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ANALYSIS OF THE IMPACT OF INNOVATION POLICIES ON REGIONAL DEVELOPMENT

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ANNOTATION

In the current knowledge-based economy, innovative ideas are the main source of competitive advantage and a tool for economic growth. Governments from various parts of the world stimulate innovation by introducing policies that modify companies' existing innovation models within the private and public sectors of the national economy. Such policies are enacted to counter market failures that prevent companies from engaging in R&D and include both supply-side instruments and demand-side instruments. Despite the growing interest in this topic, there is a limited understanding of which innovation policies are most effective in supporting firms' R&D activities. The research investigates the differences in the effectiveness of innovation programs across various regions and consequently suggests a mix of supply and demand-side policies. Public procurement, which is a demand-side policy, generates demand for innovative goods and devices and this leads to more deportation of modern technologies in the market. This dissertation seeks to examine the extent to which innovation policy affects firm innovation, which may lead to regional development in emerging, moderate, and strong innovators countries. In particular, this thesis addresses two main objectives to assess the impacts of both demand and supply-side policies on firm innovation.

KEYWORDS

Innovation Policies, Supply and Demand-side policies, Public Procurement for Innovation, Regional Development

NÁZEV

Analýza vlivu inovačních politik na regionální rozvoj

ANOTACE

V současné znalostní ekonomice jsou inovativní nápady hlavním zdrojem konkurenční výhody a nástrojem hospodářského růstu. Vlády z různých částí světa stimulují inovace zaváděním politik, které mění stávající inovační modely společností v soukromém i veřejném sektoru národního hospodářství. Tyto politiky jsou přijímány s cílem čelit selhání trhu, které brání společnostem zapojit se do výzkumu a vývoje (VaV) a zahrnují jak nástroje na straně nabídky, tak nástroje na straně poptávky. Navzdory rostoucímu zájmu o toto téma existuje jen omezené porozumění tomu, které inovační politiky jsou při podpoře VaV aktivit firem nejúčinnější. Dosavadní výzkum zkoumal rozdíly v účinnosti inovačních programů v různých regionech a následně navrhl kombinaci politik na straně nabídky a poptávky. Veřejné zakázky, které reprezentují nástroje veřejných politik na straně poptávky, vytvářejí poptávku po inovativním zboží a zařízeních, což vede k většímu zavádění moderních technologií na trh. Cílem této disertační práce je analyzovat, do jaké míry inovační politika ovlivňuje inovace firem, což může vést k regionálnímu rozvoji v zemích s odlišnou inovační výkonností (rozvíjející se, mírní a silní inovátoři). Tato disertační práce se také zabývá dvěma dílčími cíli, jejichž hlavním úkolem je posoudit dopady poptávkových a nabídkových politik na firemní inovace.

KLÍČOVÁ SLOVA

Inovační politiky, Poptávková a nabídková inovační politika, Veřejné zakázky v oblasti inovací, Regionální rozvoj

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R&D	RESEARCH AND DEVELOPMENT
RIS	REGIONAL INNOVATION SYSTEM
CIS	COMMUNITY INNOVATION SURVEY
SEM	STRUCTURAL EQUATION MODELLING
PSM	PROPENSITY SCORE MATCHING
PPI	PUBLIC PROCUREMENT FOR INNOVATION
PCP	PRE-COMMERCIAL PROCUREMENT
IPRS	INTELLECTUAL PROPERTY RIGHTS

Introduction

In a knowledge-based economy, innovation is recognized as a critical factor for competitiveness and growth (Asheim et al., 2011). Innovation is expected to help society by solving interconnected economic, social, and environmental issues (Krlev et al., 2020). Fostering innovation has become a critical driver for regional development and hence, governments and policymakers around the world acknowledge the critical role that innovation performs in generating economic growth, increasing competitiveness and efficiency, and enhancing the quality of life for citizens (Sánchez-Carreira et al., 2019). Governments implement innovation policies that can stimulate firm-level innovation in driving the economic growth of a nation. Generally, innovation policies include a mix of policy instruments, which means supply-side innovation policies such as subsidies, tax credits, training, and assistance programs (Cano-Kollmannet al., 2017), and demand-side innovation policies such as procurement, regulations, and standardizations.

The reason why government innovation policies usually provide firms is due to market failures (Vaninoetal., 2019) for example, firms are not able to invest in R&D activities. Government provides incentives for the development of greater innovative capacity for firms to generate higher productivity, to encourage firms to undertake risky projects (Vanino et al., 2019), and to create more skilled jobs (Castillo et al., 2019). On the other hand, innovation policy can harm firm innovation because of the crowding-out effect. Firms can use incentives through increasing budgets that are not relevant to innovation activities (Catozzella & Vivarelli, 2016).

However, despite increased interest in the above topic, there is a lack of understanding regarding which innovation policies are the most effective to support firms' R&D and innovation activities (Dumont, 2017; Afcha & Lucena, 2021; Yaghi & Tomaszewski, 2024). Therefore, it is necessary to understand how these innovation policies affect firm innovation. Moreover, there are also varying levels of innovation capacity, innovation policy design, and resource allocation in European countries. For example, according to European Commission division of countries based on their innovation performance (leaders, strong, moderate, and emerging), in emerging and moderate innovators (for example, Romania, Croatia), there is a lack of a conducive climate for innovation, as well as an adequate ability to utilize public funding. Additionally, there is a shortage of investment in innovative activities and weaker institutional support for innovation (Prokop & Stejskal, 2017). However, strong innovators

have well-established innovation systems, developed infrastructure, and strong innovation policy framework which can provide higher level of R&D investment and collaboration in translating into higher innovation output. Moreover, analysing different countries' groups is also in line with the goals of regional cohesion policy and convergence set by the European Union which aims to promote regional development and reduce regional disparities.

Against the above backdrop, ***this dissertation thesis aims to examine to what extent the innovation policy affects the firm innovation, which leads to regional development in emerging, moderate, and strong innovators countries.***

Importantly, policymakers' attention has steadily turned away from supply-side policies due to the limitation of supply-side innovation policies such as the crowding-out effect of R&D subsidy (Bong et al., 2020) and inefficient use of the government budget (Kundu et al., 2020). Demand-side innovation policy, which focuses on creating and shaping demand for innovative products and services has become an important part of innovation policy. Demand-side innovation policies especially public procurement for innovation, therefore received increased attention more recently (Uyarra et al., 2020). Demand-side innovation policy complements traditional supply-side policy by addressing the demand aspects of innovation. Stimulating demand for innovation is crucial to ensure the successful diffusion of technological development in the market (Dai et al., 2021). Government as a main buyer can have an impact on private firm innovation by creating demand for innovative solutions for societal needs. In this sense, we need to consider firm internal capacity or R&D activities to capitalize the government contracts to contribute to innovative solutions.

Therefore, to provide a more comprehensive picture of the effects of various innovation policies on innovation activities of firms across Europe, specific objectives are defined. First, to fill the gap in research on the effects of demand-side innovation policy, Objective one is defined as follows:

Objective 1: To examine the relationship between demand-side innovation policy (procurement) and firm innovation considering the role of firms' R&D activities.

This analysis will use structural equation modelling (PLS-SEM) to investigate how demand-side innovation policy (public procurement for innovation) influences firm innovation and how R&D activities facilitate this relationship by using data from Community Innovation Survey (CIS) 2014 in emerging, moderate and strong innovators countries.

In addition, to fully understand the effectiveness of innovation policies, it is necessary to consider both supply and demand-side innovation policies in one analysis in parallel, and how they influence firm innovation. Supply-side innovation policies, for example, subsidies, and tax incentives have been largely explored (Xie et al., 2021). Therefore, according to Edler and Georghiou (2007), this thesis uses other types of measures from supply-side innovation policies such as support for training programs, market testing, and export market which are not extensively explored. Hence, the Objective two is defined as follows:

Objective 2: To explore the causal relationship between innovation policy (supply and demand-side) and firm innovation.

This analysis will be conducted using treatment effect analysis (propensity score matching technique) to explore to what extent the policy is effective for firm innovation in European countries and emerging and moderate innovators with the use of data from Innobarometer 2015. This method is suitable for analyzing the effectiveness of policy intervention because it reduces the selection bias by matching firms that received policy treatment. It gives more accurate estimates of the treatment effect and enhances the validity of results.

This dissertation is structured as below, Chapter one outlines the conceptual theoretical background of regional development. The second chapter describes the theoretical background of innovation and innovation policies. The third chapter reveals the research aim and the fourth chapter demonstrates methods and data. And next chapter explains the results and discussion for the empirical analysis. Finally, the last section summarizes the conclusion of the dissertation.

1 Regional Development and policy

1.1 Definition of Region, Regional Development, and Regional Policy

A region is a defined area of land or space with identifiable characteristics that distinguish it from other areas (Johnston et al., 2007). Regions can be determined by their physical, economic, social, or political features, and are often recognized as important units of analysis in geography, planning, and other fields (Isard, 1956). Westfall (1980) defines a region as a subnational unit as a part of one state or one national economy separated from other areas with formal boundaries and connected with other areas with economic barriers. A region is an area with specific elements, specific functional and related infrastructure, and common interest in regional development and in increasing of prosperity of inhabitants (Skokan, 2006). The law on regional development support declares a region as a **territorial unit defined by administrative boundaries of countries, districts, municipalities, or associations of municipalities**, which is supported in terms of its development (Nijkamp, 1986).

Taylor (1991, p. 113) discusses the concept of a region in the context of regional development. He proposes that a region can be defined as "*a bounded portion of the Earth's surface within which distinctive patterns of activity exist and which possess a degree of internal coherence or homogeneity*". This definition highlights both spatial boundaries and internal characteristics that contribute to the coherence of a region. Scott (2001) examines the concept of regions within the context of the global economy. He defines a region as "*a territorially bounded space that exhibits internal coherence and homogeneity in the structure of its component parts and in the relations among them*" (Scott, 2001, p. 11). This definition emphasizes the interconnectedness of the components within a region and their shared characteristics.

Furthermore, the concept of region is a complex and evolving one, with different meanings and interpretations across various disciplines. Fotheringham et al. (1998) discuss the concept of region as an explanatory possibility in spatial analysis and its relation to the planning and development process. Paasi (2003) scrutinizes the significance of the concept of the region for regional studies and social practice, highlighting critiques regarding various forms of essentialism. The concept of region is a crucial one in understanding spatial analysis, socio-

economic geography, and regional studies, but its meaning and interpretation are constantly evolving and subject to critique and revision.

Regions play an important role in economic development, but there is no clear consensus on why this is the case. Storper (1995) argues that regions are important because they are a locus of untraded interdependencies, while Khassenova (2021) describes the objective preconditions for regional studies and the role of regions in economic development. Hence, regions are important for economic development, but the reasons for this are still complex and multifaceted.

Regions possess unique endowments of natural resources, such as minerals, arable land, and energy sources, which contribute to their economic potential. The efficient allocation and utilization of these resources create comparative advantages for regions, enabling them to specialize in particular industries or sectors. For instance, regions rich in oil reserves can develop a petroleum-based industry, while those blessed with fertile land can excel in agriculture. This specialization based on regional resources fosters economic growth by harnessing the advantages inherent in specific geographic areas (Porter, 1990).

Regional development has become an increasingly important activity for national as well as local and regional governments across the world since the 1960s and 1970s. In parallel, the context of local and regional development has been dramatically reshaped by deep-seated changes in the pattern of economic activity and has become significantly more challenging. Economic dimensions such as growth, wealth creation, and job creation have long been used to define what constitutes regional development (Armstrong & Taylor, 2000; Vanhove, 2018). Regional development is sometimes confused with this narrower focus on regional economic development. According to Storper (1997), the regional pursuit of prosperity and well-being is centered on sustained increases in employment, income, and productivity, which remain at the heart of economic development. According to Beer et al. (2003, p. 5), there is "*reasonable agreement about the broad parameters of what is meant by local and regional economic development: it refers to a set of activities aimed at improving an area's economic well-being*." Reduced social inequality, environmental sustainability, inclusive government and governance, and cultural diversity have all been included to varying degrees in definitions of regional development (Haughton & Counsell, 2004).

Regional development refers to **the process of improving the economic, social, and environmental conditions of a specific region** (Laurini et al., 2023).

It involves (McCann & Ortega-Argilés, 2015):

- enhancing the productivity and competitiveness of local businesses,
- creating employment opportunities,
- improving the living standards of the people in the region.

Moreover, the goal of regional development is **to achieve sustainable economic growth and development** (Cristina et al., 2021). According to the Organization for Economic Cooperation and Development (OECD), regional development is a multidimensional concept that includes a wide range of economic, social, and environmental factors (OECD, 2017). It includes both place-based and people-based approaches that focus on improving the competitiveness and resilience of local economies (Burgalassi et al., 2019). Implementing sustainable development concepts at the regional level necessitates aligning local needs with broader demands for cooperation (Jovović et al., 2017). According to Schults et al. (2019), smart specialization is one important method for promoting regional economic development. It indicates how crucial close cooperation is between various entities in a region in order to encourage innovative approaches (Shults et al., 2019).

Similarly, the Triple Helix concept (described in the sub-section 1.4.2) supports regional economic development by encouraging innovation (a more detailed description and definition of innovations is in Chapter 2), and research activities (Todeva & Danson, 2016). Moreover, regional development is related to the presence of clusters (see sub-section 1.4.5), which are collections of related companies, suppliers, and related organisations in a certain industry. In many nations, cluster theory has greatly influenced regional development policies (Njøs et al., 2016). Another important factor in regional development is the economic and fiscal resilience of the region, as this affects the region's capacity to endure and recover from economic shocks and obstacles (Klimanov et al., 2020).

Regional policies play an important role in promoting regional economic development. Regional policy, often referred to as **the European Union (EU) Cohesion Policy**, aims to avoid **regional inequalities and to improve regional welfare** in the EU (Olson, 2020). This policy is relevant not only for the spatial distribution of economic activity but also for social equity. Moreover, regional policies are instrumental **in promoting innovation and industrial development**. For instance, in industrialized regions, the adoption of cluster industrial policies has been shown to facilitate modernization and the creation of competitive advantages in both domestic and international markets (Zastupov, 2019). The importance of innovation is

supported by the concept of Smart Specialization, which encourages regions to identify and develop their unique strengths and capabilities (Nowakowska, 2016). This approach enhances regional competitiveness and aligns with the European Union's cohesion policy, which aims to foster economic convergence among member states (McCann & Ortega-Argilés, 2013). By focusing on innovation, regional policies can drive high-quality economic development and improve regional performance (Zhou, 2024).

The other important factors that are influencing regional development are described in section (1.6).

1.2 Theoretical Grounding of Regional Development

Endogenous growth theory is important for regional development because it emphaises the role of knowledge, innovation, and human capital in generating economic growth. The theory also suggests regions can encourage innovation by investing in research and development, which generates long-term growth. Moreover, effective government institutions and policies can create positive conditions for economic activities in a region. Subsequently, a region can generate a positive spillover effect to other regions and can develop a network of growth.

Likewise, the Agglomeration theory also plays a critical role in regional development because it explains why economic activities concentrate in certain regions and how geographical concentration can spur regional development. New Economic Geography theory is also a significant concept for regional development in explaining equitable regional growth and reducing regional disparities among regions.

1.2.1 Exogenous versus Endogenous Growth Theories

Robert Solow and Trevor Swan introduced neoclassical growth theory (long-run economic growth) in 1956. Neoclassical exogenous growth theory is an economic framework that seeks to explain **long-term economic growth through the accumulation of capital and technological progress**. It posits that exogenous factors, such as increases in population, natural resources, and technological advancements drive economic growth. The theory suggests that these external factors, combined with the efficient allocation of resources and the presence of competitive markets, lead to sustained economic growth (Solow, 1956).

However, the theory neglects the role of endogenous factors driving economic growth. These are:

- human capital (Caballé & Santos, 1993; Rangong & Ngwakwe, 2019),
- innovation (Aghion et al., 1998; Malamud & Zucchi, 2019),
- knowledge (Aghion et al., 1998).

These factors are considered crucial for understanding the complex dynamics of economic development. Therefore, the neoclassical endogenous growth theories of regional development modify the traditional neoclassical theories by making technical progress endogenous to economic process. Several models have been developed many substantially altering the traditional neoclassical framework by assuming imperfect competition and increasing returns to scale. The model visualizes the local characteristics that could lead to technological change from different approaches. The concept has included modeling technological change as a function of human capital, research and development (R&D), innovation, knowledge spillovers, and technological spillovers (Romer, 1990).

Endogenous growth theory suggests that economic growth can be explained by **factors within a country's economy, such as human capital, R&D, knowledge and innovation** (Romer, 1990). Unlike traditional growth theories, which focus on external factors such as natural resources, endogenous growth theory argues that a country's growth potential is determined by its ability to create and innovate using internal resources. This theory posits that investments in education, technology, and R&D can lead to long-term economic growth by creating new ideas, products, and services (Martin & Sunley, 1998). It also suggests that these investments can generate **positive externalities**, spurring further growth. The theory underscores the importance of policies that encourage R&D investment, education, and innovation to foster sustained economic growth.

Externalities and spillover effects are fundamental components of endogenous growth theory. These concepts are crucial for understanding how growth is internally generated within an economy. In the context of endogenous growth theory, externalities are defined as the impact of economic activities on third parties outside the market transaction, leading to unintended consequences (Aghion & Howitt, 1990). One type of externality is **knowledge spillovers**,

where the diffusion of knowledge from one entity to other results in positive effects on productivity and innovation (Glaeser et al., 1991).

A) Endogenous and Technology Change

According to the endogenous growth theory, technology is endogenous since it depends on decisions about investment in R&D and diffusion (Bassanini & Scarpetta, 2001). Endogenous growth theories forecast **technology can be seen as increasing returns to scale**, which will lead to long-term knowledge-based growth (Cortright, 2001). Endogenous growth theory holds that intentional investments in technology and knowledge, as opposed to external factors, are what actually drive economic growth. Technological change is emphasised heavily in this approach since it is considered an endogenous factor that significantly supports long-term economic growth (Romer, 1990). This hypothesis, in particular, emphasises the close connection between economic growth and innovation with respect to the labour force participation rate in the knowledge sector (Schilirò, 2019).

Sustainable growth depends on the **creation of new technologies and the accumulation of knowledge** (Rezny et al., 2019). Knowledge, expertise, and experience collectively known as human capital are seen as investments that fuel the development of new technologies and accelerate economic progress (Boztosun et al., 2016). Moreover, as internal forces behind economic development, endogenous growth theory emphasizes the importance of elements like technical advancement and human capital. In contrast to exogenous growth theories, these factors are considered as exogenous influences. By integrating technological change as an endogenous element, the theory aims to offer a more comprehensive understanding of the mechanisms behind sustained economic development (Brinkman & Brinkman, 2001).

B) Externalities and spillover effects

Spillover effects, especially **knowledge spillovers, are significant drivers** of endogenous growth in various studies (Black & Henderson, 1999; Audretsch & Keilbach, 2004). These spillovers are often linked to **agglomeration and human capital accumulation**, which promote innovation and economic development (Black & Henderson, 1999). The literature also underlines that knowledge spillovers are essential mechanisms triggering endogenous growth (Audretsch & Keilbach, 2004).

Endogenous growth models emphasize the role of knowledge spillovers for growth (Romer, 1990; Grossman and Helpman, 1991). Additionally, relatively recent literature has

emerged that focuses on the **geographic dimension of knowledge externalities** (Audretsch & Feldman, 1996). This literature suggests that not only do knowledge spillovers generate externalities, but that they also tend to be geographically bounded. In other words, proximity is important for the flow of knowledge. As Henderson (1992) argues, close firms engage in networks that facilitate communication and knowledge spilling. These networks are most often local and are the reflection of interpersonal contacts and mutual trust that develop through the years. The theory of endogenous growth suggests that local growth and economic concentration arise from localized knowledge spillovers, features the prominence of these externalities in propelling regional development (Bode, 2002).

1.2.2 Agglomeration Theory

Theories of agglomeration have been used to explain the **clustering of firms and industries in certain regions** and their impact on regional economic growth. According to Ki (2001), there are three main theories of agglomeration:

- *Localization economies*: Localization economies are the benefits that firms gain from their location being close to other firms in the same industry (Jofre-Monseny, 2014). These benefits include access to specialized inputs, shared knowledge, and the ability to collaborate on R&D. Localization economies are particularly important for industries that require specialized inputs, such as the high-tech sector.

- *Urbanization economies*: Urbanization economies are the benefits that firms gain from their location being close to a large urban center. These benefits include access to a large pool of skilled labor, infrastructure, and other amenities. Urbanization economies are particularly important for industries that require a large pool of skilled labor, such as the financial sector (Jofre-Monseny, 2014).

- *Marshallian externalities*: Marshallian externalities are the firms' benefits from their location being close to other firms in different industries. These benefits include the sharing of knowledge and ideas, as well as the ability to access a diverse range of inputs (Chertow et al., 2008). Marshallian externalities are particularly important for industries that require a diverse range of inputs, such as the creative sector.

Theories of agglomeration have important implications for innovation policy on regional development. According to McCann (2008), policies that promote agglomeration can be effective in promoting innovation and economic growth. These policies can include

investments in infrastructure, education, and R&D, as well as policies that promote collaboration between firms and industries (McCann, 2008). Policies that promote agglomeration can be particularly effective in promoting innovation and economic growth in industries that require specialized inputs or a large pool of skilled labor. For example, policies that promote the clustering of high-tech firms can help to promote innovation in the high-tech sector.

1.2.3 New Economic Geography Theory

With the work of Paul Krugman and Anthony Venables, new economic geographic theories of regional development began in the 1990s and were integrated within a formal (mathematical) neoclassical framework developed in the 1950s (Fujita & Thisse, 2009). In so doing, the new economic geography theories of regional development change the traditional neoclassical model by assuming increasing returns to scale and imperfect competition in interregional trade.

The New Economic Geography theory emphasizes the need for **agglomeration economies and the role of transportation costs** in determining regional development. The theory suggests that regions that have a competitive advantage in a particular industry will attract firms and industries, leading to agglomeration and increased economic growth (Neary, 2001). The New Economic Geography theory has been used to explain the clustering of firms and industries in certain regions. The New Economic Geography theory also emphasizes **the role of transportation costs in shaping the spatial distribution of economic activity**. Specifically, the theory proposes that transportation costs can create **a trade-off between the benefits of agglomeration and the costs of dispersion**, with firms and industries choosing to locate in regions that offer the optimal balance between these factors.

In addition to agglomeration effects and transportation costs, the New Economic Geography theory also considers **the impact of trade liberalization and globalization** on the spatial distribution of economic activity (Redding, 2010). The theory suggests that the removal of trade barriers can lead to **increased specialization and concentration of economic activity** in certain regions, while also creating new opportunities for trade and investment between regions.

1.3 Selected Institutional Theories of Regional Development

Contemporary theories of regional development focus on understanding the complex processes and factors that shape the economic, social, and spatial dynamics of regions. Although there are many contemporary theories, some selected theories such as the Triple helix theory, Quadruple helix, Quintuple helix, Cluster theory, and Industrial district that can reflect the current stage of regional development. These chosen theories provide an understanding of the dynamic of innovation and regional development. In addition, theories are consistent with the aim of the thesis by providing a structured approach to investigate how institutional structures and interactions among actors play an important role in fostering regional development through R&D and innovation activities Theories dealing with innovation systems also belong to this group of theoretical concepts, however, section 2.4 is devoted to this issue, so innovation systems are not specified in more detail in this chapter.

1.3.1 Industrial Districts

In the late 19th century, the English economist Alfred Marshall distinguished the possibility of the manufacturing industry into two: under the one roof of a big enterprise and small enterprises within localities specializing in a particular industry (industrial districts). Industrial districts were very dominant at that time. Moreover, the **localization of small and medium-sized enterprises** by one industry became very common in Britain in the second half of the 19th century (for example, metal industry in Sheffield and in the textile industry in Lancashire). Marshall describes the following claim by incorporating the concepts of district "*external economies*" (Marshall, 1920, p. 271) and "*industrial environment*" (Marshall, 1920, p. 284, 287). *"The advantages of large-scale production can generally be achieved by building a small number of large businesses into a district by combining a large number of small business owners"* (Whitaker, 1975, p. 196).

After Marshall's first theoretical concept of an industrial district, Giacomo Becattini, a researcher on industrialization in Tuscany during the post-World War II era described the further explanation. Becattini came up with **the idea of external economies** to clarify the emergence of small enterprises within a sector, in places like Prato (textiles) and Cascina (furniture), while also alluding to the concept of industrial atmosphere (Becattini, 1991). He gave a deep explanation of the economic development of Tuscany and reintroduced the concept of the industrial district in industrial economies (Becattini, 1991). Another scholar, Piore and Sabel (1984) highlighted **constant innovation as an important feature of industrial districts**

and a requirement for their continuous growth. "*A combination of productive action; in a narrower sense, with the greater life of the people*" (Piore & Sabel, 1984, p. 275) will bring about a balance between cooperation and competition and ensure constant innovation and the adoption of new technologies.

According to Alfred Marshall, the term 'industrial district' refers to **a location where a cluster of firms** is established, however, it is not limited to a localized industry. A localized industry means "*an industry concentrated in certain localities*" (Marshall, 1920, p. 268). Geographically, firms' focus may vary. The first is to get closer to the resources on which producers depend. The location of the region is related to physical conditions (climate, soil, land and water), for example English districts such as Staffordshire, Bedfordshire and Buckinghamshire. The second point is that a court's patronage creates a market for exceptionally high-quality products (Marshall, 1920). The third point is almost every industrial district has been concentrated in one or more large cities (Marshall, 1920).

Alfred Marshall's perceptions into agglomeration economies highlight the potential benefits of close proximity for firms, particularly in terms of innovation and diffusion of new ideas. The "**industrial atmosphere**" and "**mutual knowledge and trust**" among small firms can indeed foster a collaborative environment conducive to innovation. However, as Marshall noted, these factors alone do not ensure innovation; they simply create a fertile ground for it. Other elements, such as investment in research and development, the presence of skilled labor, and access to capital, also play critical roles in the actualization of innovations within industrial districts. The unique industrial atmosphere' prevalent in industrial districts can facilitate the acceptance, modification, and spread of new ideas among small and medium-sized enterprises (SMEs), as noted by Asheim. Similarly, the existence of trust can encourage the integration of new technologies within these districts, as trust not only lowers transaction costs but is also essential for forming informal business networks without formal agreements.

Nonetheless, it is important to recognize that the role of geographically concentrated economic activities in fostering innovation is primarily associated with incremental improvements. Industrial districts are adept at nurturing step-by-step developments in products, processes, and overall organizational management, as described by Amin (2017). Furthermore, Asheim (1996) posited that these districts are better equipped to handle progressive changes rather than rapid technological disruptions. Moreover, agglomeration economies can serve as essential foundational elements and incentives for incremental innovations, which often occur through unstructured *learning by doing* and *learning by using* and are largely dependent on tacit

knowledge. Becattini (2014) viewed this as a common process of shared self-realization, where the choice to adopt new technology is influenced by the shared values and mindset within the districts and is seen as a chance to maintain a competitive edge which already established.

1.3.2 Triple Helix Theory

The triple helix theory is a framework developed to understand and analyze the dynamic **interaction between academia, industry, and government** in the process of **innovation and knowledge creation**. It was first proposed by Etzkowitz and Leydesdorff in the 1990s and has since gained significant attention in the field of innovation studies (please see, for example, Ranga & Etzkowitz, 2013; Etzkowitz & Zhou, 2017; Cai & Amaral, 2021). This theory explains the interdependencies and collaborations among these three sectors, which emphaise their role in fostering innovation, regional growth, economic development, and societal progress. The triple helix model views the traditional relationship between academia, industry, and government as a symbiotic system in which each sector contributes unique resources, knowledge, and capabilities. This interplay of actors creates a dynamic and developing innovation ecosystem (Ranga & Etzkowitz, 2013).

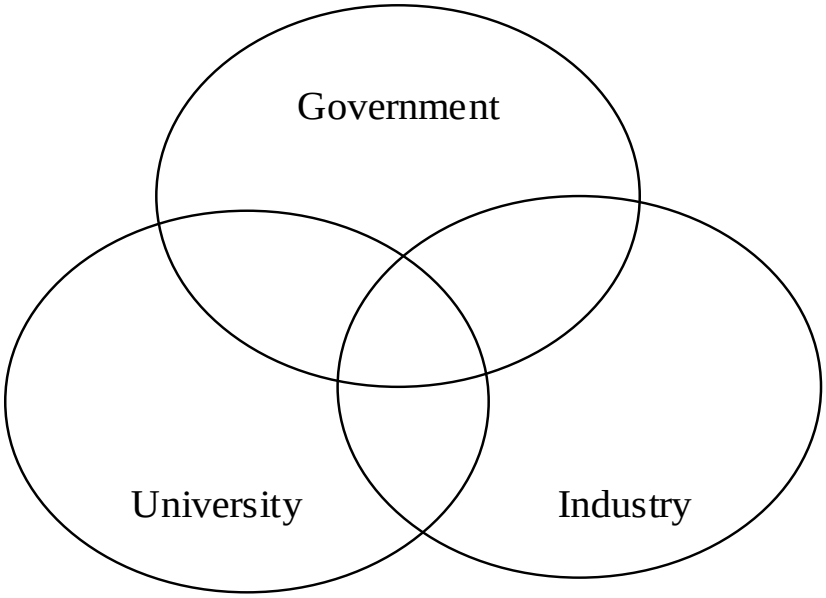

Figure 1 Triple Helix Model

Source: Ranga & Etzkowitz (2013)

In Figure 1, the triple helix framework explains the flow of knowledge and information across academia, industry, and government as a crucial driver of innovation. Research by

Carayannis and Campbell (2009) highlights the importance of collaborative networks in enabling knowledge exchange and transfer, leading to the creation of new ideas and technologies. Industry-academia collaboration is a key aspect of the triple helix model. Academic institutions provide a rich source of scientific knowledge and expertise, while industry brings practical applications and market-oriented perspectives. Studies by Caloghirou et al. (2004) have shown that such collaborations enhance the innovation capacity of both sectors and contribute to the development of new products, processes, and technologies. The triple helix theory recognizes the role of government in creating an enabling environment for innovation. Governments often play a regulatory and supportive role by providing funding, establishing policies, and creating incentives for collaboration. Lundvall and Borrás (1998) argue that government policies that promote knowledge sharing and collaboration can stimulate innovation and economic growth.

In addition, there are two more models based on Triple-Helix model, namely Quadruple Helix and Quintuple Helix models. The Quadruple Helix integrates the viewpoints of a media and culture-based public and civil society (Carayannis & Campbell, 2009), whereas the Quintuple Helix is broader and inclusive by adding knowledge and innovation in terms of natural environment (Carayannis et al., 2012).

1.3.3 Quadruple Helix

The Quadruple Helix theory emphasizes the **collaboration and interaction of four key actors ("helixes")** in the innovation process: **government, academia, industry, and society**. This model represents a shift from the Triple Helix model, which focused on the interaction between university, industry, and government. The Quadruple Helix model recognizes the increasing role played by society in the innovation process, highlighting the importance of societal stakeholders in knowledge creation and innovation (Alhassan et al., 2017; Pandjaitan et al., 2022).

Quadruple Helix theory can be traced to the recognition of the need for a more inclusive and comprehensive innovation model that incorporates the **active participation of societal actors**. This modification is encouraged by a demand for increased and differentiated participation in the development of society in general, leading to the emergence of the Quadruple Helix concept as part of the coevolution of the political and knowledge systems (Höglund & Linton, 2017). The Quadruple Helix framework is viewed as a facilitator of regional collaborative business environments, emphasizing the importance of government,

universities, industries and civil society creativity in knowledge production, and innovation (Carayannis & Campbell, 2014; Cai & Lattu, 2021).

The Quadruple Helix model lies in its ability to promote sustainable development in a knowledge economy through cooperation with the knowledge society (Carayannis et al., 2012). This model provides both theoretical and practical understandings to help universities progress towards effective mechanisms for open innovation and commercialization within a Quadruple Helix ecosystem. It also addresses the important of main investigators having strong ties to realize collective and individual value motives (Miller et al., 2016; Cunningham et al., 2017). Moreover, the Quadruple Helix[1] model is seen as a comprehensive approach to understanding the opportunities and challenges at the intersection of incapacity and employment. It focuses on the engagement of government, university, industry, and society in research and innovation (Musid et al., 2023) shown in Figure 2.

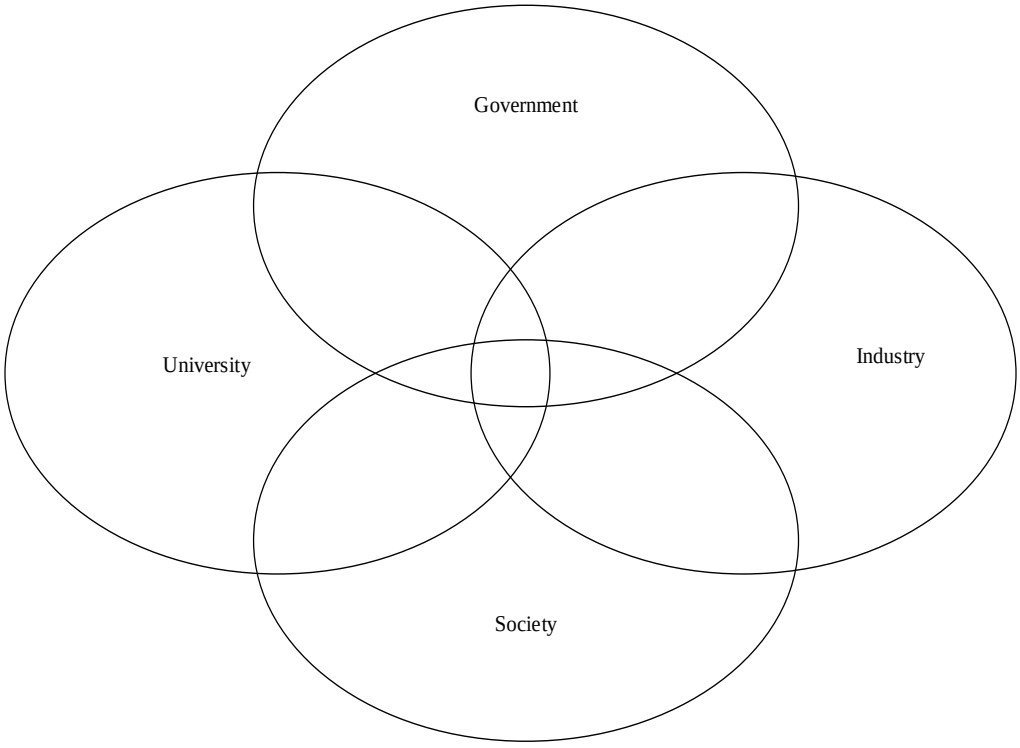

Figure 2 Quadruple Helix Model

Source: Carayannis et al. (2014)

[1] Based on the helix concept, the author of the dissertation thesis also analyzed the effect of triple and quadruple helix cooperation on firms' product and process innovation and R&D activities in the case of Norway (please see Sein & Prokop, 2021).

1.3.4 Quintuple Helix

The Quintuple Helix theory is an innovative model that expands on the Triple and Quadruple Helix models, incorporating the natural environment as a crucial component in the innovation process. The concept of the Quintuple Helix emphasizes the interconnectedness of ecology, knowledge, and innovation, creating synergies between the economy, society, and democracy (Carayannis et al., 2012). It also focuses on the integration of the natural environment, government, university, industry, and civil society as drivers of regional co-opetitive entrepreneurial ecosystems, contributing to the development of dynamic tangible and intangible assets within the resource-based view and the new theory of the growth of the firm (Carayannis et al., 2017).

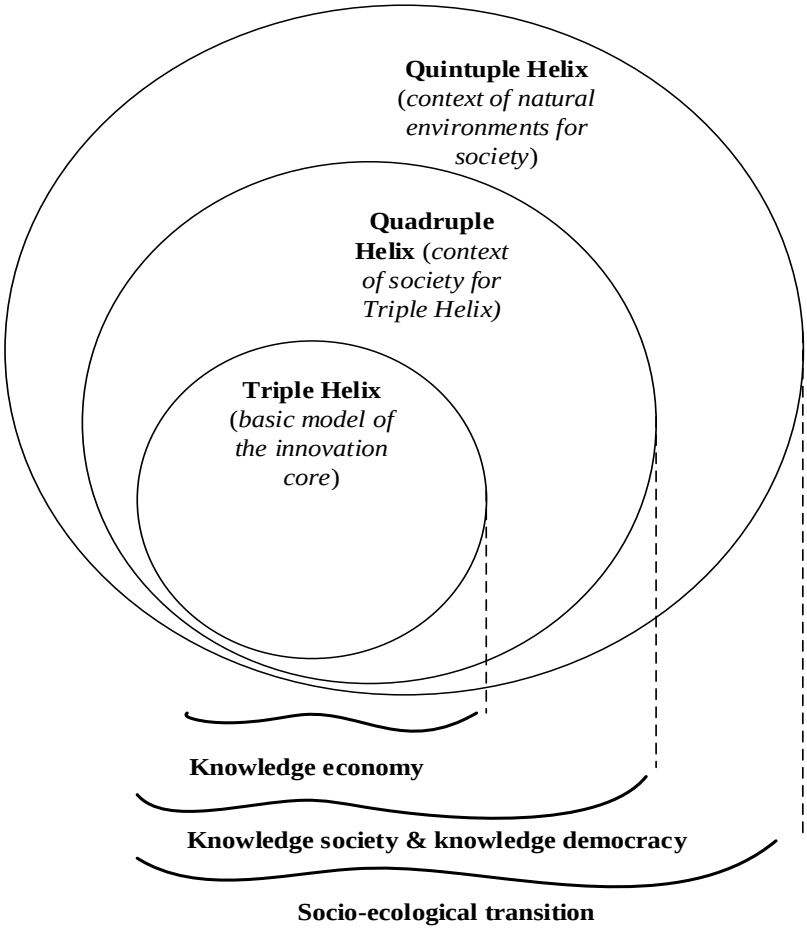

Figure 3 Quintuple Helix Model (knowledge production & innovation)

Source: Carayannis & Campbell (2012)

The Quintuple Helix model has been proposed as a framework for analyzing drivers of innovation, with a focus on the natural environment of society and the economy for knowledge production and innovation systems (Carayannis & Campbell, 2011). Moreover, recent developments recognize the importance of societal stakeholders and the natural environments of society in the Quintuple Helix concept highlights on socioecological transitions and natural environments (Campbell et al., 2015). The Quintuple Helix model is also seen as a holistic approach that incorporates the natural environments of society which contributesto sustainable development and social ecology (Reis et al., 2022). Figure 3 shows five interconnected helixes (government, university, industry, civil society, and the natural environment). It represents collaborative interactions and knowledge sharing among actors. The natural environment represents its significance among all other helixes.

The Quintuple Helix model has been applied in various contexts, such as in the management of tourism villages, where it is utilized to restore the balance of nature and promote effective development (Susanti & Pradana, 2021). Additionally, the model has been used to assess marine fisheries sustainability under climate change pressure to demonstrateits cross-sectional framework and interdisciplinarity towards sustainable development and social ecology (Mohamad et al., 2022).

1.3.5 Cluster Theory

Clusters, which are concentrated in one location with exceptional competitive performance in specific fields. Clusters can be found in almost every national, provincial, state, and even metropolitan economy, particularly in more developed countries,for example, Silicon Valley and Hollywood (Porter, 1990; Zonnenshain et al., 2020). Porter defines clusters as "*geographical concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, associated institutions (for example universities, standards agencies, and trade associations) in particular fields that compete but also cooperate*" (Porter, 1998, p.197). The connections are both vertical (buy and sell chains) and horizontal (complementary products and services, use of similar inputs, technologies, workers, etc.). These connections are based on social contacts or networks that help to the advantage of firms. Another is geographical proximity; clusters are **interconnected businesses** that are **spatially localized**. Co-location promotes the building of networks of direct and indirect interactions between enterprises, as well as the value-creation benefits that result from them.

Secondly, the cluster concept seeks global development and utilization focusing on **competitive advantage** sources especially knowledge, relationships and motivation (Porter 1998). Clusters influence competition in three ways: (a) increasing the current (static) productivity of constituent firms or industries, (b) increasing the capacity of cluster participants for innovation and productivity growth, and (c) stimulating new business formation that supports innovation and expands the cluster. Many cluster benefits are based on external economies or spillovers between different enterprises, industries, and organizations (Porter, 1990). The competitive advantage of a regional focus community is linked to the economics of geographical proximity (Porter, 1998).

Agglomeration is believed to be the result of interconnected economic activities in a given area. Having cluster results in lower input costs, the establishment of common suppliers, specialist labor pools, spillovers of technical know-how, and the creation of a stronger understanding of the workings of the particular industry by individuals and enterprises. According to social embeddedness theories, when social links among geographically proximate economic actors are strong, transactional costs of trades are minimized (Barnes & Gertler, 2002).

Finally, cluster's concept is wide and constitutes many characteristics of firms and institutions. Clusters are composed of large firms mostly and it can coexist with small and medium-sized firms as well. Clusters address a wide range of external economies and have several types of efficiencies, linkages, and spillovers that affect productivity and innovation. In clusters, externalities can occur naturally and through institutions, such as government, universities, etc. Cluster theory has a broader framework for the influence of locations on a firm's competitiveness and it also mainly focuses on the industrial economies, competitive advantage, value chain, and firm strategy. Moreover, the cluster approach concerns how firms compete across locations and the **location choices of multinational companies** (Porter, 2007). Porter deliberates that if firms in a region are more competitive, attainable via optimal localization in the value chain, those regions will have the higher level of welfare.

The Figure 4 describes the Porter's diamond model. This model contains the interconnected components that Porter speculates as the deciding factors of country comparative economic advantage : firm strategy, structure and rivalry, factor conditions, related and supporting industries and demand conditions.

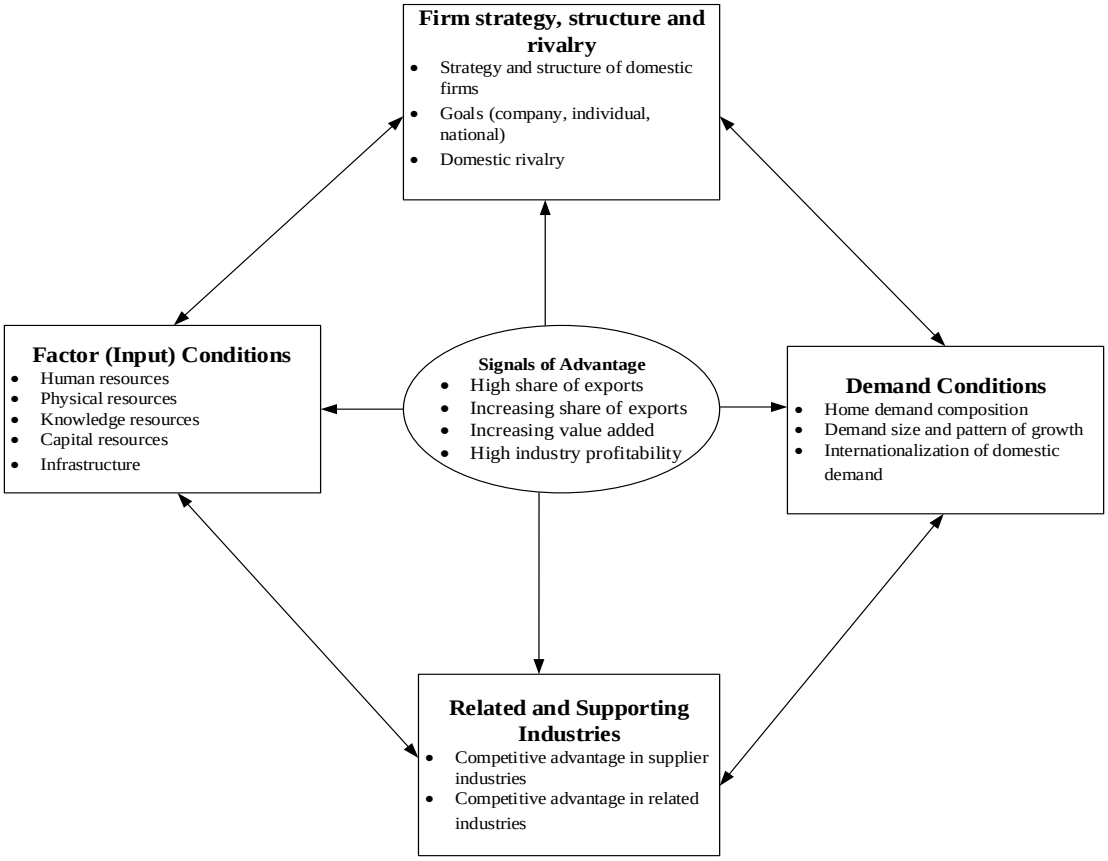

Figure 4 Porter's Diamond Model

Source: Porter (2000)

1.4 Factors influencing Regional Development and the key role of innovation

Regional development is a complex process involving various factors that influence a region's economic, social, and environmental aspects. Some factors are related to regional development, such as management, resources, participation, local industry, infrastructure, technology, local policy, innovation, and entrepreneurship (Hakimi et al., 2021). These factors are essential for the development of a region as they provide the necessary resources and support for economic growth. For instance, the availability of resources such as land, labor, and capital can attract investors and businesses to the region, leading to job creation and economic growth. Additionally, the presence of a supportive regional policy, innovation, and entrepreneurship can foster a conducive environment for business development and innovation. In fact, innovation has a main role in economic growth (Lorenzini, 2014). Innovation and entrepreneurship are the success factors that can increase productivity and business

competitiveness (Khiari & Rejeb, 2015). The competitive advantage of a region can be developed based on the innovation of the firm inside the region (Porter, 1998).

The structure of the economy and the quality of public administration at the national and regional levels are also significant factors in regional economic development (Romanova & Ponomareva, 2021). The structure of the economy refers to the composition of industries and sectors in a region, which can affect the region's economic stability and growth. Meanwhile, the quality of public administration can influence the effectiveness of policies and programs aimed at promoting regional development. Government funding is also important for regional development. Government allocated budget can trigger regional development (Onder & Ozyildirim, 2010). For example, when government increases investment in innovation, the investments can provide the necessary resources for R&D, which can lead to the creation of new products and services, job creation, and economic growth. Finally, the importance of technological development in regions which can improve the region's competitiveness and attract investment and businesses. Malecki (1983) found that technology plays a significant role in regional development, particularly in the manufacturing sector, and contributes to the formation of clusters of linked industries that stimulate regional development. Table 1 explains factors that can drive regional development.

Table 1 Factors Influencing Regional Development

Factors	**Explanation**	**References**
Infrastructure	Efficient transportation networks, communication systems, energy supply, and other infrastructure plays a crucial role in attracting investment and facilitating economic activities in a region.	Sebayan & Sebayang (2020)
Industrial Structure	Regions with more advanced and diversified industries tend to have higher levels of development than regions with less developed and specialized industries.	Lu (2024)

Intellectual Capital (Human/Social/Structural Capital)	Intellectual capital integrates an intangible asset, a human-related component that is relevant to the innovation process which is crucial for regional development and competitiveness in a knowledge-based economy • Human capital has an impact on the pattern and degree of regional development because it determines the productivity, competitiveness, and growth potential of various sectors and industries within a region. For instance, when regions have more human capitals, it will increase migration, create agglomeration economies, produce knowledge spillovers, and positive externalities in a region. • Social capital also reduces the transaction costs and enhances the cooperation and increase innovation within the region. • Structural capital is important for developing regional innovation capability, providing a basic factor for asset development and transfer to promote regional innovation.	Bronisz et al. (2012)
Government Policies	Governments implement a comprehensive set of policies that address both supply and demand side factors. Governments usually use subsidies, grants and tax incentives, etc. as supply-side policy tools to encourage innovation. On the other hand, governments stimulate innovation by adopting innovative public procurement policies, and by creating regulation frameworks as demand-side policy tools.	Lu et al. (2022)
Innovation	Innovation can foster regional development by increasing the efficiency, effectiveness, and equity of the production and distribution of goods and services in a region. Innovation can also enhance regional development by generating positive externalities.	Bristow & Healy (2018)

Source: own

1.4.1 Intellectual Capital as an influencing factor of Regional Development

Intellectual capital is a broader concept that incorporates an intangible asset, a human-related component that is relevant to the innovation process which is crucial for regional development and competitiveness in a knowledge-based economy (Bronisz et al., 2012). It consists of human, structural, and social capital components (Lalueva, 2023). Intellectual capital plays a vital role in activating and enhancing regional development patterns, as demonstrated through empirical analysis of Italian regions (Lerro & Schiuma, 2008). It is strongly interlinked with sustainable regional competitiveness, influencing factors such as economic growth, sustainability, and the well-being of future generations (Januškaitė & Užienė, 2018). Intellectual capital can be also is defined as accumulated knowledge, abilities, and intellectual resources that create added value and ensure effective regional economic development (Lalueva, 2023). It is increasingly recognized as a critical factor in regional performance and competitiveness (Bronisz et al., 2012) and its complex structure and multidimensional nature make it a fundamental resource for strategic regional development in the knowledge economy (Lalueva, 2023).

A) Role of Human Capital in Regional Development

Human capital is widely recognized as a key driver of economic development in a region (Mincer, 1974). Human capital has a tremendous impact on regional economic progress. According to Faggian et al. (2019), regions with a highly educated and skilled workforce tend to have higher economic growth and development levels. The relationship between human capital and regional development has important implications for innovation policy. Policies that promote access to education and training can attract and retain highly educated and skilled workers which can effectively promote innovation and economic growth (Faggian et al., 2019).

Furthermore, having a strong human capital increases entrepreneurship, which is essential for regional development. This is because entrepreneurship creates jobs, drives innovation and market competitiveness which can lead to regional economic growth. Regions with high levels of human capital can access to skilled labour, knowledge networks and capital further enhance entrepreneurship. Skilled individuals are more likely to identify and exploit entrepreneurial opportunities, increasing employment opportunities and stimulating economic activity in the region (Audretsch & Keilbach, 2004). Qualified people will be more likely to recognize and capitalize on possibilities for entrepreneurship, resulting in increased employment and economic activity in the region.

Human capital works as a catalyst for regional growth with its role in supporting innovation. Studies have shown a strong relationship between human capital and regional innovation. According to Lucas (1988), highly trained employees may originate and implement new ideas, resulting in technical improvements and increased production. Furthermore, Romer (1990) contends that regions with a higher level of educated and skilled people demonstrate better rates of innovation, which contributes to economic progress. As a result, human capital becomes a critical aspect in promoting regional development by fostering innovation.

Scholarly research confirms the importance of human capital in regional development. Human capital drives regional innovation, economic growth, and entrepreneurship. At the same time, innovation is an essential driver of regional development. Hence, it is necessary to create policies and incentives that can support R&D to foster innovation for regional development.

B) Role of Social Capital in Regional Development

Social capital theoretical frameworks have been thoroughly studied. In contemporary sociology, researchers have explored the history and uses of social capital, and its importance in social transmission and economic contexts (Portes, 2009). The notion of social capital has been associated with multiple academic fields, including political science, sociology, and economics, demonstrating its transdisciplinary character and extensive relevance (Somers, 2005). Moreover, the relationship between social capital theory and neoliberalism has been a subject of discussion, with the theory being popularized and integrated into political discourse during the 1990s (Ferragina & Arrigoni, 2017). This integration has contributed to a better understanding of how social capital can influence policy-making and societal development.

According to some academics, social capital theory includes the **relationships, networks, and norms that allow people to act collectively** (Woolcock & Narayan, 2000; Adler & Kwon, 2002). Because it can clarify the origins, advantages, risks, and uncertainties related to social capital, it has become increasingly popular in a variety of academic fields (Adler & Kwon, 2002). According to Portes (2009), this theory emphasizes the value of social interactions in promoting the mutual benefits of both people and communities. Furthermore, it includes characteristics of entire communities and nations in addition to individual assets.

Social capital theory emphasizes the **significance of social relations in facilitating knowledge exchange and reducing investment risks** (Shaari et al., 2015). It emphasises how important human connections are to knowledge management and sharing in businesses (Joseph & Totawar, 2020). Moreover, the theory asserts that social capital is a type of capital obtained

through interactions meant to achieve desired benefits, resulting from formal and informal social contacts. Social networks are at the core of the concept of social capital, which denotes the means by which people engage with each other in these networks (Vlies & Maas, 2009). By emphasising social relationships where gifts and favours are given and received, it sets social capital apart from market and hierarchical relationships (Wikaningrum & Mas'ud, 2020). In addition, social capital theory clarifies why certain businesses succeed in this area while others fail by assisting in the understanding of innovation dissemination and adoption processes within sectors like construction (Sander & Teh, 2014).

Moreover, social capital can be categorized into different types, such as structural, cognitive, and relational (Bhandari & Yasunobu, 2009). The theory emphasizes the strategic importance of relational assets over technical assets in organizational learning and knowledge transfer (Liu, 2018).

Structural social capital: is the characteristics of the overall **social system and the network of relationships** within it (Nahapiet & Ghoshal, 1998). This term describes the formal arrangement of connections among individuals or entities, encompassing roles, rules, precedents, and procedures that reflect this arrangement (Uphoff & Wijayaratna, 2000). Unlike other forms of social capital, structural social capital is tangible and readily observable. It represents the network of individuals whom an individual is acquainted with and can rely on for benefits like information and support. Factors such as density, connectivity, hierarchy, and the potential for appropriation within this network define its significance within a given context, whether it be a group, organization, or community (Davenport & Daellenbach, 2011).

Key elements of structural social capital include the number of connections an individual maintains, the strength of these connections, and the identity of those with whom they are connected (Taylor, 2007). Structural social capital fosters accessibility to various parties for the exchange and dissemination of knowledge, thus enhancing opportunities for knowledge sharing (Ansari et al., 2012). It enables individuals to connect with peers possessing desired expertise or knowledge sets (Andrews, 2010), facilitating collective action by reducing transaction costs and promoting social learning (Uphoff & Wijayaratna, 2000).

Cognitive social capital: involves **resources facilitating mutual understandings, interpretations, and frameworks of meaning among involved parties** (Nahapiet & Ghoshal, 1998). It encompasses the cognitive patterns and structures of meaning manifested through mutual terminology and narratives (Davenport & Daellenbach, 2011). Essentially, cognitive social capital embodies the common language and conventions that underpin effective

communication (Gooderham, 2007). Initially, Nahapiet and Ghoshal (1998) linked cognitive social capital to shared language and narratives, while subsequent scholars have also associated it with shared objectives or visions, as well as shared cultural attributes (Inkpen & Tsang, 2005). Unlike the observable nature of the structural dimension, which involves tangible relationships, roles, regulations, and processes, the cognitive dimension remains intangible, as it concerns the interpretation of a shared reality. Finally, cognitive social capital characterizes shared values or paradigms that foster a collective comprehension of appropriate behaviors. Consequently, cognitive social capital establishes a framework of norms guiding acceptable conduct (McKeever et al., 2014).

Table 2 Distinctions between structural, cognitive, and relational social capital

Structural	**Cognitive**	**Relational**
Social Structure	Shared understandings	Nature and quality of relationships
➢ Network ties and configuration ➢ Roles, rules, precedents, and ➢ procedures	➢ Shared language, codes, and narratives ➢ Shared values, attitudes, and beliefs	➢ Trust and trustworthiness ➢ Norms and sanctions ➢ Obligations and expectations ➢ Identity and identification

Source: Claridge (2018)

Relational social capital: is a dimension of social capital that relates to the characteristics and qualities of personal relationships such as trust, obligations, respect and even friendship (Gooderham, 2007). This dimension of social capital is defined by elements such as **trustworthiness, norms, obligations, and identity** (Nahapiet & Ghoshal, 1998). It reflects the nature and quality of relationships developed over time through interaction (Lefebvre et al., 2016), manifesting in behaviors like trustworthiness, adherence to group norms, and shared obligations (Davenport & Daellenbach, 2011). Relational social capital promotes **normative**

behavior grounded in trust, reciprocity, and mutual expectations (Lee & Jones, 2008). Fundamental to this dimension is associability, which involves prioritizing collective goals over individual interests (Lazarova & Taylor, 2009). Table 2 shows the difference between the types of social capital.

C) Role of Structural Capital in Regional Development

Structural capital is a key driver of innovation capacity and regional development. Structural capital, sometimes referred to as organizational capital, includes intangible assets such as information systems, distribution networks, strategy for work team creation and maintenance, competitive market intelligence, and knowledge of structures, systems, and the market that facilitate at the regional level (Carson et al., 2004). Regional structural capital has a significant positive impact on regional economic development beyond contributions from human and relational capital (Zeng et al., 2021). Structural capital is crucial for developing regional innovation capability, which provides a basic factor for asset development and transfer to promote regional innovation (Schiuma & Lerro, 2008).

Structural capital represents the knowledge owned and systematized by an organization (Demuner-Flores et al., 2016). It includes not only organizational capabilities, processes, and structures that support product development and value creation (Shanthi, 2018) but alsoIt includes formal instruments, policies, procedures, and informal culture that influence practices within institutions (Garnett et al., 2008). Key dimensions of structural capital are processes, culture, structure, and intellectual property (Demuner-Flores et al., 2016). Effective management of structural capital can improve organizational effectiveness through knowledge transmission (García-Álvarez et al., 2011). In higher education institutions, structural capital plays a vital role in supporting work-based learning programs by providing the necessary structures and processes (Garnett et al., 2008). To effectively manage it, organizations can use various indicators related to its different dimensions, allowing managers to select the most appropriate measures based on their organisation's characteristics and objectives (García-Álvarez et al., 2011).

Within the realm of intellectual capital, structural capital emerges from organizational processes and values, reflecting both internal and external company focuses, and providing renewal and development value for the future (Bontis et al., 2000). It is a critical component alongside human and relational capital in shaping competitiveness and well-being in a region, particularly during the transition to an innovative economy (Roze & Kuzminykh, 2023). Additionally, studies have shown a positive relationship between structural capital and business

performance, particularly in non-service industries, emphasizing its significance in driving economic success (Maditinos et al., 2010).

1.4.2 Role of Innovation in Supporting Regional Development

One of the key drivers of regional development is innovation (Frenken et al., 2007; Aarstad et al., 2016). Innovation is essential for the creation of new businesses, the development of new products and services, and the improvement of existing ones. It can help to increase the productivity and competitiveness of local firms and to attract new investment to the region (Gardiner et al., 2012; Boschma, 2015). Sokira et al. (2021) stress that innovation is fundamental for boosting a country's and region's competitiveness, highlighting its role in driving sustainable development. Xue (2022) suggests that promoting innovation across regions is important to bridge development gaps and foster inclusive growth. Moreover, the study by Yuan et al. (2022) emphasizes high-tech industrial technological innovation promotes regional economic development. Tian and Wang (2018) regional innovation spillover is vital for sustainable regional economic development, because of the importance of knowledge diffusion across regions.

In addition, research from current articles highlights the importance of innovation in promoting regional development. A study by Figueiredo et al. (2021) examined innovation's effect on Brazil's regional development. The study found that innovation positively affected regional development. Another study by Nifo et al. (2020) examined the relationship between innovation and regional development. The study found that innovation notably affected regional development and showed the importance of policies that support innovation, such as access to finance, business support services, and entrepreneurial education and training. A study by Agostini et al. (2020) examined how innovation promotes regional development. The study found that innovation positively impacted regional development.

According to Mitra (2019), innovation can significantly impact regional development by:

- promoting economic growth,
- driving productivity,
- creating new industries and jobs.

Innovation can also help to address regional challenges and promote sustainable development. Innovation can be facilitated through a range of policies and initiatives. Mitra

(2019) identifies several policy areas that can be used to promote innovation, including R&D, technology transfer, and innovation support services. R&D is important for promoting innovation as it provides the knowledge and understanding required to develop new products and services. Technology transfer can help to facilitate the commercialization of R&D and the diffusion of new technologies (Mitra, 2019). Innovation support services, such as innovation centers and technology parks, can provide entrepreneurs and innovators with the necessary resources and support to develop and commercialize their ideas.

In conclusion, the above institutional theories describe the importance of innovation in promoting regional development. Innovation can have a notable effect on regional development by promoting economic growth, job creation, and social well-being. As such, policymakers should prioritize the development of policies (National, regional, and local) and initiatives that support innovation in order to promote regional development. These policies can include R&D support, technology transfer, access to finance, business support services, and entrepreneurial education and training. The following chapter is therefore focused on the description of these innovation policies.

2 Innovation and Innovation Policies

2.1 Definition and Concept of Innovation

Innovation is essential that drives societies, industries, and individuals toward progress and evolution. Innovation refers to the process of creating something novel or improving upon existing ideas, products, services, or processes (Verganti et al., 2023). It involves the application of new perspectives, inventive thinking, and the integration of advanced technologies or methodologies to generate value and bring about positive change.

Schumpeter (1934) was one of the first scholars to make an impact in the field of innovation, with a focus on the individual entrepreneur, who strives to grasp a broad picture and push innovation towards the market. This understanding of innovation as an individual process continued for decades before researchers began to conduct innovation studies in organizations (Van de Ven & Rogers, 1988). Extending the field of innovation, researchers began to explore how one could structure the process of product development. Researchers, such as Cooper (1990), examined product development in depth and introduced linear and more rigid approaches that many companies deployed internally. However, some researchers started rejecting this stage-by-stage conception and called for a deeper understanding of the dynamic nature of innovation processes (Van de Ven & Rogers, 1988), thus still looking at the process as a closed entity. Researchers such as Chesbrough et al. (2006) have later been opening up to the paradigm of open innovation enrolling several perspectives in the process by viewing innovation as a network model.

According to Baregheh et al. (2009), **innovation is a complex concept that encloses the generation, and implementation of new ideas, processes, products, or services**. Traditionally, innovation has been associated with the creation of novel products or services (Roach et al., 2021). In a more specific context, innovation can be defined as **the successful exploitation of new technologies, ideas, or methods leading to the introduction of new products or processes, or the enhancement of existing ones, ultimately contributing to long-term profitability and growth in firms** (Munisamy et al., 2015). Moreover, innovation is not a one-time process but a continuous and cumulative process involving various organizational decision-making stages, from idea generation to implementation (Kogabayev & Maziliauskas, 2017). It is a creative process where new or improved ideas are developed and applied to produce practical and valuable outcomes (Taylor, 2017). Innovation is not limited to

the business sector, it extends to various organizations, including non-profit and governmental entities (Sándorfi & Pataki, 2021).

Subsequently, the concept of innovation is not solely focused on commercial advantage, it can also involve cultural aspects and technological advancements (Woronkowicz, 2021; Lewis & Mikołajczak, 2023). Innovation is a demanding task that requires teams to have confidence, persistence, and the ability to overcome obstacles to achieve successful outcomes (Wong et al., 2009). It is more than just creating something new, it involves redefining business models, value chains, and products to serve users with affordability constraints in an accessible and sustainable manner (Ślęzak & Jagielski, 2020). Bock (2012) described that innovation is essential for economic development and increasing profits. It plays a significant role in increasing productivity and competitiveness, which are vital for the growth of businesses and economies (Janjić & Rađenović, 2019). Moreover, innovation is closely linked to sustainability, as it allows organizations to adapt to changing environments and meet the needs of society (Lipták, 2019).

Moreover, innovation is also vital for organizational success, with studies emphasizing the importance of innovativeness in both public and private sector organizations (Janiszewski, 2019). It is a key driver of growth and success, enabling firms to stay ahead of the competition and respond effectively to market demands (Janjić & Rađenović, 2019). Additionally, innovation is essential for the development of new products and services, which are critical for meeting customer needs and preferences (Ismail et al., 2012). Furthermore, innovation is associated with leadership and team dynamics, with research highlighting the role of leaders in fostering innovation within organizations (Mallén et al., 2019). Effective leadership can inspire creativity and a culture of innovation, leading to improved outcomes and performance. Collaboration and knowledge sharing are also key aspects of innovation, with cooperative research and development activities playing a crucial role in enhancing firm performance (Liu et al., 2017).

2.2 Types of Innovation

This section is going to describe types of innovation, mainly product, process, organizational, and marketing innovation.

Product innovation: is a fundamental element of business growth and sustainability. It includes the **introduction of new products or improvements to existing ones** to meet market demands and gain a competitive advantage (Sinaga et al., 2021; Kumbara & Afuan, 2021).

Product innovation significantly contributes to a firm's growth and profitability (Zhang et al., 2020). It is because innovative products are essential for capturing consumer interest, driving sustainable profits, and assisting in strategic decision-making for a firm or industry (Setiobudi, 2021). Moreover, product innovation has been shown to have a more substantial impact on a firm's productivity compared to process innovation, especially in terms of entering new markets and enhancing export capabilities (Martínez-Ros, 2019). According to Meng et al. (2019), appearance innovation focuses on visible changes in products that consumers can easily notice (for example, design, texture, packaging or branding etc). Green product innovation, in particular, concentrates on developing environmentally friendly products that comply with green standards, with the goal of reducing energy consumption, pollution, and promoting human health and ecological well-being (Du & Wang, 2022). This form of innovation is crucial for addressing environmental regulations and market dynamics (Zhang et al., 2019).

Process innovation: is defined as an activity in a new manner, implying the use of specialized tools and the transformation of corporate processes. According to the Oslo Manual, process innovation is defined as **the use of a novel or significantly enhanced production method or delivery system**. It involves major modifications in techniques, equipment, and/or software. Process innovations can be designed **to reduce unit costs of manufacturing or delivery**, improve quality, or create or provide new or significantly improved products (OECD, 1997). Blaug (1963) defines process innovation as the use of a new technique to reduce average costs per unit of output while keeping input prices constant.

The aim of process innovations is to gain a competitive advantage by supporting initiatives that **lower production or operating costs** (Davenport, 1993). According to Damanpour et al. (2009), this sort of innovation is distinguished by its focus on the internal workings of an organization and its efforts to increase the efficiency and effectiveness of operational and administrative procedures. Suárez-Barraza (2013) identified the main results that stem from process innovations:

- reducing operational costs,
- providing a means of comprehending the labor performed,
- serving as a tool for identifying, resolving, and averting issues or mistakes in the work and enhancing many departments within the organization,
- reducing the time spent on processes,

- helping to measure the work more effectively and systematically,
- improving company's customer services,
- offering systemic and integrated perspective of the company, and
- enhancing collaboration and the integration of many business divisions.

Marketing innovation: can be defined as the implementation of **new marketing strategies, techniques, and practices** (include significant changes in the design, distribution, promotion, or pricing of a product or service) to meet the evolving needs of customers and stay ahead of competitors (Purchase & Volery, 2020). A market orientation facilitates technological innovations that provide mainstream customer needs (Zhou et al., 2005). This emphasizes the importance of aligning marketing efforts with customer demands to drive innovation. Innovative marketing entails creating improved or entirely new products or services and utilizing innovative marketing tools and methods to effectively address consumer and producer needs (Putsenteilo et al., 2018). It emphasizes the use of novel approaches to enhance product offerings and reach target markets more efficiently.

Moreover, the concept of positive marketing, which focuses on creating value for the firm, customers, and society at large, has gained attention in the area of marketing innovation (Akgün et al., 2017). This shift towards positive marketing underlines the significance of generating value through marketing activities to drive innovation and business success. In the context of small and medium enterprises (SMEs), entrepreneurial marketing plays a vital role in fostering innovation. Understanding the interplay between customer engagement, innovation, and entrepreneurial marketing approaches is essential for SMEs to thrive in competitive markets (Jones & Rowley, 2011). This indicates the need for SMEs to leverage innovative marketing strategies to differentiate themselves and attract customers.

Organizational innovation: can be defined as the implementation of **new methods** within a **firm's business practices, workplace organization, or external relations** (Pauget & Wald, 2018). Organizational innovativeness, which refers to an organization's openness to new ideas and its ability to innovate and adopt new processes or products successfully, is a critical component of organizational innovation (Eng, 2011). The origins of organizational innovation can be traced back to Schumpeter's early work (Damanpour & Aravind, 2012). This concept extends beyond technological advancements to include **administrative and management innovations** (Volberda et al., 2013). Organizational innovation is a key driver of success, with a positive impact on the introduction of new products and services (Lalic et al., 2018) and

emphasizing its role in enhancing competitiveness and fostering growth (Binder et al., 2013; Kessler et al., 2015).

In addition, leadership plays a crucial role in fostering organizational innovation. Leaders have a significant influence on employees' innovative behavior, which focuses on the significance of leadership styles in driving innovation within organizations (Jong & Hartog, 2007; Jia et al., 2018). Additionally, the impact of human practices on organizational innovation highlighted the role of human resources in promoting innovative practices within organizations (Hussain et al., 2019).

2.3 Open Innovation Approach

The history of open innovation is extensive and has changed throughout time. The idea of open innovation was first presented by Chesbrough in 2003 as a novel approach to industrial innovation (Aastvedt & Higdem, 2022). Since then, it has grown to be a crucial component of small and medium-sized enterprises' (SMEs) growth (Stanisławski, 2020). According to Trąpczyński et al. (2018), Chesbrough described open innovation as a paradigm where **firms use both internal and external ideas and pathways** to reach new markets. This concept emphasises the significance of utilising outside sources of innovation and underlines how business models set open innovation apart from previous studies on inter-organizational collaboration in innovation (West & Bogers, 2013).

Initially, Chesbrough's definition of open innovation concentrated on businesses that leveraged both internal and external concepts and routes to market whereas, the concept of the closed innovation model describes a conventional strategy in which innovation processes are carried out **entirely internally** within an organisation, with **limited external cooperation** (Stanko et al., 2017). Open innovation is currently seen as a dispersed innovation process based on regulated knowledge flows across organisational boundaries, however, the idea has expanded (Stanko et al., 2017). This progression demonstrates the ongoing broadening of the concept of openness in innovation (Heimstädt & Friesike, 2020). Open innovation implies sharing or exchanging knowledge without formal agreements or command-and-control connections (Dolfsma & Eijk, 2017). It highlights how crucial it is to share knowledge across boundaries to spur innovation. This strategy acknowledges the challenges that come with an organisation depending entirely on internal resources for innovation (Julião et al., 2022). One of the main factors influencing the success of open innovation business models is the incorporation of external knowledge sources (Błach & Klimontowicz, 2021). It has been

discovered that the open innovation paradigm extends beyond high-tech industries into more traditional sectors, indicating its adaptability and application across multiple areas (Chesbrough & Crowther, 2006).

One key aspect of open innovation is the need for **collaboration among different actors** who depend on each other's capabilities for value creation and capture (Chesbrough et al., 2018). In order to profit for firms from open innovation initiatives, they must be able to successfully integrate external and internal knowledge, a process known as absorptive capability (Wu et al., 2019). Furthermore, interactions with external entities have increased the adoption of the open innovation concept, emphasising the value of collaborating with a diverse network of partners for innovation and business development (Pīlēna et al., 2021).

According to some research, firms that use open innovation strategies can improve how well they use their capacity by making effective use of low institutional quality to stimulate innovation processes (Gyamfi & Sein, 2021). This emphasises how important it is to understand how external factors can affect a firm's capacity for innovation. Additionally, open innovation has been linked to increased adaptability, which is necessary for the growth of social enterprises that make low profits (Svirina et al., 2016). Figure 5 illustrates how firms benefit from external sources of innovation, using pathways such as technology insourcing, outlicensing, and spin-offs to expand their market. The R and D arrows at the bottom represent the Research and Development stages.

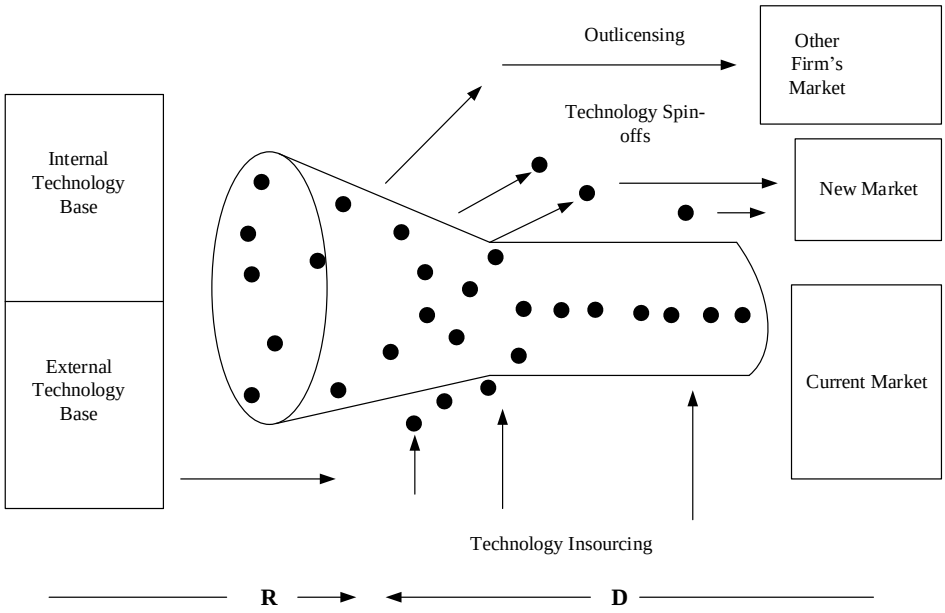

Figure 5 Open Innovation Model

Source: Chesbrough (2012)

2.4 Innovation Systems and Proximity

Innovation systems belong to the group of institutional theories of regional development and are described as **networks of organizations, institutions, and individuals that engage in the production, diffusion, and utilization of knowledge and technology** (Chaminade, 2018). Innovation systems include basic and applied research organizations, universities, industry associations, and other organizations engaged in knowledge and technology production, diffusion, and utilization. There are three types of innovation systems (Edquist, 2010):

- National Innovation System,
- Regional Innovation System,
- Sectoral System of Innovation.

2.4.1 National Innovation Systems and Proximity of Actors

The concept of National Innovation System has become a popular framework in the literature for discussing a system approach to technological innovation (Nelson, 1993; Lundvall, 2007). National Innovation System (NIS) refers to the **network of institutions, organizations, policies, and resources within a country** that collectively support and promote innovation and technological development. It recognizes that innovation is not solely driven by individual companies or researchers but is influenced by the broader environment in which they operate. NIS emphasises the importance of the distinctive methods and frameworks that various countries have for promoting innovation (Furman et al., 2002). Over the past few decades, NIS has drawn a great deal of attention from academics and policymakers worldwide because it recognizes the role plays in determining a nation's capacity for innovation. It emphasizes the importance of elements that are necessary for effective innovation and are frequently supplied within the national context, such as demand, knowledge, skills, and financial resources (Edler & Fagerberg, 2017).

The collaborative growth of innovative capability and absorptive capacity drives the dynamics of NIS, indicating that the ability to generate new ideas and technologies is closely linked to the capacity to assimilate and apply external knowledge effectively (Castellacci & Natera, 2013). Furthermore, studies examining how NIS may promote sustainability within particular industries like the construction industry show that NIS is not just about technology developments but also includes sustainability issues (Ružičić et al., 2021). Moreover, NIS is viewed as a historically evolved subsystem of the national economy where various entities

interact and influence each other in the innovation process. It involves a complex network of relationships among firms, research institutions, government bodies, and other stakeholders that collectively contribute to a country's innovation performance (Balzat & Hanusch, 2004). The efficiency of NIS can vary between countries, as demonstrated by studies comparing how different national systems transform innovation inputs into outputs. This describes the importance of understanding the specific contextual factors that shape the effectiveness of NIS in driving economic development (Jankowska et al., 2017).

Moreover, proximity in NIS can create an atmosphere of collaboration and cooperation, which spurs innovation in the long run. Proximity in NIS is essential as a tool to develop co-innovation. Co-innovation is crucial as it brings about varied solutions among actors. Proximity allows for forming relationships and connections between different actors, institutions, and organizations. Another critical role of proximity in national innovation systems is its ability to generate synergies (Lundquist & Trippl, 2013). Through the exchange of information and resources, proximity can create a more efficient and effective collaboration between different stakeholders. According to research, NIS can benefit both large and small businesses, providing access to resources and expertise that may not be available at the regional or sectoral level (Fagerberg & Srholec, 2008).

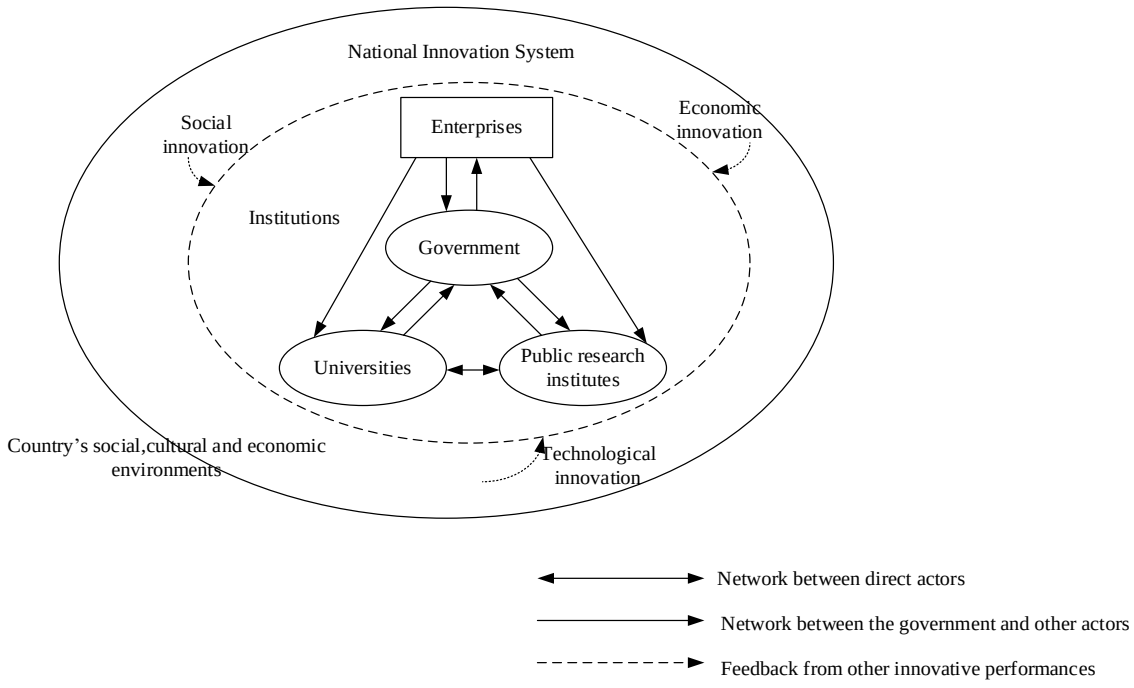

Figure 6 The role of proximity within National Innovation System

Source: Oh & Yi (2022)

Figure 6 presents the roles of direct actors and supporting actors of innovation. The government has been put in the center because it often plays a supportive role in coordinating and encouraging the innovative efforts of various actors at the national level. The direct actors (e.g. universities, enterprises etc.) are positioned around the government since they obtain guidance and encouragement for innovative ventures from the government.

2.4.2 Regional Innovation Systems and Proximity of Actors

The idea of Regional Innovation System (RIS) is based on the idea of National Innovation System (NIS) that concentrates on a specific area (Iammarino, 2005). Asheim and Coenen (2005) define the RIS as the institutional framework that facilitates innovation within the production network of a region. This idea was created as a tool for regional and national policy-makers to promote innovation (Asheim & Coenen, 2005; Almeida, Figueiredo, & Silva, 2011) because market forces seem inadequate to generate a suitable, and fast change in the growth of a region (Fiore et al., 2011). Regional governance mechanisms, such as clustering and policy incentives, support knowledge creation and help to geographically integrate the firm (Kramer et al., 2011).

The effectiveness of RIS is contingent upon the alignment of firms' internal assets with the resources available at the regional level, thereby strengthening innovation activities and supporting regional restructuring (Isaksen et al., 2020). Moreover, the concept of RIS has gained prominence due to the identification of regionally distinct industrial clusters and nodes, coupled with the implementation of regional innovation policies aimed at fostering innovation-based learning economies at the regional scale (Doloreux & Parto, 2005). Scholars have also highlighted the need for regional innovation policies to address potential threats to both regional and national innovation systems, underscoring the importance of strategic planning and policy development in safeguarding innovation ecosystems (Mikhaylov et al., 2018).

The role of proximity in RIS has been widely studied in the literature, with research typically focusing on how the geographical proximity of actors and resources can impact the development and implementation of regional innovation policies and strategies. Proximity is a valuable tool for understanding how different actors interact, collaborate, and share knowledge (Lalrindiki & O'Gorman, 2021). It is also a critical factor in understanding how RIS are structured and how they evolve. The concept of proximity has long been used to explain the dynamics of (RIS). Proximity is a crucial dimension of RIS. It is increasingly being used in policymaking to understand how local and regional actors interact and collaborate in generating

and transferring knowledge. This is because proximity has the potential to create greater efficiency and effectiveness in the development and implementation of regional policies and strategies.

Proximity is also seen as a critical factor in understanding how RISs are structured and how they evolve. Proximity is critical in understanding how local and regional actors interact and collaborate in generating and transferring knowledge. Proximity can also be used to identify potential opportunities for collaboration and knowledge sharing between actors within the same region (Asheim, 2016). Proximity also enables actors to better understand the needs of their local and regional environment and thus to develop more effective and tailored policies and strategies (Coenen et al., 2010).

Proximity can also be used to identify challenges and opportunities specific to a particular region. For instance, it can help to identify the areas of weakness and strengths of the local economy and thus inform the design and implementation of regional policies and strategies. In addition, proximity can be used to identify areas of potential collaboration and partnerships between different regional actors. This can foster more incredible innovation and collaboration within the region, leading to the development of more effective regional innovation policies. Proximity also has a vital role in the development of regional innovation policies. Proximity enables regional innovation policies to be tailored to the specific needs and conditions of the local and regional environment, leading to better outcomes for the local economy. It also helps to identify the different actors and resources that can be used to develop and implement regional innovation policies. Proximity can be used to identify the stakeholders needing consultation and involvement in developing and implementing regional innovation policies (Stuck et al., 2016)

The following Figure 7 describes the regional innovation system and its components and shows how various actors and subsystems interact to foster innovation in the regional context.

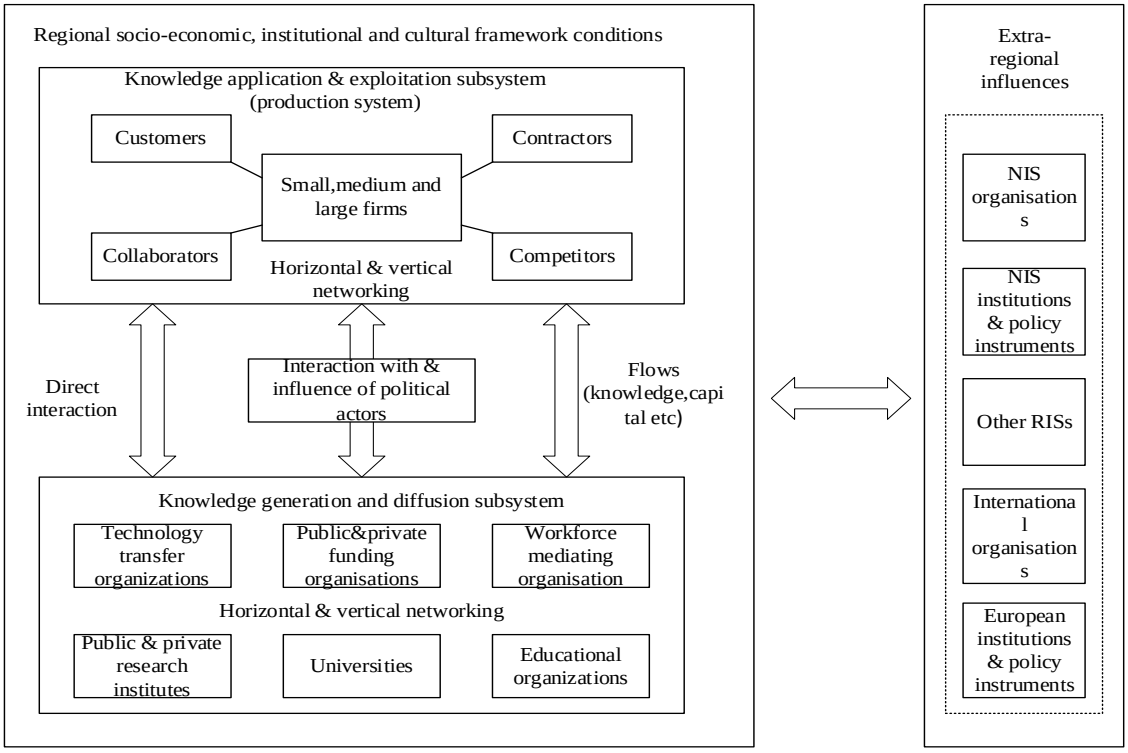

Figure 7 Regional Innovation System

Source: Stuck et al. (2016)

2.4.3 Sectoral Innovation System and Proximity of Actors

A sectoral innovation system can be defined as a framework that links innovation to the knowledge base, structure, and dynamics of specific sectors (Malerba, 2005). This system involves a set of specific products, agents, and interactions, both market and non-market, aimed at creating, producing, and selling products within a particular sector (Cheong et al., 2020). It focuses on the interactions within learning, innovation, and application processes specific to that sector, making it a valuable tool for identifying sector boundaries and exploring the relationships between participating agents (Cheong et al., 2020).

According to Kubeczko et al. (2006), sectoral innovation systems from a business-oriented and technology-driven perspective, emphasizing the role of firms in developing sector-specific products and technologies. This highlights the importance of firms in driving innovation within a sector. Additionally, the concept of a sectoral system of innovation and production involves a set of new and established products for specific uses, along with the agents involved in their creation, production, and sale (Havas, 2007).

Proximity is vital in sectoral innovation systems by facilitating knowledge exchange between organizations (Breschi & Malerba, 1997). By being geographically close to each other,

organizations can quickly access the latest technologies and information, thus enabling them to innovate more quickly. Being proximate also facilitates the development of trust between organizations, which is necessary for effective knowledge exchange (Boschma, 2005). Proximity in sectoral innovation systems allows firms to collaborate more efficiently (Lalrindiki & O'Gorman, 2016), as they can meet face-to-face and discuss ideas. Discussions face-to-face are generally done within a short span; thus, it saves time.

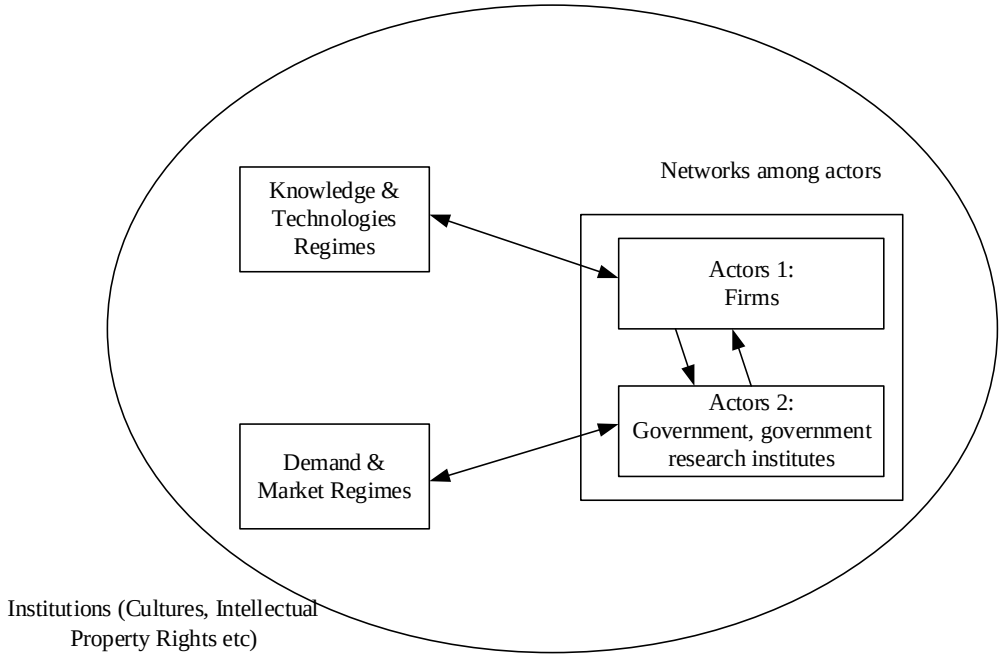

Figure 8 Sectoral Innovation System

Source: Malerba (2004)

Figure 8 illustrates key components and interactions between actors involved in innovation within a specific sector.

Given that geographical closeness is generated, organizations can establish relationships with other organizations, thus creating a network of organizations that share resources, knowledge, and ideas (Letaifa & Rabeau, 2013). The resulting network can then be used to facilitate collaboration and knowledge exchange, which can lead to innovation. This allows organizations to better understand each other's needs and objectives, leading to more effective collaboration and helping organizations more easily identify areas where they can cooperate (Dahesh et al., 2020). Proximity also allows organizations to develop relationships and trust, which is necessary for successful collaboration. Proximity also allows governments to provide support to organizations in the form of subsidies and other incentives. Governments can use this support to encourage innovation and make it easier for organizations to collaborate and

exchange knowledge. Governments can also use proximity to identify potential partners, which can help them to more easily identify organizations that are most likely to succeed in the sector.

2.5 Innovation Policies

The origins of innovation policy can be dated back to postwar industrial policies, in which governments directly funded research and development (R&D) and supported vital industries. In the 1980s and 1990s, the emphasis changed to providing favourable conditions for private sector-led innovation, with policies encouraging R&D investment, technology transfer, and research commercialisation (Freeman & Soete, 1997). In recent years, there has been a significant movement towards mission-oriented innovation policies that aim to address major societal concerns such as climate change and ageing populations (Mazzucato, 2018).

Innovation policy refers to a set of strategic actions, measures, and regulations implemented by governments or organizations to foster and support the process of innovation within an economy or sector (Edquist, 2001). It also aims to promote economic growth, productivity, and competitiveness (Chaminade & Esquist, 2010) and has emerged as a crucial field of economic policy in recent decades, addressing both economic and non-economic objectives (Fagerberg, 2017). The rationale for government intervention in innovation stems from the systemic understanding of innovation processes and the need to support large-scale technological shifts (Chaminade & Esquist, 2010). Innovation policy instruments can be financial, regulatory, or informational, supporting **not only the generation and diffusion of innovations but also absorptive capacity and linkages within the innovation system** (Radosevic, 2020). While innovation policies in developed countries tend to be more comprehensive, those in developing countries are often fragmented and incipient (Cirera et al., 2020). To assess and improve innovation policies, frameworks such as the Innovation Policy Index have been developed, considering governance structure, policy instruments, processes, and institutional capacity (Radosevic, 2020).

According to Fagerberg (2017), innovation policy aims not only promoting economic growth but also incorporates addressing societal challenges, fostering demand for innovative solutions, and encouraging democratic innovation. These aims reflect a broader perspective on the role of innovation in addressing various issues beyond economic growth. For example, innovation policy may aim to develop solutions for societal challenges, promote demand for innovative solutions, and involve the expertise of the broader public in democratic innovation.

The development of a systemic understanding of innovation has had a significant influence on policy discourse. The systemic approach emerged in the 1990s and provided a better understanding of the stylized facts of innovation activity. This approach recognizes that innovation is a complex process that involves interactions between various actors and institutions, and it emphasizes the importance of policies that support these interactions. As a result, innovation policy has shifted from a narrow focus on R&D investments to a broader perspective that considers the entire innovation process, including the diffusion and use of new products and processes. The systemic approach has also highlighted the need for coordination among policies across different levels and domains, which presents a significant challenge for policymakers. The systemic understanding of innovation has led to a more comprehensive and integrated approach to innovation policy.

Innovation policy depends on various measures and tools, typically categorized into two types (Borrás & Edquist, 2013):

- Supply-side policies, and
- Demand-side policies.

Supply-side policies directly support R&D activities in terms of subsidies and tax incentives. They stimulate innovation by investing in education and skill development. These policies are especially effective in firms with high R&D intensity (Aghion et al., 2018). Demand-side policies aim to increase market demand for innovative products and services. These include public procurement rules that prioritise creative solutions, establishing regulatory standards that stimulate innovation, and stimulating consumer demand through promotion of awareness (Edler & Georghiou, 2007).

2.5.1 Supply-side Innovation Policy

Supply-side innovation policies are designed to encourage innovation and technical development from the production side of the economy. The goal of these policies is to encourage and facilitate innovation in industries. Supply-side innovation policy aims to provide a minimum feasible ecosystem for industries, encourage technology skills for innovation, and incentivize enterprises to enhance production (Jang et al., 2015; Wu et al., 2018; Pantuosco & Tarabar, 2020). Traditionally, supply-side innovation policies have focused on incentives such as R&D subsidies, tax grants, and research funding to directly motivate innovation activities and address market failures in the innovation process (Yao et al., 2021; Su & Wang, 2022).

Additionally, supply-side policies are crucial in driving the adoption of service innovation and increasing the number of potential and actual innovators (Bhatnagar & Gopalaswamy, 2017; Reenen, 2021).

Supply-side innovation policies are characterized by a decentralized structure that allows organizations to remain flexible, innovative, and dynamic from within (Mazzucato, 2016). Additionally, the combination of place-based supply-side and demand-side innovation policies is considered particularly important for environmental innovations, highlighting the significance of integrating both supply and demand-side approaches for regional sustainability transitions (Hansmeier & Losacker, 2021). Moreover, supply-side policies generally complement demand-side policies, leading to a positive impact on the adoption of demand-side innovations (Yi & Feiock, 2012). While supply-side policies have been extensively discussed and empirically investigated (Guo et al., 2016; Wu et al., 2020; Zuo & Lin, 2022), the analysis of innovative public procurement as a demand-side policy instrument is a growing trend in the literature, which still lacks robust empirical evidence (Guerzoni & Raiteri, 2015). Additionally, the shift toward mission-oriented innovation policies calls for a major change in the public sector's role, steering innovation toward addressing societal challenges (Lehoux et al., 2023). The combination of supply-side and demand-side policies is essential for promoting sustainable development, environmental innovations, and regional sustainability transitions.

A supply-side innovation policy is a government action that enhances the skills and resources of firms, research institutions, and other organizations participating in the innovation process. The aim is to increase firms' incentives in innovation activities. Supply-side policy usually includes the following instruments;

Table 3 Measure of Supply-side innovation policy

Supply-side innovation policy	**Measures**
Equity support	• Public venture capital funds • Mixed of subsided private venture funds • Loss underwriting and guarantees • Tax incentives
Fiscal measures	• Corporation tax reductions for volume or increment in R&D

	• Reduction in employers payroll tax and social contributions • Personal tax incentives for R&D workers
Support for public sector research	• University funding • Laboratory funding • Collaborative grants • Strategic programmes for industry • Support for contract research • Equipment sharing
Support for training and mobility	• Tailored courses for firms • Entrepreneurship training • Subsidised secondments • Industrial research studentships • Support for recruitment of scientists
Grants for industrial R&D	• Grants for R&D • Collaborative grants • Reimbursable loans • Prizes to spend on R&D

Source: Edler & Georghiou (2007)

Based on the above measurement of supply-side policies, some specific government supply-side support activities include:

A) Government funding

Government funding could be seen as a free transfer of government grants to firms for specific purposes (Kong et al., 2013). It is not only part of the government's fiscal expenditure but also an important means of direct intervention in the market. Government subsidies can provide many benefits to firms, specifically those with limited financial resources (Amezcua et al., 2013; Söderblom et al., 2015). On the one hand, according to Czarnitzki and Hussinger

(2004), government grants can enhance firms R&D and increase intangible assets indirectly. On the other hand, Prokop et al. (2018a) showed in the case of the Czech, Slovak, Estonian, Lithuanian, Romanian, Croatian, Slovenian, and Hungarian firms that the effects of financial sourcing and cooperation could differ across the countries.

In another way, government funding represents alternative source of funding instead of replacing private R&D investment. Government subsidies help in attracting both human and financial capital to increase the firm performance, which can be seen as a sign of legitimacy and quality (Söderblom et al., 2015). According to Zhang and Bai (2017), government subsidies will increase investment in R&D to improve product quality, so government subsidies can have a positive effect on the quality of firms' products. Moreover, government subsidies can minimize the prices and risk of R&D activities, create financial leverage and spill-over effects, also encourage private investment by firms in basic research and development that have a positive impact on product development of the firm and extension of new goods (Hewitt-Dundas & Roper, 2010). Moreover, government funding affects scientific and technological cooperation positively (Zhang et al., 2020).

B) R&D tax incentive

R&D tax incentives are government-initiated tax deductions that encourage firms to engage in research and development activities, which provide firms with an incentive to enhance their innovation efforts (Kennedy & Barry, 2020). These incentives work by allowing firms to claim tax credits for a portion of their R&D costs, effectively reducing the financial burden associated with innovation activities (Xiao, 2023). R&D tax incentives play a crucial role in promoting firm innovation by encouraging firms to allocate resources towards R&D investments (Ivus et al., 2021). Since tax credits are usually offered to all businesses in the economy, private agents are free to choose the kind of project for which to submit an application (Castellacci & Lie, 2015). Tax incentives are a market-driven strategy that increases private investment in research and development while enabling businesses to take advantage of credit flexibility to meet demand from the market.

By encouraging the commitment of resources to conduct R&D investment, the R&D tax incentive encourages enterprises to be more inventive. The majority of empirical research on the effectiveness of R&D tax incentives concludes that such incentives boost businesses' private R&D (Busom et al., 2014). R&D tax credits have a positive impact on the firm's decision to conduct R&D and to increase innovation output (Czarnitzki & Delanote, 2015).

2.5.2 Demand-side Innovation Policy

Demand can be considered as the market size and users' sophistication (Guerzoni, 2010; Zahler et al., 2022) and is recognized as one of the innovation policy approaches of the national innovation system, but the demand-side approach has been neglected for a long time in many OECD countries (Edler, 2009). Policymakers have paid less attention to a demand-side policy that can stimulate the creation and diffusion of innovation. However, in recent years, researchers (Stojčić et al., 2020; Caravella & Crespi, 2021) have turned their attention to the demand-driven approach to innovation. Demand-side innovation policy instruments can be defined as a set of public measures to increase the demand for innovations, to improve the conditions for the uptake of innovations, and/or to improve the articulation of demand in order to spur innovations and the diffusion of innovations (Edler, 2007). According to Edler et al. (2016), demand-side innovation policy aims to stimulate innovation or accelerate innovation diffusion by increasing demand for innovation, characterizing new business requirements for products and services, and promoting user involvement in innovation production.

In addition, demand-side measures, in contrast to supply-side ones, involve public procurement of innovative solutions, regulatory actions, support for private sector demand for innovations, and systemic policies. Typically, policy-making instruments are deliberately designed and integrated into different policy mixes, with the goal of addressing specific challenges within the innovation system (Borrás & Edquist, 2013).

Demand-side innovation policies seek to encourage the adoption of new technologies and can address global and societal challenges such as climate change and aging populations (Edler et al., 2016). Under the demand-driven approach, there are three forms of innovation-based public procurement, performance-based regulations and standards, and technology-based regulations and standards. Among them, innovation-oriented public procurement is one of the most popular and powerful demand-driven and underused innovation policy tools. Public procurement is a powerful tool that enables national and local authorities to achieve sustainable development goals while purchasing needed goods and services (Edquist & Hommen, 2000). Public procurement of innovation occurs when a public agency places an order for a product or system that does not exist at the time but could probably be developed within a reasonable period (Edquist & Zabala-Iturriagagoitia, 2012). Table 4 illustrates the measurement of demand-side innovation policy.

Table 4 Measure of Demand-side Innovation Policy

Demand-side policy	Measures
Public Procurement	• R&D procurement • Public procurement of innovative goods
Regulation	• Use of regulations and standards to set innovation targets • Technology platforms to coordinate development
Systemic policies	• Cluster policies • Supply chain policies

Source: Edler & Georghiou (2007)

Based on the above measurement of demand-side policies, some specific government demand-side support activities include:

A) Public Procurement of Innovation (PPI)

Innovative public procurement is one of the demand-side innovation policies, which is a relatively new approach in order to foster innovation. PPI can be defined as procurement where the authority serves as an early adopter of innovative products or services that are not yet widely available commercially.

According to scholars Edquist and Zabala-Iturriagagoitia (2012), PPI can be distinguished into two types based on the level of innovativeness of the invention process: adaptive and developmental PPI.

- An adaptive PPI situation arises when the product or system acquired is new only to the specific country or region where it is being introduced. Adapting the product or system to meet specific local or national requirements therefore requires innovation. This approach is also referred to as “diffusion-oriented” or “absorption-oriented” public procurement of innovation (PPI) and involves incremental innovation.

- Developmental PPI involves the procurement process to create entirely new products or systems that have not existed before. This type of PPI is considered "creation-oriented" and focuses on driving radical innovation.

According to Edquist and Zabala-Iturriagagoitia (2015), the primary features of PPI can be stated as follows:

- Early adoption: Under PPI, the procurer serves as a launch customer and initial adopter, becoming the first buyer of an innovative solution that isn’t yet widely available.
- Unbundling of R&D and large-scale production: PCP and PPI function as distinct but complementary tools, after a successful PCP results in the creation of a viable prototype, the procurer may decide to move forward with large-scale procurement of the solution through PPI.

To successfully execute PPI methods, the standard PPI process includes the steps listed below (Edquist & Zabala-Iturriagagoitia, 2012):

- Identify a challenge
    - A procurement institution identifies a major challenge based on a lack of satisfaction of a human need or an unresolved societal issue.
- Define the functional specification of the proposed solution
    - Careful translation of the identified challenge into functional specification while avoiding technical overspecification.
- Tendering Process:
    - The bidding procedure begins with a tender.
    - Potential vendors translate functional specifications into technical specifications.
    - Potential providers can submit formal bids.
    - Evaluation of tenders and award of contracts.
- Delivery Process:
    - Product development.
    - Production of the product.

- Final delivery to the procurer.

B) Pre-commercial procurement

The concept of Pre-Commercial Procurement (PCP) as an instrument to promote innovation and mitigate grand challenges was introduced by the European Commission in 2006. The PCP concept was developed to promote innovation in the public sector while also improving the quality and efficiency of services (Edquist & Zabala-Iturriagagoitia, 2012). Pre-Commercial Procurement (PCP) encourages the industry from the demand side to produce creative solutions for public sector demands, and it serves as a first customer reference, allowing enterprises to gain a competitive advantage in the market and also helps public procurers compare and select the most effective market-based solutions to meet public needs (Bedin et al., 2014). PCP aims to bridge the gap between knowledge and the market by establishing public demand (Rolfstam, 2015).

According to Gavras et al. (2010), three different PCP process variations can be defined:

- Procurement is undertaken by the public subject for the needs of the same subject.
- Procurement is undertaken by a public agent or partnership for another public user (e.g. the UK SBRI model);
- Procurement is undertaken by a public subject or agent for a set of private clients where a clear public benefit is present (assimilated to what is called a catalytic procurement).

The results or success of PCP is difficult to predict and therefore produces uncertainties and risks. PCP process applies three aspects to handle these uncertainties (Turkama et al., 2012),

- Risks and benefits are shared between suppliers and developers.
- Competitive development in phases/iterations is securing the best solution that market is able to offer.
- Separation of development of product and the final procurement of the developed product itself.

These characteristics require the private supplier to bear the risk of the R&D phase, while the public entity is not obligated to purchase the generated product (Aschhoff & Sofka, 2009). However, several authors considered PCP as a type of PPI that consists only of R&D phase and not of procuring a certain product itself (Edquist & Zabala-Iturriagagoitia, 2012).

Figure 9 shows a detailed explanation process of pre-commercial procurement.

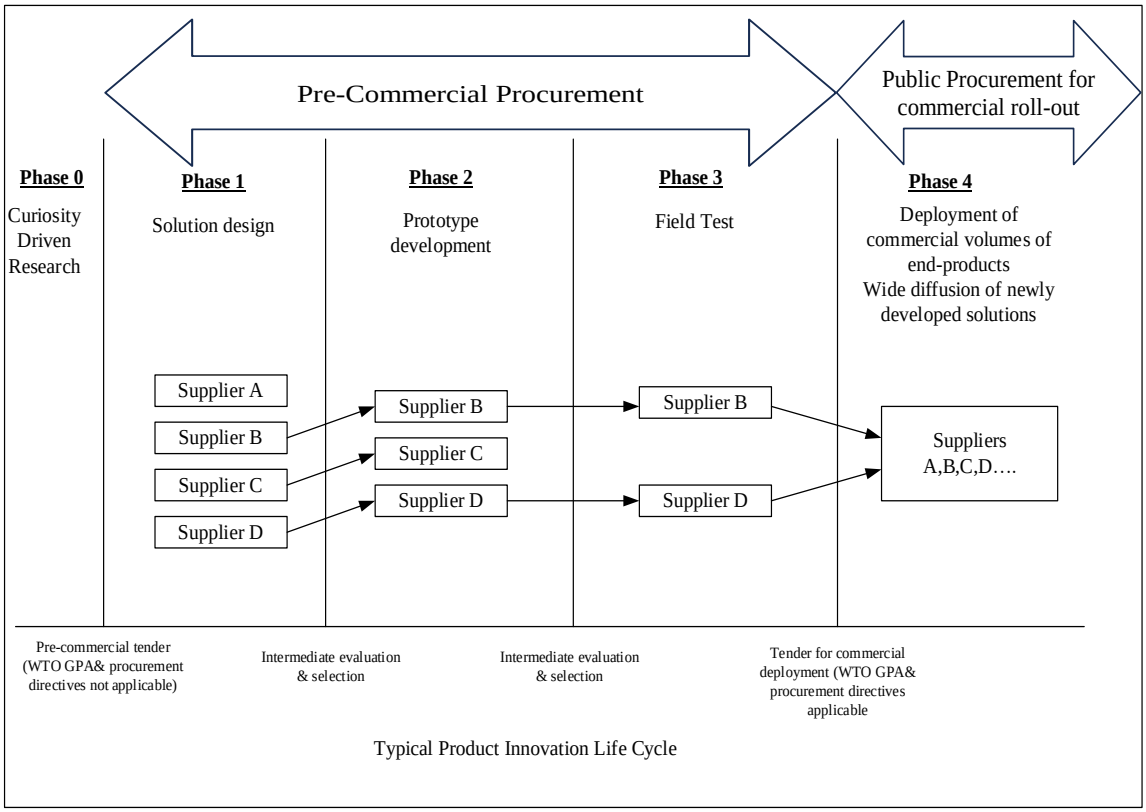

Figure 9 Pre-commercial procurement process (PCP)

Source: European Commission (2007)

PCP may not produce an effective outcome in the sense of a working product or even viable R&D results, and so PCP may be supplemented by PPI; nonetheless, PCP cannot be treated solely as a type of PPI (Lucas et al., 2009). According to Lucas et al. (2009) and Delina et al. (2021), the PCP process can be divided into three stages:

- Solution development phase: Analyzing the procurer's needs, creating designs, evaluating proposals, and selecting the best offers.
- Prototyping phase: Developing and adjusting the recommended service or goods prototype.
- Testing phase: Undertaking field tests to validate solutions validation. Throughout this stage, a limited number of prototyped goods are manufactured and field tested in preparation for the solution's commercialization.

This chapter reviewed the literature on innovation, innovation systems, the role of the proximity of actors in innovation systems, and innovation policies. The concept of

an innovation system emphasizes the importance of a systemic approach, in which the interactions of numerous components impact innovation output and economic performance. Proximity, both geographical and relational, plays an important role in the operation of national, regional, and sectoral innovation systems which affects actor relationships, knowledge spillover effects, and innovation process efficiency. Proximity facilitates the informal exchange of knowledge and ideas, leading to spillovers that drive innovation. Proximity supports the formation of strong networks and collaborative relationships. Proximity also gives benefits to the actors to implement innovation policies within regions due to mutual trust.

Innovation policy provides the guidelines and support mechanisms that encourage firms to pursue new ideas and technologies. Moreover, innovation policy can help to address market and system failures, where firms may not invest in their innovation activities due to high costs or uncertain returns, by providing incentives and regulations to reduce risks associated with innovation for firms.

Innovation policy, demand-side innovation policy especially public procurement for innovation has recently got less attention from scholars and policymakers, however, some scholars focused on the direct impact of demand-side policy on firm innovation. There is a lack of comprehensive research to examine how demand-side policy impacts firm-level innovation through R&D activities. Remarkably, the mediating role of R&D activities between two relationships has not been sufficiently explored. This gap will be investigated as an objective 1 in Chapter 3. Moreover, objective 2 will be explored the effectiveness of policies on firm-level innovation in Chapter 3. To fully understand the effectiveness of innovation policies, we have to consider both, the supply and demand-side approach, and how these different types of policy interventions impact firm innovation effectively. Therefore, this research framework will be investigated in the Chapter 3.

3 Research Aim

Summarizing findings so far that lead to the identification of research gaps below, there is a need to state that innovation is seen as a key driver of economic growth, productivity, and competitiveness. According to Bryan and Williams (2021), innovation activities are exposed to severe market and system failures. The process of innovation is very risky, costly, and uncertain which discourages private firms from investing in research and development (R&D) (Alam et al., 2019). In this sense, government innovation policy has become crucial to support firm-level innovation. An effective innovation system not only requires financial support but also needs to support innovation ecosystems, which include infrastructure, skilled labour force, and regulatory frameworks. Generally, government implements – on the one hand – **supply-side policy tools**, which means incentives such as direct subsidies and grants to encourage firms to invest in R&D, collaboration, and innovation activities. On the other hand, the government can use some policy tools such as public procurement for innovation and regulations as **demand-side approaches** to boost innovation.

However, the effects of these policies on firm innovation across different European countries are still not clear, providing a mixed picture about this topic. A large number of studies have demonstrated the importance of government support in promoting firms' innovation (Xu et al., 2021; Gao et al., 2021; Shao & Wang, 2023; Xu et al., 2023). By contrast, some studies also find that government support policy may crowd out private investments and thus adversely impact the innovation outcomes (Guo et al., 2016; Wu et al., 2022). In this case, government policy failed to stimulate additional R&D investment from enterprises, and the substitution effects may reduce the total amount of R&D investment and innovation activities. Moreover, a study conducted by Gao (2023) proved that government policy has no impact on firm innovation outcomes and might not encourage firm innovation. While some firms may greatly benefit from government innovation policies, some firms may not benefit effectively, which might be lagging in innovation performance within a region. Without a comprehensive understanding of these policy variations, policymakers may not be able to achieve the desired outcomes and not to able to implement effective policy tools.

Against the above backdrop, ***this dissertation thesis aims to examine to what extent different innovation policy approaches affect firms' innovation, as one of the main prerequisites of regional development in emerging, moderate, and strong innovator countries.***

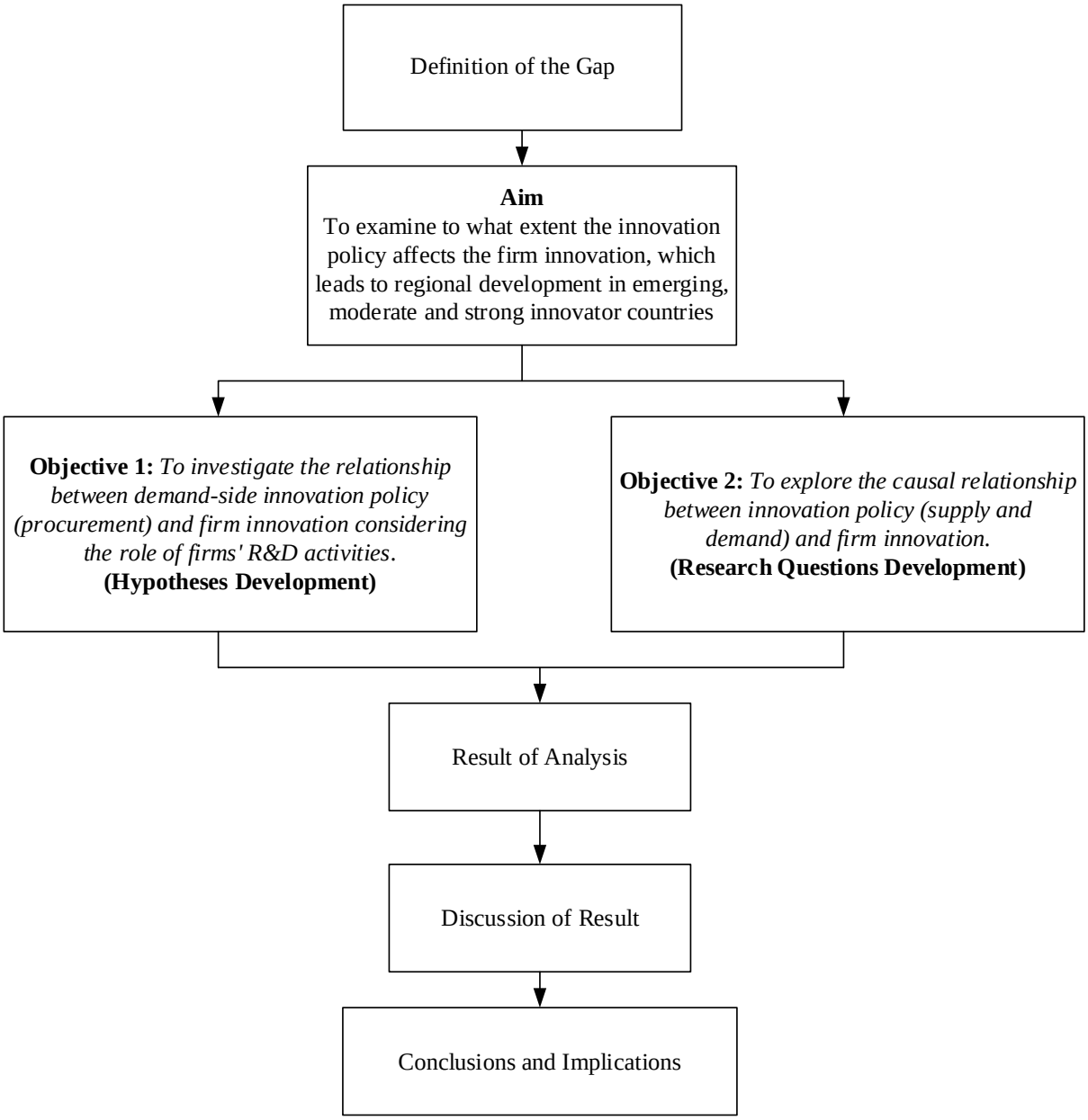

Figure 10 Process of Dissertation

Source: Own

To get a better and more comprehensive picture of the issue of the effects of different innovation policies on firms' innovations that are expected to be key drivers of regional development and about which we still have mixed conclusions provided by the literature so far, the research is divided into two main objectives (argued and described in more detail in the sub-sections below; the process of the dissertation is shown in the Figure 10). Starting with the objective 1, it is defined as follows:

Objective 1 examines the relationship between demand-side innovation policy (procurement) and firm innovation considering the role of firms' R&D activities.

To address the ***objective 1***, the present thesis leverages a comparative analysis of three groups of EU countries based on the European Innovation Scoreboard (EIS), emerging, moderate, and strong innovator countries[2] by using structural equation modelling to understand demand-side policy influence firms' R&D activities and how these R&D activities mediate the relationship between demand-side policy and innovation outcomes.

To extend the *objective 1* and to have a more comprehensive picture about this issue, as well as to be able to compare effects of different innovation policy approaches and to suggest relevant policy and firm implications, it is necessary to consider both supply and demand side innovation policies – within one analysis – to capture the effectiveness of different types of innovation policies fully on firm-level innovation. Hence, the objective 2 is as follows:

Objective 2 is to explore the causal relationship between innovation policy (supply and demand-side) and firm innovation.

To address ***objective 2***, data from Innobarometer 2015 and a two-step analysis method are used. In the first step of analysis, the logistic regression is conducted. In the second step, a doubly robust estimator, treatment effect analysis is used to compare the effectiveness of policies in different European countries.

3.1 Objective 1: Demand-side innovation policy (procurement) and firm innovation

3.1.1 Justification of the Objective 1

Public procurement as one of the demand-side innovation policy tools has received great attention in a recent debate on innovation policy options both at the European level and at the national level (OECD, 2017). The Europe 2020 Strategy, which sets out the EU's growth and development objectives, highlights the importance of innovation for sustainable growth and competitiveness. Public procurement is seen as a means to translate this policy focus into practice, by creating demand for innovative products and services. Moreover, supply-side policy did not provide the intended results and the world is facing increasing budgetary constraints which ultimately pushed them to seek more effective solutions to complement the policy mix without being too costly (Lember et al., 2015).

[2] Emerging,moderate and strong innovators countries are described in section 4.1.1.

Therefore, the government approach has changed significantly towards demand-side policy recently (Edler et al., 2012). Interest in public procurement which is utilize in innovation policy framework has increased (Crespi & Guarascio, 2019; Uyarra et al., 2020). This is called the public procurement for innovation (PPI), the concept of demand-pull innovation (Edquist & Zabala-Iturriagagoitia, 2012). Theoretical reviews have been done in demand side policy to develop innovation in firms (see for example Chicot & Matt, 2018; Uyarra et al., 2020). Lately, public procurement has been recognized as an important driver for encouraging innovation (Uyarra et al., 2014) and it supports products and services much more efficient and effective, as well as provide citizens with better services (Edquist & Zabala-Iturriagagoitia, 2012; Edler & Yeow, 2016). Moreover, it is a powerful tool in supporting private sector innovation through innovation demand (Edquist & Zabala-Iturriagagoitia, 2012) and can be used strategically to promote ecosystem innovation (Rainville, 2017). Another thing is that procurement can be served as a substantive tool because government interference in the procurement process can result in more innovations than government R&D subsidies (Demircioglu & Vivona, 2021).

In a study conducted by Demircioglu and Vivona (2021) found that procurement activities are positively related to innovation within public organizations. They further mentioned R&D procurement has a significant and meaningful impact on new technologies and services. Likewise, Dai et al. (2021) revealed public procurement significantly increases firms' R&D investment, promotes high-tech product sales, and enhances firms' access to external finance in China. Moreover, another scholars, namely Stojčić et al. (2020), suggested that PPI has a large effect on innovation and output, and the highest additionality is sometimes achieved when firms receive both financial support and innovation-oriented public procurement.

Looking at the above literature, most of the studies are literature reviews, qualitative and single-case/single-country analyses with limited generalizability (Obwegeser & Müller, 2018) with less attention given to empirical analysis. Moreover, R&D activities play an important role in solving complex technical problems, and in identifying and investigating new technologies that can be used to develop innovative products, services, and solutions.

Therefore, to the best of our knowledge to fill the gap from previous research, ***the first objective aims to examine the relationship between demand-side innovation policy (proxied by the procurement) and firm innovation considering the role of firms' R&D activities within these processes.***

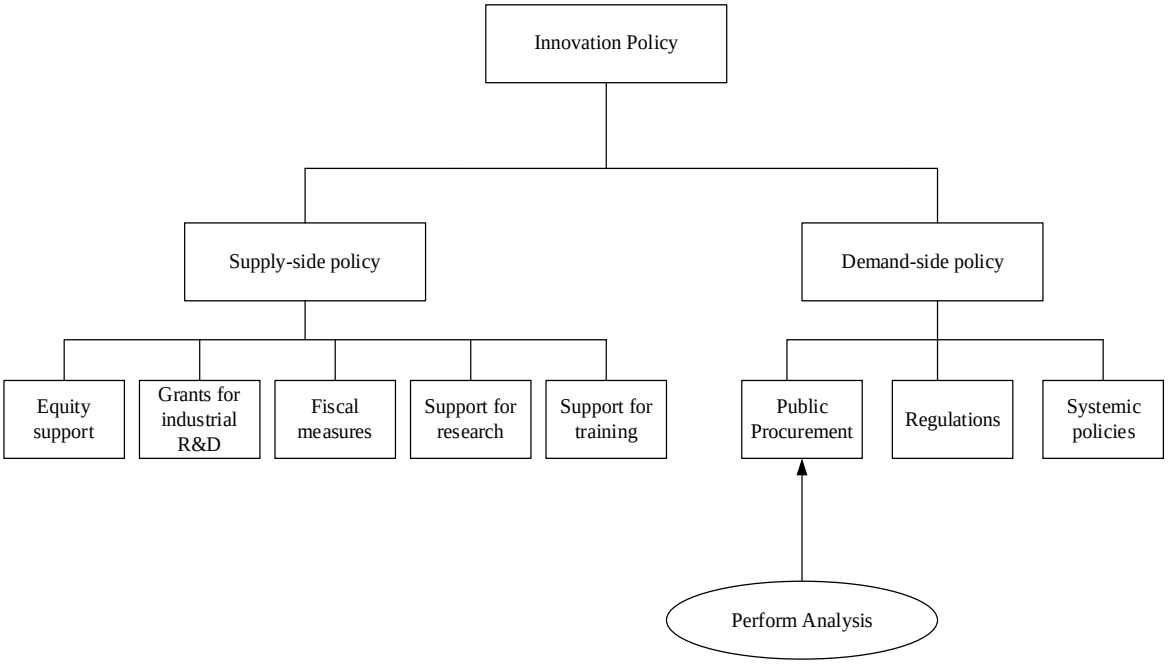

Figure 11 Components of innovation policy

Source: Based on Edler & Georghious (2007)

Figure 11 shows the components of innovation policy. As shown in Figure 11, public procurement for innovation is chosen as a demand-side innovation policy tool according to scholar Edquist and Zabala-Iturriagagoitia (2012).

3.1.2 Hypothesis Development and Research Framework: Effects of Demand-side Policy on selected firms' outputs

Some empirical studies described the potential of **public procurement for innovation** (PPI) in driving innovation and economic growth in recent years. In a study conducted by (Dai et al., 2020), public procurement significantly boosts firms' R&D investment, encourages the sale of high-tech products, and improves firms' access to external finance. Innovative public procurement is crucial in the application and dissemination of sustainable manufacturing technologies (Ghisetti, 2017). Public procurement can provide critical support to investments in innovation and complement other types of finance (Georghiou et al., 2014). Public procurement for innovation can contribute to the transformative processes of (1) the articulation of societal demands to direct challenge-driven transformation; (2) the development and production; selection; and (3) the diffusion and use of new technologies to meet these societal demands (Wesseling & Edquist, 2018). Public procurement can encourage business innovation by supporting the formation of markets for new products, technologies, and services (Bleda & Chicot, 2020). **Innovative public procurement** has a strong and significant impact on turnover

from new products and services. The impact is obviously attributable to innovations of an incremental nature rather than market innovation (Czarnitzki et al., 2018). Based on the above argument, following hypotheses are developed:

H1a: Demand-side innovation policy positively and significantly affects firm product innovation.

H1b: Demand-side innovation policy positively and significantly affects firm process innovation.

H1c: Demand-side innovation policy positively and significantly affects firm patents.

Moreover, by using demand as a tool for innovation, governments can encourage firms to invest in R&D and develop new solutions to societal challenges (Lember et al., 2015). It can stimulate R&D investments, encourage innovation, and lead to the development of new products and services. A study conducted by Selviaridis (2021) found that public procurement stimulates collaboration and R&D interaction and also allows small businesses to gain access to relevant innovation ecosystems, expand their knowledge and capabilities, and explore potential routes to market. Furthermore, innovative procurement can encourage collaboration between public and private sector entities, resulting in knowledge sharing and the development of new technologies (Thai, 2015). Furthermore, **innovative public procurement** can help to improve the efficiency and effectiveness of public services and reduce costs (Edler & Yeow, 2016). It means that firms are likely to invest in R&D activities to advance their technology in the manufacturing process to offer quality service to the public sector. Based on the above argument, we develop the following hypothesis:

H2a: Demand-side innovation policy has a positive and significant indirect effect on firm product innovation through R&D activities.

H2b: Demand-side innovation policy has a positive and significant indirect effect on firm process innovation through R&D activities.

H2c: Demand-side innovation policy has a positive and significant indirect effect on firm patents through R&D activities.

Figure 12 describes conceptual framework of hypothesis development for objective 1.

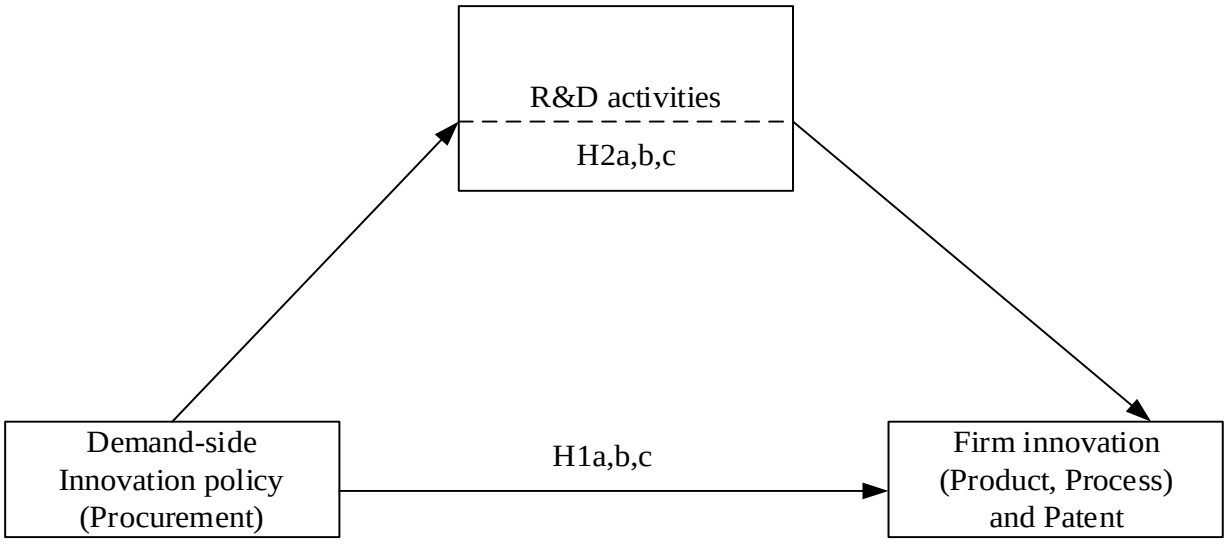

Figure 12 Conceptual Framework

Source: Own

3.2 Objective 2: Supply and Demand-side innovation policies and firm innovation

3.2.1 Justification of the Objective 2

Objective 1 so far analysed the impact of demand-side innovation policy on firm innovation considering the role of R&D activities. Proceeding to ***objective 2***, it is still necessary to consider whether government policies to support innovation activities are effective for private firms or have a crowding-out effect. The government can also use a mix of policy instruments such as supply-side (e.g., subsidies, tax credits, etc.) and demand-side (e.g., public procurement for innovation, regulation and standardizations, etc.). Previous studies emphasized the impact of government subsidies, grants, tax credits, and public procurement for innovation. For example, A study conducted by Lin and Luan (2020) examined the effects of government subsidies and other influencing factors on innovation performance in photovoltaic enterprises. Another scholar, Szczygielski et al. (2017) evaluated the efficiency of grants for innovation activities in catching-up countries using the 2010 Community Innovation Survey (CIS) and found that government grants contributed to better innovation performance. Similarly, studies like Chen et al. (2021) have emphasized the importance of tax policies, including R&D tax credits, in influencing innovation performance. Moreover, scholars Stojčić et al. (2020) the relationship between both public funding and public procurement for innovation (PPI) and firm-level innovation output and outcome additionality, in eight Central and Eastern European countries.

More specifically, this dissertation thesis considers approaches from both supply-side and demand-side policy instruments. Many scholars have mostly focused on the effect of R&D subsidies, grants, tax credits, and public procurement for innovation on firm innovation, To the best of our knowledge, we believe that not only subsidies, tax credits, and public procurement for innovation, there can be other influencing factors from government innovation policies. Hence, in the thesis, we mainly focus on the measure of government policies for providing training staff programs, market-testing before launching to market, and assessing the export market, which are less focused factors on firm innovation performance. Moreover, from the demand-side policies, we used not only public procurement for innovation but also government regulation, and protection for Intellectual Property Rights (IPRs) on the firm innovation. Moreover, we also focus on manufacturing SMEs in European countries, which are recognized as a major driving force in the European Union (EU) (Uuskoski et al., 2020). Unlike previous studies, this paper aims to test the causal impact of government policies on firm innovation performance.

3.2.2 Relevant Research questions

A) Supply-side innovation approach

Government support policies are a crucial factor in fostering firm innovation. Government policies have the potential to impact the business environment greatly, so businesses constantly monitor their effects and consider participation (Greco et al., 2017). Government funding and support generally stimulate innovation and private-sector entrepreneurship. A study showed innovative enterprises' growth through investment-supporting policy, especially in high-technology industries, to argue for the favourable impact of government sponsorship on technological development (Mazzucato, 2014). By actively investing in human and physical infrastructure (for example; subsidies, tax breaks, government-funded research facilities, and direct investment), governments can foster the advancement of technology (Jugend et al., 2018). Initially, government support for corporate innovation has mostly concentrated on supporting research and development (R&D) efforts, both directly and indirectly (Cano-Kollmann et al., 2017). Government policies can offer a favourable institutional and policy environment for local collaborative innovation (SMEs) (Xie et al., 2017). These policies are particularly effective for small and medium enterprises (SMEs) firms because they can help firms maintain competitiveness in the global market (Guijarro et al., 2009). The effectiveness of government policies and R&D activities on firm innovation can be influenced by market uncertainty (Kim et al., 2023).

According to studies, government support policies can improve a firm's capacity for innovation by boosting innovation input, lowering the cost of financing, and encouraging inventive activity (Gao et al., 2023). Moreover, government support initiatives like funding and subsidies increase businesses' capacity for innovation and enable adaptation in their innovation processes (Rojas et al., 2021). Government subsidies, which are part of supply-side policy tools can increase a firm's incentive for long-term technology innovation, reduce R&D costs, and encourage the overall level of innovation (Geo, 2022). However, government subsidy policies have limitations in their effectiveness and firms can leverage government resources strategically without compromising their ability to be innovative (Yi et al., 2021).

Government support for the training program is crucial in fostering innovation within firms. According to Hlásny (2023), staff training supplied by the firm can lead to result in ongoing innovation in processes and products as well as increased productivity in SMEs. This indicates Investing in employee training programs is crucial for the adoption of creative behaviour that propels firms towards notable performance (Aziz et al., 2022). **Government support** is also important **for market testing** to ensure successful product introduction. By performing market testing activities, firms can identify issues with the product before it is introduced to the market and, thus firms can reduce the risk of negative customers' response (Calantone et al., 2012). Target market physical product testing and launch strategies guarantee that all products fulfill consumer demands and technical standards, which in turn guarantees the product's commercial achievement (Hsieh et al., 2008). Moreover, the government program aims to simulate and optimise early-stage innovation tests in order to gradually lower risks and uncertainties before the product's release (Bekhradi et al., 2018). According to WolKinson and Brouthers (2006), small and medium-sized export firms have the biggest challenges in their export due to the lack of information about the foreign markets and these challenges greatly impact firm export performance. However, the degree of this impact is influenced by how firms effectively apply government support for the export system (Kim, 2020). In addition, **government export promotion programs** can improve firms' internationalization efforts (Takyi et al., 2022).

Based on the above literature review, the following research questions (RQ) are developed:

RQ1: What are the potential causal effects of government support for training staff programs on firm innovation?

RQ2: What are the potential causal effects of government support market testing on firm innovation?

RQ3: What are the potential causal effects of government support for the export market on firm innovation?

B) Demand-side innovation approach

Government innovation policies not only deal with supply-side innovation policies but also demand-side innovation policies. Demand-side innovation policy has been a popular topic recently among scholars (Gheorghiou et al., 2014). Demand-side innovation policy usually includes **public procurement for innovation**, regulatory frameworks, IPRs, and standardizations in promoting firm innovation. Typically, demand-side innovation policy complements supply-side policy, which mainly uses public investment through grants and other avenues to stimulate innovation. Thus, demand-side policy measures operate alongside supply-side measures, rather than replacing them (Edler, 2009). In demand-side innovation policy, public procurement for innovation has been emphasized as one of the key measures in innovation policy in fostering innovation (Crespi & Guarascio, 2018). Public procurement for innovation not only improves contextual conditions to encourage innovation adoption but also addresses government-defined societal challenges (Edler, 2016). Public procurement for innovation has a positive effect on firm innovation efficiency and performance (Ghisetti, 2017; Zhang et al., 2023). It also increases the size of the market and reduces the associated demand uncertainties (Caravella & Crespi, 2020; Krieger & Zipperer, 2021). Moreover, public procurement for innovation can act as a catalyst for innovation by providing a safety net that encourages firms to invest in new technologies and ideas, even when the market conditions are uncertain (Ghisetti, 2017).

Not only innovative public procurement but also regulations, standardizations, and intellectual property rights protection (IPRs) are the measures of demand-side innovation policy because many countries have limited amounts to boost public spending on R&D and other innovation-related initiatives after the global financial crisis. Hence, **government support for intellectual property rights protection (IPRs)** has a significant impact on firm innovation. A study conducted by Lichtenthaler (2009) showed that stronger IPRs can promote the dissemination of technology and increase the effectiveness of technology transfers which leads to increased firm innovation. These stronger IPRs enhance firms' capacity to capture the benefit from their innovative effort and encourage R&D investment (Czarnitzki & Toole, 2006). Stricter IPRs can also enhance the innovative activity of firms and increase profitability (Sethi et al., 2021). According to Uribe-Echeberria et al. (2019), protecting IPRs not only allows firms

to guarantee their future profits from their innovation investment but also enables firms to realise the full value of their technological assets.

Government regulations have been identified as important factors influencing the innovation activities of firms. Originally, the emergence of regulations came from the presence of market failure. Regulation can have positive and negative effects on firm innovation. Some studies showed that regulations influence the direction and rate of innovation by creating markets and reshaping the competitive landscape (Crafts, 2006; Blind, 2012). Regulations can also cause a burden for firms in the short term and harm innovation, whereas, the effect of regulations on innovation can vary vastly depending on the specific nature and details of the regulations in the long term (Aghion et al., 2023). A study conducted by Wang and Dai (2020) revealed that regulation has a positive impact and has better product innovation performance at a certain threshold level, however, regulation has a negative effect on innovation beyond the threshold level.

Based on the above literature review, the following RQs are developed:

RQ4: What are the potential causal effects of innovative public procurement on firm innovation?

RQ5: What are the potential causal effects of government support for IPRs on firm innovation?

RQ6: What are the potential causal effects of government regulations on firm innovation?

4 Data and Method

4.1 Data Collection and Selected Countries

This section will present where data is collected from and why countries are selected for analysis for Objective one and Objective two.

4.1.1 Data Collection and Selected Countries for the Objective 1

To meet the objective 1, data is collected from the Community Innovation Survey (CIS) 2012 – 2014. CIS provides innovative public procurement variable which is used as demand-side policy. CIS was developed earlier 1990s. It stemmed from a shared vision of researchers and policymakers to understand the scale and distribution of innovation activities which is necessary for direct and economic-wide indicators of firm's level innovation inputs and outputs (Arundel & Smith, 2013). Moreover, CIS is a survey of innovation activities of enterprises in Ireland and other EU Member States, which collects information about product and process innovation as well as organizational innovations, collaboration and the flow of knowledge, and other key variables during a specific period (Forfás, 2008). Additionally, CIS is a harmonized survey that is also a component of the EU's scientific and technological statistics. It is conducted in EU Member States every two years and CIS is frequently used to examine a firm's innovation efforts. Despite the CIS questionnaire is from 2012-2014, there are several prior – and still current – studies working with its data (for example: Stojčić et al., 2020; Caravella & Crespi, 2021) to analyse the effect of demand-side policy on firm innovation.

The reason and main advantage of using the CIS questionnaire (despite its outdatedness) is the fact that it allows researchers to work with a large data set covering different countries and industries, while providing information on other firm activities, such as cooperation, financing, R&D, and others. This is an advantage over, for example, other datasets such as the World Bank Enterprise Survey, where the information is not as complete. This subsequently enables easier generalization of the results and the design of such implications that are not only country-specific, but it will be possible to propose them for wider territorial units.

The following Table 5 shows the description of the variables used in the dissertation in order to perform the analysis leading to the objective 1.

Table 5 Variable Description

Variable description	**References**
Independent Variable	
Firms especially undertake innovation activities as part of a contract to provide goods or services to a public sector organization (PBINCT)	(Stojčić et al., 2020)
Mediation Variables	
Firms undertake R&D activities to create new knowledge or to solve scientific or technical problems (RRDIN)	(Sein & Vavra, 2020)
Firms undertake in-house training for personnel specifically for the development of new or significantly improved products and processes (RTR)	
Firms undertake in-house activities for the market introduction of new or significantly improved goods or services, including market research and launch advertising (RMAR)	Prokop et al. (2018)
Firms undertake in-house activities to alter the shape, appearance or usability of goods or services (RDSG)	Duarte et al. (2022)
Firms undertake in-house activities to implement new or significantly improved products and processes such as feasibility studies, testing, tooling up, industrial engineering, etc. (RPRE)	
Dependent (output) Variables	
Firms introduce new or innovative products to the market based on customer's needs (INPDGD)	Zhylinska et al. (2020)
Firms introduce new or significantly improved production or delivery methods, including changes in techniques, and equipment in manufacturing process (INPSPD)	
Firms apply for patents, trademarks, and industrial designs (PROPAT)	

Source: Own

4.1.2 Description of selected countries

The research uses purposive and random sampling techniques to select some European Union member states constituting the unit of analysis. Three countries are chosen according to European Innovation Scoreboard 2022[3], emerging innovator, moderate innovator, and strong innovator. 3,265 firms from Croatia as emerging innovator, 5,198 firms from the Czech Republic as moderate innovator, and 5,045 firms from Norway as strong innovator are used for conducting analysis. The reason is that Croatia and Czech Republic are catching up economies, which may have different drivers of innovation, whereas Norway is advanced economy, where policy makers can have a better understanding of the characteristic of innovation systems in two different economies. In this dissertation thesis, single countries are understood as regions. Based on the above theoretical background, firm innovations and patents are thus expected as factors influencing regional development.

A) Emerging Innovator: Croatia

Croatia has been recognized as an emerging innovator with a performance of 66.5% of the EU average in the European Union, making it a suitable candidate for research analysis. Performance is above the average of Emerging Innovators (50.0%) and performance is increasing (15.5%) at a rate higher than that of the EU (9.9%). The country's performance gap with the EU is becoming smaller (European Innovation Scoreboard, 2022). The country's commitment to research and innovation, as well as its efforts to create a favorable environment for entrepreneurship, have made it an attractive destination for researchers and investors alike (European Commission, 2020). The Croatian government has made many efforts to support entrepreneurship, innovation, the transfer of knowledge, and the commercialization of research, yet government support for firms' innovation is relatively weak (European Innovation Scoreboard, 2022).

Moreover, the Croatian innovation system is inefficient and has a low impact on economic development (Bečić & Švarc, 2015). The Croatian economy is dominated by traditional, low-technology sectors. Productivity is low and the economy is poorly integrated into global value chains. R&D expenditures and patenting activity are also low and different policy initiatives have failed to encourage companies to innovate and collaborate with the public research sector (Anić, 2019).

[3] See https://researchandinnovation.ec.europa.eu/statistics/performance-indicators/europeaninnovationscoreboard_en

B) Moderate Innovator: Czech Republic

In recent years, the Czech Republic has established itself as one of the leading moderators of innovation in Europe (European Innovation Scoreboard, 2019). Based on a study conducted by the World Intellectual Property Organization (WIPO), the Czech Republic is placed 29th among the leading innovative nations worldwide, surpassing bigger economies such as Brazil, Russia, and India, according to the report (WIPO, 2020). A key factor in the Czech Republic's innovation success is the government's emphasis on investing in R&D. Over the past few years, the government has increased its funding for R&D by 1.99% in 2020, especially in the fields of technology, science, and engineering (World Bank, 2022). It has attracted some of the best researchers and scientists from around the world who have helped drive innovation in this country. Moreover, the country is becoming a preferred hub for foreign investors seeking to invest in innovative startups due to the significant growth of startup businesses, its talented workforce, cost-effectiveness, and favorable business environment (Vlčková, 2019).

C) Strong Innovator: Norway

Norway is recognized as a strong innovator and has become renowned for its focus on innovation and development. Norway's government has implemented a range of policies that encourage and support innovation within firms. The government has consistently invested in R&D, with spending increasing from 1.4% of GDP in 2000 to 2.1% in 2017 (OECD, 2021). In 2020, R&D expenditure reached 2.28% of GDP (World Bank, 2020). Moreover, Norway's government has also implemented numerous schemes that directly support innovation in firms, such as Skatefunn, the Research Council of Norway, and the Innovation Norway scheme, which provides tax credits, grants, and loans to firms developing innovative products or services (Galindo-Rueda et al., 2021). These government policies are an important aspect of Norway's innovative culture and help to foster an environment in which firms are incentivized to innovate. In addition, Norway has a strong tradition of collaboration between firms and research institutions, which has contributed to the country's high level of innovation performance. A study by Sein and Prokop (2021) found that firms that collaboration with universities and research institutions are more likely to introduce new products and services and such collaborations contribute to the development of new technological capacities to develop new products and services.

4.1.3 Data Collection and Selected Countries for the Objective 2

To meet objective two, secondary data from the Flash Eurobarometer 415 (Innobarometer 2015-The Innovation Trends at EU Enterprises) conducted by the European Commission (European Commission, Brussels) were collected. The survey was created by the TNS Political & Social Network and implemented within the 28 EU Member States, including Switzerland and the United States. It is like CIS and focused on firm-level data. The data were collected in the period between 2 February 2015 and 18 February 2015. It covers businesses with one or more employees in the manufacturing, service, and industry sectors and the sample is stratified by size, sector, and country. Respondents were general managers, financial directors, or owners. It is a valuable source of information, as it is the only available survey that combines, at the firm level, information on innovative public procurement and some other government policy intervention for firm innovative activities. The overall data show that more than 14,118 companies were interviewed. However, the total number of 1975 European manufacturing firms was analyzed in the study. Some recent studies, for example, Ghisetti (2017), Ghisetti and Montresor (2019), Montresor and Vezzani (2022) also used the same survey Flash Eurobarometer 415. Some selected variables for analysis from the survey are mentioned in Table 6 below.

Table 6 Description of Variable

Variables	Description	References
Input		
Innovative Procurement	Has your company included any of its innovations as part of any public procurement contract that you have won? (if 'yes'=1, otherwise= 0)	Stojčić et al. (2020)
Government Support	Public support for commercialization of your innovative goods or services, Support for: • *Meeting regulations or standards* • *Training staff in how to promote and market innovative goods or services*	Montresor & Vezzani (2022)

	• *Managing, or protecting intellectual property rights* • *Accessing or reinforcing your presence in export markets* • *Market-testing a product or service before launch*	
Training	"Since January 2012, what percentage of its total revenue has your company invested in training?"	Martínez-Sánchez et al. (2020)
R&D	"Since January 2012, what percentage of its total revenue has your company invested in research and development (R&D)?"	
Software Development	"Since January 2012, what percentage of its total revenue has your company invested in software development?"	García-Romanos & Martínez-Ros (2023)
Acquisition	"Since January 2012, what percentage of its total revenue has your company invested in the acquisition of machines, equipment, software or licenses?"	
Design of products and services	"Since January 2012, what percentage of its total revenue has your company invested in the design of products and services?"	Ghisetti & Montresor (2019)
Output		
Product innovation	Has your company introduced new or significantly improved goods since January 2012? 'yes' = 1; otherwise, zero	

Process Innovation	Has your company introduced new or significantly improved processes since January 2012? 'yes' = 1; otherwise, zero	Zhylinska et al. (2020)
Innovative sales	Approximately what percentage of your company's turnover in 2014 was due to innovative goods or services that have been introduced since January 2012?	Douglas & Radicic (2016)

Source: Own

4.1.4 Description of selected countries

The EU's innovation policy has also been examined in the context of its impact on different member states, with studies exploring the innovation-growth nexus and the effectiveness of EU funds on innovation in the SME sector (Kacprzyk & Doryñ, 2017; Norek, 2018). Moreover, the EU's innovation policy has been analyzed in relation to national competitiveness and inclusive development, emphasize the need for specific actions to improve innovation performance in different EU countries (Herman, 2018). Furthermore, the EU has emphasized the importance of innovation in small and medium-sized enterprises (SMEs) and has sought to address barriers to eco-innovation, reflecting a comprehensive approach to fostering innovation across different sectors (Marin et al., 2015; Matviienko et al., 2022). Among EU countries, moderate and emerging innovators are suitable to analyse the government innovation policy because of the varying institutional and economic contexts (Guijarro et al., 2009). Besides, the economic crisis of 2008 has especially hit catch-up economies, resulting in significant dispersion in creative investment in those countries (Archibugi & Filippetti, 2011).

In terms of innovation performance, the European Innovation Scoreboard identifies the four groups. The first group of Innovation Leaders includes five Member States where performance is above 125% of the EU average. The second group of Strong Innovators includes six Member States with a performance between 100% and 125% of the EU average. The third group of Moderate Innovators includes 10 Member States where performance is between 70% and 100% of the EU average. The fourth group of Emerging Innovators includes six Member States that show a performance level below 70% of the EU average. Figure 13 shows the performance of the EU Member States's innovation system.

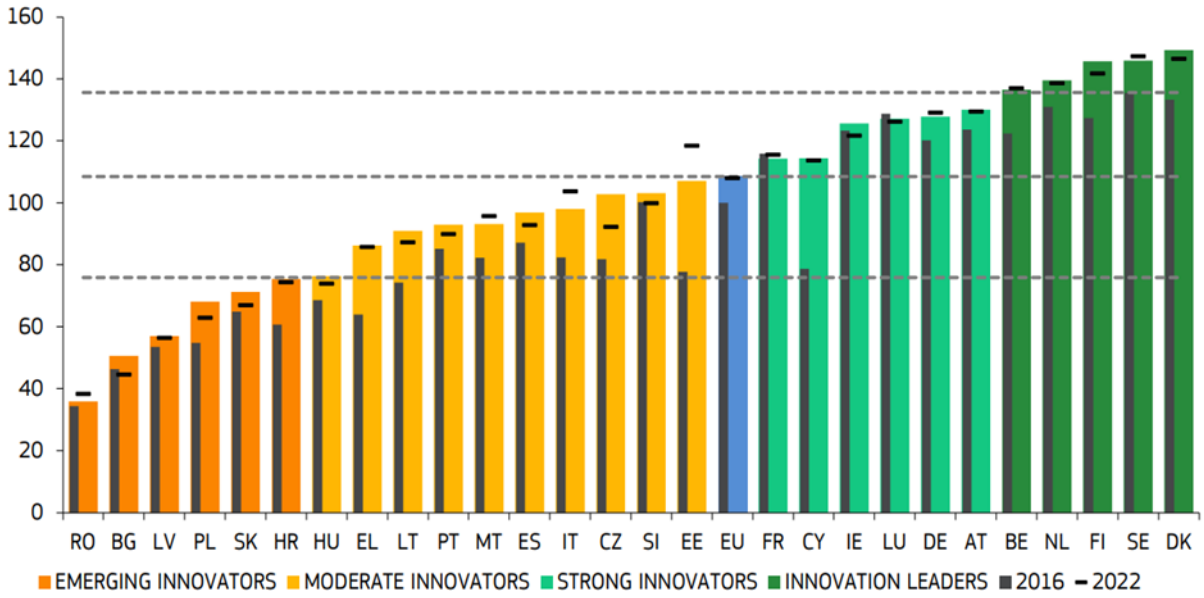

Figure 13 Performance of EU Member States' innovation systems

Source: European Innovation Scoreboard (2023)

4.2 Methods description

In this dissertation thesis, a quantitative research approach is used to fulfill the aim. Quantitative research is a research approach that involves collecting and analyzing numerical data to test hypotheses and make predictions. Watson (2015) explains that quantitative research involves identifying dependent and independent variables, measuring them, and analyzing the data using statistical methods. Moreover, Rahman (2020) notes that quantitative research involves larger sample sizes and can be conducted more quickly than qualitative research. Price and Lovell (2018) emphasize that well-designed quantitative studies can produce findings that are generalizable to larger populations. Mohajan (2020) highlights that quantitative research can be used to quantify attitudes, opinions, behaviors, and other variables, and can generate numerical data that can be used to generalize results. Overall, quantitative research can be a successful and effective approach in natural and social sciences.

4.2.1 Method for the objective 1: Partial Least Square Structural Equation Modelling

Structural equation modelling (SEM) is a useful technique that is being used more and more in scientific studies to examine and verify the causal connections between multiple variables. Using this technique helps researchers to evaluate and confirm a theoretical model, which can then be used to validate or expand upon their hypotheses. SEM varies from other

modeling methods by evaluating both the direct and indirect impacts on pre-determined causal relationships (Fan et al., 2016). Basu (2019) explains that SEM involves two main steps: identification and model specification. In the identification step, the analyst determines the number of free parameters to be estimated from the data provided. In the model specification step, the analyst specifies the relationships between different entities in the model. Moreover, Drton (2016) discusses recent advances in SEM, including parameter identification and determinantal relations among the covariances.

One of the SEM methods is partial least squares structural equation modelling (PLS-SEM), which was introduced as a causal-predictive approach to SEM (Jöreskog & Wold, 1982) with an emphasis on describing the variance in the model's dependent variables (Chin et al., 2020). PLS-SEM applications have dramatically increased in recent years particularly in the social sciences (e.g., Ali et al., 2018; Ringle et al., 2020), but also in agricultural science, engineering, environmental science, and medicine. PLS-SEM uses a combination of principal component analysis and regression-based path analysis to estimate the parameters of equations in a structural equation model and it helps in identifying relationships between variables (Mateos-Aparicio, 2011). Moreover, PLS-SEM technique allows researchers to estimate complex models with many variables even with smaller sample sizes compared to other SEM methods (Hair et al., 2022). It also provides flexibility in estimating different types of relationships between variables, such as conditional process models or higher-order models (Sarstedt et al., 2019). According to research (Willaby et al., 2015), PLS-SEM is an effective method for analyzing complex models with even small sample sizes.

PLS-SEM is a two-step approach that combines elements of factor analysis and regression analysis. It allows researchers to simultaneously evaluate the measurement model (reflective and formative constructs) and the structural model (relationships between constructs) using a small-to-medium sample size. PLS-SEM overcomes limitations of covariance-based SEM, such as non-normal data, small sample sizes, and complex causal relationships (Hair et al., 2019).

The measurement model in PLS-SEM focuses on assessing the relationships between latent variables (constructs) and their corresponding observed indicators (manifest variables). Unlike covariance-based SEM, which relies on the assumption of multivariate normality, PLS-SEM is a non-parametric approach that estimates latent variable scores through a process called "soft modeling" (Hair et al., 2019). The structural model examines the relationships between constructs and provides insights into causal paths among variables. PLS-SEM estimates the

path coefficients using the partial least squares algorithm, which minimizes the sum of squared residuals. This algorithm allows researchers to assess both direct and indirect effects in a model and enables the examination of complex relationships, including mediating and moderating effects (Hair et al., 2019).

PLS-SEM offers several advantages over traditional covariance-based SEM. First, it is less sensitive to violations of distributional assumptions, making it suitable for analyzing non-normal or small sample data. Second, PLS-SEM handles complex models with multiple dependent and independent variables more effectively. Third, PLS-SEM provides robustness in situations with low indicator-to-construct ratios, such as formative constructs (Hair et al., 2019). PLS-SEM finds wide application in various research domains, including marketing, management, information systems, and social sciences. It is commonly employed in studies investigating consumer behavior, brand management, innovation adoption, and organizational performance. PLS-SEM also plays a significant role in exploring complex phenomena, such as sustainability, corporate social responsibility, and technology acceptance (Hair et al., 2019).

PLS-SEM is given by the following equation (Gyamfi & Sein, 2021):

$$EV=\beta 0^{(k)} + \sum \beta i^{(k)}\, zi + v_k \quad (1)$$

Where EV describes the variables (patent, product, process innovation), $\beta 0^{(k)}$ means the constant term, $\sum \beta i^{(k)}$ represents the regression coefficient and v_k explains the residual term.

4.2.2 Methods for the Objective 2

This dissertation for ***objective 2*** conducts two analysis methods by using logistic regression and propensity score matching methods to estimate policy effects (Guo et al., 2016; Wu et al., 2020). Firstly, a logistic regression model is employed to investigate the relationship between government policy and innovation outputs and sales. The regression model helps to capture the impact of policy support on firm innovation and sales, and robustness check by using propensity score matching method confirms that the results are reliable and not influenced by other factors. This will reduce endogeneity issues. The logistic regression model is widely accepted for the analysis of dichotomous outcome variables. The concept of logistic regression involves predicting the probability of a binary outcome, where the response variable is categorical and represents two possible outcomes (Park, 2013). A logistic regression model using multiple variables of this study is described as the following equation:

$$\ln (P(Y=1)/1- P(Y=1)) = \beta 0+\beta 1GP+\beta 2X1+\beta 3X2+\ldots+\beta kXk \quad (2)$$

where P(Y=1) is the probability that firm engage in innovation, β0 is the intercept of the model, β1GP represents the coefficient for the government policy whether the firm received government support and X1, X2, Xk means other control variables that might impact firm's likelihood of innovation.

Secondly, inverse probability-weighted regression adjustment treatment effect estimation techniques were used according to previous studies (Kurz, 2022; Yu et al., 2023; Jiang et al., 2023). The treatment effect is the average causal impact of a dichotomous variable on an outcome variable of policy or scientific interest. Using doubly robust estimation, we were able to combine outcome regression with a model for propensity scores to assess the causal impact on an exposed outcome model. The doubly robust estimation combines the outcome regression with a model for the propensity scores to evaluate the causal effect on an exposed outcome model (Benedetto et al., 2018). The doubly robust method combines both outcome regression model and propensity scores. Both the outcome regression and the propensity scores approach can overcome biases from the confounding variable that might affect the results. Propensity scores matching (PSM) method is widely used to analyze the impact of innovation policy (Foreman-Peck, 2013; Antonioli et al., 2014). This method estimates the average effect of policy on firm innovation, when a firm received government support to counterfactual outcomes for same firm. Since counterfactual outcomes are not observable, matching establishes them by considering firms equivalent in terms of characteristics, besides government policy. Each supported firm is matched with the closest non-supported firm based on a propensity score. To guarantee matching quality, the standardized mean and variation ratio after matching were checked. This consideration ensures that only twin firms are matched. The average treatment effect on the treated is estimated as follows:

$$ATT = E(Y1-Y0/D = 1) = E(Y1/D = 1) - E(Y0/D = 1) \quad (3)$$

where Y1 represents the value of outcome (firm innovation) if the firm received the innovation policy support (treatment) and Y0 is the value of outcome if the firm did not receive the innovation policy support (treatment). D is the status of the treatment D = 1 when treated and D = 0 when untreated. E (Y1/D =1) is the average innovation output for treated firms, however, E (Y0/D = 1) counterfactual outcome for treated firms where we cannot directly observe. To estimate this issue, propensity score, P (D = 1/X) can be calculated. Propensity scores ensure that the differences in the innovation outcomes between the treated and matched control firms are more likely to reflect the impact of the innovation policy, rather than other confounding factors (Mähringer-Kunz et al., 2021; Tseng et al., 2023).

5 Results and Discussions

This chapter will present the results from the data analysis for **objective one and objective two**, afterwards an interpretation of these results will be discussed, linking with existing literature and how these findings support or contrast with previous studies.

5.1 Objective 1: Demand-side innovation policy (procurement) and firm innovation

5.1.1 Factor Analysis

All outer loading values are greater than 0.4 shown in Table (A1, A2, A3) in the Appendix.

Table 7 Construct Reliability and Validity for Product Innovation

	Croatia				**Czech Republic**				**Norway**			
	CA	RA	CR	AVE	CA	RA	CR	AVE	CA	RA	CR	AVE
Prod Inno	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
DSP	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
R&D Activities	0.847	0.851	0.890	0.619	0.870	0.873	0.906	0.657	0.860	0.865	0.899	0.641

Note: DSP = Demand-side policy; CA = Cronbach's Alpha; RA = Rho_Alpha; CR = Composite Reliability; AVE = Average Variance Extracted

Source: Own

Table 8 Construct Reliability and Validity for Process Innovation

	Croatia				**Czech Republic**				**Norway**			
	CA	RA	CR	AVE	CA	RA	CR	AVE	CA	RA	CR	AVE
ProceInno	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
DSP	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
R&D Activities	0.847	0.851	0.890	0.619	0.870	0.873	0.906	0.658	0.860	0.864	0.899	0.641

Note: CA = Cronbach's Alpha; RA = Rho_Alpha; CR = Composite Reliability; AVE = Average Variance Extracted; Proce Inno = Process Innovation

Source: Own

Table 9 Construct Reliability and Validity for Patents

	Croatia				**Czech Republic**				**Norway**			
	CA	RA	CR	AVE	CA	RA	CR	AVE	CA	RA	CR	AVE
Patent	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
DSP	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
R&D Activities	0.847	0.855	0.890	0.619	0.870	0.880	0.905	0.656	0.860	0.866	0.899	0.641

Note: CA = Cronbach's Alpha; RA = Rho_Alpha; CR = Composite Reliability; AVE = Average Variance Extracted

Source: Own

Outer loading above 0.4 can be considered acceptable (Hair et al., 2019). Moreover, the Variance Inflation Factor (VIF), shows that the VIF values are lower than 5. Hence, the model shows no collinearity problem in all values shown in Table (A1, A2, A3) in the Appendix. Moreover, in the assessment of the measurement model, Cronbach's Alpha is greater than 0.6, Composite Reliability and Rho_Alpha are greater than 0.7, and Average Variance Extracted (AVE) is greater than 0.6 (Fornell & Larcker, 1981). Therefore, all requirements for construct reliability and validity are achieved shown in Tables 7, 8, and 9.

The Heterotrait-Monotrait (HTMT) ratio of the correlations is used to assess the discriminant validity of the model shown in Tables 10, 11, and 12). According to Henseler et al. (2015), the HTMT ratio is less than 0.85 or 0.9. Hence, discriminant validity has been established between two reflective constructs in the model.

Table 10 Heterotrait-Monotrait Ratio (HTMT) for Product Innovation

	Croatia			**Czech Republic**			**Norway**		
	Prod Inno	DSP	R&D activities	Prod Inno	DSP	R&D activities	Prod Inno	DSP	R&D activities
Prod Inno									
DSP	0.239			0.119			0.202		
R&D activities	0.734	0.341		0.707	0.213		0.659	0.323	

Source: Own

Table 11 Heterotrait-Monotrait Ratio (HTMT) for Process Innovation

	Croatia			**Czech Republic**			**Norway**		
	Proce Inno	DSP	R&D activities	Proce Inno	DSP	R&D activities	Proce Inno	DSP	R&D activities
Proce Inno									
DSP	0.239			0.119			0.171		
R&D activities	0.683	0.341		0.592	0.213		0.519	0.323	

Source: Own

Table 12 Heterotrait-Monotrait Ratio (HTMT) for Patent

	Croatia			Czech Republic			Norway		
	Patent	DSP	R&D activities	Patent	DSP	R&D activities	Patent	DSP	R&D activities
Patent									
DSP	0.119			0.106			0.108		
R&D activities	0.204	0.341		0.233	0.213		0.342	0.323	

Source: Own

Table 13 Model Fit for Product Innovation

	Croatia		**Czech Republic**		**Norway**	
	Sat. Model	Est. Model	Sat. Model	Est. Model	Sat. Model	Est. Model
SRMR	0.066	0.066	0.062	0.062	0.059	0.059
Chi-Square	1561.584	1561.584	2833.133	2833.133	2596.999	2596.999
NFI	0.843	0.843	0.851	0.851	0.845	0.845

Note: Sat. = saturated, Est. = estimated, SRMR—standardized root mean squared residual, and NFI—normed fit index.

Source: Own

The Saturated and Estimated model measures the relationship between all concepts. SRMR values that are less than 0.095 can be assumed as good functioning of the model. NFI

values should be between 0.0 and 1.0 with values closer to 1.0 indicating good fit. Therefore, the model shown in Tables (13,14,15) can be assumed a good fit model.

Table 14 Model Fit for Process Innovation

	Croatia		**Czech Republic**		**Norway**	
	Sat. Model	Est. Model	Sat. Model	Est. Model	Sat. Model	Est. Model
SRMR	0.067	0.067	0.060	0.060	0.059	0.059
Chi-Square	1580.571	1580.571	2566.225	2566.225	2384.436	2384.436
NFI	0.835	0.835	0.855	0.855	0.846	0.846

Note: Sat. = saturated, Est. = estimated, SRMR—standardized root mean squared residual, and NFI—normed fit index.

Source: Own

Table 15 Model Fit for Patent

	Croatia		**Czech Republic**		**Norway**	
	Sat. Model	Est. Model	Sat. Model	Est. Model	Sat. Model	Est. Model
SRMR	0.065	0.065	0.060	0.060	0.059	0.059
Chi-Square	1471.820	1471.820	2639.024	2639.024	2464.686	2464.686
NFI	0.815	0.815	0.836	0.836	0.833	0.833

Note: Sat. = saturated, Est. = estimated, SRMR—standardized root mean squared residual, and NFI—normed fit index.

Source: Own

5.1.2 Results and Discussion

Most previous studies focused on supply-side policy on firm-level innovation and few studies emphasized on direct relationship between demand-side innovation policy on firm-level innovation which neglected the mediating role of R&D activities. Therefore, the aim of this dissertation thesis for **objective 1** is to analyse the influence of demand-side innovation policy on firm innovation mediated by R&D activities. Table (16,17,18) represents the results of the empirical analysis.

In analysis, demand-side innovation policy has no significant direct effect on firm product and process innovation in Croatia, the Czech Republic, and Norway as shown in Table (16,17,18). Therefore, Hypothesis (H1a,b,c) are rejected for Croatia and Norway, whereas (H1c) for the Czech Republic is accepted. These results go against the findings of Stojčić et al. (2020) and Czarnitzki et al. (2018) who found that demand-side innovation policy (public procurement for innovation) has a significant effect on firm's innovation output (product and process innovation) and drive the success of firm's innovation.

Table 16 Results of Path Analysis for Croatia

Product Innovation		
	T Statistics	P Values
Demand-side policy -> Product Innovation	1.039	0.299
Demand-side policy -> R&D Activities	10.533	0.000***
R&D Activities -> Product Innovation	40.399	0.000***
Demand-side policy -> R&D Activities -> Product Innovation	10.022	0.000***
Process Innovation		
	T Statistics	P Values
Demand-side policy -> Process Innovation	1.733	0.083
Demand-side policy -> R&D Activities	10.197	0.000***
R&D Activities -> Process Innovation	34.783	0.000***
Demand-side policy -> R&D Activities -> Process Innovation	9.447	0.000***
Patent		
	T Statistics	P Values
Demand-side policy -> Patent	1.448	0.148
Demand-side policy -> R&D Activities	10.442	0.000***
R&D Activities -> Patent	5.710	0.000***
Demand-side policy -> R&D Activities -> Patent	4.977	0.000***

*Note: *** significant at p<0.01; ** significant at p<0.05*

Source: Own

However, the finding supports the result of Gyamfi et al. (2019), who found no significant effect of innovative public procurement on firm product innovation. The results indicate that demand-side innovation policy is not likely to be a main driver of firm innovation directly. Factors such as resources, and competition can influence firms to innovate (Ganglmair

et al., 2020). In addition, the government may have some specific requirements and standardized specifications that can limit some extent of the firm's innovation.

Secondly, demand-side innovation policy has a positive and significant indirect effect on firms' product, process innovation, and patents mediated by R&D activities in Croatia, the Czech Republic, and Norway, see Tables (20,21,22). Therefore, (H2a,b,c) are accepted. This indicates that firms exposed to higher customer demand for innovative products are more likely to engage in R&D efforts, leading to increased innovation outcomes (Crépon et al., 1998). Moreover, large market power and high demand expectations can positively influence firm R&D investment which spurs innovation activity (Stadler, 2001).

Table 17 Results of Path Analysis for the Czech Republic

Product Innovation		
	T Statistics	P Values
Demand-side policy -> Product Innovation	0.963	0.336
Demand-side policy -> R&D Activities	11.151	0.000***
R&D Activities -> Product Innovation	64.007	0.000***
Demand-side policy -> R&D Activities -> Product Innovation	10.962	0.000***
Process Innovation		
	T Statistics	P Values
Demand-side policy -> Process Innovation	0.577	0.564
Demand-side policy -> R&D Activities	11.725	0.000***
R&D Activities -> Process Innovation	43.658	0.000***
Demand-side policy -> R&D Activities -> Process Innovation	11.067	0.000***
Patent		
	T Statistics	P Values
Demand-side policy -> Patent	2.057	0.040**
Demand-side policy -> R&D Activities	11.290	0.000***
R&D Activities -> Patent	12.741	0.000***
Demand-side policy -> R&D Activities -> Patent	9.002	0.000***

*Note: *** significant at p<0.01; ** significant at p<0.05*

Source: Own

Table 18 Results of Path Analysis for Norway

Product Innovation		
	T Statistics	P Values
Demand-side policy -> Product Innovation	1.005	0.315
Demand-side policy -> R&D Activities	18.884	0.000***
R&D Activities -> Product Innovation	51.968	0.000***
Demand-side policy -> R&D Activities -> Product Innovation	17.795	0.000***
Process Innovation		
	T Statistics	P Values
Demand-side policy -> Process Innovation	1.550	0.121
Demand-side policy -> R&D Activities	19.116	0.000***
R&D Activities -> Process Innovation	36.261	0.000***
Demand-side policy -> R&D Activities -> Process Innovation	16.464	0.000***
Patent		
	T Statistics	P Values
Demand-side policy -> Patent	0.457	0.648
Demand-side policy -> R&D Activities	18.716	0.000***
R&D Activities -> Patent	20.741	0.000***
Demand-side policy -> R&D Activities -> Patent	13.985	0.000***

*Note: *** significant at p<0.01; ** significant at p<0.05*

Source: Own

Table 19 Confirmation of Hypothesis

Hypothesis Statements	**Confirmation of Hypothesis (Accepted/Rejected)**	
H1a: Demand-side innovation policy positively and significantly affects firm product innovation.	Croatia	Rejected
	Czech Republic	Rejected
	Norway	Rejected
H1b: Demand-side innovation policy positively and significantly affects firm process innovation.	Croatia	Rejected
	Czech Republic	Rejected
	Norway	Rejected

H1c: Demand-side innovation policy positively and significantly affects firm patents.	Croatia	Rejected
	Czech Republic	Accepted
	Norway	Rejected
H2a: Demand-side innovation policy has a positive and significant indirect effect on firm product innovation through R&D activities.	Croatia	Accepted
	Czech Republic	Accepted
	Norway	Accepted
H2b: Demand-side innovation policy has a positive and significant indirect effect on firm process innovation through R&D activities.	Croatia	Accepted
	Czech Republic	Accepted
	Norway	Accepted
H2c: Demand-side innovation policy has a positive and significant indirect effect on firm patents through R&D activities.	Croatia	Accepted
	Czech Republic	Accepted
	Norway	Accepted

Source: Own

In addition, demand-side innovation policy has a direct effect on firm patent applications in the Czech Republic. In this case, the contractor or buyer might be interested in involving patents to protect products, services, and technology that they procure. Results support the finding of Raiteri (2018) who found a positive and significant impact of innovative public procurement on patent applications. However, the demand-side innovation policy doesn't have any significant effect on patents in Croatia and Norway. In this case, there may be some limitations to participating in the government contract awards program. If a firm's innovative efforts lie beyond the defined framework, it may not benefit from the program, and thus its patent applications may not increase.

5.2 Objective 2: Supply and Demand-side innovation policies and firm innovation

5.2.1 Results and Discussion of Analysis

This section will describe the results and discussion for the analysed countries. Initially, the results of regression analysis for all European countries and selected four groups from the European Innovation Scoreboard (EIS), emerging, moderate, and strong innovators and

innovator leaders based on their innovation performance. Subsequently, we conduct a treatment effect analysis to examine the effectiveness of specific policy interventions and present the results for all European countries and further for emerging and moderate innovators where the effectiveness of the policy is expective to be more clear.

Table 20 shows the results of logistic regression analysis of all EU countries. Innovative public procurement, government support for training staff, and protecting IPR are not significant in product innovation. However, product innovation is significantly influenced by government regulation, government support for market testing, and export markets in all EU countries. Innovative public procurement and government support for training staff are the highest statistically significant on product innovation, whereas government regulations, government support for market testing, export markets, and protection IPR are not found to be significant in these countries. In terms of innovative sales, innovative procurement and government support for the export market showed to be significant, meanwhile, government regulations are negatively significant on innovative sales. In addition, control variables such as internal training, design of the products, and research and development (R&D) activities are significant in product innovation, however, software development, design of the products, and research and development (R&D) activities are profound to be significant on process innovation. The design of the products is found to be significant in innovative sales. Finally, manufacturing sectors are noticeably significant in product and process innovation.

Table 20 Regression Analysis Result of EU Countries

	Product Innovation		**Process Innovation**		**Innovative Sales**	
Const	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z
Const	0.011 (0.136)	0.079	-0.980 (0.133)	-7.340***	-1.334 (0.138)	-9.660***
Procure	0.065 (0.103)	0.635	0.473 (0.098)	4.793***	0.471 (0.097)	4.827***
Gov_Regu	-0.266 (0.124)	-2.150 **	-0.073 (0.124)	-0.592	-0.226 (0.125)	-1.815*
Gov_train	0.073 (0.109)	0.664	0.284 (0.105)	2.684***	-0.106 (0.104)	-1.015

Gov_IPR	-0.241 (0.212)	-1.135	-0.103 (0.218)	-0.473	-0.058 (0.204)	-0.286
Gov_Mark	0.355 (0.155)	2.285 **	0.156 (0.142)	1.092	-0.022 (0.138)	-0.158
Gov_Export	0.395 (0.136)	2.896 ***	0.152 (0.123)	1.237	0.234 (0.119)	1.959*
Training	-0.227 (0.113)	-2.001 **	0.120 (0.108)	1.110	-0.164 (0.109)	-1.494
Software	0.132 (0.109)	1.212	0.370 (0.104)	3.548***	0.023 (0.103)	0.227
RD	0.498 (0.119)	4.163 ***	0.383 (0.111)	3.457***	0.219 (0.109)	2.016
Design	0.339 (0.114)	2.955 ***	0.287 (0.109)	2.639***	0.436 (0.108)	4.042***
Acquis	0.067 (0.118)	0.567	0.081 (0.115)	0.708	0.131 (0.115)	1.140
Sector	1.294 (0.162)	7.973 ***	0.489 (0.128)	3.818***	-0.156 (0.123)	-1.268
McFadden R-squared	0.078		0.082		0.056	

*Note: *** significant at p<0.01; ** significant at p<0.05*

Source: Own

Table 21 describes the regression results of moderate innovators. Government regulations have a negative and significant effect on product innovation. Likewise, government support for market testing and export market are significant for product innovation. However, only government training for staff is significant for process innovation, and government support for the export market shows a significant impact on innovative sales. Control variables such as the design of the product and sectors also influence product and process innovation. Acquisition of knowledge and design of the product is significant for innovative sales.

Table 21 Regression Analysis of Moderate Innovators

	Product Innovation		**Process Innovation**		**Innovative Sales**	
	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z
Const	-0.438 (0.378)	-1.159	-0.732 (0.345)	-2.120 **	−1.673 (0.373)	−4.474***
Procure	-0.197 (0.214)	-0.919	0.219 (0.200)	1.095	0.319 (0.202)	1.580
Gov_Regu	-0.460 (0.261)	-1.756 *	-0.016 (0.267)	-0.061	−0.239 (0.259)	−0.922
Gov_train	0.074 (0.228)	0.327	0.367 (0.209)	1.754 *	−0.192 (0.216)	−0.890
Gov_IPR	0.002 (0.529)	0.005	-0.013 (0.511)	-0.025	−0.529 (0.535)	−0.990
Gov_Mark	0.832 (0.321)	2.587 ***	0.361 (0.287)	1.258	−0.284 (0.293)	−0.969
Gov_Export	0.512 (0.282)	1.813 *	0.332 (0.251)	1.321	0.384 (0.232)	1.651*
Training	-0.040 (0.236)	-0.173	0.149 (0.230)	0.649	−0.172 (0.231)	−0.744
Software	0.255 (0.218)	1.165	0.116 (0.207)	0.558	0.151 (0.212)	0.714
RD	0.241 (0.241)	0.998	0.357 (0.225)	1.581	0.075 (0.223)	0.338
Design	0.688 (0.225)	3.051 ***	0.418 (0.214)	1.949 *	0.396 (0.213)	1.857*
Acquis	0.070 (0.231)	0.305	0.170 (0.224)	0.762	0.486 (0.231)	2.104**
Manuf. Sector	1.781 (0.396)	4.497 ***	0.669 (0.284)	2.352 **	0.137 (0.255)	0.536
McFadden R-squared	0.120		0.079		0.068	

*Note: *** significant at p<0.01; ** significant at p<0.05*

Source: Own

Table 22 shows the results of the logistic regression analysis of emerging innovators. In emerging innovators, product innovation is substantially influenced by innovative public

procurement and government support for export markets. Government regulation also has a significant and negative impact on product innovation. Government support for protecting IPR is highly significant for product innovation. R&D activities, the design of the products, manufacturing sector are also significant in product innovation. Moreover, innovative public procurement is highly significant in process and innovative sales. Development of software, R&D, and sectors are also found to be significant in process innovation. Only internal training and acquiring of external technology influence innovative sales.

Table 22 Regression Analysis Result of Emerging Innovators

	Product Innovation		**Process Innovation**		**Innovative Sales**	
	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z
Const	-0.278 (0.368)	-0.755	-0.928 (0.333)	-2.787 ***	-1.532 (0.361)	-4.240 ***
Procure	0.414 (0.210)	1.967 **	0.551 (0.196)	2.800 ***	0.775 (0.198)	3.909 ***
Gov_Regu	-0.627 (0.249)	-2.516 **	-0.017 (0.257)	-0.067	-0.401 (0.278)	-1.442
Gov_train	-0.066 (0.231)	-0.288	0.300 (0.214)	1.402	0.045 (0.212)	0.215
Gov_IPR	-1.293 (0.487)	-2.653 ***	-0.281 (0.458)	-0.613	-0.534 (0.420)	-1.271
Gov_Mark	0.532 (0.313)	1.698 *	0.098 (0.277)	0.355	0.383 (0.267)	1.433
Gov_Export	0.335 (0.283)	1.183	-0.008 (0.247)	-0.035	0.009 (0.255)	0.037
Training	0.031 (0.243)	0.128	0.035 (0.221)	0.161	-0.395 (0.232)	-1.702 *
Software	-0.014 (0.243)	-0.060	0.721 (0.223)	3.231 ***	-0.181 (0.227)	-0.797
RD	0.736 (0.271)	2.712 ***	0.536 (0.237)	2.254 **	0.366 (0.228)	1.599

Design	0.467 (0.239)	1.955 *	0.117 (0.215)	0.543	0.225 (0.219)	1.026
Acquis	-0.089 (0.261)	-0.341	-0.159 (0.247)	-0.643	0.481 (0.264)	1.816 *
Manuf. Sector	1.908 (0.350)	5.438 ***	0.409 (0.245)	1.671 *	-0.076 (0.247)	-0.309
McFadden R-squared	0.144		0.095		0.099	

*Note: *** significant at p<0.01; ** significant at p<0.05*

Source: Own

In addition, the covariate balancing test for all EU countries before and after matching is performed to determine if the matching process effectively eliminates biases caused by confounding variables.

Table 23 Covariate Balancing Test of EU countries

	Product Innovation	**Process Innovation**	**Innovative Sales**
Pseudo R2 Unmatched	0.048	0.056	0.044
Pseudo R2 Matched	0.008	0.010	0.006
LR Chi2 (p-Value) Unmatched	119.45*** (0.000)	150.44*** (0.000)	118.02*** (0.000)
LR Chi2 (p-Value) Matched	29.97*** (0.003)	32.64*** (0.001)	13.95 (0.236)
Mean Standardised Bias Unmatched	15.2	19.4	16.6
Mean Standardised Bias Matched	4.7	5.7	4.4

Source: Own

Table 23 shows the results for all EU countries. The standardized mean for outcome variables is 15.2, 19.4, and 16.6 percent respectively before matching. It has reduced to 4.7, 5.7, and 4.4 percent after matching. This indicates there is a better covariate balance between groups. The p-value ratios show the highest significant level before matching; however, the

significant level is lower after matching for all outcome variables, which means an improved balance exists between treated and untreated groups. The pseudo-R2 value also dropped drastically from between about 5, 6, and 4 percent before matching to about 1 percent for all outcomes after matching. Lower pseudo-R2 results in a good covariate balance in the matching process.

The covariate balancing test for moderate innovators is performed before and after matching in the table (24). The standardized mean for outcome variables is 18.3, 19.5, and 19.1 percent respectively before matching. It has reduced to 6.5, 5.5, and 6.4 percent after matching. Reduction in standardized bias indicates matching process has effectively minimised differences among groups. This reduces bias and enhances the reliability of the predicted treatment effect. The p-value is significant before matching, however, there is no significance after matching for all outcome variables. In this essence, the matching process has balanced the covariates and reduced the effect of confounding. The pseudo-R2 value also dropped drastically from between about 7, 6, and 6 percent before matching to about (2,1,2) percent for all outcomes after matching. Therefore, the matching process significantly increased the comparison of treatment and control groups, which gives a more reliable and unbiased estimation of the treatment effect.

Table 24 Covariate Balancing Test of Moderate Innovators

	Product Innovation	**Process Innovation**	**Innovative Sales**
Pseudo R2 Unmatched	0.074	0.059	0.058
Pseudo R2 Matched	0.021	0.009	0.016
LR Chi2/(p-Value) Unmatched	48.43*** (0.000)	40.95*** (0.000)	39.22*** (0.000)
LR Chi2/ (p-Value) Matched	19.70 (0.073)	7.67 (0.810)	8.06 (0.780)
Mean Standardised Bias Unmatched	18.3	19.5	19.1
Mean Standardised Bias Matched	6.5	5.5	6.4

Source: Own

The covariate balancing test for emerging innovators is performed before and after matching in the table (25). The standardized mean for outcome variables is 20.8, 22.7, and 20.1 percent respectively before matching. It has reduced to 7.6, 3.8, and 5.5 percent after matching. The p-value is significant before matching, however, there is no significance after matching for all outcome variables. The pseudo-R2 value also dropped drastically from between about 9, 8, and 10 percent before matching to about (2,1,1) percent for all outcomes after matching. The statistically insignificant p-value ratio, low pseudo R2, and high bias reduction after matching indicate that the propensity score matching was effective in balancing the distribution of the covariates between the treated and untreated sub-samples.

Table 25 Covariate Balancing Test of Emerging Innovators

	Product Innovation	**Process Innovation**	**Innovative Sales**
Pseudo R2 Unmatched	0.086	0.084	0.097
Pseudo R2 Matched	0.022	0.006	0.013
LR Chi2/(p-Value) Unmatched	55.28*** (0.000)	57.92*** (0.000)	66.45*** (0.000)
LR Chi2/ (p-Value) Matched	19.13 (0.085)	4.24 (0.979)	7.34 (0.834)
Mean Standardised Bias Unmatched	20.8	22.7	20.1
Mean Standardised Bias Matched	7.6	3.8	5.5

Source: Own

The previous research (for example, Mulligan et al., 2019; Caravella & Crespi, 2021) on firm-level innovation in EU countries has mostly favored particular government innovation policies such as subsidies, R&D tax credits, innovative public procurement, etc. They neglect other important factors such as government support for training staff, export market, and market testing, which can also influence the firm innovation. Therefore, this dissertation has brought up the other omitted important factors of government policy tools influencing firm-level innovation and has filled the gap by using manufacturing sectors of EU countries from the Innobarometer of 2015 enterprise data set.

Table 26 Treatment-effects Estimation of all EU countries

	Product Innovation		**Process Innovation**		**Innovative Sales**	
	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z
Procure	0.044** (0.021)	2.09	0.159*** (0.021)	7.29	0.146*** (0.021)	6.72
Gov_Regu	-0.082*** (0.027)	-3.02	-0.035 (0.027)	-1.27	-0.065** (0.026)	-2.42
Gov_train	-0.014 0.022	-0.65	0.053** (0.023)	2.30	-0.017 (0.023)	-0.76
Gov_IPR	-0.000 0.045	-0.00	0.025 (0.047)	0.54	0.024 (0.047)	0.51
Gov_Mark	0.095*** 0.028	3.38	0.052* (0.031)	1.68	0.021 (0.031)	0.67
Gov_Export	0.136*** (0.023)	5.81	0.073*** (0.026)	2.82	0.081*** (0.026)	3.04
Training	-0.016 (0.021)	-0.78	0.121*** (0.022)	5.31	0.051** (0.022)	2.30
Software	0.076*** (0.021)	3.62	0.170*** (0.021)	7.79	0.092*** (0.022)	4.20
RD	0.172*** (0.020)	8.34	0.195*** (0.021)	8.96	0.147*** (0.022)	6.59

Design	0.130*** (0.021)	6.16	0.180*** (0.021)	8.23	0.178*** (0.021)	8.28
Acquis	0.043 * (0.024)	1.76	0.098*** (0.025)	3.85	0.078*** (0.024)	3.21

*Note: *** significant at p<0.01; ** significant at p<0.05*

Source: Own

The discussion emphasizes the results of the average treatment effects (ATE) shown in Tables 26, 27, and 28 because they are robust to potential endogeneity and confounding issues. **Answering research question one**, the empirical results indicate that government support for training staff has no significant effect on product innovation and innovative sales in all European countries. Product innovation likely relies on design improvement and marketing analysis, where trained staff might not be sufficient to drive significant changes in developing products. However, government support for training staff positively and significantly affects process innovation. It indicates that trained staff is likely to improve process innovation by 5%. Process innovation often focuses on improving the manufacturing process, where trained staff plays an important role, which has a direct impact on implementing new technologies and development in operation efficiency. In the context of emerging and moderate innovators, government support for training staff is not found to be significant in product, process, and innovative sales.

Answering research question two, government support for market testing has a positive and statistically significant on product innovation by 10% in European countries and 12% in emerging innovator countries. This can be the nature of product innovation. Product innovation needs significant product design improvement to meet market demand. Market testing allows firms to receive feedback from customers, which helps firms improve their products and reduce the risk of negative responses before launching into the market (Calantone et al., 2012). In comparison with product innovation, market testing has a positive and the lowest level of statistically significant impact on process innovation by 5% only in all European countries. This is because process innovation mostly focuses on improving production methods which means enhancing efficiency, quality improvement, and reducing costs (Rammer, 2023) which is less directly influenced by market testing. However, government innovation policies for market testing do not significantly impact firm innovation in moderate innovator countries.

Table 27 Treatment Effect Estimation of Moderate Innovators

	Product Innovation		**Process Innovation**		**Innovative Sales**	
	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z
Procure	0.004 (0.041)	0.11	0.102** (0.043)	2.37	0.105*** (0.042)	2.48
Gov_Regu	-0.094* (0.054)	-1.72	0.006 (0.055)	0.11	-0.032 (0.053)	-0.62
Gov_Train	-0.011 (0.044)	-0.26	0.065 (0.045)	1.43	-0.025 (0.044)	-0.57
Gov_IPR	0.026 (0.104)	0.25	0.059 (0.108)	0.54	-0.058 (0.104)	-0.56
Gov_Mark	0.155 (0.051)	3.04	0.091 (0.059)	1.52	-0.048 (0.058)	-0.82
Gov_Export	0.144*** (0.044)	3.23	0.095* (0.050)	1.90	0.124** (0.051)	2.41
Training	0.029 (0.042)	0.69	0.121*** (0.044)	2.74	0.070* (0.042)	1.66
Software	0.104*** (0.040)	2.57	0.113*** (0.043)	2.63	0.109*** (0.042)	2.56
RD	0.157*** (0.040)	3.90	0.184*** (0.042)	4.34	0.117*** (0.042)	2.73
Design	0.187***	4.66	0.187***	4.42	0.165***	3.96

	(0.040)		(0.042)		(0.041)	
Acquis	0.067 (0.046)	1.46	0.115** (0.048)	2.40	0.137*** (0.044)	3.10

*Note: *** significant at p<0.01; ** significant at p<0.05*

Source: Own

Additionally, **answering research question three**, government policy for supporting the export market has a positive and highly significant impact on firms' product, process innovation, and innovative sales in all European countries and moderate innovators, and has a significant impact only on product innovation in emerging innovators. Government support as a form of export subsidy is likely to assist firms in entering foreign markets and improve their export performance (Julian & Ahmed, 2005). Government support is particularly beneficial for market entry, helping exporters understand market conditions and institutions, especially for new market entrants (Creusen & Lejour, 2013). Exporting increases a firm's innovative activity as well as increases the firm's productivity in the long run (Lin & Tang, 2013). Firms that export tend to spend more on R&D and exporters demonstrate stronger R&D intensity, higher levels of R&D investment, and are more likely to invest in R&D activities (Srhoj et al., 2023).

Answering research question four, the demand-side approach, innovative public procurement has a significant effect on product, process innovation, and innovative sales in European countries and emerging innovators, process innovation, and innovative sales in moderate innovators. This means when firms win government contracts, it will increase firms' product innovation by 4% in all European countries, 9% in emerging innovators, process innovation by 16% in all European countries, 10% in moderate innovators, 17% in emerging innovators, and innovative sales by 15% in all European countries, 10% in moderate innovators and 19% in emerging innovators. These results are consistent with the findings of Czarnitzki et al. (2020) who found that firms winning innovative public procurement contracts enhance their share of turnover with newly released products.

In addition, in **answering research question five**, government regulation negatively and significantly impacts product innovation and innovative sales, not process innovation. When the government imposes the rules that are applied to the market, it decreases the development of new products by 8% in European countries, 9% in moderate innovators, 18% in emerging innovators, and reduces innovative sales by 7% in all European countries, 12% in emerging innovators. Our findings are in line with the previous studies that observed strong

government regulations create a compliance burden for innovators and harm firm innovation (Ciriaci et al., 2019). **Answering research question six**, government support for IPR is not significant in European countries, moderate and emerging innovators.

For control variables, firms' internal training is statistically significant and improves process innovation by 12% in European countries, 12% in moderate innovators, 15% in emerging innovators, and innovative sales by 5% in European countries, 7% in moderate innovators. Acquiring external knowledge, R&D, design development and external acquisition enhances the development of products, processes, and innovative sales respectively in all European countries and moderate innovatiors.

Table 28 Treatment Effect Estimation of Emerging Innovators

	Product Innovation		**Process Innovation**		**Innovative Sales**	
	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z
Procure	0.091** (0.042)	2.18	0.170*** (0.043)	3.92	0.192*** (0.043)	4.46
Gov_Regu	-0.180*** (0.056)	-3.21	-0.068 (0.056)	-1.20	-0.120** (0.053)	-2.25
Gov_Train	0.000 (0.045)	0.02	0.066 (0.047)	1.42	-0.001 (0.047)	-0.03
Gov_IPR	-0.095 (0.095)	-1.00	0.049 (0.095)	0.52	-0.021 (0.095)	-0.23
Gov_Mark	0.123** (0.053)	2.30	0.028 (.061)	0.46	0.079 (0.061)	1.28
Gov_Export	0.141*** (0.046)	3.03	0.050 (0.053)	0.95	0.029 (0.053)	0.55

Training	0.051 (0.042)	1.21	0.145*** (0.044)	3.27	0.046 (0.044)	1.04
Software	0.067* (0.042)	1.60	0.237*** (0.042)	5.54	0.066 (0.044)	1.51
RD	0.230 (0.040)	5.75	0.243*** (0.043)	5.61	0.157*** (0.045)	3.45
Design	0.146*** (0.041)	3.54	0.152*** (0.043)	3.50	0.144*** (0.043)	3.31
Acquis	0.029 (0.051)	0.57	0.077 (0.054)	1.43	0.137 (0.050)	2.70

*Note: *** significant at p<0.01; ** significant at p<0.05*

Source: Own

This chapter presented the results and discussions of analysis for ***objective one and objective two***, explaining how the findings support or contrast with existing literature. The next chapter will present a summary of the dissertation drawn from the findings. It will also outline the practical implication of the research and the student's contributions.

6 Conclusions

6.1 Summary of the thesis

In conclusion, innovation has been recognised as a major factor in economic growth, hence governments are encouraging innovation in both the public and private sectors. In essence, innovation policies play an important role in fostering firm innovation, translating into regional development. In recent years, the public sector has been seen as one of the key actors capable of promoting innovation on the demand side through its public agencies. Demand-side innovation policies focus on increasing the demand for innovative products and services, encouraging firms to innovate to meet market needs (Krieger & Zipperer, 2021). These policies reduce market uncertainties and expand the market size for innovations, providing firms with incentives to invest in research and development (Iizuka & Uchida, 2017). On the other hand, supply-side innovation policies aim to enhance the supply of resources for innovation, such as through tax incentives, subsidies, and grants, which support firms in developing new technologies and processes (Lember et al., 2010). A mix of supply and demand-side policies can also effectively promote firm innovation (Chen & Chen, 2023). Therefore, ***this dissertation thesis aimed to examine to what extent the innovation policy affects the firm innovation, which leads to regional development in emerging, moderate, and strong innovators countries.***

Objective one sought to examine the relationship between demand-side innovation policy (procurement) and firm innovation considering the role of firms' R&D activities. In the research, structural equation modeling was conducted to fulfill the objective. The results showed that demand-side innovation policy does not have any direct significant impact on product and process innovation in Croatia, the Czech Republic, and Norway. However, demand-side innovation policy has a positive and significant effect on firm products, process innovation, and patents mediated by R&D activities in Croatia, the Czech Republic, and Norway. This indicates that demand-side innovation policy (innovative procurement) is likely to motivate firms to invest in R&D. Increasing demand for innovative products and services also creates a market-driven incentive for firms to allocate resources to developing new technologies and products. By increasing demand for innovative products, policies encourage firms to devote greater resources to R&D. Increased R&D investments contribute to increased levels of innovation. In addition, the demand-side innovation policy has no direct impact on patents in Croatia and Norway. In this case, patenting might be costly, especially for smaller firms and demand-side innovation policy is likely to encourage innovation to meet local

demand without the need for patenting for an international market. As a result, policymakers should consider implementing and supporting demand-side policies as viable tools for encouraging corporate innovation.

Additionally, ***objective two sought to explore the causal relationship between innovation policy (supply and demand-side) and firm innovation across various European country groups***. At the first stage of analysis, logistic regression analysis was used because the dependent variable is binary. In the second stage, the treatment effect estimation technique was employed to estimate the causal effects of a treatment on a given outcome of policy interest. The results showed that in a supply-side approach, government policy for supporting training staff programs is positive and significant for process innovation in All EU countries, and improves process innovation in those countries. However, that policy is not significant in moderate and emerging innovators countries. Subsequently, government policy for supporting market testing is significant and enhances product innovation in EU countries and emerging innovators whereas there is no significant level in moderate innovators. Government policy for accessing the export market significantly enhanced product, process, and innovative sales in EU countries and moderate and emerging innovators. In addition, in the demand side approach, innovation public procurement encourages firm innovation in all EU countries, moderate and emerging innovator countries. Surprisingly, government regulation has a significant and negative effect on firm innovation in all analyzed countries. When government regulation is very strict for firms, the innovation level is lower in those countries. At the same time, government policy for protecting IPRs was not found to be significant in all chosen countries.

6.2 Practical implications

Based on the analysis of results, there are practical implications for policymakers and firms for chosen countries (emerging and moderate innovators) as the following:

For policymaker, in emerging innovators like Croatia and the Czech Republic, firstly, policymakers should provide capacity-building such as training programs for procurement authorities to understand more and implement innovative public procurement. Secondly, policymakers in those countries should also invest in capacity-building programs such as training programs, subsidies for technology development, and knowledge-sharing networks for local firms to be able to participate in PPI projects in a way that helps to meet the criteria for PPI projects. Thirdly, policymakers should implement procurement policies that prioritize innovative solutions and make the tendering process accessible for SMEs in reducing

administrative burdens and ensuring transparency to encourage more firms to engage in PPI projects. Moreover, policymakers should set monitoring and evaluation mechanisms to examine the effectiveness of PPI. Strong innovators like Norway have successfully implemented PPI and hence, they should put more effort into focusing on sustainable innovation. Importantly, policymakers from emerging and strong innovators, ought to consider creating frameworks for firms that incentivize patenting through reduced administrative challenges or financial incentives.

Concerning with training program, policymakers should consider revising the training programs by collaborating with firm managers to ensure the provided training programs address the specific skills and knowledge that firms need. Moreover, policymakers should evaluate the effectiveness of the training program and implement new measures to foster innovation within firms. Policymakers should integrate training programs with other forms of support, such as R&D funding, innovation vouchers, and tax incentives, to create a more comprehensive innovation support policy. Regarding IPR, policymakers should reconsider IPR policies, and simplify and make them more accessible to firms, especially SMEs. Policymakers should also add an awareness program about IPR's benefits, and how firms can use them to protect and promote their innovation. In addition, rather than focusing on IPRs as a primary policy tool, policymakers in those countries should expand innovation policy to support R&D subsidies, infrastructure, and skill development. Policymakers should offer incentives for agreements to license or R&D collaborations with foreign or sophisticated domestic enterprises which can spill over the knowledge of technology and enhance local without relying too much on rigid IPR restrictions. Policymakers ought to adopt regulations to reduce unnecessary burdens on firms and implement a more flexible regulatory framework. Importantly, engage more actively with stakeholders, especially firms, to understand the actual impact of regulations and to establish rules that are feasible and promote innovation.

For firms, firms should concentrate on developing R&D capabilities that can meet the criteria of the PPI process. Firms should make sure the training program is strategically integrated with the firm's innovation goals and that the skills developed are directly applicable to the firm's innovation project. Firms should invest in in-house R&D training programs to build internal capacity and should encourage external collaboration such as research institutes and other partners for sharing knowledge and resources in strengthing innovation. Firms should engage with policymakers to highlight the issues faced by current regulations and IPR protection and encourage them to adopt more innovative friendly legislation.

6.3 Student contributions

A) Research contributions

This study contributes to several theoretical approaches. By exploring the impact of innovation policy on firm innovation, this research provides how government innovation policies can directly or indirectly influence firm-level innovation. This study contributes to the science according to the Triple Helix model (Institutonal theories of Regional Development), which focuses on the role of the actor (government) in providing subsidies to create a favourable condition for firm innovation. Moreover, the role of firms' R&D activities described the importance of collaboration between firms and academia to drive innovation across various European countries with different innovation performance. In terms of the system of innovation theory, this research contributes to the importance of internal firm capabilities and their interplay with external policy initiatives, which provides a comprehensive view of all actors and interactions in the innovation system, as a necessary condition for supporting regional development in general.

From the empirical point of view, SEM approach was used to help to better understand effects of innovation policies on regional development in terms of innovation performance of selected European countries. This approach identifies multiple relationships between variables for methodology contribution and examines the direct and indirect effects of innovation policies on firm innovation. It also observes how firm's R&D activities mediate the relationship between innovation policies and innovation output. SEM allows latent and manifest variables in complex models, which allows the researchers to understand the constructs of the model. SEM is important for researchers because they can gain an understanding of complex theoretical models and relationships that are very helpful for social sciences. Simultaneously, policymakers can also benefit from SEM to implement targeted policies that can consider the multidimensional effect of innovation policies on firm behavior and output due to its complex model.

Secondly, logistic regression was performed. This method helps to handle binary outcome variables and indicate the direction and strength of the relationship between each predictor. Researcher can estimate the tendency of firms' engaging in innovation activities and the influence of innovation policies on firm innovation by using logistic regression analysis. Moreover, treatment effect analysis is also important for researchers and policymakers. This analysis technique allows researchers especially medical researchers to understand the causal effect of treatment, for example, evaluating the effectiveness of new drugs. Likewise, it also

helps policymakers to assess the impact of policy intervention, to what extent existing policies are effective, and further implement the new policy interventions. Therefore, all these analyses used in this dissertation thesis help stakeholders in making decisions based on empirical data.

B) Teaching contributions

The author of the dissertation thesis prepared study materials that are in line with the current theoretical approach and practical application used in the dissertation for subjects Spatial Economics and Economic and Financial Aspects of Innovation taught at the Faculty of Economics and Administration of the University of Pardubice. These study materials include slides for lectures, reading lists references, case studies, and practical exercises that can help students grasp the concepts of regional economic disparities, the spatial distribution of resources, theories for regional development, role of innovation and knowledge in economic development. The study materials of theoretical concepts from this dissertation thesis, for example, endogenous growth theory, and agglomeration theory provide the students for an understanding of the spatial distribution of economic activities and factors driving regional growth. Moreover, the theoretical concepts used in the dissertation such as Triple helix, Innovation system theory, Industrial district, and Clusters, explain the importance of innovation, a key driver for regional development. The interaction, collaboration, and proximity between actors bring knowledge spillover effects in enhancing innovation capacity and the development of the local economy. These theoretical concepts from the dissertation provide the students with an understanding of how economic activities are influenced by spatial factors. These materials developed from this dissertation will be used in the creation of textbooks for students, who focus on subjects of Spatial Economics and Economic and Financial Aspects of Innovation.

Overview of the doctoral student's publication activity

A) Journal papers

1. Sein, Y. Y., & Prokop, V. (2021). Mediating role of firm R&D in creating product and process innovation: Empirical evidence from Norway. *Economies*, *9*(2), 56.
2. Gyamfi, S., & Sein, Y. Y. (2021). Determinants of Sustainable Open Innovations—A Firm-Level Capacity Analysis. *Sustainability*, *13*(16), 9088. **IF: 3.9**
3. Kotková Stříteská, M., & Sein, Y. Y. (2021). Performance driven culture in the public sector: The case of Nordic countries. *Administrative Sciences*, *11*(1), 4.
4. Rehman, F. U., Sein, Y. Y., & Dmytrenko, D. (2023). Translating the impact of internal and external factors in achieving sustainable market competitiveness: the mediating role of management practices. *Journal of Competitiveness*, (1). **IF: 7.3**
5. Prokop, V., Gerstlberger, W., Vrabcová, P., Zapletal, D., & Sein, Y. Y. (2023). Does being stricter mean doing better? Different effects of environmental policy stringency on quality of life, green innovation, and international cooperation. *Heliyon*, *9*(5). **IF: 4.0**
6. Sein, Y. Y., & Darfo-Oduro, R. (2024). Analyzing the Impact of R&D Tax Incentive Policy on Firm Innovations in OECD Countries. *Scientific Papers of the University of Pardubice. Series D, Faculty of Economics & Administration*, *32*(1). **IF: 1.0**

B) Conference papers

1. Sein, Y. Y., & Vavra, M. (2020). External Knowledge and Technology Acquisition and Firm Innovation Performance in CEE Countries. In *European Conference on Knowledge Management* (pp. 712-XXIII). Academic Conferences International Limited.
2. Vávra, M., Sein, Y. Y., & Vohralík, G. (2020). Innovation Cooperation as a Crucial Source of Firms' External Knowledge. In *European Conference on Knowledge Management* (pp. 824-XXIII). Academic Conferences International Limited.
3. Sein, Y. Y. (2021). Revealing Employees´ Knowledge Contribution in the Process of Innovation: The case of Latvia and Estonia. In *European Conference on Knowledge Management* (pp. 674-XXIV). Academic Conferences International Limited.
4. Sein, Y. Y., & Prokop, V. (2022). The role of Intellectual Property Rights in Enhancing Regional Development. In *23rd European Conference on Knowledge Management Vol 2*. Academic Conferences and publishing limited.
5. Sein, Y. Y., & Prokop, V. (2023). The Effects of Demand-Side Policy on Firm Innovation: The Mediating Role of R&D Activities. *In ECKM 2023 24th European*

Conference on Knowledge Management Vol 2. Academic Conferences and Publishing Limited.

C) Chapters in books

1. Arthur, E. E., Darfo-Oduro, R. K. A., Gyamfi, S., Sein, Y. Y., Stejskal, J., & Prokop, V. (2022). Tax and Non-tax Policies Towards the Finance of Sustainable Economy: The Mediating Role of Eco-Innovation. In *Asia-Pacific Conference on Economics & Finance* (pp. 181-199). Singapore: Springer Nature Singapore.

D) Submitted papers in the Review process

1. Institutional quality and Economic growth: The mediating role of human capital and innovation within OECD countries (Yee Yee Sein & Fazal Ur Rehman) – International Journal of Innovation Science
2. Assessing the complementarity between internal R&D intensity and R&D tax credit for innovation (Raymond Kwame Adane Darfo-Oduro & Yee Yee Sein) – Journal of the Knowledge Economy

Bibliometric indicators

Scopus: 12 papers, 48 citations, h-index 5

Web of Knowledge: 8 papers, 33 citations, h-index 4

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List of the appendices

Table A 1 Outer loading and Collinearity Validity (VIF) for Product Innovation

Product Innovation							
		Croatia		**Czech Republic**		**Norway**	
Variables		VIF	Outer loading	VIF	Outer loading	VIF	Outer loading
INPDGD	Prod.Inno	1.000	1.000	1.000	1.000	1.000	1.000
PBINCT	DSP	1.000	1.000	1.000	1.000	1.000	1.000
RDSG	R&D Activities	1.864	0.809	2.114	0.808	1.889	0.797
RMAR		1.891	0.802	2.177	0.821	1.869	0.798
RPRE		1.677	0.759	2.387	0.851	1.781	0.780
RRDIN		1.683	0.786	1.698	0.788	1.924	0.822
RTR		1.779	0.777	1.920	0.785	1.963	0.805

Note: Prod Inno = Process Innovation; DSP = Demand-side Policy

Source: Own

Table A 2 Outer loading and Collinearity Validity (VIF) for Process Innovation

Process Innovation							
		Croatia		**Czech Republic**		**Norway**	
Variables		VIF	Outer loading	VIF	Outer loading	VIF	Outer loading
INPSPD	Proce.Inno	1.000	1.000	1.000	1.000	1.000	1.000
PBINCT	DSP	1.000	1.000	1.000	1.000	1.000	1.000
PBINCT		1.507	0.842	1.895	0.875	1.861	0.894
PBINN	DSP	1.507	0.928	1.895	0.953	1.861	0.937
RDSG	R&D Activities	1.864	0.790	2.114	0.796	1.889	0.790
RMAR		1.891	0.800	2.177	0.813	1.869	0.785
RPRE		1.677	0.756	2.387	0.859	1.781	0.789
RRDIN		1.683	0.779	1.698	0.780	1.924	0.820
RTR		1.779	0.808	1.920	0.804	1.963	0.818

Note: Proce Inno = Process Innovation; DSP = Demand-side Policy

Source: Own

Table A 3 Outer loading and Collinearity Validity (VIF) for Patents

Patent							
		Croatia		**Czech Republic**		**Norway**	
Variables		VIF	Outer loading	VIF	Outer loading	VIF	Outer loading
PROPAT	Patent	1.000	1.000	1.000	1.000	1.000	1.000

PBINCT	DSP	1.000	1.000	1.000	1.000	1.000	1.000
RDSG	R&D	1.864	0.805	2.114	0.788	1.889	0.789
RMAR	Activities	1.891	0.809	2.177	0.821	1.869	0.802
RPRE		1.677	0.759	2.387	0.856	1.781	0.789
RRDIN		1.683	0.793	1.698	0.796	1.924	0.821
RTR		1.779	0.765	1.920	0.788	1.963	0.801

Source: Own

Table 29 Regression Analysis of Strong Innovators

	Product Innovation		Process Innovation		Innovative Sales	
	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z
Const	1.229 (0.428)	2.871***	-1.184 (0.381)	-3.103	-1.270 (0.388)	-3.273
Procure	0.251 (0.249)	1.005	0.470 (0.229)	2.045	0.375 (0.236)	1.585
Gov_Regu	-0.433 (0.281)	-1.541	-0.023 (0.258)	-0.089	-0.176 (0.278)	-0.6331
Gov_train	0.167 (0.251)	0.664	0.262 (0.234)	1.118	0.162 (0.246)	0.659
Gov_IPR	-0.459 (0.426)	-1.076	0.041 (0.432)	0.096	0.026 (0.399)	0.066
Gov_Mark	-0.249 (0.357)	-0.699	0.335 (0.343)	0.976	-0.311 (0.339)	-0.918
Gov_Export	0.337 (0.348)	0.970	0.152 (0.284)	0.536	0.090 (0.302)	0.299
Training	-0.933 (0.269)	-3.456***	0.138 (0.247)	0.558	0.244 (0.257)	0.949
Software	0.327 (0.255)	1.283	0.079 (0.240)	0.331	0.059 (0.245)	0.244
RD	0.072 (0.289)	0.249	0.445 (0.255)	1.746*	0.909 (0.279)	3.249***
Design	0.498 (0.286)	1.742*	0.331 (0.253)	1.307	0.410 (0.274)	1.499
Acquis	0.166 (0.263	0.630	0.153 (0.267)	0.575	-0.189 (0.271)	-0.6950
Manuf. Sector	1.361 (0.406)	3.352***	0.415 (0.303)	1.369	-0.301 (0.317)	-0.9522
McFadden R-squared	0.103		0.079		0.083	

Source: Own

Table 30 Regression Analysis of Innovation Leaders

	Product Innovation		Process Innovation		Innovative Sales	
	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z	Coef. (Robust Std.Err)	z
Const	0.467 (0.437)	1.068	-0.668 (0.416)	-1.604	-0.574 (0.404)	-1.419
Procure	0.259 (0.250)	1.037	0.617 (0.238)	2.585***	0.275 (0.223)	1.233
Gov_Regu	0.466 (0.333)	1.400	-0.487 (0.295)	-1.653*	0.049 (0.284)	0.173
Gov_train	0.079 (0.261)	0.304	0.219 (0.265)	0.827	-0.268 (0.243)	-1.104
Gov_IPR	1.042 (0.596)	1.745*	-0.198 (0.469)	-0.423	0.442 (0.449)	0.985
Gov_Mark	0.750 (0.344)	2.181**	-0.219 (0.314)	-0.697	-0.145 (0.301)	-0.482
Gov_Export	0.399 (0.357)	1.117	0.040 (0.314)	0.127	0.621 (0.287)	2.160**
Training	-0.355 (0.261)	-1.358	0.096 (0.251)	0.383	-0.192 (0.243)	-0.791
Software	-0.149 (0.256)	-0.580	0.584 (0.245)	2.382**	0.170 (0.234)	0.729
RD	0.612 (0.281)	2.173**	0.328 (0.261)	0.207	-0.026 (0.246)	-0.107
Design	-0.104 (0.288)	-0.361	0.143 (0.270)	0.527	0.388 (0.253)	1.530
Acquis	0.393 (0.276)	1.424	0.192 (0.270)	0.711	-0.212 (0.258)	-0.820
Manuf. Sector	0.852 (0.336)	2.531**	0.319 (0.293)	1.090	-0.570 (0.273)	-2.085**
McFadden R-squared	0.087		0.081		0.053	

Source: Own