, rather than only focusing on overall regional economic growth and convergence, assessing the effectiveness of cohesion policy funding within particular programme periods with respect to the respective programme period's particular goals, might lead to different, more detailed conclusions.

The fact that these separate programme periods exist, also brings in the notion of time lags. It is imaginable that there is an overall delay between the moment of funding allocation and the actual investment of the allocated funding. In general, programmes are created, presented and evaluated before the final funding allocation decision. Nevertheless, it is very likely that certain effects of cohesion policy funding on regional economic growth and convergence take place with a certain delay.

Furthermore, assessing the effectiveness of each of the individual funds supporting the policy in terms of their respective particular goals, might also lead to different results with regard to the policy's effectiveness. Throughout this research, only the effectiveness of the cumulative funding from the funds that make up the cohesion policy is assessed in terms of the overall goals of the policy. Though, each of the funds that support the overall goals of cohesion policy have their own particular goals in turn. Assessing the impacts of the individual funds on their corresponding individual goals is not only more precise, but also allows for a comparison between the individual funds' effectiveness.

After taking into account the previously described limitations, it can still be concluded that cohesion policy funding is effective in terms of achieving its overall goals, on the basis of this research. However, this does not imply that the policy's effectiveness is maximized. The statistical significance of the effectiveness of cohesion policy funding is clear, but the economic size of the impact can possibly still be

increased. In other words, the empirical validation of the policy's effectiveness does not imply that the policy is also efficient.

Throughout the research, it is also found that the effect of cohesion policy funding is heterogeneous across space, as empirical evidence is presented for the existence of two spatial regimes, one of eastern and one of southern European regions. Typically, this spatial heterogeneity is not really taken into account with respect to the cohesion policy funding allocation, as the same conditions and specifications for funding eligibility are applied to all European regions equally. Given the empirical evidence for the existence of the spatial regimes, it can be questioned whether this funding allocation approach is sufficient.

Similarly, the sufficiency of the funding allocation system can be questioned when considering economic spillovers. After extending the data analysis by assessing potential regional economic spillovers of the cohesion policy funding to adjacent regions, it is estimated that such spillovers indeed exist. As a consequence, it is concluded that the impact of cohesion policy funding on regional economic growth and convergence is not limited to the targeted region, but also positively affects regional economic performance, as well as regional productivity, in adjacent regions.

Resulting from this, it can be questioned whether the funding allocation system should really target regions as completely distinct geographic entities. Alternatively, from an individual region's perspective, the existence of economic spillovers of cohesion policy funding calls for more cooperation with adjacent regions. Nevertheless, it is important to keep in mind that these economic spillovers are found to be heterogeneous across the EU. Consequently, dissimilar forms of cooperation might be optimal for and desired by different regions.

Though, again, focussing on more detailed economic performance indicators when assessing regional economic spillovers might lead to different, more detailed conclusions. Also, it is likely that using other classifications in obtaining regional economic spillovers than adjacency, such as proximity, results in different findings as well. Finally, it should be noted that despite the fact that the empirically validated existence of regional economic spillovers calls for increased cooperation between regions, it does not necessarily imply a positive argument for cohesion policy funding in general. Only the statistical significance of the existence, rather than the desirability, of regional economic spillovers is assessed, while the existent cohesion policy is treated as given.

VI. CONCLUSION

Based on a sample consisting of panel data on 279 European NUTS-2 regions over the period 2000-2018, it is found that the cohesion policy and the accompanied regional funding mechanisms have indeed significantly increased regional economic growth and convergence. That is, on the basis of fixed effects modelling to disentangle time-invariant country specific and time-variant aggregate effects, empirical evidence shows that cohesion policy funding has significantly improved regional economic development, increased regional productivity, and supported the creation of jobs, as operationalized by the GRP, the GRP per capita and regional employment, respectively.

Furthermore, throughout this research, explicit empirical evidence is presented for significant overall regional economic convergence among the regions included in the analysis over the period assessed. It also shows that the effects of cohesion policy funding are significantly heterogeneous across space and that two particular spatial regimes exist, one with respect to eastern European regions and one existing of southern European regions. In addition, empirical evidence is presented for the existence of significant regional economic spillovers of cohesion policy funding to adjacent regions, as well as for spatial heterogeneity in these economic spillovers.

However, it is important to note that the findings presented in this research are subject to certain limitations, as discussed in the previous section. Resulting from this, when more detailed data on variables related to more particular goals of the policy becomes available, it will be valuable to assess the overall effectiveness, the existence of spatial regimes, and the regional economic spillovers in an increasingly precise manner in future research. Nevertheless, based on the dataset subject to this research and the regression model specifications used, it can still be concluded that the cohesion policy is effective in pursuing the overall goals the policy has been designed for.

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APPENDIX A - DESCRIPTIVE STATISTICS

 Table 10. Descriptive Statistics

Variable Name Regressions 1-9	Variable Description	Observations	Mean	Standard Deviation	Minimum	Maximum
GRP	Gross Regional Product	4746	4.44•10¹0	4.89•1010	8.07e•10 ⁸	7.34•1011
Log(GRP)	Natural Logarithm of Gross Regional Product	4746	24.03658	1.041731	20.5094	27.3216
GRP/Capita	Gross Regional Product per Capita	4559	25561.73	15695.21	1252.883	229412.1
Log(GRP/Capita)	Natural Logarithm of Gross Regional Product per Capita	4559	9.967976	0.665044	7.133203	12.34328
Employment	Total Regional Employment	4972	763011.7	631057.3	13200	5349100
Log(Employment)	Natural Logarithm of Regional Employment	4972	13.23119	0.870066	9.487972	15.49244
Cohesion Policy Funding	Total Amount of Cohesion Policy Funding	5301	1.34e+08	2.14e+08	1	2.31e+09
Log(Cohesion Policy Funding)	Natural Logarithm of Total Amount of Cohesion Policy Funding	5301	16.33644	5.303861	O	21.55849

Population	Total Regional Population	5037	1797839	1496665	25706	1.22e+07
Tertiary Education	Total Regional Population with Tertiary Education (ISCED levels 5-8)	4834	462480.3	473231.7	5732.438	6019788
R&D Expenditure	Total Regional Intramural Expenses in Research and Development	3281	8.16•108	1.52•10 ⁹	0	1.87•10 ¹⁰
Variable Name Regressions 10-12	Variable Description	Observations	Mean	Standard Deviation	Minimum	Maximum
GRP growth	Gross Regional Product Growth over the 2000- 2018 period	237	0.576150	0.349750	0.111694	1.816815
GRP/Capita growth	Gross Regional Product per Capita Growth over the 2000-2018 period	207	0.52607	0.395828	0.061942	1.809965
Employment growth	Total Regional Employment Growth over the 2000-2018 period	233	0.107036	0.127041	-0.337733	0.829111
GRP (2000)	Gross Regional Product in the year 2000	237	23.70803	1.124582	20.5094	26.27538
GRP/Capita (2000)	Gross Regional Product per Capita in the year 2000	207	9.659945	0.820370	7.133203	10.88233
Employment (2000)	Total Regional Employment in the year 2000	233	13.20297	0.886721	9.487972	15.4146
Population (2000)	Total Regional Population in the year 2000	242	1770354	1467557	25706	1.10•10 ⁷

Tertiary Education (2000)	Total Regional Population with Tertiary Education (ISCED levels 5-8) in the year 2000	228	344957.7	358673.6	5732.438	3636597
R&D Expenditure (2000)	Total Regional Intramural Expenses in Research and Development in the year 2000	104	5.66•10 ⁸	1.42•10 ⁹	0	1.35•10 ¹⁰
Variable Name	Variable Description	Observations	Mean	Standard Deviation	Minimum	Maximum
Regressions 13-18						
East Dummy	Eastern European Region Dummy (1 = East, 0 = non-East)	5301	0.175627	0.380539	0	1
East x Log(Cohesion Policy Funding)	Interaction Term of Eastern European Region Dummy and the Total Amount of Cohesion Policy Funding	5301	2.593856	6.4391	0	20.98034
East x Population	Interaction Term of Eastern European Region Dummy and the Total Regional Population	5037	302592.4	756442.8	O	4783570
East x Tertiary Education	Interaction Term of Eastern European Region Dummy and the Total Regional Population with Tertiary Education (ISCED levels 5-8)	4834	53830.27	146711.8	0	1336756
East x R&D Expenditure	Interaction Term of Eastern European Region Dummy and the Total Regional Intramural Expenses in Research and Development	3281	2.57•10 ⁷	9.14•10 ⁷	0	1.22•109
South	Southern European Region Dummy (1 = South, 0 = non-South)	5301	0.236559	0.425009	O	1
South x Log(Cohesion Policy Funding)	Interaction Term of Southern European Region Dummy and the Total Amount of Cohesion	5301	4.337229	7.92201	0	21.55849

	Policy Funding					
South x Population	Interaction Term of Southern European Region Dummy and the Total Regional Population	5037	494623.7	1356955	О	1.00•10 ⁷
South x Education	Interaction Term of Southern European Region Dummy and the Total Regional Population with Tertiary Education (ISCED levels 5-8)	4834	107632.5	328984.4	0	3091374
South x R&D Expenditure	Interaction Term of Southern European Region Dummy and the Total Regional Intramural Expenses in Research and Development	3281	1.67•10 ⁸	5.48•10 ⁸	O	4.90•10 ⁹
Variable Name	Variable Description	Observations	Mean	Standard Deviation	Minimum	Maximum
				Deviation		
Regressions 19-21						
Regressions 19-21						
Cohesion Policy Funding in Adjacent Regions	Total Amount of Cohesion Policy Funding in Adjacent Regions	5301	9.76•10 ⁷	1.36•10 ⁸	O	1.11•10 ⁹
Cohesion Policy Funding	•	5301 4827	9.76•10 ⁷ 2.883522	1.36•10 ⁸ 0.086549	0 1.504035	1.11•10 ⁹ 3.07077
Cohesion Policy Funding in Adjacent Regions Log(Cohesion Policy Funding in Adjacent	Adjacent Regions Natural Logarithm of the Total Amount of			-	-	-1

East x Cohesion Policy Funding in Adjacent Regions	Interaction Term of Eastern European Region and Total Amount of Cohesion Policy Funding in Adjacent Regions	5301	3.64•10 ⁷	1.29•10 ⁸	0	1.29•10 ⁹
South x Cohesion Policy Funding in Adjacent Regions	Interaction Term of Southern European Region and Total Amount of Cohesion Policy Funding in Adjacent Regions	5301	5.95•10 ⁷	1.85•10 ⁸	O	2.31•109

APPENDIX B - CORRELATION TABLES

Table 11. Correlation Table for Regression Models 1-9 & 13-27

Variable Name	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
(1) GRP	1.000																								
(2) Log(GRP)	0.814	1.000																							
(3) GRP/Capita	0.448	0.535	1.000																						
(4) Log(GRP/Capita)	0.438	0.579	0.911	1.000																					
(5) Employment	0.872	0.715	0.069	0.063	1.000																				
(6) Log(Employment)	0.667	0.798	0.006	-0.016	0.826	1.000																			
(7) Cohesion Policy Funding	0.077	0.125	-0.362	-0.266	0.328	0.307	1.000																		
(8) Log(Cohesion Policy Funding)	0.116	0.179	-0.308	-0.157	0.279	0.294	0.735	1.000																	
(9) Population	0.824	0.673	-0.010	-0.005	0.975	0.804	0.423	0.336	1.000																
(10) Tertiary Education	0.828	0.734	0.235	0.244	0.858	0.715	0.262	0.234	0.825	1.000															
(11) R&D Expenditure	0.781	0.654	0.525	0.456	0.582	0.480	-0.094	-0.031	0.497	0.635	1.000														
(12) East Dummy	-0.323	-0.403	-0.613	-0.754	-0.042	0.087	0.176	0.108	-0.026	-0.179	-0.280	1.000													
(13) East x Log(Cohesion Policy Funding)	-0.315	-0.381	-0.599	-0.723	-0.038	0.090	0.217	0.193	-0.021	-0.168	-0.276	0.991	1.000												
(14) East x Population	-0.262	-0.293	-0.562	-0.707	0.083	0.182	0.223	0.132	0.101	-0.081	-0.244	0.880	0.879	1.000											

(15) East x Tertiary	-0.210	-0.207	-0.461	-0.541	0.075	0.164	0.275	0.213	0.087	-0.000	-0.204	0.796	0.815	0.896	1.000										
Education																									
(16) East x R&D	-0.108	-0.049	-0.181	-0.164	0.015	0.087	0.198	0.179	0.002	-0.001	-0.091	0.531	0.551	0.496	0.663	1.000									
Expenditure																									
(17) South	0.128	-0.001	-0.139	0.021	0.130	-0.088	0.264	0.312	0.203	0.079	-0.088	-0.363	-0.360	-0.319	-0.289	-0.193	1.000								
(18) South x Log(Cohesion	0.143	0.021	-0.148	0.012	0.156	-0.056	0.311	0.348	0.233	0.104	-0.082	-0.362	-0.359	-0.318	-0.288	-0.192	0.997	1.000							
Policy Funding)																									
(19) South x Population	0.628	0.441	-0.031	0.062	0.706	0.441	0.436	0.361	0.779	0.582	0.221	-0.233	-0.231	-0.205	-0.185	-0.123	0.640	0.667	1.000						
(20) South x Education	0.583	0.409	-0.011	0.073	0.665	0.408	0.369	0.320	0.709	0.709	0.234	-0.207	-0.206	-0.182	-0.165	-0.110	0.571	0.594	0.904	1.000					
(21) South x R&D	0.705	0.442	0.074	0.127	0.707	0.419	0.187	0.218	0.721	0.610	0.334	-0.175	-0.173	-0.154	-0.139	-0.093	0.481	0.491	0.875	0.854	1.000				
Expenditure																									
(22) Spatially Lagged	-0.097	-0.045	-0.373	-0.287	0.078	0.138	0.590	0.591	0.112	0.028	-0.163	0.278	0.322	0.255	0.281	0.193	0.216	0.241	0.168	0.174	0.070	1.000			
Cohesion Policy Funding																									
(23) Log(Spatially Lagged	0.119	0.183	-0.260	-0.115	0.256	0.270	0.666	0.986	0.307	0.222	-0.016	0.071	0.163	0.098	0.181	0.154	0.294	0.326	0.331	0.294	0.205	0.543	1.000		
Cohesion Policy Funding)																									
(22) East x Spatially Lagged	-0.182	-0.157	-0.386	-0.400	0.027	0.110	0.449	0.415	0.043	-0.038	-0.178	0.685	0.748	0.713	0.763	0.533	-0.249	-0.248	-0.159	-0.142	-0.120	0.476	0.377	1.000	
Cohesion Policy Funding																									
(23) South x Spatially Lagged	0.193	0.191	-0.170	-0.070	0.333	0.225	0.768	0.476	0.439	0.283	-0.017	-0.203	-0.201	-0.178	-0.161	-0.108	0.558	0.609	0.653	0.561	0.335	0.348	0.428	-0.139	1.000
Cohesion Policy																									
Funding																									

 Table 12. Correlation Table for Regression Models 10-12

Variable Name	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
() CDD 4									
(1) GRP growth	1.000								
(2) GRP/Capita growth	0.951	1.000							
(3) Employment growth	0.335	0.082	1.000						
(4) GRP (2000)	-0.399	-0.409	-0.125	1.000					
(5) GRP/Capita (2000)	-0.700	-0.809	0.003	0.491	1.000				
(6) Employment (2000)	-0.008	0.038	-0.152	0.862	-0.002	1.000			
(7) Population (2000)	-0.177	-0.172	-0.49	0.778	0.130	0.795	1.000		
(8) Tertiary Education (2000)	-0.011	-0.067	0.145	0.687	0.179	0.690	0.801	1.000	
(9) R&D Expenditure (2000)	-0.262	-0.302	-0.011	0.735	0.477	0.586	0.711	0.660	1.000

APPENDIX C - CONVERGENCE REGRESSION MODELS

Table 13. Regression Results for Regression Models 10-10c

9 0	O			
	(10a)	(10b)	(10c)	(10)
	$_{\Delta}\text{GRP}$	$_{\Delta}$ GRP	$_{\Delta}\text{GRP}$	$_{\Delta}\text{GRP}$
GRP	-0.13931***	-0.23607***	-0.25772***	-0.17197***
	(0.01814)	(0.02155)	(0.02762)	(0.04581)
Population		1.37•10 ⁻⁷ ***	1.15•10 ⁻⁷ ***	4.34•10-9
		(1.85•10-8)	(2.43•10-8)	(3.68•10-8)
Tertiary Education			2.07•10-7	5.01•10 ⁻⁷ ***
			(1.33•10-7)	(1.74•10-7)
R&D Expenditure				-6.32•10-11
				(9.09•10-11)
Constant	3.87897***	5.93074***	6.41205***	4.52961***
	(0.43051)	(0.49185)	(0.62837)	(1.03204)
Observations	237	207	196	69
R-squared	0.201	0.371	0.346	0.296
Region Fixed Effects	No	No	No	No
Year Fixed Effects	No	No	No	No
Adjusted R-squared	0.197	0.365	0.336	0.252
F-statistic	58.99	60.27	33.88	6.713

Notes: The main independent variables are expressed in natural logarithms. Below the estimated regression coefficients, standard errors are in parentheses. * denotes significance at the 10% level $(\alpha = 0.1)$, ** denotes significance at the 5% level $(\alpha = 0.05)$, *** denotes significance at the 1% level $(\alpha = 0.01)$.

Table 14. Regression Results for Regression Models 11-11c

. 0	8			
	(11a)	(11b)	(11c)	(11)
	∆GRP/Capita	⊿GRP/Capita	⊿GRP/Capita	⊿GRP/Capita
CDD/C :		V.V.V		0**
GRP/Capita	-0.40352***	-0.40323***	-0.45192***	-0.48057***
	(0.01848)	(0.01847)	(0.02327)	(0.03910)
Population		1.23•10-8	-3.69•10 ⁻⁸ *	-1.02•10 ⁻⁷ ***
		(1.13•10-8)	$(2.00 \cdot 10^{-8})$	$(2.35 \cdot 10^{-8})$
Tertiary Education			2.88•10-7 ***	3.35•10-7 ***
			(9.84•10-8)	(1.15•10 ⁻⁷)
R&D Expenditure				1.89•10 ⁻¹⁰ ***
				(6.64•10-11)
Constant	4.42400***	4.40071***	4.86283***	5.16116***
	(0.17912)	(0.18030)	(0.22602)	(0.37236)
Observations	207	207	196	69
R-squared	0.699	0.701	0.689	0.740
Region Fixed Effects	No	No	No	No
Year Fixed Effects	No	No	No	No
Adjusted R-squared	0.698	0.698	0.684	0.724
F-statistic	477	239.3	142	45.52

Notes: The main independent variables are expressed in natural logarithms. Below the estimated regression coefficients, standard errors are in parentheses. * denotes significance at the 10% level $(\alpha = 0.1)$, ** denotes significance at the 5% level $(\alpha = 0.05)$, *** denotes significance at the 1% level $(\alpha = 0.01)$.

Table 15. Regression Results for Regression Models 12-12c

(12a)	(12b)	(12c)	(12)
$_{\Delta}$ Employment	$_{\Delta}$ Employment	$_{\Delta}$ Employment	$_{\Delta}$ Employment
			-0.06439***
(0.00938)	(0.01582)	(0.01555)	(0.01998)
	1.65•10-8*	-6.88•10 ⁻⁹	1.15•10-8
	(9.44•10 ⁻⁹)	(1.21•10-8)	$(1.52 \cdot 10^{-8})$
		1.22•10 ⁻⁷ ***	1.81•10-7 **
		(4.04•10-8)	(7.37•10-8)
			-4.32•10-11**
			(1.79•10-11)
0.30152**	0.55059***	0.56912***	0.92018***
(0.12408)	(0.19538)	(0.19204)	(0.24433)
000	208	208	101
			0.135
			No
No	No	No	No
0.006	0.014	0.047	0.099
2.468	2.554	4.807	3.753
	-0.01473 (0.00938) 0.30152** (0.12408) 233 0.011 No No 0.006		

Notes: The main independent variables are expressed in natural logarithms. Below the estimated regression coefficients, standard errors are in parentheses. * denotes significance at the 10% level $(\alpha = 0.1)$, ** denotes significance at the 5% level $(\alpha = 0.05)$, *** denotes significance at the 1% level $(\alpha = 0.01)$.

APPENDIX D - REGIMES REGRESSION MODELS I

Table 16. Regression Results for Regression Models 7-9 for Eastern European Regions

	(7)	(8)	(9)
	GRP	GRP/Capita	Employment
Cohogian Paliay	0.00682*	0.00501*	0.00050*
Cohesion Policy		0.00591*	0.00250*
Funding	(0.00353)	(0.00348)	(0.00132)
Population	-4.88•10 ⁻⁷ ***	-8.51•10 ⁻⁷ ***	4.36•10 ⁻⁷ ***
	$(8.45 \cdot 10^{-8})$	$(8.34 \cdot 10^{-8})$	$(3.38 \cdot 10^{-8})$
Tertiary Education	1.47•10-6 ***	1.28•10-6 ***	3.25•10-7***
	(1.68•10-7)	(1.66•10 ⁻⁷)	(3.54•10-8)
R&D Expenditure	4.24•10-11	-1.08•10-11	-7.08•10-11**
	$(8.52 \cdot 10^{-11})$	(8.41•10-11)	(3.35•10-11)
Constant	22.92190***	9.32222***	12.49766***
	(0.14789)	(0.14603)	(0.06142)
Regime	East	East	East
Observations	636	636	736
R-squared	0.894	0.904	0.462
Number of Regions	49	49	49
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.881	0.893	0.406
F-statistic	227.6	255.1	27.24

Table 17. Regression Results for Regression Models 7-9 for Non-Eastern European Regions

, 0	O	, ,	1 0
	(7)	(8)	(9)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.01732***	0.01599***	0.00378***
Funding	(0.00141)	(0.00138)	(0.00090)
Population	4.89•10-8	-2.95•10 ⁻⁷ ***	2.41•10-7 ***
	$(3.04 \cdot 10^{-8})$	$(2.99 \cdot 10^{-8})$	(1.87•10-8)
Tertiary Education	-7.85•10 ⁻⁸ **	1.03•10-7***	-2.04•10 ⁻⁷ ***
	$(3.33 \cdot 10^{-8})$	$(3.28 \cdot 10^{-8})$	(1.99•10-8)
R&D Expenditure	6.28•10-11 ***	6.92•10-11***	2.99•10-11***
	$(5.76 \cdot 10^{-12})$	$(5.66 \cdot 10^{-12})$	(3.47•10 ⁻¹²)
Constant	23.47366***	10.03245***	12.70273***
	(0.05212)	(0.05121)	(0.03399)
Regime	Non-East	Non-East	Non-East
Observations	2,241	2,241	2,527
R-squared	0.742	0.686	0.326
Number of Regions	200	200	222
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.714	0.652	0.254
F-statistic	276.6	209.9	52.49

Table 18. Regression Results for Regression Models 7-9 for Southern European Regions

	(7)	(8)	(9)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.00817***	0.00567***	0.00550***
Funding	(0.00143)	(0.00125)	(0.00110)
Population	1.76•10 ⁻⁷ ***	-1.34•10 ⁻⁷ ***	2.87•10 ⁻⁷ ***
	$(3.09 \cdot 10^{-8})$	(2.70•10-8)	$(2.38 \cdot 10^{-8})$
Tertiary Education	-5.68 • 10 ⁻⁸	1.07•10-7 ***	-2.04•10 ⁻⁷ ***
	$(3.56 \cdot 10^{-8})$	(3.11•10-8)	(2.74•10-8)
R&D Expenditure	-2.61•10 ⁻¹²	3.70•10-11***	-2.47•10 ⁻¹²
	(1.61•10 ⁻¹¹)	(1.40•10-11)	(1.24•10 ⁻¹¹)
Constant	23.16464***	9.79092***	12.38733***
	(0.06179)	(0.05397)	(0.04755)
Regime	South	South	South
Observations	905	905	905
R-squared	0.817	0.779	0.533
Number of Regions	66	66	66
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.798	0.756	0.484
F-statistic	174.4	137.5	44.47

Table 19. Regression Results for Regression Models 7-9 for Non-Southern European Regions

	(7)	(8)	(9)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.03350***	0.03543***	0.00028
Funding	(0.00157)	(0.00155)	(0.00056)
- u	(0.0019/)	(0.00100)	(0.000)
Population	-5.55•10 ⁻⁷ ***	-1.04•10 ⁻⁶ ***	2.75•10-7 ***
	$(5.00 \cdot 10^{-8})$	$(4.95 \cdot 10^{-8})$	(1.99•10-8)
Tertiary Education	4.62•10 ⁻⁷ ***	4.85•10 ⁻⁷ ***	2.10•10-9
Ternary Education	(6.28•10-8)	(6.22•10 ⁻⁸)	(1.97•10-8)
	(0.20-10)	(0.22-10)	(1.9/-10)
R&D Expenditure	9.44•10-12	1.55•10-11 *	1.04•10-12
	$(8.33 \cdot 10^{-12})$	$(8.26 \cdot 10^{-12})$	(3.60•10-12)
Constant	23.87026***	10.51987***	12.78992***
Constant	(0.07622)	(0.07556)	(0.03337)
	(111)	(3337003)	(===000/)
Regime	Non-South	Non-South	Non-South
Observations	1,972	1,972	2,358
R-squared	0.811	0.819	0.343
Number of Regions	183	183	205
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.790	0.798	0.273
F-statistic	361.8	381	52.95

APPENDIX E - REGIMES REGRESSION MODELS II

Table 20. Regression Results for Regression Models 19-21 for Eastern European Regions

O	O		1 0
	(19a)	(20a)	(21a)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.00719**	0.00635*	0.00237*
Funding	(0.00354)	(0.00350)	(0.00132)
Tunung	(0.00334)	(0.00330)	(0.00132)
Cohesion Policy	-6.28•10-11	-7.49•10 ⁻¹¹	2.60•10-11
Funding in	$(6.09 \cdot 10^{-11})$	$(6.01 \cdot 10^{-11})$	$(2.53 \cdot 10^{-11})$
Adjacent Regions			
Population	-4.90•10 ⁻⁷ ***	-8.54•10 ⁻⁷ ***	4.37•10 ⁻⁷ ***
1	(8.45•10-8)	$(8.34 \cdot 10^{-8})$	(3.39•10-8)
	(10)	() ((00)
Tertiary Education	1.47•10-6 ***	1.28•10-6 ***	3.23•10-7***
	(1.68•10 ⁻⁷)	(1.66•10 ⁻⁷)	(5.54•10-8)
R&D Expenditure	3.60•10-11	-1.84•10 ⁻¹¹	-6.78•10 ⁻¹¹ **
Tions and oriented	(8.54•10-11)	(8.43•10-11)	(3.36•10-11)
	(0.07 10)	(0.40 10)	(3.30 10)
Constant	22.92767***	9.32910***	12.49516***
	(0.14799)	(0.14606)	(0.06147)
Regime	East	East	East
Observations	636	636	736
R-squared	0.89432	0.90470	0.46289
Number of Regions	49	49	49
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.881	0.893	0.406
F-statistic	217.3	243.8	26.05

Table 21. Regression Results for Regression Models 19-21 for Non-Eastern European Regions

	(19b)	(20b)	(21b)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.01758***	0.01606***	0.00418***
Funding	(0.00142)	(0.00140)	(0.00091)
Cohesion Policy	-4.34•10-11	-1.09•10 ⁻¹¹	-6.72•10-11***
Funding in Adjacent Regions	(3.20•10-11)	(3.15•10-11)	(2.04•10-11)
Population	4.88•10-8	-2.95•10 ⁻⁷ ***	2.41•10 ⁻⁷ ***
	$(3.04 \cdot 10^{-8})$	$(2.99 \cdot 10^{-8})$	$(1.87 \cdot 10^{-8})$
Tertiary Education	-8.10•10 ⁻⁸ **	1.02•10 ⁻⁷ ***	-2.08•10 ⁻⁷ ***
	$(3.34 \cdot 10^{-8})$	$(3.28 \cdot 10^{-8})$	(1.99•10 ⁻⁸)
R&D Expenditure	6.34•10-11 ***	6.93•10-11 ***	3.07•10-11 ***
	(5.77•10-12)	$(5.68 \cdot 10^{-12})$	(3.47•10-12)
Constant	23.47256***	10.03217***	12.70172***
	(0.05212)	(0.05123)	(0.03392)
Regime	Non-East	Non-East	Non-East
Observations	2,241	2,241	2,527
R-squared	0.74220	0.68580	0.32870
Number of Regions	200	200	222
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.714	0.651	0.257
F-statistic	264.2	200.3	50.81

Table 22. Regression Results for Regression Models 19-21 for Southern European Regions

•	•		•
	(19c)	(20c)	(21c)
	GRP	GRP/Capita	Employment
Cohesion Policy	0.00895***	0.00628***	0.00607***
Funding	(0.00140)	(0.00123)	(0.00108)
Tullullig	(0.00140)	(0.00123)	(0.00100)
Cohesion Policy	-1.84•10 ⁻¹⁰ ***	-1.43•10 ⁻¹⁰ ***	-1.33•10 ⁻¹⁰ ***
Funding in	$(3.05 \cdot 10^{-11})$	$(2.68 \cdot 10^{-11})$	$(2.35 \cdot 10^{-11})$
Adjacent Regions			
Population	1.80•10 ⁻⁷ ***	-1.31•10 ⁻⁷ ***	2.89•10 ⁻⁷ ***
•	$(3.02 \cdot 10^{-8})$	(2.65•10-8)	$(2.33 \cdot 10^{-8})$
			, 00
Tertiary Education	-7.13•10 ⁻⁸ **	9.57•10 ⁻⁸ ***	-2.15•10 ⁻⁷ ***
•	$(3.49 \cdot 10^{-8})$	$(3.06 \cdot 10^{-8})$	$(2.69 \cdot 10^{-8})$
R&D Expenditure	$2.29 \cdot 10^{-12}$	4.09•10-11 ***	$1.08 \cdot 10^{-12}$
	$(1.57 \cdot 10^{-11})$	(1.38•10-11)	$(1.21 \cdot 10^{-11})$
Constant	00.16.00=***	0.50405***	10.000=4***
Constant	23.16907*** (0.06051)	9.79437***	12.39054***
	(0.00051)	(0.05308)	(0.04668)
Regime	South	South	South
Observations	905	905	905
R-squared	0.82520	0.78669	0.55066
Number of Regions	66	66	66
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.807	0.764	0.503
F-statistic	175.3	137	45.51

Table 23. Regression Results for Regression Models 19-21 for Non-Southern European Regions

	(19d) GRP	(20d)	(21d) Employment
		GRP/Capita	
Cohesion Policy	0.02886***	0.03031***	0.00019
Funding	(0.00170)	(0.00168)	(0.00061)
Cohesion Policy	2.40•10-10 ***	2.64•10 ⁻¹⁰ ***	5.69•10-12
Funding in Adjacent Regions	(3.59•10 ⁻¹¹)	(3.55•10-11)	(1.54•10 ⁻¹¹)
Population	-4.86•10 ⁻⁷ ***	-9.60•10 ⁻⁷ ***	2.77•10-7***
	(5.04•10-8)	(4.98•10-8)	$(2.05 \cdot 10^{-8})$
Tertiary Education	4.47•10-7 ***	4.67•10-7 ***	9.74•10-10
	$(6.21 \cdot 10^{-8})$	$(6.13 \cdot 10^{-8})$	(2.00•10-8)
R&D Expenditure	1.28•10-11	1.92•10 ⁻¹¹ **	1.14•10-12
•	$(8.25 \cdot 10^{-12})$	$(8.15 \cdot 10^{-12})$	$(3.61 \cdot 10^{-12})$
Constant	23.80099***	10.44359***	12.78783***
	(0.07601)	(0.07513)	(0.03386)
Regime	Non-South	Non-South	Non-South
Observations	1,972	1,972	2,358
R-squared	0.816	0.825	0.343
Number of Regions	183	183	205
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.795	0.804	0.273
F-statistic	355.9	377.3	50.53