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EFFICIENCY OF THE PUBLIC SECTOR SUPPORT SYSTEMS FOR CREATING INNOVATIVE MILIEU

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In Pardubice, 30.06.2021 Ing. Solomon Gyamfi

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DEDICATION

I dedicate this research thesis to my loving parents, Mr. Stephen O.Y. Barimah and Madam Elizabeth Y. Frimpomaa.

ANNOTATION

The proponents of the innovative milieu concept contend that every support system should create supportive environment. The effects of public policy on R&D activities of the firm, impact of public funding such as subsidies and grants are the creation of the national innovation policy with entrenched public sector support systems. An efficient and successful public policy with support systems both financial and non-financial should meet the efficiency threshold to justify the need for increasing government expenditure in R&D. In lieu of the worsening public finance deficits, most current is the advent of the Covid-19 pandemic outbreak, which has wreaked havoc in the public expenditure and at the same time the pressing motive of concurrent need for innovation to sustain competitiveness of the economies in the world, public support systems should create innovative ecosystems that benefit all economic entities and society at large. However, due to market and government failures, the intended purpose of support is not achieved. Since the public sector play the role as the creator of the enabling environment for firms' innovation activities, support programs and policies should invoke collaborations, leading to firm innovation performance. The aim of the dissertation was in two folds, 1. to explore how SMEs innovative activity fuels the attraction of public support systems in the creation of an innovative environment for SMEs innovation, and 2. to measure how efficient the financial and nonfinancial public support systems and framework conditions facilitate the innovation performance of SMEs in the European Union countries.

KEYWORDS

support systems, innovation, collaboration, social capital, human capital

ANOTACE

Zastánci konceptu inovačního prostředí tvrdí, že každý systém podpory by měl vytvářet podpůrné prostředí. Účinky veřejné politiky na aktivity společnosti v oblasti výzkumu a vývoje, dopad veřejného financování, jako jsou dotace a granty, ústí ve vytvoření národní inovační politiky se zavedenými systémy podpory ze strany veřejného sektoru. Účinná a úspěšná veřejná politika s podpůrnými finančními i nefinančními systémy by měla splňovat prahovou hodnotu účinnosti, aby ospravedlnila potřebu zvýšení vládních výdajů na výzkum a vývoj. Do již tak deficitního financování státu zasáhla akutní potřeba financovat následky pandemie Covid-19, který způsobil nesystematické zásahy v systému veřejných výdajích. Nelze však pominout, že i podpora vzniku inovací pro udržení konkurenceschopnosti ekonomiky si zaslouží pozornost. Systémy veřejné podpory by měly vytvářet inovativní ekosystémy, z nichž budou mít prospěch všechny hospodářské subjekty a společnost jako celek. Z důvodu selhání trhu a vlády však není dosahováno zamýšleného efektu. Vzhledem k tomu, že veřejný sektor hraje roli tvůrce příznivého prostředí pro inovační aktivity firem, měly by podpůrné programy a politiky navazovat na spolupráci vedoucí ke stabilní inovační výkonnosti. Cíl disertační práce je dvojí: zaprvé prozkoumat, jak inovativní činnost malých a středních podniků podporuje přitažlivost systémů veřejné podpory při vytváření inovativního prostředí pro jejich inovace, a zadruhé měřit, jak efektivní jsou finanční a nefinanční systémy veřejné podpory a rámcové podmínky usnadňují inovační výkonnost malých a středních podniků v zemích Evropské unie.

KLÍČOVÁ SLOVA

systémy podpory, inovace, spolupráce, sociální kapitál, lidský kapitál

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LIST OF ABBREVIATIONS

ASEAN	Association of Southeast Asian Nations
AVE	Average Variance Extracted
CCR	Charnes Cooper and Rhodes
CEE	Central and Eastern European countries
CF	Critical Factors
CIS	Community Innovation Survey
CRS	Constant Return to Scale
DEA	Data Envelopment Analysis
DMU	Decision Making Unit
EIS	European Innovation Scoreboard
EU	European Union
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
HTMT	Heterotrait – Monotrait Ratio of Correlations
ICT	Information and Communications Technology
MNE	Multi-National Enterprises
NIS	National Innovation System
OECD	Organization for Economic Co-operation and Development
PLS-SEM	Partial Least Squares Structural Equation Modelling
PPF	Production Possibility Frontier
PSS	Public Support System
R&D	Research and Development
SBIR	Small Business Innovation Research
SME	Small and Medium-size Enterprises
TFP	Total Factor Productivity
US	United State of America
VIF	Variance Inflation Factor
VRS	Variable Return to Scale

INTRODUCTION

Since its introduction decades ago, innovation has become the backbone of economic development of many countries. Key examples are that of the groundbreaking innovation strategies the automobile companies in Japan and Korea created which broke into the world market then heavily dominated by General Motors that help escalate the economic growth of these Asian countries. Hence, there has been a very strong advocate for Public Support Systems to intervene in the economic activities of the national economy after the great depression. Even though there exists a relentless debate over the causes of the greatest economic crisis (Timberlake, 2008) to which the free market has widely been blamed for its role played in the events leading to the crisis, government role in ensuring the efficient and effective economy has since arisen. The fundamental reasons for public sector support for firms' innovative activities are attributable to market failures, which stems from underinvestment in innovative activities and financial constraints. Together with the advent of the new growth theory, further government's interest in supporting and actively engaging in economic growth efforts by actively supporting firms via subsidies, grants and other forms of support has been hailed during the late nineteenth and the twentieth centuries.

In addition, the reason that the public sector must ensure improvement in technology (Czarnitzki, et al. 2011) to provide valuable products and services to the public also stimulates public sector support. Westmore (2013) finds in his investigation of the influence of the public policies on innovation of some selected OECD countries that social rate of return on innovative support exceeds the private rate of return, which propels government conscious effort in supporting innovation activities of the national economy. In recent times, the adoption of the open innovation and specifically the triple helix models have created the avenue for firms to source government assistance, but more importantly, prompted an interactive collaborations among the most important economic agents (Government-Industry-University) in the now knowledge economy. This has entrenched cooperative knowledge creation and sharing for innovative products that provide value for the society, a phenomenon vehemently supported by contemporary innovation and economic growth models such as the endogenous growth theory.

It is in view of these assertions that the importance of the role played by the public sector specifically the government is highlighted to ensuring the interactive environment for the firms in the regional and national innovation domains. Many scholarly researches have

claimed the unending support government being a key participant of collaborative arrangement provide to the shaping of institutional framework.

In the numerous literatures about innovation, support from the government has been touted most as the facilitator of innovation especially firms' R&D expenditure, which may have two key consequences on the firm's activities in research and development. The resulting effect associated with public funding in particular has been observed to create *additionality* and *crowding- out* effects. Additionality in that, the call for public sector financial intervention is because R&D investment is costly therefore, few firms who are financially endowed can invest to profit from the social benefit accruable to the firm, which is minimal in nature. In this case, firms on the hind side looking at the cost will not engage in investment into R&D if financial support is not extended to facilitate such innovative activities. This create additional funds available for the use of firms' innovation research and development activities, which otherwise may create probable inefficiencies of which public financial support through subsidies aim to correct.

Moreover, in the advent of the open innovation and the knowledge-based economy has meant that economic entities desire to collaborate for innovative activities is more dwindled due to the increasing social rate of return on R&D investment hence, subsidies from the government must endeavor to cure all obstacles to collaborate. In other words, public support systems aim is to foster efficient collaborative networking in firms R&D activities and between other institutions such as universities, public and private research centers, which hitherto strengthens the innovation systems and capacity of a nation at the same time, ensuring economic growth and wealth creation for the welfare of the society. Government constant support in R&D activities facilitating collaborative network and human capital (Knowledge creation) and ensuring framework for employment of the human resource in knowledge–intensive activities proves to be not markedly efficient and effective.

1. CONCEPTUAL FRAMEWORK

1.1. Public sector support systems

Public sector support is invariably important for firms to be able to engage in innovative activities as a tool of innovation policy. The effects of public policy on R&D activities of the firm, impact of public funding such as subsidies and grants are resulting national innovation policy with entrenched public sector support systems (Hall & Lerner, 2010; Atkinson, 2015). Policy maker's task is to make stout vow in ensuring effective and efficient support for fostering innovation. For instance, the European Union and many public authorities globally have endeavored to pursue robust and strategic measures geared towards the creation of enabling environment for innovation (Peschl, & Fundneider, 2014; Pelikánová, 2018). In likeness, in the US, states offer the needed support to public colleges and universities to encourage creation of collaboration systems of industry, academia and research institute networks at the local governments (Auerswald & Branscomb, 2003; Shapira & Youtie, 2010).

For improved innovation and productivity in an economy, there must be high introduction and diffusion of innovation (Anderson & Stejskal, 2019). This could be done through the pursuant of increasing innovation capacities of all economic sectors and actors. The innovation systems must build strong knowledge intensive economy and support it growth through the injection of R&D investment. Access to finance and strong support for skills and capabilities of workforce is paramount. Every support system needs to gauge supportive environment Clark et al. (2007) as also contend by the proponents of the triple helix model. Most support systems engineered by the public sector for innovation take the form of financial support (however, in this research dissertation, the term is used broadly to encompass multifaceted roles the government play as the creator of the enabling environment for firms' innovation activities to enhance economic growth and competitiveness).

A typical example within the European Union Competitiveness and Innovation Framework Program is pursued **through financial instruments for market replication** as well as **firm level support for commercial innovation activities**. Additionally, the Enterprise Europe Network openly offers **support services to businesses**. More so, **capacity building for prospective and viable innovators** are all examples of support systems public sector put in place to create the framework environment for innovation. The support system is engrained in the national and regional innovation systems. Smith (2018) underscores the importance of support in his dissertation about fostering innovation in the public sector. In the thesis, organizational innovation ecosystem has three core elements, namely: people, support, and

the environment. Support for innovation creates systems, processes, governance, technology, training, and education, which together with the people strikes the balance for the innovation ecosystem to be effective and efficient. Systems create alliances and cooperation to achieve innovation objective. Public financial support, regulations and all the policy mixes of the government to ensuring innovative environment cannot be overlooked rather effort be made to achieve strong innovative ecosystem that ensures improvement and trust.

1.2. Typology of Public Sector Support for Innovation

The Keynesian theory views market failure as the justification for public intervention in the economy and only if it is geared towards fixing situations in which market fails efficiently to allocate resources (Arrow 1951; Samuelson 1954). In this approach**, government intervention is intended to fix market failures by supporting the market in areas characterized by positive or negative externalities**. Positive externalities may arise from a public non-rivalry and non-excludable goods by which there is under-investment by the private sector in this area, therefore, the market requires public investment to boost the benefit for all in the society. For instance, in the case of basic research for innovation into a cure of some epidemic diseases or basic research for innovation with high spillovers, it becomes difficult for private returns to be appropriated. Hence, basic research is characterized by too little private investment.

According to the Keynesian view, negative externalities of low investment in such areas if the government does not intervene lead to economic crises arising from market failures. On the other hand, most societal challenges come because of negative externalities, which amount to systemic failures such as those created by production or use of goods and services by people for example pollution, climate change, traffic congestion, or antibiotic resistance, for which there is no market in the society. Moreover, the evolutionary economics aim is to understand the processes that links technological innovation, economic growth, and development. Key concepts such as technological paradigms and technological trajectories (Dosi 1982; Nelson and Winter 1982) have intended to reveal the limitation of market forces in providing direction to economic development. The development economists agree with the assertions of the evolutionary theorist on the invisible hand. In addition, has shown the importance of the visible hand of the state (public sector) in industrialization and technological change (Wade, 2004; Amsden, 2001).

The prospect of innovation is more exciting, to which much has been written about. The impact of innovation on economic development cannot be underestimated. More so, in an era

where competition has become keen among firms and nations alike due to the struggle for the world's scarce resources, innovation has been touted as the anchor on which firms and countries can nick a competitive advantage for themselves over their competitors. Over the years, public sector interest in innovation has been emphasized owing to the market failures leading to systemic challenges and economic hardship. Due to the impact, technological innovation has made on economic development of some nations many **campaigns for support of innovation by the public sector has been supported**. Whereas, many researchers have found the need not for the public sector intervention to be made on technological innovation due to crowding out effect, many others have keenly concluded that **public support especially towards knowledge creation** through research and development has been found to **provide additionality effect** for firm's innovation activities. Different support systems are available to firms to access for their innovative activities especially from the public sector.

Numerous Technological innovation programs, which are mostly government-sponsored, have been established decades ago to support national and regional economic competitiveness and growth through the commercialization of new technologies introduced on to the market. There are varieties of policy instruments and programs use to promote technological innovation as outlined by Brown et al, (1995). These include financial incentives, which comprise of grants and low-interest loans or public financial support; regulatory interventions including codes and standards in patency registration and Licenses; expansion of public demand through government procurement programs and information dissemination for instance, technology transfer networks and clearing houses of information on available technologies.

1.2.1. Financial Support for Technological Innovation

It is a conventional knowledge that innovative companies are subject to financial constraints especially SME's. With the accompanying existence of information asymmetry and moral hazard problems, which create a higher cost of financing research and development (R&D) activities for innovation.

In respect of ordinary investment and a lower level of funding, **private external financiers are reluctant to give financial support** or invest funds when the investment is concentrated essentially on intangible assets (Himmelberg & Petersen, 1994; Hall, 2002; Hall and Lerner, 2010). **Efficient public policy must be used to support activities** that are intended either to

stimulate private sector innovation or to meet particular socio-economic objectives such as defence and healthcare through public funding.

Public funds can be used to support basic and applied research in public research organizations, as well as to provide direct government support for commercial research and tax breaks for private sector R&D expenditures. Direct government funding allows public subsidies to be directed towards activities which are thought to offer the highest marginal social returns from research expenditures. Generally, identifying such projects and the suitable contractors to undertake them and the optimal means by which they should be funded require difficult judgements. Evaluating the outcomes from projects is also difficult, both because of the difficulties in estimating the wider social benefits generated from them, and because of the need to establish what the counter-factual would have been in the absence of public funding. Although, the reason for public intervention in technological innovation is as generally accepted to correct market failures (Czarnitzki and Lopes-Bento, 2013), public agencies may have other goals when supporting business R&D. For instance, Huergo et al, (2016) emphasize the **promotion of national champions**; **technological upgrading of declining firms that are of certain importance or traditional industries; or the funding of R&D projects that would not be otherwise carried out**.

From an empirical point of view, Wallsten (2000) analyzing firms on the effects of government-industry R&D programs on private R&D using the case of the small business innovation research (SBIR) program in USA found that, government subsidies crowd out firm-financed research and development expenditure. In a similar research in Israel, Lach, (2002) observes that government subsidies stimulate firm private spending in research and development in small firms, however, was negative for large firms. Similar findings have been provided by studies focusing on the European context such as González et al. (2005) for Spain, Almus & Czarnitzki (2003) and Czarnitzki & Licht (2006) for innovative German firms, Duguet (2003) wrote about French firms' spending on R&D, Clausen (2009) for Norway, and Takalo et al. (2013) analyze Finnish firms. These findings lead to a lack of consensus the effect of public subsidies whether they complement or substitute between private R&D expenditures and public funds (García-Quevedo, 2004; Zúñiga-Vicente et al., 2014).

Nevertheless, recent studies have found public R&D subsidies to stimulate private R&D (Becker, 2015). The implication is that regarding the crowding out of private funds, it can be assumed that all the public financial support is ineffectively being spent when the market

value for the private funds are not being used in tandem or simultaneously. Therefore, Mazzucato (2016) demands public financial support in the economy to provide a more strategic and mission-oriented approach when providing subsidies for firms. Other researchers have also looked at eco-innovation. Constantini et al, (2015) have found environmental policies and subsidies to R&D as the most important drivers of eco-innovation. Less is known in literature about the impact of tax credits than of the impact of public grants. In part, this is because the use of tax credits is harder to monitor. Tax regimes often offer different incentives according to firm size and location as well as amount of investments in research and development (Bronzini and Piselli, 2016). In many countries, tax credits tend to be more generous for smaller firms, whereas direct subsidies are more likely to be received by larger firms (Hall & van Reenen, 2000).

1.2.2. The role of public financial support in creating innovation

Ultimately, government investments and its fund injection do enable firms' innovation success. However, not every public financial support reaps the economic value of innovations. For instance, the Concorde aircraft, which ultimately failed commercially; the discovery of new drugs (of which most attempts fail); and the provision of guaranteed loans to companies which then might go down the tunnel for bankruptcy (Mazzucatom & Semieniuk, 2017) are few example in cases where public financial support is not sacrosanct. Public financial support for innovation has also endured criticism of public financial officers favoring firms with special interests who may be least innovative but those with the best connections to the public funding agencies. Conversely, in light of multiple funding schemes and the aggressive push for firms and regions to commit more expenditure to research to innovate, **public funding support is a very significant means in creating the enabling atmosphere for firm innovation** in the case of countries in the European Union to promote innovation effort for firms' product, process and marketing innovation activities.

Different support Systems are available to firms to source for their innovative activities especially from the public sector. Diverse avenues exist through which the public sector supports firms' innovative activities. They include facilitating cooperation arrangements between firms, and other bodies, Loan from the public banks, tax incentives, grants and direct government funding through policies and projects of the government aimed at stimulating innovation. Such subsidies given to firms have both positive and negative ramifications (Tingvall & Videnord, 2020), i.e. they may complement private financial investment in firms' R&D or block such avenues (crowding-out effect).

This corroborate the findings of Marino et al. (2016) whose further researched into the crowding-out hypothesis revealed evidence of either no additionally or substitution effects between public and private R&D expenditure; though, they found that crowding-out effects appear to be affecting medium-high levels of public subsidies under the R&D tax credit regimes. The underlying reasons for **public sector financial support for firms' innovative activities is attributable to market failure**, which stems from underinvestment in innovative activities and financial constraints. In addition, other reasons are that the public sector must ensure improvement in technology (Czarnitzki et al., 2011) for product and service innovation. More so, to stimulates public financial support that spike R&D, which eventually creates spillovers (Cappelen et al., 2012). Subsidies and financial support in general provide firms with the ability to grow most importantly support for small and medium-size firms to survive and create innovation for national economic growth.

1.2.3. FDI and trade as a means to creating innovation environment

The world economy is characterized by increasing international transfers. Such significant constituents of transfers are that of Foreign Direct Investment (FDI). Even though, the flow of contemporary FDI hinges on the attractiveness of the receiving country or region, such pull factors of FDI mainly comprise of technology availability, research, and development (R&D) and human capital (Iamsiraroj, 2016). Over the years and in most recent open economic systems, FDI constitute an essential means by which national economies, be it developed or underdeveloped extensively develop the economy by going into research and development as well as capital formation. FDI is purported **to induce economic growth in the long run of developing economies** as it provides reliable capital support for productive activities. Public sector role and for that matter, the government has always been **to ensure framework conditions, which seeks to efficiently support the attractiveness of FDI to the national economy**. Higher externalities and spillover effect accrue to the national economies most importantly where these transfers stimulate productivity leading to export opportunities into foreign markets (global market), at the same time expanding the financial resources and economic stability (Alvarado et al., 2017).

The neoclassical and the endogenous growth models profess contrasting views on the effects of FDI and economic growth. In the view of the neoclassical model of economic growth, the long-run economic growth exogenously is triggered by technological advancement and human capital development. De Mello (1997) and Solow (1957) have empirically studied the effect of FDI and its link with economic growth, which technological progress stimulates. The

neoclassical growth theory posits the convergence of global economies due to diminishing capital input returns. This makes FDI effect to be realized in the short term rather than in the long-term economic growth. However, the endogenous growth model developed in disagreement to these assumptions, which the proponents found to be not realistic concerning changes in technology effect on economic advancement. The main proponents (Lucas, 1988; Rebelo, 1991 and Romer, 1986) of the endogenous growth model, which advances the increasing human capital, research and development in science pinpoint the advantages that such capital (knowledge from the human resources) provide for economic growth.

FDI contributes to the transfer of technology and novel ideas onto the national systems of production of the receiving nations (Sokhanvar, 2019). It could also **increase productivity through technological diffusion, positive externalities, and spillover effects of knowledge** (human capital) in the national economy. Likewise, as in the human capital effect on economic growth, the endogenous growth model offers better proposition both direct and endogenous means of explaining FDI-economic growth nexus than the neoclassical growth model. The alternative models such as Nelson and Phelps model has touted the fundamental importance of the availability of absorptive capacity and corroborates the Romer, Rebelo & Lucas assertion of human capital importance in receiving economies. However, economic growth of a country being a product of capital inputs, **comprise of local capital, human capital (knowledge),** FDI as well as critical factors, which include **workforce, institutions, and government policies**.

As such, extant literature has found direct causal relationship between FDI and economic growth (Hansen & Rand, 2006; Iqbal et al., 2010; Sothan, 2017) while others indicate inconclusive and two-directional causality. Moudatsou & Kyrkilis (2011) found for EU countries that economic growth attract FDI but their result established a two-way causality for ASEAN countries in their research using panel data, which corroborate the findings of Zhao & Du (2007) whose result was true but inconclusive. However, Gupta & Singh (2016) found country-specific causality reasons in their research.

Carp (2015) results from the study of FDI and economic growth nexus in selected CEE countries found a unidirectional causality between FDI-GDP with the exception of Hungry, which confirms Szkorupová (2014) findings on Slovakia. More so, Maitah et al. (2014) found both long and short-term causal effects of FDI on employment and economic growth in their panel data from 1993-2011. Significance of FDI is numerous ranging from spillovers as Wang & Wu (2016) found in China about the geographical knowledge spillover from FDI.

However, for FDI to have positive impact on the economic growth of a nation, **absorptive capacity** is a requirement (fig. 1). Otherwise, the relationship of FDI flow to a country may be observed as opportunistic due to the reason that the human capital base of the receiving country is at low point hence, the overall economy will not benefit as found by Casadella & Liu (2019) regarding the FDI inflow to Senegal from China. This corroborates the findings of Liu & Fan (2020) whose analysis of panel data from Provinces in China to estimate technology spillover turning point in enhancing economic growth.

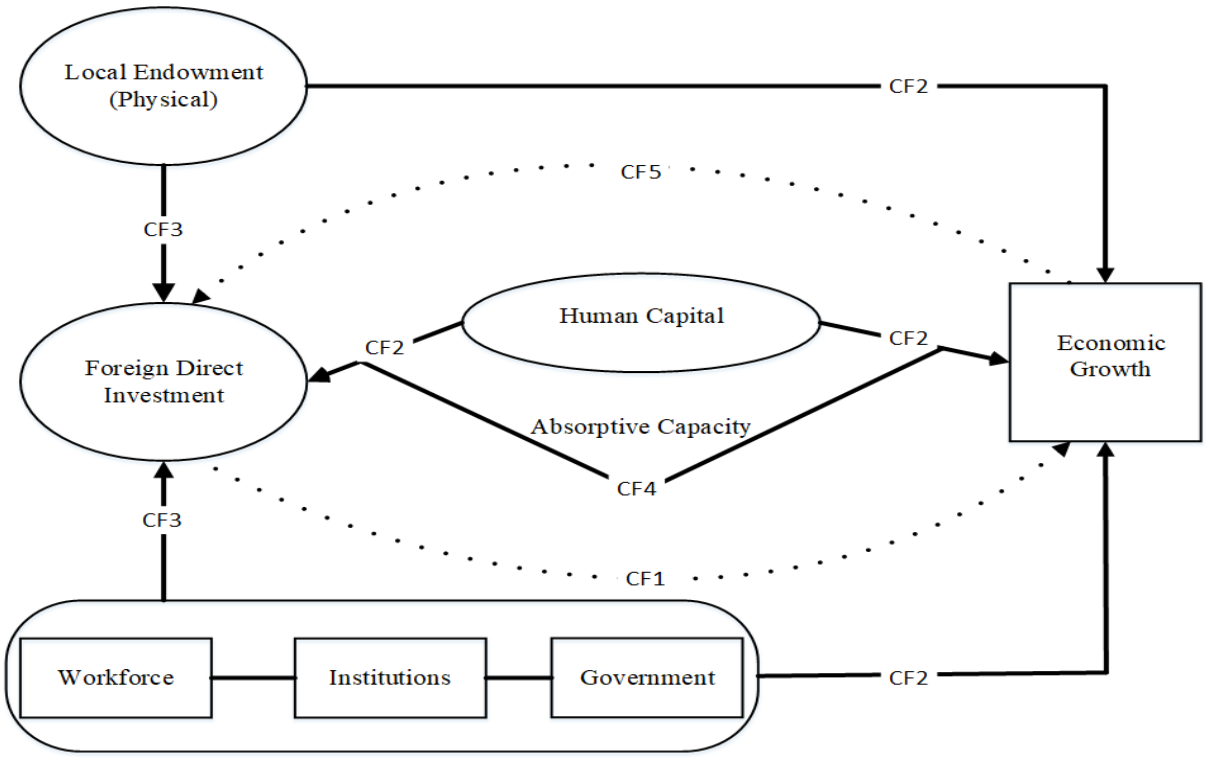

Figure 1 FDI and National Economic Growth Nexus

Source: Adapted from (Lamsiraroj, 2016)

As found in the extant empirical review, this analytical model depicts the linkages between flow of FDI and the **underlying critical factors** (*CF*). FDI inward flow obviously foster economic growth, as found by many of the reviewed literature above marked as *CF1*. The local endowment in addition to the workforce, government policies and institutions constitute the pull factors of international funds as well as directly contributing to economic growth (*CF2*), which are marked *CF3* in the figure. However, to translate the associated technology and knowledge spillovers into economic growth, human capital (*CF2*) availability is critical, as it constitutes the absorptive capacity (*CF4*) required for making use of external knowledge and technology adoption. This leads to the importance of public sector and regional

government support systems to invest in the development of the knowledge base i.e. the human capital development and their utilization. Even though, economic growth does attract FDI, in the reviewed literature on flow of international fund, empirical research has adduced less evidence hence marked at the same level as absorptive capacity.

1.2.4. Public Support through Procurement

Public procurement can be an effort **to supplement the then failing and falling business investment in research and development expenditure** (Edler & Georghiou 2007). Copious literatures have recommended the use of public procurement as a tool in the quest to supplement innovation activities of firms. Aschoff and Sofka (2009) researched on German firms and found heterogeneous effect of public procurement on innovation. Georghiou et al. (2014) addressed the deficiencies of effective public procurement and added that public procurement can also incentivize innovation by being responsive to innovation through the purchase of recent but recognized innovations that are new to the organization.

Uyarra (2010) expressed concern that demand is very specific to local problems and issues may make procurement difficult to access to outsiders effectively deterring potential innovators and reducing the impact of market creation and even the adoption and spillover effects of the innovation. Research of Aschoff & Sofka (2009) pointed out the selective impact that public procurement could potentially be giving the impression the initiatives to utilize public procurement as **a tool to spark private and public sector innovation efforts**. Having found that public demand spurs technological innovation and spillovers when oriented towards innovative products and solutions (Edler & Georghiou 2007), European Commission's Research Investment Action Plan following an European expert group research suggested public procurement to be incorporated as an element in public demand for private innovative goods to raise expenditure to 3% of Barcelona target (Georghiou et al., 2003).

In recent times, empirical evidence has endorsed the essence of public procurement as a policy strategy for the firm and regional innovation. The use of procurement in support of innovation have been backed in respect to European Union by recommendations of a number of inquiries, reports, and policy documents, both at EU (Lember, et al., 2007) and National level (Stern et al., 2011). In Aschoff & Sofka (2009) research on 1,100 innovative firms in Germany, they assess the degree to which innovation sources including public procurement stimulates innovation. They found public procurement to significantly propel innovation. Additionally, the findings revealed public procurement on innovation (as in delivery and technology services) to be more effective in small firms in regions under economic turmoil.

In spite of the pre-established connection of public support and innovation, Uyara & Flanagan (2010) argue that procurements that are undertaken with the sole objective of spurring innovation are likely to fail. This is because **most efforts aimed at utilizing public procurement to generate innovation have not been a concerted or deliberately induced effort** to accelerate the course of innovation rather a by-product of an innocent public procurement effort. He went further to imply public procurement as taking a multi-objective stature with the sole objective of ensuring the quality of government services and the use of product and services in the interest of consumers.

1.2.5. Regulation as a Form of Public Support for Innovation

Regulation is a demand side non-financial public support instrument for technology innovation. It involves according to the European Commission the implementation of rules by public authorities and governmental agencies to affect the behavior of private entities in the economy. Regulations can be classified as economic with policies such as antitrust policy and price control: social for instance, environmental or safety regulation on renewable energy/sustainable development. Alternatively, it may be administrative as in product liability regulations). **Regulation policy** is therefore **an indirect method of affecting innovation** since it **outlines the framework conditions for a firm and no public funds** are used (Geroski 1990). However, it has a **direct effect** on firms since they have to comply with the environmental regulations, quality standards, and so on. Compliance probably causes additional costs for the firm and delays the time to market. Rigorous environmental regulation may induce flows of innovations that enable compliant with the environmental targets by altering relative prices and the profitability of other technologies (Newell, 2010; Porter and van der Linde, 1995).

Additionally, Regulation **constitute a non-selective system** since all firms of an industry in a county are affected. Regulations can have **both positive and negative impacts on innovation**. Positive effects may include protection from liability claims or increased acceptance of new products by consumers and users and negatively as increasing labor and development costs of the firm. Aschoff and Sofka, (2009) state that the most significant regulations for the introduction of new products and services relate to health and safety aspects, the quality of products and services and liability.

Per the above review, public support has been found by many scholars to encompass both positive and negative impact on technological innovation. Bozeman, (2000) has argued that

effect of public sector support on technological transfers could be analyzed from both the market perspective and economic development point of view. Essentially, the effectiveness of any public support for innovation is viewed based on **the success of the supported innovation projects in contributing to the economic development** at both national and regional levels.

One of the topmost advantages of public support for technological innovation is capability building. It encompasses the enhancement in effort at all levels of a firm, to harness new skills and knowledge that are essential in mastering new technology Kruss et al. (2015). Government may use its support systems **to firms to engineer and sustain networks** as the means of bridging the profit motives of the firm and national economic development. Thus, **inducing linkage capabilities between actors in the national system through science and technology links and knowledge exchange with universities, research organizations and other economic entities**. All of these are critical for technological capability building, especially to foster knowledge in the human capital through **support of university basic research** linked through public support with industrial innovative activities. A notion heavily propagated by the triple helix model. In addition, aid firms to acquire complementary resources, mainly skilled employees,

More so, an effective public support on particular sectors arising from an earlier focus on national systems of innovation Lundvall (1992) and Nelson (1993), assert that when public support places emphasis on a particular economic sectors within a systems of innovation with agents carrying out market and nonmarket interactions for the generation, adoption and use of new or established technologies for the creation, production and use of products that pertain to the particular sector, **similar knowledge base is created to inform the productive activities** and are influenced by the same institutional environments, which becomes a necessity for technological development.

However, firms will also be influenced by their previous learning experiences, competences, organizational routines and culture, and opportunity conditions. Therefore, the knowledge base of the sector and accessibility of appropriate technologies may act as both the foundation for and a constraint to innovation and learning. Un-Anique & Montoro-Sanchez found a positive influence of public funding on innovation of service firms that public funding assists firms in acquiring the necessary complementary resources, such as skilled R&D employees, to generate the innovations. However, caution that public funding must be complemented with private funding from other organizations and firms regardless of whether they are

domestic or foreign. The assertion leads us to ponder one the possible disadvantages perhaps that may arise from the public support of firm's technological innovation. It is perceived that government funding may be motivated by a belief that firms face capital market constraints. However, a question can be raised as to what impact the government tax incentives and subsidies has on the capital market itself. Why most government support fail in their intended purpose. Pottelsberghe (2003) and Falk (2004) as quoted in Jaumotte & Pain (2005) found an inverse relationship between R&D tax incentives and private R&D investment expenditure. They found a positive effect of a reduction in government R&D tax incentives on the growth of private sector R&D expenditure. Many analysts have found this situation as a crowding out effect. The intention of most of these support systems are mostly to support an innovative venture which a future prospect of contributing to the economic growth of the nation or region but as said above, the firms mostly substitute the private expenditure on innovative activities for public funds which leads to an eventual fall in investment in the sector. More so, the selectivity nature of public funding of R&D may contribute to the failure or lack of efficiency of some technological project supported. This leads to the conclusion that government support must be targeted more effectively.

1.3. The concept of national and regional innovation systems

Many proponents of the National and Regional Innovation system (hitherto NIS/RIS) contend with increasing collaboration between institutions in the economic structure of the country. This entails in the definition of Lundvall (1992) to search and explore knowledge and its diffusion. Freeman (1987) posits that, NIS consists of the national education and training infrastructure, which enables technology dissemination by the vast availability of human capital for efficient firm innovation activities. In effect, Freeman defined the NIS to be the collaborative and interactive relationship between the actors of the private and public sector institutions that engage in the business of innovation activities. As concisely postulated by Nelson (1993), the NIS's prominent aim is **to foster innovation performance through interactive relationships and networking of economic, social, and institutional bodies**.

In this era of enduring changes in the economic processes of the global world, the importance of the four key elements for NIS as found in Freeman's case study of the Japanese innovation systems are even more relevant now. These elements as Őnday (2016) outlines include the crucial role of policy, which emanates from the public sector; for knowledge creation, dissemination and use into novel creation of technology and innovations, research and development within the national firms and in collaboration with other research institutes both

public and private is essential in all NIS likewise the regional innovation systems. Knowledge creation, dissemination and its use are all dependent implicitly on the base and quality of human capital. Consequently, training and development of capabilities of people enables the creation of absorptive capacity of the national and regional economies for external knowledge and technology diffusion, which is very crucial for economic development (Chaminade & Nielsen, 2011). A notion, critics of the linear model of innovation points out as the missing element of the interpretation of innovation and a shortfall acknowledged by (Balconi et al. 2010) in their paper. In the nutshell, firm agglomeration, and possibility to share and collaborate for innovation performance strengthens the competitiveness of industrial players and the national or regional economies (Porter, 1990). After all, the innovation success of a nation or region is implicitly linked to the national innovation systems.

Regarding the role the public sector or government should play, Lundvall carefully reiterate that **government must enhance firm innovation activities through interventionist approach**, however must take a cautious approach in keeping the balance of the innovation systems (Lundvall, 2010:90) through efficient resources allocation and turning the **dynamic button of the system on**. Accordingly, from a Keynesian point of view, labour force utilization should be the concern of the NIS as the system performance, which can be measured mainly on (…) **the efficiency and effectiveness in producing, diffusion and exploring economically useful knowledge.** In contrast, the innovation system theory underscores the important of interaction in the complex relationships of the NIS actors, a view incorporated from the evolutionary theory.

Institutions assume a key role regarding the system of innovation to make available actors and their linkages or networking smooth for effective operation of the innovation system. This is due to insecurity associated with every economic activity likewise is in innovation activities of the firms. However, the economic systems persist in the dynamic global world through quality of the national institutions. Such routine activities that seek to direct national normative activities in production, distribution and consumption must also be concerned with technological development and diffusion through the innovative activities of scientists, engineers, and technicians (the science base) and overall, knowledge sharing and learning. Institutions command lasting stability hence, due to the ever changing and uncertainty in the world of innovation, institutions should offer guidance for efficient utilization and appropriation of the innovation processes in the national economic activities. Quality

institutions foster national economic systems to trek in a long-term competitiveness whereby firm's innovative capability echoes the quality of the national innovation systems.

The regional innovation system in all likeness to the national innovation systems has gained enormous interest from researchers in recent times (Cooke et al., 1997; Asheim & Isaksen, 2002; McCann & Ortega-Argilés, 2013). This is wholly attributable to the innovation disparities that exist within and across regions of countries (Hudec & Prochádzková, 2015). Whereas proponents of NIS took the view of innovation activities in the country at a macro perspective, the RIS scholars propose rather a microanalysis of innovation with keen interest in the regions. This is mainly because knowledge and its flow are a key determinant of innovation. The RIS perspective on innovation system points out that if knowledge and information flows enhance innovation activities in the region then, it is at that level where there exist mutual understanding and collective learning (Lorenzen, 1998; Camagni & Capello 2017). In the regional context, **proximity is valuable for mutual relationships between economic actors** with shared norms (Boschma & Frenken, 2018) to share tacit knowledge. Therefore, the RIS is akin to the NIS as a sub-system structure to effectively deal with the innovation processes of a nation (Ponsiglione et al. 2018).

1.4. The role of government /public sector in the national innovation system

The public sector cannot be oblivious in this era of massive technological advancement and enormous knowledge and information flow due to globalization. Technology and abundant knowledge stock have enabled firms to make new inventions and modernized ways of doing things, which has become the order of the day. Thus, innovation has become a key element in the current knowledge economies in all spheres of the world's economy. This therefore bestows on policy makers the obligation to make it a matter of **public policy to ensure better conditions for innovation activities of firms**. To scrutinize the role of the government in the NIS is to analyze it in **the perspective of the triangle of innovation success**. In that way, it could be easier to conceptualize these critical roles the government play and those factors, which foster innovation within a national economy. Atkinson (2014) contends looking at the NIS of the United State of America that the triangle of innovation success entails a business environment factors; trade, tax and regulatory environment coupled with the innovation policy environment. Hence, the critical role public sector play is to marshal these three pillars effectively and efficiently for a national innovation success as shown below.

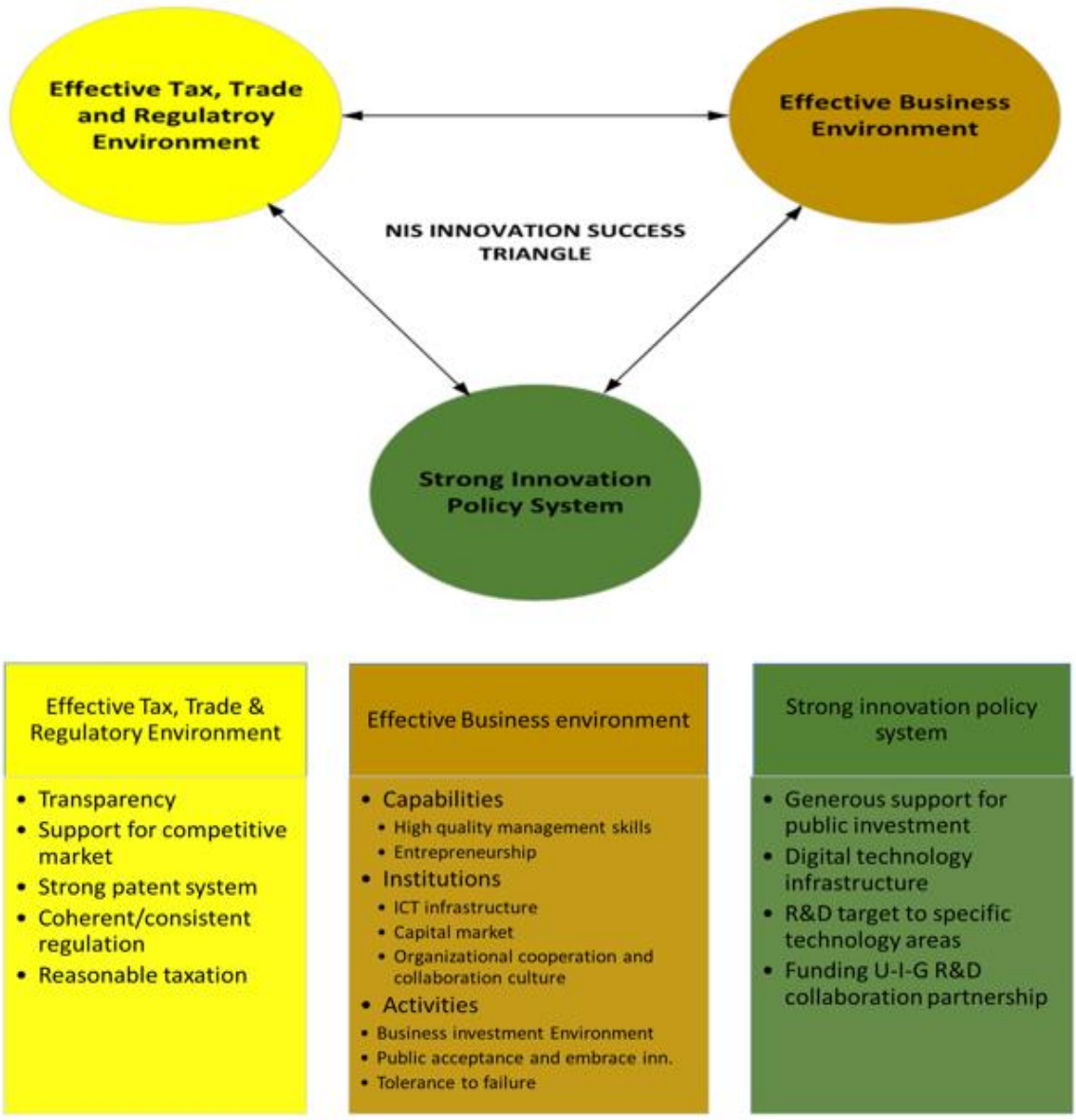

Figure 2 Factors for NIS innovation Success Triangle

Source: author's own based on (Atkinson, 2014)

From figure 2, the success of the NIS is dependent on the tripartite interaction of the factors outlined by the figure. A strong innovation policy system has to be in place, which is associated with public investment and benevolent support that seeks to target R&D of firms in a specific technological area. At the same time, ensuring that funds are available to collaborative partnerships within the triple helix agents. More so, a strong digital technology infrastructure must be in place to support the innovation activities within the national innovation systems. These become the kingpin of the other factors such as the creation of an effective business environment. This super structure factors consist of **institutions,**

capabilities and activities of national systems' business community and the overall cultural outlook.

Many important factors include robust ICT adoption, active capital market, organizational cooperation, and collaborative culture. This constitute the institutional behavior of the business community and their capabilities such as high-quality management skills and entrepreneurship. These lead to business environment full of investments opportunities where the public accept and embrace innovation with tolerance to failure. Similarly, **taxation, trade and regulatory environment** of the NIS must be effective in that; there will be **transparency, coherent and consistent regulation** to support the competitive market and availability of strong patent systems. The balance of all of these factors outlined surely leads to achieving a successful national system of innovation. The public sector's role is therefore to enact innovation policy regimes to hold these factors in balance through all the public support systems.

1.5. The innovative milieux concept

Innovative Milieu emphasizes the social and economic interactive relationships as well as networks of actors within a spatially defined area serving as a catalyst for innovation (Maennig, 2010). This concept was first introduced in the 1980's by GREMI (Groupe de Recherche European Sur les Milieu), a European Research group which Crevoisier (2004) argues that it is one of the outcomes of economist and other social scientists attempt to model economic problems using a territorial approach. Proulx (1992) highlights the economic importance of small and medium-sized firms as a catalyst for job creation in most western countries to be one of the reasons, which informed the development of the innovative milieu concept. It sought for those factors influencing **the inception, location, and growth of these SME's** as a determinant for regional development.

Following this, several definitions have been offered (Lawson, 1997; Camagni, 1991 and Camagni (2000) cited in Maening (2010)). The most frequently used definition is that of Camagni (1991). Camagni describes innovative milieu as the set, or the complex network of mainly informal social relationships on a limited geographical area, often determining a specific external 'image' and a specific internal 'representation' and sense of belonging, which enhance the local innovative capability through synergetic and collective learning processes.

This means that when universities, research laboratories, public support institutions and firms, are combined within a special regional framework, through efficient inter-organizational interaction and co-ordination in an informal setting, positive regional outcomes could spark for instance, the emergence of large numbers of innovating enterprises in the region (Fromhold-Eisebit, 2004). Additionally, Maillat (1998), Ratti (2019) and Proulx (1992: 149) agree on a common definition of an innovative milieu as a **grouping of elements of social, economic, political, and cultural characteristics occurring within a specific shared geographic context.**

Fromhold-Eisebit (2004) has identified three sets of essentials of innovative milieus, namely

- effective actor relationships within a regional framework
- social contacts that enhance learning processes
- image and sense of belonging. Just like the triple helix concept, there is the flow of information and cooperation between key actors in an endogenous setting, which give actors the sense of informal personal contact.

Due to the closeness of the actors in the innovative milieu, members **enjoy social interaction through personal and physical interaction in the same region** (Aula & Harmaakorpi, 2008; Cherkasova et al., 2013). Also, **learning and knowledge sharing is facilitated** as a result of social contacts, know-how exchange as well as enhanced mutual trust occur which reduce uncertainty and induce constant learning and innovation. However, establishing mutual social contacts is a gradual process (Rosch, 1998 cited in Fromhold-Eisebit, 2004), which takes good time to be realized. Consequently, Regional policies and programs do not always achieve proactive milieu but the trust essential to innovative milieus need to grow by itself, which may be considered as a time-related phenomenon.

Additionally, **the third milieu element** indicates **a sense of belongingness among actors of regional innovative milieu** who then turn to project the image of the region and carries a common regional identity with a clear unity among the group of actors in an economically successful region. Fromhold-Eisebit (2004) indicates that it is a form of regional marketing portraying collective image to the outside to induce competitiveness of the region. The shared sense of belongingness creates harmony and unity, which in the end trigger innovativeness among actors in the milieu from different sectors and organization to share their individual knowledge. Furthermore, the underlying factor, which serves as a motivating force for creating innovative milieu, is the shared objectives of regional development.

The regional innovation systems view the firm as being part of an innovative environment of networked entities. It seeks to analyze the various relationships there is between firms and other several institutions in the regional economic space (McKelvey, 2016). Firms seek innovation spaces to develop capabilities and enjoy the appropriation of knowledge for economic gains. The systems of innovation therefore have the fundamental obligation to make available **network infrastructures, science and technology, institutions, and human capital**. This is what evolutionary economics term as system innovation processes at the micro (firm) level innovation process. The firm inadvertently has **three functional spaces**, i.e.

- production space:
- the market space and
- the support spaces linked to the macro processes of innovation.

Firms normally do look beyond their industrial environment to the external environment for support and empowerment. Such innovation processes lead to relationship building within the support space. For instance, with regard to factors of production, firms create collaborative relations with the choice of location for economic activities. Likewise, within the industry, strategic partnerships occur between the firm and other partnerships such as suppliers or clients (customers) and most importantly, relations occur among agents that belong to the territorial environment of the firm (Russell & Smorodinskaya, 2018). In this case, the innovation capacity of the collaborating firms from the milieu is dependent on the learning capacity of the actors.

1.5.1. Innovation, new technologies and the local environment

The industrial environment of the local and regional economic activities is boosted because of dynamic novel technologies, which creates concentration of economic activities in a region. To be able to analyze this phenomenon, Aydalot and Keeble (2018) posit **three approaches** such that, one must observe **the enterprises' choices of location** for economic activities and **associated new technologies** that come in conjunction with the firms and their resulting **impact on the socioeconomic development** of the region. At the same time, it is imperative to assess the local environmental situation to distinguish between the regional innovative milieu that effectively and efficiently supports the creation and dissemination of technological innovation.

Effectively, Aydalot & Keeble (2018) point to the fact that the innovative environment of every region is a determining factor to which firms' technological innovation depends. It can be classified as the hatching grounds for innovative firms and enterprises. For instance, key examples of such factors include industrial inputs and linkages, accessibility of qualified human resource to be employed in knowledge-intensive economic activities as well as availability of technological know-how, which goes a long way to determining the space for national and regional innovative activities. The importance of the innovative milieu cannot therefore be overemphasized such that the existing collaborative network in a region help to appreciate the dynamics of technological innovation. To this, the innovative milieu should support the innovation activities of firms' cooperation and human capital (knowledge) generation as a catalyst for ensuring innovation leading to regional economic growth.

1.5.2. Cooperation, collaborative networks, and the triple/quadruple helix model

The network systems profess collaboration in the open innovation model. Cooperation in the modern day aims to create knowledge and its appropriation thereof. Open innovation paradigm has changed the reliance of firm internal innovation activities through R&D as invaluable to enhance collaboration networks of different entities for mutual benefit for all (Inauen, & Schenker-Wicki, 2011). Open innovation offers improvement to firm innovativeness through sourcing of knowledge and technology from outside of the firm such as customers and suppliers (Gassmann et al. 2010). In this way, firms are able to create value for customers while maintaining flexibility. This has been due to the changing innovation environment because of globalization where access to knowledge and technology have seen free flow and sharing between international collaborators and many other reasons.

Cooperation and collaboration networks are thence important characteristics of the open innovation model. It is in this preceding view the triple helix model is imperative for the success of the national innovation systems touted as the backbone for economic growth of nations in the modern knowledge economy. One can on the analytical review considers the seemingly similarity of the open innovation model and the triple helix mainly due to the overarching idea of coordinating innovation activities of the economic actors into the public space research and development (Leydesdorff & Ivanova, 2016). Leydesdorff & Ivanova further posit that the triple helix seeks the knowledge infrastructure of the social relations between the actors and considers policy coordination, which seeks to improve the innovation eco-systems. This knowledge infrastructure engineers the creation of knowledge and its diffusion, which must be managed by the government or public sector authorities. In effect,

(Ivanova & Leydesdorff, 2014) consider the functions of the agents of the triple helices. They constitute:

- the academic knowledge production through science and technology
- the goal of the business or industry to create enormous wealth through employment and taxes paid to government and shareholder dividends: and lastly,
- the function performs by the government seemingly control the social relations through rules and regulations as shown in the figure below.

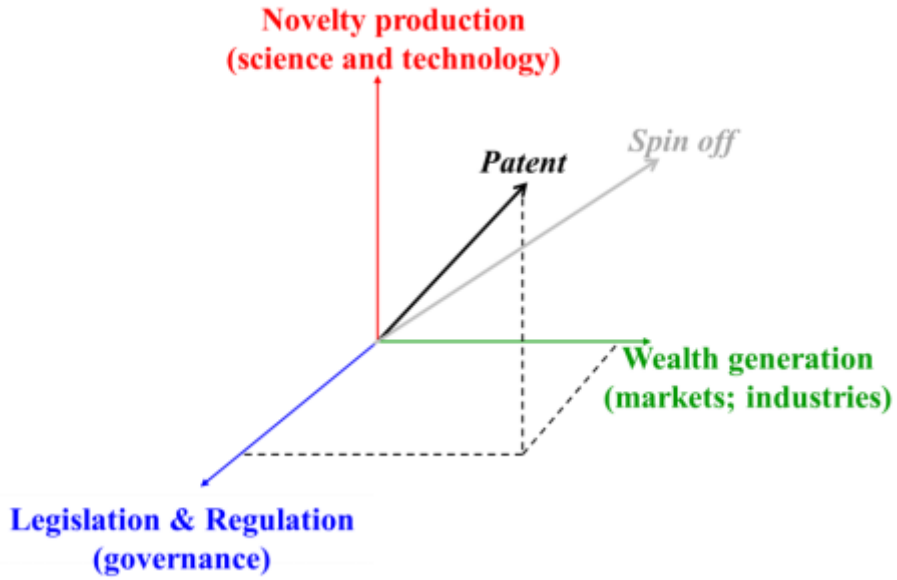

Figure 3 The three functions of the triple helix agents

Source: Adapted from (Ivanova & Leydesdorff, 2014)

These regulations and legislations are not entirely controls instituted by the government, rather are support systems, which focus on creating conducive environment for the collaborative knowledge production and dissemination for innovation, with the eventual aim of fostering economic growth and wealth creation.

1.6. Human capital as the backbone of innovation and economic development

Endogenous theory of economic growth has extensively discussed the importance of human capital and its associated role in ensuring economic development of countries. Schultz and Becker theorized the concept of human capital as introduced in the early 1960s. To them, the judicious use of the innate faculties and acquired knowledge, skills as well as motivations of people contribute to increase in essence, the growth of firms and economic development of countries as well (Becker 2009). Simkina (2000) extended Schultz and Becker's notion of human capital to encompass the availability of values that are inherent and caused by specific

investments and other consumer expenditures. In Simkina's view, it is difficult to achieve economic success without using social and moral factors represented by a person, the intellectual potential and level of knowledge, classification, and practical skills, as well as motivational mechanism. Hence, in order for countries to achieve desired economic expansion, training and development of people cannot be underestimated (Cherkesova et al., 2016).

The human capital of every nation comprises the intrinsic value; culture, health, knowledge, abilities, and skills employed for the execution of economic activities of countries. To Kuznets (1955), the main stock of economically advanced countries is the body of knowledge available within the economic system including the strong social infrastructure in regard to proper institutional arrangements and its functioning as well as adequate physical infrastructure. A strand of researches have reviewed the changing contributing factors of economic development from the beginning of the financial liberalization which accompanied by massive flow of international capital in the form of aid and grants to less developed countries which has since been seemingly fading away with the resurgence of Foreign Direct Investment (FDI). Hall and Jones (1999) concur that those countries with the above-mentioned infrastructural development do attract FDI's. An intriguing side of how countries' economic development has introduced another and essential link, institutions which researchers claim matter more than the endowment of a state in the form of human and physical resource as well as technology transfer for economic development (Rodriguez-pose, 2013). If institutions do matter in economic development of countries, then it is imperative for the human capital of every nation to be developed to shape those institutions set up to oversee the economic growth and development of countries, after all, institutions in and of themselves are made up of people.

1.6.1. Human capital and economic growth theories

Many growth theories stipulate the capacity and training of people to use knowledge effectively hence, the noticeable differences in economic growth of different countries. Among the models created to analyze economic growth, Neoclassical and Endogenous models stand out. Neoclassical and endogenous models can be distinguished based on the postulations made in regard to technology production factor and the role human capital plays in the growth of the economy. Even though, technology is viewed as the most important determinant of economic growth in all models, the early neoclassical models of growth with its exogenous dynamics for the economic systems considered technology exogenous.

However, during the recent periods of the development of growth theory, technological change has been connected to the behavioral characteristics of consumers and producers, which then became endogenous to the economy. That is, it was used as an endogenous production factor in the same vein as human capital. Lukianchikova (2011) sums up the human capital as a system of efficient competences of employees, namely the aggregation of their knowledge, practical skills, creativeness and behavioral peculiarities, which an individual deploy when fulfilling job and strategic tasks, and contribute to innovational activity, development of moral values of the company or nation alike, and its organization along with societal culture.

In this view, the role of human capital in the production process may be quite complex, there is a sense in which we can think of it as epitomized by a unidimensional object, such as the stock of knowledge or skills and this stock is directly part of the production function. In the same vein, Gardener (1986) warned we should not think of human capital as unidimensional, since there are many types of skills. In this regard, the approach underscores the notion of mental and physical abilities as different skills. Perhaps, in relatively similar view of those above, Schultz or Nelson-Phelps explain human capital as mostly the capacity to adapt. Accordingly, human capital is especially useful in dealing with different situations, or more generally, with circumstances in which there is a changing environment, and adaptation becomes non-negotiable. Qualified as well as inspired workers can support strategic plans of firms and countries alike in notching a niche by increasing productivity. This eventually may contribute to economic growth (Škare & Lacmanović, 2015). In the end, the rate of economic growth, as measured by the gross domestic product (GDP), depends on the growth rate of total factor productivity (TFP), which underscores the rate of technological progress, high stock of intellectual capital in the form of employee education and development.

- **The neoclassical growth theory view on technological innovation**

The neoclassical growth theory of Solow (1956) and Swan (1956) assume the rate of technological progress as a scientific process that is separate from, and independent of, economic forces. Neoclassical theory thus implies that economists can take the long-run growth rate as given exogenously from outside the economic system. Endogenous growth theory challenges this neoclassical view by proposing channels through which the rate of technological progress, and hence the long-run rate of economic growth, can be influenced by economic factors. Human capital is a key example here in determining those economic factors necessary for economic growth and development. Technological progress through innovations

spur economic growth, in the form of new products, processes and markets, many of which are the result of economic activities. For example, because firms learn from experiences how to produce more efficiently, a higher pace of economic activity can raise the pace of process innovation by giving firms more production experience.

In addition, because many innovations result from R&D expenditures undertaken by firms, economic policies with respect to trade, competition, education, taxes and intellectual property can influence the rate of innovation by **affecting the private costs and benefits of doing R&D** all of it geared towards economic growth. Aghion and Howitt (1992) made the provisional classification of models studying the influence of human capital on growth. They distinguished the two approaches in growth modeling as that, in the neoclassical model approach of Lucas (1988). Based on the human capital theory of Becker, the idea that growth was chiefly determined by human capital accumulation and the cross-country differences in growth rates could be explained by the variations in the rates of human capital accumulation. This approach has since expanded the set of production factors in the macroeconomic production function of Solow classified under the neoclassical approach. It encompasses the theoretical and empirical models of Lucas (1988), Mankiw et al (1992) and so on.

- **The Endogenous models approach to technological innovation**

On the contrary, the Endogenous models approach introduced by Romer (1990), based on the theory of Nelson and Phelps (1966) on technological diffusion adopted the idea that the engine of growth is the human capital stock which determines the ability of economies to develop technologically which thus ushered in the technological progress approach. This group of models analyze **the relationship between total factor productivity that is, technological development in a given economy and the average level of human capital**. Major endogenous models of human capital influence on economic growth are those of (Romer, 1990; Benhabib & Spiegel, 1994; de la Croix, 2002). Within the endogenous growth literature, Aghion and Howitt (1992) distinguish two views about the influence of human capital on the growth rate of output, the Nelson-Phelps approach, and the Lucas (1988) approach. In the Nelson-Phelps approach as adopted by Romer (1990), Aghion, & Howitt (1992) amongst others, human capital is necessary for the discovery of new technologies, through Research and Development.

As a result, the growth rate of output depends on the level of human capital. In the Lucas approach, human capital is an input just like technology and physical capital. Therefore, the

rate of growth of output is dependent on the growth rate of human capital. Aghion et al (ibid) suggest that the difference between the rates of growth of output is dependent upon the growth rate of human capital. They further posit that it provides the early testable prediction of the Nelson-Phelps approach. The conclusions of the resultant model are remarkably similar to the standard Solow-Swan model adjusted to allow for economies of scale. Hence, the essential idea is that it becomes increasingly hard to make new discoveries as the stock of existing knowledge increases. Nevertheless, since innovation has proved repeatedly to be the vehicle for economic growth and development, it becomes a no brainer to why human capital development is paramount in the quest for economic development.

1.6.2. Human capital and economic growth nexus in the open knowledge economy

The level of the human capital development is a key indicator of state competitiveness (Cherkesova et al., 2016). The human capital theory under the present dispensation has turned to special and novel scrutiny from its system approach to a more competence building perspective as well as managing such competences strategically. Competences has become imperative in the contemporary management of employees where the firm and country strategize to combine knowledge, skills, abilities, motivation, and cultural values of human resource with strategic tasks of propelling growth and development of economies. One must not lose sight of the fact that availability of competences is not simply about the level of knowledge and abilities; however, it includes the efficiency of the competences use in specific operational processes. Competences are the basis of the corporate culture nowadays per the integrated behavioral models of employees. Managing competences is the business of strategic personnel management where the human capital is valued as a rare resource for the nation's competitiveness. The reproduction of the human capital is an endless process repeatedly to impart knowledge, creativity, and other forms of human capital.

This is ensured through the support, acquisition, and reproduction of intellectual potential of personnel to increase profits and be gratified denoting personnel human capital. More so, the basis for human capital of the organization is captured by the growth of profit and competitiveness of the firm largely the national economy. The national human capital in similar vein consists of the increase in the economic growth in the country and at the global level; global human capital involves the global economic progress. Kucheruk (2013) view the reproduction of the human capital in the current knowledge economy as the intellectual trajectory of development that takes place in the context of globalization and post-industrial tendencies.

In that, there exist a form of economic relations between the participants in a scientific operational process involving the production of new knowledge to make profit. Such intellectual development involves the educational and scientific institutes which Cherkesova et al., (2016) refer to human capital (knowledge) produced by these institutions as *competitiveness acquirer*. The availability of purposeful policy of social and economic development with the implementation of the required structural reforms in education can trigger economic growth. The foundational component that defines competitiveness of the human capital includes investments that is continuous and efficient in nature to ensure full potential of the human capital.

1.6.3. Human resources (capital) in science and technology

Throughout the review, terms such as absorptive capacity and human capital has been professed quite often. The humans possessing both tacit and coded knowledge according to the resource-based view constitute valuable and unique assets of which competitive advantage could be achieved. According to the Canberra Manual (OECD, 1995), human resources in science and technology are the workforce or individuals who have successfully completed education at the tertiary level in Science and Technology program and are employed in science related jobs, thus the special skilled labour force. Stock and inflow of HRST according to the report depicts the potential of the nation who's utilized well its pool of HRST's knowledge and have devolved policies to create needed and future pool, which implies the technological knowledge base. Most human resource quality measures deploy some indicators as follows: qualifications and skills of the population, participation in education, expenditure on education, human resources for the development of technology and knowledge intensive industries.

The stock of workforce and flow of human resources who are engaged in science and technology contribute immensely to the successes of national and regional innovation systems as well as the research and innovation intensity are predicate on economic growth. Hunady et al. (2017) researched on the linkages between human resources in science and technology and regional economic development within the EU and found a significant positive effect of the share of employees in science and technology on regional GDP per capita. Balcerzak (2016) also found that within the EU, there exist divergence among the European economies regarding their quality of human capital that policy to enhance training and development of the CEE countries saw improvement in the human capital quality. It is important to invest in the quality of human resource base of a nation for a sustainable competitive advantage in the

global knowledge-based economies. The internationalization of the labour market for HRST may cause imbalance between the supply and demand of human resources depending on various demographic changes in the world. In Japan, Inoue & Koshiba (2019) highlighted the important need for the local government to support human resources in development to facilitate entrepreneurship for rural innovation.

1.6.4. Fostering employment of human capital in knowledge intensive activities

As hinted and discussed above, human capital is a key determinant of economic growth as is mostly included in the numerous analysis of economic growth determinants recognized by the Neoclassical and endogenous growth theory together with international trade, consumption from the government, institutions and so on (Faggian & McCann, 2006; Teixeira & Queirós, 2016). In particular, Faggian & McCann's use of simultaneous equation model on the relationship between interregional human capital knowledge flows and regional knowledge assets in UK found the purported spillover between universities and regional innovation to be rather minimal. Such that, we observed the principal role of the University for providing qualified and skilled undergraduate workforce into a region but the flow of highly qualified human capital from other regions were imperative for regional learning and innovation. Since there has been a general acceptance for high quality human capital in knowledge intensive activities, the public sector through policies and law ensure the employability of this human capital. The commitment of the creation of the framework condition such as, that of the Europe 2020 strategy that is coveted to a Financial Framework (2014-2020) supports considerable increase in the member states' budget allocation to invest in education, research, and innovation. The goal is to help provide highly skilled human capital, but also must be geared towards job creation, economic growth, and prosperity. More so, when investment in human capital is done mainly through financial support of the education sector not in technology and knowledge- intensive activities, which seeks to generate economic value, Teixeira & Queirós, (2016) argue that desired economic growth cannot be achieved. Rather, focus support on the matching of highly skilled labour force to those economic activities they qualify to undertake, which will spur productivity and ultimately economic growth and societal wealth creation.

1.7. Importance of location and spatial distribution of economic activities

Analysis of the location of economic activities is a very intricate task in order to scan the pull factors. Due to the desire of firms to minimize fixed production and transportation cost, firms tend to locate their production activities near to the market and the sources of production

inputs. That is why Krugman (1991) sees the spatial concentration of the production of firms as the underpinning assumption or characteristic of the geography of economic activities. The firm considers the characteristics of a region before it moves into that particular location. In that, **the firm takes the decision to locate in a small or large region owning to the consumption characteristics of the area as well as production and distribution of services. More importantly, the question of the environmental conduciveness and public support systems are considered**. With the advent of innovation and inventions and their appropriation thereafter has shifted emphasis then to what systems best suit the innovation activities of firms.

This approach advocates for systems in the environment (Milieu) to serve as the enabler for firms to undertake technological innovation, which contributes to the national and regional economic growth in the end (Edler & Fagerberg 2017). Location and distance have been the main emphasis of spatial economics. Prevailing assumption of location theories seek to explain the distribution of economic activities in space against the backdrop of identifying the factors that influence the location of separate activities regarding territorial differences in the type of production and spatial market Capello (2011). The role of transportation costs across distance from hinterlands to the city center has been the determining factor for the locations of different agricultural land uses. This was the general idea espoused by Thunen (1842) over two centuries ago. The productive value of Land has been determined by combining distance costs of land use on a heterogeneous land (Albers, 2013). The assumptions of the hoteling model and Thunen has formed the basis for most of the recent spatial economics analysis to ascertain the strategic considerations of firms in deciding on a location for their economic activities.

1.7.1. Models of spatial distribution of economic activities

A critical look at these two models offers the structure for the economic analysis of location decisions within the framework of two-dimensional outcomes Albers (2013). Nevertheless, current analysis has resulted to a one-dimensional approach, which fail to consider the important steps in defining the many points on the location decision of firms in a spatial distance. The dichotomy of spatial heterogeneity in spatial economic analyses depict the two dimensions implicit and explicit spatial framework. Where the relationship between the two regions comes from flows or constraints that do not rely on the distance between, or configuration of the regions, the dimension is said to be implicitly spatial. Thus, when site-specific characteristics determine decisions on each individual location, variation, or

heterogeneity across space leads to spatial patterns that reflect this underlying heterogeneity without reflecting spatial processes or relationships. On the other hand, when processes, values, decisions, or constraints depend on the configuration and distance between patches, the relationship is explicitly spatial.

Other contributors to the theoretical background for the analysis in spatial economics include Weber‘s (1909) triangular diagrammatic presentation of input and output points, which illustrate how new firms can minimize cost with regard to resource inputs and product outputs to be transported to the market. Which must secure an optimal location for the new firm in order to minimize cost. In addition, remarkable contribution of the spatial concentration of economic activity is by the work of Marshall who believes that a key factor for city formation is because of agglomeration externalities or benefits such that better information and skills, trade growth, specialized equipment, and availability of skilled labor are enjoyed by firms, which agglomerate Marshall (1925). An astute contribution to the spatial concentration of economic activity is the central place theory Christaller (1933) and Lösch (1954). The basic tenets of the theory are that the location of economic activity is subject to **agglomeration advantages** reechoing the ideas of Marshall. Due to this, there is an uneven spread of economic activities leading to firms clustering in a geographical area.

More so, Krugman (1991) saw concentration as the most striking feature of spatial distribution of economic activities. However, Audretsch et al. (2005) argue that recent findings regarding the factors, which determines the spatial distribution of economic activities, have reechoed that of the classic characteristics identified in recent regional studies. More so, the impact of geographic characteristics on choice of location of firms have been found to be neutral by many studies. All these theoretical dispositions have maintained the continuous importance of geographical characteristic of a location. Regional characteristics are shaped by regional policies of the public sector. Therefore, it fits well for one to ask to what extent the public sector can influence economic activities of a region.

Since the decisions about firm location choices are strategic decisions of the top management, which is influenced by availability of human capital, and research (Audretsch et al., 2005), the question then again is to find out how the **public sector induces training of human resources** of the region or country to attract firms. More so, to create the needed atmosphere and support for research, which creates local knowledge and regional, capabilities inured to the benefit of firms. Thus, firms with the strategy to locate close to University may do so due

to the existence and geographic distribution of university spillovers and the impact of location on the entrepreneurial choice to start and sustain a new firm around the area.

In analyzing space and agglomeration, three main theories (traditional trade theory, economic geography, urban and spatial economics) form the theoretical background for most empirical researches in this field. There exist forces, which determines the location of concentrated firms or specialization. Combes and Overman (2004) have identified them as transaction costs and labour mobility and so on. Regarding the theory of comparative advantage, the location of firms in a concentrated space may specialize in goods the location has competitive advantage of and it is possible mainly due to the exogenous differences in endowments technology.

Conversely, economic geography views technology as increasing returns to scale which is identical across locations together with endowments. The increasing returns encourage firms to concentrate. Firm's location in the urban centers are due to quality access to suppliers and customers. In the case where agglomeration forces dominate dispersion forces, firms concentrate in a few places and export to other locations. Thus, whereas economic geography considers cost and demand linkages as the key agglomeration force, Urban and Spatial Economics emphasize additional agglomeration externalities because of localized knowledge spillovers, labour market considerations and the provision of public goods.

Quite a tremendous body of literature have analyzed the economic dynamics that is manifested by the concentration of firms within geographic regions, largely due to the cost benefits or otherwise that accumulate to firms working in regions in the developed economies, which possess agglomeration. Weber defines **agglomeration as the economic advantages** because of the location of production activities in a region. Analysis of the review of the literature shows three main concepts that predominantly run through the host of studies on the location and spatial concentration of economic activities.

Each of these phenomenon- agglomeration, industrial districts and industrial clusters offer distinct contributions on the perspective of geographic concentration of industries. However, the agglomerations and industrial districts concepts have been prominent. In spite of their uniqueness, they are however interrelated in that, agglomeration stresses economic benefits firms and the regions accrue due to the concentration of firms. On the other hand, the other two concepts on industry concentration underlines the i**nstitutions and systems that support firms** within geographic regions (Gilbert, 2016). In this case, the economic activities in the country are located within the core and periphery regions. It can be observed in the pattern of

incomes flows within the localized economic area. Income flows from the rich area due to the concentration of economic activities.

Due to globalization and changes in technology and competition, most of the classic roles of location have lessened (Porter, 2000). The emergence of the global market has changed the rules of the game because resources, (capital both human and cash), technology, and other production inputs can be acquired efficiently from global markets. Yet, in reality, location is still relevant in the midst of the intense competition in the global market. The new role of location in the current competitive advantage of firms, regions and nations cannot be underestimated. Various new roles have been assigned to the participants of the business environment at the national, regional, or local levels. Therefore, there is the need to emphasize the role of the public sector or government in advancing the concentration of firms for a competitive advantage.

The high concentration of economic activities clustered in a particular geographical region for instance, Silicon Valley, in the past decades have triggered public policy instrument delimiting large firms with potential power in the market economy to ensure innovation and competitiveness. Through deregulations and privatizations of state monopolies, public policies across the world especially the North American and Western European regions have emphasized the implementation of competition policies geared towards innovative activities through the creation and commercialization of knowledge. The era of strict and antitrust regulations has been on the descending giving room for clustering and innovation in the regional economic activities.

1.7.2. What does the empirical literature disclose?

A review of empirical literature reveals that, the concentration of regional economic activities or otherwise differ across the globe. Many literatures have found differences concerning the spatial distribution of economic activities in United State of America and the European Union and across sectors and region. For instant, Dominicis et al. (2007) found in their research differences in geographical concentration of production across sectors in Italy and conclude that concentration has decline absolutely in some sectors but the empirical result reveal that the traditional and the high technology industries remained concentrated. In India, Desmet et al. (2015) conclude that in the service sector, agglomeration forces dominate in contrast with dispersion forces in high-density cluster areas. In other words, these high-density clusters of economic activity are considered India’s growth engine.

Concentration of firms turns to diminish with respect to time and sectoral changes. In his study of economic geography, industry location and trade, Brülhart (1998) found that over two decades, specialization had been trending in the European economies. The time space between the findings of Dominicis et al. (2007) regarding Italian case is an evidence of this observed pattern. In their paper on review and extensions of foreign location choice of Multinational Enterprise (MNE) Kim & Aguilera (2016) allude that MNEs adopt different means in organizing their value chain. The earlier trend has changed from value chain activities on country-to-country basis to a diverse space across location with each activity having different level of geographic scope. In similar account, Buckley & Strange (2015) found that the increase in the changes regarding the global location of economic activities over the past three decades could be attributed to increase in FDI, increase in number of firms in the emerging economies and the nature of outsourcing. Nevertheless, there exist the need to ensure governance of the location of economic activities globally. A distinct phenomenon perpetuated by the intricacies of globalization such as economic integration has a strong impact on the concentration and or specialization of regional economic activities. More so, the availability of human capital and low cost of labour has pushed firms to locate at a geographical space showing some level of concentration of economic activities. This is mostly evident in regional trade systems. For instance, the US-Mexico trade cooperation has seen firms moving away from the core centers to approximate locations at the border regions. The obvious reasons as outlined by many regional economic theories is that of attracting cheap labour due to the interregional wage differences, in the case of US firms as well as closeness to the market for the products of the firms (for Mexican companies). More so, the availability of suitable and qualified workforce likewise proximity to large urban centers are found by most empirical studies to be the reasons for concentration of regional economic activities.

In their research on the geography of logistics firm location, the results of Holl & Mariotti (2018) based on a large national representative data set showed that the important location determinants of Logistics industry are market oriented. Thus, firms turn to locate close to the consumer market. In addition, efficient transportation infrastructure is a crucial determinant of efficient logistics industry making it possible for economic activities in the logistics industry to agglomerate within a geographical area. In the same token, in the context of the EU, Polese et al. (2007) illustrated the location of economic activities employing a similar model used for a Canadian analysis. They found that, there prevailed a substantial difference between the

Canadian patterns and that of the Spanish but the results corroborate the classical location assumptions because distance persistently is a factor determining the concentration of the economic activities as well as size of the country. In particular, with Spain and Canada, settlement densities also played role in the location of firms. With regard to technological innovation and for that matter spatial distribution of R&D expenditure, government or public sector finance determines the concentration of economic activities across regions over time (Martin et al., 2005).

1.7.3. Public policy role in the location of regional economic activities

The efficient government spending through innovation policy will produce regional polarization in the EU leading to dispersion of economic activities. It is found by most European studies that contemporary regional policies have pushed economic activities to be localized (more specialization). Through the regional and local policies of the European Union, which seek to bridge the gap between high GDP per capita regions and poor or less GDP per capita regions in terms of development, surely create more economic activities in the periphery areas. Nonetheless, the extent of concentration of economic activities is diverse across industrial sectors (Combes & Overman, 2004). The above listed factors indicate that public policy has a huge influence on the location of regional economic activities. The ultimate question is vested in the **how the public sector influences regional economic activities to propel economic development**. Such roles the public sector (central or supranational government) may play is to align the institutional architecture to collaborate with diverse institutions to achieve efficient and effective regional economic development. At the regional level, public sector plays the role of infrastructural building and maintenance to attract investment into the region. Training of human resources through the support of higher institutions of education and research centers as well as collaboration network could also go a long way in determining the attractiveness of a locality leading to concentration of firms in the region. All of these activities improve the capabilities of the region.

In the nutshell, the outward growth and expansion or otherwise of companies has mainly been the key determinants of firm location coupled with the classical view of production, transportation, and transaction cost as well as size and distance. Firms decisions are based on the **trade-offs between agglomeration, economies, and diseconomies of high concentration of similar economic activities** within a spatially distributed space or region (industrial cluster with increased collaborative network possibilities). In addition, the relationship between increasing returns to scale and transaction cost creates a self- supporting

process of industrial agglomeration, which forms the desire for firms to concentrate production closer to consumer market, which allows the firms to minimize both fixed production cost and transportation cost.

This prevailing phenomenon helps to induce more companies' establishment in certain geographic spaces; the site becomes more attractive (pull factor) as production hub for many other firms. The exogenous features of the region such as climate, and production resources barely have influence on such industrial center creation rather, regional policies both concerted and unplanned as well as historical factors do (Hanson, 1998). In that regard, the public sector with public authority plays a key role in determining the geographic of economic activities of firms in order to foster competitive advantage and economic growth both at the national and regional levels. Owing to the immeasurable role of the public sector in creating the active environmental forces (Milieu) which propels firms to agglomerate and the changing dynamics of what the public sector brings to the table in terms of policy measures helps to ensure convergence of industrial activities in a national economic space.

1.8. The industrial district/cluster concept, a collaborative effort of firms for economic growth

The world has witnessed major decentralization processes of both political powers and administration across the globe. Yet, in most advanced economies patterns of industrial agglomeration and specialization in specific locations is however on the ascendancy. Regional analysts to be the prevalent advantage of concentration of firms where firms can reap profit from this activity have investigated a phenomenon called external economies.

Among the numerous representation of spatial forms and the nature of business concentration Lonsdale's (1965) territorial production complexes, Aydalot's (1986) regional innovation milieu; Scott's (1988) new industrial spaces; Becattini's (1990) industrial districts and Porter's (1990) cluster theory are prominent. Amin & Thrift (1992) neo-Marshallian nodes; Florida (1995) learning regions; Martin & Sunley (2003) network regions, Becattini's industrial districts are other notable representations (Ortega-Colomer et al., 2016). Porter (2000) postulates that clustering has become the new way of thinking about the synergistic role the various participants play and for other institutions in increasing and sustaining competitiveness of a region.

This is because, a great deal of competitive advantage exists externally of the company and its industry but could be found in the environment (location) of the industry hence the role of the

various cluster institutions must be geared towards the growth of the cluster. Since cluster is based on gaining and sustaining competitive advantage, any connection created within the cluster conceptual framework must lead to the effective competitive advantages of the entire cluster industry and its associated environment. It is therefore safe to assume that the social capital as a resource acquired through social and collaborative networks such as that of the cluster industry plays a significant role in ensuring competitive advantage.

Ruiz-Ortega et al., (2016) in their research to investigate whether firms located within the industrial district have superior performance than those firms located outside the district find that the factors which enable better performance of firms within the industrial district is social capital in its three dimensions (structural, relational, and cognitive). Additionally, they also found that industrial districts firms acquire more knowledge than firms outside, though the differences are weak in their empirical result. Hence, firms located within the district show high innovation performance, which is linked to the development of new products. However, empirical findings of Chuang et al., (2016) indicate that social capital does not directly increase competitive advantage, rather, through the intermediating factor of collective learning and absorptive capacity.

1.8.1. Industrial cluster and the effect of social capital

Socio-cultural factors play essential role in regional economic development. This notion has given rise to numerous concepts such as the social capital concept. Norms, values, networks, reciprocity, or trust that a community hold onto leading to social and economic consequences positively are the social capital of every region. Prominence of social capital concept is sometimes cluttered in lack of clarity in the meaning of the concept in literature overly because of trivial conceptualization in some economic geography and regional studies. Despite such hitches, the theory has seen elegant admiration in several scholarships from the economics and development studies field where social capital has been hailed to be the missing link to the economic advancement of regional economy and national development.

Huber (2009) suggests that the geographical dimension of social capital is crucial because social capital has been touted to generate regional externalities. Especially, (Maskell, 2000; Fromhold-Eisebith, 2004; Capello & Faggian, 2005; Tura & Harmaakorpi, 2005) have argued that social capital plays an imperative role in the knowledge-based economies ensuring **regional innovation and local knowledge externalities**. Social capital has also been linked to spill over of local knowledge in agglomeration economies. Likewise, the cluster theory by

Porter (1998) viewed social capital as a contributor to economic prosperity of the nation state. Most cluster studies have stressed the critical role relational assets plays in cluster industries. The social capital concept, however, is not devoid of criticisms. Huber (2009) have criticized the dominant understanding of social capital in economic geography and regional studies with the aim of offering an alternative perspective arguing for the need to offer diverse conceptualization to save the concept from it catch-all approach. Social capital has been perceived as the answer for recent regional economic development of certain cluster regions all over the world, as evidenced by various literature in cluster and regional and economic geography studies.

Social capital is defined based on the view of the network-based approach as resources entrenched in social networks, which can potentially be accessed or are actually used by individuals in the network. In this case, trust, institutions, norms, and values becomes external factors necessary to influence or affect social capital. In addition, Social capital is defined as the aggregate resources embedded within, available through, and derived from network relationships possessed by local firms (Dyer & Singh, 1998; Chang et al., 2010).

Social capital dimensions comprise of structural, relational, and cognitive (Nahapiet & Ghoshal, 1998). Putnam et al., (1994) see social capital as consisting of social organization features (trust, norms, and networks) to improve the effectiveness of the public in this case the industry cluster by assisting and organizing action. Lesser (2000) also contend that social capital involves inter-organizational ties and firm interrelation dynamics (collaborative networks) within a common context of industrial behavior. For industrial cluster to benefit effectively from social capital, Fukuyama (1995) stresses that trust is the most essential constituent of social capital leading to cooperation in groups.

Yoon et al., (2015) stipulate that social capital is a statutory network, in which members acquire information, support, and resources. Additionally, such relational network depicts the extent of trustworthiness in personal relations. Cognitive social capital represents the social norm including shared systems of meanings and language, which facilitates **the exchange of information, learning and knowledge creation** among the individuals. Hence, geographically clustered firms that have the capacity to maintain networks in linking close or strong ties, and sustain these relationships with other regional institutions, are well placed to access new information, ideas, and opportunities (McEvily & Zaheer, 1999).

Relational capital aids knowledge acquisition, which improves firms' capacity to attain competitive advantage (Grant, 1996; Yli-Renko et al., 2001; Li et al., 2010; Presutti et al., 2011), which are the basis of achieving superior business performance (Weber & Weber 2007). Regarding industrial districts, the knowledge transfer between companies has been a significant element for firms' competitiveness. This is because of local processes of knowledge creation and transfer through which companies can obtain knowledge indispensable for prompt response to shocks in the market as well as indicating a firm's innovative activity (Cohen & Levinthal 1990). The knowledge transfer unlocks new productive opportunities, which improves the ability of firms to use them and generates improved performance (Yli-Renko et al., 2001). The cluster industry comprises of social networks of members with resources embedded in their relationships. The actors have the possibility to access resources for their industrial activities collectively, which denote the internal social capital (Lin, 2008), and is dependent on the existence of structure and relationships quality.

On the contrary, actors' access to external social capital is due to external relationships with other collaborators who are outside the cluster through **gatekeepers**. Therefore, social capital is the resources embedded in internal and external social networks, which can be possibly retrieved or are essentially mobilized for collective members of the cluster industry. Governance of the structure of the collaboration is thus important as its survival. Lorenzen (2007) further argues that various social relations in the industrial cluster help **to derive social capital**, which can be combined with normative and cognitive capabilities to expedite collaborations among social institutions.

In analyzing the effect of social capital on industrial cluster demands that the analysis looks at the knowledge interactions in the cluster networks. Knowledge could be transmitted because of the relations between individuals working in the same industry or in other industries. More so, from a local agglomeration of non-firm actors of the cluster for example universities or consumers. Therefore, social capital of the industrial cluster is considered the knowledge as well as work-related knowledge cluster actors are able to possibly acquire or actually marshal for work activities through internal and external social networks of the members through institutionalized or formalized relationships between organizations. In this case, social capital affects the gaining and sustaining of competitive advantage whereby actors are able to utilize both local knowledge networks and the ability to absorb external knowledge.

On the other side of this conceptualization lie the tendency of the industrial cluster to affect social capital. Molina-Morales et al. (2010) have argued that concentration of industrial activities shapes social networks, which is embedded in the social capital of the cluster location (i.e. the milieu). The influence is realized through what is called **dense structure of the cluster industry and strong ties**. These enable firms to benefit in return from the efficient exploitation of opportunities through sharing of high-quality information, tacit knowledge in cooperative activities. Lorenzen (2007) posits that social capital facilitates technological and institutional learning. Social capital develops better at local scales than at the international or national space because social relations are sensitive to distance, but cost of communication has been the lack of global spread of social capital. Nevertheless, this conclusion falls flat especially in the 21st century, this notion is inconclusive or obsolete due to technological changes and advancement in human communication and interactions in the global world. Regarding the interdependent relationships between the shared resources of clusters, and the role government and institutional support play in shaping the internal capabilities of the firm, Li et al., (2015) found that the capability to utilize localized and external cluster networking and the relative market performance of a firm is enhanced by social capital.

More so, cluster shared resources interact collectively to enhance individual firm market performance which cause for policy makers to promote cluster development. Additionally, Chen et al. (2016) suggest that social capital also helps firms to gain, integrate, restructure, and transfer resources. This is because the ability of the firm to obtain resources constitutes its social capital and social network (relational), which may enhance institutional legitimacy, in that; it may also affect the organizational performance of clustered firms leading to economic growth of the region.

1.8.2. The industrial district concept and innovation

In its definitive form, Industrial District is a territorial system of small and medium-sized firms (Goodman, 2016). The concept's main emphasis is on how these small and medium-size firms could harness the economies of scale. Due to their presence in the industry and proximity, Asheim (2000) contends that the external economy of scale will create other competitive advantage for the firms akin to the internal economies of scale large firms enjoy by virtue of their size and scope of operation. Becattini et al. (2009) distinguished three levels of the Industrial District evolution. They consist of structuring the economic activities and

processes; the rediscovery of the characteristics of the industrial revolution; and the modern Industrial District characterized with globalization and networks.

The industrial district in Marshall's perspective took socio-economic nature rather the concept should take a socio-territorial approach where the industrial district has active presence of people in a community with group of firms who naturally and historically interrelated. Belussi & Caldari (2009) identified **five importance** of Industrial District to include **first,** the knowledge spillover transmitted from generation to another within the district creating a sort of hereditary skill sets for posterity. **Second**, the close concentration of the firm leads to increased growth of ancillary firms within the locality ensuring the supply of industrial inputs, transportation, and consultative activities to boost the local economy. **Thirdly**, specialized industrial activities created out of extreme division of labour and specialization characterizes the Industrial District leading to highly specialized machinery usage and innovation. **Fourth,** the small set of the district human capital enables shaping and nurturing to provide market demand for special skilled workforce, which outsider firms may struggle to find. **Lastly**, Marshall's view that the Industrial District atmosphere leads to industrial leadership by virtue of local atmosphere, stimulate cooperative and competitive activities of the firm within the local district.

The evolutionary concepts of the industrial district also focus on **four main processes** (Dei-Ottati, 2018). These processes are akin to that of the Marshallian propositions except to add the process of concerted and coherence interrelation between the productive system and that of the local society ingrained in the designed governance structure. The Industrial District can also be seen as a network or system of firms operating at the various phases of the manufacturing process (Amin, 2000). They mostly are made up of unique composition of firms and factors of production with key importance on collaboration both contrive and involuntary within the district division of labour and specialization, which lead to its interconnectedness with other territorial models such as the innovative milieu. The main emphasis of the concept is on **co-location of firms** hence the geographical proximity of firms influences their cooperation arrangement for innovative activities.

1.8.3. The classical and contemporary cases of industrial districts

The industrial districts in contemporary times emphasized on specialization based on the Marshallian industrial district characteristics to create a niche bounded by quality products and efficient means of production. The European Union industrial policy in the recent period

has sought to use the smart specialization strategy. Many of such classical examples can be inferred from the Italian case where the northern and southernmost parts of Italy possessed a unique industrial hub in these regions in the 1970s. The Oxford Handbook of Industrial Hubs and Economic Development classifies an industrial district as an example of an industrial hub in an industrial ecosystem, which consists of the creation of institutional networks and symbiotic collaboration of the social structure and their public political economy and politics in the macroeconomic sense. Industrial hubs have supported industrialization across many Western countries where the industrial policies of nations seek to create a concentration of industries to harness the agglomeration effects of cluster firms.

At the turn of the 18th century, transition and developing countries have promoted export-based industrialization through industrial hubs where significant economic development has been achieved by the technological improvement in many catching-up country's industries. Many studies of the industrial district theory have opined that positively personality **SMEs gain other benefits of agglomeration and clustering of firms such as reduction in transaction costs, and both external and internal economies of scale**. These benefits contribute to the innovation activities of firms located in the space to learn and create linkages with the support of public and private institutions. The classical example of industrial districts is those of the English industrial areas studied by Alfred Marshall and in the Italian case of central and northern regions, which constitute firms with specialization in fashion (apparel, footwear) and furniture, as many industrial district scholars have perceived it to be the Third Italy.

The Oxford Handbook of Industrial Hub and Economic Development classifies clusters and other forms of concentration in agglomerated industries in the generic form, which are akin to the new versions of the *Fordis*t production system with a flexible system of operation. Cusinato & Compagnucci (2011) observed that the Marshallian approach of industrial districts as a post-Fordist production system had placed little emphasis on the crucial role of the region as the indispensable provider of social capital. This may stem from two main reasons that the Marshallian industrial district emphasized on the agglomeration economies created within the clustered firms and placed attention on the diseconomies as well as the countryside root of most district pioneers. Amidst the increasing globalization and the dawn of the knowledge economy, several sprawls of industrial hubs have gained enormous development.

The observed different concepts about the industrial district (hubs) are profoundly argued by Cusinato & Compagnucci (2011) to be impacted by the advent of information and communication technology, which has enormously changed the structure and organization of firms and industry and more importantly the displacement of firm production phases. De Marchi & Grandinetti (2014) recount the effect of globalization on the collapse of the Italian Marshallian industrial district to include:

- Effect of firm population in the fabric of district inter-organizational relationships
- Mutual interpenetration of social structure and production due to the impact of immigration
- declining entrepreneurial factor reproducibility
- Diversification of the local production structure by weakening of the district fabric of firm collaboration
- Overconcentration concentration of turnover in workforce of the districts

For example, in this research, three cases of Industrial Districts have been reviewed, which include the Italian Case, the case of Spain, and the Czech Republic that have created concentration of economic activities in the Districts and with enterprises engaged in manufacturing sector in food processing, textiles and clothing, Mineral processing petrol chemical, machinery and metal work.

In Italy, the Industrial District consists of concentrated economic activities in districts where small and medium size enterprise develop endogenous processes of handicraft and a network of economic entities in a co-petition relationship spreading across the nation. At its peak, the Industrial District as studied by (Becattini & Dei Ottati, 2006) showed that the Italian Industrial Districts performed well than other areas where economically and in quality of life of the people in those areas. They found that in 2001 the Industrial District enterprises accounted for 62 percent of all Italian exports with a positive trade balance with high-rise of employment even though this prowess of these enterprises has declined over the course of two decades. Grando et al. (2008) provided key elements of the Italian Industrial Districts characteristics as, specialized manufacturing sector with **clear division of work amongst district firms**, show of **high entrepreneurial ingenuity** and a **strong connection between social and economic life** of the populace, which corroborates that assertions of Belussi & Caldari (2009).

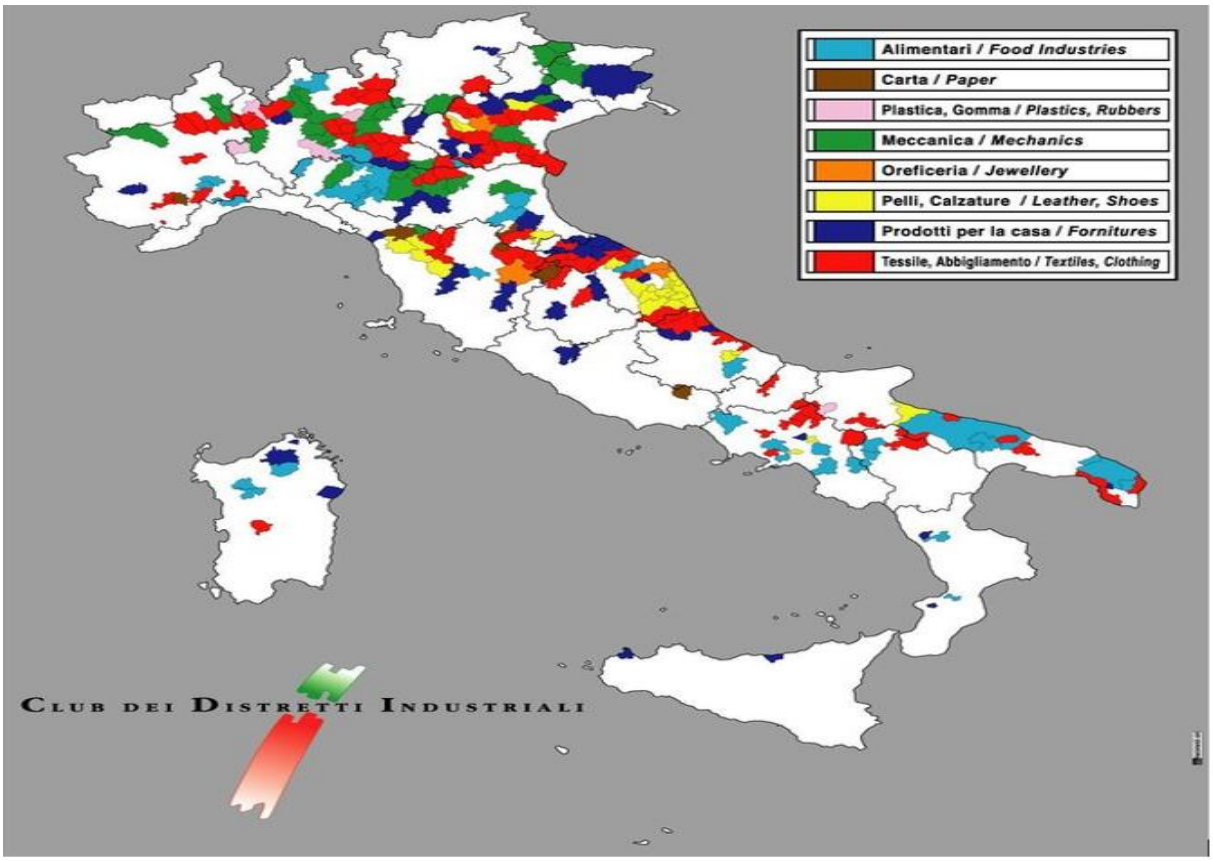

Figure 4 Map of the industrial district in Italy

Source: Adapted from Italian National Institute of Statistics (Istat), (2011)

According to the Italian National Institute of Statistics (Istat) in 2011, about a quarter of the countries production emanated from the industrial district even though, the local labor systems saw a decreasing trend. Employment within the Industrial District accounted for more than third of the total employment in the country. With about twenty-two percent of the Italian population living within the enclaves of these districts, the economic impact is enormous, which makes industrial districts such an important economic system found in many advanced countries.

In the case of Spain, industrial activities in are concentrated in major industrial hubs such as the Catalonia regions with Barcelona at the heart of it all. Many of these industrial set ups are found in the northern part of Spain (Asturias and the Basque Provinces), Madrid and parts of the Southwestern regions with mineral endowment. In the region of Catalonia, huge concentration of processing and engineering industries are located in this area concentrating in food and textile industrial activities with electronics. Engineering industrial activities in Barcelona include a large oil refinery and a petrochemical complex located at Tarragona and well-developed machinery industry. Many of this machinery industry has an automobile plant,

railroad foundries and workshops including diesel, electrical engineering, and various industrial equipment plants. The northern coast and the Basque region hot lots of iron and steel industry by virtue of its natural resource endowment such as coal and iron ore deposits and other engineering industries, shipbuilding facilities, and chemical plants. Madrid region has the second manufacturing centers engaged in automobiles, electrical equipment, and aircraft. Madrid is at the center of Spain with low endowment with key factor being its large population, transportation facilities, and governmental policy has made it the second largest industrial region in the country contrasting it with the northern coast and the Catalan areas.

The Spanish situation is comparable with most European countries with concentration of industrial economic activities located in areas by virtue of their physical and socio-economic reasons. These factors are similar to the classical pull factors of location of economic activities modelled by Capello in his location theory. Thus, natural resources endowment, Land, terrain (climate), and accessibility of infrastructure such power, which constitute the physical factors. On the other hand, labour supply, communication and transportation infrastructure, capital and most often than not, government policy. The influence of policies government implements greatly affect location of industrial economic activities. Government as means of incentive through fiscal and monetary policy creates industrial zones within the areas, which are economically deficient as a cohesion policy to check regional disparity and its adverse effect on household income and growth of the economy.

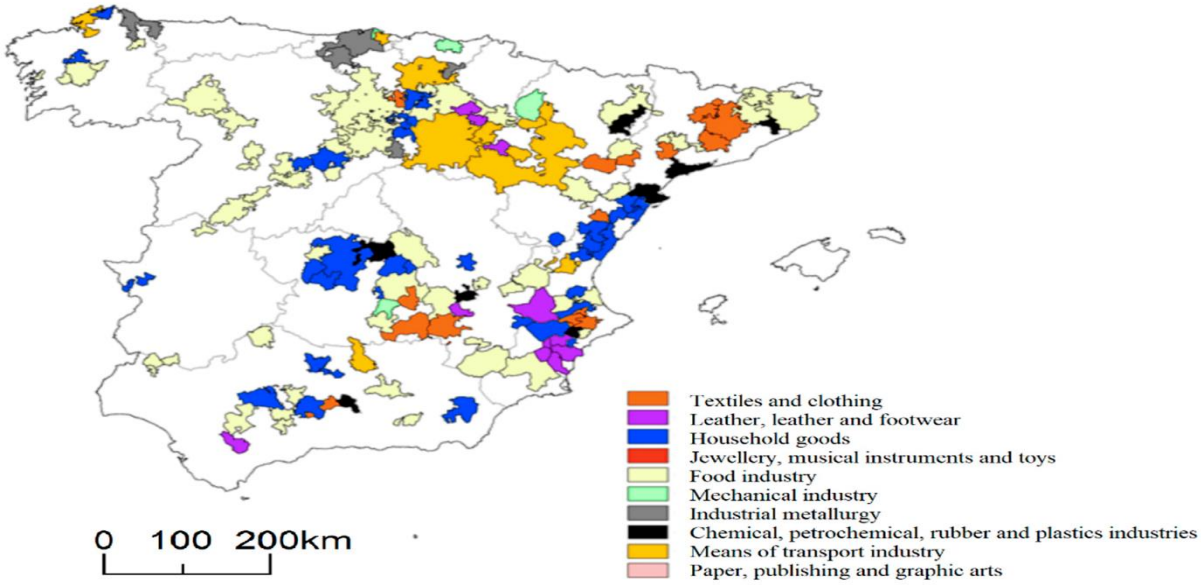

Figure 5 Industrial Enclaves in Spain

Source: Adopted from Zambon et al. (2019)

Similarly, the case of the Czech Republic implies a concerted effort of the government to create industrial clusters through industrial policy in an attempt to change the economic conditions of old industrial areas as professed by the evolutionary concept of path contingency (Birch et al., 2010).

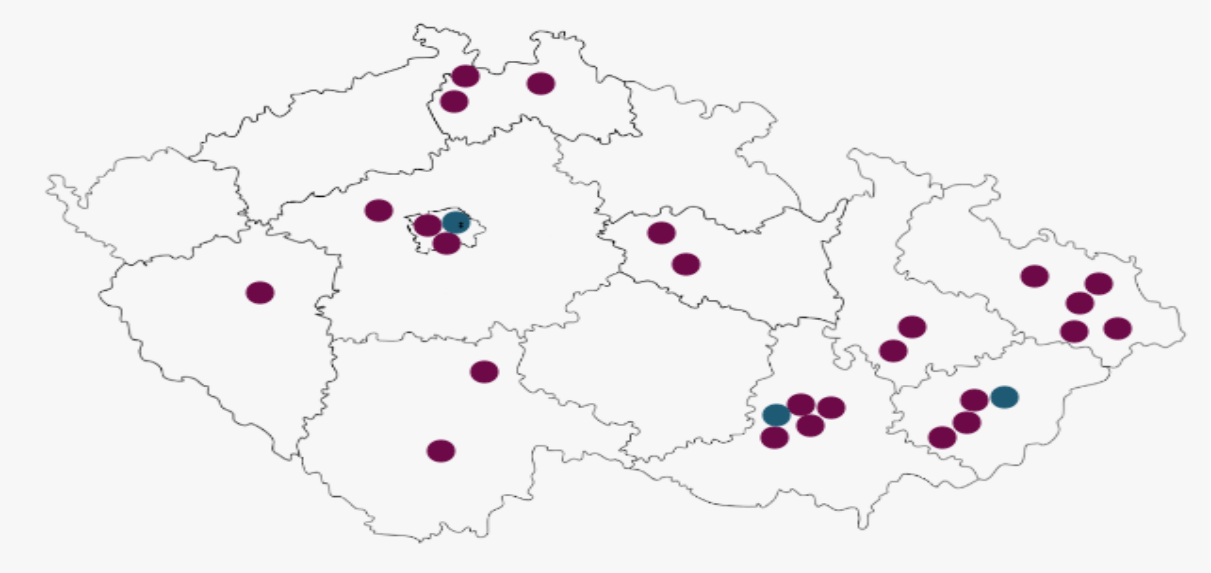

Figure 6 Czech cluster organizations

Source: Czech National Cluster Association

The case of the Czech Republic and many other Central and Eastern European countries present the policy shift formulated within the European Union. The Czech Republic industrial cluster as depicted by figure six (6) show a homogeneous spread of cluster industries across the country where many firms engages in economic activities such as manufacturing and processing. However, Czech Invest, the national organization, which seeks to enable competitiveness through support from foreign direct investment, seeks to create conducive environment for the restructuring and recovery of industries within areas where old industrial sites have closed and facing the danger of unemployment. These supported cluster areas concentrate on key sectors of the Czech economy such as aerospace, advanced engineering, electrical engineering & electronics, nanotechnology & advanced materials and many more. This industrial cluster policy as a form of a hybrid or modern industrial districts support the economic restructuring and pushing through the economic transition of the Czech Republic through the creation of competitiveness, innovation, R&D, and support for SME (Bialic-Davendra & Břusková, 2014). Cluster firms add to the efficient use of available resources leading to economic development at the regional level. Damborsky et al. (2013) found a positive effects support of industrial zones by the Czech Government on the regional labour

market, where those firms located in these zones offer technological development through industrial reformation. The presence of these companies in these cluster areas improves the performance of SMEs gauging a business image for the region. This shows the importance of proximity of firms seeking to promote innovative effort and innovative behavior of economic entities.

1.9. Proximity and innovation

Proximity has been well researched in the regional science and innovation studies. Many scholars within the economic geography field have sought to assess the key role proximity plays in the economic activities at the national, regional, and local levels. Over two decades ago, some French economists organized themselves to set the beginning of the proximity perspective, which has now become the French proximity school. These researchers had in mind to ascertain the relationship between the notion of proximity and the industrial dynamics (Ferru &Rallet, 2016). The objective was to conceptualize the connection between industry and its environment, which later transcended into the field of innovation. In the innovation field in particular, the proponents of the proximity concept perceived that proximity in its various modes causes much innovation activities within a geographical area. Ferru and Rallet (ibid) state that, proximity concept started as a critique of the Industrial District and Innovative Milieu concepts whose concentration was mainly on the territorial research in regional economics. The concept sought to provide an alternative approach to regional economic analysis using both spatial and non-spatial proximities to influence public policy in innovation.

To understand the interactive learning and innovation activities among co-located firms, territorial economists point to the different dimensions of proximity which includes geographical, cognitive, organizational, social, and institutional proximities (Boschma, 2005). Geographical proximity constitutes a spatial or physical distance between actors within an economic space, which provides the propensity for them to interact closely in sharing information and creating knowledge what Boschma called spatial externalities. In addition, cognitive proximity denotes the extent to which individual economic agents within the RIS accesses a particular knowledge source. Thus, each member becomes exposed to common knowledge base and information, which may stimulate learning among the actors. Balland et al. (2016) posits that, whereas organizational proximity implies the shared relationship within and between organization, social proximity involves the informal (personal) relationship or close ties associated with individuals in the organization. Lastly, institutional proximity

describes the extent to which economic actors share similar or same norms or systems for example the institutional arrangement within the triple helix (University-Industry-Government collaboration). Initially, the proximity concept relied solely on co-location which understandably serve as an enabler of firm collaboration and means of knowledge exchange (Shearmur et al., 2016), but further dynamic strands have been perpetuated with Boschma leading the way.

These various dimensions are intertwined (Oerlemans & Meeus, 2005) and sometimes work interdependently to ensure the effective realization of innovation in a firm through the processes of knowledge creation and absorption. Boschma alluded to the fact that social, organizational and institutional modes of proximity are strongly interconnected yet distinguished social proximity from institutional proximity, as the former involving an embedded relationship at the micro level (involving individual actors) and the latter associated with the macro level institutional framework of a firm. One can further realize the need, better still; the influence co-location (geographical proximity) has on the other modes of proximity. Subsequently their overall effect on knowledge creation and interactive learning among agents of the Regional Innovation System.

The fact, as acknowledged by Arundel & Geuna (2001) is that, knowledge being prerequisite for innovation, and the tacit nature of it thereof turns to make direct and personal contact between members of the Regional Innovation Systems imperative. This makes it easier for knowledge transfer (Rodriguez-pose & Crescenzi, 2008), which corroborates with the ideas of the innovative milieu and industrial district concepts. However, due to changes in technology and especially in the communication industry, it is relevant to point out the telecommunication effect on personal contacts through the internet and it associated social media platforms.

Again, the non- spatial dimension of proximity together with geographical proximity underscores the idea of innovation being an interactive process- an idea highly centered within the innovative milieu concept and many other approaches to innovation studies (Todtling et al., 2013). This notion has informed many public support systems especially in the EU to formulate government support for innovation programs such as regional cluster initiatives and establishment of science parks close to the agents of the RIS and other fiscal support such as R&D subsidies, tax holidays and so on (Arundel & Geun, (2001).

Consensus can be observed per the above theoretical analysis that there exists importance of proximity for innovation. The prominent notion highlighted in the literature is the proximity effect localized networked firms enjoy. One difficulty is that, there is less empirical studies since the proximity concept is highly centered in theoretical propositions and few attempted empirical studies focus on network success in certain areas where proximity is prevalent (Oerlemans & Meeus, 2005). Hence, it has been difficult to create a defined variable to represent the proximity due to it **fuzzy nature**. This makes most of the empirical proximity research inconclusive because they become dependent on proxy and dummy variables classified to capture the proximity concept into more empirical for proper analytical studies.

Nevertheless, Oerlemans & Meeus (2005) found partial result for the impact of geographical proximity on firm performance in their empirical research. They noted in their study that among the other proximity dimensions, geographical proximity impact innovation of firms. Conversely, Romijn & Albu (2002) found no significant association of **firms' innovative intensive networking with proximate customers** in small high technology firms in the UK. However, Molina-Morales et al., (2015) found interesting result in their analysis of the dynamics of network formation in mature and declining foodstuff clusters in Spain and concluded that, various dimensions of proximity interrelate but stipulate that too much proximity (both cognitive and institutional) lead to reduction in inter-cluster linkages.

These findings corroborate that of Boschma (2005) and many others that there is the need to ensure relative proximity to avoid lock-ins and other barriers to collaborate. Nonetheless, the interrelationship among the various proximity dimensions may help mitigate these barriers caused by other dimensions of proximity through what may be called complementary process. In their paper, Steinmo & Rasmussen (2016) suggest an evolution and interplay of the various proximity dimensions over time in engineering and science -based firms. They found that, engineering- based firms with established **collaboration with research organization require cognitive proximity as a complementary proximity means to cooperate** with other research organizations. Likewise, science-based firms need the interplay of social proximity with their well-established organizational and cognitive proximity in order to collaborate over time with other research organizations contributing to the dynamic perspective of proximity (Balland et al., 2015).

1.10. Summary and research motivation

The literature review specifically those on industrial districts, innovative milieus, and industrial clusters has elucidated the tenets of the endogenous elements and processes, which drive regional economic development and the impeccable role the region (public sector) plays in coordinating economic activities. These territorial theories have brought forth new arguments as opined by the exigencies of territorial development and the ongoing differentiation policies of national states. Hence the findings of the **New Economic Geographers** and many other **Growth theorists** show that there exist a positive external effect in the form of **spillover effects** and **knowledge externalities** where the innovation processes within the context of the region portrayed the **presence of localized and non-standardized knowledge** due to **quality human and social capital** availability. These propel **learning and sharing** processes within the innovation **support networks** with **interregional and inter-institutional** openness.

More so, in the midst of **increasing decline** in the global economic environment, an efficient and successful public policy with support systems both financial and non-financial must meet the efficiency threshold to justify the need for increasing government expenditure in R&D. With the present wave of worsening public finance deficits, most current is the advent of the pandemic outbreak, which has wreaked havoc in the public expenditure and at the same time the pressing motive of concurrent need for innovation to sustain competitiveness of the economies in the world, **public support systems should create innovative ecosystem that benefit all economic entities and society at large**. The justification for the intervention implies that these market and system failures need to be tackled to restore the deteriorating disparity among regions by implementing the policy intervention(s), which seek to foster the effects of agglomeration through the creation of enabling environment for collaborative efforts of economic activities.

Extant literature has devoted much scrutiny into the public financial support. For example, (Himmelberg & Petersen, 1994; Hall, 2002; Hall & Lerner, 2010) found public funds to be used mainly:

- to support basic and applied research in public research organizations,
- provide direct government support for commercial research, and
- give tax breaks for private sector R&D expenditures.

These public subsidies support activities that are believed to offer the highest marginal social returns from research expenditures and to correct market failures (Czarnitzki & Lopes-Bento, 2013). These studies of the public financial support have made useful contribution in advancing the knowledge and investigation into the causes and effect of public support for innovation. However, less to no strides has been made to look into the non-financial public support, which include **creating institutional environment** that fosters **collaboration** in the innovation processes, most importantly, in the Central and Eastern European corridors of the EU whose innovation transition has been enormously boomed but lacks the collaborative touch of the advanced innovative European nations. To the best of my knowledge, no research has made effort to combine both financial and non-financial public support systems to explore their efficiencies in firms (SMEs) collaborative innovation performance.

This thesis has two interlinked purposes to explore the role SMEs innovative activities fuels the attraction of public financial support systems. Additionally, to investigate the creation of innovative environment for SMEs innovation by these financial and non-financial Public Support systems by measuring how efficient the framework conditions facilitate collaborative innovation performance of SMEs in some selected countries in the European Union.

2. AIMS AND METHODOLOGY OF DISSERTATION

2.1. Aim of the dissertation

Government designs public support systems that public authorities use to trigger innovation and create an innovative ecosystem that benefits not just innovators but also the entire society. With this in mind, public support systems, both financial and nonfinancial, are being committed to **the cause of creating knowledge and boosting innovation** (Cano-Kollmann et al., 2017). Due to the market failure of SMEs to fund their R&D activities, many scholars and papers (Mazzucato & Semieniuk, 2017: Grabowski & Staszewska-Bystrova, 2020) have devoted much attention to the **financial support from the public sector such as grants and subsidies** to fund complex collaborative innovation projects. However, less effort has been made to look into **nonfinancial public support**, which includes creating an institutional environment that fosters collaboration. For instance, through the public policy of the government, conditions are created to facilitate foreign investment into the national economic space, which boost investment opportunities for innovating SMEs R&D activities. Such conditions include enacting effective regulations to stimulate SMEs innovation activities, provision of training and training facilities, mentorship, and/or coaching innovators. Therefore, it is ripped to become cognizant of **the inalienable importance of monetary public support** to combine with nonfinancial public support systems to explore their efficiency in SMEs innovation performance.

In line with the above reasoning, the thesis seeks **to explore how SMEs innovative activity fuels the attraction of public support systems in the creation of an innovative environment for SMEs innovation,** and **to measure how efficient the financial and nonfinancial Public Support systems and framework conditions facilitate the innovation performance of SMEs in some selected countries in the European Union**.

2.2. Specific objectives

Several literatures have identified the support systems of the public sector to foster innovation, performance, and environment, which have revealed factors. These include availability of knowledge and information; technical infrastructural development to disseminate information and technology; ensuring creative as well as innovative human capital through education and learning; and the willingness to cooperate with innovative actors (Aschhoff & Sofka, 2009; Herstad et al., 2010; Cano-Kollmann et al., 2017; Stejskal & Prokop, 2018). However, the public sector financial support plays a significant role in

ensuring the cooperation and innovation activities of the national and regional innovation actors. Public sector funding can induce diverse roles and the effect it has on the innovation ecosystem. Financial support associated with the national authorities turns to stimulate collaboration among economic entities within the innovation ecosystem such as public research institutions and government agencies. On the other hand, an EU financial support seeks to enjoin collaboration with external partners, taking a broader perspective on the EU innovation ecosystem.

When knowledge within SMEs is not adequate for the firm's innovation activities, SMEs must acquire knowledge through collaboration networks involving other firms, customers, and suppliers (Prokop et al., 2019) that may manifest in either formal or informal relationships and networks (**an open innovation approach**). In addition, through a strategic alliance between public and private institutions such as universities, research institutions within the firm's location, firms may form partnerships with other entities outside the home country (Svetina & Prodan, 2008). However, when the SMEs' internal absorptive capacity is not developed, external knowledge may not be useful for ensuring innovation (Gyamfi & Stejskal, 2019). Hence, there is the need for territorial innovation patterns with external knowledge linkages (Srholec & Žížalová, 2014; Tödtling & Trippl, 2016; Zdražil & Kozuń-Cieślak, 2017; Liu, 2018; Trippl et al., 2018; Stejskal et al., 2018;). Firm open innovation involves external networks that are not structured and based on informal settings that enable the acquisition of new knowledge (Bigliardi & Galati, 2016) for innovation even though there exist mixed empirical results about this phenomenon.

However, other research for instant, Radicic et al. (2020) has found that certain public sector innovation support programs aimed at SMEs in the traditional manufacturing sectors do not foster cooperation among competing firms. In addition, Henry Junior & Odei (2019) also conclude that financial support from the regional government has no influence on firm-university collaboration arrangements. These clearly suggest that there exist **ineffectiveness and inefficiencies in the support systems of the public sector**, which provides the motivation for this dissertation research. The research seeks to offer analysis on the effect of the public support system on firms' cooperation, arrangement, and innovation activities, highlighting that the various means the public sector through policy efficiently induce innovation and economic growth. In light of the preceding reasons, **the first objective (C_1)** would analyze the role of public financial support of SME innovation activities in some selected EU countries. Pursuant to achieving the first specific objective, the research seeks:

C_1: To determine the role of SMEs innovation activities in attracting public financial support.

The research question thus far is as follows.

Q_1: How does the role of SMEs innovation activities stimulate the provision of public financial support?

The public sector's main agenda in relation to the support of private R&D firms can be characterized by **the classical idea of correcting market failures**. Regarding OECD (2016), there are at least five ways by which public policy helps to resolve such market failures. Specifically, public, industrial, or regional policy may seek **to foster the science base through the support of basic research commissioned within public sector universities as well as applied research of research institutes**, what Landabaso (1993) called "scientific subsystem" to foster the transfer of knowledge and technology, which helps to spur innovation diffusion among firms.

Additionally, public support seeks to encourage innovativeness within the public sector itself and foster, through the procurement of innovations made by firms, the so-called **demand-side of public support for innovation**. There is also the means of creating framework conditions that provoke financial support for innovation within the private sector, such as fiscal incentives (like tax credits) to firms that invest massively in research and development and training of workers for the adoption of new technology and innovative equipment. Lastly, public innovation support policies require direct assistance to innovation and research from private firms. This is realized through:

1. the provision of grants and loans for firm R&D funding.
2. giving advice and other forms of support in relation to the innovation activities of the firm.
3. creating the fora and access for firms' collaboration activities such as ensuring facilities and platforms that spur innovation from private companies by which they may not be interested to acquire due to the larger social benefit they may present to the entire innovation ecosystem (**the problem of free riding**).

This suggest that government funding is important, which generates economic impact by means of **additionality effects** at the input, output, and outcome phases of innovation processes. Upon review of the prior existing literature, it was observed that less attention has been given to **the propensity for firm characteristics and innovation activities** to influence

the public sector financial support they may receive within the EU, national and local levels. This offers the motivation

The second objective (C_2) is premised on the objective **C_1** as stated above. Having established the role of firm innovation activities in attracting public funding support in SMEs, the efficiency of such and many other public supports are imperative to determine whether **the public sector support systems efficiently induce collaboration networks** for firm innovation within the innovation ecosystem. Among the EU countries, public support systems (most often used is the financial tool) are rampantly being thrown at private R&D in lieu of promoting innovation, which the EU is lagging in comparison with other regions of the world. Albors-Garrigos & Barrera (2011) claim that **the impact of EU supports is minimal** in that such support to firms constitutes only the exposure of receiving firms to the international market for international collaboration. Other academic research has also concluded that public funding is less effective regarding the sales of innovating products of firms, which questions the innovation performance of firms when being supported by funds from the public sector.

Suffice to say, the European Innovation Scoreboard (2020) report touted a great achievement for EU countries, innovation performance increasing in 2019 by nine percentage points approximately. This surpasses the performance growth rate of US for the first time but trails in comparison with China, Canada, Australia, and Japan. The European Commission's Innovation scoreboard (EIS) turns to measure innovation performance by countries within the EU. The considered input variable requires the conditions necessary for the innovation performance of firms within the EU countries, which captures the framework conditions that exist within the NIS. Conditions such as availability of human resources (i.e., the knowledge base of the National Innovation Systems), innovation friendly environment, and investment help to propel innovation. In this dissertation, these conditions are classified as nonfinancial public support systems. CIS also performs surveys on the innovation performance of firms and further offers harmonized data on dichotomous responses to types of innovation, sources of funding, and collaboration arrangement of firms in categories of economic activities in participating EU countries.

It is based on this condition that firms within the EU innovation and research activities are measured to provide a macro-level comparative analysis of the innovation system performance of member states. More so, there exist within the innovation ecosystems of the countries of Europe linkages and relations that help to interconnect the framework conditions for innovation activities and the impact to be realized thereof, which is centered mainly on

collaboration networks. Numerous researches have examined the impacts of public support as analyzed above. However, EU wide analysis of innovation performance has been lacking, with only European Innovation Scoreboard offering a comprehensive analysis, even so, not concentrating on the efficacy of public support systems except (Hudec, 2015). Concerning this assumption, the second research objective looks to

C_2: To measure the efficiency of financial and nonfinancial PSS in facilitating collaboration networks for SMEs innovation performance in selected EU countries.

To which the following research question has been developed as

Q_2: Does financial and nonfinancial PSS efficiently promote the innovation performance of SMEs

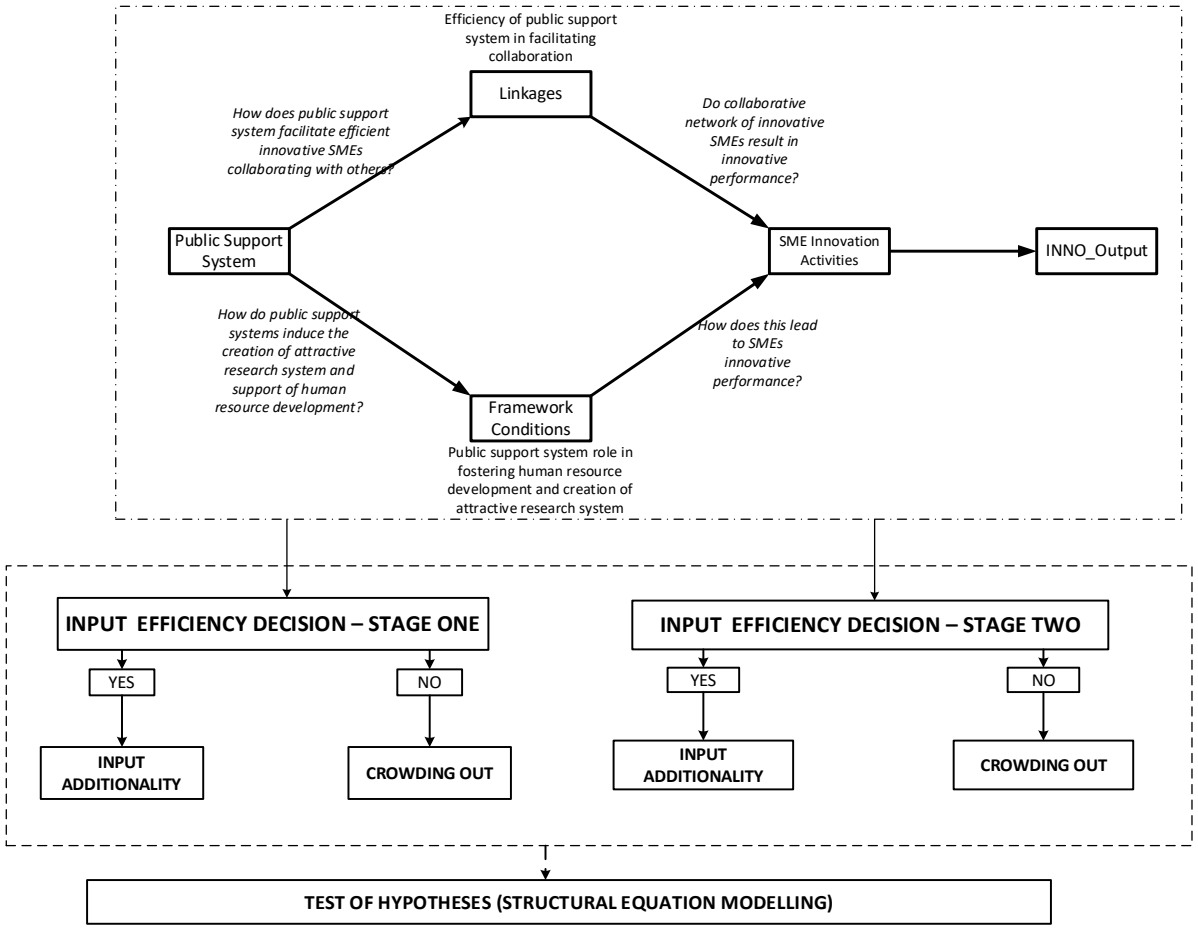

Figure 7 The conceptual framework for input efficiency analysis

Source: author's own based on the theoretical framework

The notion of this framework is to model the financial and the framework condition in the facilitation of collaboration among SMEs that seeks to innovative activities of SMEs.

Collaboration arrangement of firms has seen wider scrutiny especially in the past few decades after the advent of the open innovation model (Chesbrough, 2006) and the triple helix of University-Industry-Government institutional arrangement (Leydesdorff & Etzkowitz (1998). Likewise, public funding, FDI, and trade also serve as an opportunity for firms to interact, engage in direct investment of innovative products and services leading to the export of innovation products. Additionally, collaboration can increase the flow of knowledge and information. In recent times, theory and research on innovation has found interfirm collaboration as the commonly means by which many firms gain external knowledge for innovation (Kotkova & Prokop, 2020). Since innovation activity mostly involves collaboration between producers and customers, especially of products, the interaction becomes inevitable mainly informal, but other organizations have created formal means, which may take the form of exchange of technical knowledge at the same time offering important information about relevant market trajectories and specific modern trends.

The supply chain involving suppliers are also an important source of external knowledge for the firm understanding of the production process, logistics, and other functions of the innovation process (De Zubielqui et al., 2019; Von Delft et al., 2019). Thus, a firm's cooperation with other firms may also involve collaborative activities connecting business partners and competitors as well (Mukherjee et al., 2019). In so far, both horizontal and vertical interfirm cooperative arrangements have provided important sources of external knowledge and information to the firm for innovation performance.

With the existence of absorptive capacity measured by the quality of human capital within a firm, arranging for cooperation would yield an astounding result, increasing the innovation performance and turnover of collaborating firms. Since the idea of public sector support in fostering firm collaboration is to maximize the innovation performance of the firm through high turnover, the larger picture is set on spurring economic growth. This objective would be realized by measuring the efficiency of the PSS using Data Envelopment Analysis. Few researchers have used this method making this research necessary to fill that gap. As mentioned above, an important means by which a firm utilizes knowledge and information for innovation performance is the quality of human capital. Human resources in science and technology constitute the high absorptive capacity of every nation. To this end, Public Sector Support Systems with various innovation policies around the world aim to facilitate the

training and development of quality human resources while creating the necessary conditions for their involvement in the economic activities of the country. A nation-wide employment of human resources in knowledge intensive activities is thus desirable. High quality human resources also signal opportunities for high growth enterprises, which could emanate from human capital sources and employment in knowledge-intensive economic activities that spur growth in economies around the world.

Additionally, Peters &Boeing (2019) research on effectiveness and efficiency analysis of firm R&D supports using a Chinese firm level data (2001-2011). Their results confirmed that firms that receive grant support misappropriate the funds, prompting a compliance policy to be enacted. Using Data Envelopment Analysis (CCR model), Anderson & Stejskal (2019) found a contrasting result for an EU wide efficiency analysis of member states' innovation diffusion. Their results showed that the most innovative member states recorded lower efficiency scores in comparison with the so-called less or moderate and modest innovators. One highlighted issue perhaps is the hint of potential input inefficiencies leading to less innovation performance of firms in member states' innovation systems. As stated earlier, these reasons and many others are the reasons for the public support system to facilitate and moderate efficient innovation performance. This, in the view of neo-classical theorists, provides ***an additionality effect*** at both the input and out ends of the innovation processes. However, this thesis seeks to investigate the likelihood that less efficiency scores may be recorded, which this research attributes to ***crowding- out*** of support or investment within the private sector.

2.3. Sources of data

This dissertation thesis employed two separate datasets that gather and use innovation indicators in collecting firm-level data for innovation analysis. Data for the empirical analysis is sought from **the European Community Innovation Survey CIS** and the **European Innovation Scoreboard (EIS) 2020**. CIS gather coordinated information regarding firms' innovation activities within different sectors of a state and hence offers harmonized data on the different facets of firm micro-level innovation activities concerning public funding support, firms' economic activities and collaboration as well as the expenditures in research and development for innovation. Other focus of data collection is on accessing information about the sources of knowledge and firm information. This Community Innovation Survey is a means for data collection within the EU's science and technology statistics conducted bi-annually in EU Member States that have agreed to take part. The use of the CIS data helps the research empirically to conduct innovation analysis, which is touted as the most complete data

source offering microlevel analysis of innovation systems within the EU. In addition, it has seen a wide range of usage (Cricelli et al., 2016; Mina et al., 2014: Leiponen, 2012; Köhler et al., 2012 Hajek, & Henriques, 2017). The CIS data enables the reproducibility of the dissertation analysis and covers an extensive sample size offering reliable results, as guaranteed by the ability and expertise of European Union statistical teams.

The European Innovation Scoreboard (EIS) provides annual and composite indicators for comparative evaluation of the EU Member States research and innovation performance, at the same time offering a relative strengths and weaknesses analysis of these research and innovation systems of the EU nations. The main motive is to help Member States evaluate their innovation capacities and to identify spaces that need focus by putting effort into enhancing their innovation performance. Just like the CIS, EIS captures key innovation performance framework conditions external to the firm and distinguishes between three variables such as the human resources base, research systems attractiveness, and an environment that is friendly for firm innovation. These affect the innovation activities of the firm, gathering data on the linkages of firm collaboration, efforts between other innovating firms, research collaboration with both the private and public sector, and the extent to which the private sector finances public R&D activities to spur employment and innovation performance. Many researchers like (Anderson & Stejskal, 2019; Paas & Poltimäe, 2012; Archibugi & Filippetti, 2011) have used this source of data.

2.4. Research process

The research begins with analysis of the role SMEs innovation activities play in attracting public financial support. This seeks to fulfil the first and foremost objective paving the way for modelling the efficiency of public support systems in facilitating SMEs collaboration networks for innovation performance. The last and final part of the research looks at identifying efficient enabling factors and causes of inefficiencies of public support systems, a course for public policy. Overall, the satisfying analysis will usher the next stage for further research into the perceived crowding-out effect emanating from the inefficiency scores of the analyzed EU countries, highlighting the possible causes and perception of identified members of the Czech cluster organizations in a case study research.

Pursuant to the proposed aim and identified research gaps as shown through the extant and systematic review of literature, the figure below offers a schematized pictorial illustration and sequential steps taken in the conduct of this research dissertation.

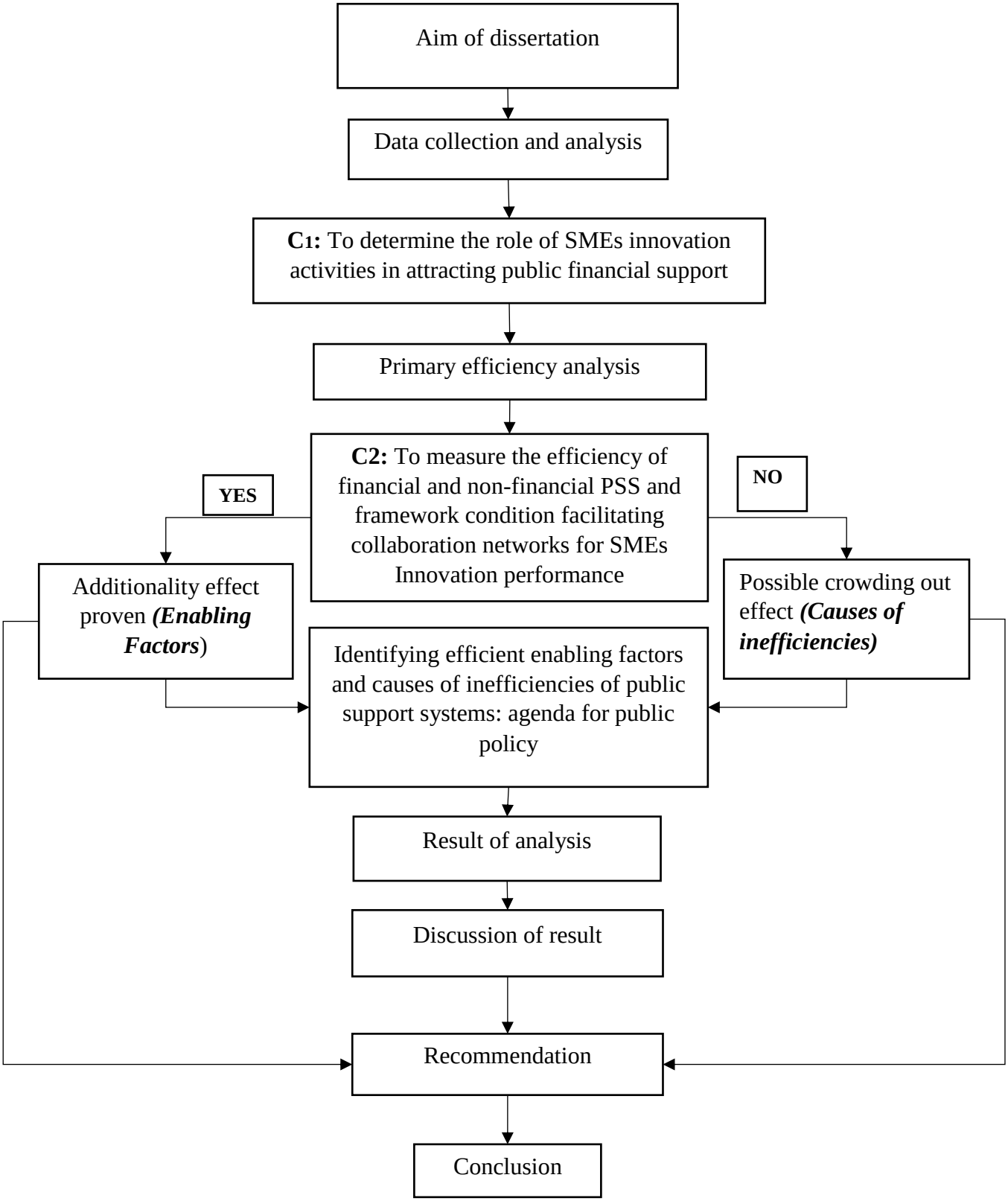

Figure 8 Structured Research Process

2.5. Methods used in this dissertation

The research approach used for the research dissertation is that of quantitative in nature. Quantitative research approach deploys numerical data, which can be analyzed using statistical processes (Creswell & Creswell, 2017). This approach can aid in the formulation and testing of propositions that seek to offer answers to research questions and help to explain the social phenomenon.

The research dissertation uses both **exploratory and explanatory quantitative** research methods. Moreover, the research uses a purposive and random sampling technique to select some European Union member states constituting the unit of analysis. Since the research intends to assess the efficacy of the inputs and framework conditions created within the national innovation systems to facilitate innovation performance of the firm's collaborative network arrangements and enabling conditions for human resource employment in KIA leading to high innovation performance, a comparative analysis of all European Union member states turns to be appropriate. The motive to emphasis on EU-wide analysis has been motivated by the seemingly **increase in public investment and conversely poor private investment**, venture capital investments in comparison with other regions like United States and China is a clear indication of a crowding-out effect.

Exploratory research design used in this research dissertation offers the flexibility to scan the efficiency and or otherwise of the role public support systems play in the creation of an innovative environment for firms' the innovation ecosystem in the European Union. In addition, to investigate how the efficient the inputs and framework conditions created in the national innovation systems enable innovation performance of firms. This design is mainly devoted to the efficiency analysis. With the determinant of firm innovation and cooperation activities and the role of public financial support, an **explanatory design** is preferred. This is because the researcher seeks to elucidate the causal linkages between public financial support and collaborative networks of the firm and their innovation activities to offer understanding and help improve knowledge about this causal relationship.

The research dissertation employs three methods for empirical analysis, i.e., Partial Least Square Structural Equation model (PLS-SEM), Logistic regression, and Data Envelopment Analysis. The PLS-SEM model is used to classify the cooperation network arrangement of firms to their innovation performance and sources of knowledge and information for innovation, aimed at establishing the extent of collaboration network in the innovation of selected European countries. Logistic regression analysis was used to explain the influence of

public financial support of firm innovation activities and collaboration arrangement. The statistical software deployed for the empirical analysis was JASP (version 0.13). This tool aided the logistic analysis, which many researchers have used in recent times. Finally, Data Envelopment Analysis enabled the researcher to estimate the efficiency scores (see Sickles & Zelenyuk, 2019 for more insight) of the framework conditions necessary to ensure the employment of human resources in Knowledge Intensive Activities and the efficiency of PSS in facilitating collaboration networks for firm innovation performance.

2.5.1. Data Envelopment Analysis

In testing for efficiency, most research resorts to the use of both parametric and nonparametric tests. Amongst several parametric and nonparametric techniques, Data Envelopment Analysis (DEA) has been applied to measure the relative efficiency of DMUs, which transform multiple inputs to multiple outputs in a similar framework. Unlike parametric models, DEA requires an unequivocal function that relates input to outputs, which has been touted as the main advantage of the model and serves as a valuable analytical and practical decision support tool. Charnes created DEA models in 1978, and the most commonly used DEA model is the Charnes, Cooper, and Rhodes (CCR) model. It analyzes efficiency Decision Making Units (DMUs) by means of a constant or variable return to scale (CRS/VRS) using the input and or output orientations. In the CCR model, at constant returns to scale, a DMU is viewed as inefficient when the technical efficiency value is less than 1, suggesting that the production value is beneath the production–possibility frontier; conversely, a DMU is deemed efficient when its technical efficiency value is equal to 1. In so doing, the researcher is able to further investigate inefficient units, which will offer the opportunity to suggest improvement and through calculating the redundancy and the deficiency value. The Model function is as follows, as used by (Li et al. 2019).

$$ej = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{mn} v_i x_{iJ}}, j = 1, \dots, n \qquad (1)$$

From the equation above: *ej* constitutes the technical efficiency of DMU j; X_{IJ} and y_{rj} denote input *i* and output *r* for DMU *j's* values, whereas v_i and u_r constitute the weight coefficients measure of input *i* and output *r*. when using CCR model, the underlying assumption is to maximize the efficiency value *ej* of the above DMU. In this way, the DMU *j's* efficiency value as the object, all other values for efficiency regarding all DMUs are modelled as constraints. According to Charnes, Cooper, and Rhodes (1978), the CCR (C2R) model depicts the following equations.

$$\text{Maxh}_{j0} = \sum_{r=1}^{s} u_r\, y_{rj0} \Big/ \sum_{r=1}^{m} v_i x_{ij} \tag{2}$$

$$ej = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{mn} v_i x_{iJ}} \leq 1 \tag{3}$$

$$\text{u} \geq 0\ \text{v} \geq 0; \text{j} = 1, \ldots, \text{n}; \text{r} = 1, \ldots \text{s}; \text{i} = 1, \ldots, \text{m} \tag{4}$$

As can be seen in the equation (5) below, $S^+$and S^- represent the slack and residual variables, respectively. These variables seek to transform the constraints from inequality to equality constraints. DEA has seen alterations by the proponents, introducing a minor *non-Archimedean* quantity bringing convenience and efficiency into the usage of the model, which has been illustrated below.

$$\left\{ \begin{array}{c} min\left(\theta - \varepsilon \sum_{j=1}^{m} S^- + \sum_{j=1}^{m} S^+\right) = v_d(\in) \\ \sum_{j=1}^{m} x_j \lambda_j + S^- = \theta_{X0} \\ \sum_{j=1}^{m} y_j\, \lambda_j + S^- = \ y_0 \end{array} \right\} \tag{5}$$

$$\lambda_J \geq 0, S^+ \geq 0, j = 1, \ldots, n \tag{6}$$

In the equation, the classification criteria, which denotes θ indicates the optimal solution and a radial distance from the production possibility frontier (PPF), whilst $S^+$and $S^-$are correspondingly the redundancy and deficiency values. Hence, the following propositions are made: A DEA-inefficient of DMU j is realized only when θ < 1; on the other hand, DMU j is considered DEA-efficient when θ = 1 and $S^+ + S^- = 0$ and the DMU j is considered as weak DEA-inefficient when θ = 1 and $S^+ + S^- > 0$.

2.5.2. Partial Least Square Structural Equation Model

Partial Least Square Structural Equation (PLS-SEM) model was used for the empirical analysis (Hair et al., 2017; Henseler et al., 2016). PLS-SEM leans on multi-regression analysis to provide scores for the latent variable measured by one or more indicators. It can estimate with small sample size issues measuring very complex models with many latent and manifest variables. The PLS-SEM model is given by the equation below (Zawojska, 2010).

$$zk = \beta 0^{(k)} + \sum \beta i^{(k)} z_i + v_k \quad (7)$$

zk depicts the explained variable in this study, innovation performance,

$\beta 0^{(k)}$denotes the constant term,

$\sum \beta i^{(k)}$represents the regression coefficient,

$v_k$connotes residual term.

PLS-SEM employs two supplementary approaches that seek to measure causative linkages between latent variables and associated indicators. These approaches include the covariance-based SEM used to assess model path co-efficiency, by exploiting the covariance matrix difference. Through parametric assumptions, the significance levels of a hypothesized relationship of factors are ascertained (Hair et al., 2017). The variance-based is the second type of PLS-SEM and opposite to the first regarding its use of parametric in analysis, used in estimating the latent variable scores through a weighted aggregation of indicators. Rather, it focuses on numerous method usages, which constitute a regression analysis based on sum scores, principal component analysis, and partial least squares path modelling. This underscores the worldwide acceptance and usage of this method due to its broad system and development.

Inferential statistics are estimated through confirmatory composite analysis to identify data incongruities as well as to offer data reliability. This is done through the goodness-of-fit analysis, which enables the researcher to ensure the correctness of the data, which may not be a hindrance to the results estimated by the data. Such technique used for goodness-of-fit estimation is with unweighted least squares (dULS), geodesic discrepancy (dG), and many others. Different indicators such as the Cronbach's alpha and others (Henseler et al., 2016) also measure the data reliability and internal consistency of PLS-SEM model. A minimum value of 0.7 is a desirable reliability measure score. Models are also assessed using the average variance extracted (AVE) with values above 0.5 required. Regarding collinearity, the variance inflation factor (VIF) estimates the dataset, which requires a range of acceptable values between 1 and 10. Model effects are estimated using Cohen's effect size, which indicates ≥0.35 and ≥0.15 as a strong and moderate effect, with ≤0.02 seen as a weaker effect.

The model below depicts the test of hypothesis as indicated in the DEA analysis.

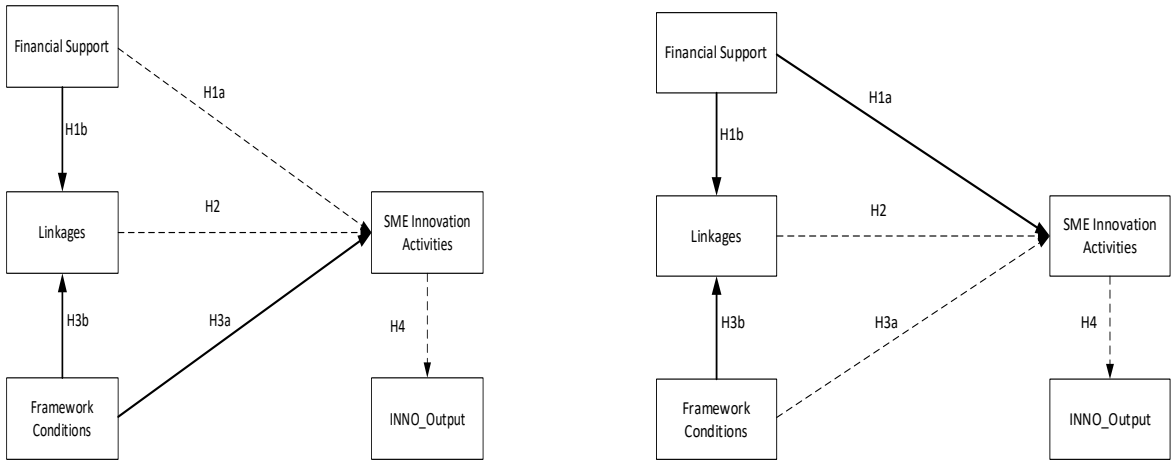

Figure 9 PLS-SEM Analytical Framework 2012 and 2019

Source: author's own

Based on the framework, the following set of hypotheses have been developed.

Hypotheses

H_{1a}: Financial supports have a direct positive significant effect on SMEs innovation activities.

H_{1b}: Financial supports have a direct positive significant effect on Linkages.

H_2: Linkages have a direct positive significant effect on SMEs innovation activities.

H_{3a}: Framework conditions have a direct positive significant effect on SMEs innovation activities.

H_{3b}: Framework conditions have a direct positive significant effect on Linkages.

H_4: SMEs innovation activities have a direct positive significant effect on innovation output.

2.5.3. Logistic regression

This method of analysis tests the relationship between several independent variables and or categorical dependent variables (Tranmer & Elliot, 2008) aimed at evaluating the likelihood of an outcome on a logistic curve (Park, 2013). It looks at the models that fit best to assess the relationship between the dichotomous dependent variable and independent variables (Maroof, 2012). Logistic regression, standard errors, coefficients, and significance levels can predict the logit transformation of the probability of a phenomenon in real life.

The general binary logistic model assumes a linear relation between the predictor variables and the log odds in the event that the dependent variable (p_x) is equal to 1 (Cramer, 2002) and is given by the equation.

$$ln\frac{p_x}{1-p_x} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k \quad (8)$$

β_0 denotes the intercept of the base

$\beta_0 + \beta_0 \ldots + \beta_k x_k$ denote the independent variables

$x_1 + x_2 \ldots + x_k$ denote the intercept of the independent variables

The dependent variables take a binary response (0, 1) and the odds are computed for by making the log-odds an exponent of the base in equation (8) above. This signifies that when a positive coefficient is measured, the consequential effect on the independent variable does increase. One can analyze as well as interpreting the model through an observation of the odds, where the likelihood of the increasing function $\frac{p}{1-p_x}$ if correlated with $ln\frac{p_x}{1-p_x}$ shows a positive outcome in relation to the variable using the maximum likelihood and probability estimation methods.

3. THE ROLE OF SMES INNOVATION ACTIVITIES IN ATTRACTING PUBLIC FINANCIAL SUPPORT

Public sector interest in innovation is well researched as highlighted in previous sections. This is mainly due to the impact innovation has made on economic development of some nations. Different support systems are available to firms to access for their innovative activities especially from the public sector. Small and Medium-size Enterprises (SMEs) play vital role in the economies of most countries. Most importantly, in the EU, SME innovative activities are prevalent leading to the major economic growth in some countries in the region. Despite their contribution to development, they are constrained by inadequate funds to engage in R&D for innovation. Outcomes of the firm innovation are because of firm activities such as firms internal and external R&D, purchase of external knowledge and so on and mostly are used as means to attract financial support from the public sector. Research assessing the impact of public sector subsidies and financial support and firm performance face quite a number of methodological issues as Karo & Kattel (2017) re-echoed in their analysis of SMEs in Eastern Europe. Amongst them is the issue of reverse causality and selectivity bias with government funding of innovation at the firm level on one hand, and the nature of data set (Correa et al., 2013). They emphasize the endogeneity of firms' innovative activities and funds SME's receive from the government.

Most studies ignore the fact that government deliberately select firms to receive R&D subsidies and this mostly led to significant bias in the econometric estimates and conclusion. Recent papers have however tried to account for this bias by putting certain dummies such as industry and location dummies to control for this bias. However, one possibility to eliminate this bias is by making the public financial support or subsidy dependent on the innovative activities of the firm and their outcomes while accounting for the propose dummies. The current research employs this methodology to show that firms innovative activities determines the public sector financial support for SME's in selected EU countries. We believe that the motive of most if not all public financial support programs is to boost and stimulate the innovations of SMEs, which are inherent in the criteria for firms to meet before accessing public funds.

To determine the role of SMEs innovation activities in attracting public financial support, three models were prepared using econometric analysis. The dependent variables (Local, Government and EU Funding) are dichotomous and other dummy variables used for the firm innovation activities constituting the independent or explanatory variables.

3.1. Variables and sources of data

The empirical analysis sourced data from the European Union Community Innovation Survey (CIS) conducted for three years from the period 2012-2014. The CIS data has enormous reference across various fields of innovation. The CIS gather data on innovation and innovation activities of firms in the EU using a harmonized survey questionnaire. The data from the CIS provides dichotomous variables, which makes analysis of the data possible by using binary logistic regression (Westmore, 2013). Several firm innovative activities are considered as determinants for public financial support. The current analysis is based on Bellucci et al. (2019) analysis of additional contribution of public subsidies to SMEs' R&D.

The outcome variables used in the analysis were all dummies consisting of both input and out variables for firm innovation such as innovation input as follows. The input variables include in-house R&D (rrdin); external R&D (rrdex), which explains contracting out research, and development, machine acquisition (rmac); acquiring knowledge from external sources (roek) and training for innovation thus training workforce and human resource base of the firm (Zúñiga-Vicente et al. 2014).

Output innovation variables employed are as follows; intellectual property right, which consist of application for patent for an innovation (propat) or European utility model (proeum) and registration of industrial design right (prodsg) these papers has previously used this variable (Bronzini & Piselli, 2016; Costantini et al., 2015).

Innovation outcome is dummied by the kinds of innovation introduced by the SMEs. This include product and service as well as process innovation (inpdgd, inpdsv, inpspd).

Lastly, in regard to open innovation, SMEs innovation collaboration was dummied by national and European innovation ecosystem which comprise of firm cooperation arrangement with other enterprise group both national and Europe (co11, co12). Others include suppliers (co21, co22); customers (co311, co312); other competitors (co41, co42); consultants (co51, co52); Universities or other higher institutes (co61, co62) and public or private research institute (co71, co72).

3.2. Result and discussion

The empirical results on whether the innovativeness of SME's determine the public sector financial support firms attract in some selected EU countries are presented in the tables below. The research considered all SME's that responded to the CIS 2012-2014 innovative questionnaire based on the CIS NACE category regardless of their enterprise group to be able

to determine whether innovative SME's funding support come from the EU, National or Local government. The selected countries were grouped in respect to their innovation classification based on the current European Union Innovation Scoreboard. The models predictive powers with public financial support at the Local, National and EU levels are between 19% and 65% shown by the McFadden R^2 in tables 1-3 below.

As provided in the table 1, SMEs firms' innovation activities such as training for innovation, internal innovation activities and machine acquisition are key determinants that attract public financial support in all innovation categories (modest, moderate, and strong innovators). Except for the moderate innovator, Czech Republic, SMEs contracted out R&D to other enterprise was significant in determining support from public funds.

Innovation output, which is intellectual property right was generally not significant determinant for SMEs to access local funds for innovation. However, application for EU utility model was only the significant factor, which was true only for Romania in the modest innovators' category. Application for patent for introducing innovation was significant determinant for Public financial support in Hungary and Spain (moderate innovators) and Germany a strong innovator.

Generally, SMEs cooperation partnership within the national innovation ecosystem is not much a determinant to access public funds. Specifically, SMEs partnership with consultants within the national ecosystem is significant for Bulgaria, whereas partnership with customers is significant for SMEs in Romania. The cooperation of SMEs with other partners within the enterprise group were not significant for SMEs in the modest innovators. This indicate the least attention public funds (especially at the local level) and programs give to instilling open innovation attitude within the regional innovation systems. SMEs collaboration with customers from the private sector, research institutes and other competitors in Spain stimulates local funds. SMEs collaboration partnership with university and consultants are key factors for public fund in the Czech Republic. In Croatia, customer's partnership with SMEs help stimulate access to public local funds. Interestingly, in Hungary, local funds for SMEs do not depend on SMEs collaboration arrangement in the national innovation ecosystem. With strong innovators, cooperation arrangements between consultants and SMEs stimulate public fund in Estonia and Germany (as well as universities and research institutes). Cooperation with customers were significant at 95% confidence level in Portugal.

Local funds for SMEs innovativeness are not dependent on collaboration partnership in EU innovation ecosystem except for Romanian SMEs whose cooperation with suppliers attract local funds for modest innovators, no significant result obtain for Bulgaria. Similar result is observed for moderate innovators like Hungary. However, in Czech Republic cooperation with other enterprise within the enterprise group located in EU help attract local funds. Cooperation with suppliers from EU was significant for SMEs in Croatia. Finally, in Spain, collaboration with other enterprise within the enterprise group and EU research institutes were significant for SMEs to access Local government funds. For strong innovators, Portugal recorded no significant influence of SMEs collaboration on attracting local funds. Institutional collaboration with Universities within Europe was key determinant for Local funds in Germany and Estonia (also, collaboration with other enterprise within the enterprise group in EU and suppliers are significant for firms to attract local funds).

Regarding innovation output of SMEs dummied by the kinds of innovation proved as key determinant in attracting local funds at all levels except for Bulgaria in the modest innovator category, Croatia, and Hungary in moderate innovators level surprisingly. Only process innovation was significant in Estonia but not in Portugal.

Table 1 Public financial support (Local)

	Bulgaria	**Romania**	**Czech Rep.**	**Croatia**	**Hungary**	**Spain**	**Estonia**	**Portugal**	**Germany**
Firm Innovative Activities									
rrdin	18.574 0.991	3.705 **0.002*****	-0.507 0.363)	-0.663 0.634	2.271 **0.086***	1.605 **< .001*****	-0.129 0.941	0.320 0.513	1.466 **< .001*****
rrdex	-17.715 0.991	0.194 0.819	0.641 0.023**	-0.198 0.793	-0.767 0.318	0.087 0.243	0.252 0.786	0.088 0.754	-0.205 0.358
rmac	1.137 **0.041****	0.615 0.439	0.647 **0.030****	19.789 0.984	0.637 0.432	0.446 **< .001*****	2.964 **< .001*****	0.939 **< .001*****	:
roek	0.883 0.145	1.216 0.108	0.063 0.828	-0.166 0.710	0.089 0.912	0.273 0.199	-0.557 0.317	0.286 0.258	:
rtr	-1.177 **0.073***	-5.228 **0.026****	0.489 **0.047****	-0.043 0.909	-0.187 0.774	0.277 **< .001*****	-0.187 0.752	0.250 0.266	:
Intellectual Property Right									
propat	-0.747 0.515	0.282 0.760	0.745 0.101	-0.956 0.386	1.493 **0.064***	0.432 **< .001*****	-17.181 0.994	0.310 0.367	0.693 **< .001*****
proeum	0.717 0.539	5.063 **0.002*****	-0.255 0.553	-18.403 0.999	0.359 0.772	-0.122 0.572	-15.869 0.997	0.850 0.125	0.240 0.276
prodsg	-0.284 0.808	19.602 0.994	3.948 **0.065***	1.317 **0.095***	-17.963 0.994	-0.020 0.878	5.381 1.000	-0.918 0.177	-0.428 0.273
Cooperation Partners- National Innovation ecosystem									
co11	-15.967 0.996	0.943 0.749	-0.114 0.772	-0.441 0.654	-0.784 0.563	0.361 **< .001*****	-0.157 0.900	-0.742 0.126	0.088 0.749
co21	-1.758 0.193	0.637 0.564	-0.178 0.575	-0.042 0.933	0.011 0.989	-0.018 0.834	-1.779 **0.069***	0.401 0.232	-0.194 0.445
co41	-18.344 0.994	0.561 0.725	-0.679 0.300	-0.781 0.462	1.226 0.171	0.356 **< .001*****	1.755 1.000	-0.295 0.516	0.095 0.737
co51	3.862 **<.001*****	-3.080 0.280	0.645 **0.088***	0.951 0.203	0.786 0.361	0.140 0.166	2.405 **0.018****	0.463 0.240	0.654 **0.008*****
co61	-14.433 0.994	-0.219 0.848	0.938 **0.003*****	-1.527 0.146	-0.261 0.776	-0.072 0.416	-1.583 0.389	0.510 0.119	1.071 **< .001*****

co71	2.701 **0.058***	1.361 0.194	0.028 0.948	1.005 0.342	-0.794 0.522	0.960 **< .001*****	1.948 0.190	0.010 0.981	0.502 **0.014****
co311	-17.622 0.991	-1.535 0.339	-0.178 0.680	-0.367 0.712	1.090 0.358	0.476 **< .001*****	0.015 0.990	-0.316 0.437	0.307 0.174
co321	-11.710 0.997	7.236 **0.006*****	0.344 0.494	2.495 **0.013****	1.983 0.198	-0.003 0.986	1.821 0.344	1.227 **0.025****	0.287 0.396
Cooperation Partners- EU Innovation ecosystem									
co12	-15.863 0.995	-2.579 0.218	-0.884 **0.088***	-20.561 0.997	0.349 0.714	-0.670 **< .001*****	-17.471 0.992	-1.349 **0.091***	-0.595 0.221
co22	0.720 0.603	3.835 **0.006*****	0.301 0.437	1.407 **0.018****	1.393 0.135	-0.085 0.533	-0.555 0.548	-1.006 **0.051***	0.263 0.556
co42	-11.577 0.997	14.070 0.998	-0.518 0.537	0.385 0.791	0.695 0.570	-0.307 0.100	-0.744 0.680	0.083 0.893	0.279 0.613
co52	-12.777 0.998	5.057 0.160	-0.564 0.446	-0.097 0.939	-18.797 0.994	-0.044 0.834	-0.585 0.711	-1.007 0.187	-0.076 0.896
co62	0.177 1.000	-28.315 0.998	0.918 0.153	-20.134 0.999	-0.270 0.883	-0.230 0.246	-15.399 0.997	1.532 **0.014***	0.659 **0.055***
co72	-17.292 0.998	12.789 0.998	0.342 0.649	-17.964 0.999	-12.978 0.998	0.570 **0.002*****	-3.865 1.000	0.647 0.325	0.354 0.376
co312	-14.027 0.994	-4.211 0.249	0.020 0.966	-1.530 0.241	0.179 0.889	0.096 0.501	-0.868 0.650	0.094 0.852	-0.203 0.589
co322	-14.401 0.997	-21.441 0.998	0.196 0.816	-22.009 0.999	-16.525 0.998	0.062 0.821	-16.348 0.997	-0.970 0.350	-0.900 0.137
Kinds of Innovation									
inpdgd	2.046 **0.002*****	0.035 0.980	1.830 **<.001*****	0.149 0.852	1.273 0.227	0.589 **< .001*****	0.803 0.415	1.151 **0.003*****	0.604 **0.019****
inpdsv	2.283 **0.007*****	-19.990 0.992	1.595 **0.006*****	0.091 0.884	1.453 0.286	0.673 **< .001*****	1.024 0.419	1.113 **0.009*****	0.767 **0.026****
inpspd	2.066 **0.012****	1.111 0.328	2.099 **<.001*****	0.107 0.851	1.679 0.149	0.657 **< .001*****	2.450 **< .001*****	0.379 0.426	0.970 **0.003*****
N	**13749**	**7143**	**4193**	**3022**	**6195**	**27214**	**1672**	**6638**	**4680**
McFadden R^2	**0.305**	**0.617**	**0.256**	**0.428**	**0.313**	**0.244**	**0.418**	**0.193**	**0.299**
Cronbach's α	**0.827**	**0.854**	**0.866**	**0.864**	**0.866**	**0.855**	**0.892**	**0.849**	**0.834**

Source: Own calculations; significance levels are p<0.05, p<0.01**, p<0.001****

In table 2, the overall probability for SMEs' innovative activities to attract government funding at the national level can be observed. The results indicate a positive and significant attracting effect of selected countries' SMEs internal research activities and acquisition of tangible machines for innovation from government support (national level) except for Estonia whose SMEs intramural innovation activities had no significant effect on accessing government financial support.

Specifically, firms' innovative activities were key stimulating factors for SMEs in Spain and Hungary to harness public financial support from the national government. Suffice to say, all the selected countries' SMEs contracting out research and development to other enterprise with the exception of Romania (positive effect but not statistically significant) and Estonia (negative but not statistically significant) showed negative significant effect. What this means is that regardless of the firms selling out viable innovation to other companies, government financial support can be extended to such firms. Surprisingly, external knowledge acquisition and training for innovation were positive and significant for only two moderate innovators (Spain and Hungary) and Romania (only training for innovation). Let me hasten to add that, result for Germany (rmac, roek, rtr) were not included due to omission from the CIS data. All the three strong innovators, two modest innovators and two out of the four moderate innovators (Croatia and Spain) had firms applying for patent of innovation significant in SMEs access to government fund.

SMEs cooperation networks with partners within the national innovation ecosystem were somewhat not important determinant for accessing government funding generally. Most important collaboration networks that influence government funding as observed from the results were partnership with higher institutions or Universities in all cases except for Croatia and Estonia, as well as research institutes both public and private (not significant for Romania and Croatia). Similar observation is true for cooperation networks with partners within the EU innovation ecosystem. Cooperation with Universities within the EU was only significant for Bulgaria and Portugal, which shows the propensity for firms to attract national government funding support. However, when SMEs collaborating partners are with enterprises within their enterprise groups, the propensity to source government funding was significant in the case of all selected countries except Bulgaria.

SMEs innovation output as showed in the table indicate a key determinant factor for SMEs to attract public financial support from the government.

Table 2 Public financial support (Government)

	Bulgaria	Romania	Czech Rep	Croatia	Hungary	Spain	Estonia	Portugal	Germany
Firm Innovative Activities									
rrdin	1.940 **<.001*****	5.049 **< .001*****	**2.129** **<.001*****	1.291 **0.032****	1.460 **< .001*****	2.891 **< .001*****	0.757 0.362	2.395 **< .001*****	3.126 **< .001*****
rrdex	-0.781 **0.021****	1.180 0.204	-0.644 **<.001*****	-0.634 **0.052***	-0.390 **0.098***	-0.315 **< .001*****	-0.127 0.768	-0.595 **< .001*****	-0.576 **< .001*****
rmac	2.211 **<.001*****	1.504 **0.002*****	**1.135** **<.001*****	3.842 **<.001*****	2.998 **< .001*****	0.334 **< .001*****	1.373 **0.003*****	0.877 **< .001*****	:
roek	-0.054 0.788	-0.279 0.589	-0.154 0.439	-0.038 0.867	0.688 **0.003*****	0.704 **0.001*****	0.472 0.202	0.059 0.692	:
rtr	0.149 0.371	1.230 **0.068***	0.054 0.718	-0.351 0.167	0.367 **0.041****	-0.180 **0.021****	0.374 0.322	0.050 0.659	:
Intellectual Property Right									
propat	0.677 **0.004*****	1.608 **0.014*****	1.612 **<.001*****	-0.035 0.948	0.090 0.808	0.636 **< .001*****	1.678 **0.004*****	0.557 **0.006*****	0.531 **0.002*****
proeum	0.725 **0.041****	1.101 0.444	0.462 0.107	-14.101 0.986	0.094 0.872	0.005 0.979	-0.049 0.976	-0.415 0.245	0.157 0.451
prodsg	0.043 0.889	-0.756 0.505	1.172 0.754	0.954 **0.077***	-0.266 0.648	-0.235 **0.068***	-0.748 0.684	0.651 **0.018****	-0.866 **0.012****
Cooperation Partners- National Innovation ecosystem									
co11	-0.790 0.166	2.432 **0.049****	-0.129 0.648	0.461 0.331	0.151 0.718	0.246 **0.012****	-0.389 0.507	-0.451 **0.069***	-0.460 0.107
co21	0.978 **< .001*****	-0.195 0.796	0.096 0.640	0.027 0.927	0.306 0.204	0.084 0.323	-0.246 0.594	0.089 0.653	-0.145 0.530
co41	-0.804 0.149	-0.618 0.473	0.673 0.107	0.215 0.704	0.384 0.242	0.391 **< .001*****	-0.797 0.651	-0.283 0.338	0.751 **0.012****
co51	-0.325 0.467	-2.761 **0.043****	0.066 0.831	0.175 0.703	-0.058 0.855	0.003 0.976	-0.623 0.316	0.212 0.390	0.275 0.279
co61	1.243 **0.002*****	3.045 **< .001*****	1.131 **<.001*****	0.556 0.198	0.861 **0.009*****	0.926 **< .001*****	0.817 0.157	1.165 **< .001*****	1.928 **< .001*****

co71	1.870 **<.001*****	1.051 0.171	1.284 **<.001*****	0.162 0.817	1.529 **< .001*****	0.808 **< .001*****	1.479 **0.030****	1.110 **< .001*****	co71 **< .001*****
co311	0.578 0.103	0.370 0.668	-0.053 0.858	-0.308 0.512	0.126 0.681	0.178 **0.058***	0.122 0.831	-0.042 0.854	0.542 **0.017****
co321	-1.223 0.101	0.065 0.955	-0.100 0.807	0.578 0.378	-0.343 0.511	-0.115 0.465	1.360 **0.081***	0.098 0.803	-0.045 0.907
Cooperation Partners- EU Innovation ecosystem									
co12	-2.096 **0.016****	0.692 0.522	-0.529 **0.067***	-0.966 **0.089***	-1.241 **0.007*****	-0.843 **< .001*****	-1.604 **0.011****	-0.964 **0.006*****	-1.233 **0.008*****
co22	-0.447 0.204	-0.489 0.644	0.011 0.969	0.296 0.432	0.035 0.916	-0.099 0.490	0.244 0.596	0.205 0.434	0.000 1.000
co42	-0.514 0.529	-3.445 0.167	0.016 0.980	-0.368 0.637	0.188 0.758	0.323 0.109	-0.127 0.833	-0.136 0.796	0.056 0.931
co52	-14.439 0.964	9.981 **0.002*****	-0.793 0.118	-0.731 0.269	-1.305 **0.034****	-0.268 0.243	0.811 0.215	-1.091 **0.031****	0.093 0.887
co62	-0.365 0.638	-7.793 **0.006*****	0.449 0.581	-14.271 0.980	0.229 0.775	0.197 0.348	1.344 0.165	1.390 **0.016****	0.556 0.183
co72	-0.351 0.793	5.241 **0.087***	0.786 0.385	0.779 0.660	0.414 0.768	0.367 **0.071***	-0.407 0.813	0.165 0.770	-0.023 0.963
co312	-0.151 0.752	-0.878 0.641	0.260 0.464	0.123 0.808	-0.218 0.630	-0.037 0.807	-0.524 0.426	0.485 0.103	0.351 0.446
co322	0.368 0.706	-16.121 0.986	-0.512 0.496	0.224 0.830	1.192 0.391	0.305 0.345	-0.230 0.859	-0.150 0.843	-1.134 **0.067***
Kinds of Innovation									
inpdgd	1.216 **<.001*****	0.989 0.150	1.500 **<.001*****	1.103 **0.019****	0.272 0.295	0.432 **< .001*****	1.299 **0.024****	1.395 **< .001*****	0.643 **< .001*****
inpdsv	1.495 **<.001*****	0.735 0.374	1.072 **<.001*****	0.664 0.146	0.226 0.511	0.808 **< .001*****	1.322 **0.091***	0.830 **< .001*****	0.021 0.944
inpspd	1.777 **<.001*****	0.566 0.546	1.766 **<.001*****	1.349 **<.001*****	0.899 **0.001*****	0.647 **< .001*****	2.258 **< .001*****	1.557 **< .001*****	0.131 0.653
N	**13749**	**7143**	**4193**	**3022**	**6195**	**27214**	**1672**	**6638**	**4680**
McFadden R^2	**0.331**	**0.652**	**0.398**	**0.424**	**0.441**	**0.365**	**0.453**	**0.356**	**0.507**
Cronbach's α	**0.827**	**0.854**	**0.866**	**0.864**	**0.866**	**0.855**	**0.892**	**0.849**	**0.834**

Source: Own calculations; significance levels are p<0.05, p<0.01**, p<0.001****

The result in the table 3 below exhibits similar trends as observed in the case of Government financial support. Again, the overall propensity for firm's innovation activities to attract EU funds show moderate effect. Notable of them all, are internal research and development, acquisition of tangible assets for innovation and training. Acquiring external knowledge for innovation was less a determining factor for SMEs to attract EU funds; similar observation is true for selling out of R&D to other enterprises. Strikingly, Estonian SMEs EU fund support do not depend on their innovation activities, which is surprising. However, this may be because of other factors inherent in the criteria or policy direction of the government. The Czech Republic also showed similar result except to say, SMEs machine acquisition showed a positive and highly significant effect.

Application for patent and EU utility right proved to be a significant determining factor for SMEs in Bulgaria and Romania to source EU funds. This was not true for Czech SMEs. The highly significant influence of patent application in obtaining EU fund was seen in Croatia.

European Union motive as observed in the Europe 2020 policy document (created in 2013) seeks to entrench innovation by fostering collaboration and networks among firms especially SMEs. However, the current result show otherwise. Cooperation seems not to be a highly determining factor for SMEs to stimulate their access to EU funds. Few of the selected countries results, which indicate there is still gaps to be covered. The most important take from the result is however, the significant result showed by the collaboration partnership of SMEs with higher institutions and Universities and government or private research institutes within both national and EU innovation ecosystem. Collaboration with consultant and other enterprises within the enterprises group stimulates SMEs access to EU fund. Lastly, innovation outcomes remain highly significant factors, which determine SMEs access to funds within the EU funding support framework.

Table 3 Public financial support (EU)

	Bulgaria	Romania	Czech Rep	Croatia	Hungary	Spain	Estonia	Portugal	Germany
Firm Innovative Activities									
rrdin	1.507 0.006***	3.140 < .001***	0.410 0.243	-3.440 0.053*	0.763 0.047**	2.443 < .001***	-0.112 0.894	1.071 < .001***	3.027 < .001***
rrdex	-0.484 0.122	-0.169 0.809	-0.078 0.685	2.230 0.013**	0.225 0.307	-0.159 0.168	0.513 0.237	-0.199 0.243	-0.562 0.040**
rmac	2.417 <.001***	1.805 < .001***	2.028 <.001***	0.372 0.616	2.321 < .001***	0.215 0.062*	0.166 0.692	0.851 < .001***	:
roek	-0.217 0.218	0.448 0.329	0.006 0.976	0.376 0.495	0.217 0.348	0.527 0.076*	-0.430 0.248	0.039 0.825	:
rtr	0.503 <.001***	0.329 0.609	0.103 0.504	0.411 0.416	0.228 0.165	0.224 0.046**	0.600 0.109	0.240 0.083*	:
Intellectual Property Right									
propat	0.424 0.053*	2.365 < .001***	0.558 0.129	2.543 0.003***	0.276 0.434	0.521 < .001***	1.210 0.032**	0.239 0.297	0.371 0.105
proeum	1.095 0.001***	-3.870 0.030**	-0.377 0.231	16.023 0.994	0.969 0.070**	-0.472 0.178	-1.616 0.287	0.480 0.243	-0.016 0.952
prodsg	0.050 0.860	-3.165 0.018**	2.317 0.378	-0.806 0.440	-0.403 0.442	-0.229 0.253	-1.001 0.574	0.887 0.002***	-0.147 0.750
Cooperation Partners- National Innovation ecosystem									
co11	-0.384 0.403	-5.306 0.125	-1.518 <.001***	-1.272 0.295	0.444 0.252	-0.172 0.230	0.434 0.374	-1.139 < .001***	0.491 0.110
co21	0.482 0.031**	1.596 0.016**	0.018 0.932	1.057 0.145	0.603 0.008***	-0.199 0.112	0.701 0.101	-0.058 0.800	-0.052 0.859
co41	-0.773 0.100	-0.957 0.387	-0.324 0.492	1.663 0.088*	0.560 0.098*	0.195 0.147	-16.235 0.983	-0.326 0.334	-0.039 0.906
co51	0.144 0.726	-0.557 0.614	0.234 0.446	0.498 0.528	-0.342 0.276	-0.118 0.405	1.085 0.024**	0.161 0.555	0.262 0.384
co61	0.330 0.393	0.185 0.783	0.951 <.001***	-18.682 0.987	1.229 < .001***	0.634 < .001***	-0.567 0.302	0.981 < .001***	0.571 0.018**
co71	0.249 0.650	0.632 0.396	0.427 0.192	2.213 0.069*	0.769 0.103	0.932 < .001***	1.135 0.076*	0.649 0.011**	0.856 < .001***

co311	0.333 0.316	-0.245 0.769	0.021 0.944	-0.343 0.706	-0.230 0.442	0.209 0.098*	-0.926 0.109	-0.170 0.516	0.236 0.364
co321	-1.159 0.085*	0.796 0.458	0.187 0.637	-0.490 0.659	-2.213 < .001***	-0.043 0.818	0.353 0.671	0.234 0.582	0.541 0.148
Cooperation Partners- EU Innovation ecosystem									
co12	-1.184 0.013**	-15.972 0.984	-0.991 0.003***	-1.113 0.404	3.334 < .001***	-1.093 < .001***	-1.477 0.012**	-0.899 0.032**	-1.209 0.043**
co22	0.164 0.577	-0.365 0.709	0.317 0.263	1.499 0.022**	-0.190 0.566	0.059 0.746	0.644 0.127	0.141 0.635	0.716 0.142
co42	-0.013 0.985	2.005 0.288	0.869 0.162	0.934 0.405	1.325 0.047**	0.772 < .001***	-0.008 0.989	0.819 0.090*	0.452 0.484
co52	-1.279 0.171	1.946 0.546	-0.033 0.949	-0.564 0.446	0.127 0.834	-0.658 0.023**	-0.065 0.913	-0.485 0.333	-1.367 0.059*
co62	3.029 <.001***	2.881 0.108	2.192 <.001***	0.325 0.718	3.975 0.003***	1.483 < .001***	1.484 0.121	1.427 0.003***	1.550 < .001***
co72	0.982 0.388	-0.059 0.976	0.160 0.822	2.213 0.069*	-3.255 0.174	1.430 < .001***	0.232 0.857	1.690 0.001***	2.094 < .001***
co312	-0.382 0.371	-1.526 0.253	0.360 0.301	-0.343 0.706	0.644 0.140	0.204 0.268	-0.052 0.932	0.358 0.261	1.004 0.015**
co322	-1.290 0.163	-13.950 0.996	-0.717 0.317	-0.490 0.659	1.723 0.568	0.139 0.685	0.712 0.545	-0.774 0.306	0.809 0.226
Kinds of Innovation									
inpdgd	1.322 <.001***	1.005 0.184	1.148 <.001***	3.628 0.006***	1.362 < .001***	0.009 0.948	2.995 < .001***	1.451 < .001***	0.610 0.049**
inpdsv	1.607 <.001***	1.443 0.090*	0.823 0.014**	2.679 0.064*	0.765 0.014**	0.372 0.024**	2.864 < .001***	1.030 0.001***	1.414 < .001***
inpspd	1.883 <.001***	1.868 0.012**	1.558 <.001***	3.912 0.002***	1.683 < .001***	0.189 0.213	2.767 < .001***	1.594 < .001***	0.637 0.138
N	**13749**	**7143**	**4193**	**3022**	**6195**	**27214**	**1672**	**6638**	**4680**
McFadden R^2	**0.410**	**0.585**	**0.350**	**0.471**	**0.472**	**0.352**	**0.432**	**0.298**	**0.430**
Cronbach's α	**0.827**	**0.854**	**0.866**	**0.864**	**0.866**	**0.855**	**0.892**	**0.849**	**0.834**

Source: Own calculations; significance levels are p<0.05, p<0.01**, p<0.001****

3.3. Conclusion and implications

Government intervention in innovative activities is imperative for the realization of social benefits on outcomes of innovation of firms especially SMEs. Government financial support in general provides firms with the ability to grow therefore as many literatures have found, SMEs need to be supported. In fact, subsidies from the public sector are however given to government-selected projects with high social rate of returns. This has created firm's innovation and public financial endogeneity nexus, which many studies have identified but it seems there, exist no solution to break this link, which bias most analysis of the public support for firm innovation. Public financial support policies place emphasis on knowledge base innovations, which encourages SMEs to increase their knowledge capacity as the result has shown by the collaboration partnership of SMEs with higher institutions and Universities and government or private research institutes within both national and EU innovation ecosystems.

Prior literature paid more attention to the financial aspect of the public support system, which the current research followed suite. However, it is imperative to keep in mind the vast and varying result research in this field have shown measuring the effect of public support on firm innovation of treated firms that sourced funds from the public sector. The research deduced that innovative SME's that are engaged in innovation activities attract government financial support (Local and National) and EU funds for their innovative activities in most cases peculiar to the kind of innovation activities an SME is engaged in. As a result of public innovation policies that support SMEs, which engage in innovative activities, national and EU, funds are likely to be awarded SME innovators. Collaboration arrangement was generally not key determining factor for SMEs to source funds. For EU and national funds, the triple helix collaborations are being entrenched as showed in the result to be the most significant determinant factors for SMEs access to public funds for innovation.

The findings of this analysis call for policy and practical implications that both the SMEs and public sector policy makers need to consider ensuring a win-win situation in providing financial support and attracting same from the public sector.

- from the analysis, it could be deduced that local funding is less to no existent in the innovative support pool of SMEs in the analyzed countries. SMEs are more inclined to the regional innovative systems of the state, hence public sector innovation support policies should make use of this channel to effectively ensure support of firms at the

same time building a strong ecosystem at the local level, specifically Croatian and Hungarian policy makers should explore the local funding channels in supporting SMEs.

- the local funds that SMEs secure at the local level do not foster cooperation within the local innovation ecosystem as well as international collaboration in the selected countries. The focus on innovative output may be detrimental to the effectiveness of the innovative systems especially Bulgaria, hence local funding of member states should take a turn in support of collaborative firms.
- SMEs in order to be able to attract public financial support at various levels should inculcate development of collaborative culture and innovation management skills as the public policy is fine-tuned towards same.
- additionally, in the current sphere of unknown consequences of the pandemic, diverse support systems and support packages to the business sector have been approved by different nation. The global crisis induced- public debt rise require both support and regulatory schemes of firm innovation to become a supplementary driver of the shift towards efficient public support systems.
- finally, firm innovation support is critical within the context of international policy collaboration for Estonia and Romania. This imperative implication is directed to most especially, CEE countries whose innovation systems are still catching up. SMEs collaboration with international cooperative partnerships within EU and the rest of the world to boost firms export and knowledge sources for innovation performance.
- This support the notion of transnational innovation systems where cross-country linkages are stimulated for firm research and innovation activities as well as support institutions which will create knowledge transfer and diffusion across the participating regions.

From the analysis, the financial support from the national government and EU to SMEs do not facilitate network effort of SMEs yet, enormous amount of financial interventions has been earmarked year by year through the various policies of the EU and member states. This indicates that this financial support does not efficiently influence linkages of SMEs leading to a disjoint of the innovation policy objective and the reality of the phenomenon as showed by the result. Therefore, in the next section, an efficiency analysis is conducted to determine the efficiency of the financial support as well as the framework condition in enabling network among SMEs.

4. MEASURING THE EFFICIENCY OF FINANCIAL AND NON-FINANCIAL PSS IN FACILITATING COLLABORATION NETWORKS FOR SMES INNOVATION PERFORMANCE

In the previous analysis, the research has shown how SMEs innovativeness influences their propensity to be supported by public financial support system. Even though there is a general debate about the difficulties of overtly assessing this phenomenon, the current analysis has highlighted critical assumption in dealing with the design of support mechanisms of the public sector in the midst of increasing public debt due to the increased public expenditure. Whereas the implication for these findings are critical to the selected countries, further analysis is required, the objectives of this research seek to highlight the combination of both financial and non-financial public support system as facilitators of SMEs innovation activities and collaboration.

To this end, Data Envelopment Analysis (DEA) was employed to ascertain the technical efficiency of both public financial support and framework conditions in inducing SMEs innovation collaborative activities. This section starts with the analysis of description of selected EU member countries. The research selected all the 27 member states of the EU to compare their National Innovation Systems by analysing public support system variables and framework conditions to compare their efficacy. The analysis employs a two stage DEA analysis to compute the technical efficiency of the selected decision-making units (Carayannis et al., 2015). The analysis used the 27 member states of EU against the backdrop of mammoth public investment and relatively high innovation performance of firm. Many issues are thus surround the failure of these support system in facilitating efficient collaboration of firms. Hence, the current analysis employs a two-stage variable return to scale DEA analysis of the selected variables in the table 5.

The member states are grouped based on the 2020 innovation performance ranking of the European Innovation Survey. The table is constructed based on the innovation classification of EU. Thus, five member states constitute innovation leader whose innovations performance is significantly way above the average EU performance, and seven strong innovators with innovation close or above the EU average. Others are moderate innovators which include thirteen member states whose performance is below EU average and lastly, two modest innovators with innovation performance below 50% of the EU average as outlined in table 4 below.

4.1. Data and Methodology

The European Innovation Scoreboard (EIS) include a ten innovation dimensions within five major areas. Overall, 27 indicators are used in the ranking process, with data sourced from different databases such as: Eurostat, the Scopus database, Data calculated by Science-Metrix as part of a contract with the European Commission (DG Research and Innovation), Community Survey of ICT Usage and E-commerce in Enterprises, Global Entrepreneurship Monitor (GEM), Venture capital data from Invest Europe, GDP data from Eurostat, Community Innovation Survey, Patent data from the OECD, Trademark data from the European Union Intellectual Property Office (EUIPO) and World Intellectual Property Office (WIPO), Design data from the European Union Intellectual Property Office (EUIPO) and many others (Bielinska-Dusza & Hamerska, 2021). For the purpose of the DEA analysis, thirteen variables were selected within the EIS structural methodology as follows.

Table 4 EIS Country Innovation Rank

Innovation Leaders	Strong Innovators	Moderate Innovators	Modest
Denmark (DK) Finland (FI) Luxembourg (LU) Netherlands (NL) Sweden (SE)	Austria (AT Belgium (BE) France (FR) Germany (DE) Estonia (EE) Ireland (IE) Portugal (PT)	Croatia (HR) Italy (IT) Latvia (LV) Czech Republic (CZ) Lithuania (LT) Malta (MT) Greece (EL) Poland (PO) Slovenia (SI) Hungary (HU) Slovakia (SK) Spain (ES) Cyprus (CY)	Bulgaria (BG) Romania (RO)

Source: Author's own based on EIS (2020)

In order to conduct the efficiency analysis of Public support for SMEs, the following variables have been selected to be used in the analysis as outlined in table 5 below.

Table 5 Variable Description

Latent Variables	**Manifest Variables**	**Descriptions**	**References**
Framework Conditions	PTE	Population completed tertiary education	Anderson & Stejskal (2019) Nasierowski & Arcelus (2012) Bielinska-Dusza & Hamerska, (2021)
	ISCP	International scientific co-publications	
	ODE	Opportunity-driven entrepreneurship	
Financial Support	R&D-Exp (PS)	R&D expenditure in the public sector	(Filippetti, Frenz & Ietto-Gillies, 2009) & (Zygiaris,
	R&D-Exp (BS)	R&D expenditure in the business sector-R&D-	

		Exp (BS)	2010)
	R&D co-fund	Private co-funding of public R&D	
	NON-R&D-Exp	expenditures Non-R&D innovation expenditure	
Linkages	INNO-SME.CO	Innovative SMEs collaborating with others	(Filippetti, Frenz & Ietto-Gillies, 2009) & (Nasierowski, 2019)
	PP-Co-P	Public-private co-publications-PP-	
SME Innovation Activities	SME-Prod/Proc INNO	SMEs with product or process innovations	(Nasierowski, 2019) & (Zygiaris, 2010)
	SME-MKT/ORG INNO	SMEs with marketing or organisational innovations	
INNO_Output	SALES	Sales of new-to-market and new-to-firm innovations	(Anderson & Stejskal, 2019) & (Nasierowski & Arcelus, 2012)
	EMP-KIA	Employment in knowledge-intensive activities	

Source: Author's own based on EIS (2020)

In order to detect any multicollinearity issues, a variance inflation factor (VIF) analysis was done to detect no variance of the variables had undesirable inflation. To detect inflation of the variance of the variable, Hair et al. (2012) underscore that the VIF value of the variables should not exceed the value of five. Any value according to them which exceed this threshold means the dataset has potential high collinearity among the variables which may bias the findings. Our data showed no such issues with the VIF values all below <5 (see appendix for details).

4.2 Data Envelopment Analysis Model

The DEA model is based on Charnes, Cooper and Rhodes (CCR) model. It analyses efficiency Decision Making Units (DMUs) by means of a constant or variable return to scale (CRS/VRS) using the input and or output orientations. The CCR model at variable returns to scale, a DMU is viewed as inefficient when the technical efficiency value is less than 1, suggesting that the production value is beneath the production–possibility frontier; conversely, a DMU is deemed efficient when its technical efficiency value is equal to 1. A two-stage model approach was used in this assessment to determine the technical efficiency which is measured in line with the output/input ratio between the years of 2012-2019 (the current year as of writing this thesis).

The model included all the 27 EU member states as the DMUs using the input-oriented approach. By using the Variable Return to Scale, we assumed that member states have the possibilities to adjust and control the input variables which is technically within their domain of public policies and programmes, however, has little to no chance in the output consequences.

In the analysis the number of input variables were six and three output variables making altogether nine variables at the first stage. These variables consist of the framework conditions and financial support variables over the linkages variables as shown in the table (5) in the preceding paragraphs. In the second stage, with the same approach, six input variables were used, which constitute the combination of the financial support and linkages variable and additional four output made up of SMEs innovation activities and innovative outcomes of the firms.

4.3 Findings and Discussion

In measuring the efficiency of financial and non-financial PSS in facilitating collaboration networks for SMEs innovation collaboration, population who has completed tertiary education, International scientific co-publications, Opportunity-driven entrepreneurship, R&D expenditure in the public sector, R&D expenditure in the business sector-R&D-Exp (BS) and Private co-funding of public R&D expenditures were used in estimating the efficiency result. The descriptive statistics can be found in the table below.

Table 6 Descriptive Statistics

	PTE	ISCP	ODE	R&D-Exp (PS)	R&D-Exp (BS)	NON-R&D-Exp	INNO-SME.CO	PP-Co-P	R&D co-fund	SME-Prod/Proc INNO	SME-MKT/ORG INNO	EMP-KIA	SALES
Valid	27	27	27	27	27	27	27	27	27	27	27	27	27
Missing	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	125.852	119.747	103.593	77.704	74.256	105.037	93.481	87.481	122.741	105.926	77.778	102.741	78.481
Std. Deviation	72.136	78.742	82.356	42.574	58.666	49.903	43.729	36.855	69.975	94.081	34.303	52.561	34.976
Minimum	3.000	18.000	0.000	10.000	3.000	34.000	20.000	18.000	21.000	8.000	18.000	11.000	0.000
Maximum	255.000	279.00	276.000	157.000	204.000	227.000	155.000	163.000	248.000	323.000	143.000	232.000	157.000

Source: Author's own

The current result is premised on the EU long-term strategy for smart, sustainable, and inclusive growth- Europe 2020 Strategy. This flagship strategy as a matter of priority sought to induce growth, which is smart, sustainable and inclusive within the Union through developing an economy, which is based on knowledge and innovation, **promoting a more**

resource efficient, greener and more competitive economy as well as fostering a high-employment economy delivering social and territorial cohesion. To wit, any policy among member states should be geared towards ensuring these objectives. From the efficiency analysis **for the base year 2012** (first stage), all modest innovators were not efficient in the deployment and usage of the financial support and the framework condition to inducing collaboration among innovative SMEs Surprisingly, only one member state (Luxembourg) amongst the innovation leaders was technically efficient. This finding affirms the earlier indication of the regression analysis in chapter three.

Whereas, relative efficiency was recorded among all strong innovators, three member states (Slovenia, Hungary, and Spain) were found not to be efficient. Regarding the reference year (2019, first stage), all member states within the innovation leaders were efficient including the modest innovators. Portugal and France were the inefficient folks among the strong innovators. Hungary, Spain, and Slovakia are the only inefficient state within the moderate innovators as shown in the table below.

Table 7 Stage one DEA Result

Country		Eff. Score 2012	Ranking	Eff. Score 2019	Ranking
Innovation Leaders	Denmark (DK)	0.89	22ND	1.0	1ST
	Finland (FI)	0.87	23RD	1.0	1ST
	Luxembourg (LU)	1.0	1ST	1.0	1ST
	Netherlands (NL)	0.87	24TH	1.0	1ST
	Sweden (SE)	0.69	27TH	1.0	1ST
Strong Innovators	Austria (AT	1.00	1ST	1.0	1ST
	Belgium (BE)	1.00	1ST	1.0	1ST
	France (FR)	1.00	1ST	0.92	23RD
	Germany (DE)	1.00	1ST	1.0	1ST
	Estonia (EE)	1.00	1ST	1.0	1ST
	Ireland (IE)	1.00	1ST	1.0	1ST
	Portugal (PT)	1.00	1ST	0.62	27TH
Moderate Innovators	Croatia (HR)	1.00	1ST	1.0	1ST
	Italy (IT)	1.00	1ST	1.0	1ST
	Latvia (LV)	1.00	1ST	1.0	1ST
	Czech Republic (CZ)	1.00	1ST	1.0	1ST
	Lithuania (LT)	1.00	1ST	1.0	1ST
	Malta (MT)	1.00	1ST	1.0	1ST
	Greece (EL)	1.00	1ST	1.0	1ST
	Poland (PO)	1.00	1ST	0.83	25TH
	Slovenia (SI)	0.86	25TH	1.0	1ST
	Hungary (HU)	0.92	21ST	0.97	22ND
	Slovakia (SK)	1.0	1ST	0.88	24TH
	Spain (ES)	0.79	26TH	0.74	26TH
	Cyprus (CY)	1.0	1ST	1.0	1ST
Modest	Bulgaria (BG)	1.0	1ST	1.0	1ST
	Romania (RO)	1.0	1ST	1.0	1ST

Source: Author's own

The second stage was framed on the translation of the output variables deployed as inputs together with financial support and the framework condition in relation to SMEs with marketing or organizational innovation and SMEs with product or process innovation as well as the impact output- sales of new to market and new firm innovation and employment in knowledge intensive activities. For 2012 (second stage), all innovation leaders and modest innovators were efficient. Among the strong innovators, Belgium, France, Estonia-ranked least efficient, and Portugal were inefficient, whilst Czech Republic was the only inefficient member state among the moderate innovators ranked as the third least efficient member of the lot. Slovenia, which was ranked among the topmost efficient members in 2019 was ranked as the least efficient relative to the lots, together with Hungary, Poland Czech Republic and Croatia were the inefficient members among the moderate innovators. Likewise, Estonia as the only inefficient member of the Strong innovators. Sweden and Denmark, innovation leaders are ranked the second and fourth least efficient members of the lot.

Table 8 Stage two DEA Result

	Country	Eff. Score 2012	Ranking	Eff. Score 2019	Ranking
Innovation Leaders	Denmark (DK)	1.00	1ST	0.58	24TH
	Finland (FI)	1.00	1ST	1.00	1ST
	Luxembourg (LU)	1.00	1ST	1.00	1ST
	Netherlands (NL)	1.00	1ST	1.00	1ST
	Sweden (SE)	1.00	1ST	0.56	26TH
Strong Innovators	Austria (AT	1.00	1ST	1.00	1ST
	Belgium (BE)	0.94	23RD	1.00	1ST
	France (FR)	0.88	24TH	1.00	1ST
	Germany (DE)	1.00	1ST	1.00	1ST
	Estonia (EE)	0.43	27TH	0.80	22ND
	Ireland (IE)	1.00	1ST	1.00	1ST
	Portugal (PT)	0.67	26TH	1.00	1ST
Moderate Innovators	Croatia (HR)	1.00	1ST	0.95	20TH
	Italy (IT)	1.00	1ST	1.00	1ST
	Latvia (LV)	1.00	1ST	1.00	1ST
	Czech Republic (CZ)	0.71	25TH	0.81	21ST
	Lithuania (LT)	1.00	1ST	1.00	1ST
	Malta (MT)	1.00	1ST	1.00	1ST
	Greece (EL)	1.00	1ST	1.00	1ST
	Poland (PO)	1.00	1ST	0.67	23RD
	Slovenia (SI)	1.00	1ST	0.51	27TH
	Hungary (HU)	1.00	1ST	0.57	25TH
	Slovakia (SK)	1.00	1ST	1.00	1ST
	Spain (ES)	1.00	1ST	1.00	1ST
	Cyprus (CY)	1.00	1ST	1.00	1ST
Modest	Bulgaria (BG)	1.00	1ST	1.00	1ST
	Romania (RO)	1.00	1ST	1.00	1ST

Source: Author's own

The findings as outlined in the preceding sections paints a picture of the potential for public policy in developing efficient innovation policies. The underlying assumption of this analysis

was to explore and measure about the long-term effect of public support policies in inducing collaboration activities. As Ponsiglione et al. (2018) have discussed cooperation as being imperative to competitiveness. The efficiency analysis has shown that support systems and the right combination of framework conditions can induce collaborative networks. This is practically and theoretically robust in that it corroborates the new economic geography assumption of spillover effect where human resource become the agent of knowledge transfer.

The human capital within the region is key based on the innovation system theory. The research system within the local context ensure networked-induce innovation nevertheless, different accounts and outcomes are placed on innovation system measurements. Generally, the findings have shown results consistent with Anderson & Stejskal (2018) that the so-called high performing innovative states within the European Union constitute the most inefficient input utilizers. The variable return to scale analysis has revealed that the highest ranked based on the EIS survey ranking are mostly inefficient in inducing SMEs collaborative networks in regard to the choice of combining framework condition and financial support to efficiently induce collaborative networks.

Table 9 Input redundant and output deficient analysis (in %)

	PTE %	ISCP %	ODE %	R&D-Exp (PS)	R&D-Exp (BS)	NON-R&D-Exp	INNO-SME.CO	PP-Co-P
Denmark	12	45	42	92	84	13	-1	-10
Finland	15	33	15	55	74	16	-	-15
Hungary	8	8	28	41	54	8	-47	-11
Slovenia	16	30	105	16	101	17	-	-
Sweden	45	45	70	47	54	45	-	-5
Netherland	-	-	-	-	-	-	-	27

Source: Author's own

The input redundant and output deficient analysis was used to analyze the inefficient states. Sweden has topped the EIS ranking for a very long time and has been used as benchmark for other transition and emerging economies in Europe and beyond as shown by the efficient value. The input variables show a higher percentage redundancy in the reference year. An interesting pattern is that the member states from the Northern Europe (Denmark, Finland, and Sweden) have deployed in excess of requirement to achieving technical efficiency in relation to other member states or may have used the available resources in areas not required. This could also be as a result of the early economic shocks (see Skrinjaric, 2020) of the

Pandemic which thwarted the excess capacity utilization or induce highest redundance in the public expenditure for R&D.

4.4. Conclusion and implications

This section of the dissertation investigated the efficiency of financial and non-financial public support system in inducing SMEs collaborative innovative activities. The research measured the technical efficiency of member state in their use of input variables for innovation performance. Based on the framework condition and financial support were set as the output are the first stage and SMEs linkages being the output variable. Subsequently, the analysis employed a combination on the framework condition, financial support and SMEs linkages as input variable for the firm innovation activities performed by SMS impact thereof as output.

The findings proved that generally at the first stage approximately 26% of the 27 member states of the EU recorded in efficient values relative to the groups. Similarly, 22% of member states were inefficient at the second stage. Most member states of the European Union are using the input resources efficiently. However, an observed trend includes the innovation leaders inefficiently in combining the framework conditions and financial support to induce SMEs collaborative networks. Among the inefficient member states were four Scandinavian countries. It was interesting to observe that these countries constitute according to the EIS ranked among the topmost innovation performing countries in EU. The result cannot entirely be interpreted as to mean that they're input deployment are in excess but must be associated with the soci-economic and political ideologies of these states which researchers must pay attention to in the interpretation of the efficiency result.

The welfare state demand for support of the national economy at various levels hence, innovation programs in these countries have enormous access to financial support within the national economy. With their status as belonging to elite states, it may be necessary to put input resources into efficient use. Therefore, the following implications are imperative for these countries to adhere to optimal use of resources to eliminate redundancy in the innovation systems. Theoretically, it could be argued that these inefficient sets with high percentage of input redundancy may be interpreted as state funds **crowding-out private financial resources**. However, other factors such as failure within the government may cause the observation to be made, which may be key to the findings of this research.

From the theoretical and practical point of view, the following implications are crucial to the public support of the observed system of EU member states.

- An effective public support for firm's innovation should be linked to strong institutional and structural changes such as decentralizing most support systems to offer the needed and right amount of support to firms that can be monitored to ensure efficient realization of the desired outcomes. This does not translate to the calling of many to ensure sovereignty in technology ownership as the linkages in regard to international linkages and influence as being evasive.
- Member states must design support systems based on the needed objective and desired outcomes but must be focused especially in the current crisis. Resource allocation must be linked to innovation R&D 4 for the usage of new and improved drugs which may create an obscure redundancy where all input resources would be channeled towards the trendy arena instead of building a balanced optimality between the input resources and the output to create and sustain growth in the economy.
- Hungary and Slovenia are within the member states who are considered as insufficient input utilizers. It is important for such transition state to use input resources efficiently and to the right areas of the innovation system of the country's economy.

DEA analysis upon its robust solution in determining efficiency of DMUs, is limited in measuring effect of set of input variables on the output ones, which gave the necessity to conduct hypothesis testing as set out in the following sections.

4.5. Test of hypothesis

Based on the findings as per the DEA analysis, as a matter of implication to ascertain the validity and effect of these factors enveloped for the measurement of technical efficiency of the European member states, the following research questions have been formulated in accordance with the theoretical underpinnings of the public support systems.

Q1. How does public support system facilitate efficient innovative SMEs collaborating with others?

Q2. How do public support systems induce the creation of attractive research system and support of human resource development?

Q3. How does this (Framework Conditions) lead to SMEs innovative performance?

Q4. Do collaborative network of innovative SMEs result in innovative performance?

We believe that, based on the conceptual framework and the extant literature, the research set out to prove or otherwise the critical decisions of the DEA result, which underpins the analysis and to test these factors that induce the crowding out or input additionality effect. Based on the two-stage approach DEA analysis, the assumptions of the research were to be able to conclude in answering these critical questions in the input-oriented efficiency decision. We set to show that when these Member states result shows a technical efficiency, we assume an input additionality effect of the input factors on the SMEs collaborating and innovation performance. With which a test of hypothesis has been generated based on the DEA result using a multiple regression analysis tool.

The test of hypothesis was based on the unput factor variables of the DEA analysis. However, for robustness and model fit, two of the variables (Non-R&D innovation expenditure Employment in knowledge-intensive activities) were dropped. Hence eleven (11) out of the thirteen variables was employed in the analysis. The analysis was based on the partial least square structural equation model (PLS-SEM) was used for the empirical analysis (Hair et al., 2020). PLS-SEM leans on multi-regression analysis to provide scores for the latent variable measured by one or more indicators. It can produce estimates with small sample size issues while measuring very complex models with many latent and manifest variables. PLS-SEM is given by the following equation (Zawojska, 2010; Gyamfi & Stejskal, 2021).

4.6. Discussion of Result

4.6.1 Model evaluation

To ensure the internal consistency of variables operationalized to measure constructs used in the model, an analysis of construct reliability and validity was carried out in order to test the trustworthiness of the result obtained from the model. The research used Cronbach's alpha, rho_Alpha, composite reliability analysis, and average variance extracted (AVE). The generally acceptable value for consistency analyses as per (Franke & Sarstedt, 2019) is O.7. However, this was true only when using Cronbach's alpha and rho_Alpha measures.

Table 10 Construct Reliability and Validity

	Cronbach's Alpha		Rho_ Alpha		Composite Reliability (CR)		Average Variance Extracted (AVE)	
Year	**2012**	**2019**	**2012**	**2019**	**2012**	**2019**	**2012**	**2019**
Financial Support	0.812	0.878	0.976	0.926	0.877	0.924	0.714	0.802
Framework Conditions	0.659	0.428	0.940	0.837	0.794	0.691	0.626	0.547
INNO_Output	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Linkages	0.805	0.625	0.810	0.637	0.911	0.841	0.837	0.726
SME Innovation Activities	0.929	0.900	0.964	0.911	0.965	0.952	0.933	0.909

Source: Author's own

Following the test for construct reliability and validity, the goodness-of-fit test was conducted to measure overall model fitness (Cheah et al., 2018). This helped in a better estimation to ascertain whether the model fits well with the data used, which goes a long way in affecting the conclusions drawn from the results.

Table 11 Model Fit

	Saturated Model		Estimated Model	
Year	2012	2019	2012	2019
SRMR	0.109	0.122	0.111	0.132
d_ULS	0.779	0.979	0.811	1.141
d_G	0.798	1.058	0.817	1.059
Chi-Square	101.949	120.628	103.879	124.439
NFI	0.645	0.535	0.639	0.520

Source: Author's own

Five goodness-of-fit estimations are generally used for this test (Table 4). After bootstrapping, the research used unweighted least squared Euclidean distance (dULS) as well as geodesic discrepancy (dG), which helped assess the general goodness of fit (Dijkstra & Henseler, 2015). In addition, the standardized root mean squared residual (SRMR) was also used to prove the approximate model fit. This test helped us estimate how important the discrepancy between the implied model and the empirical correlation matrix is. According to Henseler et al. (2014), the model fit recorded between zero (0) and 0.6 signal perfect and acceptable fit, respectively. Coupled with chi-square and normed fit index (NFI), these tests prove that the data used in the analysis fit the model constructed.

4.6.2 Analysis of Findings

This section presents the results of the econometric analysis and a summary of the effect analysis, as shown in Table and the path model with coefficients of the PLS- SEM algorithm. The result as showed in the table comprise of the years 2012 and 2019. Public financial

support indicates investment both by the public and business sector. Our result showed a rather a minimal positive effect on the innovation output of the SMEs in all the 27 selected European states in 2012 and moderate positive effect was observed in 2019 however proved to be not significant. The ultimate goal of every innovation economic policy seeks to impact positively economic growth and productivity by increasing SMEs innovation output. At the EU level analysis, the current analysis has proved the direct support of SMEs innovation R&D activities do not impact SMEs innovation output. Unlike the studies of Zemplinerova & Hromadkova (2012), whose findings showed a negative effect on firms transforming innovation input into output using a Czech sample, this finding corroborates that of Radicic et al. (2016) who studied 28 EU countries on the effect of national and EU R&D programmed on output additionality. Their result found no evidence of innovation output additionality from national programmes and crowding-out of EU programmes. However, our analysis is contradicts Hottenrott & Lopes-Bento (2014) whose findings showed that R&D induced by public subsidies do indeed contribute to innovation performance of SMEs and that both, privately financed as well as publicly induced R&D have significant positive effects on firms' innovativeness. Our finding clearly shows that within the EU, financial support does not lead to input additionality of SMEs innovativeness.

Table 12 PLS-SEM path coefficient

	Original Sample		**T-Statistics**		**P-Values**	
Years	***2012***	***2019***	***2012***	***2019***	***2012***	***2019***
Financial Support -> INNO_Output	0.031	0.105	0.357	0.919	0.722	0.358
Financial Support -> Linkages	0.369	0.521	2.484	4.881	**0.013 ****	**0.000 *****
Financial Support -> SME Innovation Activities	0.149	0.398	0.682	2.528	0.495	**0.012 ****
Framework Conditions -> INNO_Output	0.130	0.087	0.852	0.887	0.395	0.376
Framework Conditions -> Linkages	0.625	0.489	5.201	4.191	**0.000 *****	**0.000 *****
Framework Conditions -> SME Innovation Activities	0.633	0.328	2.987	1.857	**0.003 *****	0.064
Linkages -> INNO_Output	0.051	0.172	0.354	0.846	0.724	0.398
Linkages -> SME Innovation Activities	0.247	0.652	0.602	1.680	0.547	0.094
SME Innovation Activities -> INNO_Output	0.205	0.264	0.898	1.165	0.370	0.244

Source: Author's own

Firm financial support of R&D within the public sector as well as those support from the venture capitalist and within the business sector itself showed a high path co-efficient in both years under review in relation to the linkages. We therefore **accept the hypothesis H_{1b}** that financial supports have a direct positive significant effect on Linkages. What this suggest is

that, within the EU, financial support facilitates innovative SMEs collaborating with others as well as Public-private co-publications and Private co-funding of public R&D expenditures with a positive and significant p-values. This finding is consistent with (Caloffi et al., 2018, Kim et al.,2021) assertion that subsidies to collaborative R&D activities of the firm tenaciously and effectively stimulate networking behavior among the firms that receive such supports. On the contrary, a Probit analysis done by Hottenrott & Lopes-Bento (2014) showed that both collaborative status of firms was not significant for firms that receive direct financial interventions. However, reiterate that collaboration significantly induce SMEs innovation activities. Both public and private R&D financial support significantly affects firms' innovativeness.

Our findings **reject the first hypothesis H_{1a}** that financial supports have a direct positive significant effect on SMEs innovation activities. The path co-efficient value showed a rather weak effect size at least for the year 2012. However, was significant in the year 2019, therefore this hypothesis is confirmed for the current year under review.

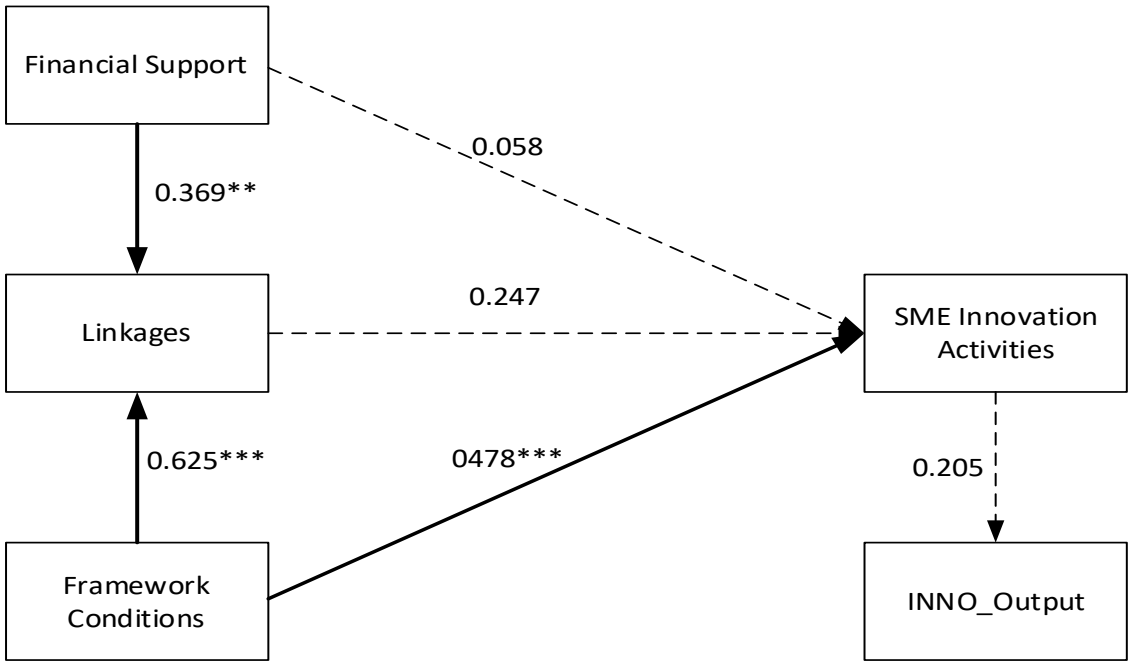

Figure 10 Results of PLS-SEM model

*Source: Author's own; *** significant at; 0.01; ** significant at 0.05*

From the analysis, even though EU financial support highly induce collaborative networks among innovative SMEs, their collaborations do not necessary translate into SMEs product or

process and marketing or organizational innovation. Therefore, **hypothesis H_2 is rejected** for all years. This finding is in line with that of Haus-Reve et al. (2019) which examined the complementarity between supply scientific and chain partners interaction using panel data found that collaborating with both scientific and supply-chain partners simultaneously does not yield greater innovation. Shi et al. (2020) however, found interesting result that when collaboration between Universities and industry deepens, such collaborations show significant innovation efficiency but across different stages of the collaboration. To ensure effective collaboration therefore, it is imperative to strengthen institutions as the key moderators. It is rather interesting for this research that much financial and R&D support within the EU framework strategy seek to instil collaborative linkages among especially transnational SMEs, yet the result has proven that, the effort are seemingly not efficient enough, which was also confirm in the DEA analysis among the Scandinavian and welfare economies of the EU as well as some other member states. One may argue that it takes time for firms to realize result from innovative activities at least until a long period of time. This line of argument may not be valid for this result as a time lag of seven years is used which is within the definition of a long-term enough for result to be achieved and be visible. This stimulate interesting policy thinking which need fine-tuning.

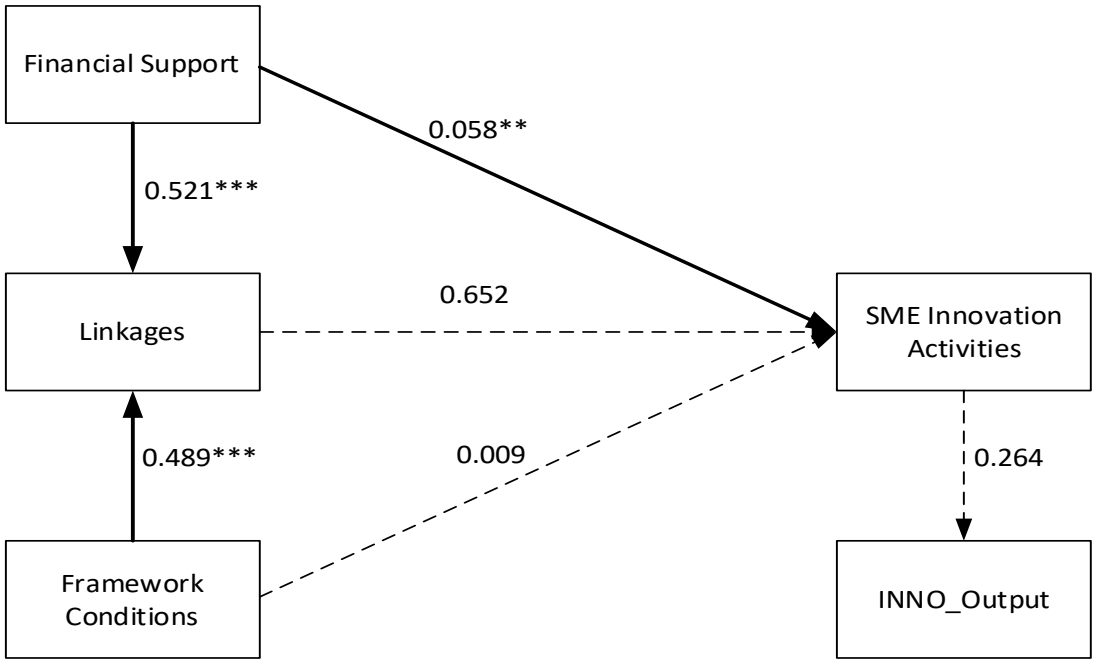

Figure 11 Results of PLS-SEM model

*Source: Author's own; *** significant at; 0.01; ** significant at 0.05*

The framework condition implies the human capital stock within the EU as well as the attractiveness of the research systems of member states. From the path analysis, in 2012, a high positive and significant effect was observed for the framework condition on SMEs innovation activities, thereby **accepting hypothesis H3a**. What this suggest is that, firm knowledge capacity and the availability of highly qualified human capital lead to innovation if efficiently and effectively utilized to full capacity. However, in 2019, the result proved no significant effect, which leads to **rejection of the hypothesis H3a**. According to the knowledge-based view, the stock of human capital is crucial for firm competitiveness and serves as a source of perpetual advantage to the firm when managed well. From the inclusive growth point of view, it is critical in fostering a high-employment economy delivering social and territorial cohesion. This result is consistent with the theoretical assumptions of (Cohen & Levinthal, 1989;1990). When the knowledge carriers or bearers are at full employment, competitiveness and growth will be within the stretch of firms. Farace & Mazzotta (2015) found that human capital characteristics, experience, and training increases innovation propensity as well as growth of SMEs. Hypothesis H3b was accepted for all years which is connected to the effect of the research system attractiveness and human capital stock on inducing collaboration among innovative SMEs, public private co-publications, and private co-funding of public R&D expenditures. This is true, in that international scientific co-publications coupled with innovation- friendly environment and the human resources base of new doctorate graduates may lead to collaboration as the social capital theory has propounded. The current literature about this finding is consistent and replicated in many areas. For instance, Iturrioz et al. (2014) had found social capital system leads to development shared innovation. Cooke &Wills (1999) have opined that risk and uncertainty get mitigated by social capital, which include enhanced business, knowledge, and innovation performance in R&D funded innovation programs constituting the interaction among individuals within the network systems and the innovative environment.

Table 13 PLS-SEM model hypothesis year 2012

Hypotheses	Decision
H_{1a}: Financial supports have a direct positive significant effect on SMEs innovation activities.	Rejected
H_{1b}: Financial supports have a direct positive significant effect on Linkages.	Accepted
H_2: Linkages have a direct and positive significant effect on SMEs innovation activities.	Rejected
H_{3a}: Framework conditions have a direct positive significant effect on SMEs innovation activities.	Accepted

H_{3b}: Framework conditions have a direct positive significant effect on Linkages.	Accepted
H_4: SMEs innovation activities have a direct positive significant effect on innovation output.	Rejected

Source: Author's own

Finally, the result proved in all years that SMEs innovation activities impact less on the sales of the new-to-market and new-to-firm innovations thereby, **rejecting the final and H4 for all years**. In contrast to our findings, D'Angelo (2012) found in his Tobit regression analysis that innovative activities positively and significantly affect the export intensity of firms in Italian high technology small and medium-size firms. Also, Kang & Park (2012) found internal R&D resources to significantly affect the innovation output directly and indirectly of Korean firms. The table below presents the test of hypothesis and their decision.

Table 14 PLS-SEM model hypothesis year 2019

Hypotheses	Decision
H_{1a}: Financial supports have a direct positive significant effect on SMEs innovation activities.	Accepted
H_{1b}: Financial supports have a direct positive significant effect on Linkages.	Accepted
H_2: Linkages have a direct positive significant effect on SMEs innovation activities.	Rejected
H_{3a}: Framework conditions have a direct positive significant effect on SMEs innovation activities.	Rejected
H_{3b}: Framework conditions have a direct positive significant effect on Linkages.	Accepted
H_4: SMEs innovation activities have a direct positive significant effect on innovation output.	Rejected

Source: Author's own

4.7 Conclusion and Policy Implications

Organization of the firm capabilities and resources for SMEs innovation activities need critical look at by policy makers if we seek to address the ancient and persistent socio-economic challenges of the state. This section was built on the result and implication of the DEA analysis to regress the inputs factors which lead to SMEs innovation activities and networking.

The result of the Structural Equation modelling shows that, the financial support system had significant effect on SMEs innovation output in 2012, however, no significant influence on SMEs innovation output in the reference year 2019. The result shows a declining tend in the impact of public financial support on SMEs innovation output. This demand for policy makers to enact rescuing policies to ensure a turn around most especially due to the negative effect the Covid-19 pandemic may have on the national economy in medium to the long-term

period. We recommend that and most especially to the V4 countries as the DEA result affirms that these countries inconsistent efficient utilization of the input resources for SMEs innovation output need a robust policy reformulation towards government expenditure of R&D to initiate strong engagement of the private venture capitalist and FDI to create competitiveness.

Financial support induces SMEs collaboration with others and public private co-publication. Likewise, are the framework conditions, which showed a high statistically significant at 99% confidence interval. These input latent variables proved to be important factors in facilitating SMEs cooperation for innovation. It was also proven by the model that framework condition highly induces SMEs innovation activities in the 2012 but was not significant in 2019. Collaboration among innovative SMEs do not lead to innovation outcome, likewise linkages. More so, the result showed no direct influence of linkages on SME innovative output. Generally, at least at the EU level, firm support with EU funds are obliged to cooperate with others most importantly within the EU corridors. However, many scientific researches (Puljak et al., 2014; Prokop et al., 2019; Gyamfi & Stejskal, 2020) have found lack of collaboration among firms within the CEE countries. Collaborative induced policies should be implemented and with the necessary support systems such as science parks, SMEs incubators and cluster initiatives with firm coordination and supervision to strengthen SMEs innovation performance. The framework condition seems to be on the right path; hence it needs steering by the policy makers to mix the right policies to achieve a strong EU.

This cause for implications for the firms and policy makers at the EU level. It must be reiterated that; the data set was for all 27 member states.

- SMEs innovation collaboration must ensure benefits for not only the firm, but the society as whole when support systems from the public and business investment and the public non-financial support systems such as the research attractiveness are used.
- If financial investment in SMEs innovative activities do not translate into innovation outputs then, inefficiencies are inherent in the systems or mode of support programs geared towards firm innovation performance. Therefore, proper support systems should be instituted to monitor, coordinate, and enhance the use of support funds for innovation activities of the firms.

- Significant amount of money is given to firms that cooperate, however, the collaborations among SMEs do not translate into outcomes of innovations. Hence, member states must ensure usage of linkages supported by funds by not only supporting innovative SMEs, however, start-ups and new firms with potential to grow and not discriminate in terms of innovation credential.
- Redundancy in the input resources demand for a reshape of matching audit to identify the need in the short-medium term and the long-term efficient deployment of these resources for economic development.

CONCLUSION

Since its introduction decades ago, innovation has become the backbone of economic development of many countries. The Innovative Milieu emphasizes **the social and economic interactive relationships** as well as **networks of actors** within a spatially defined area serving as a **catalyst for innovation**. Just like the triple helix concept, there is the flow of information and cooperation between key actors in an endogenous setting giving actors the sense of informal personal contact. Firms seek innovation spaces to develop capabilities and enjoy the appropriation of knowledge for economic gains. The systems of innovation therefore have the fundamental obligation to make available network infrastructures, science and technology, institutions, and human capital as the system innovation processes at the micro (firm) level innovation process. The firm inadvertently has three functional spaces (i.e. the production space; the market space and the support spaces linked to the macro processes of innovation). Every support system needs to gauge supportive environment (Clark et al., 2007).

This could be done through the pursuant of increasing innovation capacities of all economic sectors and actors. The innovation systems should build strong knowledge intensive economy by supporting its growth in the form R&D investment injection. Access to finance and strong support for skills and capabilities of workforce is therefore paramount as contended by the proponents of the triple helix model. Most support systems engineered by the public sector for innovation take the form of financial support. However, in this research dissertation, *Efficiency of the Public Sector Support Systems for Creating Innovation Milieu*, the term was used broadly to incorporate multifaceted roles the government play as the creator of the enabling environment for firms' innovation activities to enhance economic growth and competitiveness.

The dissertation sought **to explore how SMEs innovative activity fuels the attraction of public support systems in the creation of an innovative environment for SMEs innovation**, and then **to measure how efficient the financial and nonfinancial Public Support systems and framework conditions facilitate the innovation performance of SMEs** in some selected countries in the European Union. The dissertation was divided into two (2) main sections as a reflective mirror of the main objectives of the thesis. Two main specific objectives include.

First, the objective sought to determine the role of SMEs innovation activities in attracting public financial support. This research, through a logistic regression analysis constructed three models based on the three dichotomous dependent variables (Local, Government and EU Funding) and other SMEs innovation activities which constituted the independent or explanatory variables for the econometric analysis. **The result demonstrated that the kind of innovation activities an SME is engaged in has great influence on the kind of public financial support to receive.** The result showed that among the three kinds of public financial support, national and EU funds are likely to be awarded SME innovators. Whereas SME collaboration activities were not generally a key public finance determining factor, the triple helix collaborations of SMEs enabled them attract EU and national funds. This conclusion drawn from the analysis of the result revealed that the overall propensity for firm's innovation activities to attract EU funds show moderate effect likewise the funds from the government, however, local funds was the least sourced public financial support.

In the second objective, the researcher employed an efficiency measurement approach to determine whether the public sector support systems efficiently induce collaboration networks for SMEs innovation within the innovation ecosystem. The DEA result proved that generally at the first stage approximately 26% of the 27 member states of the EU recorded inefficient values relative to the other member states. Similarly, 22% of member states were inefficient at the second stage. Most member states of the European Union are using the input resources efficiently. Additionally, a multi regression analysis using PLS-SEM was used to measure the effect of the framework conditions and the financial support from the public and private business sector to creating SMEs innovation activities and linkages. the conclusion made from the analysis was that both the framework condition and the financial support significantly facilitate cooperation among innovative SMEs, however, SMEs collaboration had no significant direct effect on SME innovation activities. The conclusion from the final analysis is that no crowding- out effect was observed based on the result of the DEA and the PLS-SEM. However, there were unique outliners as an interesting observation was made per the result about the countries in the Northern Europe with high input redundancy percentage aa well as Hungary and Croatia.

The findings of this dissertation have significant implication for practical and theoretical as well as policy implication to the Policy makers, industry, and member countries, which are outlined as found below.

Implication for science

1. Many scientific analyses have been conducted in terms of how public finance induce firm innovation among many other treatment analyses. This dissertation is one of the few if not the only to combine both financial and non-financial support systems to ascertain an EU- wide result.
2. The thesis therefore adds up to the growing literature in the field of support for innovation, which has looked to contribute to the innovation milieu concept.
3. Based on the analysis, further research may be provoked especially one about the observed trend of the Scandinavian states redundant use of input variables.
4. Based on the findings policy about government expenditure would be informed and tailored in their programmes orientation to ensure inputs resources employed produce optimal results if not greater to ensure European continual competitiveness.
5. The dissertation has proven that EU collaborating SMEs do not produce optimal innovation outcomes hence, the need for research into how firms can capture, and measure means of transfer of knowledge (knowledge spillover) to improve SMEs innovation performance is ripped.

Practical implications for policy makers

6. Evidence have been deduced based on the findings to enable the member countries whose input resource usage, in this case financial support and framework conditions are not efficient in relations to other EU members **to learn and benchmark** the efficient members to produce at least optimal results.
7. Policies of any form of support must **create clearer and focused** as well as **measurable** objectives in order to mitigate input redundancy within the EU.
8. Innovative SMEs collaboration have proved to be a weak source if innovation of the SMEs is to be realized. Hence, any support financial or others should be able to induce innovation performance of SMEs through **efficient and effective cluster policies**.
9. The evidence of the positive and significant effect of financial support and framework condition require for not the **institutional change** but **also structural** where innovation activities of sort could be induced in the support framework as one of the **key indicators** of collaboration. It does not make economic sense if finance support for firm collaboration do not yield innovation.

10. The EU member states, especially, those found to be having high input resources redundancy to **fine-tune their support programmes** to ensure efficient deployment of resources to achieve greater output.
11. Focus on improving the **conditions for more engagement** by the private sector
12. Match labour market demand to the expertise of the human resources unlike the phenomenon of putting square pecks in round holes.
13. Link **training and development** programmes and policies to the **changing technological demands** to ensure efficient use of human resources.
14. Inclusivity has been the hallmark of EU, however, **EU funding clearly discriminate SMEs with close to no R&D performance**. Policies must include all SMEs as they contribute a great deal to the national economy.
15. Improve access to capital of SMEs by **procuring and demanding services and goods from start-ups as well as non-innovating SMEs** to enable them deploy capital into R&D for innovation because lack of access to capital has been a bane on the growth and innovation activities of SMEs, which constitute one of the key barriers to innovate.
16. Implement coordinated innovation infrastructure within the EU for member state to link policies and programs with common objectives.

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APPENDIX

Table A1 Heterotrait – Monotrait Ratio of Correlations

2012	Financial Support	Framework Conditions	INNO_Output	Linkages	SME Innovation Activities
Financial Support					
Framework Conditions	0.699				
INNO_Output	0.171	0.122			
Linkages	0.870	1.009	0.152		
SME Innovation Activities	0.540	0.799	0.211	0.814	
2019					
Financial Support					
Framework Conditions	0.778				
INNO_Output	0.156	0.239			
Linkages	1.046	1.222	0.362		
SME Innovation Activities	0.635	0.811	0.279	0.947	

Table A2 Variance Inflation Factor

Variables	**VIF (2012)**	**VIF (2019)**
INNO-SME.CO	1.834	1.261
ISCP	4.130	1.727
ODE	4.375	1.734
PP-Co-P	1.834	1.261
PTE	1.158	1.010
R&D co-fund	1.409	1.914
R&D-Exp (BS)	3.616	3.012
R&D-Exp (PS)	4.240	3.211
SALES	1.000	1.000
SME-MKT/ORG	4.058	3.032
SME-Prod/Pro	4.058	3.032

Table A3 R square of the PLS-SEM model

Years	**2012**	**2019**
INNO_Output	0.04	0.07
Linkages	0.84	0.80
SME Innovation Activities	0.56	0.50

Figure B1 DEA Efficiency Frontier

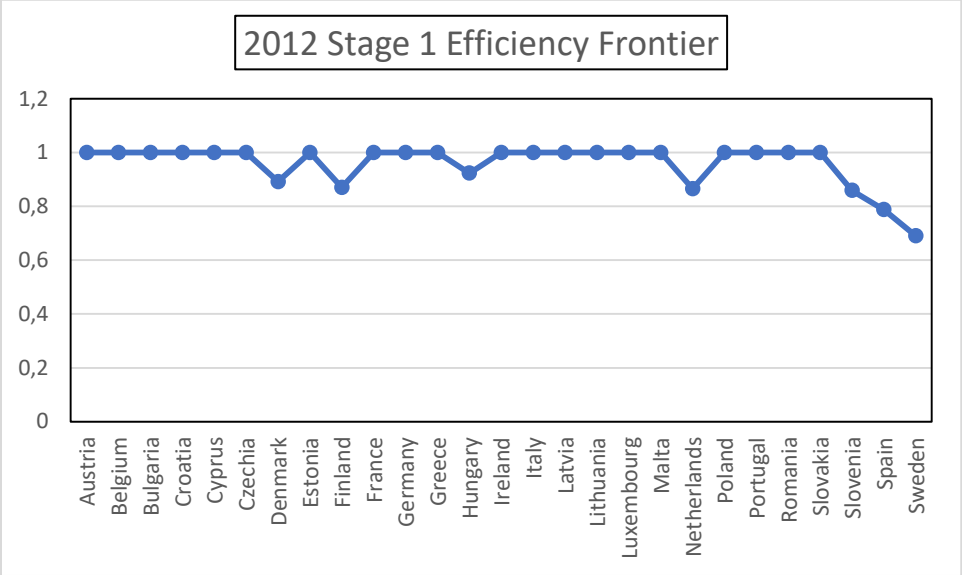

Figure B2 DEA Efficiency Frontier

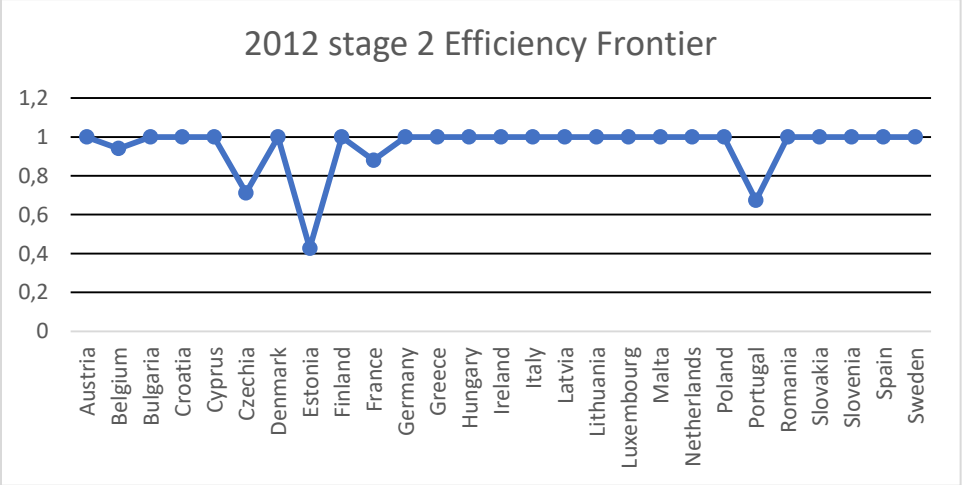

Figure B3 DEA Efficiency Frontier

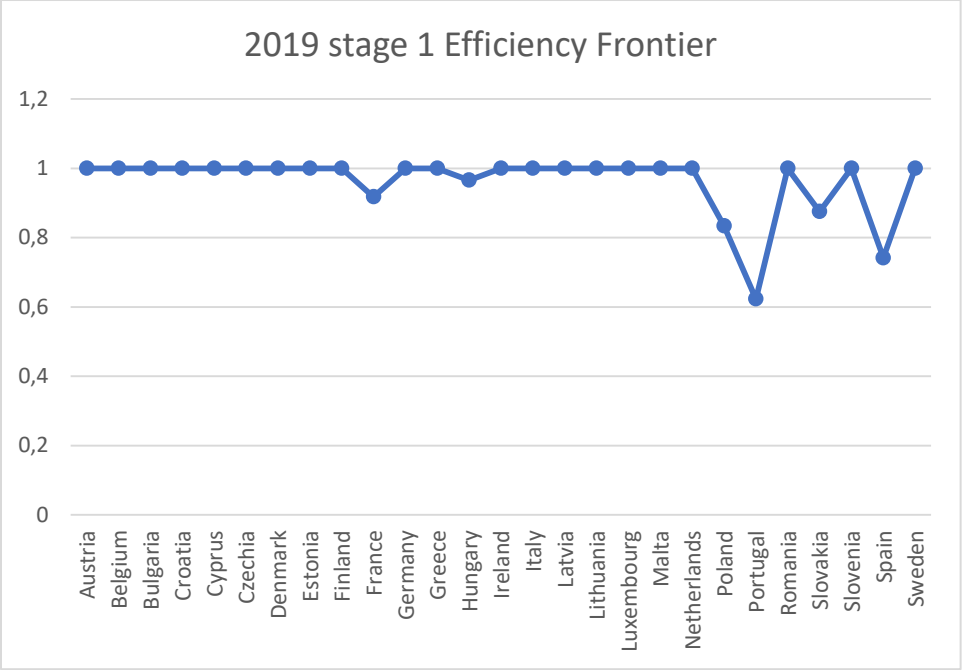

Figure B4 DEA Efficiency Frontier

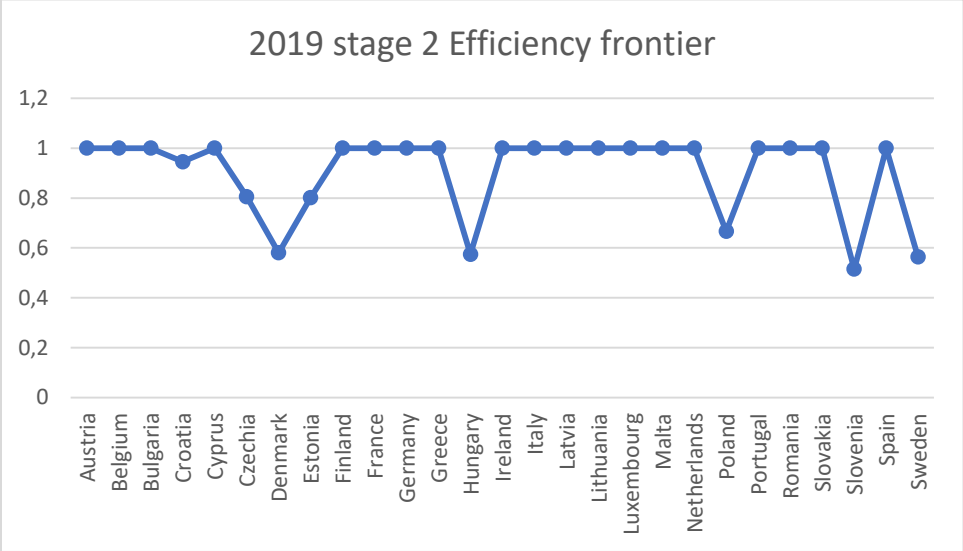

Table B5 DEA analysis of Projected Efficiency levels of DMUs

	PTE	Pr(PTE)	ISCP	Pr(ISCP)	ODE	Pr(ODE)	R&D-Exp (PS)	Pr(R&D-Exp (PS)	R&D-Exp (BS)	Pr(R&D-Exp (BS))	NON-R&D-Exp	Pr(NON-R&D-Exp)
Austria	121	121	189	189	135	135	116	116	146	146	61	61
Belgium	181	181	197	197	187	187	91	91	118	118	92	92
Bulgaria	62	62	24	24	13	13	10	10	20	20	45	45
Croatia	67	67	59	59	30	30	43	43	25	25	105	105
Cyprus	250	250	164	164	75	75	23	23	3	3	227	227
Czechia	50	50	80	80	78	78	93	93	67	67	117	117
Denmark	177	158	279	192	260	183	144	75	156	85	52	46
Estonia	139	139	122	122	104	104	116	116	114	114	162	162
Finland	136	118	213	160	125	109	157	101	204	117	89	77
France	169	169	101	101	131	131	105	105	111	111	63	63
Germany	38	38	110	110	92	92	138	138	151	151	197	197
Greece	123	123	84	84	40	40	45	45	16	16	142	142
Hungary	69	64	56	52	46	36	45	32	57	37	69	64
Ireland	255	255	170	170	37	37	52	52	85	85	49	49
Italy	3	3	76	76	106	106	58	58	64	64	103	103
Latvia	129	129	23	23	67	67	58	58	13	13	62	62
Lithuania	238	238	39	39	69	69	89	89	17	17	189	189
Luxembou	219	219	246	246	276	276	58	58	52	52	34	34
Malta	62	62	65	65	0	0	10	10	33	33	153	153
Netherlan	169	146	219	171	244	161	120	81	85	74	106	92
Poland	155	155	26	26	0	0	62	62	15	15	161	161
Portugal	63	63	111	111	110	110	91	91	53	53	93	93
Romania	13	13	18	18	41	41	23	23	12	12	81	81
Slovakia	50	50	55	55	35	35	41	41	17	17	111	111
Slovenia	117	101	160	123	193	94	80	69	141	70	97	83
Spain	146	109	89	70	49	36	84	33	54	42	67	53
Sweden	197	136	258	178	254	149	146	99	176	114	109	75

Table B6 DEA analysis of Projected Efficiency levels of DMUs continued

	INNO-SME.CO	Pr(INNO-SME#CO)	PP-Co-P	Pr(PP-Co-P)	R&D co-fund	Pr(R&D co-fund)	SME-Prod/Proc INNO	Pr(SME-Prod/Proc INNO)
Austria	125	125	107	107	236	236	241	241
Belgium	152	152	105	105	232	232	146	146
Bulgaria	29	29	18	18	26	26	10	10
Croatia	83	83	71	71	99	99	80	80
Cyprus	103	103	89	89	248	248	70	70
Czechia	87	87	103	103	111	111	77	77
Denmark	121	122	108	120	174	174	323	323
Estonia	125	125	85	85	212	212	54	54
Finland	126	126	95	112	187	187	259	259
France	87	87	109	109	121	121	112	141
Germany	155	155	163	163	157	157	169	169
Greece	84	84	116	116	137	137	35	35
Hungary	27	51	39	44	67	67	59	59
Ireland	128	128	117	117	131	131	116	116
Italy	113	113	110	110	39	39	68	68
Latvia	26	26	40	40	37	37	8	8
Lithuania	46	46	52	52	92	92	14	14
Luxembou	148	148	163	163	165	165	125	125
Malta	70	70	68	68	41	41	13	13
Netherlan	140	140	89	122	167	167	219	219
Poland	23	23	30	30	36	36	15	15
Portugal	139	139	125	125	84	84	41	41
Romania	20	20	50	50	21	21	20	20
Slovakia	68	68	55	55	87	87	34	34
Slovenia	95	98	91	91	152	152	198	198
Spain	67	67	57	57	56	60	57	57
Sweden	137	137	107	113	199	199	297	297

Table B7 DEA analysis of Projected Efficiency levels of DMUs continued

	INNO-SME.CO	Pr(INNO-SME#CO)	PP-Co-P	Pr(PP-Co-P)	R&D co-fund	Pr(R&D co-fund)	SME-Prod/Proc INNO	Pr(SME-Prod/Proc INNO)
Austria	125	125	107	107	236	236	241	241
Belgium	152	152	105	105	232	232	146	146
Bulgaria	29	29	18	18	26	26	10	10
Croatia	83	83	71	71	99	99	80	80
Cyprus	103	103	89	89	248	248	70	70
Czechia	87	87	103	103	111	111	77	77
Denmark	121	122	108	120	174	174	323	323
Estonia	125	125	85	85	212	212	54	54
Finland	126	126	95	112	187	187	259	259
France	87	87	109	109	121	121	112	141
Germany	155	155	163	163	157	157	169	169
Greece	84	84	116	116	137	137	35	35
Hungary	27	51	39	44	67	67	59	59
Ireland	128	128	117	117	131	131	116	116
Italy	113	113	110	110	39	39	68	68
Latvia	26	26	40	40	37	37	8	8
Lithuania	46	46	52	52	92	92	14	14
Luxembou	148	148	163	163	165	165	125	125
Malta	70	70	68	68	41	41	13	13
Netherlan	140	140	89	122	167	167	219	219
Poland	23	23	30	30	36	36	15	15
Portugal	139	139	125	125	84	84	41	41
Romania	20	20	50	50	21	21	20	20
Slovakia	68	68	55	55	87	87	34	34
Slovenia	95	98	91	91	152	152	198	198
Spain	67	67	57	57	56	60	57	57
Sweden	137	137	107	113	199	199	297	297

Table B8 DEA analysis of Projected Efficiency levels of DMUs continued

	SME-MKT/ORG INNO	Pr(SME-MKT/ORG INNO)	EMP-KIA	Pr(EMP-KIA)	SALES	Pr(SALES)
Austria	86	86	112	112	78	78
Belgium	110	110	134	134	82	82
Bulgaria	51	51	38	38	40	40
Croatia	73	73	66	66	66	66
Cyprus	18	18	127	127	103	103
Czechia	51	84	89	89	108	108
Denmark	69	69	128	128	105	105
Estonia	70	87	69	82	82	82
Finland	121	121	132	132	108	108
France	77	77	112	112	73	73
Germany	143	143	131	131	110	110
Greece	78	78	77	77	77	77
Hungary	104	104	99	99	94	94
Ireland	40	40	204	204	55	55
Italy	42	42	105	105	104	104
Latvia	97	97	45	45	0	0
Lithuania	126	126	43	43	31	31
Luxembourg	33	33	232	232	46	46
Malta	18	18	142	142	38	38
Netherlands	134	134	154	154	65	65
Poland	63	63	47	47	43	43
Portugal	40	81	46	64	100	100
Romania	99	99	11	11	99	99
Slovakia	69	69	64	64	157	157
Slovenia	106	106	108	108	67	67
Spain	96	96	82	82	141	141
Sweden	86	86	177	177	47	47

NB: Highlighted rows are for inefficient DMUs