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

SUMMARY

Written by: Eristian Wibisono
Supervisor: Prof. Dr. Tamás Sebestyén
Dr. Norbert Szabó

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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

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 (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), 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, 2014). Smart specialization policy strongly emphasizes 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) (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 & Kiese, 2021), the institutional readiness of peripheral regions (Marques & Morgan, 2018), and the persistence and applicability of smart specialization in regions operating with multi-level governance (Pugh, 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 (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. 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 (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.

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. 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 & Marks, 2021; Marks, 1993), offers a potential framework for the implementation of regional innovation policies such as smart specialization (Larrea et al., 2019). 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 (Domorenok, 2017; Gualini, 2016). 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, 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 (Kroll, 2017).

1.2. Research objectives

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. The synthesis of these three papers is presented in three separate sub-chapters. The *first* paper (Wibisono, 2022b), published in *REGION*, 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*, 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*, 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.

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*, 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 *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*, uses a traditional literature review approach by raising the issue of multilevel governance (MLG) and its relation to smart specialization policy. 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.

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 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, Szerb, et al., 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.

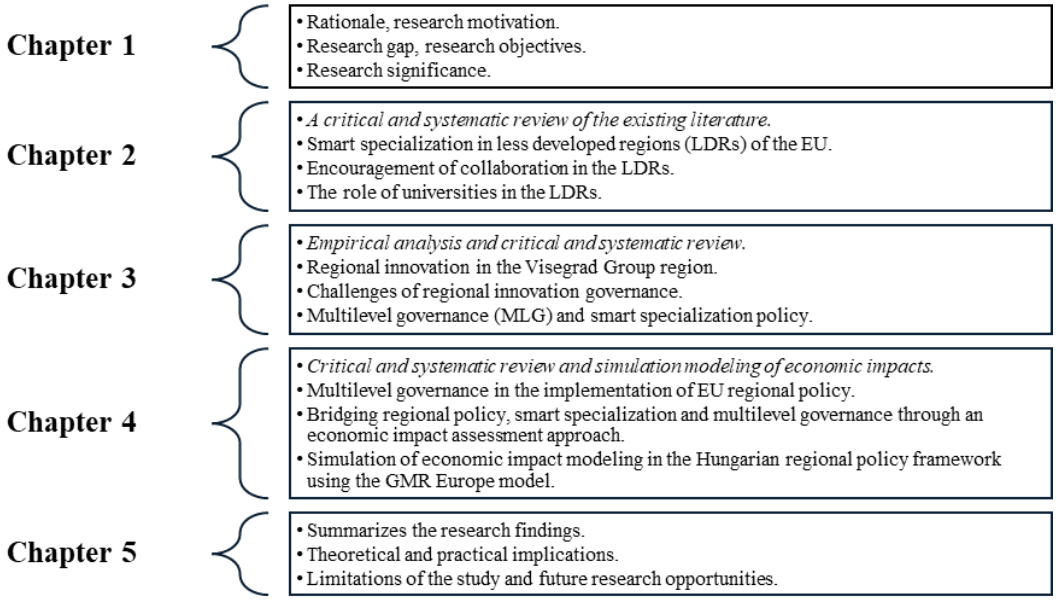
1.3. Significance of the research

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. 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.

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. 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 and the choice of policy instruments or the determination of the policy strategy to be used are the pieces that less developed regions need to assemble firmly in order to increase their success in implementing smart specialization.

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**).



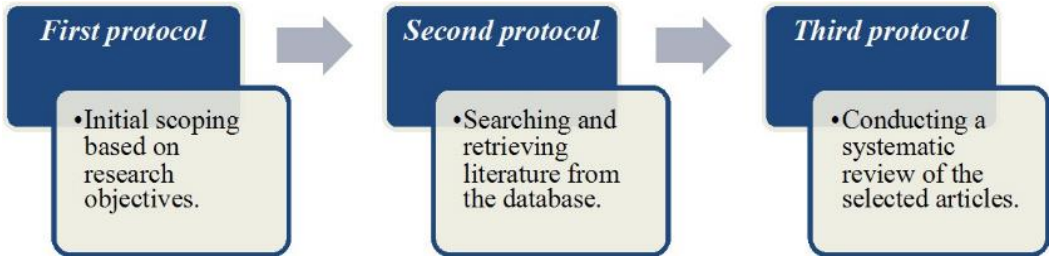
Source: Author's elaboration

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

2.1. Method of the literature review with a systematic approach

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)).



Source: Wibisono (2023a)

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 (2023a) 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, 2023a; 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 (2023a), the search was conducted in the Web of Science database. 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. 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. 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, 2023a), *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 (Wibisono (2022b, p.166); (Wibisono, 2023a, p.88)).

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. 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. 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. **Table 2.2** provides a breakdown of the articles by publication source. The study by Wibisono (2023a) characterized *11* articles based on year of publication, source, and subject category. **Table 2.3** shows the distribution of these 11 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 selected articles are mostly published in the *Social Sciences* and *Technology and Innovation Management* subject categories. 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 2.4** describes the characteristics of the selected articles.

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. Sources of journal/publications sources of the study of Wibisono (2023a)

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)

Table 2. 4. 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)

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 2.5**). The articles were first categorized into two groups according to their methodological nature: *non-empirical research* and *empirical research*. 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.

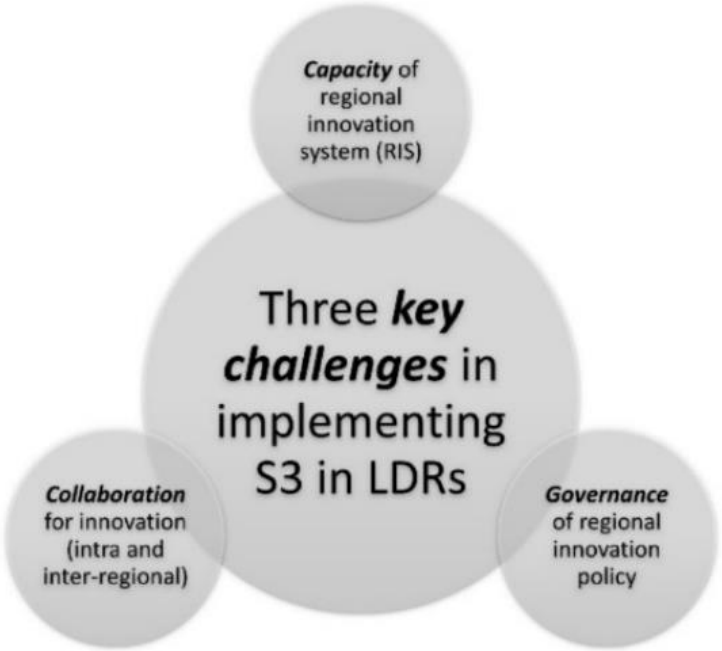
Table 2. 5. The diversity of research design and research methods

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)

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 et al., 2020; Ghinoi 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 2.2**). These three elements are interrelated and essential for building a solid regional innovation system (RIS) (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. From the critical review of the selected papers and the synthesis of the findings in Wibisono (2022b), there are *three* main points that need to be optimized to overcome the challenges in implementing S3 in LDRs (**Figure 2.3**).



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

Figure 2. 3. Three key challenges in S3 implementation in LDRs

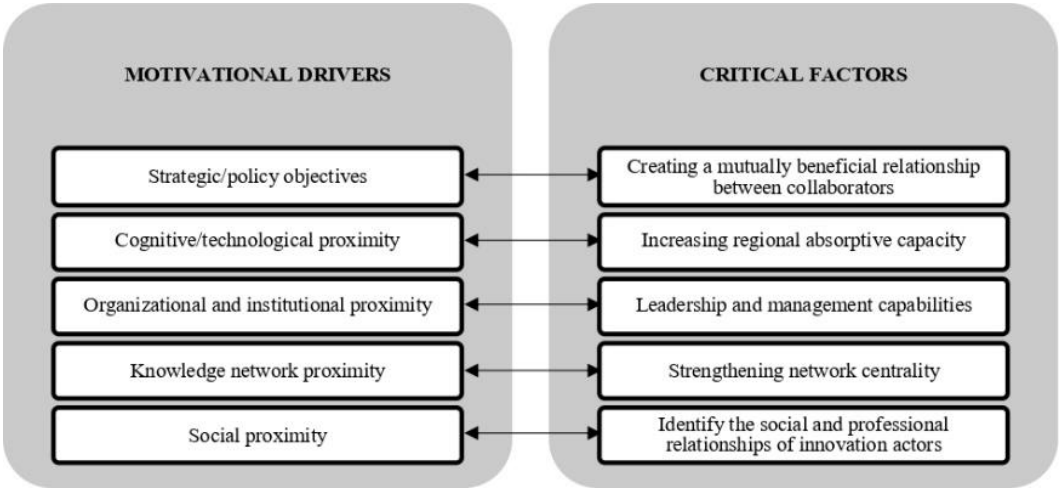
Source: Author's elaboration, modified from Wibisono (2022b)

Figure 2. 4. Optimizing three points to overcome the challenges of S3 implementation in LDRs

2.3. Encouraging R&D collaboration in LDRs

This section is based on the main contribution of the study of Wibisono (2023a), 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. 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 2.4** and referred to as "Five motivational drivers and critical factors for R&D collaboration in the LDRs of the EU".

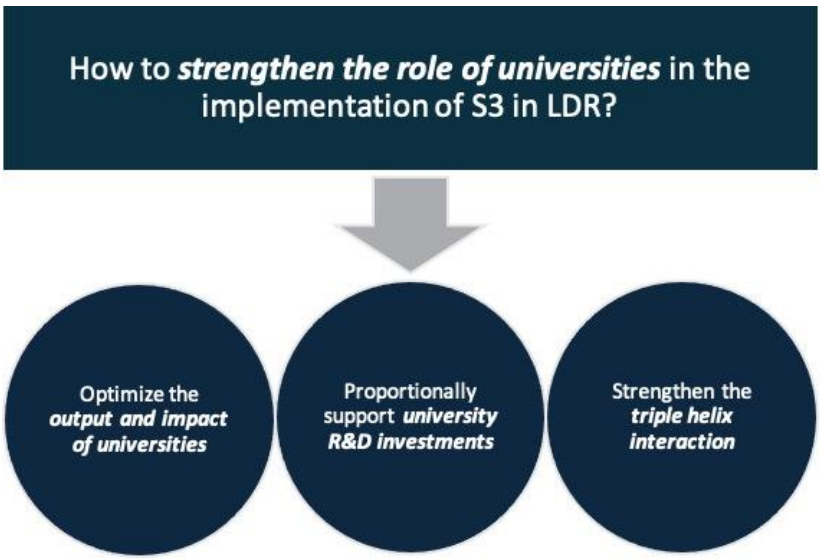


Source: Wibisono (2023a, p.94)

Figure 2. 4. Motivational drivers and critical factors for R&D collaboration

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.



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

Figure 2.5. Factors strengthening the role of universities in the implementation of S3 in LDRs

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 2.5**.

2.5. Summary

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

3.1. Methodology

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). 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 & Arribas-Bel, 2013). 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 (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.

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 (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 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 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 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; Qin et al., 2019). 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. The operationalization of the variables used in the analysis is presented in **Table 3.1** and the equation model applied is as equation **(3)**.

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)

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

where:
PATAPP = innovation parameter
GERDBUS = business sector R&D expenditure
GERDPUB = public sector R&D expenditure
ε = error term
β1, β2, β3 = coefficients of independent variables

3.1.2. Methods of systematic review and traditional review

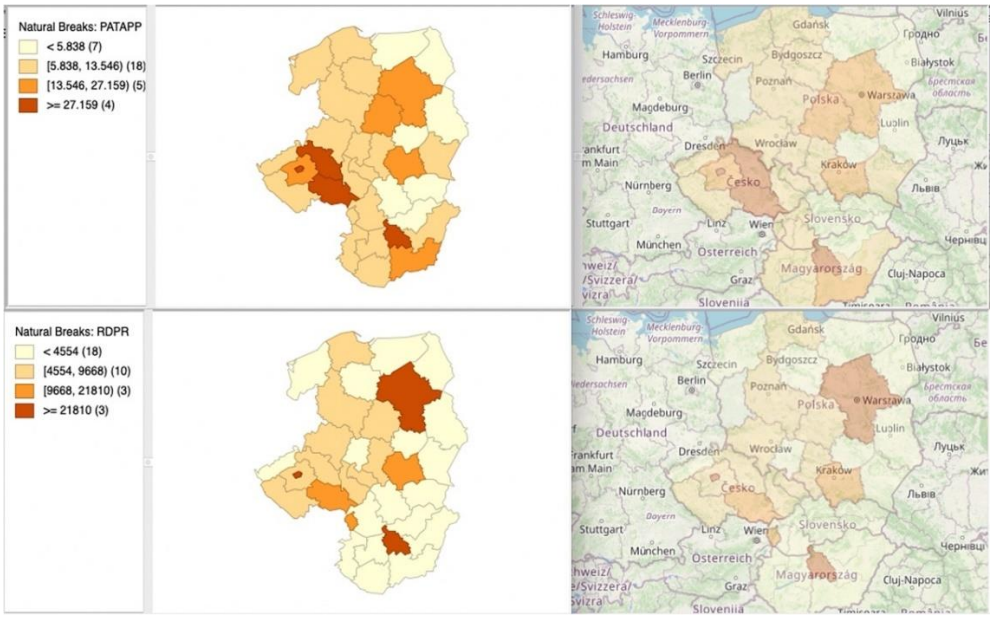
The study in the third paper uses a systematic literature review approach following the procedure (three-step protocol) outlined in **Chapter 2**. There were 34 articles that met the above criteria and were considered as potentially relevant articles. At the end of the process, the author selected *18* 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.

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). 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 3.1** shows the spatial distribution of patent applications and R&D personnel/researchers. 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 3.1** (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). 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.

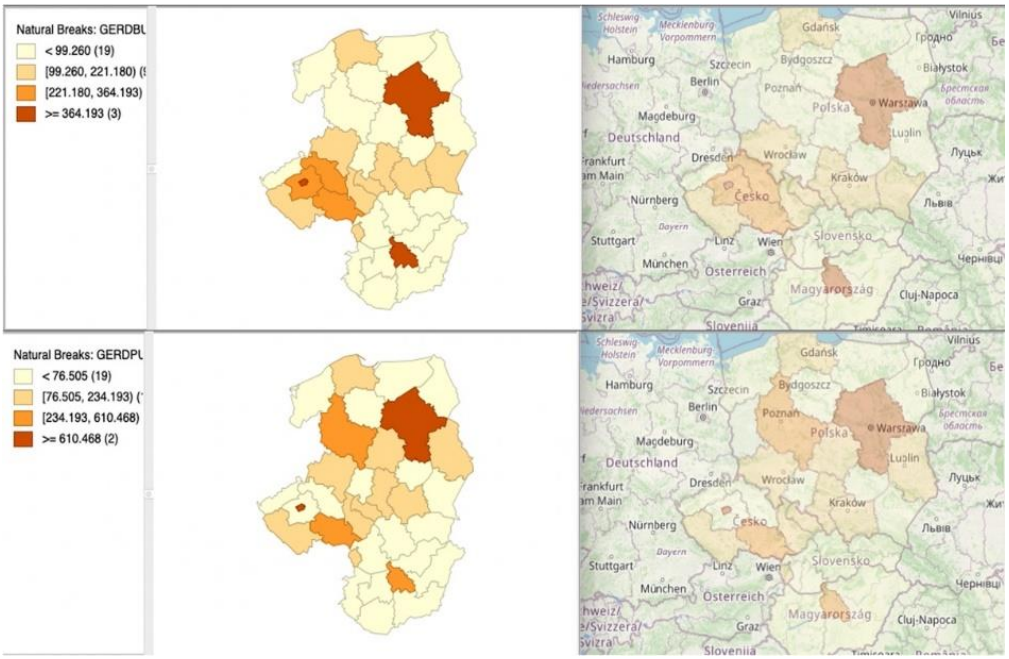


Source: Wibisono (2023b, p. 117)

Figure 3.1. Spatial distribution of patent applications (*above*) and R&D personnel/researchers (*below*)

Figure 3.2 (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. **Figure 3.2** (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

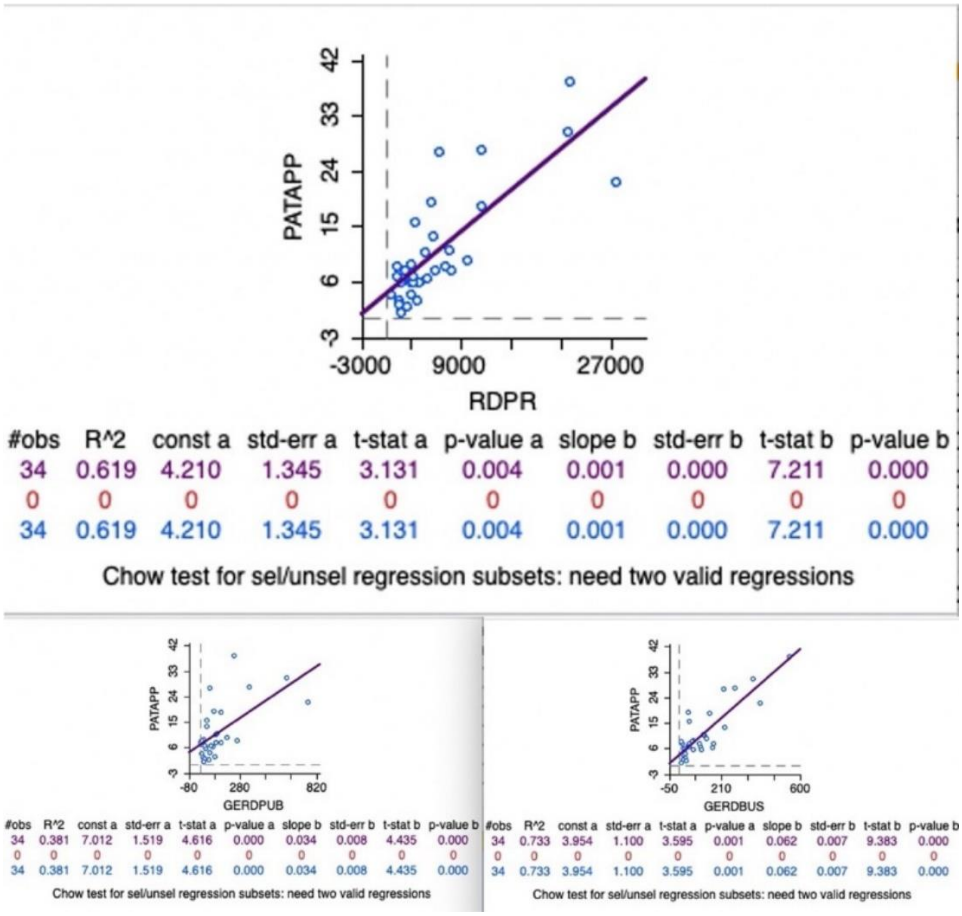
highest density of public R&D expenditure (first group), while Budapest is in the second group and Bratislava in the third group. This essentially suggests that support for business and public R&D expenditure is generally concentrated in the national capital. In the Czech Republic and Poland these business 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.



Source: Wibisono (2023b, p.118)

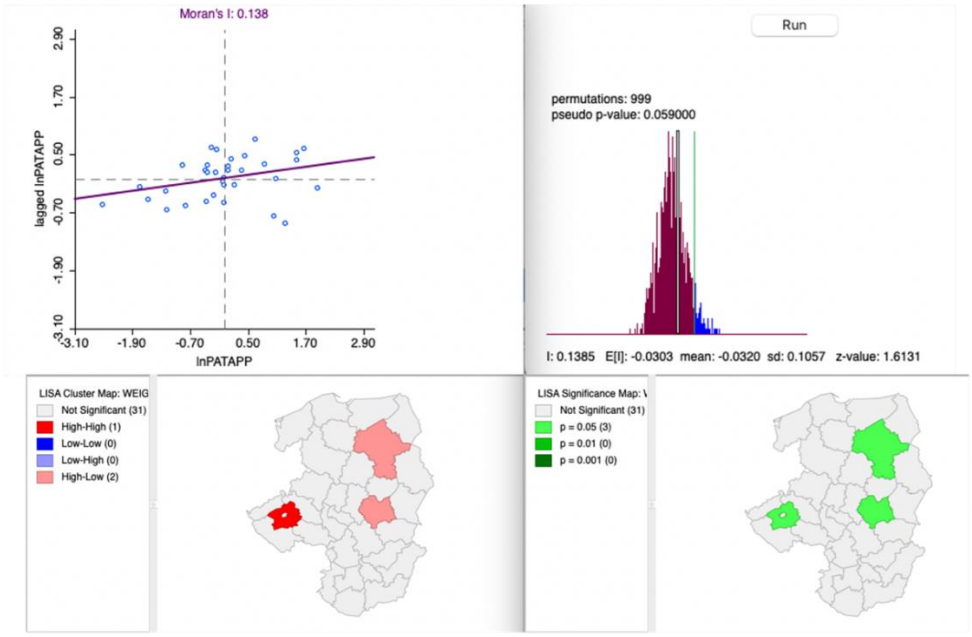
Figure 3.2. Spatial distribution of R&D expenditure of the business sector (above) and R&D expenditure of the public sector (below)

Figure 3.3 shows the correlation between the dependent variable (PATAPP) and the independent variables (RDPR, GERDPUB and GERDBUS). 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 3.3. Correlation between PATAPP, RDPR, GERDPUB, and GERDBUS



Source: Wibisono (2023b. p. 121)

Figure 3.4. Moran's I scatterplot (lnPATAPP)

Figure 3.4 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.

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

$$\ln\text{PATAPP} = -4.9169 + 0.4734\,\boldsymbol{W}\ln\text{PATAPP} + 0.2294\ln\text{GERDBUS} - 0.2258\ln\text{GERDPUB} + 0.7180\ln\text{RDPR} \quad \textbf{(4)}$$

This study's findings 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., 2010). 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. Previous studies have shown that the average public R&D expenditure in the V4 countries is below the EU average (Birkner et al., 2022), which could potentially have a negative impact on research and innovation activities in these regions (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). 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 (Morisson & Doussineau, 2019; Trippl et al., 2019). Investment in R&D infrastructure and the improvement of R&D human resources need to be linked, as this ultimately affects how investments are managed and how the governance of regional innovation resources and policies can have the desired innovation impact.

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

3.3.1. Characteristics of the selected articles

The 18 selected articles are divided into three groups according to their study focus (**Table 3.4**). 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.

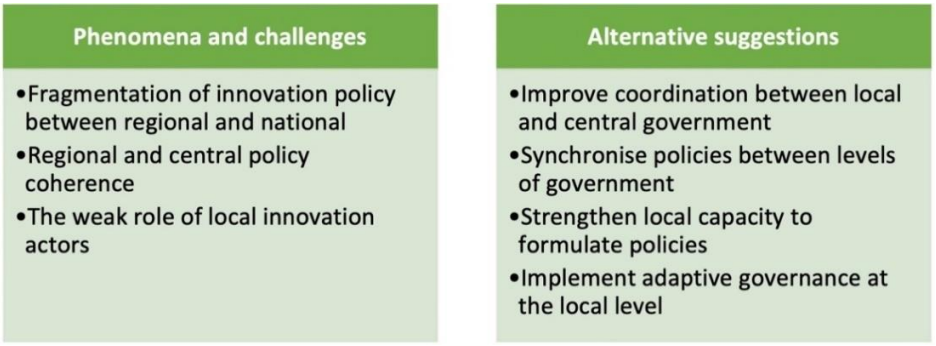
Table 3. 4. Grouping of selected articles based on discussion focus

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

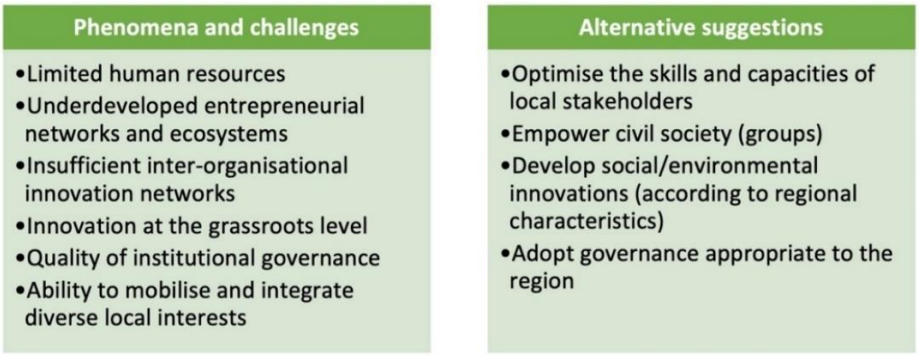
The first three studies in this section (Chrysomallidis & Tsakanikas (2017), Ruhrmann et al. (2022), and Morgan & Marques (2019)) address the prioritization of regional interests in the implementation of smart specialization strategies (S3). The phenomena and challenges of implementing smart specialization at the subnational level, which are then linked to the suggestions and recommendations from this study and other related studies, are summarized in **Figure 3.6**.



Source: author's elaboration.

Figure 3. 6. Implementation of smart specialization in the EU regions

The next three studies (Sörvik et al. (2019), Ghinoi et al. (2021), and Barzotto, Corradini, Fai, Labory, & Tomlinson (2020a)) highlight more specific challenges in the implementation of S3 in regions with specific circumstances. **Figure 3.7** 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.

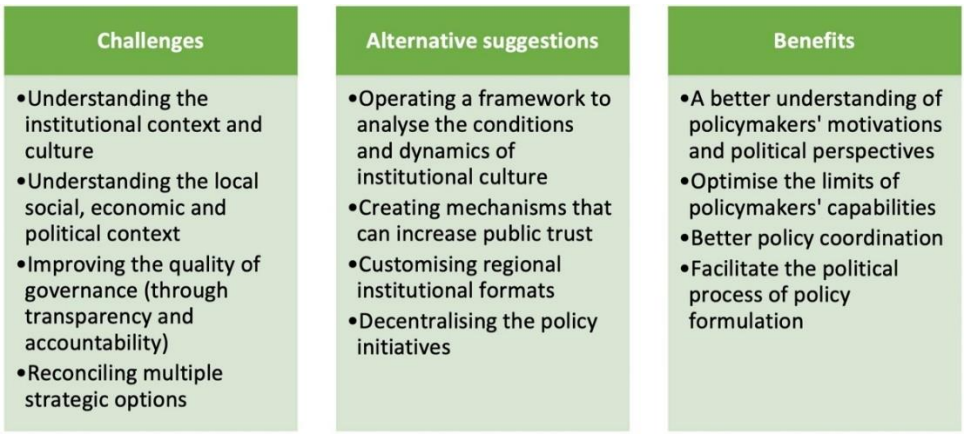
Figure 3. 7. Implementation of S3 in EU regions with specific circumstances

3.3.3. Stakeholder engagement and institutional capacity

The next three studies (Rehfeld & Terstriep (2019), Laranja (2022), and Estensoro & Larrea (2016)) discussed stakeholder engagement, which was the main focus of S3. **Figure 3.8** 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. The following three studies (Knudsen et al. (2020) , Morgan (2017), and Foray (2018)) focus on the importance of understanding institutional conditions to enhance the successful implementation of S3. **Figure 3.9** 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. 8. Challenges in stakeholder engagement

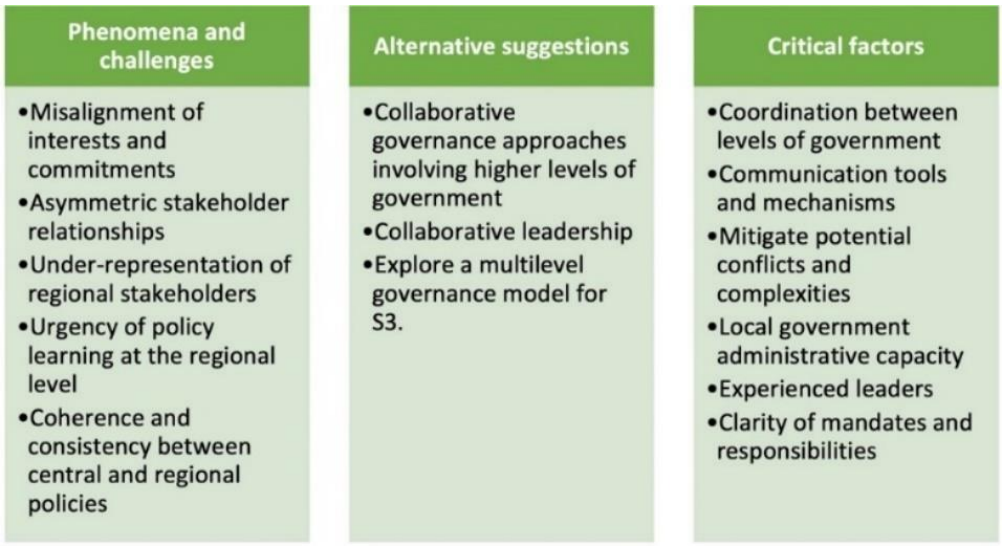


Source: author's elaboration

Figure 3. 9. 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), Cvijanović et al. (2020), Pugh (2018), González-López (2019), Kroll (2019a), and Wibisono (2022a)). **Figure 3.10** 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.

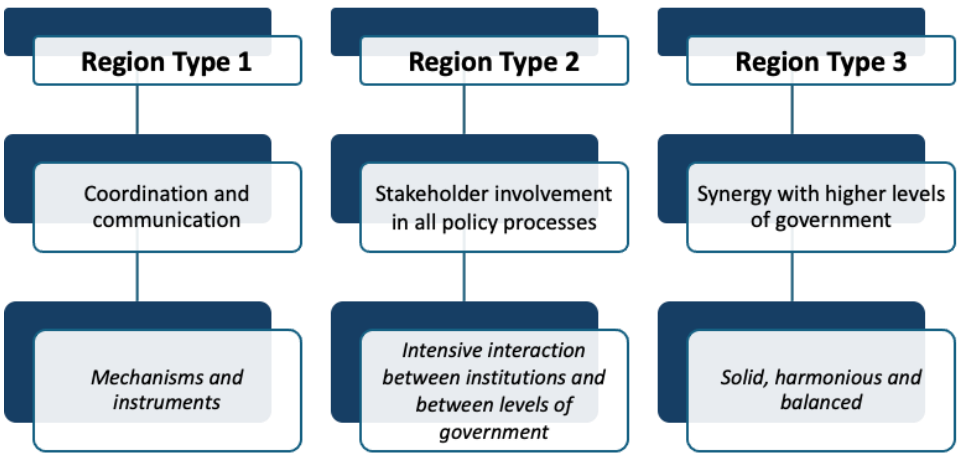


Source: author's elaboration

Figure 3. 10. Phenomena and challenges related to S3 governance

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. 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 3.11**.



Source: author's elaboration

Figure 3. 11. Key factors in addressing multilevel governance challenges in different regional contexts

3.5. Summary

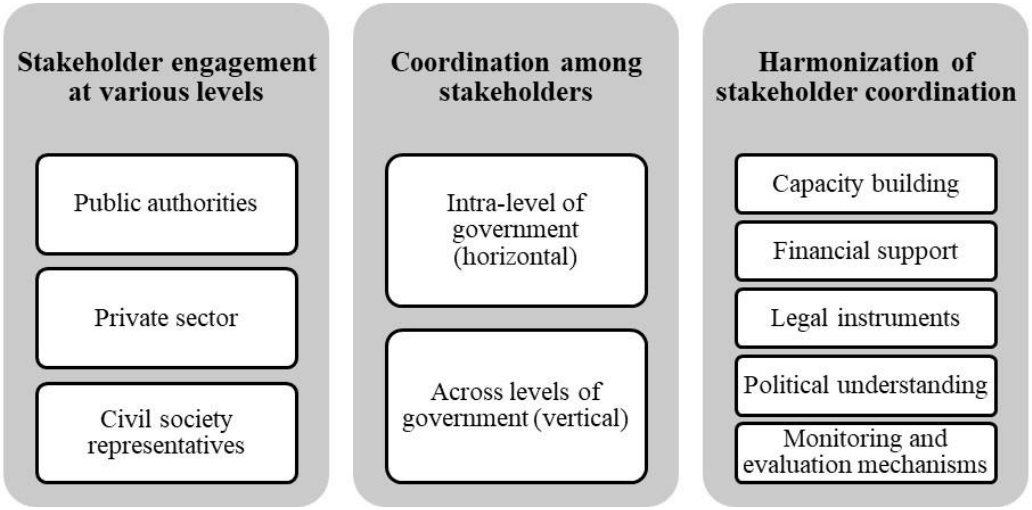
The *first* study in this chapter examines this issue specifically in the regional context of the Visegrad Group (V4) countries in Central Europe (Poland, the Czech Republic, Slovakia, and Hungary). Using a spatial econometric analysis approach, the results of this study indicate the existence of a spatial dependence of knowledge inputs and innovation in the V4 regions. The *second* study in this chapter focuses on the phenomena and challenges of governance of resources and regional innovation policies in the implementation of smart specialization. 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 *third* 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.

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

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). 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 (Enderlein et al., 2010). 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 (Börzel, 2020; Hooghe & Marks, 2021).

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 (**Figure 4.1**). 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.



Source: authors' elaboration

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

4.1.1. 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 (Poyraz & Szalmáné Csete, 2023). 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 (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.

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. 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. 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.

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., 2020). 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.

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. 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. 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 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. 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. 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

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).

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

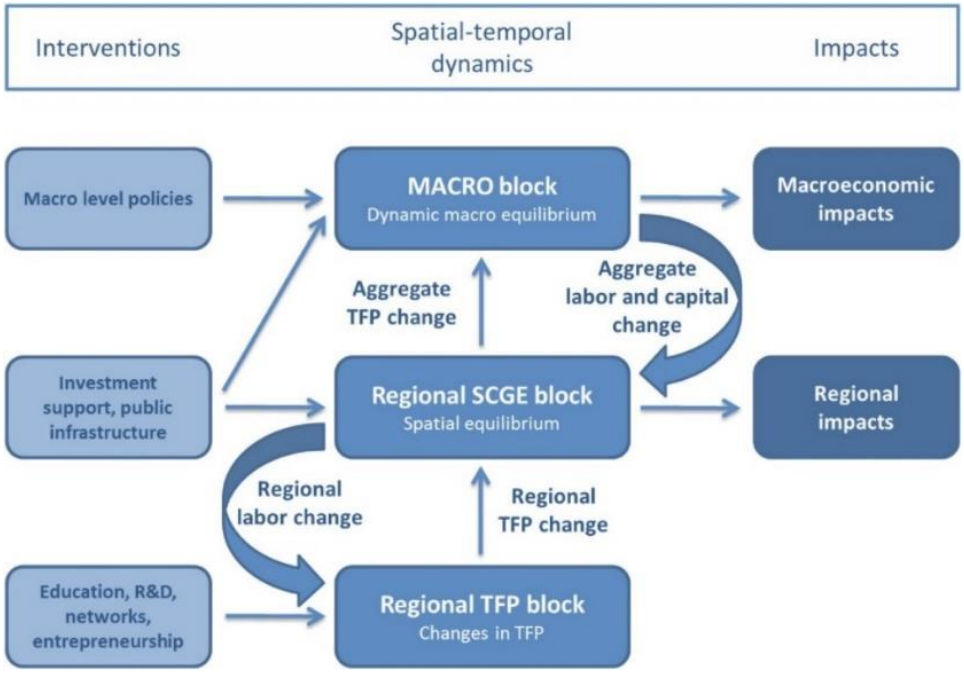
4.3.1. Main construction of GMR-Europe model

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).

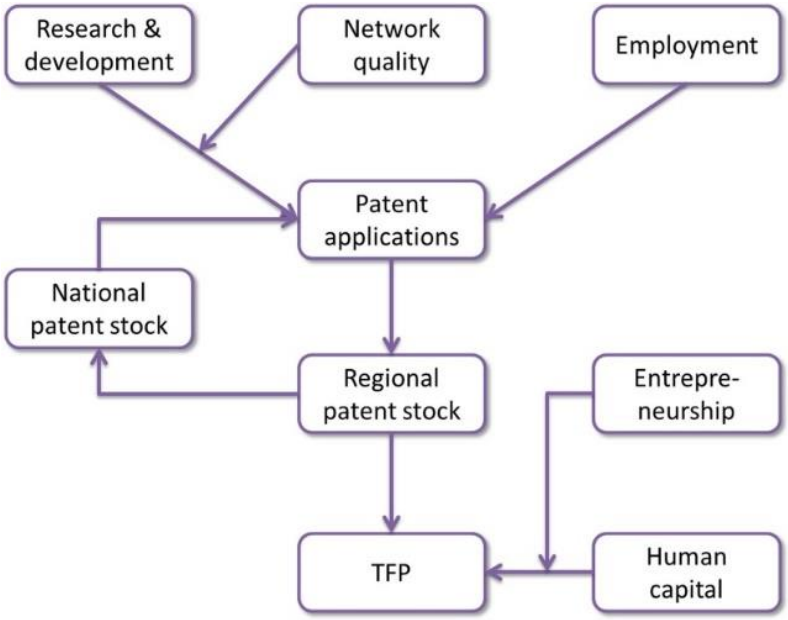
Figure 4.2 provides an overview of the policy interventions, spatio-temporal dynamics and economic impacts in the GMR-Europe model. The GMR-Europe model includes essential elements for assessing policy impacts at different levels of government. GMR-Europe thoroughly evaluates economic impacts at different levels of governance - supranational, national and regional - covering 181 EU NUTS-2 regions. 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. The arrangement of variables within the TFP block is shown in **Figure 4.3**. 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).



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

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



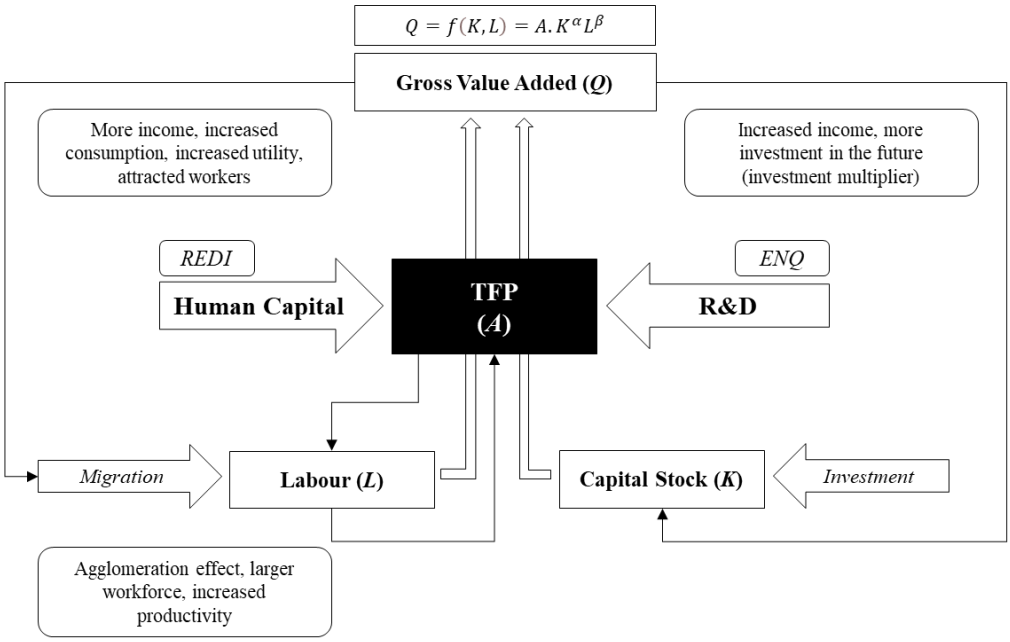
Source: Varga, Sebestyén, et al. (2020)

Figure 4. 3. TFP block construction

4.3.2. Economic impact analysis mechanism

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. 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.



Source: Author's elaboration

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

4.3.3. Selection of case studies in Hungary

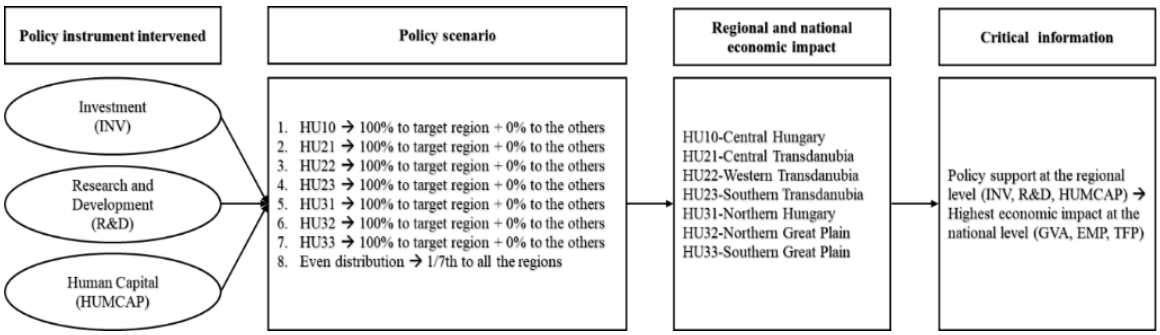
The author chooses Hungary as one of the European Union (EU) member states in the central and eastern regions that received a large allocation of funds in the Smart Specialization Strategy's 2014-2020 and 2021-2027 programming periods. In the 2014-2020 Cohesion Policy programming period, Hungary was 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.

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. 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.

4.3.4. Policy Simulation 1: Optimization at the national level

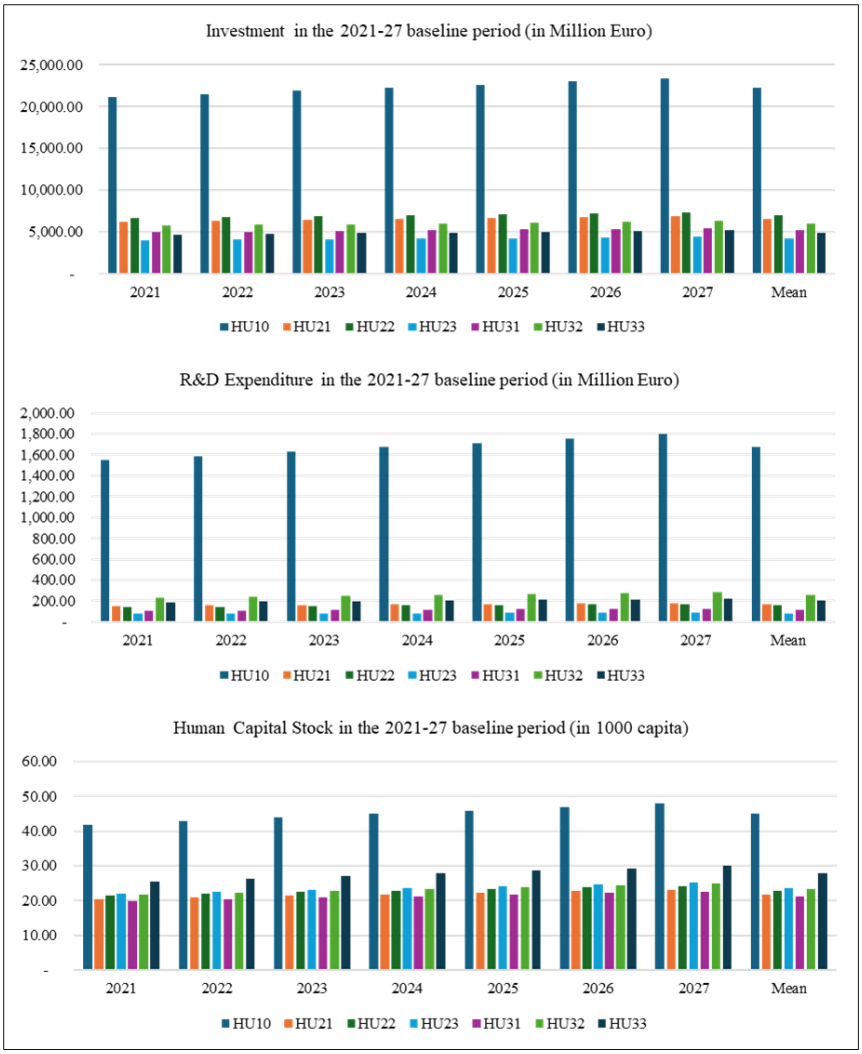
Policy Simulation 1 aims to show whether the economic impact assessment of a policy can provide insights for the national and regional governments to implement EU regional policies using a multilevel governance approach. The authors use three policy instruments - public investment (INV), research and 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.



Source: Author's elaboration

Figure 4. 5. Process flow of Policy Simulation 1

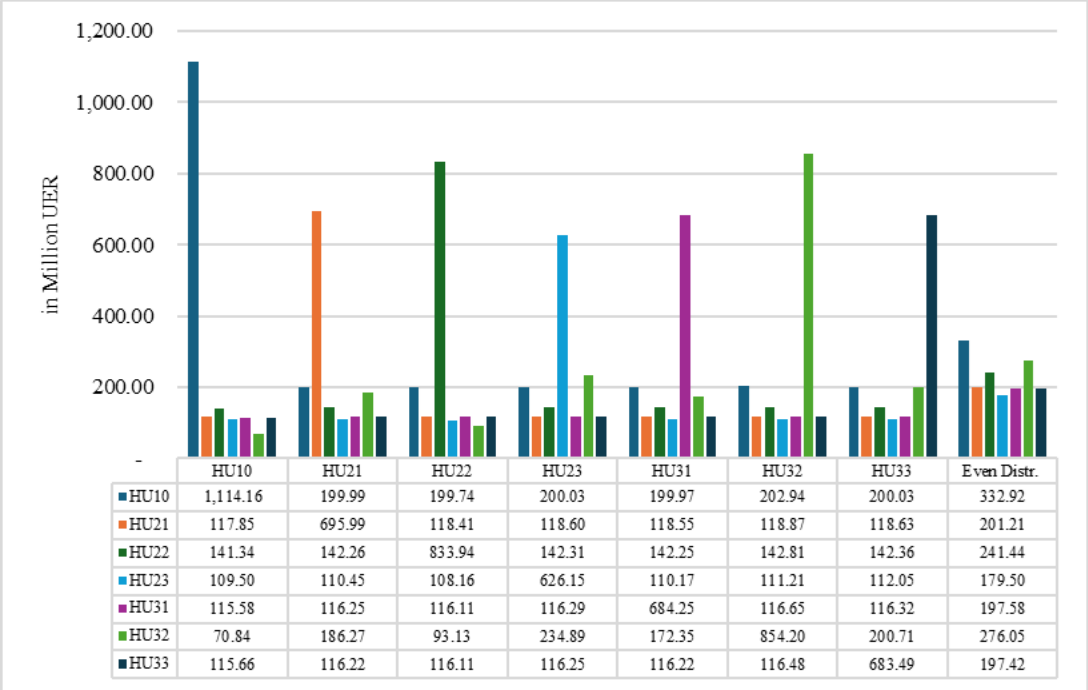


Source: Author's elaboration

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 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. 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.



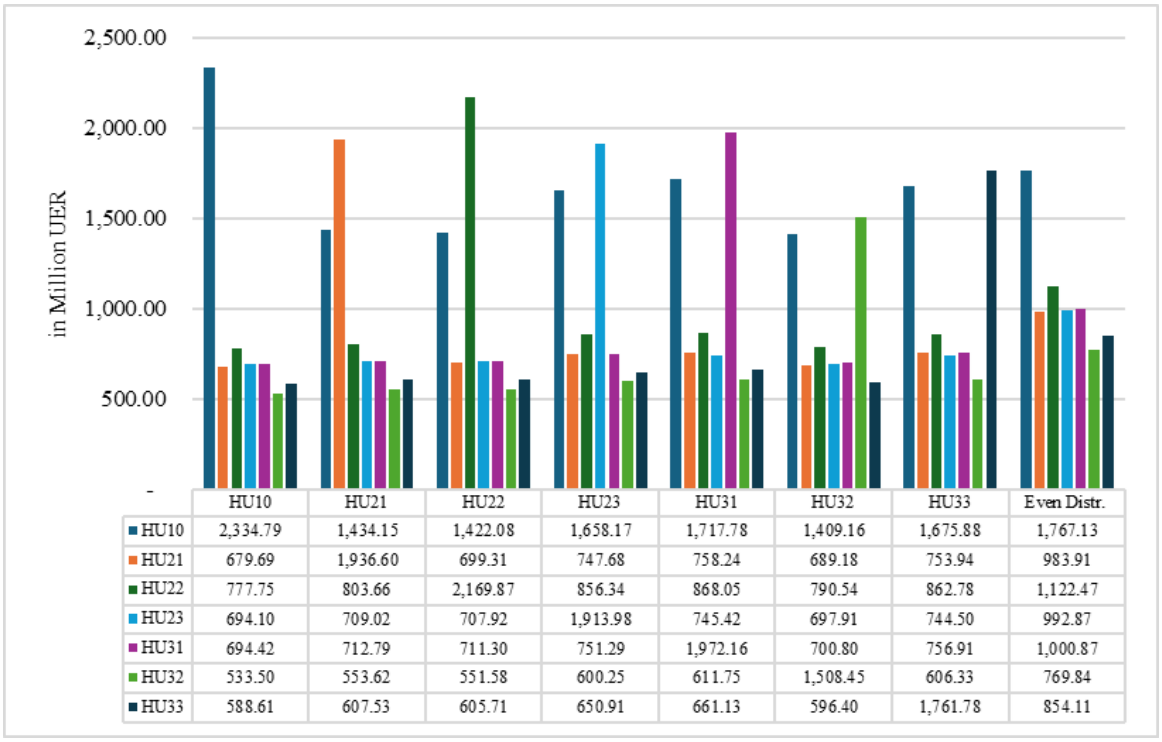
	HU10	HU21	HU22	HU23	HU31	HU32	HU33	Even Distr.
HU10	1,114.16	199.99	199.74	200.03	199.97	202.94	200.03	332.92
HU21	117.85	695.99	118.41	118.60	118.55	118.87	118.63	201.21
HU22	141.34	142.26	833.94	142.31	142.25	142.81	142.36	241.44
HU23	109.50	110.45	108.16	626.15	110.17	111.21	112.05	179.50
HU31	115.58	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

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. 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. 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.

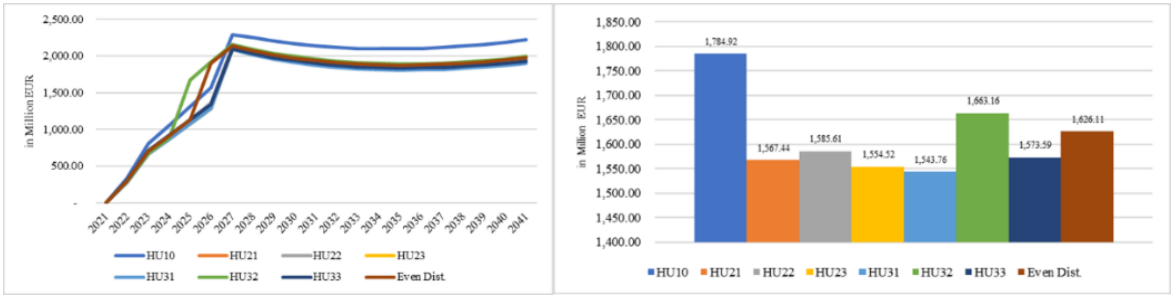
GVA growth at the national level continues to be dominated by Central Hungary, the national capital. Capital cities often function as hubs of economic activity, with a high density of firms, a skilled workforce, and adequate infrastructure. A robust infrastructure in the capital city, including transportation, 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 (Williams, 2021). The concentration of these factors leads to an overall higher productivity effect (Khanna & Sharma, 2021; Rodríguez-Pose & Griffiths, 2021).



	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

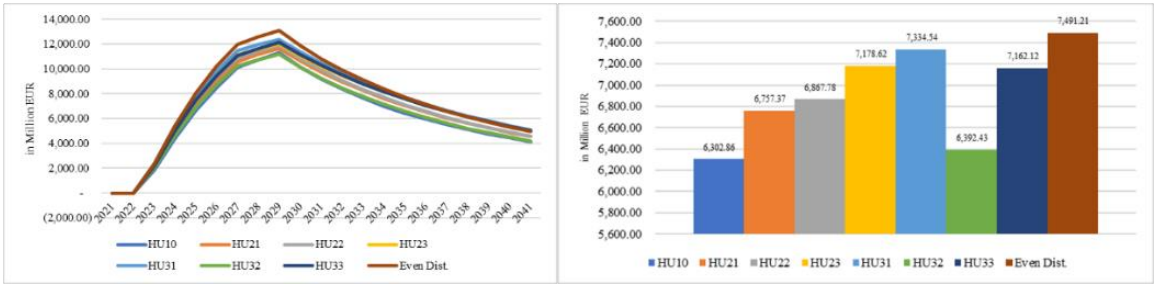
Source: Author's elaboration

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



Source: Author's elaboration

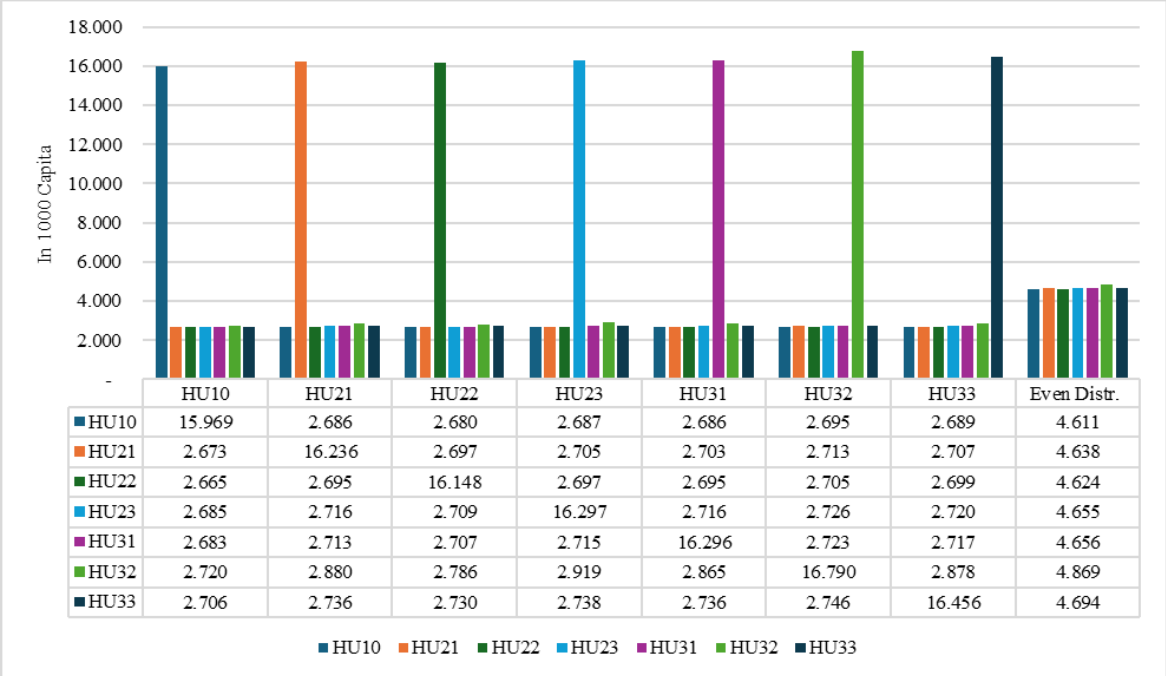
Figure 4. 9. Economic impact of INV support on GVA at the national level over time (left) and averaged in absolute terms (right)



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)

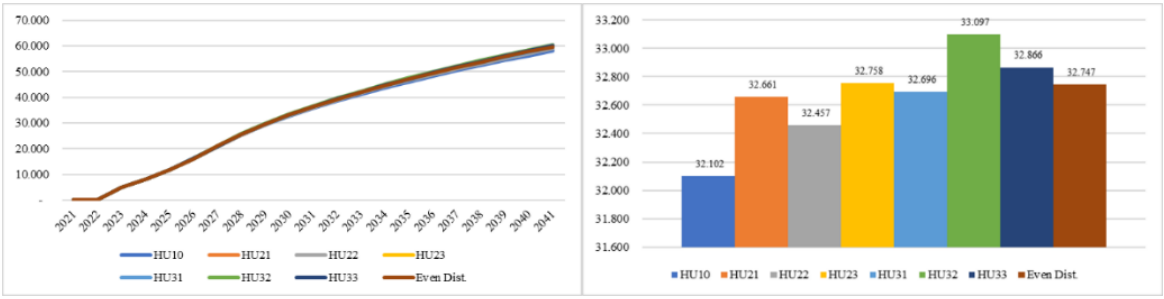
Figure 4.11 shows the impact of investment policy shocks on employment (EMP) at the regional level. Based on the simulation results, regions that receive 100% investment support experience substantial employment growth, on average eight times higher than regions that do not receive such support. **Figure 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. 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).



	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

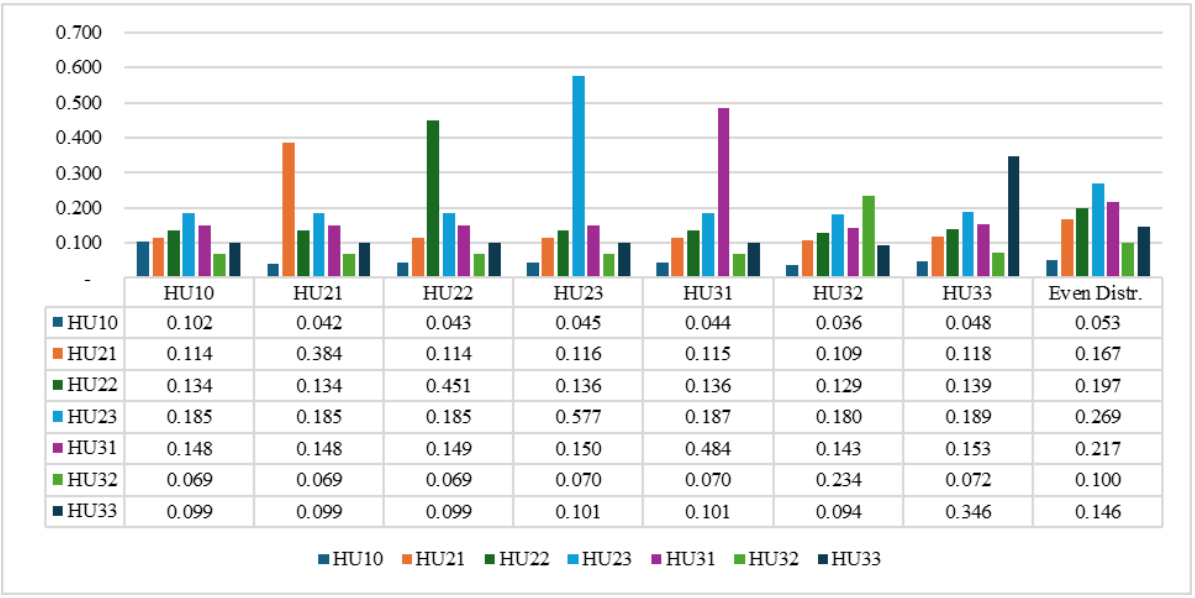
Figure 4. 11. Economic impact of investment support on regional employment



Source: Author's elaboration

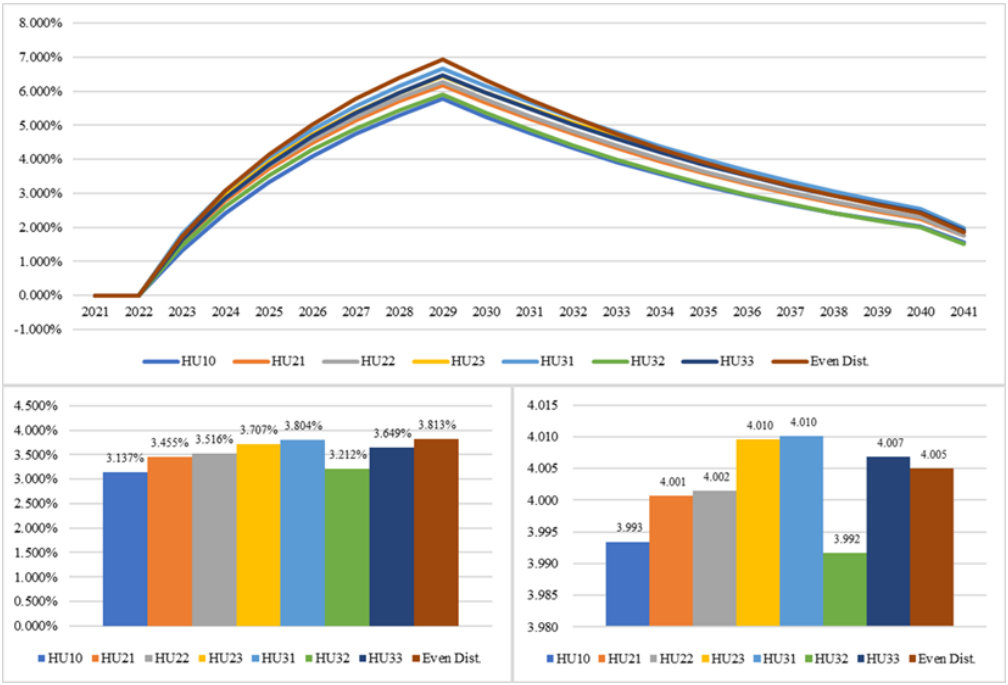
Figure 4. 12. Economic impact of INV support on EMP at the national level over time (left) and averaged in absolute terms (right)

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. **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.



Source: Author's elaboration

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

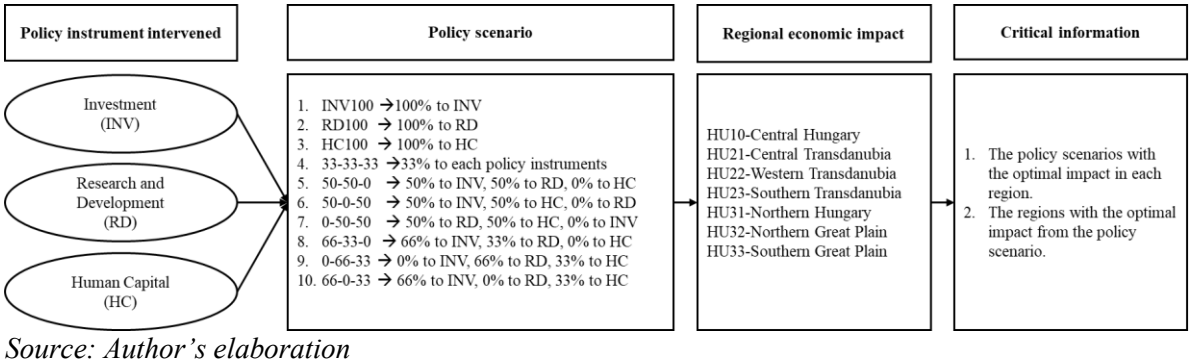


Source: Author's elaboration

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)

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*.



Source: Author's elaboration

Figure 4. 15. Process flow of Policy Simulation 2

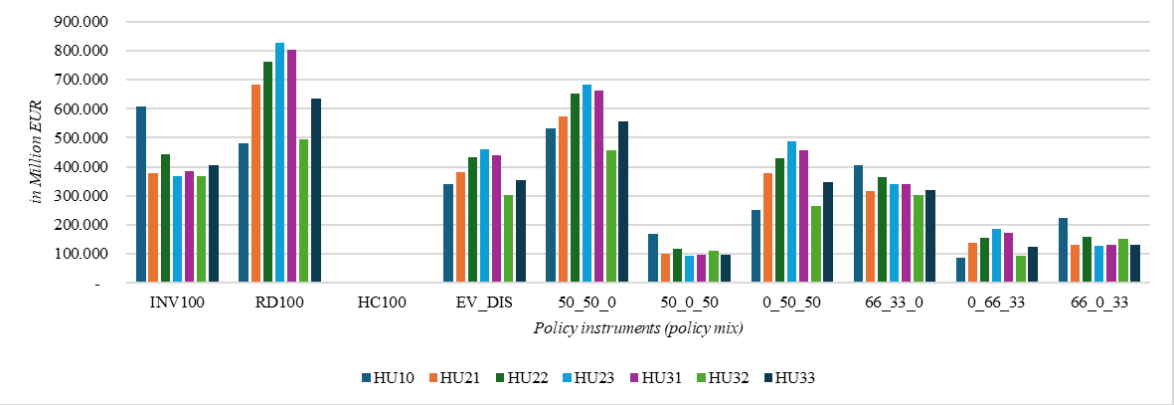
Referring to **Table 4.3**, the first three policy scenarios show that policy interventions such as the RD100 scenario have the largest impact on GVA in the six regions (LDRs). Referring to **Table 4.3** and **Figure 4.16**, it is clear that the investment instrument (INV100) is the most

optimal instrument to support GVA optimization in Central Hungary. 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**). Policy simulation 2 shows that R&D support substantially GVA impacts all LDRs except Central Hungary.

Table 4. 1. 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** **INV100**	**683.03** **RD100**	**762.70** **RD100**	**826.87** **RD100**	**802.00** **RD100**	**494.11** **RD100**	**635.76** **RD100**		

Source: Author's elaboration



Source: Author's elaboration

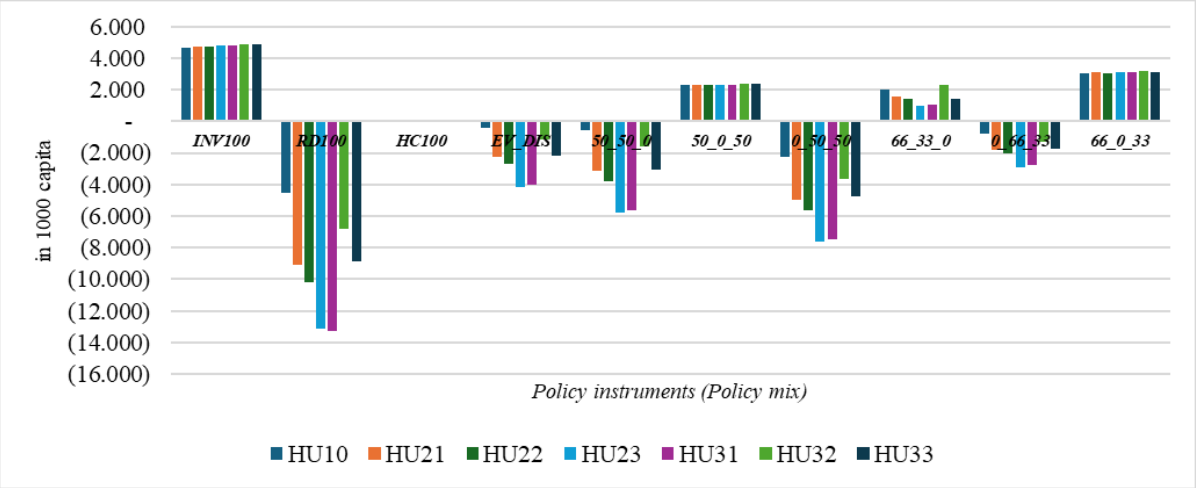
Figure 4. 16. Impact of policy support (policy mix) on regional GVA

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. 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.

Table 4. 2. 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** **INV100**	**4.741** **INV100**	**4.701** **INV100**	**4.788** **INV100**	**4.777** **INV100**	**4.834** **INV100**	**4.873** **INV100**		

Source: Author's elaboration



Source: Author's elaboration

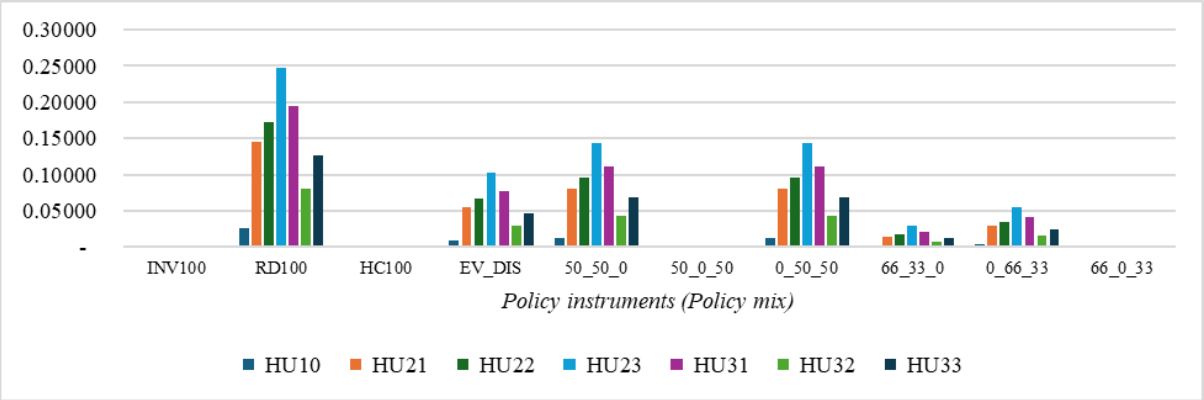
Figure 4. 17. Impact of policy support (policy mix) on regional EMP

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 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.

Table 4. 3. 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	0.000	0.000	0.000	0.001	0.000	0.000	0.000	**0.001**	**HU32**
RD100	0.026	0.146	0.173	0.247	0.195	0.081	0.126	**0.247**	**HU23**
HC100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	**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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	**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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	**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

4.3.4. 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.

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. *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. *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.

Table 4. 4. 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	33,097 (Northern Great Plain)	Minor impact
R&D	7,334 (Northern Hungary) 7,178 (Southern	Minor impact	4.010 (Northern Hungary) 4.010 (Southern
HUMCAMP	Minor impact	Minor impact	Minor impact

Source: Author's elaboration

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. 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). 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). *Second*, the estimated employment impact (EMP) shows that full investment support (INV100) has the potential to deliver the most optimal impact among all regions.

Table 4. 5. 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

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.

The concept of multilevel governance (MLG) 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. 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.

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. 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

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. Regions such as LDRs or regions with specific constraints often have limited capacity to cooperate or collaborate. 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. 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. Therefore, there is great potential for applying the MLG approach in the context of S3 implementation in LDRs. 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. This chapter also explores the potential economic impacts of the S3 implementation. 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 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. 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. 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, the 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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1. Regional Governance Challenges in the Implementation of Smart Specialization Policy in the European Union: A critical review
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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
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List of other articles

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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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1. The Financial Sector Innovation: Challenges and Alternative Solutions
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