DOCTORAL DISSERTATION

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2024

PÉCSI TUDOMÁNYEGYETEM
UNIVERSITY OF PÉCS

Faculty of Business and Economics
Doctoral School of Regional Policy and Economics

Smart Specialization Policy and Multilevel Governance

Challenges and economic impact assessment in less developed regions of the European Union

DOCTORAL DISSERTATION

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Pécs, Hungary, 2024

Acknowledgments

I am immensely grateful for the exceptional guidance of my two PhD supervisors, Professor Tamás Sebestyén and Dr Norbert Szabó. Their tremendous support enabled me to navigate the PhD process and complete this dissertation. Throughout my academic journey, Professor Tamás Sebestyén's support and advice assisted me in overcoming every challenge. Although Dr Norbert Szabó joined as my supervisor during the writing of this dissertation, I have known and discussed with him for a long time. His expertise and guidance played an essential role in completing this dissertation. I am very grateful for the kindness, friendliness, and patience with which they both guided me.

I am deeply sorrowed by losing my first supervisor, Professor Attila Varga. He was crucial to my impression of Hungary and the University of Pécs. His passing at the end of 2023 was a great loss for the field of regional economics. Although I did not have the opportunity to fully engage with his mentorship, his legacy, and remarkable contributions will continue to inspire my work. I would also like to express my gratitude to Professor László Szerb (Head of Doctoral School), Dr. habil. Monika Tiszberger and Dr. habil. Beatrix Lányi (PhD Program Manager), Tolnayné Edina Jakabfi (PhD Study Administrator), and Krisztián Tóth and Mónika Mosonyi (Directorate of Grants) for their unwavering support and cooperation during my studies. My motivation to work hard and smart in doctoral school is always supported by the presence of friendly and cooperative classmates: Ade, Thao, Byamba, Stefan, Muthama, Arthur, Evelyn, Rami, and Aggrey. I cannot thank you all enough. Your support has been incredibly meaningful in helping me grow and become the person I am today.

I am proud to acknowledge that this research is fully funded by the POLISS (Policies for Smart Specialisation) project, part of the Marie Skłodowska-Curie Actions program. This project is funded by the European Union's H2020 Research and Innovation Program under Grant Agreement No. 860887. I am deeply grateful for the support and guidance of a team of supervisors and advisors who are world-leading regional economists. The POLISS management team's hard work and the bright and passionate ESRs' dedication have been invaluable to me. Their commitment has broadened my understanding of the importance of a knowledge network in developing a scientist's skills and reputation. I am grateful for the opportunity to be part of this outstanding project and to engage with such a remarkable community of scientists. As I complete this dissertation, I am grateful for the financial support I received as a research assistant from the National Research, Development and Innovation Fund of Hungary through the Thematic Excellence Program under the project number TKP2020-IKA-08. This support will allow me to continue my research and publish my work for the next two years. I would like to thank Professor András Takács, Dean of the Faculty of Business and Economics at the University of Pécs, for this invaluable support.

I am deeply grateful for the unwavering support of my family. My heartfelt thanks go to *Ibu* and *Bapak*, *Mama* and *Abah*, my siblings, and all my extended family in Jambi, Indonesia. This year, amidst the many challenges we faced in Hungary, we suffered the loss of *Abah* (father-*in*-law). Losing a parent is an indescribable grief. I believe that *Abah* in Allah's heaven would be proud and happy to see us, his children and grandchildren. I am deeply grateful for my beloved wife Keti, my soul mate and the driving force in my life. Her gentle heart brings peace to my soul and continues to shower me and our children with boundless love. To my two children, Omar and Kimora, you may never read these words, but please know that I dedicate all my efforts to your future. You are the driving force behind my journey. I am also grateful for the unwavering support of my fellow Indonesian students, who bring immense joy to our lives in this beautiful little city. I would also like to express my gratitude to the Governor of Jambi Province and the Jambi Provincial Industry and Trade Office for granting me a study permit and supporting me during my studies in Hungary. I look forward to returning to my beloved homeland soon to contribute to its development. I would like to thank Professor Amri Amir, Dr. Zulfanetti, and Dr. Mukhza Rudfa (*Universitas Jambi*), whose presence and encouragement throughout my studies have always filled me with strength, confidence, and a longing to return home.

Finaly, I would like to acknowledge that this dissertation is not solely the result of my own efforts. Much of my published work has come from valuable lectures given by outstanding professors at the university. Many people have played a role in the research and writing of this work. I sincerely hope this work can serve as a form of recognition for everyone involved. I am very grateful and thankful, *nagyon szépen köszönöm*!

Table of Contents

List of Tables

List of Figures

Abstract

Smart specialization, one of the flagship regional innovation policies in the European Union (EU), has entered its second programming period for 2021-2027. Despite the successes and challenges of the first programming period (2014-2020), criticisms related to the conception of this policy and the choice of the optimal policy framework for its implementation still persist. The problems and challenges of implementing smart specialization in less developed regions (LDRs) are issues that continue to be discussed in the literature, indicating the need for in-depth studies that can provide evidence and offer solutions. This dissertation is a series of studies that aim to fill the gap in the literature on smart specialization policies in LDRs in the EU by addressing the main problems or challenges these regions face. In particular, it delves deeper into regional policy governance and multilevel governance, issues that remain challenging in LDRs.

The dissertation is divided into three main parts. The *first* focuses on how smart specialization is implemented in LDRs, the challenges these regions face in policy implementation and the factors that can help LDRs overcome these challenges. The study findings that answer these questions are presented using a critical and systematic literature review approach. One of the main challenges for regions or regional innovation policy actors is how to collaborate, cooperate and coordinate with multiple stakeholders to improve the success of smart specialization implementation. The *second* focus of this research addresses the challenge of increasing the capacity of regional elements in managing various regional innovation resources. Using a spatial econometric analysis approach and a critical and systematic literature review, the results show that in the context of certain EU regions (e.g., the Visegrad Group in Central and Eastern Europe), there are spatial effects associated with regional knowledge inputs and innovation. However, some constraints on the impact of these inputs on innovation have been identified. The governance of regional innovation resources is recognized as a critical challenge in implementing smart specialization in LDRs, and a multilevel governance (MLG) approach to smart specialization governance has been widely recommended in the literature. The results of the second part of the study also show how the MLG approach is aligned with the principles of smart specialization, particularly how it can benefit LDRs.

The *third* focus of this dissertation is to explore MLG further. This section uses a critical and systematic literature review approach and complex empirical analysis simulations to address how EU regional policy, particularly smart specialization, can be implemented with the MLG approach. In this context, assessing economic impacts is one of the crucial factors in implementing smart specialization. However, some methodological challenges have to be overcome. Using the Geographical Macroeconomic and Regional (GMR Europe) economic impact model, which is aligned with MLG concepts, two policy simulations were conducted to show how assessing the economic impact of one or a combination of policy mixes is one way that LDRs can rely on to optimize the success of smart specialization. Important policy lessons drawn from the results of this study are expected to encourage academics and policy practitioners at different levels of governance (regional and national) to consider reliable ways to improve the success of smart specialization in LDRs, including identifying phenomena and challenges, considering how to overcome them, and determining which policy instruments are appropriate to achieve the most optimal economic impact not only for their region but also for national implications.

Keywords: smart specialization; multilevel governance; less developed regions; European Union; implementation challenges; economic impact assessment

CHAPTER 1
Introduction

1.1. Research background

Regional innovation policy is the result of joint efforts or activities of regional elements such as local governments and related organizations or institutions to translate various public initiatives into a set of innovation strategies aimed at improving regional competitiveness and creating sustainable economic growth (B. Asheim et al., 2012; Head, 2011; Kyrgiafini & Sefertzi, 2003). Some innovation policy experts define regional innovation policy as a form of effort to build innovation capacity at the regional or local level through cooperation between organizations and regional stakeholders to promote competitiveness and knowledge-based regional growth through research and development (R&D) activities (Cornett, 2009; Etzkowitz & Klofsten, 2005; Nijkamp & Siedschlag, 2010). Other experts define regional innovation policy as a strategy for integrating different regional characteristics or unique local potential that can serve as a backdrop for driving regional economic growth or stimulating structural change (B. T. Asheim et al., 2020; Boschma, 2005; Grillo & Landabaso, 2011). Organizations or institutions in a regional innovation system have unique characteristics that distinguish them from other regions. With this regional heterogeneity, the end product of innovation policy in a region will also differ from one region to another (Andersson & Karlsson, 2006; Cooke et al., 1997; Zukauskaite, 2018). Regional policy implementation with a top-down policy approach, where the role of central government is very strong, often leads to failure at the regional level (Sabatier, 2014) due to the lack of role of local elements in policy design and formulation (Crescenzi & Rodríguez-Pose, 2011). According to several other experts, top-down policy approaches tend to be prone to private conflicts (Fogelberg & Thorpenberg, 2012; Parker, 2001), weak coordination between levels of government (Koschatzky & Kroll, 2007; Prange, 2008), and knowledge asymmetry between stakeholders or institutions involved in formulating these policies (Coenen, Asheim, et al., 2017; Cooke & Leydesdorff, 2006). Therefore, in the current development of European regional policy, the bottom-up policy approach is seen as more beneficial for the regions but, on the other hand, does not weaken the role of the central government (Arundel et al., 2015; Kuhlmann, 2001).

The bottom-up policy approach prioritizes the views of different regional stakeholders and is considered to be more in line with the concept of regional innovation policy (Fromhold-Eisebith & Eisebith, 2005; Rosa et al., 2021). In the context of innovation policy in European regions, the bottom-up policy approach is translated into smart specialization policy (Kroll, 2019; Landabaso, 2014), where the role of different elements of stakeholders and innovation actors at the regional level, such as local governments, industry and universities, are involved in the process of discovering new domains that are transformative, competitive and related to a specific technological level in the region (Estensoro & Larrea, 2016; Foray, 2014a; Morgan, 2013). Unlike traditional industrial policies, smart specialization is not a sectoral policy. It uses new domains that are independent of the sectoral nature of the region's economy (Di Cataldo et al., 2022; Varga et al., 2020). The goal is to change the economic structure of the region according to its own characteristics and to achieve better and sustainable socio-economic benefits in the future. Moreover, smart specialization policy strongly emphasize the participation of various stakeholders in the process, so that the participatory, collaborative and cooperative nature becomes an essential element (C. Cohen, 2019a; Fellnhofer, 2017). However, although smart specialization is an innovation policy concept that some experts refer to as one of the manifestations of the New Industrial Policy (NIP) (Morgan, 2017; Radosevic, 2017), and has been implemented in many regions of the EU, various criticisms of the concept have emerged since its introduction in the first programming period, 2014-2020.

The concept of smart specialization policy has received much reaction and criticism, for instance, regarding the ambiguity between specialization and diversification (Hassink & Gong, 2021; Hassink & Kiese, 2021), the institutional readiness of peripheral regions (P. Marques & Morgan, 2018), and the persistence and applicability of smart specialization in regions operating with multi-level governance (Pugh, 2018). It has also been pointed out that the Entrepreneurial Discovery Process (EDP), which is supposed to focus on the renewal and adoption of cutting-edge technologies, still creates many gaps in the field, especially between regions rich in innovation resources and those with many limitations and how each region, with all its limitations, can encourage multi-stakeholder engagement in the regional innovation policy process (Kyriakou et al., 2017; Marinelli & Perianez-Forte, 2017; Virkkala & Mariussen, 2018). The subsequent criticism relates to the institutional readiness of local governments and their ability to manage this policy in the regions with their existing resources (Foray, 2018b; Gebhardt & Stanovnik, 2016; Tsipouri, 2018). Unfortunately, some regions with a low technological level are trying to raise their technological level but, at the same time, face significant institutional problems. Formulating and implementing strategies in their regions with different requirements from the European Commission is a challenge. However, since smart specialization strategies (S3) must be formally embedded in innovation strategy documents or strategic planning documents, national and local governments urgently need to improve their institutions and strengthen their capacity to manage this innovation policy (Estensoro & Larrea, 2016; Goddard et al., 2013; Ranga, 2018). These issues are continuously discussed among European innovation policy experts, and it is becoming an essential question of how these regions, with many constraints and challenges, can move forward in harnessing the benefits and value of smart specialization policy.

In her famous work, Mazzucato (2018) found that the unique characteristics and potential of a region make a difference in creating forms of innovation. Each region's specialization and technology level affect how it produces and markets goods and services. Studies by Guzzo et al. (2018) and Marrocu et al. (2023) showed that in the implementation of smart specialization, the identification of priority areas (*prioritization*) has a significant impact on the design of smart specialization policies, and this process requires particular expertise. More advanced regions can develop innovation strategies due to the availability of expertise in specific technological areas and sufficient administrative and institutional capacity. Weaker regions, however, have limitations, especially regarding technical expertise that can help formulate policies and support policy implementation. Before the launch of the first smart specialization agenda for 2014-2020, studies on regional innovation policies flourished in the literature, focusing on different types of innovation levels in Europe. However, recent studies on regional innovation policies in the context of smart specialization policies have opened up research opportunities that specifically address this new policy and aim to provide evidence on what happens in weaker regions concerning the implementation of smart specialization.

In a "policy assemblage perspective" analysis, Lagendijk & Varró (2013) have shown the evolution of policy perspectives on regional opportunities in the context of regional innovation systems (RIS) and smart specialization policy. The study indicates that non-core regions need alternative ways to position themselves in a research and innovation-driven economy, as they are inherently weaker than core regions regarding the spatial concentration of economic activities. Given the many challenges facing weaker regions, many researchers have emphasized the importance of active engagement and cooperation between different parties and levels of government for the successful implementation of smart specialization. The concept of multilevel governance (MLG), proposed by Hooghe and Marks (Hooghe et al., 2001; Hooghe & Marks, 2021; Marks, 1993), offers a potential framework for the implementation of regional innovation policies such as smart specialization (Estensoro & Larrea, 2016; Larrea et al., 2019). In this context, the MLG is needed to establish coordination mechanisms and enhance the involvement of policy actors at different levels of governance, for example, in identifying priority areas where weak regions may lack sufficient local capacities and networks. As a place-based regional policy, smart specialization emphasizes leadership, collaboration, and participatory principles to transform the regional economy in the EU (Baier, 2021; Kristensen et al., 2023). This means that the policy concept allows regions to receive strategic support or guidance and obtain expertise transfer from others at the national level or other local levels in different regions. EU regional policy governance scholars have long emphasized the importance of multilevel coordination in local policy formulation in the implementation of EU regional policies such as environmental policy, water management, and urban planning (Benz, 2000; Domorenok, 2017; Gualini, 2016; Salet & Thornley, 2007). This study also emphasizes that implementing policies in disadvantaged regions requires a collaborative governance approach and the ability to connect with different levels of governance. Discussing governance challenges or multilevel governance in the context of science, technology, and innovation policy in the EU is not a new phenomenon (Koschatzky & Kroll, 2007, 2009). However, the recent innovation policy literature shows limited discussion on the implementation of smart specialization in the context of multilevel governance, despite the criticism and skepticism that exists about this policy (Hassink & Kiese, 2021; Kroll, 2017). Recent studies have recognized the importance of addressing governance issues in the implementation of regional policies in developed and developing regions, especially in lagging regions. However, although MLG has been mentioned in some literature on smart specialization, some critical aspects remain to be clarified, including how MLG may vary depending on the level of governance, how it is aligns with the principles of smart specialization, the challenges of implementing MLG in the context of smart specialization policy, and also its potential impact.

1.2. Motivation and research objectives

The aforementioned literature overview is the starting point for the author to understand the complex puzzle of implementing smart specialization in the weaker regions. The study presented in this dissertation is a work born out of the author's confusion regarding the debate on smart specialization in the context of weaker regions. Some scholars of regional innovation studies in Europe refer to these weaker regions as lagging regions (McCann & Ortega-Argilés, 2019; Pancotti et al., 2016; Woolford et al., 2020), less developed regions (Trippl et al., 2019; Vallance et al., 2018), less innovative regions (B. T. Asheim, 2019; Mieszkowski, 2016), and some others consider peripheral regions (Isaksen & Trippl, 2017; Kempton, 2015) or sparsely populated areas (Dubois et al., 2017; Sörvik et al., 2019; Teräs et al., 2015) to also fall into this category. However, the research presented in this dissertation will consistently use the term less developed regions (LDRs). In retrospect, my PhD studies at the Doctoral School of Regional Policy and Economics at the University of Pécs in Hungary seemed to have kept me abreast of research on "regional policy" and "regional economics". When discussing smart specialization as "regional policy", there is a strong urge to always juxtapose it with "regional economics". In other words, in the context of the EU region, the regional innovation policy we are talking about "should" be strongly linked to the various developments that will occur in the regional economy (B. T. Asheim, 2019; Boschma, 2014). Returning to the issue of the implementation of smart specialization in the EU, the first question that arises when the author explores the literature presented above is to what extent the characteristics of less developed regions are an essential issue in the implementation of smart specialization. Then, how has the implementation of smart specialization in less developed regions since the start of the first program for the period 2014-2020, what are the challenges these regions face in the implementation of the policy, and what factors can help these regions overcome these challenges to increase the success of smart specialization implementation? The study presented in this dissertation begins by exploring these critical questions.

The investigation of the first set of research questions is presented and discussed in *Chapter 2* of this dissertation. Chapter 2 focuses on answering critical questions about how smart specialization is implemented in the context of less developed regions (LDRs), the challenges faced in the field, and the solutions or recommendations offered to overcome these challenges. The content of Chapter 2 is a synthesis of three of the author's publications in international peer-reviewed journals indexed in Scopus, Scimago Journal Ranking, and Web of Science. The synthesis of these three papers is presented in three separate sub-chapters. The first paper (Wibisono, 2022b), published in *REGION* (https://doi.org/10.18335/region.v9i2.388), was written using the systematic literature review (SLR) approach. The synthesis of this paper presents the latest developments in the literature that discuss the main issues of smart specialization in LDRs of the EU, such as how it has been implemented so far. It identifies the challenges faced and recommendations for overcoming these challenges. The second paper (Wibisono, 2023a), published in *Acta Geographica Slovenica* (https://doi.org/10.3986/AGS.10934), was also written using the SLR approach. This paper presents the latest developments in the literature on R&D collaboration and innovation in LDRs, which were identified in the first paper as one of the main challenges in implementing smart specialization in LDRs. The synthesis of this paper presents the five most critical motivational drivers of R&D collaboration in LDRs and essential factors that should be considered to improve such collaboration. The third paper (Wibisono, 2022c), published in *European Spatial*

Research and Policy (https://doi.org/10.18778/1231-1952.29.1.07), takes a semi-systematic review approach that identifies the literature gap on the role of universities as one of the leading regional innovation actors in implementing smart specialization in LDRs. The synthesis of this paper presents three main factors that can strengthen the role of universities in implementing smart specialization in LDRs.

As if this puzzlement was not enough, the author found from a series of studies presented in Chapter 2 that the main issues discussed regarding the implementation of S3 in LDRs are closely related to the ability of regional elements to manage various innovation resources or their capacity to manage these resources to enhance regional innovation. Continuing this curiosity, the author further explores the issue of LDRs in the context of regional innovation more generally, apart from smart specialization policy, in a smaller scope in the European region. It is not new that issues of regional inequality and competitiveness gaps between Western Europe and Central and Eastern Europe (CEE) are often discussed by academics in the field of regional policy and regional economics (Ezcurra et al., 2007; Lang, 2015; Lux & Horváth, 2018; Smętkowski, 2013). The author's preliminary investigation shows that innovation productivity (*e.g.*, proxied by patent applications) in the four countries in CEE belonging to the Visegrad group (Czech Republic, Poland, Slovakia and Hungary) shows a relatively stable trend (see also Halaskova et al. (2020); Roszko-Wójtowicz et al. (2022)). However, there are some anomalous symptoms, such as Hungary experiencing a decline in patent application productivity since the economic crisis 2008. Despite having knowledge and innovation input support such as R&D funds and R&D researchers that are not much different from its neighbours, the Czech Republic and Poland, Hungary has not been able to catch up. In some ways, these four countries have much in common regarding innovation resources, but their circumstances are different. The Visegrad group of countries has close historical, economic, social and political ties, so the four countries often cooperate for development purposes. However, their development still lags behind that of more developed Western or Southern European countries (Jasiecki, 2020; Schmidt, 2016). This also leads to the fact that most regions in these four countries still lag behind in innovation and competitiveness (Golejewska, 2013; Ivanová & Čepel, 2018). The question then is how knowledge and innovation resources or inputs in the regions within the Visegrad group of countries relate, for example, between Poland and the Czech Republic or Hungary and Slovakia, which are geographically closer. Does the geographical factors contribute to similarities in regional development and innovation, or in other words, is there interdependence between them?

To answer this question, the author conducted a follow-up study to further explore the phenomenon of regional innovation in the context of LDRs by taking the context of a smaller European region, namely the Visegrad Group countries, which are part of Central Eastern Europe (CEE). In addition to focusing on the phenomenon, the findings of this study related to the regional context will be linked to the issues of regional innovation policy governance challenges and smart specialization in LDRs, as presented in Chapter 2. These governance issues will be the subject of the presentation of *Chapter 3*. Chapter 3 is a synthesis of three papers by the author. Two papers have been published, and one is in the peer-review process. The first paper (Wibisono, 2023b) has been published in *Bulletin of Geography: Socio-economic Series* (https://doi.org/10.12775/bgss-2023-0008), which was written using a spatial econometric analysis approach. The paper synthesizes the results of spatial description analysis and shows the spatial dependence of regional knowledge inputs and innovation in the Visegrad group regions. The subsequent two papers form the basis for further discussion of the study findings in the first paper. The second paper, currently under review in the *European Journal of Geography*, was written using a systematic literature review (SLR) approach. It aims to investigate issues or phenomena related to the challenges of regional innovation governance in the EU region, especially concerning smart specialization policy. The synthesis of this second paper presents some critical governance-related factors that are thought to affect the implementation of smart specialization, as well as suggestions proposed by experts to improve the success of smart specialization implementation. The third paper (Wibisono, 2022a), published in the *European Journal of Government and Economics* (https://doi.org/10.17979/ejge.2022.11.2.9004), uses a traditional literature review approach by raising the issue of multilevel governance (MLG) and its relation to smart specialization policy. The synthesis of these three papers in Chapter 3 discusses the governance issues that still seem to be a major problem in the implementation of smart specialization policy. Rather than questioning how best to manage smart specialization policy, the findings presented in the literature suggest that LDRs still face significant constraints in providing, preparing and managing innovation resources, knowledge inputs and related policy instruments. The multilevel governance (MLG) approach, widely used in the implementation of regional policies in the European Union, is beginning to be linked to the implementation of regional innovation policies, such as smart specialization. However, before linking it further to smart specialization, we need to discover how this MLG approach is used to implement other regional policies in the EU.

Multilevel governance (MLG) in the implementation of several regional policies of the European Union has been highlighted in various studies, such as the study of the European Poverty Reduction Strategy 2020, where this policy is implemented with an MLG approach that involves the participation of different stakeholders at the regional, national, and supranational (European Union) levels (Copeland & Daly, 2012; Jessoula, 2015). Another regional policy with an MLG approach is implemented in the Baltic Sea region through the European Union Strategy for the Baltic Sea Region (EUSBSR) program, which is also implemented with an MLG approach and is a cross-sectoral regional policy involving different stakeholders and different levels of government (Gänzle, 2017; Michalun & Nicita, 2019). In the context of spatial planning in the country, several studies discuss the MLG concept in the implementation of spatial planning policy for cities in the Netherlands, which requires the coordination of different actors at the local or regional level and the national level (Evers & De Vries, 2013; Evers & Tennekes, 2016). Overall, this study provides valuable insights into the importance of participation, coordination, and knowledge sharing between institutions and levels of government to improve the successful implementation of regional policies. Previous studies on EU regional policies often focus on a specific area or type of policy, such as social, environmental and macro-regional development policies (Ongaro, 2015; Stephenson, 2017), or on administrative governance or political issues (Allain-Dupré, 2020; Casula, 2022). This literature points to critical factors that can help regions achieve their goals, in line with the region's policy objectives. However, what is rarely discussed in the literature is how such governance approaches affect the economic conditions of regions. In general, the MLG approach implies that it is used to improve the success of regional policy implementation. Therefore, there is a push from other scholars who argue that a more comprehensive analysis of the impact of MLG in other EU regional policy contexts should also be conducted (Cucca & Ranci, 2022; Moodie et al., 2023).

The Smart Specialization Strategy (S3) has entered its second program period for 2021-2027. This means that researchers have a greater opportunity to analyze what happened in the first program period (2014-2020), the challenges faced, how these challenges were overcome, and the economic impact of policy implementation. Raising and addressing these issues could serve as lessons learned and improve the success of S3 implementation in the next period. At this stage, the author argues that measuring both *ex-ante* and *ex-post* economic impacts becomes increasingly important. Previous studies have shown that the economic impact of smart specialization is strongly related to different underlying conditions, such as economic structure, access to factors of production, and the basic quality of local governance (S. Cohen, 2021;

McCann & Ortega-Argilés, 2019). Different methodological approaches have been widely applied to measure the economic impact of cohesion policy, innovation policy, or specifically in the context of smart specialization. The challenges of economic impact modeling have also been discussed by experts in European policy studies (Barbero et al., 2024; Brandsma et al., 2015a; Guzzo & Gianelle, 2021; Varga, 2017). However, there is still a gap in the literature on how governance issues, in particular MLG, can affect the success of smart specialization in improving regional economic conditions. Some innovation policy experts in Europe have used the MLG concept, e.g. Gianelle et al. (2023) in the case of Italy, with a computable general equilibrium (CGE) approach. Meanwhile, economic impact modeling in the context of the wider EU region has also been applied by Varga et al. (2020) through economic impact modeling in the context of geography, macroeconomics and regional economics (GMR Europe) by combining spatial econometrics, spatial CGE and dynamic stochastic general equilibrium (DSGE) approaches. While this modeling has not explicitly considered multilevel governance issues, it has considered this analysis at different levels of governance (regional, national, and supranational (EU)). The author argues that incorporating multilevel governance issues into EU-wide economic impact modeling is a new challenge. Incorporating them into an existing economic impact model is not trivial, as certain constraints and procedures need to be applied before implementing further economic impact estimation.

The final research series in this dissertation, *Chapter 4*, discusses multilevel governance (MLG) in the context of regional policy and smart specialization in the European Union. This chapter is a synthesis of three of the author's papers that have been submitted and are under review in international journals. The first paper, currently under review in *Urban Governance*, uses a critical review approach and a systematic literature review procedure to examine studies on MLG in the context of EU regional policy. The paper examines the use of MLG approaches in implementing EU regional policies and their potential impact. The synthesis of the first paper identified three critical factors for implementing regional policies with an MLG approach and highlighted the limitations of economic impact analysis in the EU regional policy literature. This led to a second paper, submitted to *REGION*, which also used a critical review approach focusing on the diversity of economic impact estimation methodologies and critical considerations in estimating economic impacts in the context of smart specialization policy. The third paper, submitted to *European Planning Studies*, adopts an economic impact estimation approach using the GMR Europe model (Varga et al., 2014, 2018a, 2020), which emphasizes the importance of aligning objectives between different levels of government (*i.e.*, regional and national) and considering their economic impact when implementing innovation policies. This paper presents the results obtained by overcoming modelling constraints and performing special procedures to show that the MLG approach can also be applied in estimating economic impacts using the GMR Europe model. Furthermore, the author conducted two policy simulations for the case of Hungary, which is considered because six out of seven regions in Hungary are classified as less developed regions (LDRs) in the EU. These policy simulations aim to analyze which policy instrument or mix of policy instruments can have the most optimal economic impact at the regional and national levels.

1.3. Significance of the research

The set of research results presented in this dissertation addresses the complex phenomena surrounding the implementation of smart specialization in less developed regions (LDRs) in the European Union (EU). Among the various phenomena and challenges, the governance of regional innovation resources and multilevel governance are the main issues discussed in this dissertation. In many EU regional policies, both in the general economic context and in extensive discussions in the field of social and political science, multilevel governance has opened up opportunities for regions to use this approach to successfully implement other regional policies, such as smart specialization. While we need to understand the basic principles of smart specialization, who should be involved, and how to improve its successful implementation, the emphasis on governance never seems to be lost in expert discussions. In particular, multilevel governance is often mentioned in many study recommendations, but how it implies is still less explored. It is hoped that the authors' work, whether published, under review or presented in this dissertation, can provide insights into how smart specialization works in weaker regions. It is essential to identify the phenomena and challenges, consider how to address them and determine who should be involved.

In this dissertation, the author analyzes the implementation of smart specialization policy not only from the perspective of one policy actor. The initial research results have emphasized that local policy elements such as government, universities, and industry are responsible for governing regional innovation policies. Their roles and involvement are indispensable, and cooperation and collaboration between them, both horizontally within a level of government and vertically between different levels of government, is also highly recommended. Universities, as one of the regional innovation actors, have an essential role to play in implementing smart specialization in LDR; the factors that can enhance their role are presented in this dissertation. In addition to universities, the role of local governments as regional policy designers and managers is explored, not only in terms of why they should cooperate and collaborate between regions and levels of government. However, they are also encouraged to consider targeting the long-term objectives of innovation policy implementation through economic impact estimation techniques.

The results of the studies presented in this dissertation not only seek to present various problems and alternative suggestions to overcome them, but ultimately, the results of these studies aim to encourage policymakers and regional innovation actors to consider which policy instruments are appropriate to achieve the most optimal impact not only for their own regions but also to have a national impact. The right combination of resource allocation (suggested in the first part of the study) and the choice of policy instruments or the determination of the policy strategy to be used (suggested in the last part of the study) are the pieces that less developed regions need to assemble firmly in order to increase their success in implementing smart specialization. The author tries to present the final goal of this dissertation through a series of continuous research from the beginning.

1.4. Structure of the dissertation

This dissertation presents the results of a comprehensive investigation of smart specialization practices in less developed regions of the EU, organized into five main chapters (**Figure 1.1**). The introduction in *Chapter 1* outlines the rationale and motivation for this research, articulates the research gap, and formulates the research objectives. It also outlines the significance of this research, highlighting its theoretical and practical contributions. *Chapter 2* synthesizes the findings from the authors' three published papers, starting with a critical and systematic review of the existing literature on the implementation of smart specialization in less developed regions (LDRs) of the EU and exploring specific issues in the same context, such as the encouragement of collaboration and the role of universities. *Chapter 3* is centred on an empirical analysis with a spatial econometric approach based on one of the authors' published papers, followed by an in-depth discussion based on two other academic papers. This section highlights regional innovation governance issues in the Visegrad Group region of Central and Eastern Europe, discusses the challenges of regional governance and how multilevel governance (MLG) can be linked to smart specialization policy. *Chapter 4* further explores the realm of multilevel governance in the implementation of EU regional policy. It discusses the intricacies of EU regional policy implementation through the lens of multilevel governance and identifies its determinants of success and limitations in the literature on the economic impact of regional policy implementation with MLG approaches. It seeks to address the gaps in the literature on regional policy, smart specialization and multilevel governance by bridging them through an economic impact assessment approach. The chapter presents the results of simulations of economic impact modeling in the Hungarian regional policy framework using the GMR Europe model, which advocates a multilevel governance approach in the implementation of regional policies such as smart specialization in less developed regions of the EU. The concluding chapter, *Chapter 5*, summarizes the research findings, offers theoretical and practical implications, explains the study's limitations and suggests future research avenues.

Chapter 1	• Rationale, research motivation. • Research gap, research objectives. • Research significance.
Chapter 2	• *A critical and systematic review of the existing literature.* • Smart specialization in less developed regions (LDRs) of the EU. • Encouragement of collaboration in the LDRs. • The role of universities in the LDRs.
Chapter 3	• *Empirical analysis and critical and systematic review.* • Regional innovation in the Visegrad Group region. • Challenges of regional innovation governance. • Multilevel governance (MLG) and smart specialization policy.
Chapter 4	• *Critical and systematic review and simulation modeling of economic impacts.* • Multilevel governance in the implementation of EU regional policy. • Bridging regional policy, smart specialization and multilevel governance through an economic impact assessment approach. • Simulation of economic impact modeling in the Hungarian regional policy framework using the GMR Europe model.
Chapter 5	• Summarizes the research findings. • Theoretical and practical implications. • Limitations of the study and future research opportunities.

Source: Author's elaboration

Figure 1. 1. Structure of the dissertation

CHAPTER 2
Implementation and Challenges of the Smart Specialization Policy in the Less Developed Regions of the European Union

Regional innovation policy is an effort by government and various institutions at the regional level to create an enabling environment and ecosystem for innovation actors through various R&D activities with the aim of increasing regional growth and competitiveness (Coenen, Moodysson, et al., 2017; Cooke, 2001; Jauhiainen, 2008; Morgan, 2017). The scope of regional innovation policy can include support for different types of innovation-related activities, such as infrastructure development and the development of R&D business networks. In terms of infrastructure development, among other things, the aim is rather to create a strong R&D capacity so that in the future there can be an adequate network of innovation actors and stakeholders and mutually supportive innovation organizations and institutions (Schot & Steinmueller, 2018; Wieczorek & Hekkert, 2012). Both organizations and individuals within the regional innovation system are explored and utilized to generate the necessary competence capacity according to regional needs (Cooke et al., 1997; Koschatzky, 2005; Lawson & Lorenz, 1999). This approach also recognizes that each region has different potential, depending on the strength of the regional economy and the availability of basic regional R&D resources. Given these regional differences, innovation policies can also be very heterogeneous from one region to another (B. T. Asheim et al., 2011; Harmaakorpi, 2006).

As reported in the OECD (2020) and in another previous report by Koutroumpis & Lafond (2018), some obvious failures often occur in the implementation of innovation policies with a top-down approach, where government or higher-level policymakers have a strong role in decision-making processes. This policy approach tends to be more vulnerable to private conflicts, rent-seeking, knowledge asymmetries, and weak coordination among innovation actors (government with universities, entrepreneurs, and communities), including coordination between public and private institutions. In contrast, the bottom-up policy approach is more concerned with the perceptions of different stakeholders at both the micro (individual) and meso (regional) levels. Such an approach is more in line with the phenomenon of regional differences in the context of regional innovation policy.

In a recent study, Međugorac & Schuitema (2023) state that bottom-up policy scenarios are more easily accepted by localities due to a strong sense of "collective psychological ownership" which is perceived by local community members as more appropriate to their place. Bottom-up policies are also considered to be more adaptable to the local technological level at which policy-related projects will be developed and implemented. A top-down approach may make it easier to scale innovative ideas, but in this case, real needs and dynamics at the local or regional scale are often sidelined. As a result, the ultimate goal of accelerating development at the local or regional level becomes less than optimal. According to Schot & Steinmueller (2018), the bottom-up approach, although inherent to local issues that can increase the potential match between results and expectations of stakeholders in the region, is faced with problems of efficient resource utilization and management including challenges in coordinating and mobilizing various interests at the local level. The bottom-up approach is indeed more advantageous in producing innovation policies that are holistic and consider various local issues. However, in regions with limited resource management capabilities, it is often more effective when integrated with other top-down policies such as energy and environmental policies (Böhringer & Rutherford, 2008; Fromhold-Eisebith & Eisebith, 2005; Lerman et al., 2021). Therefore, there needs to be a clear statement in what context and boundaries the bottom-up policy approach is applied (Crescenzi & Giua, 2016; Isaksen et al., 2018).

In the context of innovation policy in the European region, the bottom-up policy approach is translated into the smart specialization strategy (S3). In S3, different stakeholders and regional innovation actors other than government, such as universities, industry, and society, are involved in an entrepreneurial discovery (ED) process that aims to discover new domains of the production structure that have a competitive advantage and unique potential and opportunities to deliver better socio-economic and business benefits in the future (Foray et al., 2021). In contrast to traditional industrial policy, S3 is not a sectoral policy, but focuses on transformative new activities and refers to a specific level of technology in the region (Bailey et al., 2019; Belussi & Trippl, 2018a). Stakeholder participation in the ED process is a very important factor in creating an appropriate regional innovation environment and ecosystem, which ultimately helps to interpret regional innovation strategies into policy instruments that favor local specificities and interests. In addition to the emphasis on participatory policy processes, decision-making in smart specialization policies also reflects the functioning of democratic processes in regional administrative and political systems (Foray, McCann, & Ortega-Argilés, 2015; Sotarauta, 2018).

Although the regional innovation policy concept of smart specialization has been implemented in almost all regions of the European Union countries and other EU-related regions since 2014, some serious criticisms have developed, both criticizing this policy concept in the theoretical field and raising the problems and challenges of its implementation on the ground. One of the early criticisms of S3 was related to the concept of discovering new domains that should focus on the renewal and adoption of cutting-edge technologies (Camagni & Capello, 2017; Hassink & Gong, 2021). This raises many issues of inequality between regions that have abundant reserves and opportunities to develop high-tech-based innovation strategies, and those that are just learning to update their technology, but at the same time are plagued by various interactions between technology application and their regional characteristics.

Further criticism is then related to the challenges of public administration and bureaucratic governance in certain regions that are limited by local resources. Since the implementation of smart specialization has to be formally embedded in the innovation strategy of each local government, the institutional context and policy governance of smart specialization is one of the most studied topics and the evidence has also been presented in many studies (Benner, 2017; E. Carayannis & Grigoroudis, 2016a). The results of this study suggest that while smart specialization provides a core framework that can be logically followed, its application in regions with unique characteristics makes the process of translating, adopting, and adapting S3 into local strategies and policies extremely challenging. The strongest suspicion behind this phenomenon is related to complex governance, especially since S3 involves multiple stakeholders in the process. The phenomenon encourages each region to create specific policy instruments to support innovation strategies that are in line with the S3 concept (Research and Innovation Strategies for Smart Specialization/RIS3), both when designing the ED process, gathering different perspectives, identifying priorities, elaborating them into strategic policies, and then implementing, monitoring, and evaluating these policies. The coherence and consistency between the innovation strategies and policies formulated by the representatives of the innovation actors in the region and the Smart Specialization framework defined by the European Commission, greatly influences the success of the region in implementing Smart Specialization and the desire for EU financial support in various fields/projects important for the development of the region (Laranja et al., 2020; Săftescu et al., 2016). Therefore, strong foundations and cooperation are needed to translate smart specialization into regional innovation strategies and policies that truly represent regional needs, while remaining in line with the rules set by the European Commission.

An important question that may arise from the above is why differences in characteristics such as strengths and weaknesses, or regional progress or backwardness, need to be considered in the implementation of smart specialization. According to Asheim & Coenen (2005), each region has unique characteristics that make it different in generating forms of innovation. Each region has its own technology specifications and specialized markets that can accommodate its products and services. The most successful regions are those that know best and are able to determine which domains of innovation and technologies have the potential to be effectively pursued in their regions (Feldman, 2014; Foray, 2014b). In the context of smart specialization, this process is called prioritization. It is the region that determines in which technological domain it is likely to excel, and then focuses on that domain by creating transformative activities that can deliver the desired value added. However, in weaker regions, such as peripheral, less-developed, less innovative or sparsely populated areas, creating such a process is not trivial. They are generally faced with limited innovation resources and social capital, as well as technical expertise that is still difficult to explore in their region (Pinheiro et al., 2022). If the concept of place-based policies is limited by the requirement that regions should only use local resources, then they will never be part of the success of smart specialization.

The concept of smart specialization offers at least two opportunities to increase success in this regard. *First*, regional innovation strategies tailored to regional characteristics should be generated through a process of cooperation and collaboration with various stakeholders, such as academics or researchers in universities, entrepreneurs or industry players, and social groups or communities in society (Markkula & Kune, 2015; Rinaldi et al., 2018). This process is a good laboratory for producing and catalyzing different levels of knowledge among local actors. *Second*, because the relationships between innovation actors in the S3 context are not bound by territorial boundaries (Uyarra et al., 2014), each innovation actor can use different forms of geographical and non-geographical proximity, or with innovation actors within a region, between regions, or between countries (Balland et al., 2022; Goddard et al., 2013). Moreover, the concept of smart specialization policy asserts that each region has equal opportunities to create intraregional and extraregional cooperation (Balland & Boschma, 2021; Stryabkova et al., 2021).

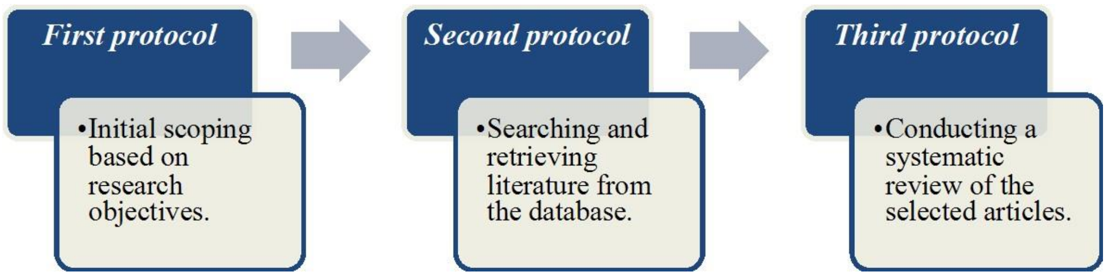
This chapter presents a literature review of current research on smart specialization strategies (S3) in less developed regions (LDRs) in the European Union. The main focus of this chapter is on how S3 is applied in the context of LDRs, the challenges faced in this field, and the solutions or recommendations offered to overcome these challenges and improve the success of S3 in LDRs. The content of this chapter is a synthesis of the author's three papers published in peer-reviewed international journals, all of which are open-access. The first paper (Wibisono, 2022b) was published in *REGION* (https://doi.org/10.18335/region.v9i2.388). The synthesis of the main contents of the paper in this chapter will present the latest developments in the literature related to the implementation of S3 in LDRs, identify the main challenges in its implementation, and propose alternative solutions or recommendations to overcome these challenges. The second paper (Wibisono, 2023a) was published in *Acta Geographica Slovenica* (https://doi.org/10.3986/AGS.10934). The synthesis of this paper in this chapter will present the latest literature development on R&D and innovation collaboration in LDRs and recommend motivational drivers and critical factors to improve its success. The third paper (Wibisono, 2022c) was published in *European Spatial Research and Policy* (https://doi.org/10.18778/1231-1952.29.1.07). The synthesis of these papers in this chapter will present critical factors that can strengthen the role of universities as one of the key innovation actors in the region to enhance the successful implementation of S3 in LDRs.

The remainder of Chapter 2 is organized as follows. Section 2.2 briefly reviews the literature on smart specialization as a new bottom-up approach to regional innovation policy. It also outlines criticisms of smart specialization related to the implementation of this policy in less developed regions of the European Union. Section 2.3 outlines the research methodology of the three main papers. Wibisono (2022b) and Wibisono (2023) use a systematic approach in conducting the literature review, while Wibisono (2022c) is technically written in the traditional literature review format. Section 2.4 outlines the characteristics of the selected articles, such as the number of articles published per year, the source and quality of the journals, and specifically presents the diversity of research designs and research methods in S3 in LDRs. Section 2.5 presents the synthesis results of Wibisono (2022b) on the main challenges in implementing S3 in LDRs and solutions or recommendations to overcome these challenges. Section 2.6 presents the synthesis results of Wibisono (2023) on the factors that drive the motivation for collaboration in LDRs and the critical factors that can improve its success. Section 2.7 presents the synthesis of Wibisono (2022c) on factors that can strengthen the role of universities in supporting the implementation of S3 in LDRs. Finally, section 2.8 summarizes and concludes Chapter 2.

2.1. Method of the literature review with a systematic approach

Chapter 2 is built on the author's three papers published in three reputable peer-reviewed international journals. Two of the papers were written using a systematic literature review research approach (Wibisono, 2022b, 2023a) and one paper was written using a traditional literature review research approach (Wibisono, 2022c). The steps used in writing the systematic literature review also refer to several previous studies, both related to the method (*e.g.*, Visković & Logar (2022)) and related to the topic of research and innovation policy studies using this method (*e.g.*, Hughes et al. (2018); Martínez-Vergara & Valls-Pasola (2021)). The second writing approach is more of a critical review of the main content of the selected articles, with a scoping approach and a semi-systematic literature search.

In the first two papers, the author used the so-called *three-step protocol* shown in **Figure 2.1** (Wibisono, 2022b, 2023a). In general, this three-step protocol is a summary of many protocols often used in systematic literature reviews (*e.g.*, (Paul et al., 2021; Sanchez et al. (2020)). The *first protocol* is a literature scoping process, conducted in a specific way and using a specific framework, and linked to the research question or objective. One of the outputs of this scoping process is the main keywords. The *second protocol* is an application of the scoping process where the keywords obtained from the scoping process are applied to the database search process. In this second protocol, several criteria are applied to include (inclusion criteria) or exclude (exclusion criteria) articles, so that at the end of the second protocol, a final set of articles is obtained, which are declared as selected articles or the most relevant articles. The *third protocol* is the core part of the literature review, where at this stage the results of the search for selected articles from protocol two are first described with tables or figures, for example in relation to the number of articles per year and the grouping of articles based on the source and quality of the publication journal. In addition, the content of the selected articles will be explored and analyzed, so that the key points will be extracted and then synthesized into new information. This last part is the part that contributes significantly to the content or quality of the paper.



Source: Wibisono (2023, p. 89)

Figure 2. 1. Systematic literature review protocol

In the *first protocol*, the PICOC (Population, Intervention, Comparison, Outcome, Context) framework was first applied to guide the process of selecting articles in the database (de Barcelos Silva et al., 2020; Mengist et al., 2020) and finding appropriate keywords for the process of searching articles in the database. A summary of the formulation of the PICOC framework in Wibisono (2022b) and Wibisono (2023) is presented in **Table 2.1**.

Table 2. 1. Application of the PICOC framework

Elements	Paper 1 (Wibisono, 2022b; p. 165-166)	Paper 2 (Wibisono, 2023; p. 87-88)
Population (P)	Studies on smart specialization conducted in the EU region	Studies on R&D collaboration conducted in the EU region
Intervention (I)	Content containing the experience and implementation of smart specialization	Findings of studies that are strongly related to the issue of R&D collaboration
Comparison (C)	Smart specialization as a form of regional innovation policy	Implementation of R&D collaboration and its driving factors
Outcome (O)	Presentation on problems, challenges, opportunities, and recommendations from the implementation of smart specialization	Presentation on outlook for LDRs in their efforts to create collaboration with more advanced regions
Context (C)	Specialized regions *e.g.*, underdeveloped, less developed, peripheral, less innovative, etc.	Regions characterized by geographical challenges such as peripheral, sparsely populated, underdeveloped, etc.
Keywords	*smart speciali*ation; innovation; less; lagging; europ*; region**	*geograph*; collaborati*; innovate*; europ*; region**

Source: Author's elaboration

The *second protocol* is a systematic literature search in one or more databases. In the study of Wibisono (2022b), the search was conducted in four main databases, namely Web of Science, Science Direct, Wiley, and EBSCO. Meanwhile, in the study of Wibisono (2023), the search was conducted in the Web of Science database. Although Wibisono (2022c) did not use a systematic literature review approach, the search was also conducted in two major databases (Web of Science and Scopus) and by using the keywords "*universit**" and "*smart speciali*ation*". The use of asterisks in keywords is intended to ensure that words or phrases that may have the same meaning or intent but are spelled differently are still found or included in the search process, for example due to differences in British and American English (*e.g.* *speciali(z)ation* and *speciali(s)ation)*, differences in adjective and noun forms (*e.g.* innovation and innovative), or differences in the spelling of singular and plural words (*e.g.* region and regions). In addition, these keywords are used in the search field of the database and organize the search in the title and/or abstract categories. This also means that these keywords should be found in the title and/or abstract of the article.

From the experience of scoping and searching the literature in Wibisono (2022b), which used more than one database that is a collection of journals from different publishers (*e.g.*, Web of Science and EBSCO) or publisher-specific databases (*e.g.*, Science Direct and Wiley), the author found that there is a very high potential for duplication of articles, so that the same article published in one database is very likely to be found in another database. Therefore, in Wibisono (2023), in order to optimize the literature search process, the author uses only one main database, Web of Science, considering that this database is a quality indexing database of peer-reviewed international journals that is highly selective and pays attention to strict compliance with the review and publication process, so that the articles obtained from this database are assumed to be of good quality (Martín-Martín et al., 2018; V. K. Singh et al., 2021).

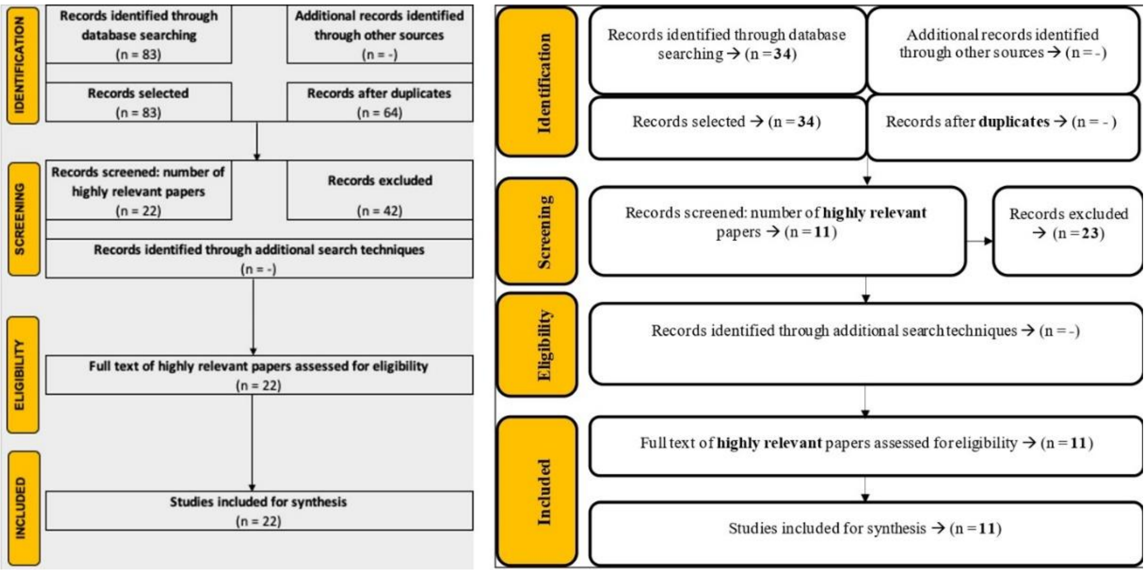
Once the search process yielded articles containing keywords, inclusion or exclusion criteria were applied at this stage. Inclusion criteria were first applied to articles containing the main keywords that fit the PICOC framework as well as the research objectives or questions. Inclusion criteria were also applied by selecting only articles published within a certain time period, the text had to be in English, the document type had to be a research article (including review articles), and by restricting the country or region of study. Articles that did not meet the inclusion criteria also became excluded articles, for example, articles that did not fall within the regulated years, languages other than English (Spanish, Russian, Portuguese, etc.), proceedings articles, and non-EU country contexts (United States, in some cases United Kingdom, Asia, etc.). In some cases, the author also excluded articles since the research context was not in line with the current research objectives, for example articles dealing with very specific smart specialization topics such as tourism, sustainable cities and environmental issues (in Wibisono (2022b)), or articles related to economic growth, comparisons between Asian and African countries, and university-industry collaboration (in Wibisono (2023)). At this stage, the articles that appear are considered as potentially relevant articles.

The next step was a meticulous pre-screening process that involved a thorough inspection of the article titles and abstracts. The screening process focused not only on evaluating the appropriateness of the keywords used, but also on the primary content presented in the abstract. Only those articles that met the inclusion criteria, were consistent with the research objectives and context, and matched the keywords were considered relevant and referred to as selected articles. These selected articles formed the basis of the subsequent analysis or synthesis process. In Wibisono (2022b), 22 articles were selected, while in Wibisono (2023), 11 articles were selected.

This process, which begins with searching the database for articles, removing duplicate articles (if any), removing irrelevant articles, and determining the most relevant articles, is summarized in the PRISMA flow diagram (**Figure 2.2**). In the systematic literature review methodology approach, the use of the PRISMA (Preferred Reporting Items for Systematic

Reviews and Meta-Analyses) flow diagram aims to demonstrate systematicity, transparency and objectivity in the process of searching, identifying, and selecting articles (Belle & Zhao, 2023; Simsek et al., 2023).

The study of Wibisono (2022c) applies traditional literature review writing that does not apply strict methodological steps such as systematic literature review. However, it can be summarized that the literature search in this study applied two main steps: *first*, the literature search in databases (Scopus and Web of Science) based on defined keywords (to obtain potential articles), and *second*, the selection of articles based on the novelty of the topic or topics that are still rarely discussed (to obtain selected articles). The search for articles in the database applied the keywords "*universit**" and "*smart speciali*ation*", with no restrictions on the year of publication, the type of document as a research article (excluding proceedings articles), and documents in English.



Source: Wibisono (2022a, p. 166) – *left;* Wibisono (2023, p. 88) – *right*

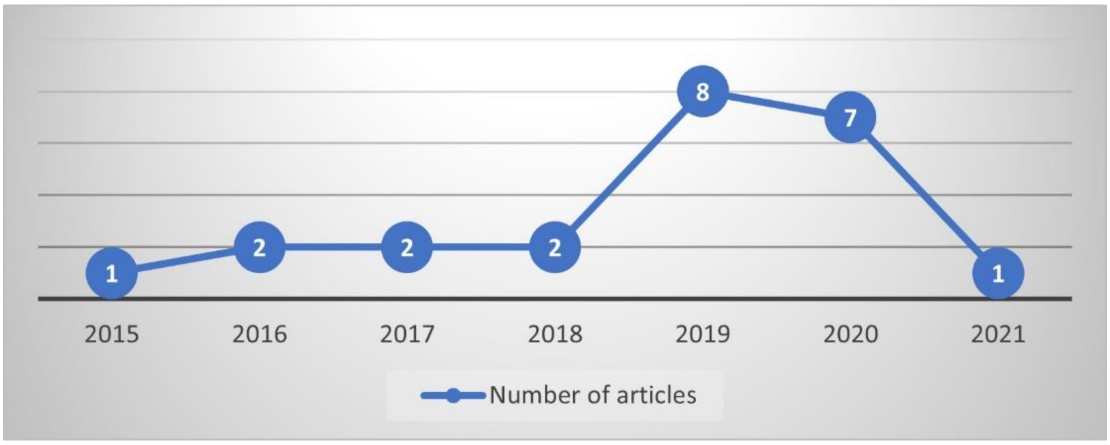
Figure 2. 2. PRISMA flow diagram

From this step, 29 potential articles were obtained. The potential articles were then screened and assessed by carefully reading the abstracts and paying attention to papers that discussed the role of universities in implementing S3 in the context of less developed regions (LDRs). Of the 29 potential articles, this particular topic was only addressed by at least three of the most relevant papers, published in reputable journals, with solid research findings and interrelated content. After reading the overall content of these three articles, the author considers these three papers as selected papers and focuses on their comprehensive evidence or research findings. Therefore, the article of Wibisono (2022c) claims to be an "evidence-based review".

2.1.1. Characteristics of the selected articles

The study by Wibisono (2022b) characterized 22 selected articles based on year of publication, source, and diversity of research methodology. As shown in **Figure 2.3**, studies on smart specialization strategies (S3) in the context of less developed regions (LDRs) in the European Union (EU) were published in leading journals around 2015, or one year after the implementation of the first S3 period (2014-2020), and the last article in 2021, when this study was conducted. The trend of publishing articles on this topic tends to increase, although the number of articles decreased at the end of the period of this study. The most articles were published in 2019 (eight articles) and 2020 (seven articles). In other years, at least one or two articles were published on this topic.

Table 2.2 provides a breakdown of the articles by publication source. The two leading journals that published the most articles on this topic were *European Planning Studies* (five articles) and *Regional Studies* (four articles). Several other articles were also published in two highly relevant journals, *Growth and Change* and *Journal of Knowledge Economy*. Meanwhile, at least one article was published in journals with similar subject categories. The subject categories most relevant to this research topic are *Geography, Planning, and Development* (eight articles) and *Social Sciences* (five articles), while the other four categories, although containing between one and three articles, are generally related to these two subject categories.



Source: Wibisono (2022a)

Figure 2. 3. Publication trends

The study by Wibisono (2023) characterized eleven (11) articles based on year of publication, source, and subject category. **Table 2.3** shows that studies discussing R&D collaboration for regional innovation in the EU started to be published in 2017, with two articles. In 2018, four articles were published, followed by one article in each of the following years. **Table 2.4** shows the distribution of these eleven articles in eight highly reputed peer-reviewed international journals, seven articles published in Q1 ranked journals and four articles published in Q2 ranked journals (based on *Scimago Journal Rank/SJR 2022*). The most articles were published in *Annals of Regional Science* (Q2 in Social Sciences), followed by *Research Policy* (Q1 in Management of Technology and Innovation). These two journals are the top journals in the field and have a high *h-index* and impact factor. This suggests that research on this topic is at the forefront of regional innovation studies and is still evolving in solving related problems. However, there is still a great opportunity to develop the topic of R&D collaboration in the context of LDRs in Europe. The selected articles are mostly published in the *Social Sciences* and *Technology and Innovation Management* subject categories (**Figure 2.4)**. The other two subject categories are still closely related to these two subject categories. Future academic research on this topic could use this as a guide to select journals and subject categories that are appropriate for their research.

Table 2. 2. List of journals/publication sources of the study of Wibisono (2022b)

No	Journal name	Best Quartile (SJR 2021)	No. of articles
1	European Planning Studies	Q1 - Geography, Planning and Development	5
2	Regional Studies	Q1 - Social Sciences	4
3	Growth and Change	Q3 - Environmental Science	3
4	Journal of the Knowledge Economy	Q3 - Economics and Econometrics	2
5	International Regional Science Review	Q1 - Social Sciences	1
6	Transylvanian Review of Administrative Sciences	Q3 - Public Administration	1
7	Innovation: The European Journal of Social Science Research	Q2 - Geography, Planning and Development	1
8	Cambridge Journal of Regions, Economy and Society	Q1 - Geography, Planning and Development	1
9	Papers in Regional Science	Q1 - Geography, Planning and Development	1
10	Agricultural Economics (Czech Republic)	Q1 - Economics, Econometrics and Finance	1
11	Technological Forecasting and Social Change	Q1 - Management of Technology and Innovation	1
12	Journal of Common Market Studies	Q1 - Economics and Econometrics	1

Source: Wibisono (2022b)

Table 2. 3. List of selected articles of the study of Wibisono (2023)

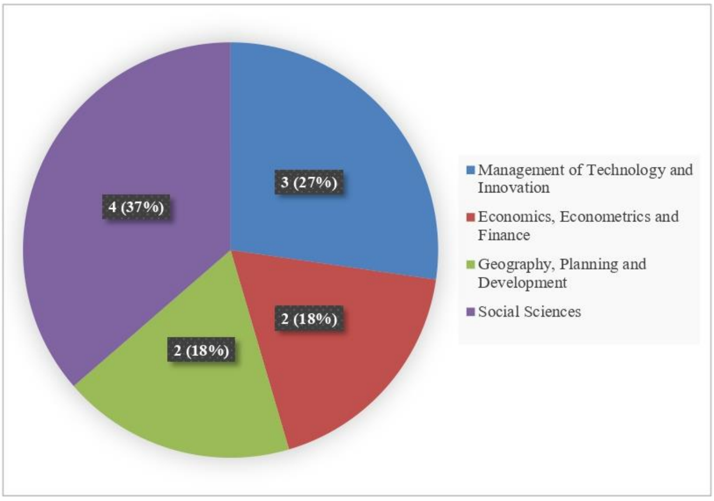
No.	Year of Publication	No. of Articles	Authors
1	2017	2	Berge (2017); Marek et al. (2017)
2	2018	4	Amoroso et al. (2018); Badillo & Moreno (2018); De Noni et al. (2018); Lata et al. (2015)
3	2019	2	Barzotto et al. (2020); Miguelez (2019)
4	2020	1	Neuländtner & Scherngell (2020)
5	2021	1	Lalrindiki & O'Gorman (2021)
6	2022	1	Filippopoulos & Fotopoulos (2022)

Source: Wibisono (2023)

Table 2. 4. Sources of journal/publications sources of the study of Wibisono (2023)

No.	Publication Source & Publisher	No. of Articles	Best Quartile (SJR 2022)
1	Annals of Regional Science - Springer Verlag	3	Q2 - Social Sciences
2	Economics of Innovation and New Technology - Routledge	1	Q1 - Economics, Econometrics and Finance
3	Papers in Regional Science - Wiley-Blackwell	1	Q1 - Geography, Planning and Development
4	Regional Studies - Routledge	1	Q1 - Social Sciences
5	Research Policy - Elsevier B.V.	2	Q1 - Management of Technology and Innovation
6	Technovation – Elsevier Ltd.	1	Q1 - Management of Technology and Innovation
7	Cambridge Journal of Regions, Economy and Society - Oxford University Press	1	Q1 - Geography, Planning and Development
8	Triple Helix - Brill Academic Publishers	1	Q2 - Economics, Econometrics and Finance

Source: Wibisono (2023)



Source: Wibisono (2023)

Figure 2. 4. Journal subject categories of the study of Wibisono (2023)

Table 2. 5. List of selected articles of the study of Wibisono (2022c)

No	Author - year of publication - title	Journal name and rank)[a]	No. of citations)[b]
1	Kempton (2015) *Delivering smart specialization in peripheral regions: the role of universities.*	Regional Studies, Regional Science *Q1 - Geography, Planning and Development*	88
2	Lilles et al. (2020) *Comparative view of the EU regions by their potential for university-industry cooperation.*	Journal of the Knowledge Economy *Q2 - Economics and Econometrics*	15
3	Vallance et al. (2018) *Smart specialization in regions with less-developed research and innovation systems: A changing role for universities?*	Environment and Planning C: Politics and Space *Q1 - Geography, Planning and Development*	76

Source: Author's elaboration. (a: based on SJR 2022, b: based on Google Scholar as of February 2024)

As described in the previous section, the study of Wibisono (2022c) is an evidence-based review paper and the process of determining the selected articles in this study did not apply a systematic literature review protocol but was done through a process of screening the relevance of the article topic (in the abstract section) and assessing the overall content of the article. **Table 2.5** describes the characteristics of the selected articles.

2.1.2. The diversity of the research design and research methods

The study of Wibisono (2022b) specifically outlines the diversity of research designs and research methods, as this trend is evident in the selected articles (**Table 2.6**). The articles were first categorized into two groups according to their methodological nature: non-empirical research and empirical research. According to Dan (2017), non-empirical research generally uses theoretical approaches to specific topics and makes logical assumptions in the analysis process. Meanwhile, empirical research generally uses an inferential statistical approach, tests hypotheses, and verifies and concludes the results of its analysis. Furthermore, each non-empirical and empirical approach is further categorized based on the type of research method. In the non-empirical research approach, the selected papers use the systematic literature review research method. While in empirical research, the selected papers are grouped into three research methods, namely qualitative methods, quantitative methods, and mixed methods.

Table 2. 6. The diversity of research design and research methods

Nature of Research Methodology	Research Method Approach	Selected Papers
Non-empirical Research	Systematic Literature Review	Pires (2020) Eder (2019) Lopes et al. (2019)
Empirical Research	Qualitative methods	Healy (2016) Kolehmainen et.al. (2016) Ranga (2018)
	Quantitative methods	Rodriguez-Pose & Wilkie (2019) Varga et al. (2020) Crescenzi et al. (2020)
	Mixed methods	Krammer (2017) Trippl et al. (2019) Ghinoi et al. (2020)

Source: Wibisono (2022b)

There are three articles that use a non-empirical research approach with a systematic review research method, namely Eder (2019); Lopes et al. (2019); Pires et al. (2020). Pires et al. (2020) conducted a systematic review of articles relevant to the topic of territorial innovation models (TIMs) in less developed regions (LDRs) in Europe. The study used an inductive analysis approach to analyze the content of the selected articles. The results show how the TIM concept is developed in the various TIM literatures, and how policy practices with the TIM approach take place in the European region. Eder (2019) conducted a literature review study in the context of peripheral regions in Europe. The review highlighted that the definition of the periphery should be explicitly emphasized in future S3 research, for example, whether the periphery is characterized as geographically challenged or functionally marginalized. Meanwhile, Lopes et al. (2019) conducted a systematic review of research and innovation strategies for smart specialization (RIS3) in the European region and identified significant research opportunities. Using the bibliometric analysis method, this study proposes six RIS3-related thematic clusters that can guide future research to explore these policies. In summary, the main contribution of these three articles can be seen in how they identify and investigate the topics they address, while providing clear directions for future research based on their review findings. These three papers implicitly show that systematic review studies in the context of innovation policy or S3 studies in LDRs can be used both to identify current developments and issues in the field and to provide guidance for future S3 research.

Research with an empirical approach and using qualitative methods has been conducted by Healy (2016); Kolehmainen et al., (2016); and Ranga (2018). Healy (2016) examined the implementation of S3 in the North-East of Romania, one of the most disadvantaged regions in the European Union. The study used qualitative data in the form of policy documents, followed by further observations through interviews with local stakeholders. Although RIS3 in Romania is still managed nationally, each region is required to have its own policy strategy (RIS3). On the one hand, this encourages each region to explore various regional innovation resources in order to develop innovation policy strategies that fit within the smart specialization framework. On the other hand, the Northeast of Romania, with weak institutional conditions, has a challenging task to effectively implement the smart specialization strategy. In a case study of eight regions in Romania, Ranga (2018) demonstrates that the existence of smart specialization strategies has led to better regional innovation strategies. The study is a longitudinal study (2017-2018), involving various stakeholders at the national and regional levels. Ranga (2018) argues that in a centralized innovation system like Romania's, multi-level governance (MLG) with strong coordination between central and local governments is necessary. Using a similar research methodology, Kolehmainen et al. (2016) investigated the role of quadruple helix actors (government, universities, entrepreneurs, and communities) in designing innovation-driven development strategies in peripheral regions. The results show that in designing these development strategies, peripheral regions can optimize the role of the fourth helix actor (civil society groups/representatives) instead of adopting urban innovation strategies, which are often assumed to have the same effect when applied in other regions.

These three study results show that lagging regions are generally characterized by weak institutional circumstances, which can make it challenging for them to design appropriate RIS3. However, the smart specialization framework encourages the involvement of more stakeholders in the processes. Therefore, in addition to strengthening the role of triple helix actors (government, universities, entrepreneurs), the involvement of fourth helix actors (representatives of society) is crucial for the development of S3 in LDRs.

Studies using empirical approaches and quantitative methods have been conducted by Crescenzi et al. (2020); Rodríguez-Pose & Wilkie (2019); and Varga et al. (2020). These studies typically use secondary data officially published by formal institutions such as regional or national statistical agencies, Eurostat, or large organizations such as the Organization for Economic Cooperation and Development (OECD). Published secondary data can be used directly or pre-processed before being used in the research. For example, Rodríguez-Pose & Wilkie (2019) used OECD data and employed econometric analysis techniques to investigate the factors affecting patent production in less developed regions of North America and Europe. One of the main findings of this study proves that patent production in LDRs in Europe tends to be influenced by R&D investment by firms located in the region, rather than by R&D investment in universities, as is the case in North America. This further supports the need for appropriate policy interventions for LDRs in the European Union, especially in efforts to increase regional innovation capacity through R&D investment instruments.

Furthermore, Varga et al. (2020) used publication data from various official institutions in the European Union. The study applied complex spatial and general equilibrium econometric modeling to develop an economic impact model (GMR Hungary) in the process of prioritization of smart specialization in Hungary. One of the main ideas of this study is that economic impact modeling can support the policy design of RIS3 at *ex-ante* and *ex-post* stages in different types of regions (developed and less developed regions). With this modeling, each region can focus on policy interventions that enable the most optimal economic impact of S3 implementation. Unpublished secondary data, such as firm-level specific data, can be obtained in certain ways or with special permission. Crescenzi et al. (2020) used firm-level data to analyze the economic impact of the implementation of the Collaborative Industrial Research (CIR) program, which was the forerunner of S3 in Italy. Using a regression discontinuity design (RDD) analysis approach, the results show a small economic impact of the CIR program, especially for large or high-tech firms. In contrast, the program has a large impact on small or low-tech firms.

From these three studies, it can be concluded that the use of quantitative data and appropriate analytical methods is very helpful in the development of S3 in LDR. The use of such data is very useful in simple economic modeling such as descriptive and inferential or even more complex economic impact modeling such as spatial econometrics, input-output (IO), and general equilibrium (GE). The research results can be an analytical tool and provide strong empirical evidence that can help in the policy design process of S3 in LDRs.

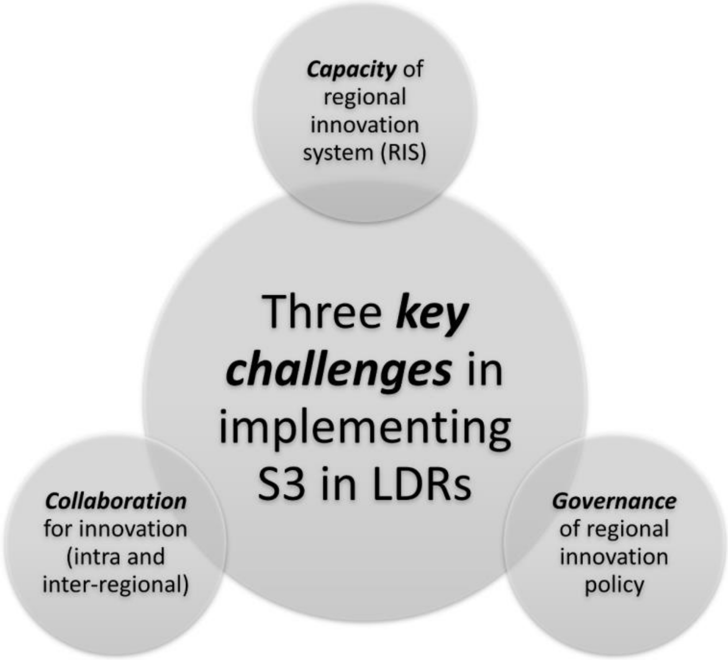
Research using empirical approaches and mixed methods was conducted by Ghinoi et al. (2021); Krammer (2017); and Trippl et al. (2019). Krammer (2017), in the case of S3 in Bulgaria, used United Nations Comtrade international trade statistics, European patent data (EPO), and United States patent data (USPTO). Within the framework of the innovation system in Bulgaria, the study identified potential economic sectors for the application of S3 in Bulgaria. The study critically analyzes the obstacles in the implementation of S3 in LDRs in Bulgaria and provides some important recommendations, namely the creation of an innovation policy strategy (RIS3) that systematically links central and local governments, as well as the promotion of the implementation of multi-level governance (MLG) in innovation policy in LDRs. Trippl et al. (2019) used mixed methods and focused on regional innovation policy practices in several EU regions. The study raised several important issues related to the implementation of S3, in particular the challenges faced by geographically diverse regions and the role of institutions in regions with different innovation capabilities (advanced, moderate, and less developed).

Meanwhile, Ghinoi, Steiner, Makkonen, et al. (2021) used mixed methods to study the implementation of S3 in peripheral regions in Finland, triangulating data (review of RIS3 documents, in-depth interviews, and online surveys) and working with local stakeholders. It can be said that the complexity of the research and the important findings demonstrated by these three studies have made significant contributions to the practice of smart specialization and the development of its studies to date. The research findings have been published in high quality and high impact journals and have become key references in many policy applications and recent S3 studies.

2.2. Key challenges of the implementation of S3 in LDRs

This section refers to one of the main contributions of the study of Wibisono (2022b), which critically reviewed the key findings of four selected papers that comprehensively address the challenges of implementing S3 studies in LDRs (Barzotto, Corradini, Fai, Labory, & Tomlinson, 2020a; Ghinoi, Steiner, Makkonen, et al., 2021; Sörvik et al., 2019; Trippl et al., 2019). The results of the critical review of this study are summarized in a diagram of key issues in the application of S3 in LDRs. These key issues outline three main challenges in the application of S3 in LDRs related to the capacity of the regional innovation system (RIS), collaboration intra- and extra-regionally, and governance of regional innovation policy (**Figure 2.5**). These three elements are interrelated and essential for building a solid regional innovation system (RIS) (B. T. Asheim et al., 2016; González-López et al., 2020; Isaksen et al., 2018; Tödtling & Trippl, 2013). The suggestions and recommendations synthesized at the end of the critical review of the study are closely related to efforts to address these three challenges in the field.

The *first* key issue in the implementation of S3 in LDRs is related to the challenges of improving regional innovation capacity, namely the ability of LDRs to optimize their resources or increase the critical mass of regional innovation. Trippl et al. (2019) found that the presence of the S3 concept in European regions has encouraged LDRs to improve their capacity to manage key RIS resources, including regional financial support and various associated institutional infrastructures. The study found that LDRs are often faced with path dependency and past policies. The creation of new growth pathways and the discovery of critical transformative activities in the process of prioritization or entrepreneurial discovery appear to be less desirable as they require specific and specialized infrastructural and organizational arrangements.



Source: Author's elaboration, modified from Wibisono (2022b)

Figure 2. 5. Three key challenges in S3 implementation in LDRs

From the beginning of the process, S3 strongly encouraged multi-stakeholder engagement, but given the weak linkages between regional innovation actors in LDRs, the process of engaging and mobilizing these stakeholders became very dynamic. Sörvik et al. (2019) highlighted that renewing growth pathways is also a challenge for demographically constrained regions, such as the sparsely populated areas (SPAs) in Europe. In developing RIS3 in SPAs, resource management needs to be effective and efficient given the limited availability of resources. Existing socio-economic conditions and institutional characteristics need to be taken into account, as they will form the basis for preparing growth pathways or creating new opportunities. Some regions may be able to adopt strategies or policies that have been successful in other regions and adapt them to their own conditions and characteristics. However, this requires resources, competencies, talents, and commitment of the actors involved in S3 processes, especially in accessing and absorbing knowledge or experience from other regions.

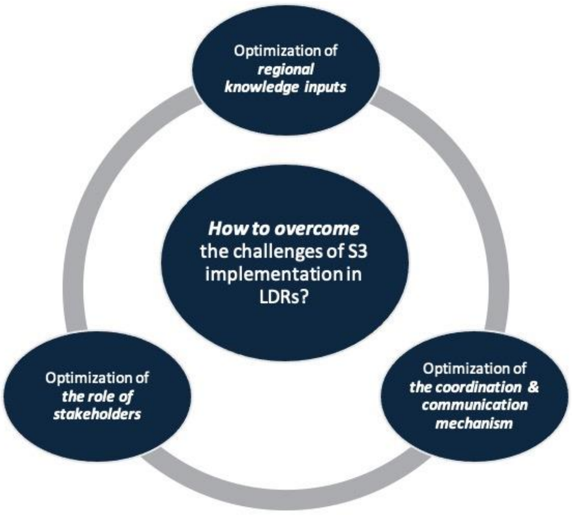
Barzotto, Corradini, Fai, Labory, & Tomlinson (2020a)show the experience of one of the poorest regions in Italy (Puglia) in creating new growth pathways and opportunities. As is characteristic of LDRs, Puglia has many structural institutional problems and limited availability of social capital. The region has long implemented sectoral policies (space and mineral sectors), but these have failed to address its socio-economic problems. Recently, the region has undergone many changes and has experienced significant economic impacts from changing growth paths and discovering new opportunities, now focused on new technology domains discovered through enhanced R&D capacity and stakeholder engagement following smart specialization framework.

The challenge of managing and optimizing regional innovation resources, which requires access to a wide range of internal and external knowledge and expertise, has led regions to seek to develop regional innovation strategies and policies (RIS3) with a participatory and collaborative approach involving multiple stakeholders. According to Trippl et al., 2019), collaboration can help overcome the problem of limited regional innovation resources. However, the problem is that to create the right form of collaboration, regions must also take into account differences in culture and institutional capacity Sörvik et al. (2019), language, and even distance and geographical conditions of each region.

Ghinoi, Steiner, & Makkonen (2021) argue that one of the important factors to overcome the challenges of collaboration between stakeholders within a region or between different regions is the provision of collaboration infrastructure (*e.g.*, industry clusters, incubators, knowledge networks, and funding allocation) and appropriate coordination mechanisms. On the other hand, Barzotto, Corradini, Fai, Labory, & Tomlinson (2020b) emphasized that when collaborating between regions with different backgrounds, attention should be paid to the balance between weaker regions and other more advanced regions. The collaboration should not have an unbalanced positive impact on the collaboration partners, or even a negative impact on other regions. Opportunities and challenges need to be identified early in the collaboration design process, and risks that may arise in the collaboration process need to be mitigated.

Ghinoi, Steiner, Makkonen, et al. (2021) specifically investigated the implementation of smart specialization in peripheral areas in Lapland (Finland) from the perspective of good governance practices. The study focuses on the governance and decision-making processes of the EDP. As the core of S3, the implementation of EDP in peripheral regions or LDRs in general faces considerable challenges, especially when the causes are related to the ability of regional innovation networks to absorb external knowledge (absorptive capacity) and the limitations of regional innovation actors to disseminate local knowledge and technology (knowledge transfer). The study also mentions that the process of collaboration to increase absorptive capacity and knowledge transfer can make use of formal and informal communication mechanisms, especially when the governance process is closely linked to other governments or at different levels of government (multi-level governance). In the context of a centralized innovation policy (national RIS3), efforts by LDRs or small regions to build RIS3 at the local or regional level can take advantage of informal coordination to access potential innovation actors that are organizationally linked to the central government, such as foreign-owned companies.

In terms of the decision-making process, regions also face the challenge of increasing the participation and involvement of all regional stakeholders in the design and governance process of S3. The governance of innovation policies such as S3, which involve many stakeholders in the region, requires a coordination mechanism specifically designed to bridge the relationship between public actors (government and universities), the private sector (business and industry) and civil society. However, before this coordination can take place, each stakeholder needs to have sufficient perception and understanding of the principles of S3 and the importance of their role and participation in the whole S3 process. Moreover, as stated by Sörvik et al. (2019), in addition to weak coordination among innovation actors, institutionally weak regions also face bureaucratic complexity and ineffective administrative governance, in addition to political interests and overlapping regulations. These challenges not only weaken the engagement of local stakeholders, but also make it difficult to build trust, which is essential for creating coordination in the long run.



Source: Author's elaboration, modified from Wibisono (2022b)

Figure 2. 6. Optimizing three points to overcome the challenges of S3 implementation in LDRs

From the critical review of the selected papers and the synthesis of the findings in Wibisono (2022b), modified as shown in **Figure 2.5**, there are *three* main points that need to be optimized to overcome the challenges in implementing S3 in LDRs (**Figure 2.6**). *First*, challenges related to RIS capacity building can be overcome by optimizing regional knowledge inputs. Fundamentally, the structural problems in the socio-economic conditions of the region need to be addressed. Moreover, improving the quality of human resources in LDRs also needs to focus on improving specific skills and competencies (not only basic ones) according to the character of the regional economy or industry (B. T. Asheim, 2019; Krammer, 2017). Thus, supporting vocational education or technical/manufacturing training is one of the important strategies that needs to be included in the development policy agenda in LDRs. With regard to human resources that play a direct role in R&D activities (researchers and engineers), especially if the region is targeting a certain level of technological output, there needs to be special encouragement to increase their productivity, for example through the provision of research incentives, in addition to adequate support for R&D investment (Foray, 2014a; Landabaso et al., 2014; Nicos et al., 2014).

Second, the challenges of building collaboration in LDRs can be overcome by optimizing the role of stakeholders. The first step of selecting stakeholders to be involved in the RIS3 project is a crucial part. The role of key actors in regional innovation such as government, universities, and industries or entrepreneurs (elements of the triple helix) needs to be maximized while strengthening the participation of civil society as the fourth element (quadruple helix) (Roman et al., 2020). The diverse perspectives of the four elements must be sufficiently mobilized to produce a strong consensus that is acceptable to all stakeholders. A balanced and optimized role of the stakeholders will increase trust and create a close relationship between them. This is an important asset when LDRs want to build more extensive collaborations, such as interregional collaborations (Mariussen et al., 2018; Uyarra et al., 2014).

Third, challenges related to S3 governance in LDRs can be addressed by optimizing coordination and communication mechanisms. Although S3 is a bottom-up and place-based policy approach, top-down hierarchical systems of governance and coordination cannot be avoided in the LDRs in centralized innovation systems (Moodie et al., 2023; Rodrigues & Teles, 2017). In recent years, the concept of multi-level governance (MLG) has become one of the forms of governance widely proposed or considered for the implementation of S3 (*e.g.*, Laranja et al. (2020); Larrea et al. (2019); Pugh (2018); Wibisono (2022a)). However, research on this topic is still evolving to provide empirical evidence in this field. The S3 framework emphasizes inclusive innovation policy governance, which promotes the involvement and participation of all stakeholders in the region. In this regard, institutional capacity needs to be consistently strengthened. In addition, continuous coordination is needed, for example through consultations, regular meetings, and discussion forums where each stakeholder can exchange information to strengthen the relationship between them. In addition to formal meetings, coordination and communication mechanisms can also be developed informally, such as sharing information through digital infrastructure (devices and platforms) that can be accessed anywhere, at any time and without the necessity of direct or formal meetings.

2.3. Encouraging R&D collaboration in LDRs

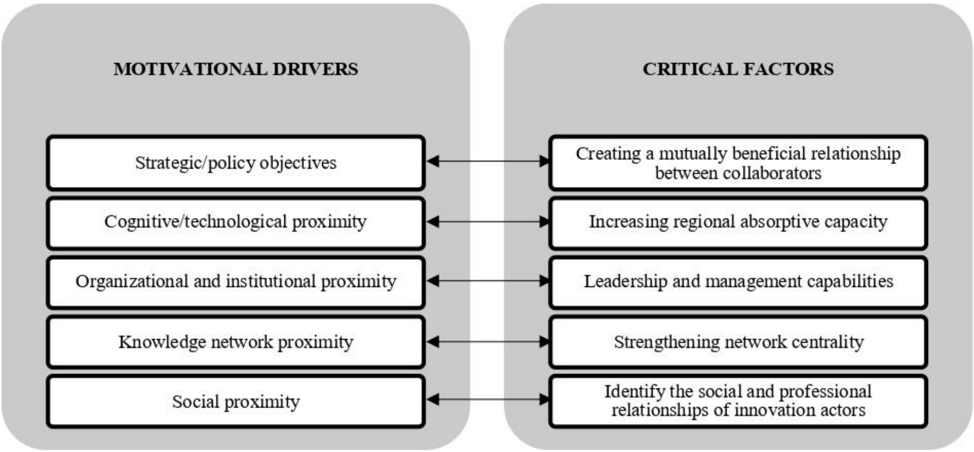
This section is based on the main contribution of the study of Wibisono (2023), which critically reviews the main findings of eleven selected papers that comprehensively discuss R&D collaboration for innovation in LDRs in the context of the geographical challenges they face. This study was motivated by the limited literature on this topic, although the results of a literature search in the database showed that this topic is evolving in the context of innovation policies in the European Union and that related work is published in high quality publication sources. In addition, this study was inspired and developed from ideas that emerged in the author's work in Wibisono (2022b), in particular regarding the issue of collaboration for innovation, as one of the main challenges in S3 implementation in LDRs (**Figure 2.5**). The results of the critical review of this study represent a contribution to the literature on this topic, presented in a diagram as shown in **Figure 2.7** and referred to as "Five motivational drivers and critical factors for R&D collaboration in the LDRs of the EU" (Wibisono, 2023, p. 94).

As noted in a critical review by Wibisono (2023), LDRs have the same opportunities as other regions to build R&D collaborations for innovation. In order to increase the success of this collaboration, this paper places two important emphasizes. *First*, in terms of efforts to increase opportunities for collaboration with more developed regions, three main things need to be paid attention to, namely:

> "… openness to external knowledge that can be used to enhance regional innovation, the ability to absorb knowledge and experience from partner regions, and the ability to identify critical actors to engage in collaboration for innovation."
>
> (Wibisono, 2023, p. 95)

To develop regions with a place-based innovation approach based on the S3 framework, regions are encouraged to develop their regional innovation strategies (RIS3) through a collaborative, participatory and inclusive process. This also means that a serious effort is needed to encourage a strong engagement of stakeholders from different backgrounds to cooperate. Internal knowledge networks, which are an important resource in RIS, need to be strengthened through organizational and institutional capacity building (De Noni et al., 2018a). This is the initial investment for LDRs to build cooperation and collaboration with more advanced regions.

The development of internal knowledge networks requires openness to external knowledge (Marrocu et al., 2013; Powell, 1998) and, at the same time, the ability to absorb this external knowledge (absorptive capacity) (Miguélez & Moreno, 2015; Van Aswegen & Retief, 2020) to be applied in the local context according to regional needs. As explained in **section 2.5**, the process of optimizing collaboration to overcome the challenges of implementing S3 in LDRs is carried out by innovation actors who have a good understanding of strategies for building and maintaining collaboration. Therefore, the identification and selection of these key actors must be entrusted to experienced experts, such as senior researchers in universities or in public and private R&D institutions, with the support of other stakeholders. The role of these innovation actors is essential in the early stages of creating interregional linkages (Thomas et al., 2021).



Source: Wibisono (2023, p. 94)

Figure 2. 7. Motivational drivers and critical factors for R&D collaboration

The *second* emphasis presented in Wibisono (2023) is the need for appropriate motivation for what the LDRs collaboration is intended to achieve. This motivation is also a driver of collaboration in LDRs, and its success also requires attention to critical factors. The *first* motivation that can drive R&D collaboration in LDRs is motivation driven by goals of strategic policy interest. This motivation can be a driver for developing a regional innovation strategy for S3 at an early stage to learn from the experience of successful organization and management of innovation policies in other regions. Unlike more developed regions or industrialized regions with a high level of technology, LDRs cannot directly target cooperation with other regions simply for the motivation of technological upgrading. Silva et al. (2021) mentioned that collaboration must have a mutually beneficial impact, so LDRs must have their own attractiveness for other regions to consider LDRs as their collaboration partners.

Once an initial relationship is established with a more developed region, LDRs may consider more cognitive or technological proximity (the *second* motivational driver). For LDRs that are geographically close to other regions, for example less than 300 km (Lata et al., 2018), such collaborations are still highly possible. Marek et al. (2017) show that regional collaboration projects in Germany, motivated by technological or cognitive proximity, benefit from their geographical proximity. To increase the attractiveness of neighboring regions in collaborations motivated by cognitive proximity, absorptive capacity becomes the next important prerequisite after initial linkage is established (Badillo & Moreno, 2018; De Noni et al., 2018a).

The same benefits may not be obtained by LDRs that are geographically distant from other regions. Therefore, a *third* motivational driver explains this, namely collaboration motivated by organizational or institutional proximity. Establishing initial relationships and strengthening institutional ties, coupled with increased knowledge uptake, can increase the success of collaboration (Lalrindiki & O'Gorman, 2021; Ranga, 2018). However, the main factor that can increase the success of collaborations motivated by organizational proximity is highly dependent on the role of each organization's leadership, including the leader's managerial skills in collaborative processes. Positive influence of leaders will increase trust and understanding between organizations and create transparency and openness in collaborative relationships (Norman et al., 2010; Oliver et al., 2020).

According to Berge (2017), barriers due to a region's geographic location or distance can have an inverse relationship if a region has a high network centrality that can attract other regions to collaborate. The opportunities for LDRs collaboration with developed regions will increase as the proximity of knowledge networks increases, despite the unfavorable geographical distance. Neuländtner & Scherngell (2020) present empirical evidence of the positive influence of network centrality on network proximity. Therefore, the *fourth* motivational driver states that R&D collaboration in LDRs can be motivated by network proximity, where LDRs should pay attention to or strengthen their centrality in the network.

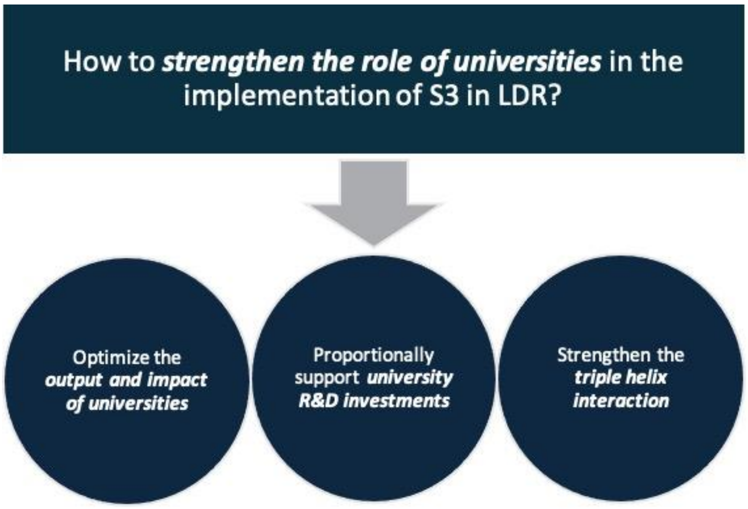
Interactions that occur between actors in a knowledge network for future collaboration can also be motivated by social relationships that occurred or were formed in the past and have lasted for a long time, without considering geographical distance (Breschi & Lissoni, 2009;

Phelps et al., 2012; Torre, 2008). By collecting data on innovation actors past relationships for over thirty years, Miguelez (2019) provided evidence that innovation actors who have had social proximity in the past and over a long period of time are more likely to create innovation collaborations in the future. LDRs, who are motivated to collaborate by leveraging this social proximity for the benefit of future collaboration, have an obligation to identify these innovators and explore their past social proximity (the *fifth* motivational driver). Lalrindiki & O'Gorman (2021) note that social proximity is closely related to cognitive proximity, so the combination of the two will provide many benefits to LDRs who have it.

2.4. Strengthening the role of universities in LDRs

This section draws on the main contribution of the study of Wibisono (2022c), which critically reviews the main findings of selected papers that comprehensively address the experiences and lessons learned from the involvement of universities in the implementation of S3 in LDRs. In addition, this review is motivated by several criticisms regarding the role of universities as a source of local knowledge, but in the context of regional innovation are faced with challenges related to knowledge transfer and their involvement in S3. As described in **section 2.5**, there are major challenges in developing the capacity of RIS in the implementation of S3 in LDRs and in this case universities play an important role as producers of local knowledge as well as one of the key actors in RIS. Although studies on the role of universities in RIS have been developed for a long time, it is still rare to discuss the same context in the implementation of S3, particularly in LDRs. The study of Wibisono (2022c) identified important factors to strengthen the role of universities in the implementation of S3 in LDRs, as reconstructed in **Figure 2.8**.

The *first* factor influencing the increased role of universities in the implementation of S3 in LDRs is the optimization of the output and impact of universities in the regional innovation system (RIS). This point is synthesized from the study of Vallance et al. (2018), which uses a case study of S3 implementation in Lodzkie (Poland), one of the less developed regions in the EU. Lodzkie has a long history in the textile industry, and the knowledge resources associated with this industry, such as higher education knowledge inputs (lecturers and researchers) and their knowledge outputs (students and technology transfer), have significantly contributed to the development of the region and made Lodzkie one of the best technical education cities in Poland.



Source: Author's elaboration based on Wibisono (2022c, p. 145-146).

Figure 2. 8. Factors strengthening the role of universities in the implementation of S3 in LDRs

Vallance et al. (2018) explored the perspectives of local stakeholders on the role of universities in S3 projects in Lodzkie, particularly their involvement in collaboration and entrepreneurial discovery. The results of this study suggest that research and technology development activities at universities play an important role in the impact that will be given to the region when it enters the labor market. Asheim (2019) states that the knowledge and technology products generated by universities are very important resources for regional innovation and can provide strong support for the implementation of smart specialization. However, what needs to be considered is the compatibility between the knowledge products, skills and competencies produced by universities and the needs of local industries. Given that S3 is a place-based policy, universities play an important role in providing solutions to the challenges faced by regions in developing their innovation strategies according to local conditions and problems (McCann & Soete, 2020; Morgan, 2019). Many studies have shown that university-industry linkages have a positive impact on regional development (*e.g.*, Benneworth & Fitjar (2019); Hou et al. (2021); Lehmann & Menter (2016)). However, in order to create a sustainable policy strategy (RIS3), the link between the two needs to be made for long-term goals (A. V. Marques et al., 2019; Veletanlić & Sá, 2019).

The *second* factor influencing the strengthening of the role of universities in the implementation of S3 in LDRs is the proportional support of R&D investments in universities. This factor is identified in Kempton (2015), which examines the implementation of smart specialization in Värmland, a county in the Swedish periphery with a relatively small productive population due to urbanization and low participation in higher education. To develop a regional innovation strategy, the Värmland government collaborated with Karlstad University in the central part of Sweden, as well as several regional industry clusters and leading entrepreneurs. This cooperation has been running for more than ten years and is an important asset for the implementation of S3 in Varmland. Varmland's economy is dominated by SMEs, which makes knowledge sharing in the region quite challenging. In 2014, the government launched an innovation park, which has become a venue for many innovation actors to exchange knowledge and experience and collaborate both formally and informally on innovation projects. This external innovation and collaboration have become an important part of the development process in Varmland.

Collaborative support in R&D funding at universities from government, public and private sources has been key to the development of innovation (Etzkowitz, 2003; Freitas et al., 2013; Gachie, 2020), such as the collaboration between steel industry companies in Varmland and Karlstad University. These experiences are evidence of successful cooperation between universities and the business sector in the process of knowledge transfer and commercialization. Although education budgets are still prioritized over R&D budgets, peripheral regions such as Varmland are trying to stabilize R&D investments for innovation and technology development within their regional limitations through cooperation agreements with actors in other regions. The involvement of Karlstad University in supporting S3 development in peripheral regions with adequate investment support also provides evidence that adequate allocation and good management of funds will increase the impact of universities on regional development and innovation even amid geographical challenges (Wagner et al., 2021; Youtie & Shapira, 2008). Transparency, accountability, and rigorous oversight of R&D investment projects are key to trust and sustainability of collaboration between local governments, universities, and industrial entrepreneurs (Bozeman et al., 2013).

The *third* factor influencing the increased role of universities in the implementation of S3 in LDRs is the existence of a solid relationship between the elements of the triple helix. The identification of this third factor refers to the results of a study by Lilles et al. (2020), which examined university-industry (UI) cooperation in NUTS 1 and NUTS 2 regions in the European Union (EU). The results of this study show that there are weak UI linkages in several regions of the EU, especially in the eastern and southern EU regions, such as Spain, Poland, and Romania. In these regions, UI cooperation tends to be weaker than in western and northern regions, such as Germany and Sweden. Lilles et al. (2020) conclude that there is little evidence of adequate cooperation in these regions, largely due to less dynamic local R&D activities. Public sector support for innovation is almost evenly distributed across all EU regions, with the strongest support found in western European regions. However, the highly educated population is more concentrated in the western region, which makes capacity building and local knowledge absorption in this region significantly different from the eastern or some southern regions. According to Todeva & Danson (2016), triple helix relationships or ties are strong when there is an alignment of goals or a common perception between the elements of the triple helix. In this case, local governments can mediate and take a central position to facilitate university-industry relationships and provide persuasive encouragement to increase interest in university-industry cooperation (Azagra-Caro et al., 2006; W. Hong & Su, 2013) or provide special incentives to encourage interest and university-industry cooperation and collaboration (Lundberg & Andresen, 2012; Zhao et al., 2024).

2.5. Summary

This chapter is a literature review summarizing three of the author's papers published in international peer-reviewed and open access journals. These papers comprehensively explore the implementation of smart specialization strategies (S3) in the less developed regions (LDRs) of the European Union (EU) and outline the main challenges faced in this field. The methodology used in this chapter combines a systematic literature review approach and a traditional literature review approach. A literature review protocol is specifically aimed at exploring the main findings of selected articles and then synthesizing these findings to obtain the required information or to achieve the designed research objectives. The review of selected articles shows that smart specialization and R&D collaboration in LDRs are growing topics in innovation policy studies, especially in the European Union. Various research issues related to this topic have been investigated and research results related to these issues have been published in high-impact publication sources to guide and inform academics and practitioners in the field.

The synthesis of the three main papers in this chapter is systematically presented in three separate sections. The section extracted from the first paper outlines three main challenges in implementing S3 in LDRs: challenges related to developing the capacity of regional innovation systems (RIS), challenges related to intra- and extra-regional collaboration, and challenges related to S3 policy governance in regions. Each of these challenges was further explored and three recommendations were made to overcome them, including optimizing the output and impact of regional knowledge inputs, optimizing the role of stakeholders in fostering collaboration, and optimizing coordination and communication to improve S3 governance in the regions. The section extracted from the second paper is closely related to the challenges faced by LDRs in building collaboration in implementing S3. Further exploration of this issue resulted in five motivational drivers for LDRs to collaborate with more developed regions, as well as critical factors that need to be considered to increase the success of this collaboration. The section extracted from the third paper is closely related to the main challenges faced by LDRs in optimizing innovation resources and increasing regional innovation capacity. The results of the study in this paper recommend three things that can strengthen the role of universities as one of the main actors in implementing S3 in LDRs, namely optimizing the output and impact of regional knowledge inputs, providing adequate support for R&D investments, and strengthening the relationships and interactions between universities, government, and industry/business.

CHAPTER 3
Regional Governance Challenges and Smart Specialization Policy

The problem of inequality and competitiveness has become a general issue in the Central European region, or more broadly in the context of the Eastern and Central European (CEE) region, even before its accession to the European Union (Dyba et al., 2018; Smętkowski, 2013). Several studies suggest that the economic instability of countries has a significant impact on the decline of competitiveness and innovation in CEE and that such disruptions have a substantial effect on innovation productivity (Filippetti et al., 2020; Filippetti & Archibugi, 2011; Kirankabeş & Erkul, 2019). In hindsight, according to Varga (2007), the decline in patent productivity (as one of the main products of technological change or development) in Central Europe, or specifically in the case of Hungary, was caused by the economic restructuring from the 1990s to the beginning of the millennium and the privatization of companies in the countries. Many experts argue that the negative impact of the economic crisis on innovation can be significantly reduced due to the adaptability of knowledge workers, who have good resilience in the face of the crisis as they have undergone a long learning process. Indeed, several studies show that most of the CEE regions that are lagging in innovation need significant support in R&D resources. Ironically, however, these regions continue to face many barriers to efficiently managing innovation resources (Kravtsova & Radosevic, 2012; Radosevic, 2012).

In a recent study, Wibisono (2023b) specifically examines innovation studies in the context of the Visegrad Group (V4) region, four countries in CEE (Poland, Czech Republic, Hungary and Slovakia), that are clustered together due to historical, political, cultural, and economic ties. In the period 2004-2018, patent productivity in the V4 was dominated by two countries, the Czech Republic and Poland. Slovakia, as a smaller country, also shows fairly stable patent productivity, although it is at the bottom of the group. This contrasts with Hungary, which has experienced a decline in patent productivity since the 2008 crisis. A closer look reveals some anomalies. Under these conditions, Hungary actually shows an upward trend in R&D researchers and R&D expenditure, similar to the Czech Republic. However, this does not make Hungary more productive in innovation and catch up with the first two CEE countries. As countries whose regions are not only contiguous but also interconnected in many ways, the question that may arise is whether innovation in one region of a country is likely to be related to other regions in other countries, as is the case, for example, between regions in Poland and the Czech Republic or between regions in Hungary and Slovakia. Or, more specifically, are knowledge input factors, such as knowledge workers or R&D researchers, and R&D investment support, both public and private, in a region related or dependent on each other because of its geography?

The research discussed in Wibisono (2023b) highlights some important issues related to the governance of innovation resources and knowledge inputs. It highlights the need to implement effective governance policies to enhance cooperation and synergies among innovation actors within and across regions and countries. This is closely related to the concept of R&D collaboration, which has emerged as a key driver of innovation (Wibisono, 2023a), especially since the implementation of the smart specialization strategies (S3) in the various EU regions. S3 emphasizes effective policy governance and encourages the development of such policies for less-developed regions (LDRs) (Belussi & Trippl, 2018b; Foray, McCann, & ..., 2015; Wibisono, 2022b). S3 governance focuses on optimizing the participation of various regional stakeholders in the public and private sectors. S3 also encourages community participation in policy strategy formulation, which can be represented by organizations, social groups, or specific communities in the quadruple helix concept (E. G. Carayannis & Rakhmatullin, 2014; Morgan, 2013).

Different regions require different approaches to managing and organizing innovation resources (Cooke et al., 1997; Prokop et al., 2019). Innovation resources may be scarce or difficult to access in LDRs due to weak institutional and administrative management capacity and bureaucratic rigidity. To address this, some experts suggest that innovation policy governance can empower local resources and foster cross-sectoral cooperation and civil society involvement in regions with weak administrative governance (Christopoulos et al., 2012; Fulda et al., 2012; Moodie et al., 2023). At the national and EU levels, effective innovation policy governance can influence the implementation of policies at the regional and local levels (Perry & May, 2007). Smaller regions can also benefit from learning and experience in innovation policy governance from higher levels of government (Isaksen et al., 2018; Magro & Wilson, 2019). It can be argued that even regions with resource constraints or governance weaknesses have equal opportunities to effectively and efficiently implement regional innovation policies (Wibisono, 2023a).

In the realm of regional policy, multilevel governance refers to the active participation of regional and local actors in developing and implementing regional policies. According to Schmitter (2004), multilevel governance involves numerous independent and politically bound actors in decision-making processes at a specific territorial level through discussion and negotiation. Multilevel governance is a framework where policies are designed and implemented across different levels of government based on their objectives Barca (2009). The integration process of different policies is established through the cooperation of many actors. The classification of multilevel governance by Hooghe et al. (2001) into MLG type 1 and type 2 is widely accepted. MLG Type 1 emphasizes vertical relationships between institutions and governments, where the government hierarchy strongly influences decision-making. Meanwhile, MLG Type 2 emphasizes more flexible horizontal relationships that may fit the concept of smart specialization. For example, in the Entrepreneurial Discovery Process (EDP), triple or quadruple helix relationships among regional actors are critical for identifying new domains for innovation-driven development. While the involvement of higher levels of government is essential in S3 at the regional level, it serves primarily as an enabler to optimize the role of local actors. Local governments have the best understanding of local conditions, but managing regional strategies and policies requires the presence of the central government regarding competencies (Larrea et al., 2019).

The concept of smart specialization is a place-based approach that has the potential to be applied in different regions. The approach emphasizes collaboration between different levels of government with the same or different levels of knowledge, and it involves using the knowledge and experience gained from the learning process to adapt it to the potential of the region and manage it for the benefit of regional development. However, it is important to note that multilevel governance, as argued by Larrea et al. (2019), is a complex form of synergy and collaboration that can make smart specialization open and accessible to different institutions and levels of government. The principles of smart specialization show that S3 is the result of the creation of a joint strategy, where regional S3 priority programs are always tailored to local investment and innovation capacity, and the role of local government as an intermediary in integrating different local knowledge is key. Furthermore, the monitoring and evaluation process of smart specialization always requires the presence and involvement of all stakeholders. These principles highlight the need for balanced central government control to align innovation projects at the local level with national priorities and cohesion policy objectives (P. Marques & Morgan, 2018). Multilevel governance and the principles of smart specialization are crucial for the success of this approach, and it is important to ensure balanced government control to ensure alignment with national priorities.

This chapter presents a combination of empirical studies and critical reviews related to the issue of innovation policy governance for smart specialization strategies (S3) in the European Union. The content of this chapter is a synthesis of three papers by the author. Two papers have been published in the *Bulletin of Geography: Socio-economic Series* (Wibisono, 2023b) and the *European Journal of Government and Economics* (Wibisono, 2022a). The first paper can be accessed at https://doi.org/10.12775/bgss-2023-0008 and the second at https://doi.org/10.17979/ejge.2022.11.2.9004. The third paper is currently under review in the *European Journal of Geography (EJG),* the leading journal in European geography published by the Association of European Geographers (EUROGEO). While Chapter 2 provides a comprehensive review of issues related to the implementation of smart specialization in less developed regions of the European Union, Chapter 3 focuses on governance issues, both in relation to the governance of innovation resources and the governance of regional innovation strategies and policies. The governance of innovation policy is a critical element for the effective implementation of smart specialization. It enables the tendency of regional governments to increase stakeholder participation, explore various financial and non-financial resources, and respond to recommendations and guidance from higher levels of government regarding policy implementation (Karo et al., 2017; McCann & Ortega-Argilés, 2016).

The content of Chapter 3 begins with the presentation of the research results of Wibisono (2023b), which examines the impact of innovation resources or knowledge inputs on innovation. This study focuses specifically on the regional context of the Visegrad Group (V4), an alliance of four Central European countries, namely Poland, Hungary, Slovakia, and the Czech Republic. The main objective of the study is to analyze the spatial dependence of knowledge inputs and their impact on innovation. The next section presents the study results of the third paper, which is motivated by the study of Wibisono (2023b). It discusses how regional innovation resources should be managed to improve the success of smart specialization implementation. This paper uses a systematic literature review approach to explore the phenomena and challenges in the governance of regional innovation resources and policies, how these challenges are being addressed, and what recommendations have been made by previous studies. The final section presents the study results of Wibisono (2022a). This paper specifically explores the issue of regional innovation policy governance for smart specialization with a multilevel governance approach. In the case of less developed regions, as is the case in most V4 regions (Egri & Lengyel, 2023; Kisiała & Suszyńska, 2017; Koišová et al., 2019), a multilevel governance approach has great potential to improve the success of smart specialization. This section critically discusses how this governance concept is aligned with the principles of smart specialization and what important factors need to be considered.

The rest of this chapter is structured as follows. Sub-chapter 3.2. briefly outlines the literature background of the three studies discussed in Chapter 3: knowledge and innovation resources in the Visegrad Group region, governance of regional innovation policy and smart specialization, and multilevel governance in the implementation of smart specialization strategies. Sub-chapter 3.3. describes the methods used, namely the spatial econometric analysis approach and the systematic and traditional literature review approach. The discussion and synthesis of the research results from the three papers are presented in sub-chapters 3.4, 3.5 and 3.6. Finally, sub-chapter 3.7. summarizes and concludes Chapter 3.

3.1. Methodology

Chapter 3 builds on the author's three papers, two of which have been published in peer-reviewed international journals (Wibisono, 2022a, 2023b) and one of which is under review in the *European Journal of Geography (EJG)*. The study by Wibisono (2023b) is an empirical study conducted using a spatial econometric approach. The study of Wibisono (2022a) was conducted with a traditional literature review approach (evidence-based critical review) by briefly applying some methods commonly used in systematic review research. Meanwhile, the study in the third paper was conducted using a systematic literature review approach.

3.1.1. Spatial econometric analysis approach

The concept of spatial econometrics is an extension of econometric approaches that explore the spatial dependence or spatial characteristics of certain variables in a region (Espoir & Ngepah, 2021; L. Wang et al., 2019; Zhang et al., 2021). This spatial dependence, represented by the spatial weight matrix (***W***), indicates how much a region changes when the same variable changes in another region (Anselin et al., 1997; Anselin & Arribas-Bel, 2013; Anselin & Florax, 2012). The spatial weight matrix (***W***) is "a non-negative matrix that describes neighborliness in an observational dataset" (Wibisono, 2023b, p. 114). In this modeling, the Exploratory Spatial Data Analysis (ESDA) technique is used to identify spatial autocorrelation that can indicate spatial dependence, the indicator is Global Moran's I (J. Liu et al., 2013; Y. Liu et al., 2018). Spatial correlation is represented by the Global Moran's I distribution map with a Moran's I threshold from -1 to 1. A negative (or positive) Moran's I value indicates a negative (or positive) spatial correlation, and the value becomes more significant as it approaches a value of -1 or 1 (Dai et al., 2023; C. H. Wang et al., 2015). The significance value of Moran's I is obtained by standardizing the z-score value at the threshold of $-1.96 < z < 1.96$ (Yan et al., 2018; Zhan et al., 2021).

Next, to test the spatial relationship between the dependent (Y) and independent (X) variables, the Local Indicators of Spatial Association (LISA) analysis is applied to the Global Moran's I statistic, resulting in the Local Moran's I value (Ali, 2021; Bednář & Halásková, 2018; Song et al., 2020; Tao & Chen, 2022). A Local Moran's I value (negative or positive) indicates the presence of a spatial relationship resembling that value (negative or positive) around the observation region. The "positive" Local Morans'I values are grouped into two parts. Clusters that show "high-high" values explain that the location has a high variable intensity value and is surrounded by other areas that also have high values, and vice versa. Meanwhile, the "negative" Local Morans'I values are also grouped into two parts. These values indicate the spatial difference (sign) of a region's variables with its neighbors. The group that shows a "high-low" value explains that the location has a high variable intensity value and is surrounded by other areas that have low values, and vice versa.

There are two known estimation models in spatial econometric modeling.

1. Spatial Lag Model (SLM) is a spatial regression estimation model that includes lag variables, which are certain variables that affect spatially adjacent variables. The spatial autoregression coefficient is denoted by ρ. SLM explains the effect of spatial dependence due to externalities or spillovers. SLM also aims to deal with disturbances due to spatial autocorrelation. The evaluation performed in SLM is to prove that $\rho \neq 0$ (spatial autocorrelation exists) (Benedetti et al., 2020; Cai & Hu, 2022; Gu & You, 2022; Sannigrahi et al., 2020; Shen & Peng, 2021; C. Wang et al., 2019). The SLM estimation model is expressed by equation **(1)**:

$$Y = \alpha + \rho \boldsymbol{W} Y + \beta X + \varepsilon \qquad \textbf{(1)}$$

where:

α = intercept

β = regression coefficient of independent variable X

ρ = spatial autoregressive coefficient/parameter

WY = spatial lag variable

ε = error

2. Spatial Error Model (SEM) is a spatial regression estimation model that includes an error term (ε), which is the result of multiplying the spatial weight matrix by the spatial error coefficient (λ). The evaluation performed in SEM is to prove that λ≠0 (there is spatial error (λ)). The SEM estimation model is expressed by equation **(2)**:

$$Y = \alpha + \beta X + \varepsilon; \text{with } \varepsilon = \lambda \boldsymbol{W} \varepsilon + \xi \quad \textbf{(2)}$$

where:

α = intercept

β = regression coefficient of independent variable X

εi = error vector

λ = spatial error coefficient

W = spatial weight matrix

ξ = modified error vector

The operationalization of the variables used in the analysis is presented in **Table 3.1** and the equation model applied is as equation **(3)**. Patent applications (PATAPP) is the total value of applications in units per million population. R&D personnel (RDPR) is the number of researchers in full-time equivalent units. R&D expenditure is divided into two types: public R&D expenditure (GERDPUB), which is a combination of government R&D and university R&D, and business R&D expenditure (GERDBUS). The analysis is carried out in two steps. *First*, spatial description analysis, which presents the spatial distribution of the four variables (PATAPP, GERDBUS, GERDPUB, RDPR) generally in the form of thematic maps (based on natural breaks), spatial correlation and scatter correlation. *Second*, estimation modeling by performing spatial regression analysis. These analysis processes were carried out using *Geoda* software.

Table 3. 1. Variable Operations

Variable	Definition	Measurement unit
PATAPP	Patent applications to the EPO by priority year by NUTS 3 regions [PAT_EP_RTOT__custom_2729431]	Per million inhabitants
RDEXP	GERD by sector of performance and NUTS 2 regions in all sectors	Million euro
GERDBUS	GERD by sector of performance and NUTS 2 regions in Business enterprise sector	Million euro
GERDPUB	GERD by sector of performance and NUTS 2 regions in Higher education sector	Million euro
RDPR	R&D personnel and researchers by sector of performance, sex and NUTS 2 regions in all sectors	Full-time equivalent (FTE)

Source: Wibisono (2023b, p. 116)

$$\ln PATAPP = \alpha + \beta 1\, lnGERDBUS + \beta 2\, lnGERDPUB + \beta 3\, lnRDPR + \varepsilon \quad \textbf{(3)}$$

where:

PATAPP = innovation parameter

GERDBUS = business sector R&D expenditure

GERDPUB = public sector R&D expenditure

ε = error term

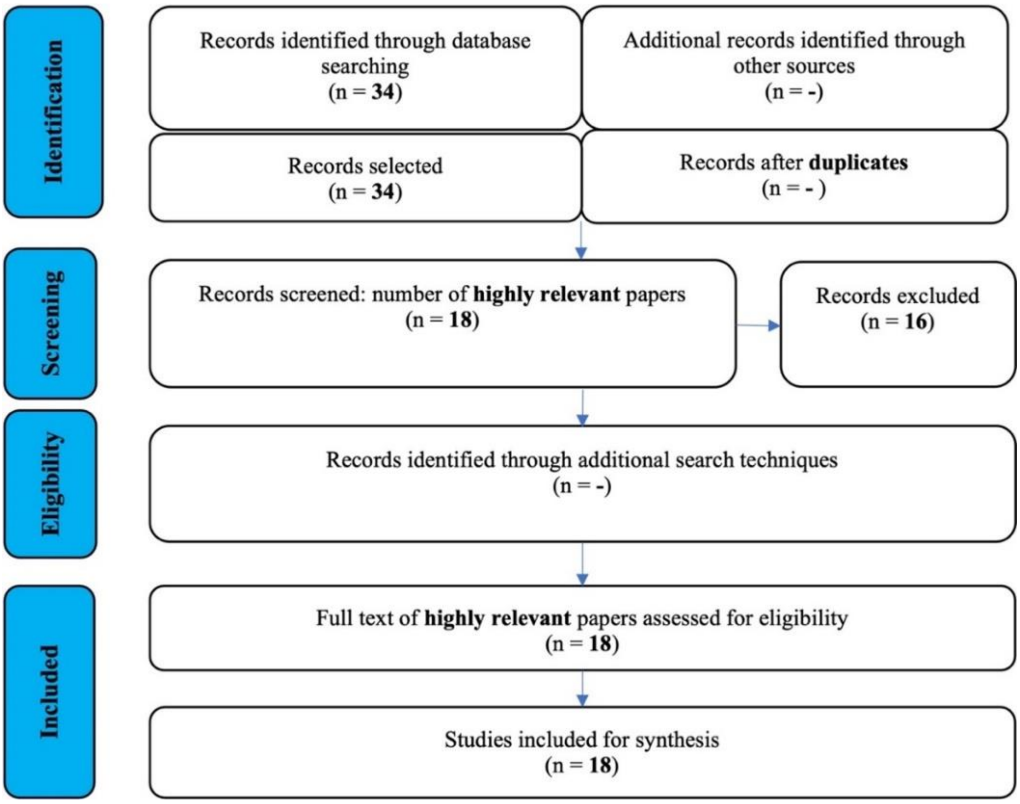
$\beta 1, \beta 2, \beta 3$ = coefficients of independent variables

The estimation using spatial econometrics in Wibisono (2023b) is conducted using cross-sectional data, considering several previous studies that show that the use of this data structure is quite robust for estimating regional knowledge impact models (Agasisti et al., 2019; Anselin, 1988; Anselin & Florax, 2012; Debarsy et al., 2018; LeSage, 2015; Naveed & Ahmad, 2016; Qin et al., 2019; Stojcic, 2021). The data used in the analysis were all obtained from the EUROSTAT website (*https://ec.europa.eu/eurostat/data/database*). The most recent data on patent applications at the NUTS-2 level are available until 2012, so the data on R&D expenditure and R&D personnel are also set to 2012. The dataset obtained from this arrangement resulted in 34 NUTS-2 region-level observations in four V4 countries. During the data processing, it was found that one region, Lubuskie (Poland), did not provide data on R&D expenditure in the public sector, so this region was excluded from the analysis. However, the number of degrees of freedom was still considered sufficient for estimation or to make a final decision.

3.1.2. Methods of systematic review and traditional review

The study in the third paper uses a systematic literature review approach following the procedure (three-step protocol) outlined in **Chapter 2** (**sub-chapter 2.3**), namely the scoping process, the process of drawing material from the database, and the systematic and critical review of the selected literature (Wibisono, 2022b, 2023a). The work on this study is motivated by the phenomenon of S3 implementation at the regional level (local/regional), which in some studies has led to a lot of encouragement to increase the wider involvement of "regions" in S3 processes at higher levels (between local, regional and national), while on the other hand, some regions have many internal limitations and limited capabilities to take advantage of existing opportunities to further involve in S3 governance. This phenomenon then raises questions such as what the challenges are these regions face in implementing S3 and what are the suggestions or ways to overcome these challenges.

The *first protocol* applied in the third paper is the scoping process, where the PICOC framework is applied at this stage (Mengist et al., 2020; Roehrs et al., 2017). The context (C) of this research is limited to governance issues in the implementation of the smart specialization strategy (S3) in the European Union (EU). The population (P) includes scholarly works that examine the governance of S3 in the EU and non-EU European regions, such as Norway and the United Kingdom, which can be a valuable source of learning for S3 implementation in the EU region. Significant findings from articles selected from this population were intervened (I) and other important information was filtered according to the study focus or research problem. The results of the investigation between one article and another are then compared (C) to produce a synthesis (Outcome/O) that provides a solution or answers the research question.



Source: authors' elaboration (de Barcelos Silva et al., 2020; Page et al., 2021)

Figure 3. 1. PRISMA flow diagram

The article search (*second protocol*) was performed using Scopus database. The authors used the search terms: "*governance*" *AND* "*smart specialization*" and limited the keyword search to the title, abstract, and keywords of the searched articles. The search year was restricted to articles published between 2017 and 2023, and all articles were published in English. The publication type was limited to journal articles, including research articles and review articles (inclusion factor), and excluded articles published in proceedings and book chapters (exclusion factor). The subject areas included in the search were restricted to economics, business, environmental and social sciences, but excluded articles technically related to health or medical sciences, and natural sciences and engineering (mathematics, physics, earth sciences, engineering, computers, etc.).

At this stage, there were 34 articles that met the above criteria and were considered as potentially relevant articles. These articles were then screened by reading the abstract content and matching it to the planned research objectives or the PICOC framework. There were 16 articles that contained the above keywords, but the content of the articles was not related to the research objectives or the problem, *e.g.* articles discussing university-industry (UI) collaboration, identifying economic sectors for S3 priorities and entrepreneurship issues (related to the Entrepreneurial Discovery Process (EDP)), analyzing the fusion of S3 and public policy, and analyzing industrial cluster policies. The topics of these articles are generally aligned with the concept of S3, but do not specifically address S3 from a governance perspective. Finally, the author selected 18 articles that were considered most relevant to the research objectives and will be used as selected articles for further processing. The article screening process is summarized in the PRISMA flow diagram (**Figure 3.1**).

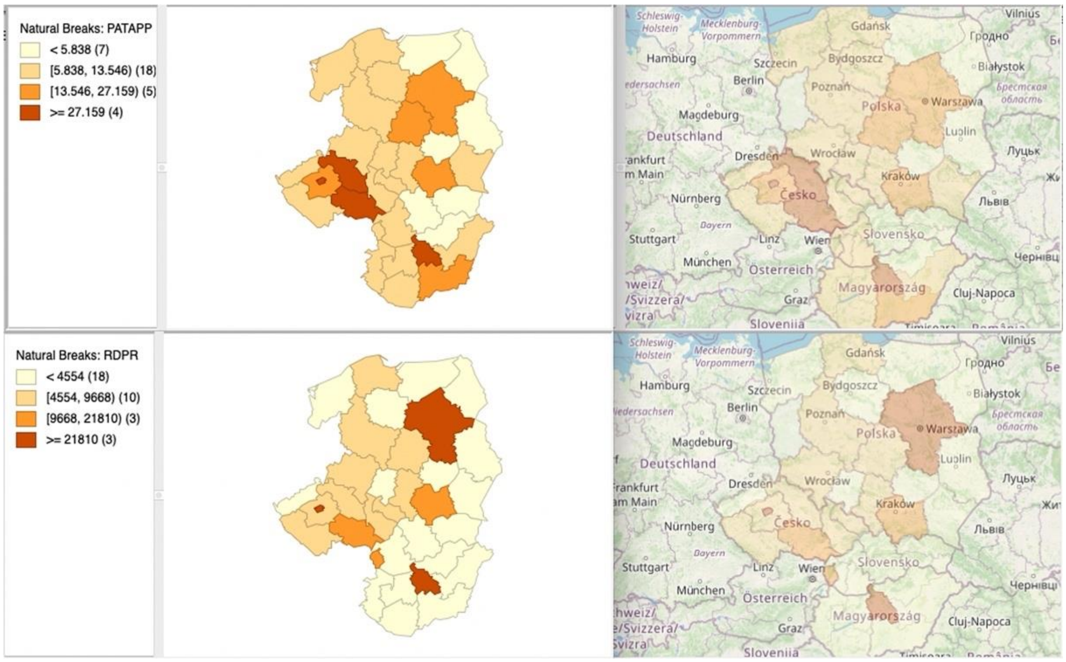
The *third protocol* is the core of the systematic review. *First*, the 18 selected articles are described in terms of the development of the literature in the period of analysis (2017-2023), publication source (journal), journal quality/quartile, and grouped by subject category according to the *Scimago Journal Rank (SJR 2022)*. *Second*, the selected articles were grouped by focus, and the main findings and synthesis of these findings are presented in this subchapter.

The study of Wibisono (2022a) is an evidence-based critical review of papers relevant to the issue of smart specialization in the context of multilevel governance. This paper was written using the traditional review writing method by applying two main steps as in Wibisono (2022c). *First*, the literature was searched in databases (Scopus and Web of Science) using the keywords "multilevel, governance, innovation, smart specialization, Europe, and region" with the limitation of publication years 2000-2021 (2021 is the year of this study), research articles including review articles, and documents written in English. This process generated 29 potential articles. In the *second* step, the articles were further screened for abstract content that, in addition to containing all keywords, also described the issue of multilevel governance in the context of S3. At the same time, the authors delved into the full content of the 29 papers and paid attention to the main findings of the papers that at least addressed the issue of multilevel governance in the context of S3 innovation policy and in the context of different regions. Finally, the author selected three papers that were most relevant to the objectives of this study, as they had comprehensive findings and discussions. A critical review of the evidence from these three papers is then compiled and synthesized at the end of the paper.

3.2. Knowledge inputs and innovation in the Visegrad group regions

This section provides an overview of the study by Wibisono (2023b) on the spatial distribution of the observed variables across 34 regions in the Visegrad Group (V4) countries in 2012. **Figure 3.2** shows the spatial distribution of patent applications and R&D personnel/researchers. The highest patent production is concentrated in the Czech Republic, especially Prague (the national capital) and two neighboring regions. Budapest, the capital of Hungary, also has a high patent density. Poland dominates the second level of patent density, with Warsaw (the country's capital), two neighboring regions, and the regions surrounding Prague and Budapest. The third density level (5-13 patent applications per million inhabitants) dominates most regions in Poland and Hungary and all remaining regions in the Czech Republic. Eighteen regions in the V4 group belong to this category. The regions with the lowest density (less than five patent applications per million inhabitants) are mostly in Slovakia and the remaining regions in Poland. This spatial distribution of patent applications shows that only two countries in the V4 group, the Czech Republic and Hungary, have the highest density of patent applications. Poland, the largest country in the group, is dominated by the third level of patent application density, together with some regions in Hungary. Slovakia has the lowest patent application density of all regions.

Based on **Figure 3.2** (below), there are three regions with the highest number of R&D personnel (RDPR) (more than 21000), namely one region in the Czech Republic, one region in Poland and one region in Hungary, these three regions being the capitals of the respective countries (Prague, Warsaw and Budapest). The second density level is for regions with 9688-21810 R&D personnel/researchers, namely one region in the Czech Republic, one region in Slovakia (capital Bratislava) and one region in Poland. The third density level is for regions with a total number of R&D personnel/researchers in the range of 4554-9688, 10 regions in total. This density level is dominated by most of the Czech Republic and almost half of Poland. The fourth density level is where the number of R&D personnel/researchers is less than 4554 persons, 18 regions consisting of most regions in Poland, almost all regions in Hungary (except Budapest) and almost all regions in Slovakia (except Bratislava).

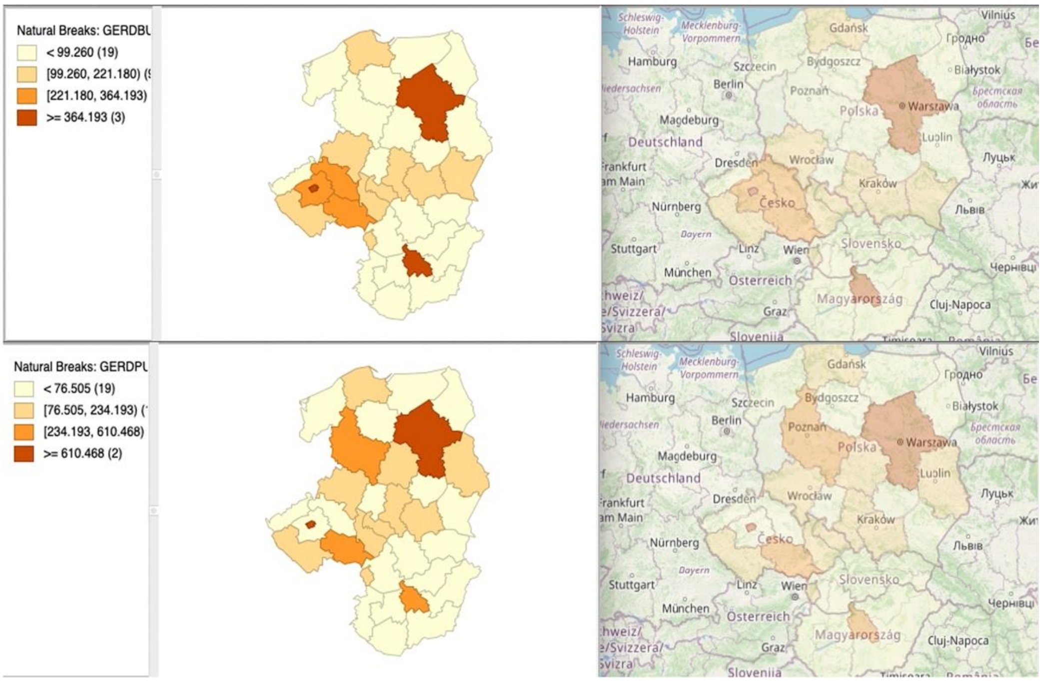


Source: Wibisono (2023b, p. 117)

Figure 3. 2. Spatial distribution of patent applications (above) and R&D personnel/researchers (below)

From the spatial distribution of R&D personnel/researchers it can be said that the highest density of R&D personnel in the Visegrad Group (V4) region is found in each capital of the V4 countries (Budapest, Prague and Warsaw), except in Bratislava. The density of R&D personnel in Bratislava is at the second level of density. Almost all regions except the capital regions in Slovakia and Hungary are dominated by R&D personnel density at the fourth level. Meanwhile, Poland is more diverse, with less than half of its regions dominated by R&D personnel density at the third level, and more than half of its regions dominated by regions with R&D personnel density at the fourth (lowest) level.

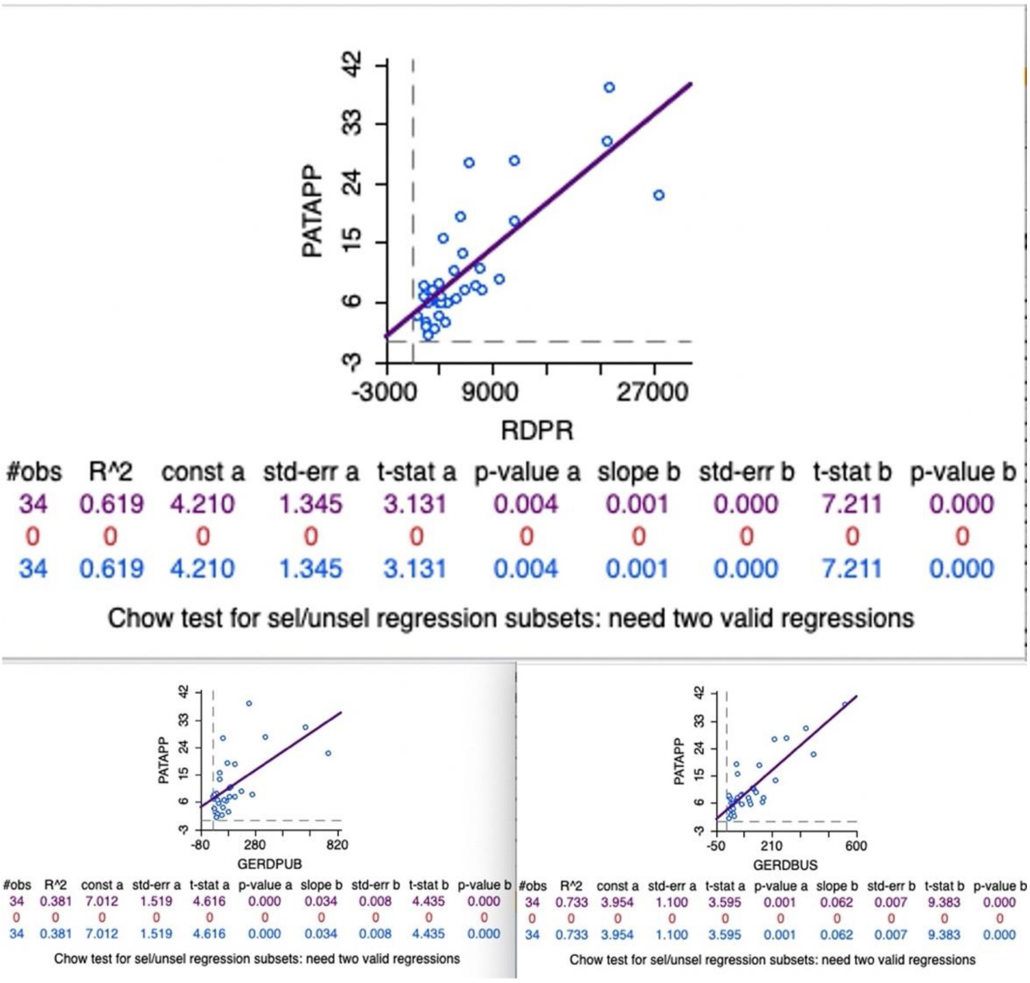
Figure 3.3 (above) shows the spatial distribution of R&D expenditure in the business sector (GERDBUS). There are three regions with the highest density of R&D expenditure (first level group), namely Prague, Budapest and Warsaw. Bratislava is not included in this group but belongs to the third tier of density. In general, the other regions have business R&D expenditure densities in the third and fourth levels (19 regions). **Figure 3.3** (below) shows the spatial distribution of R&D expenditure in the public sector (GERDPUB), which is a combination of government and university R&D expenditure. Prague and Warsaw have the highest density of public R&D expenditure (first group), while Budapest is in the second group and Bratislava in the third group. In Hungary, as in the case of business R&D expenditure, public R&D expenditure in regions other than the national capital is in the lowest level (fourth group), as are regions other than the Slovak capital. This essentially suggests that support for business and public R&D expenditure is generally concentrated in the national capital. In the Czech Republic and Poland these business and public R&D expenditures are fairly evenly distributed across all levels, whereas in Hungary and Slovakia business and public R&D expenditures show clear differences between regions, i.e. one region (the capital) has a high level of R&D expenditures while the rest of the regions are very unequal to the capital and are in the lowest level.



Source: Wibisono (2023b, p.118)

Figure 3. 3. Spatial distribution of R&D expenditure of the business sector (above) and R&D expenditure of the public sector (below)

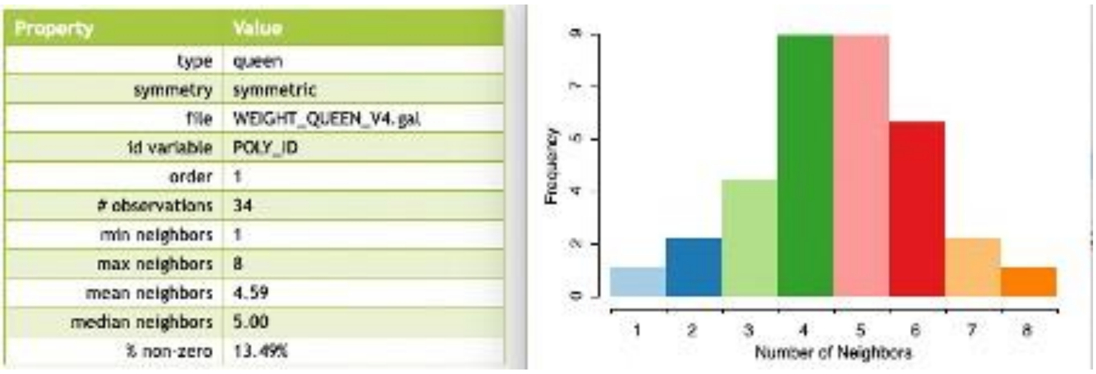
Figure 3.4 shows the correlation between the dependent variable (PATAPP) and the independent variables (RDPR, GERDPUB and GERDBUS). Based on the figure, there is a positive correlation between the number of R&D personnel/researchers (RDPR) and innovation (PATAPP) in the Visegrad Group region (top figure), with a correlation strength of 61.9% (strong correlation). Based on the bottom *left* figure, there is a positive correlation between public R&D expenditure (GERDPUB) and PATAPP with a correlation strength of 38.1% (weak correlation). Based on the bottom *right* figure, there is a positive correlation between business R&D expenditure (GERDBUS) and PATAPP with a correlation strength of 73.3% (strong correlation). This figure shows that there is an observable positive correlation of all independent variables with the dependent variable. The two knowledge input variables number of R&D personnel/researchers (RDPR) and business R&D expenditure (GERDBUS) have a strong correlation with innovation (PATAPP) in the V4 region, while the knowledge input public R&D expenditure (GERDPUB) has a positive but weak correlation.



Source: Wibisono (2023b, p. 119)

Figure 3. 4. Correlation between PATAPP, RDPR, GERDPUB, and GERDBUS

Figure 3.5 is a weighting matrix showing the contiguity or neighborhood between regions using the queen contiguity weighting type. Based on this figure, each region in V4 has on average 4-5 neighboring regions (there are nine regions). There is one region in central Slovakia that has eight neighboring regions, namely with two other regions within the country and with six other regions outside the country (Poland and Hungary).



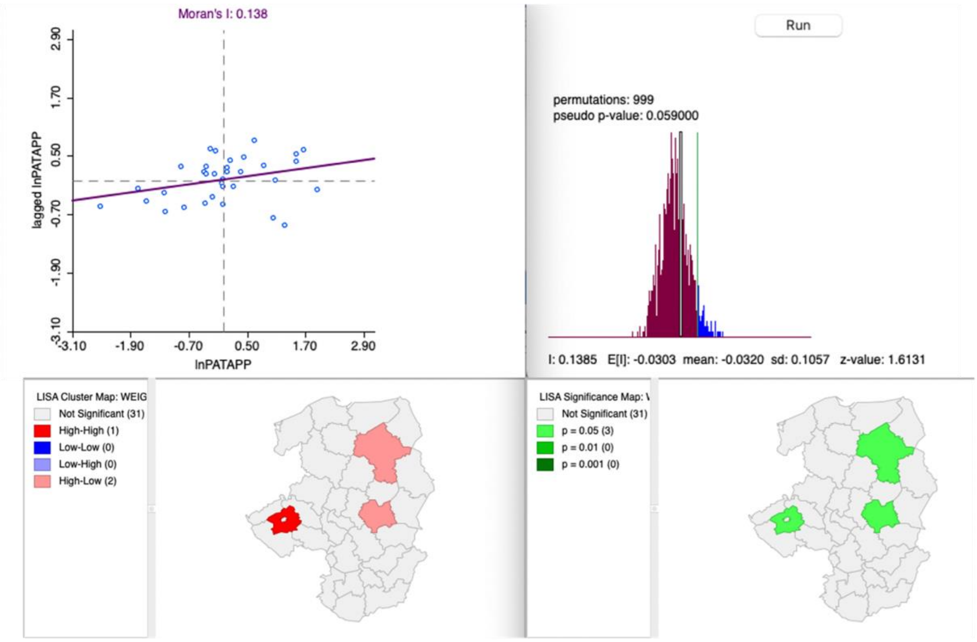
Property	Value
type	queen
symmetry	symmetric
file	WEIGHT_QUEEN_V4.gal
id variable	POLY_ID
order	1
# observations	34
min neighbors	1
max neighbors	8
mean neighbors	4.59
median neighbors	5.00
% non-zero	13.49%

Source: Wibisono (2023b, p. 119)

Figure 3. 5. Neighborhood Table and Graph

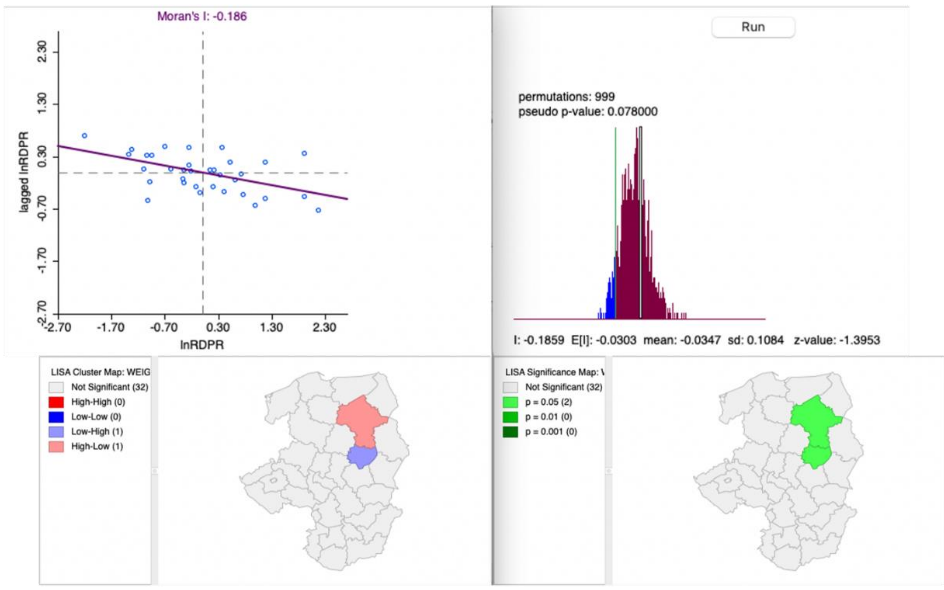
Based on Wibisono (2023b, p. 120), the spatial autocorrelation scatterplot plot of the three independent variables (GERDPUB, GERDBUS, and RDPR) shows negative spatial correlation in the three variables. GERDPUB and RDPR have negative spatial autocorrelation with pseudo-p less than 5% alpha, while GERDBUS has negative spatial autocorrelation with pseudo-p more than 10%. Meanwhile, the dependent variable PATAPP has a positive Moran's I value (0.021), but with a pseudo-p value of 0.285 (greater than 0.10 or 10% alpha), which indicates the absence of spatial autocorrelation in this variable. Therefore, the next step is to transform all these variables into lnPATAPP, lnRDPR, lnGERDBUS and lnGERDPUB.

Figure 3.6 shows that the value of Moran's I statistic for lnPATAPP (top left figure) is 0.14 with a pseudo-p-value less than 0.10 (10% alpha), indicating the presence of positive spatial autocorrelation in the innovation variable (patent applications) at the 10% significance level. The LISA Significance Map (bottom right image) shows that only the Czech Republic (one region, Prague) and Poland (two regions, one of which is Warsaw) have regions with high innovation density (significant at p=0.05), but not Slovakia and Hungary. From the LISA cluster map (bottom left image), only one region has a High-High cluster category (Prague - Czech Republic), which means that this region has a high innovation intensity and is surrounded by other regions that also have a high innovation intensity. Two regions in Poland fall into the High-Low cluster category, meaning that they have high innovation intensity but are surrounded by regions with low innovation intensity.



Source: Wibisono (2023b. p. 121)

Figure 3. 6. Moran's I scatterplot (lnPATAPP)

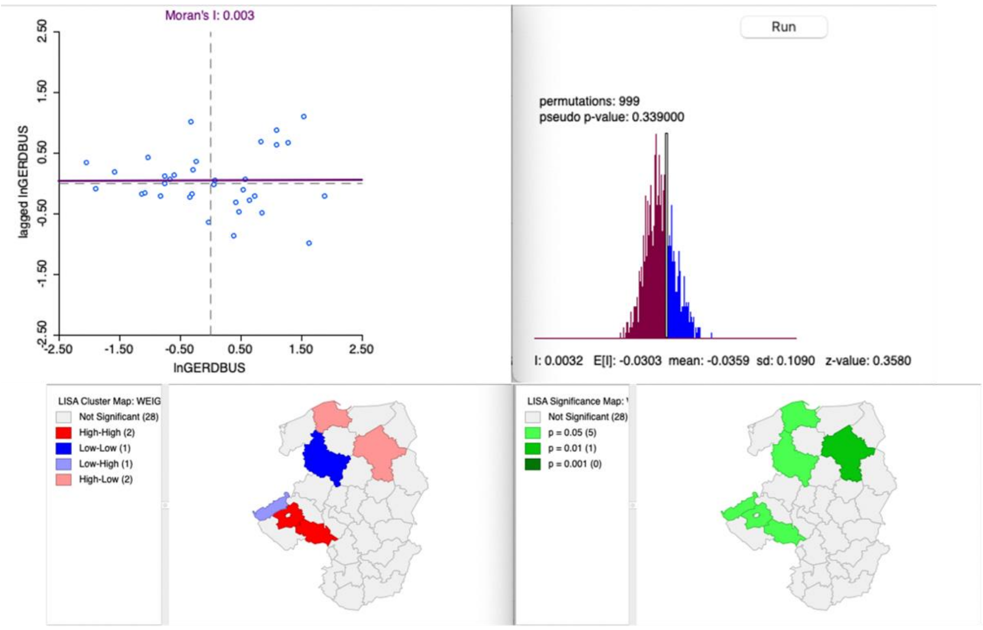


Source: Wibisono (2023b, p. 122)

Figure 3. 7. Moran's I scatterplot (lnRDPR)

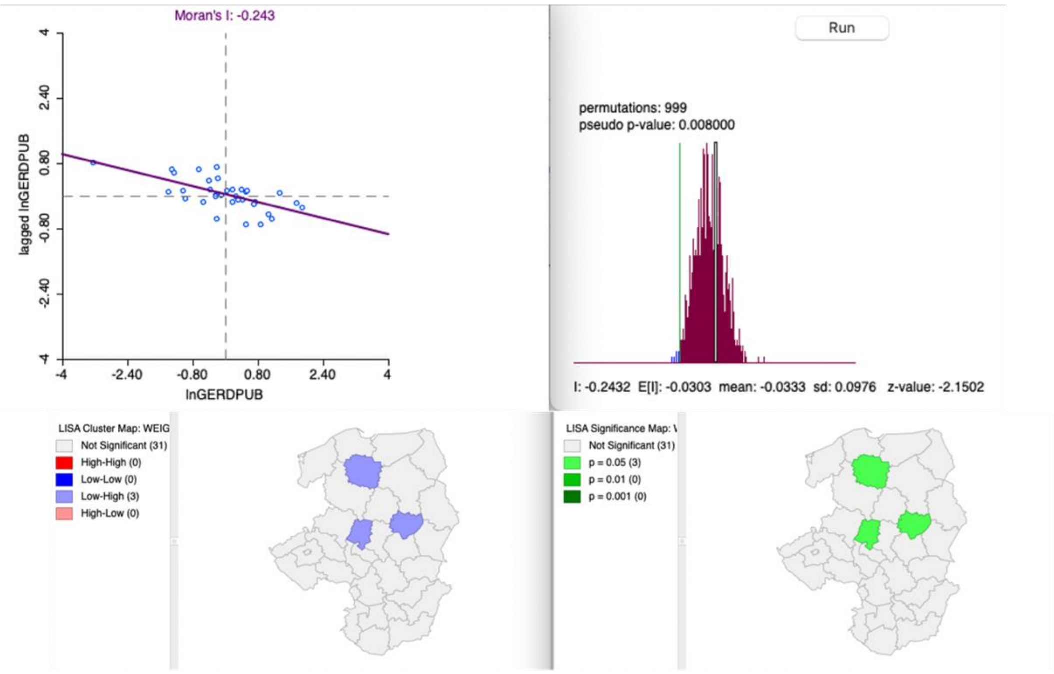
Figure 3.7 shows that the value of Moran's I statistic for the R&D personnel variable (lnRDPR) (top left of figure) is -0.19 with a pseudo-p-value of 0.008 (significant at 10% alpha), indicating negative spatial autocorrelation. The LISA Significance Map (bottom right) shows that only Poland (two regions, one of which is Warsaw) has regions with high R&D personnel density (significant at p=0.05), but not for other regions, nor for regions in the Czech Republic, Slovakia, and Hungary. From the LISA cluster map (bottom left image), there are two regions that have Low-High and High-Low cluster categories. The Mazowieckie region (PL12) has a High-Low R&D personnel density, meaning that it has a high R&D personnel intensity, but other regions around it have a low R&D personnel intensity. In contrast, Swietokrzyskie (PL33) has an R&D personnel intensity in the Low-High category, which means that it has a low R&D personnel intensity but is surrounded by areas with a high R&D personnel intensity.

Figure 3.8 and **Figure 3.9** show that the Moran's I statistic for lnGERDBUS is 0.003 and insignificant (pseudo p-value = 0.34), while the Moran's I statistic for lnGERDPUB is -0.24 and significant at 1% alpha. It indicates that public R&D expenditure in the V4 region has significant spatial autocorrelation, but with a negative relationship. This negative value also indicates that public R&D expenditures in these regions tend to be dispersed rather than clustered. The LISA significance map for lnGERDPUB shows that three regions in Poland have significant spatial autocorrelation, while the remaining 31 regions are not statistically significant. These three regions are classified as Low-High clusters, meaning that each region has a relatively low R&D expenditure intensity but is surrounded by regions with a relatively high R&D expenditure intensity.



Source: Wibisono (2023b, p. 122)

Figure 3. 8. Moran's I scatterplot (lnGERDBUS)



Source: Wibisono (2023b, p. 123)

Figure 3. 9. Moran's I scatterplot (lnGERDPUB)

3.2.1. Spatial effects of knowledge inputs on innovation in the Visegrad group regions

As mentioned in Wibisono (2023b, p. 123-125), the first step in this analysis is to run a regression on the original data without transformation. The regression results show that only the variable GERDBUS is partially significant and at the same time the knowledge input variables affect innovation with Adj R2 = 0.71. These estimation results do not indicate any spatial dependence of innovation in the observed regions. Furthermore, the estimation is carried out using the transformed data (**Table 3.2**), as was done when analyzing the value of the Morans'I statistic. The results show that lnGERDPUB and lnRDPR have a significant effect on lnPATAPP and, also, knowledge input variables affect innovation with Adj R2 = 0.59. To identify the spatial dependence, the Lagrange Multiplier (LM) test was performed, which showed that the spatial correlation lag (LM lag) was significant at 5% alpha, while the LM error and LM SARMA were not significant. Therefore, the estimation process continued with the spatial lag regression method, the results of which are presented in **Table 3.3**.

Table 3. 2. Results of OLS regression with data transformation

Variable	Coefficient	Std-error
Constant	-33.627	13.182
lnGERDBUS	0.3536**	0.1545
lnGERDPUB	-0.2565**	0.1171
lnRDPR	0.6032**	0.2349
R-squared	0.6247	
Adj R-squared	0.5872	
Ll	-24.193	
AIC	56.386	
SC	624.915	
Regression Diagnostics		
	DF	**Value**
Jarque–Bera	2	0.4981
Breusch–Pagan test	3	57.407
Koenker–Basset test	3	6.4395*
Moran's I (error)	0.1526	1.7142*
LM (lag)	1	4.3531**
Robust LM (lag)	1	3.0947*
LM (error)	1	16.582
Robust LM (error)	1	0.3998
LM (SARMA)	2	4.7529*

Source: Wibisono (2023b, p. 124)
*Note: ***, **, * indicate the rejection of H0 at 1, 5 and 10% significance level.*
AIC: Akaike information criterion; SC: Schwarz criterion; Ll: likelihood function, LM: Lagrange Multiplier

Based on **Table 3.3**, the public R&D expenditure variable (lnGERDPUB) in this estimation result has a significant effect on innovation (lnPATAPP) at 5% alpha, but with a negative coefficient. The personnel/researcher variable (lnRDPR) has a significant effect on innovation (lnPATAPP) at 1% alpha with a positive relationship. The spatial lag regression estimation also increases the Adj R2 value from 0.59 (OLS estimation) to 0.70. An important point from this estimation is the identification of spatial autocorrelation of innovation in the V4 region, which is significant at 1% alpha and the value of the rho coefficient or w_lnPATAPP of 0.47. This number explains that changes in technology/innovation that occur in one region in V4 will cause changes in technology/innovation in other regions by 47%. In addition, the regression diagnostics in **Table 3.3** show that the estimation results of this model are free from the heteroskedasticity problem. Thus, it can be stated that the regression estimation using the spatial lag method is the best estimation model in this case. The mathematical model is shown in equation **(4)**.

Table 3. 3. Results of spatial lag regression

Variable	Coefficient	Std-error
w_lnPATAPP	0.4734***	0.1458
Constant	-4.9169***	1.1948
lnGERDBUS	0.2294	0.1345
lnGERDPUB	-0.2258**	0.0989
lnRDPR	0.7180***	0.1999
R-squared	0.6992	
Ll	-21.4126	
AIC	52.8252	
SC	60.457	
Regression Diagnostics		
	DF	**Value**
Breusch–Pagan test	3	4.1299
Likelihood Ratio Test	1	5.5608**

Source: Wibisono (2023b, p. 125)
*Note: ***, **, * indicate the rejection of H0 at 1, 5 and 10% significance level.*
AIC: Akaike information criterion; SC: Schwarz criterion; Ll: likelihood function, LM: Lagrange Multiplier

$$\text{lnPATAPP} = -4.9169 + 0.4734\,\boldsymbol{W}\,\text{lnPATAPP} + 0.2294\,\text{lnGERDBUS} - 0.2258\,\text{lnGERDPUB} + 0.7180\,\text{lnRDPR} \quad \textbf{(4)}$$

The study of Wibisono (2023b) has taken the background of previous literature underlying the study objective to investigate the relationship, spatial dependence, and influence of knowledge inputs on innovation in V4 regions, with reference to the spatial econometric modeling developed by Varga (2007) for the case of Hungary. The study results in this paper indicate the existence of spatial dependence between knowledge inputs and innovation in the V4 regions. This study's findings also suggest and assume that spatial proximity between regions or linkages between innovation resources (such as researchers, universities, entrepreneurs and industry) is an important factor that presumably influences the generation of innovation cooperation or collaboration between regions or between Visegrad group countries (V4) (Hoekman et al., 2009, 2010; Ponds et al., 2007; J. Singh, 2008). The results of this study are also in line with previous research that took the focus of studies in the CEE regions (such as Kravtsova & Radosevic (2012) and Filippetti et al. (2020)), namely the importance of improving the quality of R&D personnel through funding support and the availability of adequate infrastructure and the need for specific innovation policies that take into account the characteristics and problems that exist in the region. Investment in R&D infrastructure and improvement of R&D human resources must be interrelated because in the end this will affect how investment is managed (governance of R&D funding) and how the management of regional innovation resources can have the desired innovation impact.

However, several concerns need to be highlighted. Previous studies have shown that the average public R&D expenditure in the V4 countries is below the EU average (Aristovnik, 2012; Birkner, Meszaros, et al., 2022; Dávid, 2016; Dobrzanski, 2018; DUĽOVÁ SPIŠÁKOVÁ et al., 2017), which could potentially have a negative impact on research and innovation activities in these regions (Commission, 2020; Pelikánová, 2019). The negative effect of public R&D expenditure on innovation in the V4 region is also reflected in the estimation results of Wibisono (2023b), although it has not been discussed in detail. Moreover, the governance of regional innovation resources in the EU remains a challenge in many regions, especially in the context of less developed or even under-resourced regions (McCann & Ortega-Argilés, 2013, 2014b; Morisson & Doussineau, 2019; Trippl et al., 2019).

3.3. Regional governance challenges in the implementation of smart specialization policy

3.3.1. Characteristics of the selected articles

Selected articles that served as primary source material for the paper comprising this subsection are presented in **Table 3.4**. A search of these articles in databases, limited to the years 2017-2023, shows that studies on this topic have been consistently growing and published in highly reputed journals. The most publications occurred in 2019, with six articles, and the fewest in 2021 and 2023 (as of August 2023, when this research was conducted), with one article. In other years, 2-3 papers were published each year. Considering 2019 as the year when the most publications on this topic were made, it is assumed that this is related to the year of the end of the first phase of S3 implementation (2014-2020) or related to the continuation of the second phase of S3 implementation (2021-2027). The results of studies on this topic are needed as a reflection or reference for the next S3 practice.

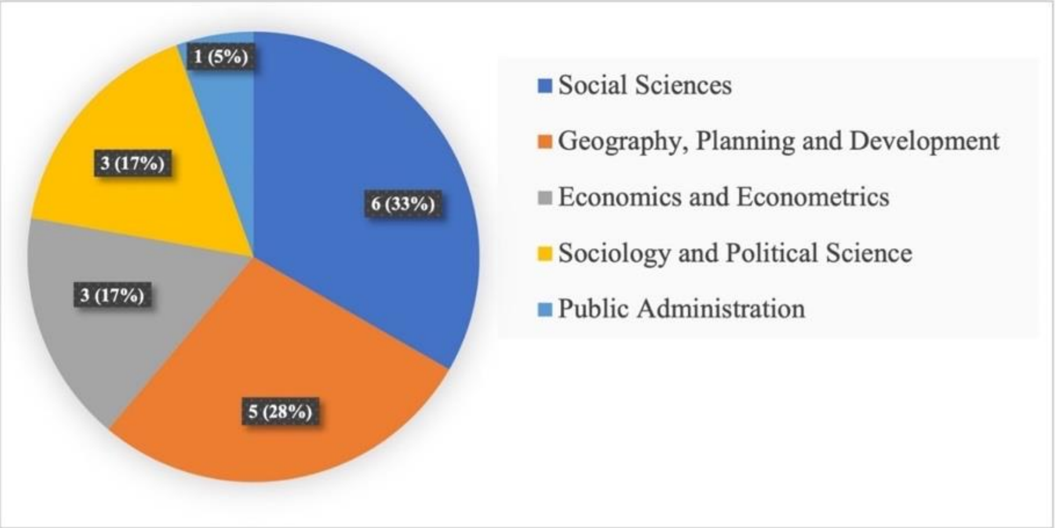
Table 3.5 presents the publication sources of the selected articles. Among the 18 selected articles, five articles were published in top (Q1) journals in the subject category Social Sciences (*Regional Studies*) and four articles were published in top (Q1) journals in the subject category Geography, Planning and Development (*Environment and C: Planning, Politics and Space, European Planning Studies,* and *Cambridge Journal of Regions, Economy and Society*). The next three articles were published in top (Q1) journals in the subject category Sociology and Political Science (*Innovation: European Journal of Social Science* and *Regional Studies Regional Science*). The next five articles were published in Q2 and Q3 journals in relevant subject categories. **Figure 3.10** illustrates the publication of articles in their subject categories.

The Social Science and Geography, Planning and Development subject categories published more than 50% of the articles on S3 governance. The subject categories Sociology and Political Science are part of the Social Science field, while the subject categories Economics and Econometrics are in different fields (Economics, Econometrics and Finance).

Table 3. 4. List of selected articles

No.	Year of Publication	Number of Articles	Author (s)
1	2017	2	Chrysomallidis & Tsakanikas (2017); Morgan (2017)
2	2018	2	Foray (2018); Pugh (2018)
3	2019	6	Aranguren et al. (2019); González-López (2019); Kroll (2019); Morgan & Marques (2019); Rehfeld & Terstriep (2019); Sörvik et al. (2019)
4	2020	3	Barzotto et al. (2020); Cvijanović et al. (2020); Knudsen et al. (2020)
5	2021	1	Ghinoi et al. (2021)
6	2022	3	Laranja (2022); Ruhrmann et al. (2022); Wibisono (2022a)
7	2023	1	Estensoro & Larrea (2023)

Source: authors' elaboration.



Source: author's elaboration

Figure 3. 10. Journal subject categories

Table 3. 5. Publication sources

No.	Source of publication - Publisher	No. of articles	Best quartile (SJR 2022)
1	Regional Studies - Routledge	5	Q1 - Social Sciences (miscellaneous)
2	Environment and Planning C: Politics and Space - SAGE Publications Ltd	2	Q1 - Geography, Planning and Development
3	Innovation: The European Journal of Social Science Research - Routledge	2	Q1 - Sociology and Political Science
4	European Planning Studies - Routledge	1	Q1 - Geography, Planning and Development
5	Industrial and Corporate Change - Oxford University Press	1	Q1 - Economics and Econometrics
6	Cambridge Journal of Regions, Economy and Society - Oxford University Press	1	Q1 - Geography, Planning and Development
7	Regional Studies, Regional Science - Taylor and Francis Ltd.	1	Q1 - Sociology and Political Science
8	Journal of the Knowledge Economy - Springer Verlag	2	Q2 - Economics and Econometrics
9	Cogent social sciences - Cogent OA	1	Q2 -Social Sciences
10	Regional Science Policy & Practice - John Wiley & Sons Inc.	1	Q2 - Geography, Planning and Development
11	European Journal of Government and Economics - University of Coruna, Faculty of Economics and Business	1	Q3 - Public Administration

Source: authors' elaboration.

The next section presents the results of the critical review, which is the main contribution of the paper that makes up this subsection. The 18 selected articles are divided into three groups according to their study focus (**Table 3.6**). The key findings of each selected paper were reviewed as a group, followed by a critical discussion, and linked to the recommendations of this study and other relevant background literature. A synthesis of the critical review ideas was presented in the form of figures/diagrams at the end of each discussion.

Table 3. 6. Grouping of selected articles based on discussion focus

Focus of discussion	Selected articles
Implementation of Smart Specialization at the regional level and in regions with specific circumstances	• Chrysomallidis & Tsakanikas (2017); Morgan & Marques (2019); Ruhrmann et al. (2022) • Barzotto et al. (2020); Ghinoi et al., (2021); Sörvik et al. (2019)
Stakeholder engagement and institutional capacity	• Estensoro & Larrea (2023); Laranja (2022); Rehfeld & Terstriep (2019) • Foray (2018); Knudsen et al. (2020); Morgan (2017)
Encourage alternative S3 governance at the regional level	• Aranguren et al. (2019); Cvijanović et al. (2020); González-López (2019); Kroll (2019); Pugh (2018); Wibisono (2022a)

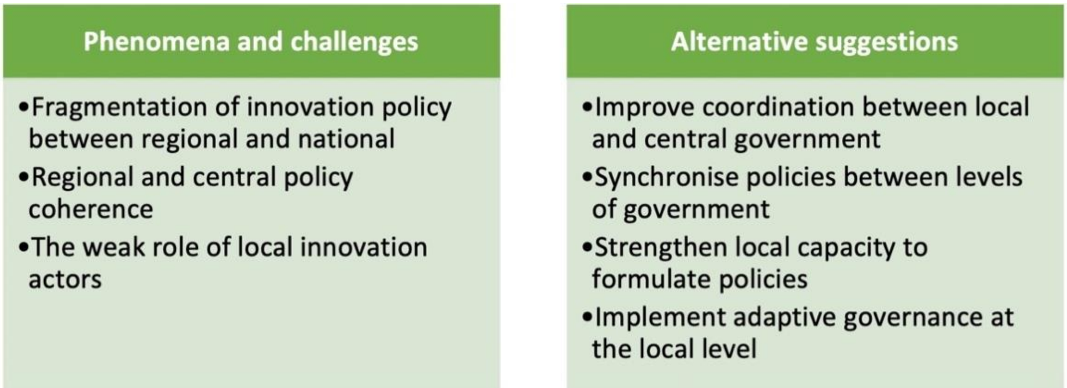
Source: author's elaboration.

3.3.2. The implementation of smart specialization in the EU regions

The first three studies in this section address the prioritization of regional interests in the implementation of smart specialization strategies (S3). The study by Chrysomallidis & Tsakanikas (2017) explores the implementation of smart specialization in Greece, showing that S3 has had a significant impact on innovation governance and regional development in Greece. The various resources and potential advantages of the Greek regions involved in S3 projects have contributed to the acceleration of development in many regions. However, given the many challenges in implementing S3 at the local level, this study emphasizes the need for a more solid integration between central and local government policies in managing S3. In the context of regional development in Germany, Ruhrmann et al. (2022) examine the relationships between different actors in regional innovation policy and how synergies and coordination are created between different levels of government in Germany. A multi-case qualitative approach using different research methods resulted in a comprehensive study showing that cooperation and coordination of innovation actors is essential at the local level. Meanwhile, Morgan & Marques (2019) examined the role and competencies of states in the European Union in facilitating the implementation of S3 in less-developed regions. The results of this study highlight the fragmentation of innovation systems in many EU member states, leading to uneven and less efficient management of R&D resources. The study suggests that less developed regions in the EU could adopt more appropriate forms of innovation governance and emphasizes the need to establish solid coordination mechanisms within regions, between regions and between Member States.

As Morgan & Marques (2019) point out, EU member states with diverse governance systems understand S3 as a form of indirect intervention for states to focus research and innovation policies on regional or local interests, although many member states still adhere to centralized innovation governance systems. On the other hand, this has led to different interpretations at the regional level on how S3 should be managed in the regions (Kroll, 2017; Marinelli et al., 2021). The review results of the aforementioned studies also show a gap in the involvement and initiation of local actors at the national level in innovation policy processes or in the design of RIS3. According to Asheim & Herstad (2005), local innovation actors are considered to have more in-depth experience of specific local conditions, challenges and development needs. However, centralized governance systems often provide few opportunities for regions to engage more substantively in innovation policy processes at the national level (Evers & De Vries, 2013; Goldsmith, 2002). In recent research, Di Cataldo et al. (2022) and Kristensen et al. (2023)

suggest that the development of regional innovation policy requires substantial cooperation and coordination involving multiple actors and stakeholders from different levels of government. In this case, the central government acts as a facilitator and accelerator, helping to improve and optimize regional innovation capacity and focusing on accelerating regional transformation by strengthening and optimizing local resources (Estensoro & Larrea, 2016; Laranja, 2022). However, given that many lagging regions have limited experience and knowledge in managing S3 independently, central government monitoring and supervision must continue by guiding all stages of policy and resource management to operate effectively and efficiently (C. Cohen, 2019b; Esparza-Masana, 2022). The phenomena and challenges of implementing smart specialization at the subnational level, which are then linked to the suggestions and recommendations from this study and other related studies, are summarized in **Figure 3.11**.



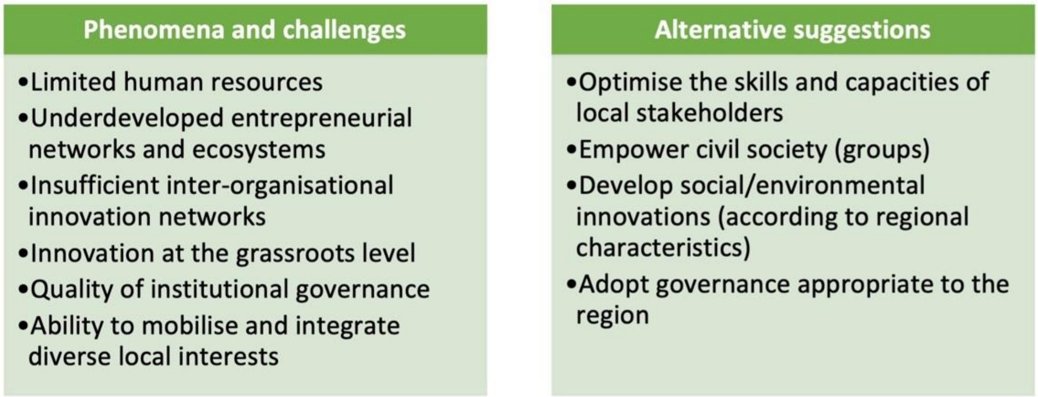
Source: author's elaboration.

Figure 3. 11. Implementation of smart specialization in the EU regions

The next three studies highlight more specific challenges in the implementation of S3 in regions with specific circumstances. Using a mixed methods approach, Sörvik et al. (2019) investigated the implementation of S3 in sparsely populated areas (SPAs). One of the challenges due to demographic limitations in SPAs is the limited quality of human resources and economic agglomeration in these regions. The study highlights the need for thorough regional economic analysis and differentiated governance due to the unique characteristics of SPAs. Ghinoi et al. (2021) analyzed the implementation of S3 in peripheral regions in Lapland, Finland, using a case study and network modeling approach. The results identified significant barriers to implementing S3 in peripheral regions, mainly due to poor institutional quality and underdeveloped entrepreneurial ecosystems and inter-organizational innovation networks. Barzotto, Corradini, Fai, Labory, & Tomlinson (2020a) investigated the challenges of S3 studies in lagging regions using a mixed-methods research approach. The study found that the application of S3 in these regions has to catch up in terms of two important pillars of S3: the baseline level of innovation and entrepreneurial networks.

The findings of Ghinoi et al. (2021) support the idea that innovation ecosystems, supported by adequate institutional capacity and the presence of local innovation actors, are important resources for learning and better innovation policy practices. Regions constrained by demographic factors, such as SPAs, by geographical location, such as peripheral regions, or by technological gaps, such as lagging regions, need to find appropriate strategies to overcome these challenges while continuing to grapple with these constraints. Regions with underdeveloped innovation ecosystems and weak institutions need innovation strategies designed for sustainable long-term goals, not just short-term policies (Tsipouri, 2018; Zapata-Cantu & González, 2021). As local actors are an important resource for regional innovation, civil society engagement has great potential to strengthen regional positions in innovation by opening broader connections with external networks or ecosystems to access knowledge and entrepreneurial networks or create opportunities for collaboration (Carl, 2020; Hasche et al., 2020; Oksanen & Hautamäki, 2014). As recommended by Ghinoi et al. (2021) and Sörvik et al. (2019), regions facing demographic or geographical constraints can increase the involvement of non-traditional actors, such as social groups or civil society organizations, in S3 policy processes and stages. Although S3 has not specifically addressed non-traditional forms of innovation, such as social or environmental innovation, there has been development of innovation policies in this direction (*e.g.* (de Souza João-Roland & Granados, 2023; Schartinger et al., 2020)). As noted by Barzotto et al. (2020), specific competencies are also needed to integrate different stakeholders at local and national levels, which is still a major challenge in many regions.

Figure 3.12 provides a summary of the phenomena and challenges in implementing smart specialization in regions with specific circumstances, as well as the suggestions and recommendations from these and other related studies.



Source: author's elaboration.

Figure 3. 12. Implementation of S3 in EU regions with specific circumstances

3.3.3. Stakeholder engagement and institutional capacity

The next three studies discussed stakeholder engagement, which was the main focus of S3. In practice, bringing together different stakeholders with different interests and goals is not an easy task. Rehfeld & Terstriep (2019) investigated the regionalization of innovation policy governance in North Rhine-Westphalia, Germany. Their findings highlighted the importance of multi-stakeholder collaboration to identify regional challenges and potential advantages, and to facilitate coordination with different levels of government in the implementation of S3. Along the same lines, Laranja (2022) proposed a mechanism to organize stakeholder participation in the S3 process in Portugal. According to the study, a collaborative and participatory approach involving different stakeholders in the S3 process offers transparency in the decision-making process, resulting in policy instruments that represent the interests of all parties. Estensoro & Larrea (2016) studied the roles and capabilities of different actors in the EDP process in the implementation of S3 in Bilbao, Spain. The results of this study argue that inclusive and adaptive policy-making is essential to address the challenges of S3 governance at the local, regional and cross-sectoral levels. However, proper coordination and attention are required for successful implementation on the ground.

Stakeholder engagement is a fundamental challenge in almost all regions, especially in less innovative or weak regions (B. T. Asheim, 2019; Kroll, 2018). As outlined by Laranja (2022), the most fundamental first step in engaging stakeholders in the S3 process is to identify potential innovation actors. This can be achieved through various means, such as technical meetings, seminars, workshops, focused discussions, and media monitoring. In addition, the different viewpoints of these potential stakeholders can be gathered to identify local needs, which will be authenticated when building a shared vision. According to Carayannis et al. (2017), serious efforts are needed to strengthen stakeholder relationships in order to instill mutual trust. Building trust among stakeholders will increase their participation and engagement. Trust will strengthen relationships, promote transparency, encourage shared learning, and support coordination. It is necessary for stakeholders to meet certain quality requirements, and to achieve this, a thorough understanding of the S3 framework is essential (E. G. Carayannis & Rakhmatullin, 2014). Laranja (2022) proposed an incentive scheme to encourage, motivate, and enhance stakeholder engagement. Such incentives can take the form of monetary support (*e.g.*, providing collaborative projects) or non-monetary support (*e.g.*, facilitating the development of innovative ideas).

Figure 3.13 summarizes the challenges of engaging stakeholders in the process of implementing S3 in the region, alternative suggestions for overcoming these challenges, and the benefits of implementing these suggestions.

Source: author's elaboration.

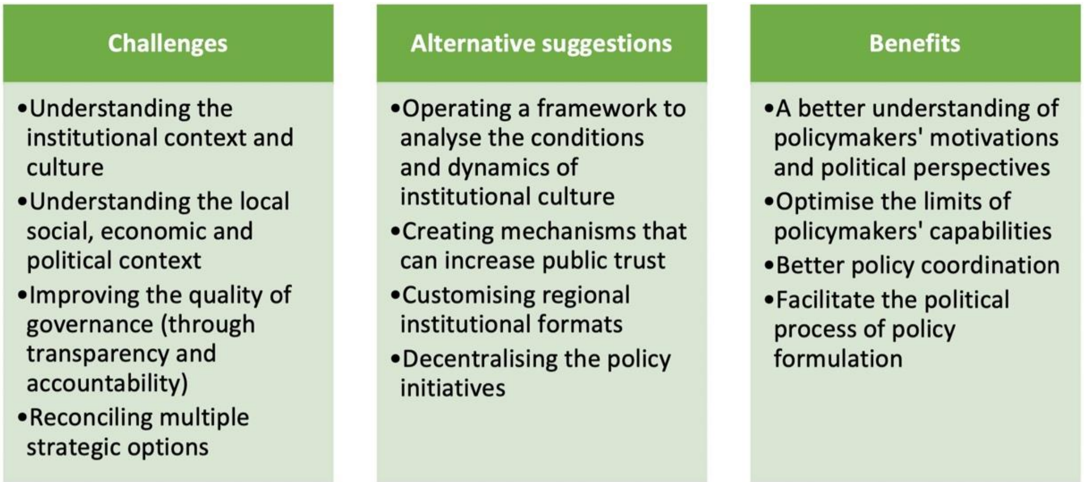
Figure 3. 13. Challenges in stakeholder engagement

The following three studies focus on the importance of understanding institutional conditions to enhance the successful implementation of S3. Through semi-structured interviews, Knudsen et al. (2020) analyzed the reactions, responses, and tendencies of twelve regions in Norway in adopting the S3 concept. The results showed that some regions chose not to adopt S3, while others were more receptive and considered that their institutional context and internal economic, political, and socio-cultural conditions could support and facilitate the implementation of S3. This paper examines the concept of governance, focusing on how regions with different local governance models in Norway can adopt and adapt to new policies such as smart specialization. Morgan (2017) analyzes regional policy documents from EU member states and compares them with policy guidelines published by the European Commission. The paper examines crucial issues in innovation in less favoured regions (LDRs), in particular regarding the institutional readiness of regions to adopt S3. According to the study, weak regional capacity to manage public funds and lack of institutional entrepreneurship are some of the unfavorable institutional characteristics for adopting S3. In some regions, the quality of governance is still low and public trust is also low due to high levels of corruption. Consequently, these conditions have provided a strong impetus for LDRs to transform their institutions. Foray (2018) argues that it is important for local innovation actors from different institutional and cultural backgrounds to be actively involved in the implementation of S3. Local institutional and cultural conditions have a significant impact on actors' attitudes and behaviors in formulating and implementing S3. Values, norms, and informal rules, which sometimes still become unofficial guidelines for innovation actors, can affect the sustainability of S3. Therefore, the diversity of local institutional and cultural conditions should be of particular concern to central and local governments, as centralized policy designs often disregard them.

One of the initial challenges related to institutional readiness in the implementation of S3 is how local policy makers can understand the institutional requirements before adopting S3. Regional institutions usually have an institutional culture that develops over time. Therefore, a framework that can analyze the conditions and dynamics of institutional culture and consider its suitability for the S3 concept, as applied in the Norwegian region, can be replicated in other EU regions. The opinion of Knudsen et al. (2020) is in line with (Bremer et al., 2021), who argue that this strategy makes economic and political sense because the actions and political perspectives of policy makers are very likely to be influenced by the cultural background of institutions when a new policy is adopted. Therefore, understanding the preconditions of S3 and the current institutional culture is crucial for a particular region to adopt a new policy such as S3 (FitzGerald et al., 2019).

Morgan (2017) emphasized that understanding the institutional context as a form of readiness to adopt S3 means being able to assess the quality of institutions, recognizing the constraints faced, such as levels of corruption and public trust, and having the capacity to overcome these constraints. Institutional capacity, fostered by accountability and transparency, can improve public judgment and trust and will have a significant impact on the effectiveness of S3 practices (Nijkamp et al., 2022; Papamichail et al., 2023). The main reason is that public trust can improve interagency coordination, promote policy effectiveness, and ensure government accountability (Mukherjee et al., 2021; Wu et al., 2015). Foray (2018) argues that the organization required to design S3 should be able to reconcile the logic of strategic choices around new ideas and domains through EDP and prioritization of transformative activities. The development of institutional formats capable of reconciling strategic choices within the S3 framework at the local level is an evolving approach, especially with regard to the decentralization of policy initiatives at the local level, which is still a challenge that needs to be addressed (Kopczynska & Ferreira, 2020; P. Marques & Morgan, 2021).

Figure 3.14 summarizes the challenges in building and strengthening institutional capacity for S3 practices, alternative suggestions, and the benefits of implementing these suggestions.



Source: author's elaboration

Figure 3. 14. Challenges in increasing institutional capacity

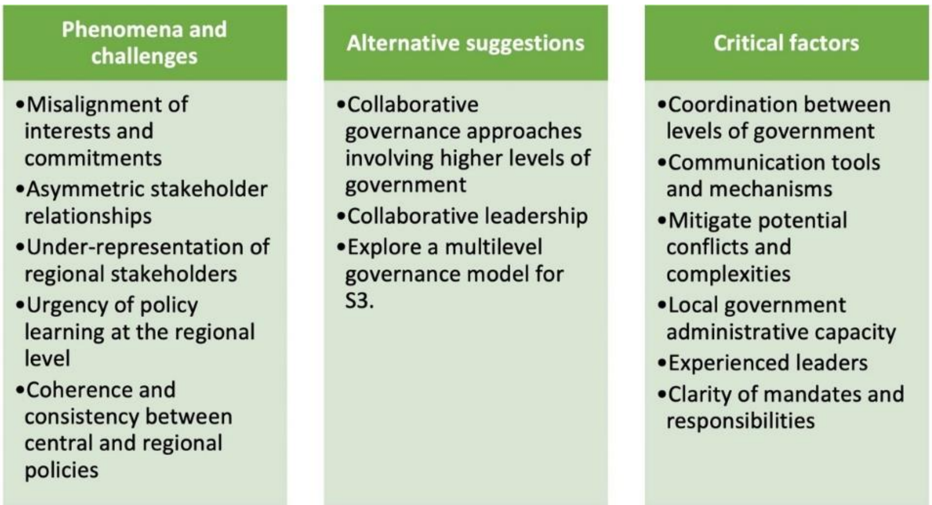
3.3.4. Improving the governance of regional innovation policy

Some of the studies described below are part of the main phenomenon of innovation policy governance, which involves the role of government at different levels of governance, and some of them explicitly refer to it as multilevel governance. Aranguren et al. (2019) investigated the governance of the territorial entrepreneurial discovery process (EDP) of several innovation projects in European regions, raising the issue of the complexity and misalignment of interests that occur within the EDP. Using a mixed-methods approach, the study involved several research teams working together to develop a collaborative framework as an analytical tool. The results showed that the relationship between innovation actors at the local level is asymmetrical, with unequal power sharing and fragmented commitments and interests. As a result, the policy formulation process (RIS3) becomes more complex, and the decision-making process tends to be very dynamic. According to this study, a collaborative S3 governance model at the local level needs to consider the involvement of higher government, not only local stakeholders. However, its proportionality should also be considered in order to address the additional complexity that may arise. Cvijanović et al. (2020) looked at this stakeholder imbalance from the other side. Their study examines stakeholder involvement in the implementation of S3 in Central and Eastern European (CEE) countries and regions. Using a comparative study approach through semi-structured interviews and analysis of policy literature, the results show that local/regional stakeholders are underrepresented in the context of innovation policy at the national level. Factors such as institutional legacy, institutional culture and historical background contribute to the variation and uniqueness of S3 governance practices at the regional level, so that policy processes largely motivated by national interests raise doubts as to whether such policies can represent true regional aspirations. In CEE, most regions still implement innovation policy governance under a centralized system of government, although some regions also show a visible regional role and power.

In a more conceptual analysis approach, Pugh (2018) identifies potential weaknesses in the current concept of S3, which is still linked to the previous concept of regional innovation policy (RIS). The study critically assesses both concepts in innovation policy practice in the semi-autonomous region of Wales, UK, by analyzing various policy documents and conducting interviews with stakeholders. In the case of Wales, S3 and RIS policy approaches tend to share common challenges and weaknesses in terms of policy governance and institutional issues at the local level. Multilevel governance, which takes into account the position of a region and its relationship with higher levels of government, could be a promising approach. In a case study investigating the regional innovation policy learning process in Galicia, Spain, González-López (2019) showed that multilevel governance has the potential to contribute significantly to policy learning at the regional level. Interactions between local governments and higher levels of government (national and supranational) can generate and enrich innovation policy knowledge.

In the context of bottom-up innovation policies such as S3, Kroll (2019a) mentions that there are potential conflicts that may arise in a multilevel innovation policy governance model, as well as inconsistencies and incoherence of such policies. Therefore, in multilevel governance, interagency cooperation within and across levels of government requires established leadership competencies and experience in organizing people, organizations, or institutions. Wibisono (2022a) has specifically highlighted the challenges of multilevel governance in the implementation of smart specialization in the European Union. This study uses an evidence-based critical review approach and examines the considerations of using a multilevel governance approach to implement S3 that can be adapted to regional characteristics and diversity. The implementation of smart specialization programs at the regional level requires a different governance approach, and multilevel governance involving the role of government at different levels (national, regional and sub-regional) has the potential to create greater cooperation and collaboration among stakeholders.

In the context of multilevel governance, regions are understood as part of a smaller innovation ecosystem compared to the supraregional or national level. That is, when regions engage in relationships with other regions at the same or higher levels of government, they involve more stakeholders and complexity (Ciasullo et al., 2020; Russell & Smorodinskaya, 2018; Walrave et al., 2018). Therefore, the ability to understand the local political and cultural context is necessary to create cooperation and collaboration. It is important to have reliable tools or mechanisms to facilitate coordination and communication in multilevel governance (Hanssen et al., 2013; Touati et al., 2019). The success of smart specialization at the local level requires appropriate coordination mechanisms that link organizations within and outside of localities, or at higher levels of government. These mechanisms should be based on stable, harmonious, and balanced synergies among different stakeholders (Larrea et al., 2019; Wibisono, 2022a; Woolford et al., 2020). González-López (2019) argues that policy coordination and coherence between different levels of government can be achieved through collaborative leadership mechanisms that clearly define the mandate and responsibilities of each agency or government involved and promote effective communication through relevant communication channels. Collaborative leadership fits well with the concept of S3 governance, which involves multiple stakeholders and different levels of government (Ranga & Etzkowitz, 2015). Horizontally, collaborative leadership facilitates the internal process of policy formulation in the region, while vertically, collaborative leadership facilitates bottom-up consultation and top-down information flow (Rouillard & Spray, 2017; Zhou et al., 2021).



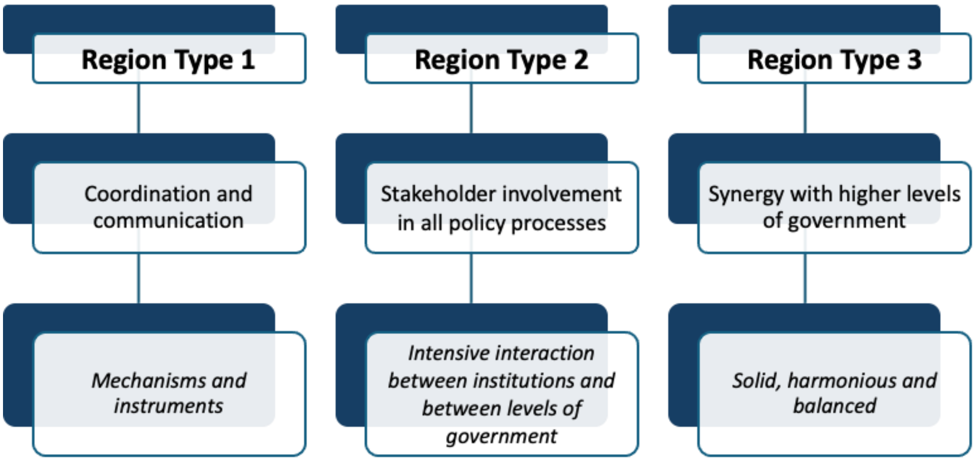
Source: author's elaboration

Figure 3. 15. Phenomena and challenges related to S3 governance

Figure 3.15 summarizes the phenomena and challenges related to policy governance in the implementation of S3 in the regions. Alternative suggestions to address these challenges are presented, along with critical factors to consider.

3.4. Key factors in promoting multilevel governance for S3

This section is a synthesis of the research paper by Wibisono (2022a). The main contribution of this paper is derived from a critical review of the main findings of selected papers that comprehensively address the importance of S3 governance at different levels of government (multilevel governance) and how this concept of multilevel governance relates to the principles of smart specialization. This critical review is also motivated by the problems and issues of smart specialization implementation that are almost always associated with the governance of regional innovation policies, but on the other hand, there is still not much empirical evidence to support what governance looks like. As outlined in the previous section, there are significant challenges related to innovation policy governance in the implementation of smart specialization at the regional level. In fact, these challenges are even more pronounced in regions with specific circumstances. The outcomes of the study in this paper take this into account, as reconstructed in **Figure 3.16**.



Source: author's elaboration

Figure 3. 16. Key factors in addressing multilevel governance challenges in different regional contexts

The results of a critical review of several cases and evidence from selected studies identify three types of regions with different characteristics and challenges, but with certain factors that enable them to face these challenges and that can be learned from each other. *First*, Type 1 regions with strong institutional conditions and governance due to their historical background. This region has been transformed gradually and over a long period of time, with strong central/federal government control at the beginning of the process through a balanced role of regional government. *Second*, Type 2 regions with an established regional innovation system where regional innovation policy has developed over time and in the current implementation of S3, regional innovation policy has been strongly integrated into the national innovation system or policy. *Thirdly*, Type 3 regions have significant limitations in terms of institutions, government administration and regional innovation systems due to various reasons such as geographical and demographic conditions.

The Type 1 regions discussed in Wibisono (2022a) are regions with well-developed governance systems in several federal regions in Germany. The case study discussing this region is taken from Kroll (2017) which discusses differences in the implementation of regional innovation policies in two regions with different characteristics but with an established level of governance. North Rhine-Westphalia (NRW) is a highly industrialized region with a large geographical area and a large population. Meanwhile, Saxony is an industrial region that has developed strongly over its long industrial history, but this region is smaller in size with a much smaller population. Despite similar governance qualities, they are quite different in terms of prioritizing innovation-based development, whether sticking to established types of firms (as in NRW) or encouraging mid-sized firms to advance (as in Saxony). This state of affairs is strongly influenced by regional geography and demographic factors, which in turn affect the complexity of state governance.

One of the key challenges in these two regions is the complexity of administrative governance and synergy in developing effective innovation policies. Regions with larger geographic and demographic sizes, such as NRW, require appropriate coordination and communication mechanisms and tools to strengthen governance at the regional level. NRW is the center of several leading industries in Germany, and they are more focused on developing existing innovation capacities than on developing or creating new ones. This differs from Saxony, which has a smaller territory but sufficient human capital. They are developing more new domains in medium-sized industries. These two regions have different standards of autonomy, more or less freeing themselves from dependence on the federal government, but still free to access structural funds from the European Union. NRW has been able to develop specific policies according to regional needs, although it faces various administrative challenges and the complexity of managing resources. On the other hand, Saxony has been able to develop a strong innovation policy strategy due to several factors, including innovation policies that proactively involve more stakeholders at different levels of government, the existence of a well-coordinated innovation policy governance framework between governments at different levels, the innovation capacity of local regions that are able to adapt to various changes at the national and supranational levels, and a strong commitment to creating cooperation among stakeholders and between regional economic sectors.

Region Type 2 takes the case of a region in Galicia (Spain) with a regional innovation system firmly embedded in the national innovation system. The innovation system in Galicia had been evolving for more than two decades prior to the adoption of smart specialization. In-depth interviews and observations conducted by González-López (2019) with the main key actors involved in innovation policy in Galicia during the government period 1989-2017, concluded that an integrated regional and national innovation policy was the main milestone of Galician innovation policy until the emergence of RIS3 in 2014. To this end, the Galician government created the Galician Innovation Agency, which has significantly created an effective and low-cost innovation governance system. This is evidenced by a much smaller number of policy instruments than in previous periods, but with greater budgetary support.

In the previous period of innovation policy implementation, Galicia often faced the problem of monitoring and evaluating its innovation policy, coupled with the forecasting and technology commercialization processes of public research institutions that were not optimally utilized. Since the implementation of smart specialization, these problems have begun to be resolved thanks to the basic principles of smart specialization, which encourage the involvement of more stakeholders in all policy processes. It is a significant development that Galicia's innovation policy has now been developed through greater public and socio-political involvement and participation. Innovation policy in Galicia is highly dependent on innovation policy at the Spanish and European levels of government. These multilevel interactions may be hierarchical in nature, according to the structure and model of government in Spain. However, Galicia uses these multilevel relationships as a means for policy learning and to continuously adapt its policy strategies to changes at the national and European levels. According to Huggins (2010), simple imitation and benchmarking in regional innovation policy is likely to have a positive effect on regions if policy makers take into account their regional characteristics and specificities.

Region Type 3 was taken from a review of the study results of Sörvik et al. (2019), who studied the implementation of S3 in several sparsely populated regions (SPAs) in Europe. With the implementation of S3, this region experienced a significant transition and change in the innovation development paradigm. The Entrepreneurial Discovery Process (EDP) is well accepted as a primary means of planning regional innovation strategies. In addition, they benefit greatly from the principle of stakeholder engagement, which is a key feature of S3. Some case examples taken from this study are Nordland (Norway), which has created a green industry project as a renewable energy source in line with the primary resources in the region, and Lapland (Finland), which has developed an innovation policy strategy to create strategic SMEs through ICT development, one of the challenges that they have been facing. These two cases demonstrate the success of developing regional innovation strategies through strong synergy with higher levels of government. Although these projects are needed by the region, they are basically part of a national strategy project. The SPA regions recognize their real regional needs, take advantage of these opportunities, and establish solid and harmonious relationships with higher levels of government. The multilevel governance approach can be quite challenging for SPAs because it is not easy to mobilize national interests and adapt them to local interests or vice versa. SPA regions are also faced with limited availability and capacity to manage resources; thus, a solid and harmonious synergy is a very important element. Dobravec et al. (2021) argue that one of the best ways to develop innovation strategies in administratively weak regions is to align their regional policy strategies with policy strategies at higher levels, for example through national regulations (such as energy, environmental and climate change policies) that can be applied down to the lowest levels of government.

3.5. Summary

This chapter consists of a combination of empirical studies and a systematic and traditional literature review. The results of the discussion in Chapter 2 on the implementation of S3 in less developed regions (LDRs) in the EU motivated further studies to investigate the factors affecting innovation in the European region. An important implication of the results of this study is that funding and investment in R&D infrastructure or management of R&D human resources must go hand in hand. Unfortunately, the V4 region, which is dominated by less-developed regions (LDRs), still faces considerable challenges related to the governance of innovation resources or even the availability of innovation resources themselves. The first study in this chapter, synthesized from a published paper by Wibisono (2023b), examines this issue specifically in the regional context of the Visegrad Group (V4) countries in Central Europe, namely Poland, the Czech Republic, Slovakia, and Hungary. Using a spatial econometric analysis approach, the results of this study indicate the existence of a spatial dependence of knowledge inputs and innovation in the V4 regions. In other words, the spatial proximity between regions or the interconnectedness of innovation resources (such as researchers, universities, entrepreneurs, and industry) is an essential factor influencing innovation in the region.

The second study in this chapter is extracted from the author's latest research paper, which is currently under review. This study focuses on the phenomena and challenges of governance of resources and regional innovation policies in the implementation of smart specialization. The synthesis of critical findings, obtained through a systematic literature review approach, proposes suggestions and alternative solutions to face the phenomenon or overcome the challenges of S3 implementation at the regional level or in regions with specific circumstances. The phenomena and challenges related to the governance of S3 in the region then raise two other important issues, namely stakeholder engagement and institutional capacity, which are key features in the S3 framework. Challenges related to these two issues are further explored, and suggestions for overcoming these challenges are presented in each of the final sections of the discussion, along with the benefits that accrue if these challenges are successfully overcome. Finally, these phenomena and challenges lead us to a drive to improve or transform the governance of regional innovation policy to be more conducive to effective and efficient smart specialization implementation. Critical factors that can enhance the success of smart specialization governance in the region emphasized the importance of higher-level government involvement or multilevel linkages in smart specialization governance.

The last study presented in this chapter is taken from Wibisono (2022a), which specifically addresses the issue of multilevel governance in the implementation of smart specialization strategies. Indeed, the concept of multilevel governance has not been widely explored, especially in the context of S3 implementation. However, how this concept aligns with the principles of smart specialization and the potential of applying this concept in the S3 context has been illustrated in this paper. Furthermore, using a traditional literature review analysis approach, some important findings from the selected articles were synthesized and grouped into three types of regions according to the characteristics and challenges of implementing innovation policy and smart specialization in the regions. The first two types of regions are well established, both in terms of government administration and innovation policy governance. The coordination and communication between the actors involved in all the processes of smart specialization policy in these regions are in great need of a special mechanism and instrument that can increase the intensive interaction between them, both inter-institutional interaction within the same regional level and with higher levels of government. While in the third region, which has significant limitations in the public administration management or innovation policy governance, it is strongly encouraged to create solid and balanced synergies, especially with higher levels of government. This synergy is aimed at harmonizing innovation strategies and policies in the regions with strategies and policies at the national or supranational level.

CHAPTER 4
Estimating the Economic Impact of Smart Specialization Policy in the Context of Multilevel Governance

The importance of multilevel governance (MLG) in supporting regional policies, especially within the EU regional policy that benefits all Member States, has been highlighted in several studies (Ferry, 2021). For example, the Europe 2020 Poverty Reduction Strategy, an EU regional policy that involves MLG, has been thoroughly examined in several studies and underlines the need for cooperation between Member States and local governments to fight poverty in Europe (Copeland & Daly, 2012; Jessoula, 2015). In addition, the European Union Strategy for the Baltic Sea Region (EUSBSR) demonstrates how cross-sectoral policy frameworks can be achieved through the participation of different stakeholders and across different levels of government, facilitating regional cooperation (Gänzle, 2017, 2018; Michalun & Nicita, 2019). Studies focusing on the implementation of spatial planning policy for Dutch cities (Dąbrowski et al., 2014a; Evers & De Vries, 2013; Evers & Tennekes, 2016) and climate policy (Di Gregorio et al., 2019a; Nilsson et al., 2012) highlight the critical role of MLG and coordination between different actors and levels (national, regional and local) for successful policy implementation. Overall, these studies provide valuable insights into the importance of participation, coordination, knowledge sharing and capacity building to improve policy implementation outcomes.

The literature shows that discussions on multilevel governance (MLG) in EU regional policy often focus on specific types of policies, such as social, environmental, and regional macro-development policies (Ongaro, 2015; Stephenson, 2017). In addition, some studies highlight the challenges of MLG approaches in policy implementation, including the coordination of institutions within and between regions and different levels of government, as well as addressing socio-political challenges in the region (Casula, 2022; Newig & Koontz, 2014). Other identified challenges include gaps between new national policies and older policies embedded in strong institutional cultures (Allain-Dupré, 2020). The literature addressing these challenges suggests key factors to help regions achieve their goals for effective regional policy. Another aspect less often addressed in the literature on MLG and EU regional policy is the impact of governance on regional economic conditions. The impact of MLG generally implies that it can enhance the success of policy implementation. However, further comprehensive analysis and research on the impact of MLG and EU regional policy is still needed (Cucca & Ranci, 2022; Moodie et al., 2023).

The implementation of the Smart Specialization Strategy (S3), which is entering its second phase 2021-2027, provides a valuable opportunity to address the challenges and build on the successes achieved during the first period 2014-2020. In this phase, it is crucial to demonstrate tangible economic impacts in the regions that have benefited from S3 programs and projects, particularly in terms of economic growth, employment, social progress, infrastructure development and regional competitiveness. Scholars have rightly pointed out that the economic impact of smart specialization is closely linked to various underlying conditions, such as economic structure, access to factors of production, innovation capacity, and the quality of regional governance (S. Cohen, 2021; McCann & Ortega-Argilés, 2014b). Given the diversity of perspectives on the economic impact of smart specialization, it is essential to promote empirical measurement and address methodological issues in future studies of EU regional policy (E. Carayannis & Grigoroudis, 2016b; Dzemydaitė, 2021; Varga, 2017). Various methodological approaches, including general equilibrium and sophisticated economic models, have been used to assess the economic impact of S3. While these efforts share common research objectives, they also highlight the technical diversity of methodological approaches (Barbero et al., 2024; Gianelle et al., 2023; Varga et al., 2020). The collective insights from these discussions underscore the need for further research to enrich our understanding of the economic impact of cohesion policies and smart specialization strategies. A better understanding of the factors that influence the success of policy impact assessments will undoubtedly contribute to advancing the discourse and practice of smart specialization.

This chapter provides a combination of critical literature reviews and empirical studies that explore the challenges of smart specialization, a flagship regional policy in the EU, in the context of multilevel governance. The content of this chapter is a synthesis and summary of three papers by the author that are currently under review for publication in leading economic geography and political science journals. The *first* paper, under review in the *Urban Governance*, examines the potential implications of implementing EU regional policy using a multilevel governance approach. This paper emphasizes the importance of assessing the economic impact of implementing EU regional policy under such an approach. The *second* paper, submitted to *REGION*, discusses the various methodological approaches to assessing the economic impact of smart specialization in the EU. It highlights the importance of understanding the evolutionary benefits of smart specialization policy and identifying the main implementation challenges in the regions and suggests incorporating these challenges into economic impact measurements as an alternative solution to improve the effectiveness of regional policy implementation. The *third* paper, submitted to *European Planning Studies*, integrates the contributions of the previous two papers into economic impact estimation, considering smart specialization as a place-based policy and emphasizing the need to align objectives between different levels of government when implementing regional policies. The main contribution of this paper is to utilize the outcomes of economic impact estimation at the regional and national levels to assist practitioners and policymakers in determining the most optimal policy instrument or policy mix at the regional level while working towards optimizing the impact of such policy support on national economic performance.

The remainder of Chapter 4 is organized as follows. Section 4.1. outlines the background literature on the implementation of multilevel governance in EU regional policy and its potential impacts. Section 4.2. outlines the methodological diversity in the economic impact assessment of smart specialization policy as one of the flagship regional policies implemented in various European regions. Section 4.3 integrates the two main issues from the previous sections to assess the economic impact of different regional policy instruments and their specific impact on the region and on the larger national economic performance, considering a multilevel governance perspective. Section 4.4 summarizes and concludes the three main sections of this chapter.

4.1. Implementation and potential impact of multilevel governance in EU regional policy

Multilevel governance (MLG) is a fundamental principle of European Union (EU) regional policy, which plays a vital role in achieving economic and social development goals across the EU (Baun & Marek, 2014; Hooghe & Keating, 1994; Jones & Keating, 1995; Leonardi, 2005). MLG entails collaboration between public authorities and other stakeholders at different levels of government - local, regional, national, and EU - which encourages active involvement in policy formulation, implementation, and evaluation and facilitates coordination between different levels of government (Benz & Eberlein, 1999; Enderlein et al., 2010; Piattoni, 2009). In the EU context, the MLG concept recognizes the role of subnational and local institutions in EU policymaking and encourages their involvement in policy development and implementation. MLG in EU regional policy recognizes that public policy results from cross-border collaboration and is not the exclusive responsibility of a single political authority (Alcantara et al., 2016; Börzel, 2020; Hooghe & Marks, 2021).

Many studies provide convincing examples of the critical role of MLG in supporting EU regional policy. Several studies have examined the Europe 2020 anti-poverty strategy, an EU regional policy that involves multiple levels of government, from the EU to the local level, underscoring the importance of multilevel governance in the Europe 2020 poverty reduction strategy (Copeland & Daly, 2012; Jessoula, 2015). In a macro-regional context, the European Union Strategy for the Baltic Sea Region (EUSBSR) shows that a cross-cutting policy context can be achieved with the support of multiple stakeholders and at different levels of government (Gänzle, 2018; Michalun & Nicita, 2019). The strategy allows other regions like Russia and Norway to collaborate in the trans-Baltic region. In the national context, several studies highlighted the critical role of multilevel governance and multi-stakeholder and multilevel coordination in implementing spatial planning policies for cities in the Netherlands (Evers & De Vries, 2013; Evers & Tennekes, 2016). Other studies emphasize the critical role of MLGs in implementing climate policies and the importance of inter-regional and intergovernmental knowledge and experience channels to address climate challenges down to the local level (Di Gregorio et al., 2019a; Nilsson et al., 2012). These studies collectively demonstrate that MLGs are critical to successfully implementing EU regional policies at various levels. They provide valuable insights into the factors that need to be considered, such as participation, coordination, knowledge sharing, and administrative capacity building, to enhance successful policy implementation.

The existing literature on multilevel governance (MLG) discussions in EU regional policy often focuses on specific policies such as social, environmental, and regional macro development policies (Ongaro, 2015; Stephenson, 2017). Some studies highlight the challenges of MLG approaches in policy implementation, including coordinating institutions within and between regions and different levels of government, as well as addressing socio-political challenges within the region (Casula, 2022; Newig & Koontz, 2014). Additional challenges identified involve gaps between new national policies and long-standing policies entrenched in strong institutional cultures (Allain-Dupré, 2020). Notably, the impact of governance on regional economic conditions is a relatively overlooked aspect in the literature on MLG and EU regional policy. While the overall impact of MLG tends to suggest improved policy implementation success, further comprehensive analysis and research on its impact is still needed in the existing literature (Cucca & Ranci, 2022; Moodie et al., 2023).

Table 4. 1. Sources of publications.

No.	Source of publication - Publisher	Author(s)	Best quartile (SJR 2023)	Cited (Google Scholar)
1	Social Policy and Administration - *Wiley-Blackwell Publishing Ltd*	Jessoula (2015)	Q1 - Public Administration	64
2	European Planning Studies - *Routledge*	Evers & Tennekes (2016)	Q1 - Geography, Planning and Development	29
3	Journal of Baltic Studies - *Taylor and Francis Ltd*	Gänzle (2017)	Q1 - Cultural Studies	23
4	Territory, Politics, Governance - *Routledge*	Casula (2022)	Q1 - Geography, Planning and Development	19
5	Growth and Change - *Wiley-Blackwell Publishing Ltd*	Kamrowska-Załuska & Obracht-Prondzyńska (2020)	Q2 - Global and Planetary Change	8
6	Review of Policy Research - *Wiley-Blackwell Publishing Ltd*	Corcaci & Kemmerzell (2023)	Q1 - Geography, Planning and Development	1

Source: authors' elaboration.

This section presents the results of a critical literature review on implementing EU regional policies using a multilevel governance (MLG) approach. In particular, it examines the factors that can facilitate the successful implementation of EU regional policies using MLG approaches, as well as the potential impacts of such processes. Using a systematic review protocol to identify the papers that best fit this purpose, this section highlights the key points derived from a critical review of the selected articles (Wibisono, 2022b, 2023a). It identifies three key issues critical for improving the successful implementation of EU regional policies using the MLG approach and five critical aspects essential for their harmonization. In addition, the synthesis also discusses the potential impact of these processes, especially those of an administrative nature, which is generally accepted. However, it is essential to note that there are limitations to the presentation of impacts in terms of economic implications. The list of selected articles is shown in **Table 4.1**.

4.1.1. The key to implementing EU regional policies with MLG approach

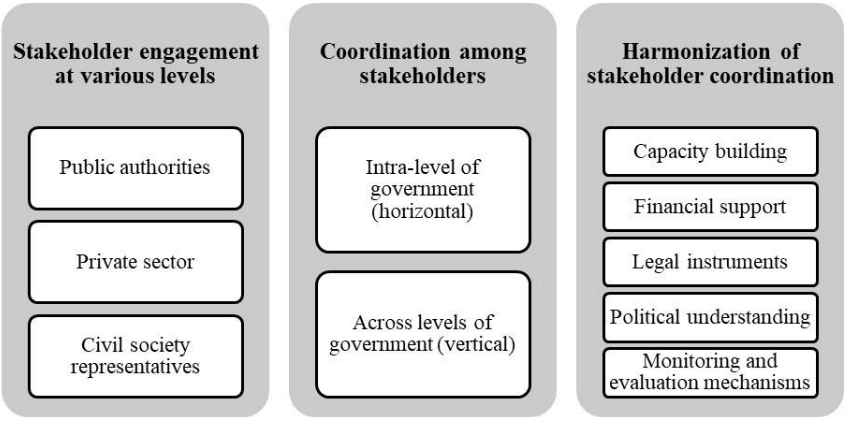
The review of the selected articles reveals crucial issues regarding the factors that can influence the implementation of EU regional policy through a multilevel governance framework. The two main foci of this critical review revolve mainly around identifying regional policy actors (stakeholders) and establishing effective coordination between them. In addition, several instrumental factors need to be considered in this process.

The *first* consideration is to ensure meaningful involvement of stakeholders at different levels of government, including strengthening cross-sectoral cooperation and ensuring the active participation of key decision-makers (heads of higher institutions, e.g., ministers) in coordinated efforts. It is important to involve all relevant stakeholders in planning and decision-making processes, including public authorities, civil society and the private sector. This inclusive approach helps to ensure that EU regional policies are based on real needs and take into account the perspectives and interests of all stakeholders (Carbone, 2008; Font & Galais, 2011; Mendez & Bachtler, 2024). In addition, the active involvement of the public in the policy-making process is strongly encouraged to improve the quality of policies and build strong public support (Edelenbos et al., 2010; Keating et al., 2015). By promoting better dialogue between government and civil society or its representatives, policy makers will gain different insights and expertise, leading to more effective and targeted regional policies. Such a social approach forms the basis for the development of EU regional policy programs at the local and regional level (Potluka et al., 2017; Roman & Fellnhofer, 2022).

The *second* principle is that effective implementation of regional policy objectives and strategies through multilevel governance requires strong coordination between central, regional and local governments and all relevant stakeholders. This should start with careful planning of inter-agency coordination mechanisms specifically designed to promote and strengthen horizontal cooperation between institutions at the regional and sub-regional levels (Øverbye et al., 2017). Facilitating the exchange of information and experience, as well as the efficient use of resources, is crucial to building an effective multilevel governance system. Close working relationships between the European Commission, national, regional and local authorities and non-state actors are needed at all stages of policy implementation (Borońska-Hryniewiecka, 2011; Pierre, 2019). This can promote learning, exchange of knowledge and experience, and effective use of resources between the parties involved. In addition, good coordination between different levels of government, in particular between central and local governments, will accelerate the implementation of regional policies, as each party naturally provides the necessary resources and authority. A good coordination process also allows for discussion and openness and can work together to overcome challenges that arise during policy implementation (S. Hong & Lee, 2018; Newig & Koontz, 2014).

The *third* factor is instrumental aspects, which serve as the main resources supporting the implementation of EU regional policies using the multilevel governance model. *First*, central, regional and local administrative capacities play an important role in the implementation of EU regional policies. This includes human resources, databases, information technology and efficient internal management systems. The development of administrative and institutional capacities aims at building mutual agreements and ensuring the sustainability of the cooperation process between institutions (Ansell, 2000; Park et al., 2021). *Second*, adequate funding is essential for sustainability and successful implementation of regional policies. This funding can come from EU funds, national governments or the private sector. Financial support is essential to enable the development and implementation of effective EU policy programmes at the local and regional level (Hooghe & Keating, 1994; Medve-Bálint & Šćepanović, 2020; Mendez & Bachtler, 2024; Morgan, 2004). *Third*, clear and applicable legal instruments at all levels of government ensure the successful implementation of EU regional policy, including the necessary regulations and legal requirements (Heidbreder, 2011; Rodrigo et al., 2009). However, flexibility is needed to ensure that policy implementation can adapt to different local and regional contexts. Multilevel governance in EU policy programs should accommodate the specificities and interests of each region, including social, cultural and political factors (Benz, 2000; Gänzle et al., 2019). *Fourth*, political understanding and support. Multilevel governance requires buy-in from all levels of government and relevant stakeholders. The aim is to maintain policy priorities and obtain the necessary support, such as social support from the public through their constituencies and legitimization of the use of public funds (Bache & Chapman, 2008; Pálné Kovács, 2021; Panara & Varney, 2017). *Fifth*, appropriate monitoring and evaluation mechanisms to assess the effectiveness of EU regional policy in achieving its objectives and targets, and to improve the implementation of such policy in the future. Monitoring and evaluation mechanisms should be designed to measure the success of program implementation. Regular appraisals should be conducted not only to assess program success but also to identify program weaknesses and facilitate appropriate improvements to achieve regional development objectives in the future (Baslé, 2006; Marra, 2018; Spyridaki et al., 2016).

Figure 4.1 illustrates the key factors in the implementation of EU regional policy with a multilevel governance approach.



Source: authors' elaboration

Figure 4. 1. Key factors in the implementation of EU regional policy with MLG approach

4.1.2. Potential impact of implementing EU regional policies with MLG approach

Subsequent analysis of the selected articles revealed that implementing EU regional policies using MLG approaches can have four main impacts: impacts related to resource management, the importance of involving local stakeholders, the influence of MLG on stakeholder learning and knowledge, and potential economic impacts.

The *first* implication of the critical review of the selected papers is that multilevel governance (MLG) can have a potential impact on the efficiency of regional resource management (Borońska-Hryniewiecka, 2011; Casula, 2022; Ferraro & Failler, 2024; Gänzle, 2017). The MLG approach provides an opportunity to tailor EU regional policies to the specific needs and interests of each regional level of governance. This leads to more effective policies that address regional problems and provide more sustainable solutions (Borońska-Hryniewiecka, 2013; Irepoglu Carreras, 2019; Kuhlmann & Franzke, 2022; Poyraz & Szalmáné Csete, 2023). The MLG approach also encourages the participation of local and regional communities, allowing them to provide input and enabling policy makers to gain a better understanding of regional issues. By involving regions and communities in policy design and implementation, local resources can be used more efficiently and minimized unnecessary spending (Gertler & Wolfe, 2004; A. L. Yang et al., 2015). The MLG approach in the region is accompanied by financial support that is critical to the development of the policy program or strategy itself. It strengthens the capacity of local stakeholders to address the challenges they face at the local level (Dąbrowski et al., 2014b; Melica et al., 2018).

The *second* impact highlights the growing importance of local actors in shaping regional policies, strategies and programs (Cucca & Ranci, 2022; Kölling & Hernández-Moreno, 2024).

The MLG approach underscores the need for close policy coordination and alignment between central and local governments to ensure policy consensus. The active political participation of local stakeholders at the regional level is crucial for the success of EU regional policy, as it promotes their sustained involvement in decision-making processes (Kolařík et al., 2014; Milio, 2014; Newig & Koontz, 2014; Zito, 2015). By adopting the MLG approach, local stakeholders are empowered to have a significant impact on the formulation and implementation of regional policies in their respective areas. Regional policies using the MLG approach can effectively promote cooperation between authorities at different levels of government and between different stakeholders at the same level of government. This collaborative framework fosters enhanced community engagement and broader participation of a wide range of stakeholders in the decision-making process (Nousiainen & Mäkinen, 2015).

The *third* impact of multilevel governance (MLG) is the enhanced capacity for learning and knowledge acquisition that results from the coordination process between different levels of government and local stakeholders. The MLG approach enables the creation of cooperative networks between different levels of government (vertical networks) and among local stakeholders (horizontal networks). This promotes knowledge exchange through open participation channels at each stage of policymaking (Casula, 2022; Poyraz & Szalmáné Csete, 2023). As a result, the understanding of EU regional policy is disseminated, reaching down to the grassroots level of government, and translated into shared national or local goals. These shared visions and missions are then advocated in the political arena to gain legal legitimacy and become official channels for EU financial support (Kull & Tatar, 2015; Piattoni, 2009; Stephenson, 2017). The learning process among stakeholders is continuous throughout the policy-making phases, including implementation, monitoring, and evaluation. Participatory processes in multilevel governance foster connectedness and positive interdependence among stakeholders (Ágh, 2010; Hermanson, 2018; Schultze, 2003). In addition, multilevel governance provides opportunities to cultivate international partnerships at the regional level, contributing to the development of human capital, strengthening institutional capacity, and promoting a common understanding of global issues (Allain-Dupré, 2020).

The *fourth* impact relates to potential economic impacts. Analyzing the economic impact of a governance model on economic indicators is challenging. However, the critical review in this paper suggests that multilevel governance should ultimately provide economic benefits in addition to strengthening regional policy implementation. For example, the EU's anti-poverty strategy aims to improve citizens' well-being, and the European Union Strategy for the Baltic Sea Region (EUSBSR) aims to boost the region's economy through cooperation between countries within and beyond the Baltic Sea, such as Norway and Russia (Gänzle, 2018). In Germany's climate innovation context, the MLG approach has played a key role in leading and coordinating development programs to promote climate innovation at the local and regional level. This proactive governance approach has not only led to the advancement of climate-friendly technologies and practices but has also contributed significantly to positive economic outcomes for society. While measuring the economic impacts of EU regional policy interventions has been widely practiced by regional economists and economic geographers (Varga, 2017), there is limited literature examining the economic impacts of EU regional policy interventions driven by multilevel governance (Idczak et al., 2024). The multilevel governance approach in EU regional policy can generate economic benefits for regional and local areas, especially when programs and policies address social and economic issues such as education, employment, transport, energy, and the environment, which requires coordination among institutions and stakeholders within the region and between levels of government (Dobravec et al., 2021b; Jänicke, 2017; Manuel Galvin Arribas, 2016; Mladenovič et al., 2022). Effective coordination among stakeholders in the implementation of these policies can ensure efficient policy implementation and resource utilization. Thus, the implementation of regional policies managed with an effective MLG approach can be expected to lead to the achievement of desired economic objectives or indicators.

4.2. Methodological approaches in measuring the economic impact of smart specialization policy

This section presents the results of a critical literature review on the potential benefits of the Smart Specialization Strategy (S3) in driving regional economic transformation. S3 is currently in its second programming period (2021-2027), which builds on the successful outcomes of the first period (2014-2020) while also experiencing some challenges. The main challenge is to provide concrete evidence of economic impact for regions that have implemented programs or projects under the S3 policy framework (Varga, Szabó, et al., 2020a). Economic impacts typically include increased economic growth, employment, improved social conditions and infrastructure, and increased regional competitiveness. These impacts may vary depending on the design, planning and implementation of the strategy (Gianelle, Guzzo, et al., 2020; Gianelle, Kyriakou, et al., 2020). Experts argue that the economic impact of smart specialization can be influenced by several underlying conditions, such as the structure of the economy, the availability of production factors, the level of innovation, and the quality of regional institutions (S. Cohen, 2021; McCann & Ortega-Argilés, 2014a, 2014b).

Existing literature shows that discussions on the economic impact of smart specialization tend to be diverse due to the relevance of different components and the evolutionary characteristics of smart specialization. Dzemydaitė (2021) and Varga (2017) advocate empirical measurement of the economic impact of specific components of smart specialization. On the other hand, Carayannis & Grigoroudis (2016) emphasize the need to address methodological issues before conducting economic impact assessments. Several studies have used general equilibrium models in the context of S3 economic impact assessment (Barbero et al., 2022; Gianelle et al., 2023; Guzzo et al., 2018). Varga, Sebestyén, et al. (2020) applied a more complex economic model to measure (through indices) and evaluate two important elements in S3: entrepreneurship and knowledge networks. Although these studies have related objectives, they have methodological characteristics that are technically different. The authors argue that further research in this area is needed to enrich the literature on the economic impact of cohesion policies and smart specialization strategies. Rather than focusing solely on sophisticated modeling strategies, it is crucial to gain a more fundamental understanding of the factors that influence the success of policy impact assessment.

This section draws from a critical literature review written following a systematic protocol to identify relevant articles and carefully examine their key findings and methodological approaches (Wibisono, 2022b). The critical review highlights the impact of smart specialization strategies and discusses methodological challenges in integrating relevant smart specialization issues into economic impact models. The list of selected articles is presented in **Table 4.2**.

Table 4. 2. Sources of publications.

No.	Source of publication - Publisher	Best quartile (SJR 2023)	Author(s)	Cited (Google Scholar)
1	Regional Studies - *Routledge*	Q1 – Social Sciences	Varga et al. (2020) Barbero et al. (2022)	88 21
2	International Journal for Quality Research - *University of Montenegro*	Q2 - Industrial and Manufacturing Engineering	Shebanin et al. (2022)	7
3	Research Policy - *Elsevier B.V.*	Q1 - Management of Technology and Innovation	Barbero et al. (2024)	-
4	Annals of Regional Science - *Springer Verlag*	Q1 - Social Sciences	Gianelle et al. (2023)	2

Source: authors' elaboration.

4.2.1. Critical findings from selected articles

This section presents the analysis of each selected article, focusing on key elements such as study objectives, methodological approach, and key results or findings. The author categorizes the articles according to the closeness of the topics analyzed, especially in terms of the methodology used. The first three papers - (Barbero et al., 2022, 2024; Gianelle et al., 2023) - are close in their analysis. All three use a computable general equilibrium analysis approach to assess the economic impact of cohesion policies or smart specialization strategies driven by different policy interventions. Shebanin et al. (2022) shares a common focus with Barbero et al. (2022), focusing on regional development projects funded under cohesion policy. The paper by Varga, Sebestyén, et al. (2020) is positioned at the end of the review as it uses a more comprehensive methodological approach.

Barbero et al. (2022) examines the economic impact of smart specialization strategies in the Southern European region (Greece, Italy, Spain, and Portugal). The study analyzes research and innovation projects related to the S3 or the EU Cohesion Policy in each country's regional development plan. The impact of these projects on macroeconomic indicators such as GDP and employment is estimated using computable general equilibrium (CGE) modeling with the RHOMOLO policy impact model. This model is widely used to measure the economic impact of policies in the EU due to its compatibility with multisectoral (NACE Rev. 2) and multiregional (NUTS 2) modeling (Brandsma & Kancs, 2015; Varga, Szabó, et al., 2020a). According to the study's simulations, smart specialization strategies implemented through regional research and innovation projects positively impact various economic indicators. The estimation results also show that the desired economic impact tends to peak at the end of the funding period or when the fund's ultimate goal is achieved.

In a separate study, Shebanin et al. (2022) evaluated the economic impact of EU cohesion policy on regional development in member states. The study used panel regression analysis and propensity score matching (PSM) techniques to assess the impact of EU cohesion policy on countries that received funding from the Cohesion Fund for regional development projects during the 2014-2020 period. The results show that EU cohesion policy positively impacts economic growth in EU Member States with a GDP below 90% of the EU-27 GDP. Moreover, the size of the Cohesion Fund is directly related to the increase in GDP and Gross Value Added (GVA) in the beneficiary countries.

Gianelle et al. (2023) analyzed the impact of improving management capacity and stakeholder involvement in the region (S3 governance). The study shows that increasing the economic impact of S3 in a region can be achieved by improving the capacity to manage all elements at each policy stage and ensuring the effective participation of all stakeholders. A measure of governance quality was developed through a survey of national and local stakeholders in the NUTS 2 region of Italy, focusing on inclusiveness and management indicators. In addition, the authors used spatial dynamic general equilibrium economic impact modeling to assess the impact of S3 governance on regional macroeconomic conditions. This study is the first of its kind to measure the economic impact of S3 governance in the EU, although it was conducted exclusively in the context of a large Italian region representing different levels of governance and quality of regional development. The results show that regions with better governance and better implementation of S3 policies obtain a higher economic impact from Cohesion Fund investments.

A subsequent study by Barbero et al. (2024) also used a general equilibrium approach to measure the economic impact of Cohesion Policy. This study examines the economic impact of technology-related diversification in the industrial transformation agenda in the EU region as part of S3. The study uses the technological diversity indicator constructed by Santoalha (2019) and models its economic impact using a spatial computable general equilibrium (SCGE) model with the RHOMOLO model for the entire NUTS 2 region in the EU. The study simulates counterfactual scenarios for technologically diversified regions. The estimation process starts with stochastic frontier econometric modeling. The results of this econometric analysis are then used to construct counterfactual scenarios, which are further simulated in a CGE/RHOMOLO spatial model to examine the regional macroeconomic impact of technological diversification activities. The results of the analysis show that less developed regions that have yet to fully diversify experience the most significant economic impacts of technology-related diversification processes. This study encourages less developed regions in the EU to further diversify their innovation efforts by exploring opportunities for transformation towards new technologies beyond their current technological frontiers.

Varga, Sebestyén, et al. (2020) examined the economic impact of two important components of S3: knowledge network policies and entrepreneurship policies. This research highlights the important role of these two policies in driving economic transformation in the S3 framework. The research uses the GMR Europe economic impact model to analyze the Regional Entrepreneurship and Development Index (REDI) and the Ego Network Quality (ENQ) index and links them to other policies such as research and development, investment and human resource policies. GMR Europe combines elements of spatial geography (G), macroeconomics (M) and regional economics (R), providing three interrelated approaches to the economic analysis of regional and national development. The results of this study show the different impacts of entrepreneurship policies and knowledge networks across EU regions and highlight the gap between industrially advanced and less developed regions. This underlines the need for well-designed and coherent policies to promote sustainable economies (McCann & Varga, 2015; Varga, 2017).

4.2.2. The diversity of methodological approaches

This section outlines the content of the selected articles, focusing on the methodological approaches used to measure or estimate the impact of smart specialization strategies or in the context of EU cohesion policy. In describing the methodological approach, the author considers what advantages are gained by using this analytical approach and what things need to be considered that are still limitations of the analytical method used.

Barbero et al. (2022) used the CGE method and the RHOMOLO model to assess the economic impact of S3. This method comprehensively assesses the policy across different sectors and regions. The RHOMOLO model considers the interaction between economic and regional factors (Brandsma et al., 2015b) and assesses the impact of the policy on indicators such as GDP growth, investment, consumption expenditure, consumer price index, and imports/exports. By integrating CGE analysis with RHOMOLO modeling, the study provides a comprehensive assessment of the performance and economic impact of the S3 under several scenarios (E. Carayannis & Grigoroudis, 2016b; Varga et al., 2020). It focuses on specific targets set by policymakers and assesses the potential economic impact of their implementation. The study highlights the challenges of setting realistic targets and advises against overly optimistic assessments. In addition, the authors highlight the importance of considering the influence of S3 policy cycles, such as the early phase of policy implementation (2014-2020) and the later phase (2021-2027). Inconsistent funding procedures across policy cycles may lead to inaccurate assessments of future policy impacts, so it is necessary to consider long-term estimates. Furthermore, this study highlights the importance of considering micro-level factors such as sectoral specialization, labor force skills, and local social network connections. The authors propose more innovative and context-specific approaches, such as agent-based analysis, to gain a comprehensive understanding of the impact of S3 (Ahrweiler, 2017; Vermeulen & Pyka, 2018).

Gianelle et al. (2023) estimated the economic impact of S3 and EU cohesion policy using the CGE method approach and the RHOMOLO model. This study incorporates survey data on the quality of governance of S3 in the NUTS 2 region of Italy into the CGE spatial analysis method. These survey data consist of composite indicators of governance quality from a managerial perspective, which are then used as input to the RHOMOLO model. These indicators play an important role in assessing the economic impact of the quality of S3 governance in different regions in the context of cohesion policy. However, the scope of this study was limited to regional or local institutional perspectives, which could influence the interpretation and generalization of the study results. The author emphasizes the importance of ensuring the validity and consistency of respondents' answers to interpret the survey results accurately. This ensures that measurements can be accurately estimated and the resulting estimates can provide input for appropriate decision-making based on data and evidence.

Barbero et al. (2024) use an alternative approach to quantitative analysis that employs two main analytical methods: stochastic frontier econometric analysis and spatial computable general equilibrium (spatial CGE) modeling. Stochastic frontier estimation helps identify the production structure and input-output relationships of each region, while the spatial CGE model evaluates the economic impact of the results obtained from the econometric analysis. Through stochastic frontier estimation, this study identifies factors that contribute to production inefficiencies at the regional level, which can be addressed through policy interventions such as technology diversification. A spatial CGE model is then used to quantify the economic impact of these changes. This combined methodological approach allows for a more comprehensive assessment of the impact of S3 and provides valuable insights for developing effective policies. In addition, this study also highlights the challenges associated with spatial computable general equilibrium (SCGE) modeling, including its reliance on extensive and comprehensive data to produce reliable results.

Shebanin et al. (2022) uses a panel data econometric approach to identify factors that can be used as inputs into a strategy or policy. However, the authors take a different approach to economic impact analysis. Economic impact measurement focuses more on quantitative descriptive measures using the propensity score matching (PSM) method. The objective is the same: to assess the economic impact of cohesion policy on the economic growth of EU Member States. First, panel data regression is used because it considers temporal and country-specific variations and can effectively deal with unobserved factors that may influence the relationship between the dependent and independent variables. In addition, propensity score matching (PSM) allows the comparison of similar groups as controls, thus ensuring an appropriate quantification of the impact of cohesion policies. This technique helps researchers and policymakers to reduce selection bias by facilitating comparisons between control and treatment groups (taking into account treatment policies). In the context of this research, the "control group" refers to countries that did not receive cohesion funding, while the comparison group or "treatment group" consists of European Union Member States that received special treatment in the form of cohesion funding. By using propensity score matching (PSM), the authors were able to minimize the influence of confounding factors or bias when comparing the impact of cohesion policy on economic growth between the two groups of countries. The propensity score matching (PSM) approach has the potential to provide more consistent and valid results by reducing differences in characteristics and unobserved variables between the control and treatment groups, resulting in a more accurate assessment of the impact of cohesion policies on economic growth in Europe. European Union Member States (Bakucs et al., 2018; Berkowitz et al., 2019; Li, 2013).

The study conducted by Shebanin et al. (2022) acknowledges several limitations, particularly in terms of data availability and measurement methods, which could potentially affect the findings and conclusions. For example, the study is limited to the period 2014-2020 and only includes European Union countries with a GDP of less than 90% of the GDP of the EU27. This limitation may limit the generalizability of the study's findings to other time periods or regions. Therefore, a different approach is needed to carry out the analysis under different conditions. Moreover, the study faces endogeneity issues, where the dependent and independent variables may influence each other, potentially leading to measurement bias of the impact of cohesion policy (Malah Kuete et al., 2022; Mohl, 2016). In addition, the study does not take into account potential changes in policy or economic conditions from a long-term perspective. It also evaluates only the impact of smart specialization policies on economic growth, ignoring other factors such as innovation and regional investment, which can also have a significant impact on economic growth but are not considered in this study.

Varga, Sebestyén, et al. (2020) stands out for its comprehensive methodological approach, combining spatial econometrics, spatial computable general equilibrium, and macroeconomic general equilibrium (dynamic stochastic GE) analysis. Using GMR Europe's economic impact model, the study simulates various policy interventions in the implementation of smart specialization strategies in the European Union. The results show the positive impact of knowledge networks and entrepreneurship policies on various regional and macroeconomic indicators in the European Union region (NUTS 2 region). The analysis carried out through GMR Europe underlines the importance of effectively managing multiple resources and combining appropriate policies at the regional level to achieve optimal results from smart specialization. The GMR Europe approach is able to accurately reflect strong economic impacts due to the complex arrangement of each model building block, in particular, the regional block (using spatial econometrics, spatial computable general equilibrium (SCGE)) and the macro/national block (dynamic stochastic general equilibrium (DSGE)). This capability enables GMR Europe to measure economic impacts at the regional and macro levels simultaneously while taking into account the relationships between regions and countries, resulting in greater and more sustainable policy impacts.

The study highlighted some limitations. The GMR Europe model integrates various data types and assumptions that may affect the estimated model results. Policy shocks related to investment, research and development, and human capital are included in the modeling. Although this model combines two element of smart specialization policies - entrepreneurship and knowledge networks - along with three other policies, it ignores important aspects of smart specialization, such as institutional and governance factors, and non-economic influences, such as political, socio-cultural, and environmental factors. Although it is possible to include additional indicators in the GMR Europe model, there are methodological challenges to overcome, *e.g.*, spatial-geographical factors, non-linear effects, and interdependencies with other factors. However, the challenges associated with modeling entrepreneurship and knowledge network policies are thoroughly explored in this paper. Another limitation is that the GMR Europe relies on assumptions and historical data to estimate future impacts, which introduces uncertainty in replicating past conditions. Nevertheless, by carefully considering the regional context and specific socio-economic characteristics, the GMR Europe will continue to serve as a valuable tool for policy evaluation and decision-making.

The critical review in this section highlights two key considerations for innovation policy researchers and practitioners in assessing the economic impact of regional development policies and strategies within a smart specialization framework. *First*, in order to identify the policy issues relevant to smart specialization strategies, a deep understanding of the evolutionary advantages of smart specialization strategies is needed. The main issues raised in the selected articles, such as regional governance, diversification related to technology, knowledge policy and entrepreneurship, as well as issues related to the implementation of the use of cohesion funds through research and innovation projects, are issues relevant to the main elements of smart specialization (Foray 2018; Foray 2014; Natalicchio et al. 2022). The results of previous studies have provided empirical evidence on the impact of this policy on various regional and national economic indicators in the European Union. However, several issues that are still challenges in the implementation of smart specialization have not been resolved, such as issues related to policy governance at different levels of government, measurement of stakeholder involvement in the policy process, social and environmental issues, as well as institutional and organizational factors that still need to be explored and linked to the implementation of smart specialization (Capello & Kroll, 2018; Grillitsch, 2016; Kroll, 2018; Nogueira et al., 2017; Pugh, 2018). It is strongly suspected that weak administrative governance in the region may explain the low success in the economic impact of implementing smart specialization strategies (Benner, 2022; Ghinoi, Steiner, Makkonen, et al., 2021; Veldhuizen, 2020).

The *second* consideration is integrating smart specialization policy-related challenges into economic impact models. The critical review of this study has highlighted the importance of incorporating policy interventions within a smart specialization framework and translating policy issues into meaningful values for modeling policy impacts. Various methodological approaches have been explored, such as general equilibrium modeling and econometric methods, including stochastic frontier econometric models and panel data econometrics. In addition, counterfactual approaches have also been used to assess the economic impact of smart specialization. Overall, these studies emphasize the importance of choosing the appropriate form of intervention according to the specific conditions of a region and following appropriate methodological steps to assess the impact of policy interventions.

4.3. Utilizing GMR-Europe model to estimate the economic impact of smart specialization policy at the regional and national levels

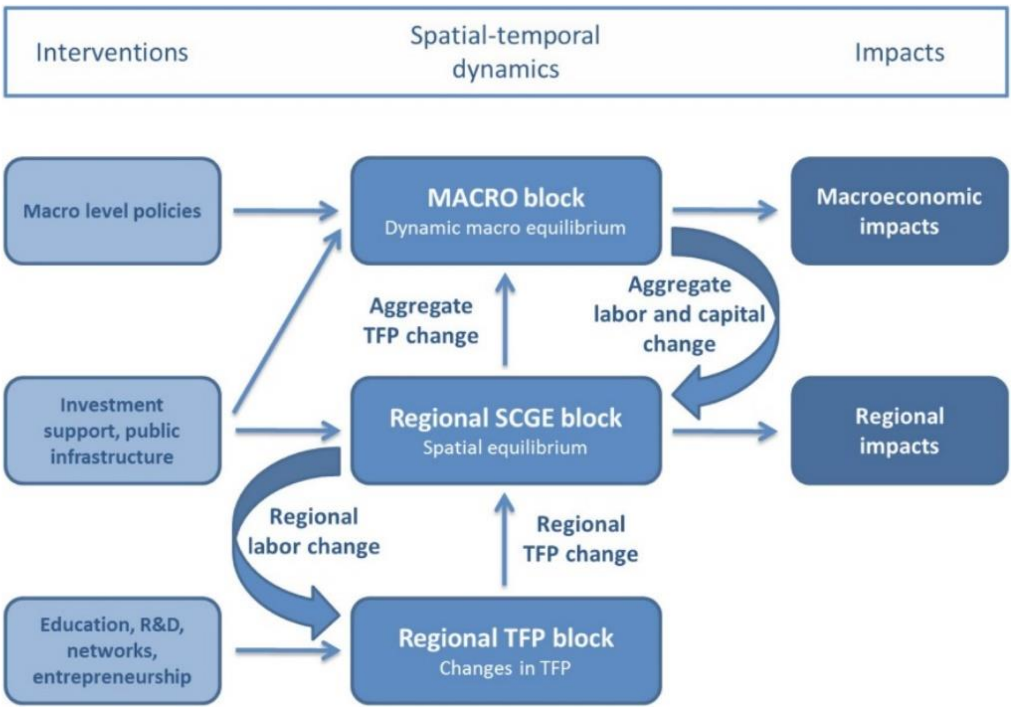
As mentioned above, assessing the economic impact of smart specialization policies involves two key considerations. The *first* is understanding multilevel governance issues, which is recognized as one of the evolutionary advantages of smart specialization strategies but remains a key challenge. The *second* consideration is to integrate the context of multilevel governance into the economic impact model. Previous research has emphasized the importance of choosing the right form of intervention based on specific local conditions and following methodological steps to assess the economic impact of a policy intervention. In multilevel governance, coordination mechanisms are crucial for the successful implementation of regional policies such as smart specialization. However, the importance of coordination between levels of government in the implementation of smart specialization policies is still an open question. How coordination significantly affects outcomes, or whether under certain conditions coordination has no effect on outcomes, is still a matter of debate. Therefore, we need to consider how multilevel governance has a substantial impact on the implementation of smart specialization policies, focusing on the viewpoint or the urgency of coordination.

The author argues that economic impact modelling can illustrate the need for coordination in the governance of smart specialization. The effectiveness of smart specialization policy may yield different results depending on the policy governance capabilities of the regions where they are implemented. Therefore, policymakers at the central level can determine whether it is essential to develop specific coordination mechanisms with lower levels of government to ensure optimal policy impact at the national level when implementing smart specialization. However, as previous research has highlighted the methodological challenges and complexities of measuring the economic impacts of smart specialization policy, the author does not intend to incorporate multilevel governance or coordination issues into the complexities of policy impact modelling. Instead, the author aims to leverage existing complex economic models that consider place-based policies in a regional context, such as smart specialization, while also considering the impact of such policies at the national or state level.

The use of economic impact models as a tool to illustrate the economic impact of smart specialization policy has become widespread. However, in the context of multilevel governance, several complexities pose challenges to empirical studies in this area. The author addresses this issue by demonstrating the relationship between multilevel governance and its potential economic impact within the smart specialization policy framework. Firstly, the complex logic of assessing the economic impact of smart specialization policy is outlined, referring to the GMR-Europe model implemented by Varga (2017) and Varga, Sebestyén, et al. (2020). Moreover, the author further explores the issue of multilevel governance concerning smart specialization policy by conducting various policy impact modelling simulations using the GMR-Europe model, distinguishing the effects of implementing these policies at the national and regional levels.

4.3.1. Main construction of GMR-Europe model

Several economic models are available to assess the impact of economic policies in the context of EU cohesion policy. These models include the QUEST model (Ratto et al., 2009), the HERMIN model (Bradley et al., 1995; Sosvilla-Rivero et al., 2006), RHOMOLO (Brandsma et al., 2015a; Brandsma & Kancs, 2018), and MASST (Capello, 2007; Capello & Caragliu, 2021). Spatial econometric approaches and computable general equilibrium models have recently largely integrated aspects of regional innovation policy or smart specialization in the EU. For example, Barbero et al. (2022) examines the case of multiregional cohesion funds, and Gianelle et al. (2023) focuses on multilevel governance for Italian regions. Economic models that consider spatial effects, integrate different regions in Europe, and incorporate the principles of smart specialization are considered the most comprehensive in analyzing the impact of smart specialization policy. The Geographic, Macro and Regional (GMR) framework, developed over two decades, evaluates the effects of economic policies based on these principles. While the impact of cohesion policy is usually assessed at the national level, GMR considers national and sub-national or regional impacts. The GMR approach was first applied to the ex-ante and ex-post impact assessment of Hungarian economic policies through the EcoRET model (Varga & Schalk, 2004), which later evolved into GMR-Hungary. The Hungarian government officially used this model during two Cohesion Policy programming periods to design Hungary's National Research, Development and Innovation Strategy and the Smart Specialization Strategy (S3). GMR-Europe, which was initially developed in various projects, including GRINCOH FP7, IAREG FP7, and FIRES, currently incorporates the basic principles of smart specialization, such as entrepreneurship policy and knowledge network policy, and is available to assess the impact of regional research and innovation policies in various regions of the European Union (Bakucs et al., 2018; Varga, 2017; Varga & Horváth, 2015).



Source: Varga, Sebestyén, et al. (2020)

Figure 4. 2. Main construction of GMR-Europe model

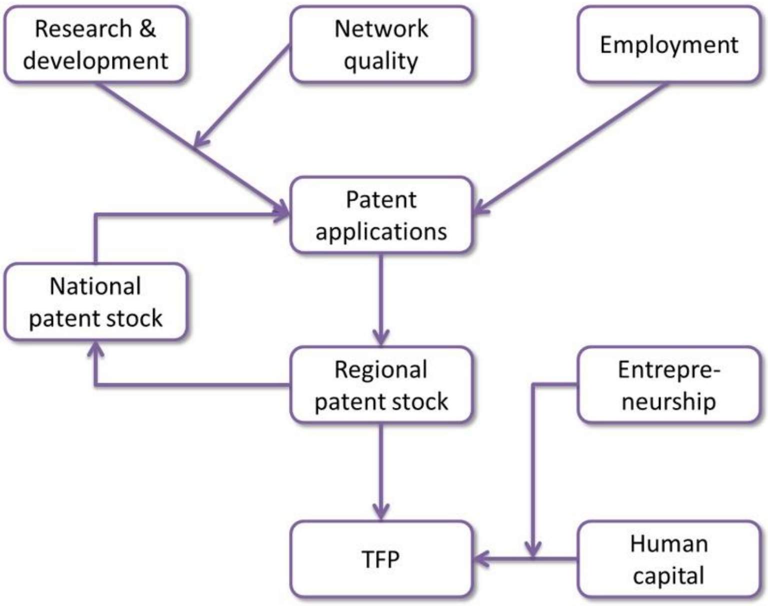
Figure 4.2 provides an overview of the policy interventions, spatio-temporal dynamics and economic impacts in the GMR-Europe model. The GMR-Europe model includes essential elements for assessing policy impacts at different levels of government. GMR-Europe thoroughly evaluates economic impacts at different levels of governance - supranational, national and regional - covering 181 EU NUTS-2 regions. GMR-Europe consists of critical building blocks, each serving a specific purpose. The MACRO block influences the evolution of economic aggregates at the EU level, the SCGE block disaggregates them at the regional economic level, and the TFP block tracks productivity changes at regional and EU levels. These three primary building blocks in GMR-Europe interact, influencing regional productivity and subsequently affecting the macroeconomy continuously. The GMR model integrates three distinct economic modeling approaches - *econometrics, SCGE, and dynamic stochastic general equilibrium (DSGE)* - while incorporating the effects of knowledge and innovation geography, as well as new economic geography elements like migration, agglomeration, and interregional trade. These aspects are indirectly interwoven into each component or block of the model, each considering different facets. The linkages between these three sub-models constitute a comprehensive and interacting system. The GMR-Europe model is designed to incorporate policy concepts related to physical capital investment, research and development (R&D), human capital upgrading, knowledge networks and entrepreneurship, which are the focus of smart specialization policy. The model makes it possible to analyze the impact of changes in those policies on total factor productivity (TFP), gross value added (GVA), and employment, capturing both macro and regional effects.

The foundation of the GMR-Europe model is the TFP block, which covers various aspects of innovation and technological progress that are closely related to smart specialization policy. This block plays an important role in modeling the productivity effects of policies aimed at promoting innovation. According to Romer (1990), the accumulation of knowledge and technology, among other regional knowledge inputs (Varga, 2007; Wibisono, 2023b), is a key driver of regional innovation. Technological concepts developed in the region will have a major impact on the economy through increased productivity (TFP). Under fixed capital and labor conditions, economic variables will increase along with the increase in TFP, indicating that the economic impact of innovation policies comes from increased productivity.

The arrangement of variables within the TFP block is shown in **Figure 4.3**. The TFP block consists of two equations or sub models: the Knowledge Production Function (KPF) and the TFP function. Both sub models are estimated using an econometric approach. The KPF represents the new knowledge (patent applications) generated by a region, influenced by various regional knowledge inputs, such as R&D funding, highly educated or skilled personnel, national patent stocks, and knowledge networks. Knowledge networks are a recent addition to modelling the impact of smart specialization policy, represented by the Ego Network Quality (ENQ) index (Sebestyén & Varga, 2013). The assumption behind the role of knowledge networks in regional innovation is that better knowledge networks lead to higher knowledge productivity. Furthermore, the new knowledge stock at the regional level dynamically shapes the national patent stock, which in turn affects the productivity of the regional patent stock through patent applications. The regional knowledge stock (regional patent stock) is modelled as a function of TFP. Therefore, regional policy interventions aimed at influencing TFP target an increase in the regional knowledge input variables that make up the regional patent stock.

In addition to the ENQ index, the TFP block has an additional feature related to smart specialization policy, which is entrepreneurship, measured by the Regional Entrepreneurship Development Index (REDI). In the TFP block, entrepreneurship contributes positively to TFP through its association with human capital development. The premise behind REDI is that regions with a better entrepreneurial ecosystem can increase productivity (TFP) due to more productive entrepreneurial activities, exploitation of creativity that can improve business opportunities, and effective alignment of knowledge upgrading with educational qualifications.

The majority of the data in the TFP block are sourced from the Eurostat statistical database, while some other data are obtained using specific methods. The GDP, employment and human capital (population with tertiary education) data used in the TFP production function are obtained from Eurostat, while the regional capital stock data are calculated using the Perpetual Inventory Method (PIM) (see Varga et al. (2018) for detailed calculations). The TFP function is then determined using the TFP equation, where human capital data is obtained from Eurostat, and regional patent stock data is calculated using Eurostat patent data, while REDI data is specifically measured (Szerb et al., 2013, 2020). In the patent function, specific data are sourced from Eurostat, such as data on registered patents, employment, and R&D expenditure. Meanwhile, ENQ data is calculated using EU Framework (FP) data (Varga & Sebestyén, 2017), and national patent stocks are calculated using Eurostat patent data.



Source: Varga, Sebestyén, et al. (2020)

Figure 4. 3. TFP block construction

The economic impact of regional policy interventions is assessed in the second block using a Spatial CGE (SCGE) model. The model in the SCGE block is a computable general equilibrium (CGE) model that incorporates a spatial dimension to account for both short-run and long-run equilibrium. Regional policies that affect total factor productivity (TFP) cause changes in regional output, leading to short-run market disequilibria within and across regions. Short-run equilibrium occurs when regions individually are already in supply and demand equilibrium. However, there will be differences in utility between regions, which may lead to labor migration, externalities, or agglomeration effects. Long-run equilibrium occurs when there are no more differences in utility between regions. These effects affect not only the region where the policy is implemented but also neighboring regions. In the long run, a market equilibrium will be reached where utility differences between regions are no longer considered. Most of the data used in the SCGE model are obtained from Eurostat for all spatial units in the NUTS 2 region. This includes regional gross value added, employment, wages, housing stock and population data. However, data for variables such as regional capital stock and rented capital are specially calculated. These variables are used in the SCGE model equations, which include supply-side, demand-side, short-run equilibrium and migration equations.

In addition to R&D and human capital interventions, public venture capital investment is another policy intervention that can affect regional output. This type of investment can leverage private capital and affect the whole economy. The impact of these policy interventions on the macroeconomy is estimated in a Spatial Computable General Equilibrium (SCGE) block by calculating the short-run and long-run equilibrium. In addition, a dynamic and stochastic general equilibrium (DSGE) modelling framework is provided in the MACRO block to capture the dynamics of macroeconomic variables caused by public and private investment policy interventions in the region and other macroeconomic policy interventions. The SCGE and DSGE blocks interact in this process, including examining the impact of changes in aggregate TFP or aggregate labor and capital. Such DSGE models are commonly used by many central banks and economic analysis institutions to assess the impact of policies (Benchimol & Fourçans, 2019; Jesus et al., 2020; Xin & Jiang, 2023). The DSGE model in the MACRO block is an extension of the QUEST III model, initially estimated for the euro area (Ratto et al., 2009) and then re-estimated by Varga et al. (2018) with additional data from Central Europe. The model describes the relationship between macroeconomic sectors, such as the government, households, firms, and the foreign sector. The data for the DSGE model come mostly from Eurostat and OECD databases, and policy interventions at the macro level are designed based on macroeconomic policy models.

4.3.2. Economic impact analysis mechanism

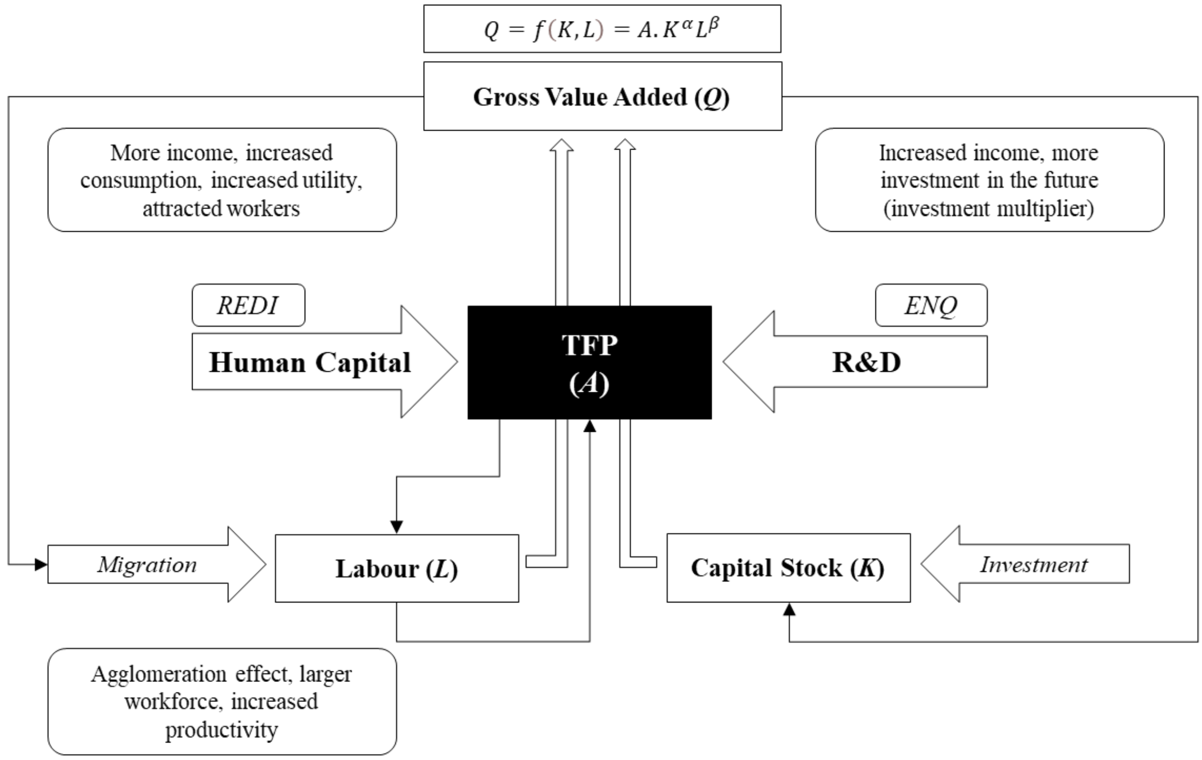
In general, the process that takes place in the GMR-Europe model, as shown in **Figure 4.2**, can be described in four primary stages:

1. The overall process within the three main blocks of GMR-Europe involves policy interventions using the abovementioned instruments, which first change the initial conditions of a particular block. For example, support for research and development or human capital (such as education or entrepreneurship) will increase total factor productivity (TFP), increasing regional output and potentially changing regional employment conditions. This process takes place within the TFP block. Meanwhile, policy interventions related to investment instruments occur in the SCGE block, which will increase the factor of production in the form of capital stock, not only increasing regional output but also affecting changes in employment.
2. As a result of the implementation of these three policy instruments, there will be differences in utility between regions. Some regions will become more attractive, leading to long-term migration effects or increasing externalities. Changes in regional output and TFP will affect TFP at the national level. If a productive region becomes more productive (even without an increase in TFP), the average TFP at the macro level will also increase, subsequently

affecting the Macro block and contributing to output and employment growth at the macro level.

3. Regional TFP is aggregated to national TFP in the Macro block. Aggregate changes in labour (L) and capital (K) variables at the national level are distributed to regions according to the spatial pattern of productivity or investment policy instrument effects.
4. The SCGE block is run with the variables derived from the Macro block and calculates the short-run and long-run equilibrium of all affected variables. The values in the SCGE block are continuously calculated until they equal the values of the same variables in the Macro block.

In the GMR modeling structure, specific policy instruments affect specific economic variables directly or indirectly related in different blocks. In other words, each particular policy instrument is strongly associated with a particular output. For example, an R&D policy instrument aimed at improving the quality of regional knowledge networks (measured by ENQ) or a human capital improvement policy aimed at improving regional entrepreneurial capabilities (measured by REDI) has a direct impact on regional productivity estimated in the regional TFP block, but it also indirectly affects changes in the regional SCGE block and the Macro block. Other policy instruments, such as investment support or public infrastructure development, may directly affect macro variables estimated in the Macro block or indirectly affect macro variables through the regional SCGE block, causing changes in national TFP. However, while there are mechanisms by which the impact of investment instruments can be directly linked to TFP, the likelihood of the economic impact of investment directly on TFP is relatively small. As reported by Haider et al. (2021), in the context of the European Union, physical infrastructure was found to have a small partial impact on long-run productivity. Investments in physical infrastructure positively impact the economy in the short run by increasing the capital stock and employment. However, productivity or TFP highly depends on R&D support and human capital development.



Source: Author's elaboration

Figure 4. 4. The feedback mechanism of the economic impact analysis

The feedback mechanism of the economic impact analysis of the three policy instruments (investment, R&D, and human capital) on the three main economic variables measured in this study (GVA, employment, and TFP) is presented in **Figure 4.4**. The economic effects and interactions between policy instruments and economic variables can be explained using the Cobb-Douglas production function approach. *First*, the relationship between investment instruments and key economic indicators such as employment, Total Factor Productivity (TFP), and Gross Value Added (GVA) occurs first through an increase in physical capital (capital stock). Increased capital stock can affect output (GVA) through increased productivity. If supported by a large capital stock and a large labor force, higher regional productivity allows all three to drive higher output growth. When output growth is high, people have more income, some of which can be spent and some saved, the former leads to increased consumption and the latter to increased investment. Consumption and investment drive growth by increasing the demand for products and improving the factors of production.

Second, the relationship between R&D investment and these three economic factors is established through the effect of R&D support on total factor productivity (TFP). One of the effects of R&D support in a region is the potential increase in new knowledge, such as patent applications. However, in the TFP block (**Figure 4.3**), the interaction between R&D support and patent applications is strongly influenced by the knowledge network quality (ENQ). The higher the ENQ in a region, the higher the potential for new knowledge creation (ceteris paribus). A higher number of patents contributes to an increase in production efficiency. As explained earlier, increased production can lead to increased income, which contributes to increased growth through increased demand for products and increased demand for factors of production such as migration and investment. It should be noted, however, that substantial R&D spending can lead to a decline in TFP growth due to diminishing returns to scale. An increase in TFP can also lead to decreased employment due to increased production efficiency or increased use of technology in the production process. This means that the output can be produced with less labor. As a result, in measuring economic impact, increased R&D support may have a much larger impact on TFP, but a much smaller impact on employment conditions.

Third, the impact of human capital policies on these three variables is often limited. According to Varga et al. (2020), the impact of human capital support on regional productivity (TFP) is strongly influenced by the quality of regional entrepreneurship development (REDI) (**Figure 4.3**). The higher the REDI in a region, the greater the impact of human capital on TFP (ceteris paribus). The impact of human capital policies is also highly dependent on the support of the institutional infrastructure in accelerating the technology adoption process so that improving the quality of human capital can impact productivity, leading to higher output and income. This, in turn, increases interregional utility differentials, encourages migration, and has implications for changing conditions and labor markets.

In this study, the author evaluates the economic impact of one or more policy interventions to determine whether coordination between the national and regional governments in a multilevel governance context is necessary to enhance the economic impact of regional policy such as smart specialization. Various interventions through policy instruments, including investment, research and development, and human capital, are simulated at both levels of government (regional and national), and their economic impact is evaluated through changes in several key economic indicators, such as gross value added (GVA), employment, and total factor productivity (TFP). The author argues that optimizing the economic impact of smart specialization requires strategically allocating financial resources to appropriate policy instruments and regions or levels of government. This leads to the question of determining the most appropriate policy instrument and the optimal allocation of financial resources to maximize economic impact. The answer lies in assessing the economic impact of implementing one or a combination of policy instruments at the regional level while taking into account the national economic impact.

In the next section, the author demonstrates the logic behind analyzing policy impacts using the GMR-Europe model in the context of different levels of governance at the national and regional levels. The different settings between policy instruments, regions, and government levels are considered to align with the multilevel governance approach. The simulation also aims to demonstrate the potential and capability of the GMR-Europe model to assess the impact of policy instrument interventions at both regional and national levels.

4.3.3. Selection of case studies in Hungary

The author chooses Hungary as one of the European Union (EU) member states in the central and eastern regions that received a large allocation of funds in the Smart Specialization Strategy's 2014-2020 and 2021-2027 programming periods. In the 2014-2020 Cohesion Policy programming period, Hungary was allocated more than EUR 25 billion in European Structural and Investment (ESI) funds and more than EUR 4.5 billion in national contributions. In the 2021-2027 programming period, Hungary has been allocated more than EUR 21 billion in ESI funds. ESI funds consist of several types of funds, the three most dominant being the European Regional Development Fund (ERDF), the Cohesion Fund (CF) and the European Social Fund (ESF), which are strongly linked to regional economic development and European cohesion objectives. These funds are allocated within Hungary's nine national and regional programs for various priority areas and programs, such as transport and energy infrastructure, SME competitiveness, employment, environmental protection, research and innovation, and various social and educational investments for inclusion purposes.

Hungary has a particular operational program called the Economic Development and Innovation Operational Program (EDIOP) for less developed regions (LDRs). EDIOP is a policy instrument corresponding to the EU thematic priorities for strengthening research, technological development and innovation in LDRs. The program has a limited territorial focus on six LDRs in Hungary, namely HU21-Central Transdanubia, HU22-Western Transdanubia, HU23-Southern Transdanubia, HU31-Northern Hungary, HU32-Northern Great Plain and HU33-Southern Great Plain. EDIOP manages structural fund resources, dominated by ERDF, ESF and CF, totaling 9 billion euros in the S3 programming period 2014-20. Meanwhile, Hungary's more developed central region (HU10-Central Hungary) manages structural funds specifically allocated to the Competitive Central Hungary Operational Program (CCHOP), totaling 913 million euros. In short, EDIOP is motivated by the dominant role of the Central Hungary region in the development of science, technology and innovation in Hungary.

In order to bridge the innovation gap between regions, EDIOP was established separately from the Central Hungary program, which provides RDI funding specifically for LDRs. According to www.nkfih.hu, 52 call titles/codes of 15 call types were allocated in EDIOP between 2015-18, funding 1,240 projects in six LDRs in Hungary during the 2014-20 budget period. This is an important step, given the significant innovation gap between Central Hungary and the other six regions. Strategic measures, including operational programs targeting LDRs, are essential to reduce the regional disparity. However, questions arise regarding the allocation of resources and the overall impact of these programs on innovation and the Hungarian economy (Birkner, Mészáros, et al., 2022; Nyikos & Soós, 2020; Szalavetz, 2014). It is essential to assess the effectiveness of these policies and their impact at the regional and national levels. An equitable distribution of funds to LDRs may stimulate regional innovation and economic growth, but the national impact may require cooperation between institutions and levels of government (Dąbrowski, 2013; Landabaso, 1997; Potluka & Liddle, 2014).

Research, development and innovation (RDI) strategies and operational programs (OPs) in Hungary are designed and formulated at the national level by the central government through the National Office for Research, Development and Innovation (NRDI). The initiatives and priority alignment in the S3 document are based on and refer to Hungary's long-term national RDI strategy, adapted to the S3 policy rules and framework for the 2014-2020 and 2021-2027 programming periods. One of the processes of identifying priority sectors or technologies was formally carried out by the NRDI Office by evaluating the *ex-ante* and *ex-post* impact of the selection of priority industries using the GMR-Hungary model, which analyzes the economic impact of policies down to the lowest regional unit of 20 NUTS 3 regions of Hungary (Varga, Szabó, et al., 2020a). These efforts led to the development of operational programs (OPs), whose implementation is overseen by three relevant ministries: the Ministry of National Economy (NGM), the Ministry of Human Capacity (EMMI), and the Prime Minister's Office (ME). Although S3 is an important part of the EU Cohesion Policy, many opinions have been expressed questioning whether S3 as a place-based policy can be implemented according to the principles of multilevel governance as other EU regional policies are implemented. There are limited studies in this regard at the EU level, including some in Hungary, which show that many other EU regional policies still face challenges at different levels of governance. On the other hand, the results of many studies on smart specialization, both in developed and less developed regions, recommend the importance of multilevel governance to increase the success and impact of smart specialization policy for regions and member states (Blažek & Morgan, 2018; Ghinoi, Steiner, Makkonen, et al., 2021; Pugh, 2018).

Kovács (2013) shows that the multilevel governance (MLG) approach, which characterizes EU-initiated development projects, has not been able to influence the smooth implementation of EU regional policies in Hungary. One of the major EU projects, which made the city of Pecs in the Southern Transdanubia region the first city in Hungary to participate in the European Capital of Culture (ECC) project in 2010, provided a great opportunity for Hungary to make a paradigm shift in development implemented in a multilevel and territorial governance mode. The ECC was implemented on the basis of the principle of partnership in accordance with the character of the MLG, involving European actors and Hungarian stakeholders at different levels. Unfortunately, the principles of the MLG were not fully applicable in this EU project, as the state could not guarantee the independence of the local authorities due to the lack of empowerment of local resources. Although regionally based EU projects are based on creative initiatives of local intellectuals and bottom-up policy approaches, local authorities may lose control over the process due to weak local financial support and competing interests between intellectuals and local political elites. As a result, they lose the opportunity to create a new development paradigm with the power of local cohesion.

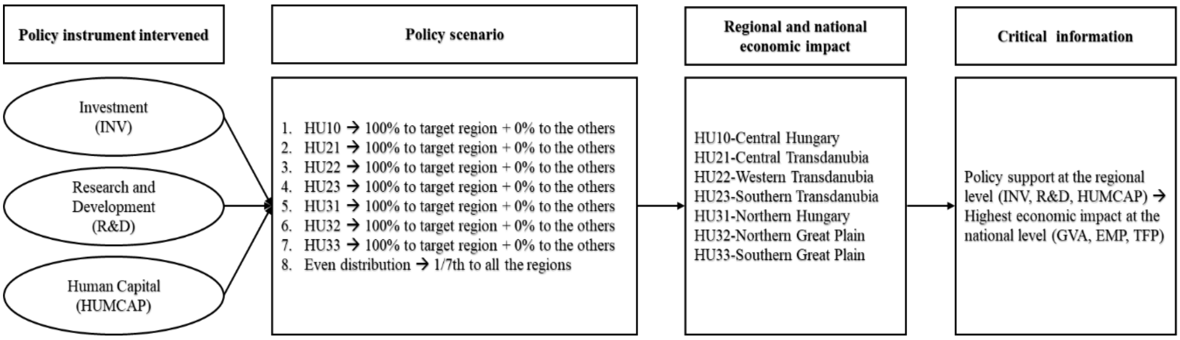
In another policy case, Leventon (2015) in his study discusses Hungary's non-compliance with EU-mandated maximum limit standards for harmful elements in drinking water. Approaching the analysis from an MLG perspective, he argues that the mismatch between policy design and implementation is largely due to the resistance of local institutions to the new paradigm shift in policy governance, which ultimately affects the level of compliance of countries and regions with the policy specifically designed at the EU level. Moreover, the EU has encouraged Hungary to strengthen its climate and energy policies and to target decarbonization by 2030 and 2050. However, according to Szabo et al. (2021), the implementation mechanism of the EU energy policy with MLG approach is still in the shadows due to the background of historical relations between Hungary and Russia in terms of nuclear technology cooperation and hydrocarbon energy consumption. Kovács (2020) mentioned that Hungary needs more political and professional efforts to develop better governance by taking into account local socio-economic and cultural issues. However, although EU regional policy encourages bottom-up initiatives, political elites and the central government do not seem to have a strong conviction to delegate authority to the regions.

4.3.4. Policy Simulation 1: Optimization at the national level

Based on the above background, the author justifies the selection of Hungary as an EU Member State consisting mainly of less developed regions (LDRs), where the adoption of place-based regional policies such as smart specialization still faces many challenges at different levels of government. Policy Simulation 1 aims to show whether the economic impact assessment of a policy can provide insights for the national and regional governments to implement EU regional policies using a multilevel governance approach. The authors use three policy instruments - public investment (INV), research and development (R&D), and human capital development (HUMCAP) - that can affect regional and national economies, using the GMR-Europe economic impact model. The simulation presents policy interventions through financial support arrangements in different policy instruments and assesses their impact on economic conditions at different levels of government.

To simplify the impact simulation process, we assume that Hungary will receive X million Euros each year during the Smart Specialization (Cohesion Policy) programming period from 2021 to 2027, and these funds can be decentralized or allocated at the regional level. We have chosen a value of X equal to 1% of Hungary's national GDP as the basis for the policy shock and spread this amount evenly over a seven-year period, based on the historical trend of the distribution of EU funds and Hungary's previous experience (Varga, Szabó, et al., 2020b). The economic impact considered here is the relative difference between the baseline scenario and the simulated scenario, or the deviation from the baseline caused by the intervention in each instrument. These additional resources are allocated separately to each policy instrument (INV, R&D, and HUMCAP), as described in **Figure 4.5**.

In order to simplify the calculation process on the one hand and to take into account priority programs in certain regions on the other hand, Scenarios 1-7 were carried out by allocating all additional funds for policy interventions to only one particular region (100%) and not allocating any funds to other regions (0%). In scenario 8, the additional funds are distributed equally to all regions. The purpose of the additional funding in this simulation is to determine which of the three instruments will have the greatest economic impact at both the regional and national levels. Specifically, Policy Simulation 1 aims to find the best spatial allocation of policy support in terms of national economic impact. The simulation results will also indicate possible improvements in the funding policy for each instrument in the future.

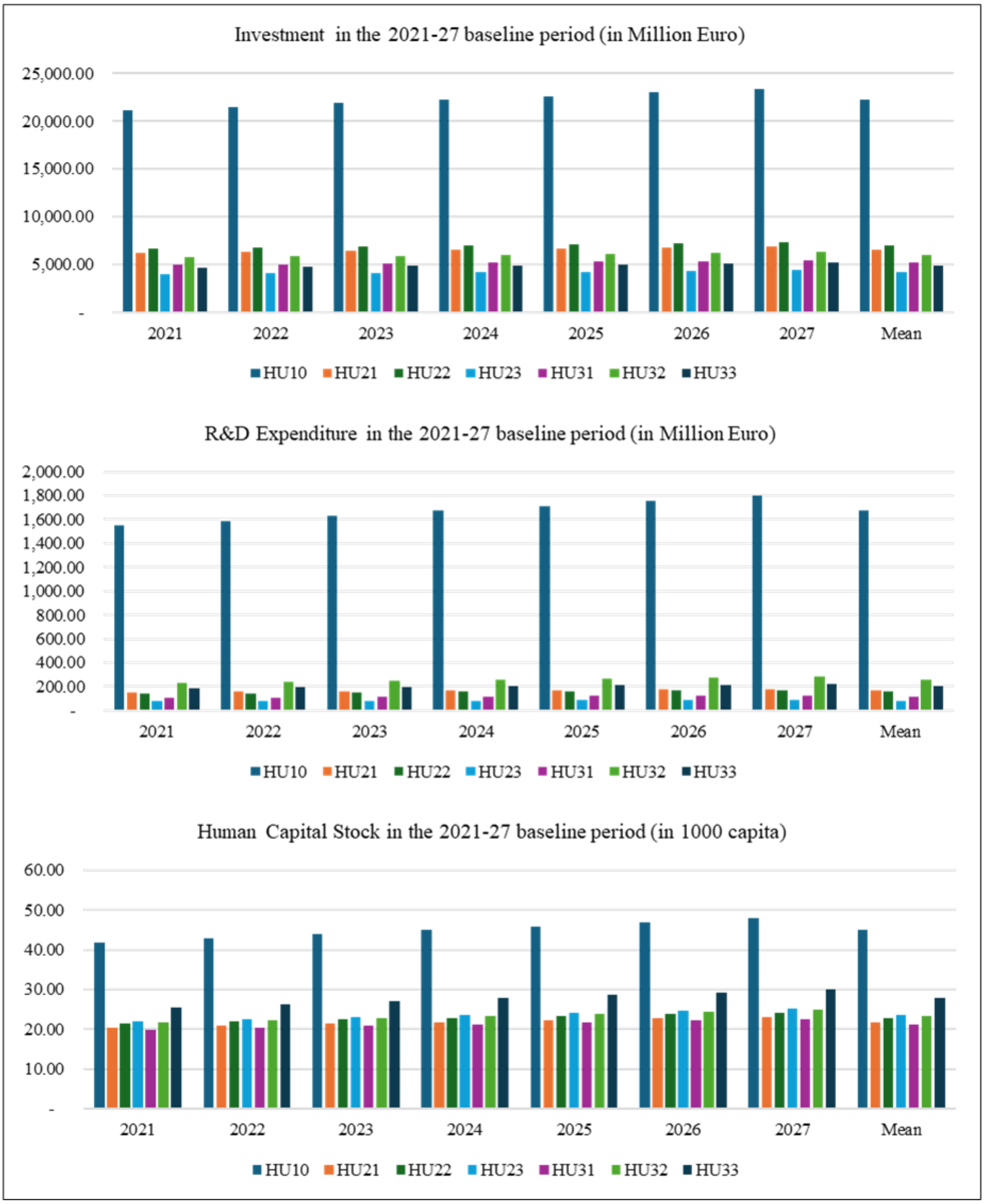


Source: Author's elaboration

Figure 4. 5. Process flow of Policy Simulation 1

Based on **Figure 4.5**, the impact of INV, R&D, and HUMCAP policy interventions in GMR-Europe refers to the following conditions:

1. The simulation base year is 2021, and the TFP block baseline follows the empirically adjusted trend until 2041.
2. Financial resources are added to the target region in 2021 - 2027, and the estimated economic impact is calculated in 2021 - 2041.
3. Policy interventions are made by allocating the ESI funds received by the country (Hungary), placing them in each instrument and simulating according to the settings of scenarios 1-8.
4. After all scenarios have been run and simulated, the impact of the intervention of each instrument on the economic variables can be observed in the form of absolute or percentage increase in gross value added (GVA), employment (EMP) and TFP growth.
5. The national-level policy simulation aims to identify "*policy instruments at the regional level that have the greatest potential to generate the most optimal economic impact at the national level*".



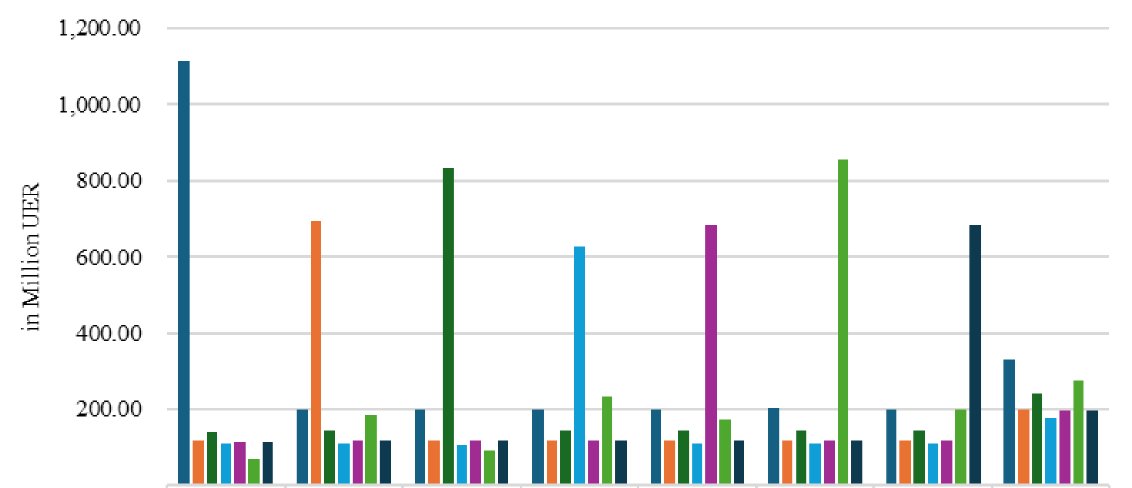
Source: Author's elaboration

Figure 4. 6. Distribution of support for the three policy instruments in each region in 2021-2027 and their average values

Figure 4.6 shows the average initial conditions of each policy instrument in each region in 2021-2027 after receiving additional effort. The significant difference in support for these three instruments between the capital region (HU10-Central Hungary) and the other six regions is quite apparent. As mentioned earlier, six out of seven regions in Hungary are classified as less developed regions (LDRs) and have established specific operational programs for regional development in these regions. The reason for this becomes clear when we assess the status of the three policy instruments shown in **Figure 4.6**.

Policy Simulation 1 aims to assess the regional and macroeconomic implications of policies supporting investment (INV), research and development (R&D), and human capital (HUMCAP) at the regional level. To analyze the impact of these policies, it is crucial to consider the factors influencing their effectiveness using the GMR-Europe model (as in **Figure 4.2**, **Figure 4.3**, and **Figure 4.4**). Patents are a measure of new economically valuable knowledge creation. This knowledge can be advanced through R&D funding and enhanced knowledge networks within TFP blocks (**Figure 4.3**). An increase in regional patents ultimately influences regional technology levels (patent stock), contributing to total productivity according to the total productivity (TFP) workflow. Another factor impacting TFP is human capital (HUMCAP). Policies focusing on enhancing HUMCAP to boost TFP involve developing regional entrepreneurial skills, strongly encouraged by the smart specialization policy. Improving local human resource capabilities can be achieved by enhancing local entrepreneurial skills through entrepreneurship training or workshops. Additionally, public investment, such as infrastructure development, can stimulate local economic activity by increasing the region's capital stock. The impact of investment on regional output can be explained using the Cobb-Douglas production function, considering other inputs like labor and private capital in the region. Public investment will ultimately influence regional productivity or result in changes in regional TFP, and the effects of these changes are computed in the SCGE block. Changes in regional TFP will then lead to adjustments in aggregate TFP, with the resulting impact on the macroeconomy calculated in the Macro block.

The GMR model can analyze different variables at different levels of government. In this analysis, the author shows the effect of policy interventions (INV, R&D, and HUMCAP) on gross value added (GVA), employment (EMP), and total factor productivity (TFP). The simulation results are presented as graphs showing the percentage deviation of GVA, EMP, and TFP values. These results illustrate the changes in these economic variables after implementing additional efforts. Policy Simulation 1 is designed to analyze the national economic effects influenced by policy interventions at the regional level. The regional-level simulation results are presented as averages over the horizon 2021-2041, with eight scenarios for each instrument. The national-level simulation results are presented in two figures; the *first* figure shows the evolution of the impact over time, while the *second* figure shows the average effect in the long run.

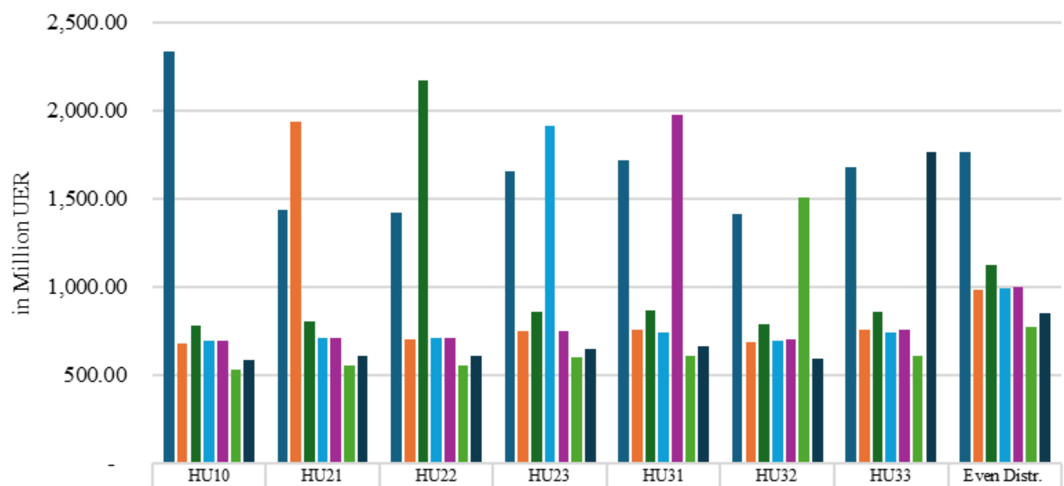


	HU10	HU21	HU22	HU23	HU31	HU32	HU33	Even Distr.
HU10	1,114.16	199.99	199.74	200.03	199.97	202.94	200.03	332.92
HU21	117.85	695.99	118.41	118.60	118.55	118.87	118.63	201.21
HU22	141.34	142.26	833.94	142.31	142.25	142.81	142.36	241.44
HU23	109.50	110.45	108.16	626.15	110.17	111.21	112.05	179.50
HU31	115.58	116.25	116.11	116.29	684.25	116.65	116.32	197.58
HU32	70.84	186.27	93.13	234.89	172.35	854.20	200.71	276.05
HU33	115.66	116.22	116.11	116.25	116.22	116.48	683.49	197.42

Source: Author's elaboration

Figure 4. 7. Economic impact of INV support on regional GVA

The analysis presented in **Figure 4.7** shows the impact of investment policy shocks on gross value added (GVA) at the regional level. Based on the simulation results, concentrating 100% of the investment funds in a particular region can have a significant impact on that region compared to other regions that do not receive these funds. Central Hungary experienced the largest impact of the investment intervention, with an estimated average GVA impact of around EUR 1,114 million. Meanwhile, Western Transdanubia and Northern Great Plain have a significant impact among the group of LDRs, with an average GVA value of more than EUR 800 million if fully supported by the investment instrument. On the other hand, the other four regions have an average GVA impact lower than this value when fully supported by investment instruments. Furthermore, the total GVA impact is significantly reduced to between EUR 179 million and 323 million if the investment instrument is evenly distributed across the seven regions. However, the three regions mentioned above still have a higher GVA impact than the other regions.



	HU10	HU21	HU22	HU23	HU31	HU32	HU33	Even Distr.
HU10	2,334.79	1,434.15	1,422.08	1,658.17	1,717.78	1,409.16	1,675.88	1,767.13
HU21	679.69	1,936.60	699.31	747.68	758.24	689.18	753.94	983.91
HU22	777.75	803.66	2,169.87	856.34	868.05	790.54	862.78	1,122.47
HU23	694.10	709.02	707.92	1,913.98	745.42	697.91	744.50	992.87
HU31	694.42	712.79	711.30	751.29	1,972.16	700.80	756.91	1,000.87
HU32	533.50	553.62	551.58	600.25	611.75	1,508.45	606.33	769.84
HU33	588.61	607.53	605.71	650.91	661.13	596.40	1,761.78	854.11

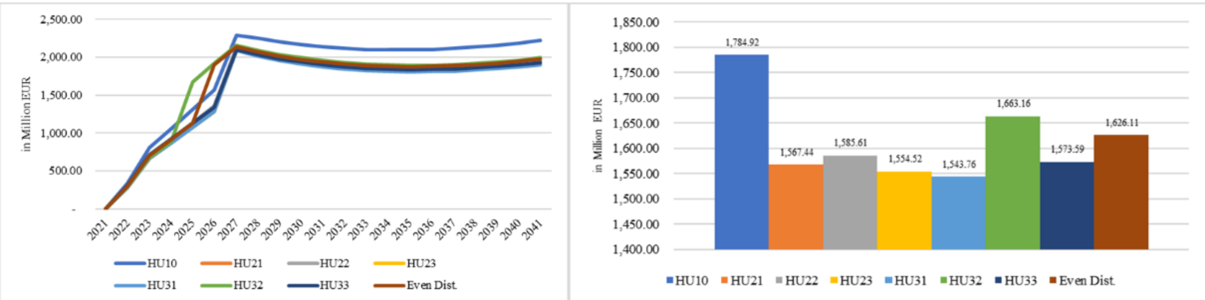
Source: Author's elaboration

Figure 4. 8. Economic impact of R&D support on regional GVA

The graph in **Figure 4.8** illustrates the impact of R&D policy shocks on GVA at the regional level. As with investment policy shocks, allocating 100% of R&D funds to a region significantly impacts GVA growth in that region. Regions that receive this R&D support can increase their GVA by at least twice as much as regions that do not. For example, Western Transdanubia experienced an average GVA increase of about EUR 2,169 million, which is close to the GVA value of Central Hungary of EUR 2,334 million. This amount exceeds the GVA of the other five LDRs. However, three of these five regions, namely HU21, HU23, and HU31, have high GVA values, indicating high productivity due to R&D support. The even distribution of R&D support seems to reduce the GVA effect in each region. Nevertheless, the first two regions still have the potential to achieve average growth between 1,000 and 1,700 million EUR, while the other LDRs only achieve average growth between 769 and 1,000 million EUR.

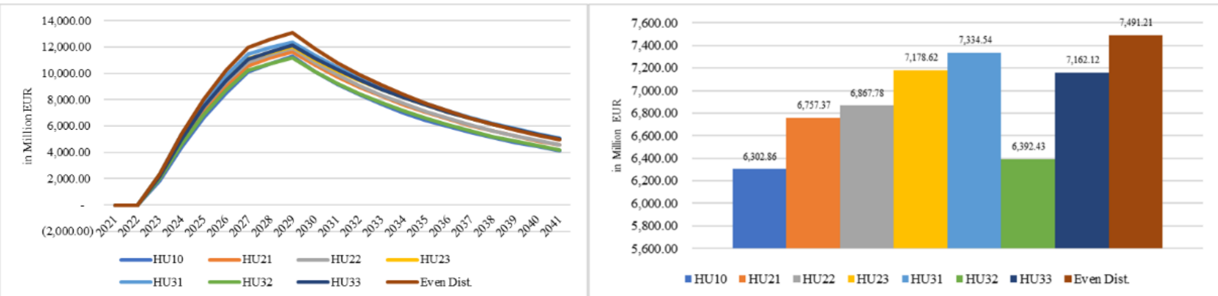
Figure 4.9 and **Figure 4.10** present the analysis of the impact of investment (INV) and R&D policy shocks on national GVA. In **Figure 4.9**, the left-hand side shows the long-run impact of regional investment policies on national GVA. The national impacts of investment shocks that affect only one region (while other regions receive no shocks) are relatively close to each other. The largest impact of investment shocks on national GVA occurs in region

Central Hungary (around EUR 1,784 million). The impact of regional investment shocks on national GVA is smallest in Northern Hungary (EUR 1,543 million) and largest in Northern Great Plain (EUR 1,663 million). **Figure 4.9** also shows that distributing investment shocks evenly across regions has a higher national impact than targeting specific regions, with an impact of around EUR 1,626 million, which is higher than targeting specific regions. Turning to **Figure 10**, the left-hand side shows the evolution of the impact of regional R&D policies on national GVA over time for each region. Similar to investment shocks, the impact of R&D shocks on national GVA is close to each other across regions. When R&D policy shocks are evenly distributed across regions, they have the largest impact, around EUR 7,491 million. Most regions have a similar impact but remain below this figure. On the other hand, the regions of Central Hungary and the Northern Great Plain have the smallest impact, around EUR 6,300 million, when some funds are concentrated only in their region.



Source: Author's elaboration

Figure 4. 9. Economic impact of INV support on GVA at the national level over time (left) and averaged in absolute terms (right)



Source: Author's elaboration

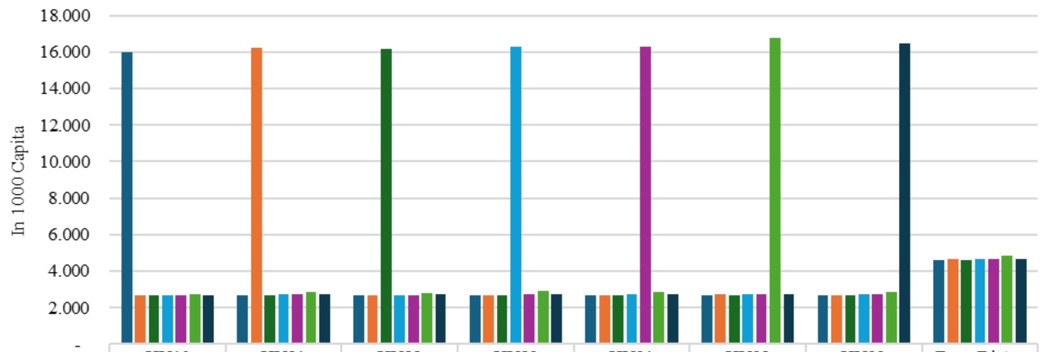
Figure 4. 10. Economic impact of R&D support on GVA at the national level over time (left) and averaged in absolute terms (right)

Comparing the two instruments, the left-hand figure shows that the long-term impact of the investment policy instrument (**Figure 4.9**) is more stable compared to the impact of the R&D policy (**Figure 4.10**), which shows a significant decline towards the end of the simulation period. The funding period for this simulation is 2021-2027 (as a baseline). Consequently, the investment and R&D policy instruments will experience a significant increase during this baseline period, but their impact will gradually decline. Without further policy support after 2027, the positive impact of policy interventions on these two instruments will likely diminish. This could happen, for example, if the capital stock depreciates after 2027, leading to a decline in the positive impact on GVA. Furthermore, despite the significant impact of investment policy interventions at the regional level (**Figure 4.7**), GVA growth at the national level continues to be dominated by Central Hungary, the national capital. Capital cities often function as hubs of economic activity, with a high density of firms, a skilled workforce, and adequate infrastructure. A robust infrastructure in the capital city, including transportation, communication, and public facilities, promotes economic efficiency and increases productivity. In addition, the administrative capacity and greater expertise in capital cities allow for more effective implementation of investment policies, maximizing the impact of even small investments (Henderson, 2010; Rodríguez-Pose, 2008; Williams, 2021). The concentration of these factors leads to an overall higher productivity effect (Ewers, 2007; Khanna & Sharma, 2021; Moretti, 2004; Rodríguez-Pose & Griffiths, 2021).

We can also find an analogy as to why investment support has a much higher impact in the capital region (Central Hungary) than in other regions by looking again at the mechanism in **Figure 4**. Investment can work optimally because of high TFP, so each addition of a unit of new capital can create more output. Meanwhile, due to the agglomeration of the economy, the stock of available labor is much larger, so the amount of output created by adding the same unit of new capital is also much more significant. The economic impact of this kind of investment support is precisely what happened in Central Hungary, as the region has advantages in physical infrastructure and economic agglomeration. The capital region has various infrastructural advantages such as transport, logistics, and communication, which facilitate the movement of goods and services and the flow of information, making the production process efficient. On the other hand, developed regions such as Central Hungary are also characterized by agglomeration. Urbanization or labor migration to the capital is most likely economically motivated or driven by the significant differences in utility with less developed regions, e.g., in the counties, which makes Central Hungary much more attractive for labor. Research and innovation facilities are better developed in Central Hungary, and most large companies are also located in the capital. As a result, companies have better access to the labor market, especially to skilled labor. Due to this synergy between a highly qualified workforce, trained human capital, and adequate R&D support, Central Hungary is much more productive, and therefore, even small investment support effectively increases output or value added.

Western Transdanubia is the second most affected region in terms of investment and R&D support. Regions such as Western Transdanubia, known for the specialization and diversification of the machinery and automotive industries, as well as Southern Transdanubia, Southern Great Plain, and Northern Hungary, which have research universities focused on biotechnology, show a higher GVA impact. This is likely due to the quality of knowledge networks and higher levels of entrepreneurship that contribute to a thriving innovation ecosystem. According to Varga, Szabó, et al. (2020b), Western Transdanubia, with Győr-Moson-Sopron as its capital, is characterized by a strong economy and industrialization driven by the machinery and automotive industries. Due to its more productive existing conditions compared to other regions, this region can effectively utilize investment and R&D support. A body of research shows that regions with highly competitive economic sectors and a diverse range of industries are more effective in managing innovation inputs such as R&D investments (Almoli & Evren Tok, 2020; J. Singh, 2008). These regions are also recognized for their strong collaborative activities and innovation networks involving universities, government agencies, and industry. These networks play a crucial role in facilitating the transfer of science and technology, thereby increasing the impact of R&D support on the economy (De Noni et al., 2018b; Kafouros et al., 2015; Rodríguez-Pose et al., 2021).

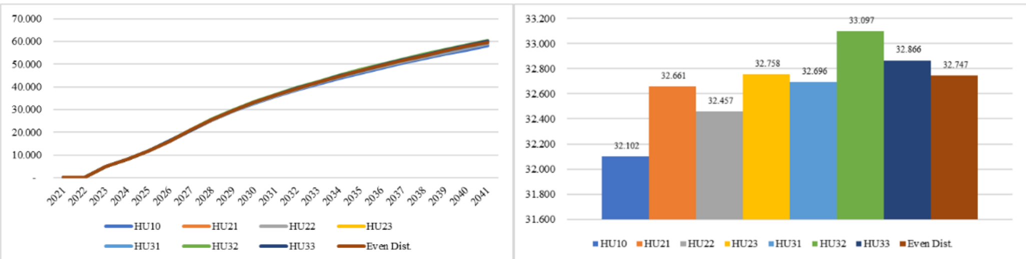
In the case of Central Hungary, the region where the capital is located, simulated R&D support has the lowest impact on national GVA. This may be because Central Hungary received much larger amounts and benefits from certain operational programs, the Competitive Central Hungary Operational Program (CCHOP). Given its role as a knowledge and resource center in Hungary, Central Hungary has a large R&D capacity. Therefore, a small amount of R&D support would probably have only a marginal effect on GVA growth. However, if the R&D support is evenly distributed across the region, its impact on national GVA will likely be much larger than if it were concentrated in one region. This underscores the opportunity to distribute R&D funding across regions to promote more inclusive and equitable growth, ultimately leading to increased innovation, productivity, and overall economic development. The initiative targeting Hungary's six less developed regions under the EDIOP program, in particular, indicates that providing equitable R&D support to the majority of Hungary's regions can enhance the R&D capabilities of the country and generate significant economic effects. In addition, the increased R&D support is expected to promote interregional cooperation, as the EDIOP program for the less developed regions of Hungary promotes cooperation through collaborative projects in various fields.



	HU10	HU21	HU22	HU23	HU31	HU32	HU33	Even Distr.
HU10	15.969	2.686	2.680	2.687	2.686	2.695	2.689	4.611
HU21	2.673	16.236	2.697	2.705	2.703	2.713	2.707	4.638
HU22	2.665	2.695	16.148	2.697	2.695	2.705	2.699	4.624
HU23	2.685	2.716	2.709	16.297	2.716	2.726	2.720	4.655
HU31	2.683	2.713	2.707	2.715	16.296	2.723	2.717	4.656
HU32	2.720	2.880	2.786	2.919	2.865	16.790	2.878	4.869
HU33	2.706	2.736	2.730	2.738	2.736	2.746	16.456	4.694

Source: Author's elaboration

Figure 4. 11. Economic impact of investment support on regional employment

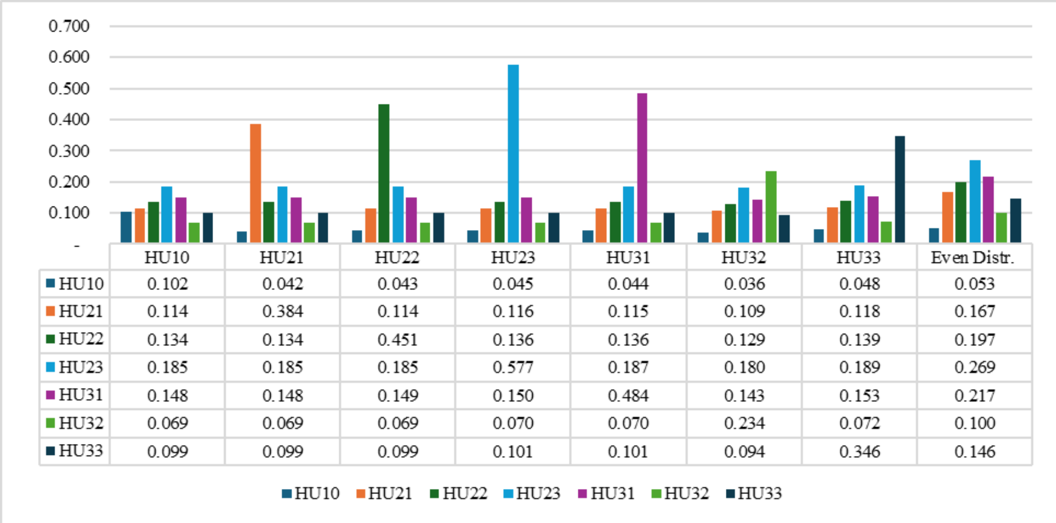


Source: Author's elaboration

Figure 4. 12. Economic impact of INV support on EMP at the national level over time (left) and averaged in absolute terms (right)

Figure 4.11 shows the impact of investment policy shocks on employment (EMP) at the regional level. Based on the simulation results, regions that receive 100% investment support experience substantial employment growth, on average eight times higher than regions that do not receive such support. In particular, the Northern Great Plain shows the most significant impact, with an increase in employment of 16,970 capita over the simulation period. The other four regions have slightly lower average impacts, with Central Hungary having the lowest impact. When the investment funds are evenly distributed across the regions, the growth impact tends to decrease, but the impact distribution becomes more equal, resulting in employment of around 4,600-4,800 capita in each region. **Figure 4.12** illustrates the impact of investment policy shocks on EMP at the national level. The simulation results show that the allocation of investment funds at the regional level can have up to twice the positive impact on EMP at the national level. In particular, targeted support for physical investment in certain regions can increase employment by between 32,000 and 33,000 capita over the simulation period. The three regions with the largest employment effects are the Northern Great Plain, the Southern Great Plain, and Southern Transdanubia. Evenly distributing investment support to each region also results in high impacts above the average region-specific allocation. In contrast to the impact of investment on GVA, which shows a declining positive trend in the long run, additional support through investment has an increasing positive trend on EMP in the long run.

It is widely recognized that investment policy instruments directed at public infrastructure can significantly boost job creation, both within the investment sector and in related sectors (Borrás & Edquist, 2013; Harrison & Rodríguez-Clare, 2010). Labor demand is generated not only during the implementation phase of the investment project, but also during the maintenance process. In addition, public investment can stimulate demand for local goods and services, thereby creating employment opportunities in the small and medium enterprise sector (Foghani et al., 2017; Gbandi & Amissah, 2014). Robust infrastructure development in regions with specific industrial advantages can stimulate the growth of industrial clusters and attract further investment in these industries. Supporting investment in specific regions can improve interregional connectivity, potentially increasing access to employment opportunities and encouraging interregional labor migration (Faggian et al., 2018; Lall et al., 2009; Sánchez-Moral et al., 2018). Simulation results at the regional level indicate that equal support for the capital region (Central Hungary) and the six less developed regions produces similar employment effects, which are generally more favorable in the long run. The results also suggest that equalizing investment support across regions has the potential to achieve better overall employment impacts, consistent with regional development objectives focused on reducing the gap between developed and less developed regions by promoting labor mobility and fostering economic growth (Crescenzi & Rodríguez-Pose, 2012; Iammarino et al., 2019).



	HU10	HU21	HU22	HU23	HU31	HU32	HU33	Even Distr.
HU10	0.102	0.042	0.043	0.045	0.044	0.036	0.048	0.053
HU21	0.114	0.384	0.114	0.116	0.115	0.109	0.118	0.167
HU22	0.134	0.134	0.451	0.136	0.136	0.129	0.139	0.197
HU23	0.185	0.185	0.185	0.577	0.187	0.180	0.189	0.269
HU31	0.148	0.148	0.149	0.150	0.484	0.143	0.153	0.217
HU32	0.069	0.069	0.069	0.070	0.070	0.234	0.072	0.100
HU33	0.099	0.099	0.099	0.101	0.101	0.094	0.346	0.146

Source: Author's elaboration

Figure 4. 13. Economic impact of R&D support on regional TFP

Source: Author's elaboration

Figure 4. 14. Economic impact of R&D support to TFP at the national level over time (top), averaged in percentage terms (bottom left) and averaged in absolute terms (bottom right)

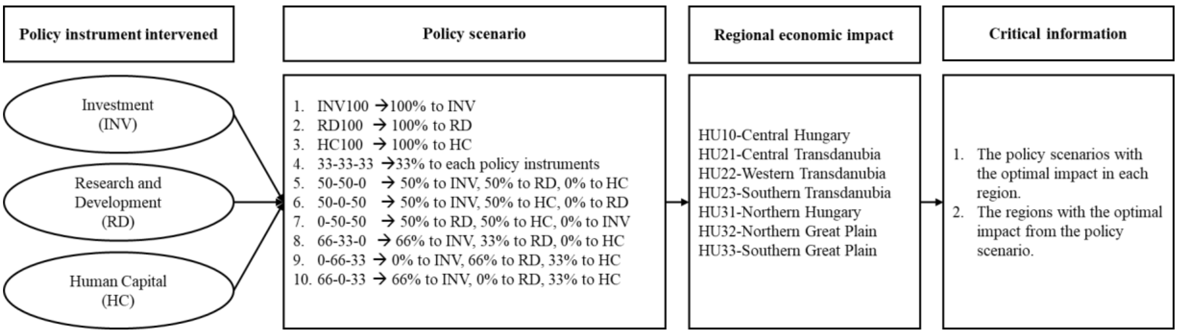
The results presented in **Figure 4.13** show the significant impact of R&D policy shocks on TFP growth at the regional level. Regions that receive full support for R&D show significant differences in TFP growth compared to regions that do not receive support. In particular, Southern Transdanubia, Northern Hungary and Western Transdanubia have the highest TFP impacts due to R&D support. The other regions show slightly lower average impacts, but Central Hungary shows a much smaller impact, about six times lower than Southern Transdanubia. Moreover, R&D support evenly distributed across the regions shows a much lower impact.

Figure 4.14 further illustrates the impact of R&D policy shocks on TFP at the national level. The simulation results show that the allocation of R&D support at the regional level can have a significant impact on TFP at the national level. This effect is particularly significant in Southern Transdanubia, Northern Hungary and the Southern Great Plain. Even if R&D support is evenly distributed among the seven regions, the average national TFP impact remains high, except in Central Hungary, which shows a minimal national TFP impact. Similar to the GVA impact simulation, the TFP impact simulation shows a similar pattern. Allocating R&D funds to Central Hungary in particular produces only a small TFP effect. Considering the larger size and more significant resources and knowledge in Central Hungary, it seems less realistic to equate R&D support in Central Hungary with R&D support in the less developed regions. It is clear that the capital region needs more adequate support to achieve the expected TFP effect.

The TFP block formulation shown in **Figure 4.3** assumes that regional innovation results from accumulated knowledge over time. This implies that the impact of R&D support on productivity and overall economic growth takes several years to be manifested. According to the GMR-Europe model, this period is estimated to be about two years after the availability of knowledge inputs. Therefore, as shown in **Figure 4.14** and **Figure 4.10**, the impact of R&D policy is expected to be realized only after 2021, when the knowledge production factor has accumulated at the regional level as a regional patent stock and then forms a national patent stock, which in turn affects TFP and GVA at the national level. An increase in TFP theoretically promotes the production of more outputs with the same level of inputs (Harb & Bassil, 2023; Lipsey & Carlaw, 2004; Rawat & Sharma, 2021). Consistent with the findings of Varga et al. (2018b) in the context of GMR simulations in different European regions, the impact on TFP in this simulation is closely related to the impact on GVA as previously described. The author notes that the simulation results of the INV and HUMCAP policy shocks are positive regarding their impact on TFP growth. However, their simulation results are not presented, given their minimal contribution to regional and national TFP.

4.3.5. Policy Simulation 2: Optimization at the regional level

In Policy Simulation 2, we simulate the estimated economic impact at the regional level of allocating funding to three policy instruments by running ten different scenarios (**Figure 4.15**). These scenarios are designed to simplify the calculation process in GMR-Europe while allowing for the possibility of prioritized programs in certain regions. For example, certain regions may be more inclined to promote physical investment policies over R&D policies or *vice versa*. The *first three* scenarios involve fully funding only one instrument (INV100, RD100, and HC100 scenarios). The *fourth* scenario assesses the impact of funding all instruments simultaneously in the region, with equal distribution for each instrument (scenario 33-33-33). The *fifth* through *seventh* scenarios distribute financial support equally between two policies and ignore another instrument (50-50-0, 50-50-50, and 0-50-50 scenarios). The *eighth* through *tenth* scenarios allocate financial support to two policy instruments, with the first instrument receiving more support than the second and the third receiving no support (scenarios 66-33-0, 66-0-33, 0-66-33). We obtained over a hundred simulation results by running these settings on GMR for each region separately. For practical reasons, Policy Simulation 2 uses the abbreviations RD for R&D policy support and HC for Human Capital policy support.



Source: Author's elaboration

Figure 4. 15. Process flow of Policy Simulation 2

After running and simulating these scenarios in GMR-Europe, we observe the economic impact of each policy intervention on three key instruments, resulting in absolute increases in Gross Value Added (GVA), Employment (EMP), and TFP growth. The simulation results show the average absolute growth over the estimation period (2021-2041) and are presented in tables and figures. The table shows the average value of the economic impact of the observed variables due to the policy intervention or policy mix applied in each region based on ten scenarios. In addition, the table also highlights which scenario is the most optimal among the ten scenarios, as well as which regions benefit the most from the implementation of the most optimal scenario. Meanwhile, the information presented in the figure below the table provides a visual representation of the different impacts of the ten scenarios per region, complementing the information presented in the table.

Policy Simulation 2 aims to assess the economic impact of ten policy scenarios, or policy mixes, implemented in each region. Among the ten scenarios, our objective is *first* to identify the most optimal policy for each region and *second* to identify which regions benefit the most from implementing each scenario. This identification is expected to provide valuable insights for the regions in three ways. *First*, by simulating the ten scenarios, a region can identify which policy or policy mix could potentially have the most optimal impact on its region. *Second*, regions should understand where they are best positioned among the ten scenarios. *Third*, suppose their region is unable to implement the scenario with the most optimal impact. In that case, they can explore opportunities to collaborate with other regions on the scenario with the highest potential impact. Regional policymakers can use this perspective when planning to allocate funds for regional development or to establish a joint operational program as part of a smart specialization strategy. This perspective can also be used by regional planning policymakers at the national level, where they can apply this approach in estimating the most optimal regional policy impact, knowing the actual conditions of each region, and finding ways to encourage regions to collaborate with other regions.

The following is an example of how to apply this approach. The illustration is based on the HU23 (Southern Transdanubia) region. *First*, based on the simulation results of the ten scenarios, the Southern Transdanubia has the potential to achieve the most optimal GVA impact under the RD100 policy scenario. *Second*, in practice, this condition cannot be applied in the HU23 region; the most appropriate or closest to the HU23 combination is the 66-33-0 policy mix. In other words, the Southern Transdanubia prioritizes investment policy (with a larger share) over R&D policy, while the human resource development policy gets the smallest share. *Third*, Southern Transdanubia tries to optimize the impact of GVA by increasing R&D efforts. Therefore, policymakers in Southern Transdanubia needs to look for opportunities to cooperate with other regions that have better policy priorities in terms of R&D. To achieve this, the Southern Transdanubia government can coordinate with regional development planners at the national level to identify which regions are likely to cooperate to achieve the development goals of the Southern Transdanubia based on their specific conditions. We expect other regions to follow the same path as the Southern Transdanubia under the central government's guidance. In this way, regions can collaborate to develop joint initiatives involving government and other stakeholders across different regions or levels of government within a smart specialization framework or by using a multilevel governance (MLG) approach. Each region can effectively maximize the benefits of a particular policy or policy mix through projections made with GMR-Europe's policy impact modeling.

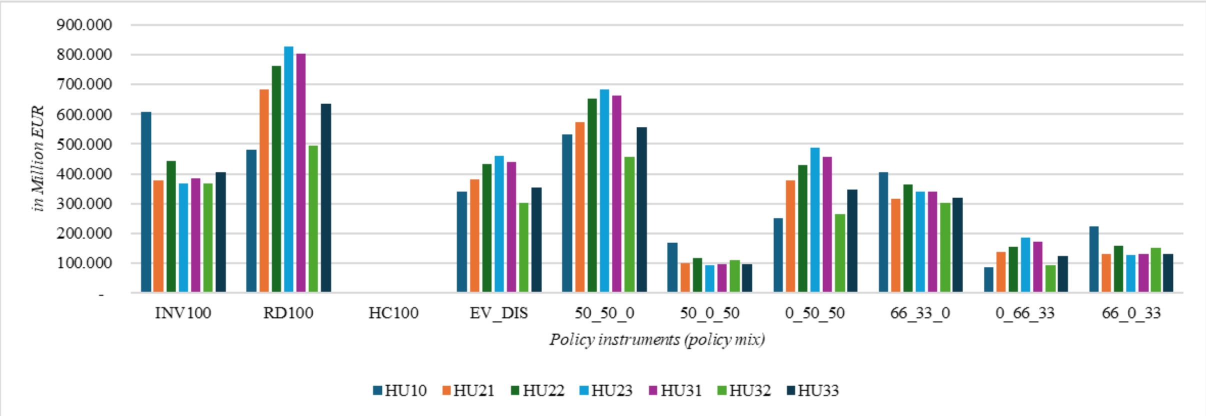
Referring to **Table 4.3**, the first three policy scenarios show that policy interventions such as the RD100 scenario have the largest impact on GVA in the six regions (LDRs). Meanwhile, in HU10-Central Hungary, the scenario represented by INV100 plays the most significant role in driving GVA growth in the region. Allocating all funds to investment (INV100) has the highest impact for Central Hungary, while the other six regions experience a 40% lower impact. This is similar to what has been explained in **Figure 4.8** and **Figure 4.9**, where the support of investment instruments concentrated in Central Hungary has a significant effect for the reasons already explained in that section, based on the mechanism described in **Figure 4.4**. Investment support that is 100% dedicated to a specific region can indeed have an optimal impact on that region. However, on the one hand, the impact of such support on Central Hungary would be very significant if it were fully allocated to the region. On the other hand, when investment support is fully allocated to other regions, the impact on Central Hungary is relatively higher compared to other regions that do not receive support. This is also the case when the support is equally distributed to all regions. Referring to **Table 4.3** and **Figure 4.16**, it is clear that the investment instrument (INV100) is the most optimal instrument to support GVA optimization in Central Hungary.

Furthermore, when the amount of R&D support is reduced or eliminated, the impact of alternative policies on GVA decreases proportionally, as in the following scenario descriptions. Equalizing funds among the three instruments, as in Scenario 33-33-33, does not significantly change the GVA impact. Also, this scenario reduces the GVA effect in Central Hungary. A balanced policy mix of investment with R&D (in the 50-50-0 scenario) or human capital with R&D (in the 0-50-50 scenario) can lead to relatively high regional GVA effects. However, this effect is significantly reduced when R&D support is removed (in the 50-0-50 scenario). In the second three scenarios, the combination of R&D and investment policies has a higher impact than the combination of R&D and HC. The last three scenarios show that when the amount of investment support is increased, and R&D support is reduced, as in the 66-33-0 scenario, the average regional GVA impact decreases compared to the balanced investment and R&D scenario. This decline is even more pronounced when R&D support is removed and replaced by HC support, as in the 66-0-33 scenario. The regional GVA impact becomes smaller when investment support is removed, although R&D support is higher than HC support (as in the 0-66-33 scenario).

Table 4. 3. Average absolute value of the impact of policy support (policy mix) on regional GVA (in million Euro)

	HU10	HU21	HU22	HU23	HU31	HU32	HU33	Max. among regions	
INV100	607.530	378.841	441.798	369.306	384.614	369.005	404.866	**607.53**	**HU10**
RD100	481.745	683.033	762.703	826.873	802.001	494.109	635.758	**826.87**	**HU23**
HC100	0.002	0.001	0.001	0.001	0.001	0.001	0.001	**0.00**	**HU10**
EV_DIS	342.074	380.917	432.197	461.281	440.280	302.310	354.727	**461.28**	**HU23**
50_50_0	532.804	575.170	651.834	683.149	661.811	457.465	554.945	**683.15**	**HU23**
50_0_50	167.723	99.275	118.840	93.821	97.690	110.798	97.740	**167.72**	**HU10**
0_50_50	252.023	379.643	428.578	486.153	458.239	263.833	346.398	**486.15**	**HU23**
66_33_0	406.417	317.865	363.799	340.547	340.280	301.093	319.125	**406.42**	**HU10**
0_66_33	85.170	137.985	156.886	187.380	170.949	92.931	123.786	**187.38**	**HU23**
66_0_33	223.623	132.354	158.439	126.548	130.237	151.305	130.300	**223.62**	**HU10**
Max. among instruments	**607.53**	**683.03**	**762.70**	**826.87**	**802.00**	**494.11**	**635.76**		
	INV100	**RD100**	**RD100**	**RD100**	**RD100**	**RD100**	**RD100**		

Source: Author's elaboration



Source: Author's elaboration

Figure 4. 16. Impact of policy support (policy mix) on regional GVA

The ten regional GVA scenarios show that R&D support significantly impacts GVA growth, especially in the less developed regions (LDRs) of Hungary (**Figure 4.16**). Reducing R&D support will gradually reduce the GVA impact but increasing investment support can help offset it. Policy simulation 2 shows that R&D support substantially GVA impacts all LDRs except Central Hungary. The impact is highest in Southern Transdanubia and lowest in the Northern Great Plain. Most policy mixes also provide the most significant benefits in the

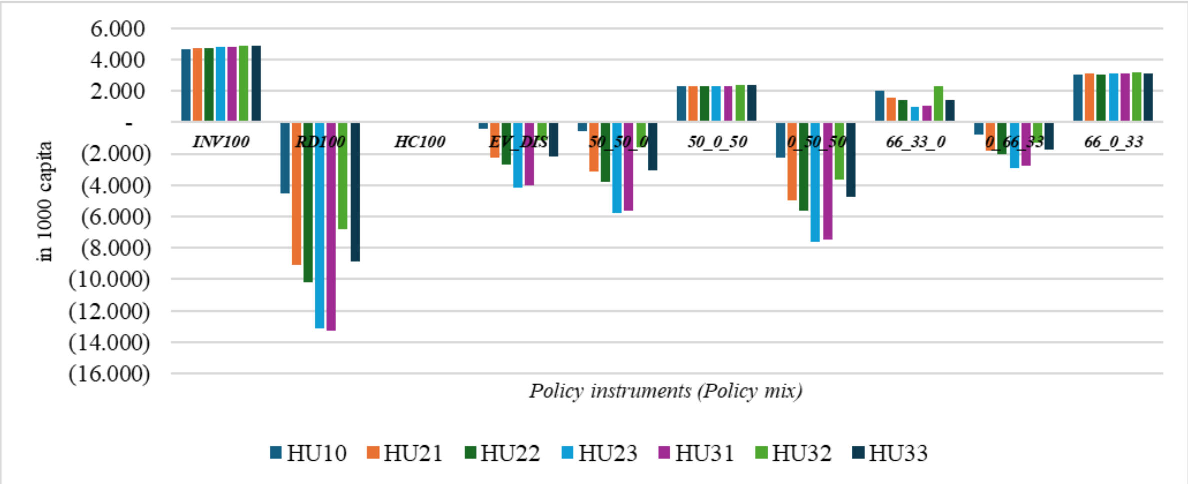
Southern Transdanubia region, with five policy mixes showing this. This region consistently showed GVA impacts that were, on average, one and a half to two times stronger than other regions. Experts and studies show that R&D spending plays a vital role in innovation, which is a crucial driver of productivity (Audretsch & Belitski, 2020; Lopez-Rodriguez & Martinez-Lopez, 2017; Venturini, 2015). Focusing R&D on technological upgrading or optimizing regional knowledge inputs can increase efficiency and productivity in the supported sectors (De Noni et al., 2017). In less developed regions, R&D support can significantly increase GVA, especially as these regions may be starting their growth from a lower base. R&D support tends to generate new knowledge that can spread to other firms or industries, leading to spillover effects (Beugelsdijk et al., 2018; Sterlacchini, 2008) Moreover, R&D support helps diversify the local economy or develop new knowledge-based and dynamic sectors, such as biotechnology, which is spread across several regions in Hungary, or traditional sectors that are growing faster due to the digitalization drive of the economy.

The TFP block of the GMR Europe model (**Figure 4.3**) shows that R&D support can boost regional productivity by increasing the region's scientific and technological capacity. Then, the spillover effect strengthens the impact of R&D on innovation, productivity and value added. According to the mechanism illustrated in **Figure 4**, R&D support can have an optimal impact on GVA in most LDRs due to sizeable external knowledge potential in the region characterized by high ENQ values and relatively low R&D levels. Thus, R&D support in LDRs can optimally impact GVA due to a significant boost from increased TFP. The case of the Northern Great Plain (the capital is Debrecen) is somewhat different. Although RD100 support significantly affects changes in GVA in LDRs, the Northern Great Plain's effect is not very large, even similar to the case of Central Hungary. This is because the Northern Great Plain has the highest initial R&D expenditure among the other LDRs or the highest outside Central Hungary (**Figure 6**, *middle*) and has a considerable ENQ value. The results of these simulations suggest that R&D support is crucial for boosting economies (GVA) in LDRs, which are often stuck in traditional low-value-added sectors or outdated incumbent industries (Hartmann et al., 2021; Kordalska & Olczyk, 2023; P. Marques & Barberá-Tomás, 2022). Constantine (2017) argues that under certain conditions, investment support can have a limited impact on a region, and investments in low-value-added or low-productivity sectors may not lead to significant changes in economies of scale. However, it is R&D support that can potentially lead to higher economic growth, increased value-added, changes in economic structure, and the creation of new opportunities in more advanced and transformative technology domains.

Table 4. 4. Average absolute value of the impact of policy support (policy mix) on regional EMP (in 1000 capita)

	HU10	HU21	HU22	HU23	HU31	HU32	HU33	Max. among regions	
INV100	4.667	4.741	4.701	4.788	4.777	4.834	4.873	**4.873**	**HU33**
RD100	(4.545)	(9.064)	(10.161)	(13.094)	(13.295)	(6.839)	(8.836)	**(4.545)**	**HU10**
HC100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.00000128**	**HU31**
EV_DIS	(0.387)	(2.243)	(2.689)	(4.184)	(4.044)	(1.148)	(2.178)	**(0.387)**	**HU10**
50_50_0	(0.564)	(3.157)	(3.793)	(5.754)	(5.659)	(1.607)	(3.089)	**(0.564)**	**HU10**
50_0_50	2.291	2.315	2.299	2.329	2.324	2.371	2.353	**2.371**	**HU32**
0_50_50	(2.284)	(4.976)	(5.613)	(7.596)	(7.495)	(3.629)	(4.768)	**(2.284)**	**HU10**
66_33_0	2.004	1.540	1.414	0.991	1.055	2.295	1.403	**2.295**	**HU32**
0_66_33	(0.773)	(1.809)	(2.047)	(2.929)	(2.801)	(1.293)	(1.710)	**(0.773)**	**HU10**
66_0_33	3.054	3.086	3.065	3.105	3.099	3.171	3.137	**3.171**	**HU32**
Max. among instruments	**4.667**	**4.741**	**4.701**	**4.788**	**4.777**	**4.834**	**4.873**		
	INV100	**INV100**	**INV100**	**INV100**	**INV100**	**INV100**	**INV100**		

Source: Author's elaboration



Source: Author's elaboration

Figure 4. 17. Impact of policy support (policy mix) on regional EMP

Based on **Table 4.4**, the analysis of the first three policy scenarios shows that the policy interventions, particularly the INV100 scenario, have the most significant impact on employment (EMP) in all regions (LDRs), including the capital region. In this scenario, the high EMP impacts due to the INV100 support are seen evenly across regions, with the Southern Great Plain experiencing the highest impacts and Central Hungary the lowest. In contrast, the HC100 scenario shows only a marginal positive effect on EMP, while the RD100 scenario shows a negative effect. The reduction of INV support still has a strong impact when combined with HC policy support, as shown in the 66-0-33 scenario. This indicates that this policy mix will be more effective if INV support exceeds HC support. Meanwhile, a balanced increase in

HC support with INV support, as seen in the 50-0-50 scenario, reduces its impact on regional EMP. INV support combined with RD in the 66-33-0 scenario still positively impacts EMP. However, the impact is much reduced compared to the previous three scenarios, indicating that INV support is better matched with HC support. The greater the INV support in the INV and HC policy mix, the greater the effect on EMP. Conversely, the effect is negative when INV support is removed, as in the 0-50-50 and 0-66-33 scenarios. Similarly, an even distribution of support across the three scenarios (33-33-33) and a balanced policy mix of INV and RD with eliminating HC support (50-50-0 scenario) also result in negative EMP effects. The analysis of ten regional EMP scenarios indicates that investment (INV) support has a substantial influence on employment (EMP) growth across all regions in Hungary (**Figure 4.17**). While gradually decreasing INV support could lessen the impact on EMP, a combination of INV and HC policies, with continued high INV support, may help mitigate the decline in its impact on regional employment.

According to this policy simulation, substantial support for physical investment in Hungary can significantly impact employment. Directly, investment support, such as funding for infrastructure development and the development of industrial facilities, creates employment opportunities in these and even related sectors. Increased economic activity in sectors that benefit from investment financing can also indirectly stimulate demand in other sectors, such as services and manufacturing, leading to additional employment growth (Bondonio & Greenbaum, 2014). In addition, physical investment can have a strong multiplier effect, leading to progress across sectors (Baum-Snow et al., 2020; Crescenzi & Rodríguez-Pose, 2012). For example, improving transport infrastructure can make a region more attractive to investors, stimulating the creation of new jobs. In addition, improving transportation networks can improve economic connectivity between less developed regions and major economic centers such as the capital region. In line with Crescenzi & Giua (2016), supporting infrastructure development, especially in less developed regions that face long-standing infrastructure constraints, is critical to improving labor mobility and expanding access to employment opportunities.

An effective strategy for improving investment policies is integrating them with human capital development policies. This integrated approach can increase the economic benefits of physical investments and improve long-term competitiveness (Hippe & Fouquet, 2024; Sima et al., 2020) (see **Figure 4.12**). For example, physical infrastructure investments in industry or transport can improve operational efficiency and reduce costs. Nevertheless, to realize its full potential, a skilled workforce is essential. Supporting human capital policies ensures that the workforce has the necessary skills to use new technologies and adapt to industry changes, thereby increasing productivity (Basile et al., 2019; Camagni & Capello, 2013). While investments in physical infrastructure can create short-term employment opportunities, a skilled workforce is essential to sustain the long-term impact of investment policies.

Upon reviewing **Figure 4.17**, it is evident that specific combinations of investment and R&D policies can negatively impact employment. This observation aligns with the findings of Boeing et al. (2022), attributing this phenomenon to various productivity gains and labor substitution factors. The transitional phase of technology and labor substitution may introduce uncertainty and lead to increased unemployment in the short term (Acemoglu & Restrepo, 2018). While R&D initiatives often result in technological advancements that enhance efficiency and productivity, these advances can also displace tasks previously carried out by human workers (Su et al., 2022). Therefore, while R&D support can boost productivity, it may simultaneously limit employment opportunities. It is worth noting that technological progress from R&D efforts may necessitate new skills that are largely absent from the current workforce (Ra et al., 2019).

Referring to **Table 4.5**, the analysis of the first three policy scenarios shows that the full support of the R&D instrument (RD100) has a more significant impact on regional TFP than the full support of the INV or HC instruments. This effect is particularly pronounced in the five LDRs, except the Northern Great Plain and Central Hungary regions. The Southern Transdanubia region has the highest impact, while the other regions have slightly lower impacts. The INV100 and HC100 scenarios still generate positive, albeit minimal, impacts. Meanwhile, the mix of R&D policy with either INV or HC policy shows similar effects, with the 50-50-0 and 0-50-50 scenarios both leading to a reduction in the regional TFP effect of around 30%. This policy mix also appears more favorable than an even distribution of support from all three instruments (even distribution scenario). The policy mix of R&D with HC leads to a drastic decline of about 60% when HC support is reduced, even with an increase in R&D support (0-66-33 scenario). An even sharper decline occurs when R&D support is reduced, investment support is increased, and HC support is eliminated (66-33-0 scenario). These simulation results suggest that R&D support is more effective and optimal when a region receives significant support or a balanced policy mix between R&D support and investment or human capital improvements. An even distribution of support, such as the even distribution scenario, can still provide adequate regional TFP effects. However, an unbalanced mix among these three instruments could lead to a decline in productivity. The analysis of ten regional TFP scenarios in **Figure 4.18** shows that R&D support strongly impacts productivity in almost all

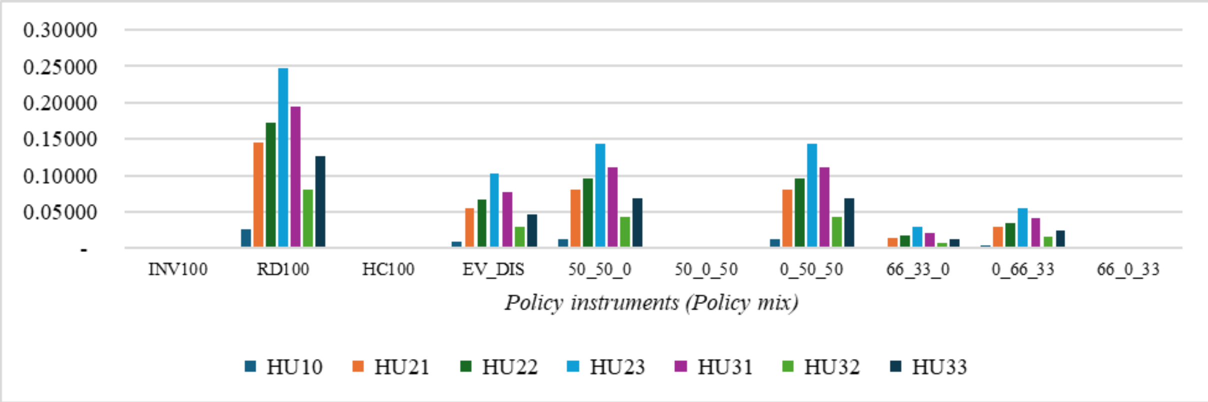
Hungarian LDRs. While a gradual reduction of R&D support could reduce its impact on regional TFP, a balanced combination of R&D policy with INV and/or HC could maintain high productivity levels.

The simulation results emphasize key insights about the combination of R&D policy with investment (INV) or human capital (HC) policy. A robust R&D policy, when paired with an insufficient HC policy, may diminish the influence of the R&D policy on regional total factor productivity (TFP). Insufficient HC policies can result in a workforce lacking the necessary skills to effectively utilize technologies or innovations arising from R&D efforts (Iammarino et al., 2019). This, in turn, leads to the underutilization of new technologies, ultimately diminishing the positive impact of R&D policies on TFP. Without significant advancements in human capital, the region's capacity to absorb and apply R&D results will be limited (McCann & Ortega-Argilés, 2018). In a scenario where R&D support is reduced, and physical investment is increased, the impact on total factor productivity (TFP) is minimal. Capello et al. (2011) suggest that a lack of R&D support in investment policy could hinder regional innovation. Without sufficient regional innovation, improvements in physical infrastructure will only expand existing capacity without increasing productivity (Bronzini & Piselli, 2009; Lau & Lo, 2015). Consistent with the findings of Yang et al. (2020) in the study of China's manufacturing sector, increased physical investment without the support of R&D innovation might lead to inefficient substitution between capital and technology. Therefore, innovation and the adoption of modern technology resulting from R&D support are essential to maximize the impact of physical investment on productivity.

Table 4. 5. Average absolute value of the impact of policy support (policy mix) on regional TFP

	HU10	HU21	HU22	HU23	HU31	HU32	HU33	Max. among regions	
INV100	0.00000	0.00000	0.00000	0.00001	0.00000	0.00010	0.00000	**0.00010**	**HU32**
RD100	0.026	0.146	0.173	0.247	0.195	0.081	0.126	**0.247**	**HU23**
HC100	0.00000	0.00000	0.00000	0.00000	0.00000	0.000000	0.0000002	**0.00000**	**HU31**
EV_DIS	0.009	0.056	0.067	0.103	0.078	0.030	0.047	**0.103**	**HU23**
50_50_0	0.013	0.080	0.096	0.144	0.111	0.043	0.069	**0.144**	**HU23**
50_0_50	0.00000	0.00000	0.00000	0.00000	0.00000	0.000049	0.000000	**0.00004**	**HU32**
0_50_50	0.013	0.080	0.096	0.144	0.111	0.043	0.069	**0.144**	**HU23**
66_33_0	0.002	0.015	0.018	0.029	0.021	0.008	0.012	**0.029**	**HU23**
0_66_33	0.004	0.029	0.035	0.055	0.041	0.015	0.024	**0.055**	**HU23**
66_0_33	0.00000	0.00000	0.00000	0.00000	0.00000	0.000066	0.00000	**0.00006**	**HU32**
Max. among instruments	**0.026** RD100	**0.146** RD100	**0.173** RD100	**0.247** RD100	**0.195** RD100	**0.081** RD100	**0.126** RD100		

Source: Author's elaboration



Source: Author's elaboration

Figure 4.18. Impact of policy support (policy mix) on regional TFP

Technological progress propelled by R&D is crucial for fully leveraging new infrastructure. When R&D is coupled with physical investment, regions can innovate advanced technologies that enhance the efficiency of new infrastructure, such as transportation and communication systems. A proficient workforce is essential for assimilating and applying new technologies stemming from R&D efforts. The study conducted by Burda & Severgnini (2018) concludes that investing in human resources ensures that the workforce can adeptly utilize and adapt to technological innovations, thus leading to increased productivity. The fusion of R&D with human resource development fosters sustainable growth, with physical investment laying the groundwork for necessary infrastructure and human resources, guaranteeing the long-term effective utilization of these investments (Habib et al., 2019; Indrawati & Kuncoro, 2021; Teixeira & Fortuna, 2010).

The results of various TFP simulations (**Figure 18)** indicate that optimal TFP can be achieved in different regions through a harmonized approach that combines R&D support with physical investment and human resource development (B. T. Asheim et al., 2016; Huggins & Thompson, 2017). The findings from this policy mix simulation corroborate Wibisono (2022) assertion that aligning diverse policy tools across different development efforts at a regional level, or via interregional collaborations, is an effective approach for enacting multilevel governance. This strategy holds promise for enhancing regional innovation policies and fostering smart specialization within the European Union region. In his influential paper on the widely recognized concept of smart specialization, Foray (2014, 2016) emphasized the significance of aligning policy instruments at both the regional and cross-regional levels to promote regional innovation and development. This highlights the crucial role of coordinated and partnership-based governance strategies within the policy framework, which can be implemented through smart specialization strategies.

4.3.6. Policy Lessons

Policy Simulation 1 demonstrates the capabilities of GMR-Europe as a policy analysis tool that takes into account different levels of government or governance at both regional and national levels. **Table 4.6** provides an overview of the results of Policy Simulation 1, which analyzes three different policy instruments at the regional level under different scenarios in order to identify the instrument with the largest potential impact on national economic variables.

Table 4. 6. Optimal impact of policy instruments and policy mix at national level

	GVA (in Million EUR)	EMP (in capita)	TFP
INV	1,764 (Central Hungary) 1,663 (Northern Great Plain)	33,097 (Northern Great Plain) 32,866 (Southern Great Plain)	Minor impact
R&D	7,334 (Northern Hungary) 7,178 (Southern Transdanubia) 7,491 (Evenly distribution)	Minor impact	4.010 (Northern Hungary) 4.010 (Southern Transdanubia) 4.005 (Evenly distribution)
HUMCAMP	Minor impact	Minor impact	Minor impact

Source: Author's elaboration

According to **Table 4.6**, the results of Policy Simulation 1 show three things that need to be considered. *First*, the simulation results show which policy instruments have the most significant potential impact. Investment (INV) policy support at the regional level can significantly impact GVA and employment (EMP) at the regional and national level. The impact of the instrument on GVA is most significant when it is targeted to Central Hungary (if the capital is considered) or to the Northern Great Plain (if only the LDRs is considered). On the other hand, the impact of the INV instrument on EMP at the regional level is optimal at the national level when the Northern Great Plain or the Southern Great Plain are considered. In this case, the even distribution of INV support across the seven regions also has the potential to provide optimal EMP impact at the national level. R&D policies have a more significant economic impact than INV policies. The average economic impact of R&D support at the regional level on national GVA is about four times higher than that of INV support. This simulation estimates that applying 100% R&D support to Northern Hungary or Southern Transdanubia could lead to a significant increase in national GVA or an increase in national TFP. The impact would be relatively balanced if this support were evenly distributed across the regions (including the capital region). Productivity gains from R&D support in a region consistently impact TFP. However, there are notable differences between regions, suggesting differences in the capacity to absorb R&D funding and translate it into growth (GVA impact).

Second, when considering the long-term trends of the two instruments, it is essential to note that INV policy has a more sustained impact on GVA or EMP. In contrast, the effect of R&D policy tends to diminish over time. The Policy Simulation 1 results show that relying on one policy instrument alone is insufficient to ensure an optimal economic impact (Borrás & Edquist, 2013; Bouma et al., 2019). Therefore, a combination of R&D and INV policies is needed to promote sustainable productivity and long-term growth. This condition also illustrates that physical investment can not only increase demand for goods and services or output through increased productivity (TFP) but can also promote job creation, which is much more beneficial in the long run. In the case of LDRs in the EU or Hungary, the policy mix aims to create inclusive, sustainable, and equitable growth across the region. Therefore, taking into account the long-term positive impact of investment policies and the more equitable impact of R&D policies, as shown in **Table 4.3**, the R&D policy mix supported by strengthening physical infrastructure or *vice versa* should be a key consideration for policymakers in promoting higher economic growth at both regional and national levels.

Third, an analysis of the growth patterns in the seven regions reveals some differences between the Hungarian western and eastern regions. For example, the three western regions (Central Transdanubia, Western Transdanubia, and Southern Transdanubia) show relatively similar growth contributions in terms of the effect of R&D on national GVA. This suggests the existence of interregional linkages, most likely due to the movement of production factors or agglomeration effects between regions (Baldwin & Martin, 2004; Gardiner et al., 2011; Lengyel & Szakálné Kanó, 2012; McCann & Van Oort, 2019). In contrast, in the eastern region, the Northern Great Plain shows slightly slower growth than its neighboring regions, Northern Hungary and the Southern Great Plain. The regional and national effects on GVA and TFP growth in the Northern Great Plain are more similar to those in Central Hungary. However, the Northern Great Plain is the region most likely to have a high impact on investment policy on GVA and EMP at the national level, given the presence of a large stock of human capital and the highest initial level of R&D among the other LDRs (Figure 6). Given the similar economic impact of investment and R&D policies on GVA and EMP in Central Hungary and the Northern Great Plain (one of the LDRs), the question arises whether these two regions are indeed very different from the other five LDRs. Therefore, the policy mix design for these two regions (at the regional level) should be slightly different from the policy mix in the other LDRs.

Policy Simulation 2 demonstrates GMR-Europe's ability as a policy analysis tool to estimate the optimal economic impact of different policy supports in different regions under different scenarios. This simulation focuses specifically on the regional level. In line with the principles of multilevel governance, which emphasize cooperation and partnership between institutions and regions, this simulation aims to evaluate how economic impact estimation with GMR-Europe can be used to determine the policy instruments with the most optimal economic impact, to identify where this impact is most felt, and to determine the most optimal mix of alternative policies when a single policy instrument may not be applicable. Understanding the economic impact of a policy from different regions is crucial for policymakers to see how a policy or combination of policies can affect regions, leading to improved coordination and effectiveness of a policy (Carmichael, 2004; Dotti, 2016; Fratesi, 2020). It also helps to identify possible differences in policy needs between regions due to region-specific challenges. By simulating these economic impact estimates, policymakers can use different policy scenarios to determine how to allocate resources and responsibilities to maximize the positive impact on economic growth and regional welfare. One of the objectives of multilevel governance in Europe is to promote socio-economic integration and cohesion across the European Union (Guimon, 2014; Hooghe & Marks, 2021; Larrea et al., 2019; A. L. Yang et al., 2015). Evaluating different policy scenarios through economic impact analysis can ensure that a policy can not only promote growth in a region. However, it should also be able to reduce its economic gap with other more developed regions.

Table 4. 7. Optimal impact of policy instruments and policy mix at regional level

	GVA	EMP	TFP
Most optimal policy instrument	INV100 (Central Hungary) RD100 (the six LDRs)	INV100 (in all regions)	RD100 (in all regions)
Region with most optimal economic impact	Central Hungary Southern Transdanubia Northern Hungary	Northern Great Plain Southern Great Plain	Southern Transdanubia Northern Hungary
Most optimal policy mix alternative	50-50-0	66-0-33	50-50-0 0-50-50

Source: Author's elaboration

Based on **Table 4.7**, the results of Policy Simulation 2 show that, *first*, the Investment (INV) instrument has the most optimal impact on GVA in the capital region (Central Hungary). In this simulation, the same amount of funding is provided to each region, regardless of whether the region is developed or less developed. Meanwhile, Central Hungary receives considerable financial support through specific operational programs (OPs), and therefore the R&D support in this simulation does not show Central Hungary as the recipient of the most optimal GVA and TFP impact, but rather this region receives the least impact among the other regions. The reason Central Hungary receives the highest impact from the investment policy has been explained in the description of the results of Policy Simulation 1 and by linking it to the economic impact mechanism based on the Cobb-Douglas production function, as shown in **Figure 4.4**.

Furthermore, the policy instrument with the most optimal impact on GVA in all six LDRs is the policy instrument of full support for R&D (RD100). The regions most affected by this policy in this scenario are South Transdanubia and North Hungary. The LDRs have different conditions and needs from the developed regions, so their R&D policies also need to be adapted to the conditions and problems of each region, as well as to the potential and advantages possessed by each region. From the initial results of Policy Simulation 2, we can surmise that it seems impossible to direct a large allocation of funds to just one R&D policy. However, by testing other scenarios through economic impact modeling, we can offer some policy scenario results, such as a 50-50-0 policy mix, where R&D investment and support are equally allocated, which can have a reasonably good impact and can be an alternative policy choice for regions that are suitable for this type of approach. In addition, given that LDRs often suffer from significant infrastructure constraints, combining two policy instruments, such as investment and R&D, can help balance the tension between national and regional governments, especially in a centralized R&D policy management system. If a region considers that it urgently needs significant R&D support for the development of its region, but on the one hand, the state cannot facilitate the request, then alternative policy options, which can be obtained through the various modeling simulations, can be one of the reliable solutions.

Second, the estimated employment impact (EMP) shows that full investment support (INV100) has the potential to deliver the most optimal impact among all regions. When analyzing the capital region, the simulation results measuring the EMP impact again show that this impact is most pronounced in the LDRs region (Northern Great Plain and Southern Great Plain), while the weakest impact is observed in Central Hungary. LDRs tend to have low employment and productive capacity levels, so a unit of investment invested in LDRs will significantly impact regional employment more than if the investment were made in capital cities or other more developed LDRs such as the Northern Great Plain. In these developed regions, the labor market may already be saturated, so the impact of additional investment on employment may not be as significant as the impact on LDRs. As a result, more developed regions may require more capital- and technology-intensive investment policies and are therefore better suited for technological investment to achieve higher productivity. Meanwhile, in LDRs where the labor market is still developing, and unemployment tends to be high, investment policies may need to be directed towards labor-intensive sectors that exploit local potentials, such as agriculture, light industry, trade, and tourism services, which can quickly absorb local labor but still produce high output (Camagni et al., 2020; Faragó et al., 2022; Stiblarova & Dicharry, 2021).

Less developed regions in Hungary, such as Southern Transdanubia and Northern Hungary, hold the potential to impact gross value added (GVA) substantially and total factor productivity (TFP) growth through effective research and development (R&D) strategies. A well-crafted R&D policy can drive innovation by introducing new technologies and more efficient production methods, leading to enhanced production efficiency, increased output value, and higher TFP and GVA (see **Figure 4.4**). Innovation is pivotal for enhancing productivity growth as it enables firms to achieve more with the same or fewer resources (Aldieri et al., 2018; Segarra-Blasco, 2010). Furthermore, R&D can help to establish and expand competitive advantages in less developed regions (Celli et al., 2024; Krammer, 2017). Many of Hungary's less developed regions possess notable potential in agriculture, light industry, and renewable energy (Bozsik et al., 2023; Hoyk et al., 2022). By concentrating R&D efforts on these critical sectors and exploring new, more competitive areas, higher productivity and economic growth can be attained (Bloom et al., 2013; Fang et al., 2022). However, some researchers in Europe have indicated that less developed European regions might encounter structural barriers such as inadequate infrastructure and low skill levels of the workforce (Di Cataldo & Rodríguez-Pose, 2017; Diemer et al., 2022; Zanazzi, 2018). By implementing suitable policies, R&D can address these challenges by creating tailored technologies and solutions to meet local needs, ultimately facilitating a quicker convergence with developed regions.

Economic impact assessment in the context of multilevel governance (MLG) is closely linked to critical aspects of MLG, such as coordination between different levels of government and stakeholder involvement. MLG emphasizes the importance of coordination between different levels of government in policy development and implementation. When assessing economic impacts, it is critical to consider the contributions and outcomes of policies implemented at each level of government. Policies set by the central government can have different impacts in different regions, depending on how regional and local governments implement them. Therefore, coordination between different actors at the central and local levels is necessary to assess the impact of policy implementation. Di Gregorio et al. (2019) provide a comprehensive insight into the coordination and interaction of different levels of government in the context of climate change policy in developing countries, such as Indonesia and Brazil. They discuss how measuring the impact of climate change policy can reveal the interactions between a policy's objectives, processes, and outcomes. Lanahan & Feldman (2015) examine the dual nature of innovation policy in the context of multilevel governance in the United States. The study provides positive answers to how state policy can strengthen federal policy. Their empirical analysis also shows that the effectiveness of state policy is influenced not only by top-down but also by bottom-up federal policy. Internal economic factors and political dynamics at the federal level affect the overall effectiveness of state policy.

The concept of multilevel governance (MLG), introduced by Hooghe et al. (2001), underscores the pivotal role of local and regional stakeholders in policy formulation and implementation. Collaborating with stakeholders, including local governments, the private sector, and civil society organizations, is essential for an accurate economic impact assessment. Therefore, involving local and regional stakeholders in economic impact assessment can offer more precise insights into how policies impact different economic conditions at various levels of government. Integrating economic impact assessment into multilevel governance entails considering the contributions of different government levels and local stakeholders and evaluating the influence of their involvement on policies. This approach can elucidate how economic impact measurement can gauge policy effectiveness while reflecting the intricate dynamics of policy governance.

4.4. Summary

This chapter is organized into three main sections. The first two sections provide a comprehensive summary of critical literature reviews currently under peer review in leading international journals. The third section presents recent empirical studies on the estimated economic impacts of supporting different policy instruments in implementing smart specialization strategies and multilevel governance context. The first section outlines the results of a critical literature review on implementing EU regional policy using a multilevel governance (MLG) approach. It examines key findings from selected papers and identifies factors that can facilitate the successful implementation of EU regional policy using the MLG approach. To improve the successful implementation of EU regional policy using the MLG approach, three main issues need to be addressed: *first*, identifying the relevant key actors to develop and implement policy strategies; *second*, creating appropriate coordination mechanisms to facilitate them; and *third*, understanding the instrumental factors that can facilitate coordination among actors in implementing regional policy strategies using the MLG approach. This study also assesses the potential impact of implementing regional policies using the MLG approach. The results of this critical review indicate that the literature on multilevel governance in terms of economic impact still needs to be expanded and requires further enrichment in future research.

Section 2 presents a critical literature review focusing on the potential benefits of Smart Specialization Strategies (S3) in driving regional economic transformation. The critical review provides strong evidence of the economic outcomes observed in regions implementing cohesion policy programs or projects within the S3 framework. Several recent studies highlight the economic impact of smart specialization strategies and discuss the methodological complexities associated with integrating policy issues into economic impact analysis models. This section highlights two main factors that innovation policy researchers and practitioners should consider when assessing the economic impact of regional development policies and strategies within a smart specialization framework. *First*, a thorough understanding of the evolutionary benefits of smart specialization strategies is essential to identify relevant policy issues. *Second*, there are complex challenges in integrating the most challenging policy issues into economic impact models. This section also underlines the importance of selecting appropriate policies based on the specific conditions of a region and of following appropriate methodological procedures when assessing the economic impact of such policies.

Section 3 presents the use of the GMR-Europe economic model to evaluate the economic impact of place-based policies at regional and national levels. The authors also investigate potential synergies between multilevel governance approaches in the context of smart specialization policies, focusing on measuring economic impacts. Two policy simulations are conducted using the GMR-Europe model, which integrates various policy interventions related to investment support, research and development support, and human resource support at the regional and national government levels. The impact of these policies is estimated by analyzing changes in key economic indicators such as gross value added (GVA), employment, and total factor productivity (TFP). The simulation focuses explicitly on seven NUTS-2 regions in Hungary, six designated lagging regions that receive development funds and special operational programs. Policy Simulation 1 analyzes the optimal spatial distribution of the impact of policy support on economic variables at the national level. The simulation results comprehensively show which policy instruments have the most optimal potential impact at regional and national levels. Based on these findings, it is crucial for policymakers to carefully consider not only the short-term but also the long-term impact of each policy instrument choice. Utilizing a combination of policy instruments is essential to promote sustainable productivity and long-term growth. Policy Simulation 2 concentrates on the regional level, aiming to identify the policy instruments that have the most optimal economic impact at the regional level and the optimal mix of policy alternatives if one of the policy instruments cannot be implemented. The results of this simulation can provide valuable insights for policymakers and practitioners, *first*, to assist decision-making in the process of allocating regional resources, *second*, to maximize the impact of that allocation through a wide selection of policy scenarios involving various policy instruments and stakeholders, third, to open opportunities for coordination and collaboration.

CHAPTER 5
Concluding Remarks

5.1. Conclusion

In the field of innovation policy in the European Union, there is a growing focus on implementing smart specialization strategies (S3) in less developed regions (LDRs). Several studies have been conducted, and their findings have been reported in influential publications, providing guidance and insights to academics and practitioners in the field. However, the implementation of S3 in LDRs faces several challenges, mainly related to the capacity of the Regional Innovation System (RIS), the region's ability to collaborate with different stakeholders within and between regions, and its ability to manage regional resources to successfully implement S3 effectively.

At the beginning of the study (*Chapter 2*), this dissertation proposes three key points to overcome these challenges. It advocates maximizing the impact of regional knowledge inputs to enhance the success of S3 in LDRs, promoting cooperation among stakeholders, and establishing communication and coordination mechanisms to facilitate more effective governance of S3 in the region. In addition, this dissertation also emphasizes the need to strengthen innovation capacity in LDRs by enhancing the role of universities as key actors in regional innovation systems. It highlights the importance of optimizing regional knowledge inputs to produce higher-quality innovation outputs and emphasizes the need for universities to enhance solid interactions and synergies with industry and government. Nevertheless, regions such as LDRs or regions with specific constraints often have limited capacity to cooperate or collaborate. They often face multiple gaps compared to more developed regions, such as the availability of minimal innovation resources and the ability to manage these limited resources. Encouraging actors in LDRs to cooperate with developed regions requires attention to the drivers that can increase their motivation to collaborate and the key factors that influence these drivers.

The implementation of S3 in LDRs in the European Union has prompted further research on the factors influencing innovation in LDRs in Europe (*Chapter 3*). Empirical studies conducted in the context of Central and Eastern Europe and, more specifically, in the Visegrad Group region, which is still dominated by LDRs, show the spatial dependence of regional knowledge inputs on innovation in this region. Further analysis shows that R&D funding support and qualified human capital are input factors whose allocation and management must go hand in hand. Efforts should be made to improve the governance of various regional innovation resources to make them more conducive to S3 implementation. Although governance phenomena and challenges are crucial issues that often arise in LDRs, several alternative solutions have been proposed by many experts, especially in terms of how to increase stakeholder involvement and what kind of institutional conditions can support the implementation of S3 in LDRs. Recent recommendations from many studies emphasize the importance of higher-level government involvement in S3 governance, even though S3 is a place-based policy and strongly emphasizes the role of regions in its implementation. Therefore, there is great potential for applying the MLG approach in the context of S3 implementation in LDRs, as the same governance approach has been well established in previous EU regional policy implementation. The final section of *Chapter 3* presents how the MLG approach aligns with the principles of S3 and what factors need to be considered when this approach is related to the implementation of S3 in LDRs.

In *Chapter 4*, the author explores and reviews relevant literature that discusses EU regional policies that have been implemented using the MLG approach. The study's results identified three main factors that can facilitate the successful implementation of EU regional policies using the MLG approach. Furthermore, more research is needed on the economic implications of the MLG approach to EU regional policy implementation. This chapter also explores the potential economic impacts of the S3 implementation. It discusses the economic impacts of S3, and the methodological complexities associated with integrating S3-related policy issues into economic impact analysis models. This study highlights the importance of understanding the evolutionary benefits of smart specialization concepts in order to identify and integrate the most challenging policy issues into economic impact models. It is essential to select the appropriate policies based on the specific conditions of a region before following the appropriate methodological procedures. Therefore, the final part of this chapter explores the potential synergies between multilevel governance approaches in the context of smart specialization policies, focusing on estimating economic impacts. To this end, two policy simulations are carried out using the GMR-Europe economic impact model, which integrates different policy interventions related to investment support, research and development, and human capital support at the regional and national levels. The first policy simulation analyzes the optimal spatial distribution of the impact of policy support on economic variables at the national level (national optimization), while the second simulation focuses on the regional level to identify the policy instrument with the most optimal economic impact and the optimal policy mix if one of the policy instruments cannot be implemented or for other more specific purposes (regional optimization). The simulation results provide valuable insights for policymakers and practitioners to assist in decision-making when allocating regional resources and maximizing the impact of such allocations through various measurable means involving policy instruments and engagement of relevant stakeholders at various levels of government.

5.2. Theoretical and practical implications

This dissertation explores various phenomena and challenges in the implementation of S3 as one of the flagship regional policies in the EU and its implementation in the LDRs. Among these phenomena and challenges, the importance of regional governance has been emphasized in many parts of this dissertation. The multilevel governance (MLG) approach, which has been widely used in previous EU regional policies, has opened opportunities for the same governance approach to be applied in the implementation of S3 in the LDRs. Many of the critical factors highlighted in this study mainly focus on resource allocation, which should be carried out by key stakeholders at the regional level, whose involvement and roles need to be effectively coordinated. The study also highlights the enhanced role of regional stakeholders other than local governments, namely universities and industry. It encourages strong collaboration among them horizontally within one level of government and vertically among different levels of government, amidst the limitations and challenges in their regions. The final part of this dissertation provides a significant contribution by further investigating the MLG approach and the implementation of S3 in LDR in the context of economic impact estimation. The results open new perspectives on how economic impact modeling and estimation can be done by linking it to S3 issues, which may be the biggest challenges in the region. With the complex modeling of GMR-Europe considering different levels of governance, the debate on MLG in the implementation of S3 in LDRs thus becomes more relevant. The policy simulation results also indicate that the principles of partnership, cooperation, and coordination between policy levels in the context of MLG align with the principles of S3.

The practical implications of this dissertation highlight key points that practitioners and policymakers can take to implement S3 in LDRs in the EU. *First,* it is crucial to increase the presence and role of key stakeholders such as local governments, universities and industry in formulating and implementing innovation policy strategies such as smart specialization. Their involvement is key to ensure effective implementation of S3 and to increase policy impact. In addition, several recent studies have recommended the involvement of civil society in regional innovation policy. This dissertation suggests improving coordination and communication among these stakeholders through multilevel governance (MLG) mechanisms to improve the implementation of S3 in the LDRs. *Second*, the empirical findings underscore the importance of aligning R&D policy support and improving the quality of human resources. This can be achieved by promoting and designing appropriate financial support to improve the effectiveness of S3 implementation in LDRs. Therefore, policymakers need to plan policy instruments or policy mixes that can be targeted to improve different economic variables at the regional and national levels. *Third*, estimating the economic impact of a regional policy intervention at different levels of government is essential. At the national level, optimizing the economic impact of a policy requires assessing the spatial distribution of the most effective allocation of policy instruments at the regional level and considering the short- and long-term effects at the national level. At the regional level, optimization needs to consider which policy instruments have the optimal impact and make the most sense. A combination of policies might be the appropriate choice at this level, as one policy might not be strictly applicable at the local level. Therefore, the principles of coordination, partnership, and cooperation between various local stakeholders and different levels of government in line with the MLG approach are potentially relevant to improving the effectiveness of S3 in LDRs.

5.3. Limitations and future research opportunities

The research presented in this dissertation has some limitations. *First*, regarding the selection of the regional context, this study focuses specifically on implementing S3 in LDRs in the EU. As such, there are apparent limitations if we want to discuss the same context with more developed EU regions. *Second*, it should be noted that the term LDRs in this dissertation may differ from other similar areas, such as peripheral regions or sparsely populated areas (SPAs). While previous studies have used these terms to describe the areas they studied, this dissertation does not explicitly distinguish between LDRs and these two types of areas, although there may be some overlap. *Third*, due to the limited regional context of LDRs, the author found significant limitations in the existing literature database, which further limited the traditional and systematic approach to conducting the literature review. In some of the author's published papers, this rationale was accepted. However, some of the other papers included in this dissertation are still in the peer review process, so there is uncertainty on this point. *Fourth*, for practical reasons, the focus on LDRs in the EU in the empirical studies in Chapter 3 is specifically limited to the context of Central and Eastern Europe (CEE) and the Visegrad Group, and Chapter 4 is limited to LDRs in Hungary. Thus, it is necessary to consider distinguishing the regional context discussed in this dissertation from other LDRs in Europe, as there may be differences in economic and socio-political characteristics among different regions and member states.

Concerning the diverse concepts used in the latter part of this dissertation, such as smart specialization, multilevel governance, and economic impact modeling, the author argues that a more comprehensive rationale is needed to address gaps in conceptualization strategies. While the rationale for this was briefly discussed in Chapter 4 as part of the strategies for the empirical analysis, there is limited literature that can bridge or link these three different concepts. This gap potentially weakens the comparative analysis of the findings in this dissertation compared to those of similar existing studies. In addition, previous MLG studies have mainly focused on fields other than economics, such as public administration and political science. It is crucial to explore areas of economics related to the aforementioned disciplines, such as the active involvement of civil society (in the quadruple helix structure), the impact of organizational culture on relationships among local stakeholders and between different levels of government, and the institutional and managerial capacity of local institutions that influence the planning and implementation of S3 in LDRs. These limitations need to be further considered and addressed in future studies.

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List of articles included in the dissertation

Published articles:

1. Wibisono, E. (2023). Encouraging research and development collaboration amidst geographical challenges in less developed regions of the European Union: a systematic literature review. *Acta geographica Slovenica*, 63(1), 85-99. https://doi.org/10.3986/AGS.10934
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3. Wibisono, E. (2022). Universities and smart specialization in less developed European regions: an evidence-based overview. *European Spatial Research and Policy*, 29(1), 135-149. https://doi.org/10.18778/1231-1952.29.1.07
4. Wibisono, E. (2022). Multilevel governance and Smart Specialization in EU regions: an evidence-based critical review. *European Journal of Government and Economics*, 11(2), 234-250. https://doi.org/10.17979/ejge.2022.11.2.9004
5. Wibisono, E. (2022). Smart Specialization in less-developed regions of the European Union: A Systematic Literature Review. *REGION*, 9(2), 161-181. https://doi.org/10.18335/region.v9i2.388

Under review (updated October 2024):

1. Regional Governance Challenges in the Implementation of Smart Specialization Policy in the European Union: A critical review
   Submitted to: *European Journal of Geography [EJG]*
2. Exploring the Economic Impact of European Union Cohesion Policy through Smart Specialization Strategy
   Submitted to: *REGION*
3. Exploring Multilevel Governance in European Union Regional Policy: Implementation and potential impact
   Submitted to: *Urban Governance (UGJ)*
4. Economic Impact of Smart Specialization Policy in the Context of Multilevel Governance: The Hungarian Case
   Submitted to: *European Planning Studies (CEPS)*

List of other articles

Published articles:

1. Wibisono, E. (2024). STRENGTHENING CIVIL SOCIETY ENGAGEMENT IN REGIONAL INNOVATION POLICY. *Theoretical and Empirical Researches in Urban Management*, 19(3), 49-69. https://www.jstor.org/stable/27321374
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3. Wibisono, E., & Umiyati, E. (2023). INDEPENDENT CAMPUS POLICY IN INDONESIA: A BRIEF OVERVIEW. *Kwangsan: Journal of Educational Technology*. https://doi.org/10.31800/jtp.kw.v11n1.p255--278
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9. Wibisono, E. (2021). A Critical Review of Open Innovation in SMEs: Implementation, Success Factors and Challenges. *Journal of STI Policy and Management*, 6(2), 145-156. http://dx.doi.org/10.14203/STIPM.2021.308

Under review (updated October 2024):

1. The Financial Sector Innovation: Challenges and Alternative Solutions
   Submitted to: *Journal of Innovation Management (JIM)*
2. EXPLORING THE ROLE OF REGIONAL RESEARCH AND DEVELOPMENT SUPPORT IN ENHANCING FOREIGN INVESTMENT IN POLAND: A SPATIAL ANALYSIS PERSPECTIVE
   To be published in: *European Spatial Research and Policy (ESRAP)*