HANTOS ELEMÉR DOCTORAL SCHOOL OF BUSINESS, MANAGEMENT AND REGIONAL SCIENCES
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Ph.D. Dissertation

The Impact of R&D on the Economy: A Cross-Country Analysis of Lower Middle Income Countries (LMICs)

By

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Declaration

I declare that this thesis entitled “The Impact of R&D on the Economy: A Cross-Country Analysis of Lower Middle Income Countries (LMICs)” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Recommendation Letter

To the Doctoral Council of The Elemér Hantos Doctoral School, Faculty of Economics, University of Miskolc,

We, Professor Emeritus Károly Balaton and Associate Professor Zoltán Bartha, are writing to recommend Ayousha Fayyaz for the public defence of her doctoral dissertation. We have had the pleasure of co-supervising Ms. Fayyaz throughout her PhD studies at the University of Miskolc from 2020 to 2025. During this time, she has consistently demonstrated the qualities of a dedicated and accomplished scholar, making her well-suited for the rigorous demands of doctoral research and the successful completion of a public defence.

Ms. Fayyaz's academic record is exemplary. She maintained a CGPA of 4.67/5, a testament to her strong work ethic and intellectual capabilities. Her doctoral thesis, "The Impact of R&D on the Economy: A Cross-Country Analysis of Lower Middle Income Countries (LMICs)," demonstrates her ability to focus on complex economic issues, conduct thorough research, and present her findings in a clear and compelling manner. This work builds upon the foundation she established during her Master of Business Administration (MBA) studies at Islamia University of Bahawalpur, where she achieved a CGPA of 3.92/4, and her Bachelor of Business Administration (BBA) (Hon's) degree from the same institution, where she earned a CGPA of 3.56/4. Her previous theses, "Impact of Financial Transparency on Stock Market Capitalization" (MBA) and "Role of Islamic Microfinance in Women Empowerment" (BBA), further illustrate her consistent dedication to research.

Ms. Fayyaz has also demonstrated a strong commitment to academic publishing. Her publications include:

1. "Research and development as a driver of innovation and economic growth; case of developing economies." *Journal of Social and Economic Development* (2025). (Co-authored by Ayousha Fayyaz and Zoltán Bartha, published in a Q2 journal)

2. "Connecting R&D and Growth through a Theoretical Model." *HANTOS PERIODIKA* 4:2, 291-303 (2023).

3. "Economic Systems and Institutions." *International Journal of Management and Economics Invention*, 8(12), 2762–2767 (2022).

4. "Latest Trends in Social Marketing." *Business and Management Horizons* (2022).

5. "Total Quality Management and its Implementation in context of Pakistan." *Review of Business & Management* TMP, 17(2), 45-51 (2021).

6. "Dynamic Capabilities in a Nutshell." *4th Smart Communities Academy: Building Smart Communities for the Future* (2021).

7. "The Impact of Transparency and Disclosure on Stock Market Capitalization through the Dividend Yield." *International Journal of Management Research and Emerging Sciences*, 10(1) (2020).

This publication record reflects Ms. Fayyaz's ability to conduct and disseminate research effectively. Her work has been presented at international conferences, including the International Conference on Business and Entrepreneurship Research (ICBER) in 2020, where she received the Best Paper Award, and the '4th Smart Communities Academy: Building Smart Communities for the Future' Academic Conference in 2021. She has also actively participated in the Miskolc University Doctoral Forums from 2020 to 2024.

Beyond her academic achievements, Ms. Fayyaz possesses a strong set of professional skills. Her experience as a Data Analyst | XaaS Specialist at Computacenter in Budapest from 2022 to 2024 provided her with valuable experience in data management, analysis, and reporting. She demonstrated proficiency in contract management, database development, data quality improvement, and statistical analysis, using tools such as Microsoft Office, Microsoft Volume Licensing, JASP/E-Views, Microsoft Azure, SAP, SPSS/AMOS. Her earlier experience as a Relationship Manager at Bank Al Falah (Ltd) in Pakistan further honed her communication, problem-solving, and customer service skills.

In summary, Ayousha Fayyaz is a highly motivated and capable doctoral student with a strong academic background, a growing publication record, and relevant professional experience. She has consistently demonstrated her ability to work under pressure, adapt to new situations, and achieve high-quality results. We are confident that she is well-prepared to successfully complete her public defence and make a valuable contribution to the field of business administration. We wholeheartedly recommend that she be allowed to proceed.

Miskolc, 6 May 2025

Sincerely,

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Károly Balaton	Zoltán Bartha

1 CHAPTER 1: INTRODUCTION

1.1 RESEARCH PROBLEM

R&D is an important engine of innovation, productivity, and long-term economic growth. R&D initiatives have the ability to greatly increase a country's competitive edge in the global market by advancing technology, developing new products, and improving processes. However, the significance of R&D in Lower Middle Income Countries (LMICs) is understudied for a while. LMICs frequently confront structural barriers to economic growth, such as poor infrastructure, limited access to modern technology and hence, low levels of innovation. These countries often devote a lesser proportion of GDP to R&D than high and middle income countries, and they frequently face challenges such as poor institutional frameworks, inadequate human capital, and limited capital investment in innovation. The Research Problem is *"How can investment in research and development (R&D) help drive economic growth in LMICs, and what are the primary barriers and enablers that determine R&D effectiveness in these settings?"*

1.2 BACKGROUND OF STUDY

In the long run, economic progress helps everyone. As a result, the factors affecting economic growth are critical. Spending on R&D (Research and Development) is one such factor. Numerous studies have been conducted on the R&D expenditure's impact on growth of economy, with varying outcomes. Empirical and theoretical work in the economic growth literature has highlighted the critical role of investment in R&D for sustaining growth of economy and the positive effect of increased innovation on productivity. Many individuals assume that R&D's mission is to produce or upgrade new goods or to establish new manufacturing methods that increase efficiency of existing items. R&D is a critical component of the manufacturing procedure to the point that corporations cannot obtain information from external sources for free. However, it is uncertain if this input is necessary for total output or whether it should be viewed as a solution capable of accelerating economic growth (Habib, Abbas and Noman, 2019). There is little doubt that positive correlation exists among economic growth and the proportion of resources spent to R&D in each country. Finally, the resources dedicated to R&D could not be employed for other purposes that might be just as beneficial to economic advancement, if not more so. Rarely are the opportunity costs of R&D spending acknowledged. Thus, increased R&D should not be assumed to be a significant causative factor in economic growth; additional research is required (Tung and Hoang, 2024). Both policymakers and the general public have made calls for higher R&D expenditure. It is not difficult to credit a large portion of the gain in living standards in the last two centuries to a sequence of technological achievements. Advocates frequently assume that more R&D results in new technological developments, which in turn stimulates economic growth (i.e., higher per capita output) and affluence (Mohamed, Liu and Nie, 2022). According to some proponents, countries struggle for technological dominance. Countries who excel in this battle produce the record advanced goods and thus reap benefits of their victory. These countries are thought to have greater output and productivity levels. Almost every economic policy has always had as its primary purpose of increased growth of economies. Since quicker growth in economy is likely the highest critical precondition for a wider concept of development in economy, it enables states to thrive in order to enhance their populations' health and literacy. Consequently, the human capital increases, benefitting output. This in turn increases productivity that enables the government to invest more in human capital, resulting in even greater growth. This phenomenon is referred to as the virtuous circle of economic growth. Economic growth enables the populations to enjoy a greater standard of life and a state of economic harmony. On the other hand, a lack of economic growth or a slow rate of expansion impoverishes the economy's occupants and results in discontent and disaster (Yusuf *et al.*, 2020).

New Growth Theory (NGT) has become common ground for development economics. It refers to the series of Endogenous growth theories proposed by various researchers. According to Capolupo (2009), change in growth can be accounted for by endogenous technical factors such as learning by doing (Romer, 1986); spillovers by Human Capital (Robert E Lucas, 1988); threshold externalities (Azariadis and Drazen, 1990); production externalities (Barro, 1990) and improving quality through invention (Gene M. Grossman and Helpman, 1991). NGT states that long-term growth can only be attained by knowledge generation (Ge and Liu, 2022). If I acknowledge that there are beneficial externalities that 'compensate' for the declining marginal productivity of capital assets, I may also observe sustainable growth. These externalities are the result of projects like public infrastructure building, knowledge distribution, and R&D. To put it briefly, because the returns from the accumulation elements are constant, growth is a self-maintaining phenomenon that occurs at a constant rate (Diebolt and Perrin, 2019).

For developing economies, NGT—and especially the growth debate it sparked—has provided some insightful lessons. First of all, it is now evident that developing economies' per capita income levels can either converge with or deviate from those of developed economies. The actions and conditions of the developing economies themselves will determine the result. Therefore, NGT contributes to dispersing the myth that Neo-Classical Growth Theory is irrelevant to policy in terms of long-term growth rate (Lee, 2020). The empirical research spurred by NGT has revealed significant productivity disparities between economies, prompting developing ones to focus on productivity rather than just investment volume (Oughton and Tobin, 2023). Moreover, NGT focuses on the function of institutions in economic development. With the recent emergence of data sets measuring different dimensions of institutional quality, it is now possible to quantitatively analyze how institutions have contributed to the development of emerging economies. NGT makes the critical link between the development of human capital and the spread of institutional and technological innovations more apparent and highlights the challenge facing developing economies in building up their human capital (Prasetyo, 2020).

The inclusion of the role of institutions in the growth debate has been largely facilitated by NGT. This integration has been made possible by the help of quantitative statistics on institutional quality that are emerging internationally (which is itself a result of 'globalization'). Additionally, this is strengthening the bonds between development and growth economics. Highlighting the importance of institutions in growth has also been made easier by the NGT feature, which allows policy to formally alter the long-run growth rate. Even in developed economies, growth must be sustained by timely institutional improvements. For developing and transitional economies, on the other hand, who are constructing the fundamental institutional frameworks necessary for the smooth operation of market economies predicated on private industry, the matter is even more critical (Ozili, Ademiju and Rachid, 2023).

Given the critical nature of economic growth, policymakers must understand the factors that contribute to it. Numerous studies have been done to have a better understanding of the elements that drive economic growth. Despite substantial research, no one variable or group of variables has been discovered as a reliable predictor of economic development. Capital accumulation is a crucial variable in both endogenous growth and neoclassical models. As a result, numerous economic growth studies have concentrated on it (Coupet, 2018; Khalfaoui & Derbali, 2021; Guliyeva et al., 2023; Zhan & Zou, 2024).

1.3 THE SIGNIFICANCE OF TOPIC

In contemporary times, R&D (Research and Development) is establishing itself as a critical element for advancement in economy. Its significance for economic growth has been emphasized in the New Growth Theories as well. Research and development results in breakthroughs that improve both the quantity as well as quality of output. While research organizations benefit from the monopoly benefits associated with each invention, these advantages are swiftly erased by subsequent innovation (Ngqulunga and Walwyn, 2020). Numerous scholars, including Baneliene et al., (2018), Abdulkadir et al., (2020), Celli et al., (2024) and others, have focused on the critical role of research and development and literacy in growth of economy. Despite the crucial necessity of R&D for the success of an economy, R&D sector in LMICs has largely escaped policymakers' attention. The goal of this research is to find out whether 'Research and Development' impacts directly on the economy of a country or are there other factors that influence its impact.

1.4 ORIGINALITY/VALUE

This study contributes to the growing body of literature investigating the impact of institutional factors on R&D and economic growth. It focuses on LMICs that are highly affected by the political and economic crises in their settings and must take an example from the High Income group countries in managing their institutions leading to their economic development.

1.5 PURPOSE OF THE RESEARCH

The purpose of this research is to find out the impact of R&D on the economy of LMICs. Numerous studies has found that this impact is influenced by other factors in the economy such as institutions (Doloreux & Turkina, 2023; Chen & Song, 2024)). Institutions play a key role in the stability of an economy as they regulate different sectors of an economy. The primary aim of research is to investigate whether R&D performance has an impact on growth among LMICs. It is suggested by Aghion (2018) that the institutional framework could slow growth down at a certain level of development. Due to these institutional structures, R&D, and innovation may not lead to economic growth in middle-income countries.

1.6 METHODOLOGY OF RESEARCH

The methodology of research employs 'The Ecosystem Approach' which comes through effective interaction between individual and national players, leading to the economic development of a country. The 3 major players in the economic development of a country are (Government) Institutions, Market and the Civil Society. Nonetheless, ecosystem development is more than a two player game (entrepreneur and government); I will test the relationship between institutions, R&D, innovation, and growth in LMICs using structural equation modelling. My research contributes to the literature discussing the role, and the limitations of R&D, and innovation in economic growth.

1.7 CONTRIBUTION OF RESEARCH

This research is expected to make an important contribution towards the crossroads of strategy by focusing on research & development and innovation. A critical notion of the Ecosystem approach is that the members of the ecosystem are affected by each other such that it will help resolve the issues at both the micro-economic level (exchange of resources between ecosystem players) and macro-economic level (institutional culture and a shared idea that innovation is an important element of an ecosystem). This perspective will contribute to highly efficient alignment between the players of the ecosystem. It is particularly important because the model of the research is based on Ecosystem approach has never been tested before on the LMICs. The LMICs countries seem to be in a growth trap which prevents them from progressing towards high-income phase. The results of this research can be used to devise policies which will help these countries to move towards innovation-led growth.

1.8 RESEARCH GAP

Middle-income countries are at a critical juncture. Over the past few decades, many have moved beyond low-income status and made significant strides in reducing extreme poverty, creating the impression of strong developmental progress. However, for the more than 100 economies with per capita incomes between $1,100 and $14,000, the ultimate goal of reaching high-income status within a generation remains elusive. Since the 1970s, the median middle-income country's per capita income has stagnated at less than one-tenth of the U.S. level (Doran, McCarthy and O'Connor, 2018). Now, these economies face mounting challenges such as aging populations, rising protectionism, and the urgent need for an accelerated energy transition. Overcoming these barriers and achieving advanced economic status will require unprecedented efforts and innovative strategies.

In order to escape the "*Middle-Income Trap*," (a term coined by the World Bank Group) middle-income nations must make two crucial transitions, according to the World Development Report 2024. To become competitive global suppliers, LMICs must abandon an investment-driven strategy and adopt one that incorporates contemporary technology and international business practices. Conversely, upper-middle-income countries need to shift from adopting new technologies to innovating, pushing the boundaries of technology, and reorganizing their energy systems, workspaces, and industries (Pereira et al., 2020). The few nations that have effectively attained high-income status by encouraging entrepreneurship, upending long-standing interests, developing human capital, and modernizing antiquated institutions demonstrate that neither move is effortless. The middle-income economies of today need to take comparable audacious and flexible steps if they are to prosper.

LMICs experience distinct issues that set them apart from high-income and low-income countries, necessitating customized approaches to address their lack of R&D. Low-income and high-income countries are not the same as LMICs. They might have more resources and a more robust infrastructure than low-income countries, but they frequently lack the sophisticated innovation ecosystems that are present in wealthier countries. Because of their "in-between" status, they may not attract the same amounts of private-sector R&D investment as high-income countries or receive the same amount of foreign investment or development assistance as LMICs (Salman *et al.*, 2020). Low-income countries with pressing developmental needs or high-income countries with well-established R&D organizations are typically the focus of research. LMICs are therefore frequently disregarded. Without adjusting insights to the particular dynamics within LMICs, studies may generalize results from high- or low-income countries, creating a gap in my understanding of the particular challenges they confront in developing R&D capacity. Productivity, innovation and economic growth all depend on research and development. Increased R&D can assist LMICs in shifting their economies away from lower-wage manufacturing and towards higher-value industries, allowing for greater financial stability and better pay. Without robust R&D, these nations run the risk of continuing to rely on foreign discoveries and technology, which can reduce their competitiveness and limit economic growth (Dadzie et al., 2017). R&D can assist in addressing the unique problems faced by LMICs, including climate vulnerability, agricultural production, and health concerns. These areas might require locally appropriate technology that are sustainable, reasonably priced, and appropriate for the local environment. Important fields, like breakthroughs in cheap healthcare and climate-resilient farming methods, would not advance as quickly without focused research and development. Skilled workers frequently leave LMICs in pursuit of work in countries with stronger research industries due to a lack of R&D funding. Reducing brain drain, promoting a knowledge-based economy, and giving local researchers significant opportunities are all possible by addressing R&D shortages (Bate, Wachira and Danka, 2023). LMICs' technological advancements help not just these countries but also international innovation. LMICs' distinct R&D contributions can provide technologies and solutions that are applicable to other nations dealing with comparable problems, particularly in light of global concerns like pandemics and climate change. In conclusion, due to their distinct location, likelihood of economic growth via R&D, and generally disregarded standing in international R&D research, LMICs need focused initiatives. In addition to providing substantial benefits for the development of LMICs and global advancement, addressing this can encourage global innovation inclusion.

1.9 Objectives of the Research

1. To explain Research & Development thoroughly

2. To study the literature on different growth models and their relationship to R&D

3. To study the role of institutions and their relationship with economic growth

1.10 Questions of Research

1. What is the role of R&D in economic growth?

2. Does R&D has a direct or indirect effect on the economic growth?

3. What is the significance of institutions in Economic growth of a country?

1.11 HYPOTHESES OF STUDY

Following will be the hypotheses of the study which are to be proved later after the thorough review of literature and data analysis.

H1: *Institutions investing in R&D have a significant impact on Innovation in lower middle income countries*

H2: *Institutions investing in Human Capital have a significant impact on Innovation in lower middle income countries*

H3: *Institutions investing in Capital Market have a significant impact on Innovation in lower middle income countries*

H4: *Innovation have a significant impact on Economic Growth in lower middle income countries*

1.12 OUTLINE OF THE STUDY

The remainder of this research is divided into the following sections: Section 2 covers a study of the literature which includes a thorough review on Research and Development (R&D), its types, roles and activities, along with its limitations and relationship with the target variable of the study i.e Economic Growth. This section then later develops hypotheses after the detailed review of literature. Section 3 details the data and methodology. It includes the description on the type of research conducted, sample of the study and the statistical methods to be used in the study. Section 4 will analyze the findings of the study as well as their robustness and discuss the results. Section 5 will discuss and conclude the research and provide recommendations.

2 CHAPTER 2: REVIEW OF THE LITERATURE

The Review of literature is divided into five sections that further consist of different components.

Section I: R&D

- Research and Development: its definition, types and activities
- Public vs Private R&D
- Limitations of R&D
- R&D Expenditures and Economic Growth
- Scientific Performance of LMICs and Economic Growth
- R&D and Innovation

Section II: Innovation

- Innovation and its significance
- The Policy Approach
- The famous Neo-classical Growth theories
- The Concept of Creative Destruction
- The Strategy of Evolution

Section III: Institutions

- Institutions
- Three Aspects of Institutions
- Coordination Mechanisms in Economic Systems

Section IV: Ecosystem

- The Ecosystem Approach
- Types of Ecosystem

Section V: Theoretical Framework & Hypothesis Development

- Theoretical Framework
- Hypotheses Development

2.1 SECTION 1: RESEARCH AND DEVELOPMENT (R&D)

In today's world, research and development (R&D) is becoming an increasingly important instrument for economic progress. Its importance for economic growth has also been underlined in New Growth Theories. Pieri et al. (2018) identify four mechanisms by which R&D can contribute to productivity growth: capital deepening (i.e., productivity gains from investment in knowledge capital), spillovers (via knowledge diffusion across firms), shifts in technical change, and reduction of technical inefficiency. R&D also boosts productivity by lowering costs (Lang, 2009), boosting the rate of innovation output (Beam, 1997), and expanding the pool of knowledge. The literature on the impact of R&D on productivity is substantial, and various evaluations have been published e.g., Hall et al., (2010); Pammolli et al., (2020); and Yoo & Lee, (2023).

Breakthroughs in research and development improve both the quality and quantity of production. While research organizations profit from the monopolistic benefits that come with each invention, these benefits are quickly eroded by successive advancement (Chen et al., 2023). Guo et al. (2022) stated that human capital and R&D play a range of functions in domestic innovation and knowledge spillovers from other countries. This is advantageous to the economy. (Blackburn and Stokes, 2000) used the theories of Romer (1986); Lucas (1988); and Grossmann (2008) to integrate R&D and human capital accumulation in an endogenous growth model (1990). According to these research, economic progress necessitates the development of new skills and knowledge. Building human capital not only stimulates economic growth, but also creates incentives for research and innovation. It raises the quality of the product. Numerous experts, including Woo et al., (2017); Sequeira, (2021); Alghazali et al., (2022); and others, have stressed the importance of R&D and education in economic growth.

Mazzucato & Semieniuk (2017) highlights the significance of government funding for scientific research and R&D, through its role in maintaining high levels of innovation and taking risks across all stages of the business cycle. Their study makes the case that public interventions actively shape and create markets rather than just fixing market imperfections. As an 'investor of first resort,' the state plays a vital role in taking on risks that the private sector frequently shies away from because of uncertainty. Public finance has fuelled important discoveries, such as revolution in the fields of biotechnology and renewable energy transitions, by providing funds for basic and applied research, development in initial stages, and technical diffusion. The study argues that strategic public funding raises business expectations and draws private sector participation, challenging the idea that involvement of public sector drives away private investment.

2.1.1 Definition

The abbreviation R&D stands for Research and Development. R&D is described as a methodical and creative activity aimed at growing the stock of knowledge (including an understanding of society, culture, and people) and creating new applications for existing information (OECD, 2015a).

Basic Research, Applied Research, and Experimental Research are the three types of R&D activity. Basic research is an exploratory or theoretical undertaking that is essentially concerned with acquiring greater understanding about the basic foundations of observable occurrences and facts, regardless of application or purpose. Applied research is a form of inquiry that is carried out in order to get new information. It is, however, largely aimed toward a definite, practical goal or objective. Experimental Research is a systematic procedure that generates new knowledge based on earlier study and practical experience in order to produce new goods or processes or to improve current products or processes.

2.1.2 Types of R&D

For all four sectors: industry, higher education, government, and private non-profit, it is prudent to split down R&D by kind. International comparisons might be made on the basis of total R&D expenditure or on the basis of current expenditure only. It can be used at the project level, albeit some R&D projects may require additional decomposition.

R&D can be classified into three categories:

- Basic Research

- Applied Research

- Experimental Research

2.1.2.1 Basic Research

'Basic Research' is experimental or theoretical study conducted solely for the purpose of gaining new information about the underlying mechanisms of observed occurrences and facts, without regard for any particular application or purpose (OECD, 2015a). Properties, structures, and interactions are investigated in 'basic research' in order to generate and evaluate hypotheses, theories, or laws. Often, the outcomes of fundamental research are not commercialized, but are instead published in scientific journals or shared to interested peers. From time to time, publication of basic research may be banned for national security considerations.

The researcher should have some discretion in establishing the researcher's fundamental research aims. Typically, this research is undertaken in the university sector, but it is also conducted to a lesser extent in the government sector. 'Basic research' can be narrowly focused or broad in scope, with the explicit goal of a variety of future applications (Coad, Segarra-Blasco and Teruel, 2021). Private sector enterprises may also do 'basic research', even if no immediate commercial uses are anticipated. According to the criteria outlined above, research on various forms of energy-saving technology can be considered as basic research if it is not directed toward a specific application. They do, however, have a definite objective. This type of research is referred to as 'guided basic research'.

The following distinguishes 'guided basic research' from 'pure basic research':

'Pure basic research' is undertaken for the progress of knowledge, not for economic or societal advantage, or with the explicit goal of adapting the results to practical situations or disseminating them to the regions responsible for their application (OECD, 2015a).

'Guided basic research' aims to build a large body of knowledge that can be used to address identified or expected present or future issues or opportunities (OECD, 2015a).

2.1.2.2 Applied Research

The term ‘applied research’ refers to an investigation that is undertaken in a creative manner in order to gather new knowledge. However, it is largely focused on a specific, practical objective. Applied research is undertaken to either uncover potential applications for fundamental research findings or to develop new methods or procedures to accomplish specified and predetermined aims. Existing knowledge is incorporated and expanded to address contemporary concerns. In industry, the transition from basic to applied research is frequently marked by the establishment of a new project to study promising results from a previous program of fundamental research. Generally, the outcomes of applied research are meant to be transferable to goods, processes, procedures, or system (OECD, 2015a). Applied research gives ideas a concrete form. To safeguard the applications of acquired knowledge, intellectual property protection techniques, including secrecy, may be applied.

2.1.2.3 Experimental Research

Experimental Research is a methodical process that relies on earlier research and practical experience to acquire new knowledge for the aim of producing new goods or processes or enhancing current ones (Tanner, 2018). Experimental research is used to describe the process of developing unique items or processes that qualify for R&D recognition. Uncertainty about the resources required to accomplish the purpose of the R&D project in which the development activity is conducted is one example.

The word ‘experimental research’ should not be confused with the term ‘product development,’ which refers to the full process of bringing a new product (item or service) to market, from idea generation to marketing (pp105-117) (Sola, Scarso Borioli and Scalabrini, 2021). Experimental research is merely one stage of the product development process; it is the stage during which broad knowledge is evaluated for the specific applications necessary for the process to be successful. The experimental development phase is the stage during which new knowledge is generated. It comes to an end when the criteria for R&D (new, uncertain, creative, systematic, transferrable, and/or reproducible) are no longer applicable. However, the economics literature also investigates circumstances in which products are developed without conducting research and development, particularly in the case of SMEs (Park *et al.*, 2020).

The word ‘experimental research’ should not be confused with ‘development prior to production,’ which refers to non-experimental work performed on a defense or aerospace product or system prior to its commercialization. Identical situations exist in other sectors (OECD, 2015b). It’s difficult to define precisely the difference between experimental research and near-production development. The distinction between these two categories necessitates a ‘technical judgment’ on the point at which the novelty component of the activity ceases to exist and the activity transitions to routine development of an integrated system.

How can different forms of research and development be distinguished?

The dynamic relationship between basic, applied, and experimental research must be recognized. It is conceivable that applied and experimental research directly adapt fundamental research findings for general use (McCombes, 2020). However, the feedback that occurs when knowledge is applied to a problem weakens the process’s linearity. This dynamic relationship between knowledge generation and issue solutions binds basic and applied research as well as experimental research together. In terms of the organizations that undertake R&D, it is unusual to see a clear demarcation between the three types of R&D. Occasionally, all three sorts of studies may be undertaken in the same unit by nearly the same people, however certain research projects may legitimately switch categorization (Binti Mohd Hame, Owee Kowang and Chin Fei, 2017).

2.1.3 R&D Activities

According to the literature, Research and Development (R&D) operations serve two unique goals or have two distinct faces. The major goal is to encourage invention, which has garnered the greatest attention in the empirical research. The second goal is to make it easier to replicate other people's findings (Santamaria and Surroca, 2011). Certain forms of knowledge are implicit; they are hard to codify in guides and textbooks and much more difficult to understand without direct inspection. Participating actively in research and development in a particular intellectual or technological domain facilitates the acquisition of this tacit knowledge and the improvement of one's understanding and assimilation of others' discoveries (Gassmann and Von Zedtwitz, 2003). The function of tacit knowledge or absorptive aptitude is a major problem in the research on the history and microeconomics of technology. Numerous theoretical models have been established in which research and development plays a creative as well as an imitative role (Cohen and Levinthal, 1990); (Howitt and Aghion, 1998); or (Howitt and Clower, 2000).

2.1.4 R&D in Public Sector

R&D at universities and Public Research Institutes (PRIs) is an important engine of innovation, economic advancement, and welfare programs. Universities and PRIs are increasingly being recognized as strategic players in the development and diffusion of information in the literature, as well as policy and public discussions. While universities' scientific output is primarily concerned with basic research, the outcomes generated have long-term implications and also have spillover impacts on industrial innovation in the immediate and medium term (Daraio and Moed, 2011). The transfer, exploitation, and commercialization of the results of public research are crucial attributes of science, innovation and technology, policy. Attempts in many industrialized nations to limit public awareness on fiscal restraint, along with competition from new competitors, have raised stress on universities, public research institutes, and governments to enhance the economic consequences and effect of public research expenditure (Szarowská, 2017). Despite the fact that the public research system distributes research and knowledge through a variety of channels, such as mobility of academic faculty, scientific publications, symposiums, contract research with industry, and certification of university inventions, some countries' primary emphasis has been on helping to promote transfer of knowledge through a dual and rather linear model of commercial exploitation.

2.1.5 R&D in Private Sector

According to Antràs (2016), companies are more likely to vertically integrate rather than outsource production in industries with high capital intensity and sizable relationship-specific investments because ownership gives them more control over investments and reduces inefficiencies brought on by contractual frictions. He uses empirical data to show that outsourcing is more prevalent in industries with standardized, readily transferable inputs, whereas multinational corporations typically dominate areas where asset specificity is essential. His study highlights the significance of clear borders and governance frameworks, challenging the conventional wisdom that trade patterns are solely influenced by factor endowments and comparative advantage. Furthermore, it has important ramifications for trade policy, indicating that in order to lower uncertainty in cross-border contracts, international agreements should have investment safeguards and dispute resolution procedures. Antràs (2016) work has had a long-lasting influence on the study of global value chains, multinational firms, and the structure of international trade by fusing trade economics with the property-rights theory of the firm.

Firm heterogeneity is included into the context of monopolistic competition with growing returns to scale and differentiated goods in the Melitz (2003) model of international trade. The model recognizes that enterprises' productivity varies, which has a substantial impact on their capacity to participate in international trade, in contrast to classic trade models that presume all firms are the same. Variations in marginal costs result from the model's assumption that businesses derive their production from a distribution. Businesses must pay a fixed fee to enter the market, and only those with high enough productivity can thrive. Additionally, while exporting, businesses must deal with both fixed and variable (iceberg) trade expenses, meaning that only the most productive businesses can afford to profitably serve outside markets. As a result, trade liberalization has asymmetrical effects, driving out smaller, less productive firms from the market due to increasing competition while benefiting large, highly productive enterprises that can bear trade expenses and enter overseas markets. Because only the most productive businesses survive, this selection effect increases the average productivity of businesses in the economy. Additionally, trade causes resources to be reallocated to more productive businesses, raising industry productivity overall. Empirical trends are also explained by the model, including the fact that exporters are often bigger and more productive than non-exporters and that only a small percentage of businesses export. Consequently, the Melitz (2003) model emphasizes how trade triggers a market selection process that improves overall economic efficiency, supporting the notion that businesses, not nations, are the main drivers of global trade.

The way economists and decision-makers view the consequences of globalization, especially with regard to the unequal distribution of trade gains and losses, has been drastically altered by Autor (2017) work on trade economics. According to conventional economic theory, trade would help the economy as a whole as resources moved towards more productive sectors, even while it would cause certain workers in particular industries to be displaced. Autor (2017) contributions have been essential in changing the global trade policy discourse. According to his observations, free trade and globalization promote efficiency and growth on a macroeconomic level, but their drawbacks must be actively controlled to guarantee that economic advancement is equitable and does not exclude entire populations. As a result, his work has caused political leaders, economists, and policymakers to reevaluate their approaches to labor market regulations, trade agreements, and the wider societal effects of economic globalization.

Along with satisfying public demands (e.g., in the military sector), government involvement in R&D is economically justified due to the prevalence of market failures in this area. This market failure is frequently caused by two factors. To begin, the imperfect appropriation or spread of information beyond the power of the creator suggests that the R&D's private rate of return is lesser than the societal rate of return. Additionally, the substantial risk associated with research creates very high hurdles that deter corporations from involving in these operations. This is particularly unfavorable to minor businesses that have a more difficult time acquiring money. For these two reasons, it is likely that enterprises operating in a competitive setting invest less in research than is socially desirable (Arrow, 1969).

2.1.6 Limitations of R&D

The knowledge spillover is one of the indicator for R&D, which is regarded as part of R&D which is officially reported. But most of the research activities occur beyond what is officially reported. This occurs because of the limiting factor that limit the transmission of knowledge. Some of these limiting factors are listed below:

Measuring inputs/outputs of R&D:

Because research results are intangible and take a long time to manifest their effects, measuring R&D outputs is a challenging task. According to Pappas and Remer (1985), the three primary ways for evaluating R&D outputs are qualitative, semi-quantitative, and quantitative approaches. Quantitative methods, including collecting patents, publications, or economic returns, create numerical comparisons between projects using strict algorithms and preset ratios. These approaches, however, have trouble capturing long-term advantages and ground-breaking discoveries. Semi-quantitative methods are helpful for R&D stages where results are less measurable since they use expert evaluations and weighted scoring systems to try and translate qualitative opinions into numerical values. Qualitative approaches, which are frequently employed in fundamental and exploratory research where results are challenging to quantify mathematically, rely on expert opinions and intuitive judgments. The study highlights that different R&D phases call for distinct measuring strategies; for instance, product improvement is easier to quantify, but fundamental research necessitates subjective assessments. Additionally, coordinating the evaluation process with organizational objectives and understanding the trade-offs between immediate productivity indicators and long-term innovation potential are critical to the efficacy of R&D measurement.

Szakonyi (1994) states that evaluating an R&D department's performance in ten essential tasks, including project selection, research planning and management, promoting cooperation between R&D and other departments, and successfully transferring technology to manufacturing, is necessary to determine how effective R&D is. He presented a six-level assessment approach that goes from identifying a problem to attaining continual improvement, as an alternative to concentrating only on output measures like patents or financial returns. By evaluating whether the proper abilities, procedures, and roles are in place, this framework assists managers in identifying areas that require development. The method guarantees that R&D is included into more comprehensive business planning and in line with corporate objectives, highlighting the fact that efficient R&D management encompasses more than just productivity metrics; it also involves strategic coordination and long-term effects. Pandit (2011) examined the impact of R&D inputs and outputs on future operational efficiency. Patent counts and citations are used to evaluate outputs, while expenditures are used to estimate R&D inputs. According to the study, companies that have more patents and patents that are often referenced would typically perform better in the future. Additionally, when businesses have better-quality patents, future performance is less variable. The study emphasizes that merely increasing R&D expenditures does not always translate into improved outcomes; rather, a firm's future stability and profitability are mostly determined by the efficacy of its innovation activities, as demonstrated by the quality of its patents.

Communication

One of the constraint is that a corporation must know that external R&D is occurring; this includes engagement and interaction. The first studies of technology spillovers were conducted in the 1940s in the United States' Corn Belt, where farm-level data was readily available and technical progress was quick and evident. Agricultural sociologists discovered that farm operators varied in their keenness to experiment with or accept novel farming practices. Some might accept them instantly, a minority would accept them during the 2nd or 3rd season, the majority may adopt them later, and a few may never adopt them. This tendency was analyzed across all societies and all innovations, prompting the development of a general model of innovation dispersion (McWilliam, 2011). Early adopters' societal position and subsequent achievement or failure impelled the diffusion rate in the public. Griliches (1998) developed an economic theory to explain the expansion of hybrid maize adoption. Hybrid corn was a technological innovation that resulted in large yield improvements and increased mechanical harvester efficiency. The hybrid seed was the embodiment of the new technology (genetics). He was able to trace the spatial spread of hybrid corn since micro-level statistics on hybrid and conventional corn acres were available. He was able to observe, for example, how hybrids generated in Iowa spread to Nebraska and Illinois. In empirical investigations, communication is quantified as a predictor of the likelihood or flow of interaction. For instance, geographical distance is frequently employed. It serves as the foundation for gravity models and agglomeration theory, which dates all the way back to Alfred Marshall and was revitalized in the 1990s. Channels of unilateral trade and bilateral trade gather same data (Coe, Helpman and Hoffmaister, 2009).

Human Capital

Human capital, as defined by the Chicago School of economics, especially through the writings of (Schultz, 1961) and (Becker, 1964), is the collection of knowledge, skills, competencies, and personal qualities that people possess and which add to their economic worth and productivity. Their views on human capital placed a strong emphasis on spending on mobility, health, education, and training as important factors that influence economic growth and personal incomes.

The human capital theory of the Chicago School offers a number of significant corollaries that emphasize the wider effects of investing in human knowledge and abilities. One important conclusion is the close relationship between economic growth and education, which shows that greater educational spending boosts innovation, productivity, and national development. Furthermore, the theory clarifies pay divergence by contending that variations in education, experience, and skill levels cause earnings discrepancies, with more skilled workers fetching higher compensation. Labour mobility is another significant factor. In order to increase labour market efficiency, people move to areas or sectors that provide better possibilities in an effort to maximize their returns (Coleman, 1988). Additionally, because individuals with greater resources can invest more in their abilities, the theory clarifies the relationship between inequality and investment by arguing that differences in access to education and training fuel income inequality. Last but not least, businesses gain from investing in human capital as demonstrated by productivity and corporate training, whereby companies that fund staff training—particularly in firm-specific skills—improve productivity, creativity, and overall competitiveness. When taken as a whole, these corollaries highlight how important human capital is in determining social and economic results.

Empirical models that place importance on endogenous, innovation-driven growth openly demonstrate growth in ‘Total Factor Productivity’. Benhabib & Spiegel (2019) offer a framework for growth accounting where human capital has a similar effect on ‘Total Factor Productivity’. Thus, human capital follows the growth equation in two ways. To begin, it is an element of production. Second, it has an effect on technical innovation, which in turn affects ‘Total Factor Productivity’. Cross-country aggregate data prove an assumption that human capital has an effect on income growth/capita via the second method. Tsamadias et al. (2019) conduct a direct regression of ‘Total Factor Productivity’ growth on capital stocks of local and foreign R&D, as well as on the effects of international trade. They demonstrate strong returns to R&D through the use of pooled OECD country data, both for local R&D and global spillovers. Jinji et al. (2019) differentiate between inter-industry and intra-industry spillovers of knowledge and demonstrate that intra-industry spillovers considerably add to ‘Total Factor Productivity’, while inter-industry spillovers have no visible effect.

Empirical studies by Barro (1992) and others have demonstrated that the economies that have been most successful in catching up to industrialized economies are those who possess a higher degree of human capital in relation to their starting income. A relationship between human capital and adoption of new technologies was suggested by Nelson & Phelps (1966). Almosabbeh (2019) established the empirical significance of the two functions of human capital for Total Factor Productivity (TFP) growth of a country. If human capital generates production via two sources; innovation and knowledge adaptation, measuring R&D spillovers presents a conceptual challenge. The Griliches (1998) and Romer (1986) concept of R&D spillovers is limited to external data used in enterprises' and organizations’ formal R&D operations. The objective of this R&D is to create new products and inputs, as well as to improve manufacturing processes. Endogenous growth theory is expressly limited to formal research and development as the means of TFP as well as growth initiative. Learning extends beyond R&D institution’s boundaries and contributes to the competencies of an individual that are utilized by competitors. This type of learning contributes to the human capital pool and must be accounted for in factor quality as an improvement; it is not related to the TFP residual.

Practically, maintaining this distinction is hard; see, for instance, according to Solow (2016), it is an error to view R&D as a sole fundamental source of ‘Total Factor Productivity’ development. Without hesitation, it is the supreme fundamental source. However, a sizable amount of productivity gain appears to be linked to people and procedures that are frequently unrelated to research and development. According to one explanation of Solow’s statement that is in harmony with Griliches (1998) and Romer (1986) difference, training and adaptations outside of R&D that result in non-competing new knowledge may add to TFP growth and innovation; else, they must be accounted for as increases in human capital. The rational issue is that these differences are not easily quantifiable. In principle, a worker who gains external knowledge and increases his or her productivity, earns a higher wage; the higher wage bill symbolizes the growth of human capital and is then omitted from the TFP residual. In practice, businesses struggle to monitor labor productivity development, and individual pay are tough to adjust. As a result, human capital growth is almost certainly unmeasured or underestimated, and all or a portion of it is recorded as TFP growth.

Corrado et al. (2017) examines the individual choices made in the pursuit of knowledge and how those choices affect both individual productivity and overall economic progress. In its role as a catalyst for growth, he views human capital as both an alternative and a supplement to technological advancement. According to his definition, it is the person's combination of technical, intellectual, and physical talents, or their 'general skill level'. Human capital is the growth engine in Azariadis & Drazen (1990) endogenous growth model with interconnected generations because it accumulates and shows growing social returns to scale. Every person is the same, and their lives may be split into two phases. The first is a time of training and employment, and the following phase is a time of working alone (the time spent in education in their early years is translated into later high-quality labor). They unintentionally leave portion of their human capital to their successors when they pass away (Altinok and Diebolt, 2023).

There is substantial evidence that education enhances individual's ability to deal well with economic instability, and that this capability is one of the most important advantages of education that benefit individuals privately in a contemporary economy. Human capital, according to Schultz (1960), is a necessary component of creativity. According to him, the most critical economic function of human capital is the capacity for adaptation, innovation, and learning. The R&D sector has a single production factor in Romer's 'Model of Endogenous Growth': human capital. The power of a country to conduct local research and development is inextricably linked to the increase in human capital, particularly human capital over a significant procedural level. Human capital is a critical variable in models of innovation dissemination since it is positively correlated with information availability, social prestige, and the ability to think and apply knowledge.

In fact, empirical studies by Barro et al. (1995) and others have demonstrated that the nations that have been most successful in catching up to industrialized nations are those who possess a higher degree of human capital in relation to their starting income. Krueger (1968) demonstrates through a cross-country analysis that the most significant factor in explaining the variations in per-capita income between the United States and emerging nations was disparities in human capital. Complex novel investigations, like those of Mincer (2022), have demonstrated a significant contribution of human capital accumulation to growth even within the rigorously neoclassical framework.

Capital Markets

Capital markets are crucial because they provide capital for new enterprises and entrepreneurship is key for innovation, thus the conversion of knowledge/ideas into products/GDP. Will (2019) defines Capital Market as the system that directs the savings into long-term investment. A capital market utilizes resources for different beneficial uses. An efficient capital market is an important driver of the commercial and industrial growth of an economy. Capital is provided for both short and long-term periods. A capital market fulfills the needs of the long-term debts and investments. Capital market is a fundamental regulating and collaborating system for balanced and free flow of economic resources into the financial system functioning in a country.

In contemporary economies, the ability of the financial sector to effectively pool domestic resources and mobilize foreign capital for profitable projects is critical to economic growth. If there isn't a strong network of financial institutions, potential investment projects will go untapped. Ineffective financial institutions will have the impact of penalizing profitable investments, which will limit the opportunity to build up the equipment stock required to compete on a worldwide scale. The result is a significant reduction in growth from potentially suitable policies and market arrangements (Ahmad and Malik, 2009).

Foreign investors are sometimes turned off by underdeveloped or poorly functioning capital markets since they are usually pricey and illiquid. If it is difficult and expensive to raise local funds, direct investment suffers. Large domestic companies' attempts to raise money are further hampered by illiquidity and high transaction costs, which may force them into overseas markets. Restricting a nation's capital market not only makes it less appealing to international investors, but it also hurts domestic businesses. This lowers growth rates below potential and particularly increases the difficulty of indigenous enterprises competing in global capital markets (Halabi, 2011).

Leading economists have recently come to the conclusion that unrestricted capital markets outperform regulated ones. Therefore, in theory, the presence of competitive financial markets ought to improve economic well-being. In fact, there is a lot of evidence from early empirical research by Shaw (1973) and Degong et al. (2021) showing a positive correlation between growth and liberal financial policy. Economists have long argued whether there is a relationship between financial development and economic growth. In the nineteenth century, economic theory maintained that an economy's financial structure had no effect on actual economic factors such as economic growth.

Capital Markets which are not properly established will be unable to provide effective financial intermediation services. They may either fail to receive all possible household savings or redirect a great deal of resources away from investments. Individuals in underdeveloped capital markets, for example, may put some of their money in passive products such as gold, which cannot be utilized immediately for physical investment. This issue could result from a lack of stability in the banking industry or from government-imposed interest rate limitations. In the latter instance, individuals would be afraid that the inflation rate would surpass the ceiling, reducing the actual worth of their savings.

Institutions

The functional environment in which the institution operates restricts its capacity to apply acquired external information in manufacturing, sourcing, and distribution. For example, local and national norms, rules, and restrictions may obstruct or ban the application of novel ideas. Recent economists have incorporated into formal economic theory the '*New Institutional Economics*' promoted by Oliver Williamson and Douglass North in the 1970s and 1980s (Richman, 2020). (Acemoglu & Johnson (2005) are most likely the primary architects of this modern synthesis. They contend that institutions, both formal and informal, play a critical role in economic growth by promoting or 7impeding efficient factor allocation. Obstacles to factor allocation to companies can catch resources in uses of low value and obstruct an efficient division of labor. Therefore, among numerous other 'non-economic' factors, the legal framework, the effectiveness of the government sector and law enforcement, interpersonal trust, and discrimination based on ethnicity, race, gender, and social origin (private or public) all have an effect on the economy's allocative efficiency. For instance, the rights of minority shareholders and creditors differ considerably between legal regimes. Due to the fact that systems of common law guarantee more rights than that of civil law, businesses have more capital raising opportunities (Rafael et al., 1999). According to Lucking (2019), economies with a primogeniture custom have a disproportionate share of ineffectively run family businesses. When the candidate pool of management is restricted to eldest sons or immediate blood relations, the probability of choosing a capable CEO is significantly reduced. Likewise, employment protection legislation can impose rigidities on the labor market, limiting enterprises' ability to adjust to changing market conditions and limiting prospects for invention.

Further literature on Institutions is discussed in Section 3 of this chapter.

2.1.7 Gross Expenditure on Research and Development (GERD)

As a proportion of GDP, gross domestic expenditure on research and development (R&D) encompasses both capital and current expenditure in the major sectors of economy such as industry, government, higher education, and not-for-profit organizations. Summary of R&D expenditures of World by region by region for the years 2017-2021 is shown below in the figure 1. Corporate R&D expenditures are a prominent indicator to quantify a company's share in innovation.

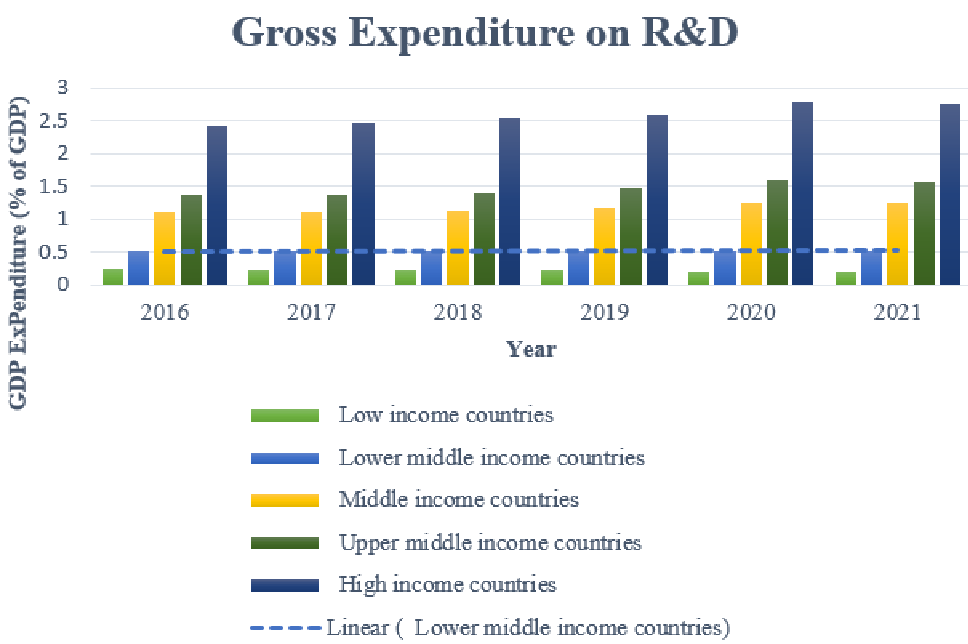

Figure 1: GERD shares of the World

Source: (UNESCO Institute for Statistics, 2024)

2.1.8 R&D expenditures and Economic Growth

Since the 18th century, the idea of growth in economy has been central to macroeconomic research. In light of the rising researches, it is clear that the association between growth in economy and a variety of elements, most notably population and capital, has been theoretically and experimentally investigated. Similarly, the importance placed on the relationship between economic growth and research and development activities is emphasized, in addition to the importance placed on technology in economic growth, which has been emphasized primarily in theories of endogenous growth since the beginning of 1990s. However, it is worth noting that studies aiming to establish a correlation between these two events have proliferated in recent years, particularly in the 2000s.

Entrepreneurial activities associated with inventions allow the generation of a wide range of novel ideas, the manufacture of novel consumer products, and the establishment of new markets. Certainly, Schumpeter asserts that explicit innovation-related activities impact the growth of economy in a capitalist economic system (Croitoru, 2012). Romer (1989) also views technical change as the core driver of growth in economy, and his endogenous growth hypothesis is predicated on capital expenditures of R&D. According to (Sequeira and Neves, 2020), efforts in R&D produce information that mitigates the effect of decreasing returns to scale on the factor of production, capital. R&D as a percent of GDP for the year 2020 is shown below in figure 3.

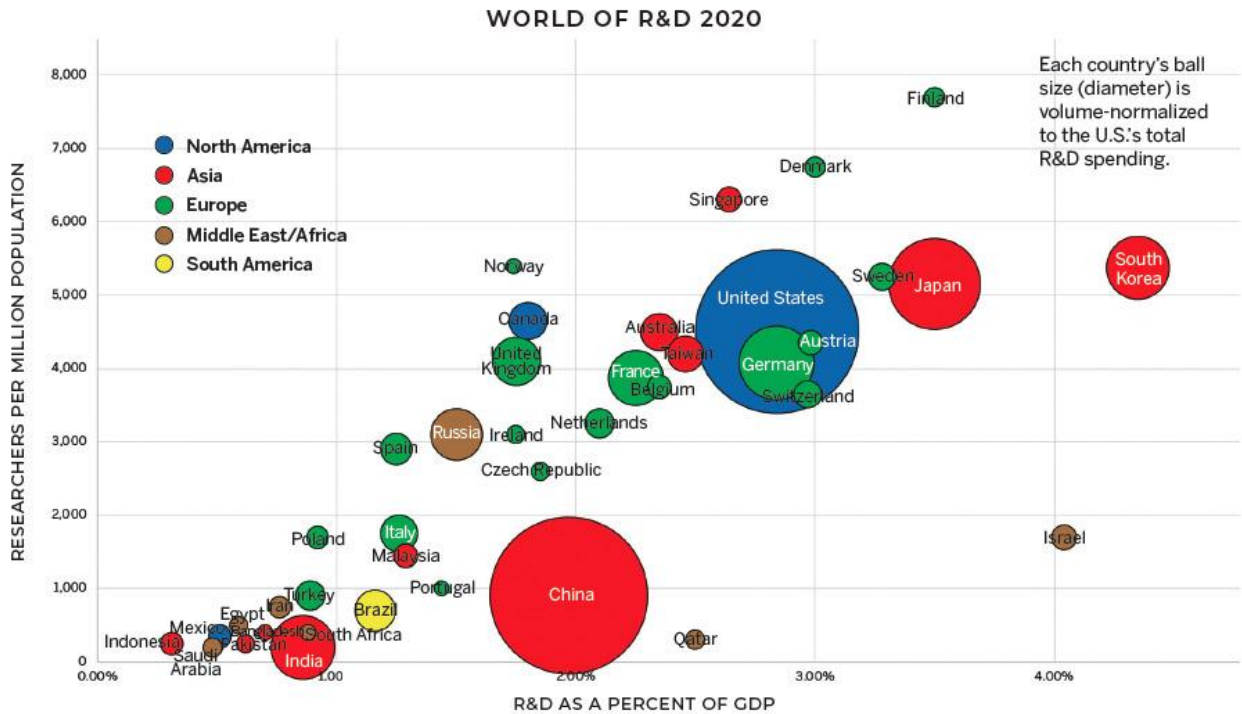

Figure 2: Global R&D as a percent of GDP for the year 2020

(Source: R&D World)

According to Sylwester (2002) research, that evaluates the link among growth of economy and R&D spending in OECD nations, it is improbable to derive a result that R&D spending drives economic growth. On the other hand, there is a favorable correlation between economic growth and investment in industrial sectors in the G-7 countries. This gap is explained, however, by the larger influence of technology on the G-7 countries' growth rates (Sylwester, 2002).

Table 1: R&D Expenditure as percent of GDP 2000-2021 for top 8 regions by R&D Performance

Source: *(OECD, 2021)*

Year	United States	China	EU-27	Japan	Germany	South Korea	United Kingdom	France
2000	268.6	32.9	158.8	98.9	53.9	18.5	25.2	33.3
2001	279.1	38.4	169.2	103.9	56.2	21.3	26.3	36.1
2002	278.4	47.8	178.1	108.2	58.6	22.5	27.9	38.3
2003	292.2	56.9	182.0	112.4	61.1	24.1	28.6	37.2
2004	303.8	69.7	188.7	117.4	63.0	27.9	29.4	38.2
2005	326.2	86.2	196.3	128.7	64.0	30.6	30.6	39.5

2006	351.7	104.8	216.6	138.8	69.6	35.4	33.3	42.4
2007	378.5	123.4	231.8	147.6	73.5	40.6	35.2	44.2
2008	405.4	145.2	254.2	148.7	81.2	43.9	36.5	46.6
2009	404.2	184.1	260.6	137.3	82.7	45.8	36.4	49.6
2010	408.5	212.2	270.2	140.5	87.0	52.1	37.5	50.9
2011	427.1	246.5	289.7	148.4	95.8	58.4	38.8	53.6
2012	434.4	289.2	302.4	152.3	100.5	64.9	38.5	55.1
2013	455.1	323.4	315.6	164.7	102.9	68.2	41.5	58.4
2014	477.0	346.3	329.1	169.6	109.6	73.1	60.4	60.6
2015	507.4	366.1	340.5	168.5	114.1	76.9	63.0	60.5
2016	533.5	393.0	360.1	160.3	122.5	80.8	67.1	63.7
2017	565.7	420.8	386.6	166.6	133.7	90.3	70.8	65.6
2018	618.1	465.3	413.8	172.0	142.3	100.3	84.9	68.7
2019	677.9	526.2	448.0	172.3	151.1	104.0	87.8	74.6
2020	730.3	583.8	448.9	172.0	147.0	111.1	90.2	74.2
2021	806.0	667.6	474.1	177.4	153.7	119.6	97.8	77.2

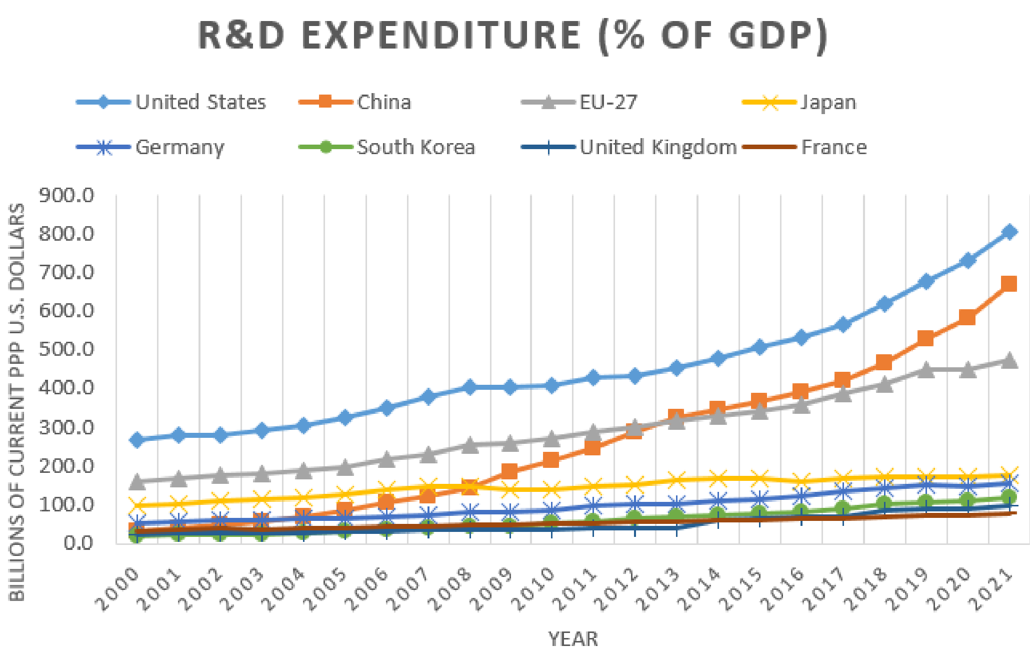

Figure 3: R&D Expenditures as percent of GDP for EU and other selected regions

Source: (OECD, 2021)

Table 2: GERD by sector and share of funds 2021

Region, country, or economy	GERD (PPP US$billions)	R&D-performing sector: Share of total (percent)				R&D source of funds: Share of total (percent)			
		Business	Government	Higher education	Private nonprofit	Business	Government	Other domestic	Rest of the world
United States	806.0	77.6	8.3	10.4	3.7	67.9	19.9	5.5	6.7
EU-27	474.1	65.6	11.6	22.0	0.8	57.0	30.8	2.4	9.9
China	667.6	76.9	15.3	7.8	NA	78.0	19.0	NA	0.2
Japan	177.4	78.6	8.4	11.9	1.2	78.1	15.5	5.9	0.6
Germany	153.7	66.9	14.8	18.3	NA	62.8	30.0	0.3	6.9
South Korea	119.6	79.1	9.8	9.1	2.0	76.1	22.8	0.8	0.3
United Kingdom	97.8	70.9	5.1	22.5	1.5	58.5	19.4	11.4	10.6
France	77.2	65.7	11.7	20.5	2.1	55.4	32.5	4.4	7.7

Source: (OECD, 2021)

There are certain cross-sectional characteristics in the way R&D is distributed among countries. Among the top R&D-performing nations, the business sector is the biggest funder and performer of R&D (Table 2). According to OECD GERD estimates, the government sector in many nations, including China and Germany, carried out a larger share of R&D than the government sector in the United States (15% in China and Germany vs 8% in the US). In contrast to China and South Korea, where the R&D performance share of higher education was in the single digits, the European Union (EU-27), the United Kingdom, and France had at least 20%. According to Figure 5, the government supported almost 30% of R&D in Germany and France, This increased the EU-27's overall share of R&D funding to 31%, whereas the US and China funded 20% and 19% of this sector, respectively.

Table 3: GERD as a percentage of GDP for LMICs (2016-2022)- UNESCO Institute for Statistics (UIS)

	2016	2017	2018	2019	2020	2021	2022
Angola	0.03229	..	..	..	..	..	..
Bolivia (Plurinational State of)	..	..	..	..	..	..	..
Cambodia	..	..	..	..	..	..	..
Côte d'Ivoire	0.06975	..	..	..	..	..	..
Egypt	0.70848	0.64486	0.68839	0.79617	0.91564	0.91175	1.01968
El Salvador	0.14493	0.18078	0.16531	0.17477	0.16294	0.16026	..
Estonia	1.24306	1.27685	1.40999	1.63146	1.75092	1.75215	..
Eswatini	..	..	..	..	..	..	..
Ghana	..	..	..	..	..	..	..
Honduras	..	0.03994	0.06394	0.05948	..	..	..
India	0.66984	0.66603	0.66001	0.65942	0.64636	..	..
Kenya	..	..	..	..	..	..	0.41019
Kyrgyzstan	0.11121	0.10707	0.10107	0.09016	0.08881	0.07515	0.07685
Lao People's Democratic Republic	..	..	..	..	..	..	..
Mauritania	..	..	0.01019	..	..	..	..
Mongolia	0.18345	0.1342	0.10161	0.0927	0.13301	0.10008	0.08521
Morocco	..	..	..	..	..	..	..
Nicaragua	..	..	..	..	..	..	..
Nigeria	..	..	..	0.28444	..	..	..
North Macedonia	0.43585	0.35439	0.36367	0.36783	0.37264	0.37719	0.38373
Pakistan	..	0.21214	..	0.17475	..	0.16443	..
Philippines	..	..	0.32222	..	..	..	..
Republic of Moldova	0.28004	0.25789	0.25626	0.24145	0.23511	0.23154	0.23122
Senegal	..	..	..	..	..	..	..
Tunisia	0.56539	0.69954	0.71645	0.74658	..	..	..
Ukraine	0.48339	0.44879	0.47113	0.43384	0.40318	0.3769	0.32696
Viet Nam	..	0.41895	..	0.41652	..	0.42533	..
Zambia	..	..	..	..	..	..	..
Zimbabwe	..	..	..	..	..	..	..

Gross domestic expenditure on research and development as percentage of GDP is the primary aggregate utilized in Table 3 shows actual figures, whereas the Figure 4 shows a graphical representation for international comparisons. It encompasses the overall expenditure on research and development (current and capital) by all resident enterprises, research institutes, university and government laboratories, and so on. They also include R&D financed by foreign governments, but exclude R&D undertaken abroad. GERD is expressed as a percentage of GDP.

Coe et al., (2009) assert that R&D investment is critical for economic growth. Aghion et al., (2011) conduct an empirical analysis using US data and discover that R&D spending as a proportion of GDP has an effect on economic growth. Lichtenberg, (2001) examines the impact of public and private sector R&D spending on economic development using data from 74 countries between 1964 and 1989 and concludes that, while R&D investment benefits growth, private sector R&D spending is more efficient and effective than public sector R&D spending.

Another study was conducted on this subject, utilizing data from the United States from 1953 to 2000. R&D expenditures are categorized into three distinct categories in this study: government, non-government, and defense, and their econometric correlations with economic growth are investigated independently. The study's findings indicate that government R&D spending has decreased dramatically over the study period. Similarly, government R&D spending in the defense industry has fallen precipitously. However, non-government enterprises' R&D spending has expanded dramatically. Contrary to what the data set suggests, the influence of government R&D expenditure on economic growth is greater than that of non-government enterprises. Defense R&D spending has the strongest association with economic growth. The results claimed that the relationship between aggregate R&D spending and economic growth is causal by examining the relationship (Goel, Payne and Ram, 2008).

In 1998, governments in the OECD countries spent over $150 billion on research and development (R&D), accounting for nearly one-third of the countries' total R&D expenditures.

Guellec & Potterie (2004) examine data from 16 OECD member nations from 1980 to 1998 and discover a positive and significant influence of R&D spending on economic development, whether private, public, domestic, or foreign.

Park (1995) explores more on the relation between R&D investment and increased output. Park studies individual and government expenditure in eleven OECD countries. He finds that both domestic and overseas private expenditures are connected to domestic production growth. He establishes a negative relationship between public R&D expenditure and domestic productivity growth using private R&D spending as a control. On the other hand, he shows that public R&D has cross-border spillover effects on private research. Given the link between public R&D investment in one country and private R&D spending in other nations, public spending may indirectly but positively contribute to productivity development. Private R&D spending in the United States does not appear to be connected to private spending in other nations. He feels that public R&D is more concentrated on fundamental research than applied research, resulting in a varied variety of applications across various countries. Another viewpoint is that public research findings spread faster than private research results, and so more effectively support following private research.

Table 3 shows the World GERD as a percentage of GDP (2016-2022) in figures, whereas Figure 5 shows the bar chart for the data.

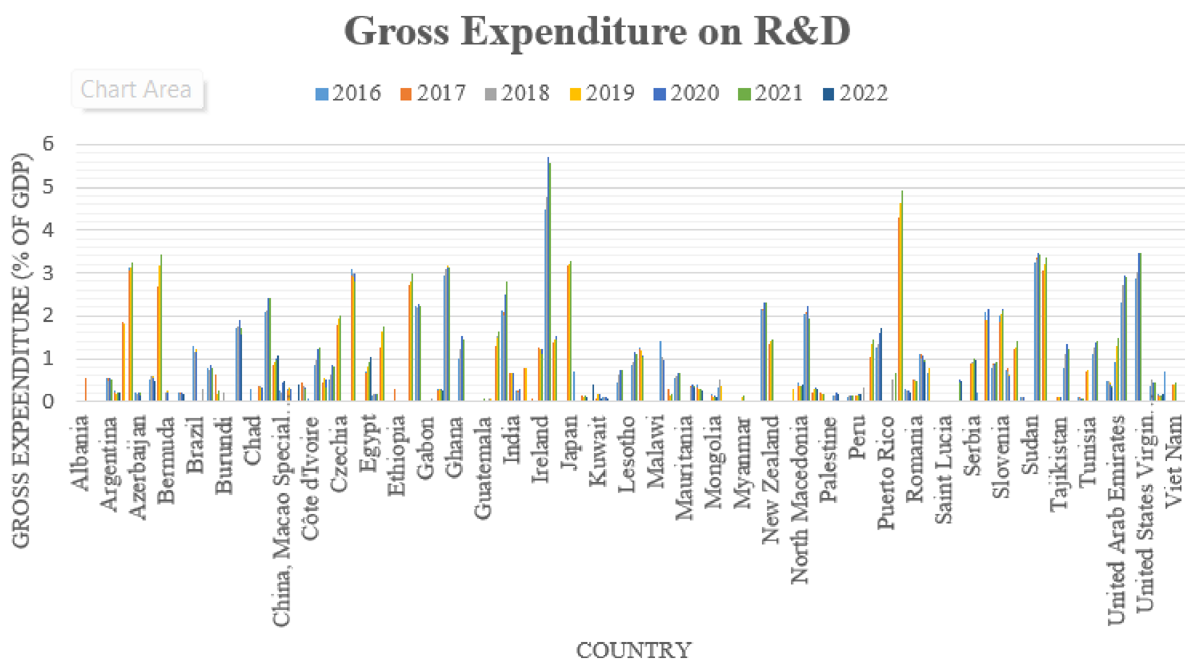

Figure 4: GERD as a percentage of GDP (2016-2022)

Source: UNESCO Institute for Statistics (UIS)

Ulku (2007) also used data from 17 OECD countries to discover that R&D concentration in the chemical, electrical and electronic, pharmaceutical, and medical sectors predicts innovation potential, and that innovation potential has a positive influence on production in the sectors analyzed.

Another study looks at the link between R&D expenditure and total factor productivity (TFP), which is one of the key drivers of economic development in China and employs big and medium-sized industrial firms. According to the conclusions of a study done between 2000 and 2007, research and development investment contributes to total factor productivity enhancement (Zhou and Xia, 2010).

While Goel et al. (2008) examine 52 nations, Gittleman & Wolff (1995) examine whether a country's degree of development has an effect on the impact of R&D spending on economic growth. Both findings demonstrate that a country's degree of development has an effect on how quickly economic growth can be accelerated by R&D spending.

Another study, undertaken for OECD nations with higher income levels, uses panel causality analysis to analyze the relationship between R&D investment, innovation, and economic growth. A significant and favorable association between R&D, R&D and economic development, and economic innovation and entrepreneurship was discovered in this study (Guloglu and Tekin, 2012).

The link between governmental and private sector R&D expenditure and economic growth is explored using a dynamic panel technique in a study of Central and Eastern European countries. The findings indicate that a 1% increase in private sector R&D expenditure translates in a 0.25%

rise in economic growth. Additionally, it is determined that there is no meaningful association between public sector R&D investment and economic growth (Pop Silaghi *et al.*, 2014).

Another study on rising economies evaluates 66 nations from 2000 to 2009 using indicators. These countries are classified into two groups based on their income levels: those with a high income level and those with a middle or low income level. According to the study, research and development spending boosts economic growth in emerging economies. While R&D expenditure has a beneficial effect on economic growth in higher and middle income countries, there is no substantial association between the two variables in lower and middle income countries (Inekwe, 2014).

Annual data for several years are used to examine the causal relationship between R&D expenditure and economic development in a research encompassing selected OECD countries. According to the study's findings, there is a long-run causal relationship between growth and R&D in the United States, with a shift in the relationship's direction from growth to R&D. In Italy, the long-run causal link similarly turns away from growth and toward research and development. However, there is a reverse causal relationship in the short run. For example, in Denmark, a long-run causal association exists between growth and R&D, but no short-run causal relationship was discovered. Additionally, a long-run bidirectional causal association was discovered in Japan, but no short-run relationship was discovered. However, it is discovered in France that there is a long-run and a short-run link. The causal association between economic growth and R&D is positive in both circumstances. There is a causal association between R&D and growth in Germany, and between growth and R&D in Canada (Tiryakioğlu, 2015).

In a related study on Turkey, data on different issues like as R&D investment, the number of people in R&D departments, the number of patents as a measure of entrepreneurship, and economic activity rates are linked using a panel regression model for the period 1998 to 2000. There is a substantial but negative association between R&D expenditure and the number of people in the R&D department and economic growth, whereas the number of patents has a significant but inverse relationship with economic development. The negative association between these two variables is mostly due to the high expense of patenting, and it is projected that the relationship would eventually reverse to a positive direction (Bayarçelik and Taşel, 2012).

On the other hand, Freire-Serén (2001) and Saraç & Alptekin (2017) discover a favorable link. Saraç & Alptekin (2017) found that R&D expenditure has a positive effect on economic development in his panel data study of data from ten developed OECD nations from 1983 to 2004. Similarly, Freire-Serén (2001) analyzes data from 21 OECD nations between 1965 and 1990 and concludes that a 1% increase in total R&D expenditure results in a 0.08 percent rise in GDP growth. Aust et al. (2013) conducted a similar study, using data from 21 OECD countries, Pedroni and Kao co-integration tests, Pedroni DOLS and FMOLS estimators, and Canning and Pedroni panel causality analyses, to examine the long-run relationship between R&D expenditure and economic growth from 1990 to 2010. According to the study’s findings, increasing R&D spending by 1% results in a 0.77 percent boost in long-run economic growth in the 21 OECD countries. According to the Lamda-Pearson statistics used in the causality analyses, there is a bidirectional causal relationship between panel causality results, R&D expenditure, and long-run economic growth in the entire panel, whereas the group's average statistical values indicate a one-way causal relationship between economic growth and R&D expenditure in the long run. As a result, it is stated that there is a bidirectional strong relationship between R&D expenditure and indicators of economic growth (Hong, 2017).

Another study examines the links between R&D and growth for each of the 34 nations investigated from 1997 to 2008 using a panel data causality test. R&D spending has been found to increase economic growth in a group of 34 nations, according to the results of a causality test (Genç & Atasoy, 2010).

Two studies use data from emerging countries to explore the relationship between R&D spending and economic growth. Samimi & Alerasoul (2009) evaluate data from 30 developing nations between 2000 and 2006 and conclude that research and development spending has no direct effect on economic growth. They conclude that this is because these countries lack funding for research and development. In comparison, Adhiutama et al. (2018) discovers a positive correlation between R&D spending and economic development in emerging economies. He examines data from 11 developing Asian countries between 1996 and 2012 and discovers that a 1% increase in R&D spending boosts exports of advanced technology goods by 6.5 percent and exports of information and communication technologies by 0.6 percent, while also accelerating economic growth by 0.43 percent.

Another related study uses a panel data model to evaluate the association between R&D spending and economic development in 15 selected OECD nations from 1990 to 2011. The study concluded that R&D spending boosted economic development in seven OECD countries: Canada, Finland, France, Italy, Portugal, Turkey, and the United States. However, it is discovered that increased R&D spending had an unexpected adverse effect on economic growth in Germany, the Netherlands, Spain, and the United Kingdom. However, the panel's findings indicate that R&D spending raises real per capita GDP in all countries (Akinci, Akinci and Yilmaz, 2014).

A significant study examines the externalities associated with R&D spending between developed and undeveloped countries. Coe et al. (1997) estimate the spillover effect of wealthy countries' R&D expenditure on developing countries. They assert that R&D investments in wealthy nations help not only national economies, but also those of developing countries, and that high-tech commodities, as well as capital goods, exported from developed countries to developing ones boost developing countries' efficiency. They discover that increasing R&D expenditure in affluent countries has a large positive effect on output in developing countries. (Lichtenberg and Van Pottelsberghe De La Potterie, 1998) studied the effect of R&D spending on the rise of total factor productivity (TFP) in developing nations once more. His research raises doubt on findings of Coe et al. (1997). These findings are consistent with the assumption that additional resources should be directed to research and development in order to attain long-run economic growth performance.

2.1.9 Scientific Performance of LMICs and economic growth

Despite the lack of particular literature on LMICs, a number of important research offer insightful perspectives on the ways in which institutions, innovation, and knowledge generation impact economic development. Together, these studies highlight how important R&D and scientific achievement are to promoting economic growth in LMICs. They draw attention to the need for specialized policies that improve R&D capacities, encourage creativity, and strengthen the absorptive capacities necessary for long-term economic growth.

Acemoglu and Robinson (2012) made the case that a country's level of institutional quality has a significant impact on its level of wealth. While extractive institutions impede development, inclusive political and economic institutions promote innovation and economic expansion. The framework can be utilized to comprehend the difficulties LMICs encounter in improving economic growth and scientific achievement, even though it is not specifically targeted at them. Islam (2024) examined R&D spending, remittances, and economic growth interact in middle-income nations, emphasizing how these factors affect the economy as a whole. This study examined the combined effects of R&D spending and remittances on economic growth by analyzing data from 25 middle-income countries (MICs) between 1996 and 2021. Using feasible generalized least squares (FGLS) and panel autoregressive distributed lag (ARDL) techniques, the study discovered that remittances and R&D expenditures both significantly and favorably impact economic growth in MICs. According to the report, policies that encourage R&D expenditures and ease remittance outflows can hasten these nations' economic growth. The study conducted by Herzer (2022) highlights the importance of R&D in improving economic performance by examining the effects of both domestic and international R&D investments on Total Factor Productivity (TFP) in developing nations. This study examined the effects of both foreign and indigenous R&D investments on emerging nations' Total Factor Productivity (TFP). The results show that raising domestic R&D spending has a beneficial impact on TFP growth rate and level, with the effect being more noticeable in middle-income nations than low-income ones. Furthermore, it was discovered that domestic R&D had a significantly higher effect on TFP than international R&D spillovers, highlighting the need of developing domestic research capacities.

The empirical connection between R&D spending and economic growth in both industrialized and developing nations was examined by Ali (2021) . By emphasizing that higher R&D investment is linked to faster rates of economic growth, the study shed light on how R&D serves as a catalyst for economic advancement. According to the findings, R&D should be given top priority in emerging nations in order to promote economic growth. Past literature also investigated how R&D expenditures affected economic growth in various economies with varying income levels. According to the findings of Inekwe (2014), R&D spending has a negligible impact on growth in LMICs but has a favorable impact in upper-middle-income ones. This implies that different wealth levels provide different returns on R&D investments, and that in order for lower-income nations to fully profit from R&D efforts, they may need to address more fundamental issues. Similarly, Agezew (2024) focused on Ethiopia in his study. He examined the relationships between R&D and economic growth by taking into account factors including patents, technology exports, research expenditures, and citable journal articles. The necessity of investing in research capabilities to promote development is shown by the study's finding that greater R&D activities are linked to economic growth. In order to examine how different capacities such as human, financial, infrastructure, technological, public policy, and social capacities, affect economic growth in low- and middle-income countries, Khan (2022) expanded the idea of absorptive capacity to the national level. The findings showed that improving public policy, financial institutions, and human capital with specialized skills, and infrastructure (ICT, energy, trade, and transportation) are all necessary to achieve economic growth. According to the report, in order to achieve sustainable development, governments with tight budgets should give priority to investments in these sectors.

2.1.10 R&D and Innovation

Innovation and research and development (R&D) are closely related ideas that frequently complement one another to boost economic growth, competitive advantage, and technological advancement. Both are necessary for the development and improvement of goods, services, and procedures inside businesses and economies (Koushik, 2023). In order to overcome obstacles and take advantage of possibilities, they require creativity, problem-solving skills, and the application of information. Whether through the creation of new technologies or the improvement of current systems, the fundamental goal of both R&D and innovation is to add value.

But even though they are closely related, R&D and innovation are not the same. The main definition of research and development (R&D) is the methodical, scientific study intended to produce new information or apply already existing knowledge in novel ways. It typically focusses on the scientific or technical underpinnings of novel concepts. Contrarily, innovation is more comprehensive and encompasses the effective application and commercialization of those concepts. R&D may result in trial models or prototypes, but innovation transforms those into goods or solutions that are ready for the market. To put it simply, R&D is frequently viewed as either a component or a catalyst for innovation, especially in sectors that rely heavily on technology (Schot and Steinmueller, 2018). Thus, R&D and innovation have a symbiotic relationship. While innovation makes sure that the results of R&D are implemented successfully to satisfy market demands and create value, R&D supplies the technical inputs and knowledge base needed for innovation. R&D outputs could remain theoretical or underutilized in the absence of innovation (Kenton, 2022). On the other hand, innovation that lacks a solid R&D base might not be as deep or innovative as what is required to maintain a competitive edge over the long run. They work together to create a cycle of application and discovery that propels advancement in both business and society (Kogabayev and Maziliauskas, 2017).

Past literature highlighted a comprehensive overview of the complex interplay between R&D and innovation, highlighting both their interdependencies and distinctions. According to Hervas-Oliver (2011), there is no discernible difference in performance between R&D and non-R&D performers as measured by sales per employee, despite the fact that around half of all innovative enterprises do not participate in formal R&D operations. Smaller businesses are less likely to participate in innovative activities, according to Baumann and Kritikos (2016), but those that do tend to have higher R&D intensity. Additionally, for product innovations rather than process innovations, there is a greater correlation between R&D effort and the likelihood of reporting innovation. Similarly, the relationship between R&D expenditure and financial leverage is examined by O'Connell (2022) in regard to the success of R&D innovation. The results emphasize the significance of innovation success in financing decisions by indicating that strong R&D outcomes might lessen the negative correlation between financial leverage and future R&D spending. Zhu (2020) highlights the importance of a firm's absorptive ability while examining the effects of R&D subsidies and investments on innovation success. It implies that companies with greater absorptive ability can more effectively use R&D investments and grants to improve innovation outcomes. Dedrick (2008) explains the difference between R&D and innovation, pointing out that while innovation stresses the commercial and practical use of technology, R&D concentrates on producing knowledge and technologies.

2.2 SECTION 2: INNOVATION

The economics literature has placed an importance on the contrast between research and development and innovation. Since the publishing of Schumpeter's books, innovation has been defined as the actual execution of an improvement, whether that improvement is the introduction of a new product or a new manufacturing technique (Halpern and Muraközy, 2012). Product innovation is distinct from process innovation, and research and development can relate to either a product or a process. In other words, R&D contributes to the process of innovation. Nonetheless, research is not considered innovative until its results are commercially viable or integrated into the manufacturing process.

The definition of innovation from the European Union's Community Innovation Survey, CIS is: Research and development (R&D) is not itself an act of innovation, but rather an investment in it. And this is far from the only instance of such expenditure. When a business invests in machinery to implement its innovations, or when managers go above and above in preparing for the introduction of new processes or products, these are instances of innovation inputs. Even if a business does not conduct research and development, it might launch new products or services through other channels, such as technology transfer. (EuroStat, 2016)

This is particularly true for small open economies and countries that are not technologically advanced. Foreign inventions and goods are crucial to the growth of these countries and must thus be a priority of innovation strategy. In today's context, the macroeconomic impact of innovation is largely undeniable. According to a recent study, conventional wisdom holds that innovation, specifically the commercialization of scientific and technological advancements, responsible for up to 75% of economic development. Up to 90% of the time, technological advancement influences societal success (Miroshnychenko, 2020). These findings corroborate recent research and economic theory (Solow, 1956); (Rivera-Batiz and Romer, 1991) that point to technology advancement as the primary source of long-term productivity growth. The rate of return on R&D is fairly exceptional; it is estimated to be 25% for private returns and 65% for societal returns (Samet, 2011).

As the mechanism by which new information is applied to economic processes, innovation serves as the catalyst for long-term economic progress. This literature begins by demonstrating how economic growth theories and models agree on the role of innovation. Businesses that innovate are ultimately responsible for growth (Burgos and Bocco, 2020). Experimental studies demonstrates that innovation, in the type of functional enhancements in processes, systems, services and products, is a necessary provision for company competitiveness and general economic growth (Farida and Setiawan, 2022). Innovation is not inexpensive: it takes financial investment and resource commitment. Investment in tangible and intangible innovation assets - such as research, design, training and skills development, intellectual property, organizational and management expertise, and so on - is necessary to foster productivity growth that benefits both GDP growth and overall prosperity. Government investment in scientific and information infrastructure, education and training, and government procurement all play a crucial role in accomplishing this.

The literature underlines the critical need of comprehending the true characteristics of innovation before proposing policy solutions (European Commission, 2010). To comprehend the essence of innovation, we need two fundamental resources. On the one hand, there is an abundance of academic research and evidence that provides a solid foundation for policy analysis. On the other hand, there is a body of prior policy research and data (Osborne, Simon and Tytler, 2009) and (OECD Factb. 2010, 2011). This enables us to delve deeper into the innovation process and gain a more complete understanding of its complexity and dynamics.

There are two forms of growth-oriented innovation. To begin, there is innovation, which results in the creation of wholly new items, usually as a result of some form of breakthrough knowledge advancement. This type of invention is frequently founded on scientific knowledge and is frequently (but not always) at the heart of technical advancement (Oleksandr *et al.*, 2020). At times, it results in the establishment of new businesses and activities. For instance, the computer and communications industries came out of semiconductor and microelectronics industry innovations. Second, there is innovative product development of existing products. This takes the form of ongoing incremental improvement that fundamentally alters established sectors. The industry remains stable (at least in name) in this arrangement, although its qualities may vary dramatically over time. For example, vehicle advances have resulted in considerable increases in fuel efficiency, mechanical dependability, material usage, and assembly costs. Although these two sorts of innovations—radical innovations and incremental changes—are produced in very different ways, both are crucial to growth performance. Both of these issues present considerable difficulties for policymakers.

What can we learn about innovation from contemporary research? Several significant solid findings include the following: innovation activities are ubiquitous across industries, collaborative (involving the engagement of many individuals), cumulative over time, hazardous and uncertain, and frequently dependent on national and regional expertise. Numerous studies have identified knowledge clusters and innovation hotspots as a common source of competitive advantage (Turkina and Van Assche, 2018). The innovation system, most critically, affects the environment in which enterprises and other actors develop and generate. The innovation system is a network of interconnected organizations (enterprises, universities, and financial actors) and institutions (such as laws, rules, and infrastructures) that influence the environment in which firms and other actors create and produce. Policymakers are charged with the essential responsibility of setting the design and operation of the innovation system.

2.2.1 Innovation's significance in growth theory

There are numerous growth theories in economics, but they all place an importance on innovation as a growth driver. Often, economists are supposed to disagree on practically every subject. They do agree, however, that all long-term growth cycles rely on innovation and technological progress (Adak, 2015). This is particularly true in advanced economies, where innovation is vital for enhancing the quality of inputs and incorporating them into the manufacturing process.

2.2.2 The Schumpeterian Model

The economist Joseph Schumpeter attributed the primary role of economic growth in the 1940s to disruptive activities by entrepreneurs and then huge businesses, which drove a process of creative destruction by producing constant disruptions in the economic system (Schumpeter & Backhaus, 2003). The catalyst for these disruptions was innovation, which Schumpeter defined as competition from a new commodity, a new technology, a new source of supply, a new type of organization, competition that offers a decisive cost or quality advantage and targets not existing firms' profit margins or output but their very foundations and existence. Although Schumpeter's research was descriptive rather than formal, subsequent economists formalized his findings and emphasized the importance of innovation in growth (Aghion and Howitt, 2006).

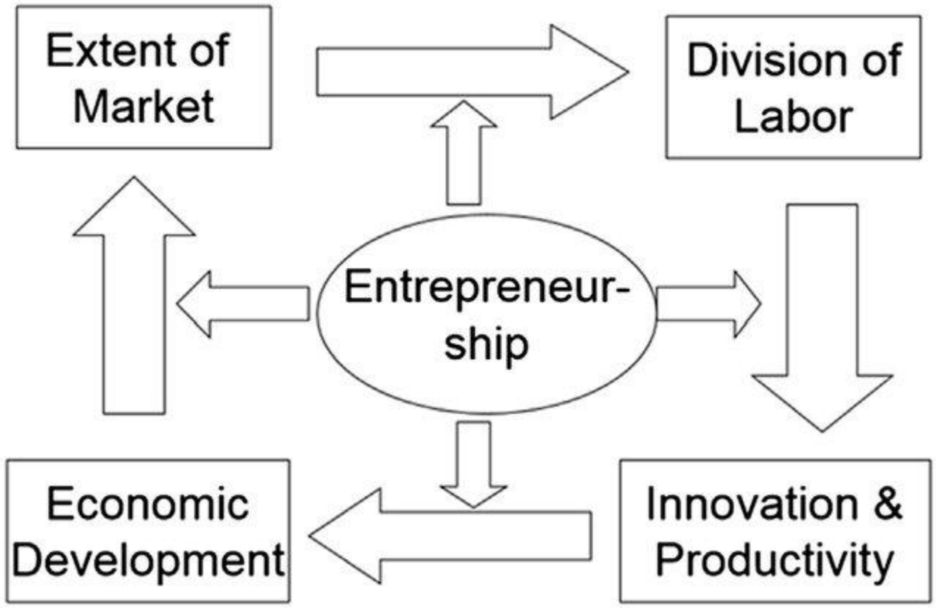

Figure 5: The Schumpeterian Growth Model

Source: (Zhang, 2017)

2.2.3 Exogenous Growth Model

The notion that the development of advanced innovations is a primary mean of growth of economy was introduced into economics by neoclassical economists. Neoclassical growth theory is largely based on Robert Solow's mid-1950s model (Akhter, 2022). Solow (1956) found that almost half of historical growth in industrialized countries was due to a third factor dubbed the residual factor. Residual growth factors encompass all intangible components of growth, including the development of current and mostly new modes of production, changes in workers' education and expertise, research and development, and changes in the structure and techniques of production. As a result, neoclassical theory has incorporated the complex of technological advancements into economic analysis as a significant determinant of economic growth. In this way, it has created an important methodological advance in the research of primary causes of growth of economy. On other hand, economic growth's 'neoclassical theory' largely overlooked the topic of the means of advancement in technology that is widely seen as its primary weakness (Sainsbury, 2021).

Additionally, neoclassical economists were unable to account for the substantial disparities in residuals between nations with comparable technical growth (Todaro and Smith, 2014). Abramovitz et al. (1973) and later Solow (2016) established empirically that long-run economic growth in the United States was mostly driven by technological advancements rather than increases in capital and labor inputs, highlighting the importance of innovation but leaving unanswered why. Arrow, (1969) argues that new ideas emerge logically as a result of the application of established concepts, i.e., when productive activities are pursued. Individuals develop through increased production, but at the industry level, a production process enables each producer to benefit from the experience of others.

Regardless of the conclusions drawn above, it is worth noting that neoclassical thought opened the path for an acknowledgment of R&D activities as economic growth's major drivers in the latter decade of the twentieth century's economically developed countries (Prettner and Trimborn, 2017). Furthermore, these perspectives have prompted governments in the majority of economies to finance major sums operations of Research and Development. Additionally, I believe that Arrow (1969) views on lowering average production costs through the learning curve (learning by doing) are critical, as is Judd (1985) dynamic general equilibrium model, which explicitly includes research activity and defends the presence of competitive profits in light of how research works.

2.2.4 Endogenous Growth Model

In neoclassical economics, endogenous growth models are used. The Solow growth model presupposed that the technical process originated outside of company activity. Later 'endogenous' growth models sought to elucidate the long-run growth drivers by integrating knowledge-creating investments (Sainsbury, 2021). This established a causal link between inventions and progress. Endogenous innovation models recognized technical advancement as critical to long-term success, but internalized it by requiring financing in innovation, especially through human capital and R&D. The primary mechanism by which these models describe growth of economy is the phenomena of increasing economies of scale that is caused by technological progress's externalities.

Several of the most well-known methodologies in this area involve replicating a specialized 'research part' of an economy that generates both new contributions and universal scientific and technological information. Growth in these models is fueled by technological advancements in tools and equipment (inputs), as well as 'spillovers' of knowledge from one industry to another. Since production tasks are not self-contained and inputs of knowledge can affect several or all production tasks at the company level, it is the spillovers that generate expanding returns (Miroshnychenko, 2020). The primary distinction between this model and neoclassical growth theory is that the growth rate can be enhanced indefinitely by actions that promote the flow and utilization of common knowledge within the system.

According to Judd (1985) general equilibrium model, technical advancements result in declining earnings and so does not contribute enduring growth which is sustainable. Judd made the assumption that a business can innovate by financing a specific quantity of resources to innovation. Additionally, such a business can patent its concept, granting it the full right to trade it for a specific time period. The weakness of the model is that succeeding innovators earn less profit as a result of rising competition. Subsequent inventors' profits are insufficient to cover the costs of research and patent application.

Certain types of models, characterized by power of monopoly, fundamentally presuppose the existence of a distinct sector of technology in an economy that delivers new technology to other sectors (Feldman, Guy and Iammarino, 2021). By purchasing new technology, producers obtain the right to use it. Additionally, they charge a premium over their marginal cost in order to recoup their costs, which include the initial investment in the new technology. Investments in innovative ventures do not result in declining returns in this regard. This ensures that the productivity of new investments in creative activity remains constant, allowing for continuous and sustainable macroeconomic growth. The growth rate is defined in these models by the quantity of money allotted to research and development, the magnitude to which the latest technology can be taken advantage of for private uses, and the investors' time horizon.

Romer (1986), for example, codified mathematically the idea that knowledge leads to perpetual economic expansion, so providing a new theoretical framework for examining economic growth drivers known as endogenous growth. Contradicting Judd’s concept, it was claimed by Romer that innovation does not have diminishing returns, hence removing the main impediment to long-run sustainable growth. According to Romer (1986) model, the growth is compelled based on research and development findings, which emerge as technological advancements that firms leverage to maximize profits. Romer (1986) notes in this context that technology is unique among other things in that it is non-competitive and, in some ways, excludable.

Romer (1986) idea is predicated on three key assumptions: (a) technological innovation is necessary for economic growth; (b) it results from the market-driven happenings of economic agents (individuals and enterprises); and (c) technology is non-competitive and partially excludable. All three of these assumptions contribute to the conclusion that equilibrium is only feasible under monopoly conditions, not under ideal competition. Indeed, if all aspects were compensated on a marginal product basis, the firm would experience losses as a result of the increased expenses associated with earlier R&D. Romer (1986) model identifies 4 critical components of manufacturing as physical capital, labor, human capital, and technology (Agarwal, Ganco and Ziedonis, 2009). As a result of that, the economy has been divided into 3 different sectors. The first of which is the research sector, which generates new knowledge through the integration of human resources and existing knowledge (technology). This industry, in particular, develops ‘latest designs’ for the manufacture of intermediary goods. The second sector is intermediate products sector, which utilizes novel designs developed in the research sector, as well as previously manufactured final goods (which are conserved rather than consumed), to create a variety of new intermediary goods. The final sector employs labor, and intermediate capital goods and human capital in order to manufacture final goods.

According to this model, the amount of accumulated human capital affects the equilibrium's long-run development rate. In an equilibrium state, scarce human capital is allotted to research and development. The incorporation of national economies into global economy accelerates growth. Growth is more noticeable when the proportion of human capital dedicated to research and development is greater than the total amassed human capital (Guo, Ning and Chen, 2022). In contrast to Romer’s model, in which the number of new designs increases constantly as a result of research, new goods might replace older goods. Grossman & Helpman (1991) as well as Aghion & Howitt (1994) have conducted extensive research on this facet of technological growth.

Firms that compete flawlessly can employ research and development products for free, which deters others from cooperating with them. By contrast, such an incentive exists under monopoly and patent protection conditions. Indeed, when a latest and more effective design is invented for manufacturing, the firm that adopts it first gains the share of market over its competitors because it can provide a better product for the same price, or the same product in terms of quality and usefulness at a lower price (Ramsza and Karbowski, 2020). Contenders must either introduce a similar or more modern design or risk losing their entire market share. Each product may be enhanced endlessly using these models, with each new generation always beating the preceding one in terms of performance per unit cost. The concept is that each new generation of product necessitates significant investment in research and development. Thus, until a new innovation arises, the market winner retains the monopoly rent. Investment in innovative projects generates no diminishing returns and boosts the productivity of all future creative endeavors, enabling sustained economic growth. Economic openness is frequently studied using R&D-based models. The dissemination of fresh knowledge is the simplest way for greater openness to result in faster growth. Even when no items are traded, Batiz (2018) show that equilibrium development occurs more quickly in an interconnected world than in isolated countries. Knowledge created in one country is easily accessible to scholars in other countries in an age when communication is very inexpensive. However, there are instances in which openness facilitates technical advancement. Indeed, corporations operating in open economies have the option to sell their findings on the global market and invest more in research and development in the expectation of bigger earnings than firms operating in closed economies. Additionally, one component of research and development models is devoted to examining the process through which technologically underdeveloped countries emulate technological advances made by technologically advanced countries.

Numerous experimental studies demonstrate that the private sector invests significantly less in research and development than is publically ideal. According to some experts, overall research and development investment is less than a fourth of what it should be (Mohamed, Liu and Nie, 2022). Inadequate private investment in research and development is partly the result of market inefficiencies, which can make these investments more expensive and risky than other forms of investments. Firms can approach the profitability of applied research investments in the same way they do other ventures.

The corporation will invest as long as the anticipated benefit from the research study would cover the costs. While the average profit from R&D projects is substantial for the corporation, ranging between 20% and 30%, the societal benefits are far greater, frequently exceeding 50%. This spillover occurs when people make use of the study findings and spread them in ways that the inventors are frequently unaware of (Liu, Lu and Cheng, 2018). The word ‘Spillover’ refers to the fact that as a result of its investment in applied research, the firm obtains a share of the profit generated by the application of the research and development project’s findings. As a result, corporations invest less in R&D than they would if they could fully benefit from their own research. In other words, some research initiatives that would generate positive net benefits overall (i.e., the sum of private and societal revenues less project costs) are privately unprofitable because the investor derives no societal benefit. Without specific market interventions, the private sector would not undertake research projects even if they were in the public interest. The idea and implementation of belligerent economic strategy based on innovation require increased public and, private investment in research and development, with the government decreasing taxes on company investment in R&D through tax policy (Gries *et al.*, 2017).

2.2.5 Creative Destruction

The term ‘Creative Destruction’ was first coined by Joseph Schumpeter. He derived it from Karl Marx’s work and called it as the ‘theory of business cycle and economic innovation’. It is sometimes referred to as Schumpeter’s gale. In Karl Marx economic theory, the term refers more broadly to the interconnected processes of wealth accumulation and destruction under capitalism (Elliott, 1980).

GDP is said to be a more important measure of a nation's prosperity than any other indicator. It is being argued that the health of millions of people is highly associated to the country's GDP/Capita in which they reside. But some parts of GDP are not directly measured by the indicator. Philippe Aghion et al. (2021), in his book 'The Power of Creative Destruction', has discussed some of the main approaches we can use to measure improvements in a nation's GDP growth. One of these approaches is to assess life satisfaction through surveys. The second approach is to assess the performance of the economy through innovation, which can be done by many products or activities or the different innovation types. Other indicators such as social mobility is used to measure the equality and inclusiveness of a nation's economic growth.

'*Creative Destruction*' is a process through which new inventions develop that in turn outdate current technologies, new organizations emerge to give competition to current enterprises, and new endeavors and employment opportunities emerge that replace current endeavors and jobs. Capitalism's driving force is creative destruction, which ensures its constant regeneration and reproduction but also producing disorder and risks that must be handled and regulated. Consequently, new paradigms are needed to describe the prosperity of countries, because the current examples have proven insufficient to describe the major developments and clarify the enigma of the prosperity and growth of nations. The neoclassical model, a growth process based on capital accumulation, was developed by Robert Solow and explains a country in which capital is needed for production and where GDP growth results from increases in capital stock. This type of economy appears to produce sustainable development even in the lack of technological progress, due solely to capital accumulation. The problem with this model is that there are diminishing returns to production using only capital, and the determinants of long-run growth are not explained. These 2 theoretical as well as empirical reasons inspired the initiation of a new paradigm.

The Schumpeterian model was introduced. Two important ideas underlie this model: the first idea is that innovation arises from entrepreneurial activity motivated by the prospect of innovation returns. These returns depend on the institutional environment, in particular the degree of protection of intellectual property rights (Bylund and Mccaffrey, 2017). The second idea underlying Schumpeter's growth theory is the idea of creative destruction: new innovations replace older technologies and consequently destroy the rents that rewarded yesterday's innovators.

According to Xu et al. (2018), human history before the Industrial Revolution was riddled with technological innovation. Three factors, he claims, made this coevolution possible. They were the diffusion of knowledge and information, international competition, and the protection of intellectual property rights. Inventors inherited the wealth of all previous inventions and were thus able to 'stand on the shoulders of giants'. According to him, openness played an important role in the cumulative process of innovation and, consequently, in getting off the ground. The Industrial Revolution exemplifies three basic tenets of the creative destruction paradigm. Printing and postal services, for example, greatly facilitated the production and dissemination of knowledge. Despite resistance or opposition from vested interests, competition enabled innovation and creative destruction.

Two common misconceptions about technological revolutions are challenged nowadays. The first is that technological revolutions always accelerate growth, while the second is that they always harm employment. I argue that taxing robots is counterproductive, meaning that discouraging automation inhibits the potential of firms to innovate, expand their markets, and thereby create new jobs. Mokyr (2018) is right to be optimistic about the future of science and our ability to innovate. But according to Gordon (2021), his pessimism is justified by real economic and political resistance to necessary institutional change. He claims that incorporating innovation into competition policy will not only stimulate growth but also increase social mobility.

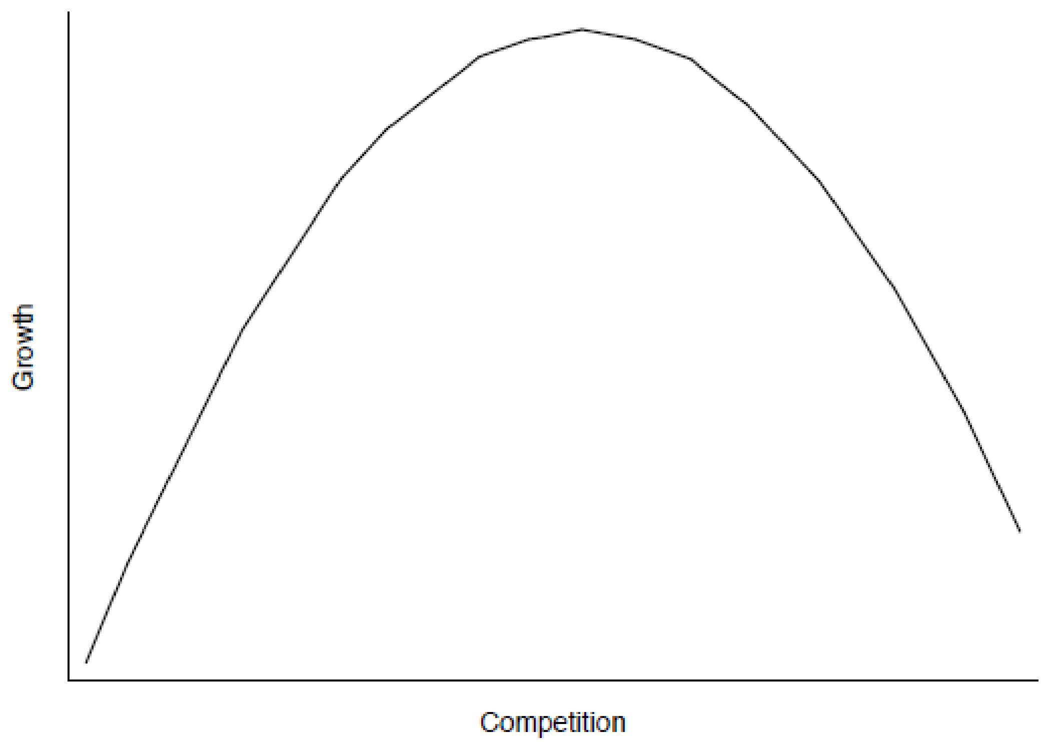

Figure 6: Effect of Innovation on Competition and Growth

Source: (Aghion et al., 2021)

Entrepreneurial investment drives innovation, which in turn is motivated by the prospect of monopoly rents that reward innovation. Increased competition lowers post-innovation profits, reducing the incentive to innovate. The Schumpeterian model assumes that only new firms entering the market innovate, not firms already in the market.

Competition has a positive effect on innovation by companies that are close to the technological frontier and a negative impact on companies that are further from the technological frontier. The closer a country is to the global technology frontier, the more its growth benefits from increased competition. In practice, however, countries should adopt more competition-friendly policies as they develop. According to (Boldrin and Levine, 2013), competition and intellectual property protection are diametrically opposed forces. They argue that capitalism must reward innovation while regulating it to prevent innovation rents from stifling competition. They argue that the European Single Market, which encouraged competition, stimulated more innovation in member countries. It was found that competition on average promotes innovation and growth and that the impact of competition on innovation and growth is positive for companies that are near to the technological frontier of technology but negative for firms far from the frontier.

The idea of innovation-driven growth in the context of creative destruction has implications for the relationship between growth and inequality. The more innovative a region or country is, the higher the share of income should be for the top 1%. According to P.-H. Chen et al. (2023), innovation rents increase an innovator's chances of climbing the income ladder and becoming part of the top one percent. According to (Agostini *et al.*, 2020), innovation is a key factor in explaining income inequality at the top. The study also shows that new entrant innovation is positively associated with social mobility. This finding supports the notion that creative destruction is a mechanism through which innovation generates social mobility. Innovative firms serve primarily as social ladders for workers in low- and medium-skilled occupations. The more innovative a firm is, the more important soft skills are to its low-skilled workers. The government has a tool to encourage innovative firms to subsidize vocational training. The pace of innovation in the United States has accelerated over the past four decades, as measured by the number of patents (Moretti, 2021). Why has productivity growth not kept pace with the pace of innovation? The measurement problem lies in the method of calculating GDP, which is defined as the value generated by the production of goods and services over a given period of time. Some R&D investments are actually defensive investments made by incumbent firms to maintain their market share. GDP, as traditionally defined, does not take into account changes in the use of products and services.

A common argument for China's increasing technological dominance is the country's astounding increase in patent applications over the last 20 years. However, both Ang (1991) and Milanovic (2006) contend that institutional incentives, governmental regulations, and state-driven economic strategies have a major impact on this patent boom and that it is not only a result of true innovation. Ang (1991) draws attention to the ways that bureaucratic performance criteria, financial incentives, and subsidies push businesses, academic institutions, and research centers to submit patent applications at a never-before-seen pace, frequently putting number ahead of quality. Many of these patents are low-value submissions used to obtain government funds, raise institutional rankings, or meet business KPIs rather than producing ground-breaking scientific breakthroughs.

Milanovic (2006) extends on this point by situating China's patent inflation within the larger context of state capitalism, where technological and economic advancement is frequently gauged by bureaucratic goals rather than by results generated by the market. He notes that utility model and design patents, which have lower novelty requirements than invention patents, account for a sizable amount of China's patent portfolio. As a result, many submissions do not always advance the state of technology worldwide. Milanovic (2006) also points out that China's total productivity growth has lagged behind the enormous increase in patents, which raises questions about whether these patents are actually resulting in increased economic efficiency and innovation-driven advancement. The appearance of quick scientific progress is produced by this patent inflation, but in practice, many of these filings are made for strategic rather than technical reasons. Even though China has unquestionably advanced significantly in a number of high-tech fields, such as artificial intelligence (AI), 5G, and electric cars, the sheer number of patent applications should not be interpreted as an indication of better invention. Ang (1991) and Milanovic (2006) propose that instead of merely counting patents as a metric of innovation, policymakers and analysts should concentrate on the quality and commercialization potential of patents. In the end, their research highlights significant issues regarding the efficacy of government-sponsored innovation initiatives and the long-term viability of China's technological development strategy.

Innovation depends first and foremost on the firms and on the market, but it also requires the state, both as insurer as well as investor. Global competition, whether it's industrial, military, or commercial, has historically led to creation of an investing government with the necessary economic competence, i.e., the ability of charging taxes (Fanani and Anjelina, 2019). Today, states react to macroeconomic phases with aggressive opposing strategies, particularly fiscal measures. These programs are only truly effective if the government maintains strict fiscal discipline outside of times of crisis. However, the state not only protects against macroeconomic upsets, it also hedges against eccentric threats. Thus, the catastrophes and conflicts of the 20th century's first half led to the development of social well-being and health care, as well as family allowances that ensure a basic income and protect against the risks of diseases. But from 1980s onwards, the economy's liberalization and the trade globalization in the industrialized countries created an acute new danger: the threat of losing jobs (Ffrench-Davis and Griffith-Jones, 2019). The model of Flexicurity, initiated in the 1990s in Denmark, was on one hand conceived as a reaction to the difficulty of striking a balance between economic moderation and invention, and on the other hand, the protection of individuals from the results of job loss. This strategy could be modified to motivate long-term vocational training so as to prevent individuals from dropping below poverty line. A negative tax is one method of mitigating the risk that is particularly dangerous for seasonal or casual workers.

The power of the executive must be limited in order for an innovative economy to function. In particular, checking the power of the executive limits the extent to which public authorities can work with incumbents to protect their pensions. In other words, it encourages new inventive companies to enter the market, stimulating the process of creative destruction (Strand, 2020). The Constitution is the first way to limit the power of the executive. The Constitution establishes a hierarchy of norms and principles for the distribution of power in an environment of incomplete contracts. In particular, it establishes the of powers' segregation among the administration and the legislature and declares an independence of the magistrates. It also establishes the system of election for selecting members of the council, the rules for voting within the council, the power to amend laws, a right to appeal Supreme Court jurisdiction, and length of tenures, all of which straightaway affect the scope and limits of the executive's power (Friz and Günther, 2021). But without an engaged and attentive civil society, all of these basic guarantees are just empty words. This makes up a triangle of state, civil society and market that is essential for an effective working of an economy of creative destruction and innovation (see figure 9). The market incentivizes innovation and serves as the framework within which innovative firms compete. The state protects intellectual property rights, enforces contracts, and acts as insurer and investor. Finally, civil society- the unions, media, and nonprofit organizations-creates or advocates for legitimate requirements to limit presidential authority and guarantee higher market efficiency, justice and ethics. Past literature shows that an organized civil society has added significantly to the progress of capitalism towards a structure that is more controlled, more comprehensive, more defensive of individuals, and more protective of the surroundings. Still, this development has not been direct and arose at different levels in different countries.

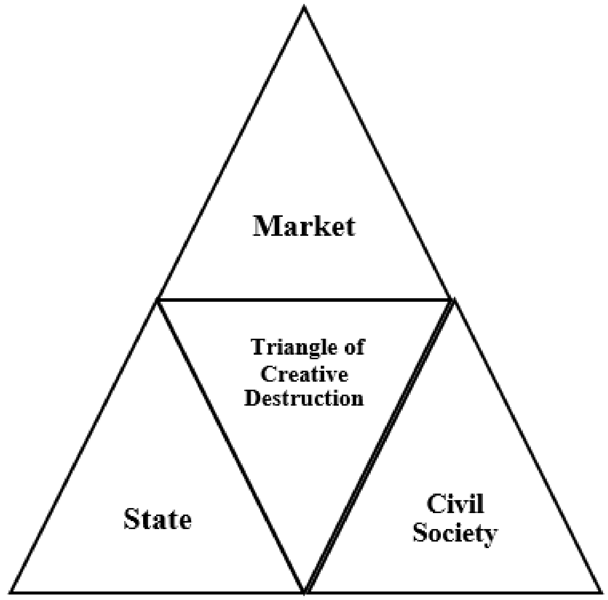

Figure 7: The Triangle of Creative Destruction

Source: Self-compiled image based on Philippe Aghion's concept of Power of Creative Destruction, 2020

2.2.6 The Strategy of Evolution

The evolutionary growth theory places a premium on innovation as a driver of economic transformation. According to evolutionary theory, businesses are compelled to innovate by technical competition: they are continually introducing new product categories and manufacturing methods (Coccia and Watts, 2020). Successful technologies are selected through both market and non-market methods (such as public procurement), and expansion occurs as successful technologies and enterprises supplant those that become less essential. Thus, innovation propels growth, but it is accompanied with considerable changes in the economic system's structure or mix of activity. The term 'innovation system' refers to a collection of institutions and organizations that contribute to the development and dissemination of novel technologies, processes, and organizations. It is a significant contribution of contemporary evolutionary approaches to older conceptions. Within this system, enterprises compete for survival by developing a diverse range of distinct tactics and goods, with market forces dictating and government action molding the growth of the company population via support, procurement, and regulation (Gruber, 2020). Innovation is a source of increased corporate productivity. Numerous empirical studies revealing positive correlations between various innovation investments and outcomes (such as R&D and patent performance) and growth outcomes attest to the robustness of the link between innovation and growth. Recent studies have demonstrated that firms that innovate outperform those that do not, and that innovation results in productivity improvements (Lee, Kempes and West, 2024).

2.3 SECTION 3: INSTITUTIONS

Within the discipline of institutional economics, there are two different schools of thought: original institutional economics (OIE) and new institutional economics (NIE). OIE sees institutions as dynamic social structures that are intricately entwined with historical and cultural settings. It is mostly linked to theorists such as Veblen (1898) and Commons (2017). It highlights how social norms, customs, and power dynamics are used by institutions to influence economic systems and human behavior. OIE focusses on how institutions arise from collective human interactions, frequently within a framework for conflict resolution, and rejects the idea of rational, utility-maximizing individuals (Spithoven, 2018). Conversely, NIE, which was developed by academics such as North (1970) and Williamson (2007) incorporates institutional issues and builds upon neoclassical economic principles. It makes the assumption that people are reasonable but are nevertheless limited by enforcement procedures, transaction costs, and knowledge asymmetries. NIE places a strong emphasis on how formal institutions, such as contracts and property rights, may ease uncertainty and promote business dealings. NIE has a more analytical and efficiency-driven viewpoint than OIE, which adopts a more descriptive and evolutionary approach. It frequently focusses on how institutions might be built to enhance economic performance. This study focused more on NIE due to its significance in development economics.

Institutions play a significant role in economic progress. Empirical tests demonstrate the association between economic growth and economic freedom. Economic freedom is a wide term that refers to a market economy that is functioning well, an effective institutional framework, macroeconomic stability, and economic agents' efficiency. Many notable economists regard the quality of institutions as a consequences arising from cross-country inequality in comparative growth studies. According to standard growth theories, economic growth is dependent on the accumulation of human capital, physical capital, and access to current technologies. Institutional qualities such as the organization and operation of the economic sector, the balance of political and civil rights, the integrity of the legal system, government performance, and so on are likely to influence the accumulation of these components (Medase, Ahali and Belitski, 2023). However, determining a measurable impact of institutions on development, measuring its size, and comprehending the technology of institutional quality transmission to growth are difficult tasks.

Institutions were first defined by North (1991) as constraints devised by humans that modify the interaction between them, or informally, the rules and regulations of a game in some society. They shape human transaction incentives, whether they be political, societal, or economic. He continues to highlight the fundamental effects of institutions because as a result, they organize economic, political and social motivations in human trade. Changes in institutions forms and adds to the development of an economy over time and impact history (Kitagawa, 2017). Institutions help to drive growth and development by lowering the potential hazards of doing business, focusing resources towards innovation rather than preserving property rights or generating opportunistic rents. Contracts and collateral requirements are examples of institutions, as are protection of property rights, the legal system, governmental institutions, and financial markets. Educational practices and attitudes, conventions, social cleavages, and traditions are also included (so-called informal institutions). As social standards in the domains of gender, class, and caste, for instance, ascertain rules of political participation in political, economic exchange methods, and the participation of various groups in society, institutional structures are usually the formation of informal institutions (Thompson *et al.*, 2018). "The state is the institution of all institutions", according to H. J. Chang, (2011, pp.435), highlighting the significance of institutions in structural change and progress. However, this viewpoint differs from that of Acemoglu and Robinson (2005) and other formal economic analysts. I demonstrate that 'strong' institutions, such as property rights may only cause structural changes if they are properly implemented, and that this is dependent on the type of economic structure. Even if they are put in place, there is no reason to assume that the new market mechanisms and economic model will be conducive to long-term growth. The effects of structural change on growth are unknown. Property rights, the law and order, and money are administrative institutions that facilitate exchange within a certain economic framework. Despite the fact that property rights have a considerable effect on output, (Goldin and Reinert, 2007) notes that they are largely used to facilitate arbitrage. According to (Haustein *et al.*, 2008), the background of invention is mostly determined by governmental support and chance rather than the application of patent rules (property rights). Trade policies (tariffs, subsidies, and so on) are production institutions that promote structural changes while fostering growth.

According to Smith (1973), institutions have an impact on economic growth because they influence property rights, transaction costs and incentive structures. (X. Chen *et al.*, 2023) discovered that institutional variables impact total factor production, and that countries with high institutional quality are more productive. Several studies have employed instrumental variable methodologies to demonstrate causation between institutions and economic performance. (Sarwar and Hayat, 2021) discovered that a larger measure of institutions had the most significant influence on growth. Bliss & Egler (2020) emphasized the critical role of diverse non-market institutions in the formation of full and dependent markets. The empirical research has identified various institutions that impact economic growth, including governance, tax administrations, regulations, justice and law enforcement, justice, and institutions that handle monetary and fiscal policies (Ofoeda *et al.*, 2024). (Pradhan (2022) demonstrate that institutional characteristics have a greater impact on long-term growth than on short-term growth. A functional system is one with clearly defined rules and a supporting state that allows agents to pursue their goal. To speed economic progress, emerging countries must assess the form and quality of their institutions (Aceves & Aragón, 2021). North (1991) groundbreaking works underscored the importance of institutions in driving economic expansion. The resurgence of interest in institutional economics can be attributed to two factors. First, the dissolution of the socialist economies in Eastern Europe led to the realization that institutions were essential to the success of the transition (Djankov *et al.*, 2003). Second, empirical research has demonstrated the importance of institutions in predicting long-term growth. Among these, the study by Acemoglu and Johnson (2001) is one that is most frequently cited. Economic efficiency was to be increased by the market economy shift that former socialist nations undertook in the late 1980s and early 1990s. Even the economic conditions were expected to improve almost soon after the shift started. Nevertheless, this expectation was not realized since all of the transition economies saw a severe decline in output, at least in the early phases of the transitions (Yeager, 2018). There were notable differences in output patterns among economies, even if a transition slump was followed by a recovery period. During the transition phase, there was an unexpectedly steep decline in output and significant differences in the economic performance of transition economies for a variety of reasons. After a range of factors were put out and empirically investigated, two things became clear. First things first: creating a working economic system takes time, especially since a market economy demands the creation of auxiliary institutions. Conversely, institutions like property rights, contract enforcement, and a coordination mechanism develop through evolution. Second, variations in the economic performance of transition economies seem to be mostly explained by shifts in the quality of institutions. Of course, political constraints, economic development, and structural reforms all affected output trends before the collapse of the communist economies; but, institutional quality also had an impact on these factors (Hernández, Nieto and Rodríguez, 2022).

2.3.1 Three Aspects of Institutions

Past literature proposed that institutions are a mixture of three aspects that are interrelated:

1. Economic Institutions

These institutions consist of elements controlling the incentive management in economy (i.e., motivations for actors in economy to make investment, carry out transactions and gather factors, etc.) and the allocation of resources (Nutassey, Nomlala and Sibanda, 2023). For instance, the management of Property rights, collection of different types of business contracts in law, barriers of entry, and schemes of transferring redistributive tax are influencing economic growth and performance.

The economic institutions such as the management of property rights and existence and excellence of markets, are of key significance to the financial outcomes in a society. Economic institutions are significant as they impact the organization of financial incentives in a society. In the absence of property rights, people will lack the motivation to make investment in human or physical capital or implement more effective technologies (Sehgal *et al.*, 2014). Economic Institutions are also of great importance because they assist in allocating resources to their most effective uses, they regulate the revenues, profits, and control residual rights. In the event of ignored market, profits from trade go unutilized and there is a misallocation of resources. Societies that have economic institutions which accelerate and aid accumulation of factors, effective allocation of resources and innovation shall progress.

Economic institutions are important for the economic growth because they outline the incentives for the key financial actors in a society, particularly, impact the investments in human and physical capital and technology, and the management of production (Ferreira *et al.*, 2023). Though, geographical and cultural factors may also contribute towards financial performance; consequently, the difference in the economic institutions in different countries result in the difference in the economic prosperity and growth among those countries. Economic institutions not only define the combined potential of economic growth of a society, but also an arrangement of financial outcomes, which includes future allocation of resources (i.e., the wealth distribution, including the human and physical capital). Moreover, they impact not only the size of the pie, but also the division of the pie between different individuals and groups in society. Economic institutions, or institutions in general, are endogenous, which means they are in part, defined by society or a part of it. As a result, the reason why some economies are poorer than others are closely associated to the fact that these economies have poor economic institutions.

2. Political Power

Economic Institutions are the result of combined choices of a society. A society is the combination of many groups with conflict of interest. The comparative political power of these groups controls their capability to choose the allocation of resources and implication of policies. The dissemination of political power governs the quality and structure of economic institutions. It is a result of ‘de facto political power (i.e., political power evolving from economic results) and ‘de jure political power (Krieger and Meierrieks, 2016).

R. Y. M. Li et al. (2019) demonstrated that the relationship between growth and democracy is even more complex. He demonstrated that income has an impact on democracy, and that this impact is strong and favorable. However, democracy has an impact on economic growth and, as a result, wealth levels. He examined the direct and indirect effects of democracy on growth and discovered that the overall effect of democracy on growth is positive because the positive indirect effect of democracy on income, as well as the positive impact of democracy on investments and education, generally compensate for the negative direct effect of democracy on economic growth. Literature emphasizes that there are no consistent net impacts of democracy following economic growth. Seema (2018) investigated the influence of bureaucratic quality on the amount of corruption in macroeconomic policies, specifically open-economy macroeconomic policies. They examined the consequences of capital regulations and financial repression. Bureaucratic corruption reduces the government's capacity to collect tax revenues. The government must rely on capital controls and financial repression. A corrupted bureaucracy reduces market efficiency, total economic efficiency, and, as a result, economic growth.

3. Political Institutions

These institutions include the ones distributing 'de jure political power' among groups. They are associated to the features of the structure and administrations of the charter. The proposed relationship between political institutions and growth has been linked to a variety of factors. In general, it has been argued that democratic features such as political diversity, institutional checks and balances, and a regular renewal of policymakers through elections safeguard the economic system from the abusive or predatory behavior that is characteristic of most powerful regimes (Parma, Rastorguev and Tyan, 2022). A significant variable that determines most of the influence of regime type on development is citizens' and investors' assumption that they would be able to realize exchange gains and safeguard investment returns. Autocrats, on the other hand, are typically unable to make credible assurances to ensuring such rights (Carothers, 2023). A variation of this justification concerns durability of the regime. (Bischoff, 2007) stated that democracies eventually fall to 'institutional sclerosis' when particular organizations come together to obtain rents. Indeed, certain types of tyranny may be more inclusive if democratic institutions enable a majority to consolidate power and defend special interests. This creates considerable difficulty in predicting how a political system would affect economic performance. (1. At the Intersection: A Review of Institutions in Economic Development, 2020) claim that the court system, independent judiciary, and adherence to law and individual rights essential for a long-term democracy are equally required for contracts and property rights protection. However, it is unclear how democracy makes these rights more secure. Fedorenko & Kyrylenko (2021) suggested that the way a regime functions is determined by its perspective. Most dictatorial governments operate as if they have limited time horizons, which leads to stealing and other anti-growth behaviors. Parsa & Datta (2023) provided one of the most comprehensive assessments of the function of institutions in the process of economic growth. The examination considers the functions of property rights, regulatory institutions, institutions for socioeconomic stabilization, institutions for social insurance, and conflict resolution. Although there is some variation among nations in terms of economic growth, as well as the structure and effectiveness of the aforementioned institutions, countries with higher quality institutions had faster economic growth. Property rights, regulatory systems, and institutions play critical roles in macroeconomic stability. (Chang, 2022) emphasized that any successful market economy is a combination of market and state, interference and laissez-faire. The efficiency of the mix is critical. He also investigated the influence of political regimes in shaping economic performance. According to (Mohammadi, Boccia and Tohidi, 2023) there is insufficient evidence to support the idea that democracy leads to slower growth. There is also no evidence that it is inherently inefficient, despite the fact that democracy has been shown to contribute to growth over time.

2.3.2 Coordination Mechanisms in Economic Systems

The coordination of economic activity within various economic activities has been studied by several economists. Based on historical and empirical research on capitalism and socialist economies, Polanyi (1944) and Kornai (1992) each offered unique frameworks for comprehending economic coordination.

Karl Polányi's Coordination Mechanisms

In his groundbreaking book 'The Great Transformation', Polanyi (1944) made the case that markets, reciprocity, and redistribution are the three main ways that economic activity is coordinated. He underlined that various kinds of coordination are required to preserve social and economic balance because markets by themselves cannot provide a stable society. Prices serve as signals for both production and consumption in the market process, which is based on supply and demand. In capitalist economies, where competition and profit incentives govern resource allocation, this type of coordination is most prevalent. But according to Polanyi (1944), an over-reliance on market forces can result in societal unrest like inequality and unstable economies. Mutual responsibilities and social networks form the foundation of the reciprocity mechanism. In place of price-driven transactions, trades take place as a result of enduring customs and relationships. This approach is prevalent in tiny towns, informal economies, and traditional societies where trust and collaboration are more important than financial transaction. The gift economy in primitive communities, where people donate products or services without expecting a return right away because they know that social rules would guarantee reciprocity in the future, is an example of reciprocity. A central authority gathers and distributes resources as part of the redistribution system. This is frequently observed in historical empires, welfare states, and centrally planned economies where the ruling class or government has significant influence over economic choices. In socialist economies, for instance, the state distributes resources and sets production goals based on social and political priorities rather than market signals. According to Polanyi (1944), a stable and effective economy requires a balance between the market, reciprocity, and redistribution.

János Kornai's Coordination Mechanisms

According to Kornai (1992) examination of socialist economies (The Socialist System, 1992), self-governing coordination, bureaucratic coordination and aggressive/informal coordination and market coordination are the four main coordination mechanisms that function in various economic systems. Polanyi (1944) theory of market coordination, in which supply and demand dictate pricing and resource distribution, is comparable. In capitalist economies, where customers base their decisions on price signals and private companies fight to maximize profits, this system is prevalent. When economic choices are made by a central authority, usually the state, bureaucratic coordination (administrative control) takes place. This is typical in centrally planned and socialist economies, in which the government distributes resources according to state priorities rather than the dictates of the market. For instance, in the Soviet Union, production limits for factories and agricultural collectives were set by central planners, which frequently resulted in shortages and inefficiencies. When collectives or cooperatives make economic decisions instead of individuals or government officials, this is referred to as self-governing coordination. In Yugoslavia's self-managed socialism, workers controlled factories and made decisions about distribution and output as a group. Some social democratic economies with robust labor unions and cooperative business models also have it. Economic activities that take place outside of official institutions, like black markets, corruption, and unofficial agreements, are examples of aggressive/informal coordination. When market and bureaucratic cooperation aren't working well, this mechanism is particularly common in transitional economies or weak institutional frameworks. For instance, when the planned economy collapsed after the fall of the Soviet Union, underground commerce and unofficial barter networks became vital for survival. Different economic systems depend on various forms of coordination, sometimes all at once, as shown by Kornai (1992)theory. Socialist economies frequently rely on bureaucratic coordination, with informal cooperation occurring during economic downturns, whereas market coordination is prevalent in capitalist systems.

2.4 SECTION 4: ECOSYSTEMS

2.4.1 The Ecosystem Approach

The term ecosystem has acquired appeal in academe, policy-making, management and business as a means of describing, explaining, advertising, and communicating concepts, theories, and perspectives on how players in the economy deal with their surroundings (Stam and van de Ven, 2021). Researchers have begun to use the phrase 'ecosystem parallel' more frequently just two decades after its inception in the field of management. The ecosystems are inspired by biology, where environmentally homogeneous units form a society of living creatures that interact as a structure with numerous parts of their surroundings. Moore (1993) established a link among a business equivalent and a biological system and a in which enterprises seeking new ideas interact with one another and live in a certain business domain. An ecosystem, in a rudimentary shape, might be a collection of various members who relate closely with one another not just inside but also outside the cluster.

The ecosystem comes through effective interaction between individual and national players, which is a convergence of national culture, legal & political, and innovative thought, as well as their character and conduct (Suresh and Ramraj, 2012). Nonetheless, ecosystem development is more than a two player game (entrepreneur and government); it also includes existing firms, the not for profit organization and colleges, all of which have duties in establishing business settings. As advising the policy makers on potential entrepreneurial-friendly frameworks, reduction in institutional hurdles and initiatives is their duty, the process of incorporating recognized market participants should start as soon as viable (Isenberg, 2014). Their opinion is critical for creating friendly venture company environments and guiding their long-term growth.

The ecosystem literature encompasses a wide range of stakeholders participating in the value chain; their existence is mirrored in their scope as well as varied degrees of examinations. Initially, there are the elementary value chain players, for example the central firm as well as its providers and clients (Iansiti and Levien, 2004); growing to state research institutions & universities (Clarysse *et al.*, 2014); and public organizations (Li and Garnsey, 2014) and other supporting organizations.

Different classifications exist for technology. However, it is critical to classify inventions as first or second order innovations. The innovation of first order, according to Knickel & Maréchal (2018), occurs gradually and frequently follows a straight path to innovation of goods or services, whereas innovation of second order occurs abruptly and frequently incorporates business model innovation. Business model of second order developments are typically based on network, implying a considerably more complicated procedure involving a large number of parties. As an explicit result of this complication, and in order to efficiently aid this difficult procedure, the concept of ecosystem evolved (Frenkel and Maital, 2014).

Academics played a major role in the early progress of this field's study by exploring the notion of the business ecosystem (Moore, 1993), and after that the entrepreneurial ecosystem (Prahalad, 2005); the innovation ecosystem (Adner, 2006), and lately, the knowledge-based ecosystem (Van der Borgh, Cloodt and Romme, 2012). Owing to its very comprehensive conceptual breadth, the term 'ecosystem' faces the danger of being stereotyped and only briefly settling into the writings before falling out of favor (Wong *et al.*, 2015). Because the word ecosystem is often used, especially in computer and environmental sciences, I narrowed my quest to economics, business, and management disciplines.

2.4.2 Types of Ecosystems

There are 4 types of Ecosystems.

1. **Business Ecosystem**

Business ecosystem as defined by Rong (2021) is an autonomous financial community that facilitates the transition of a supposedly undeveloped social network into an effective chain of value creation through multiple functional processes. Most researchers define business ecosystems as clusters of enterprises that are very close to one another or merely as naturally domestic. Nonetheless, the latter serve as an origin point to an ecosystem in the platforms' case, and that digital co-founded society serves as the primary location for communication (Mäkinen, Kanniainen and Peltola, 2014). A business ecosystem consists of several organizational members, and inter-organizational networks are formed as a result of their close contact (Moore, 1993). Given the necessity of a joint effort within the value network, to produce and trap value through innovation is one of the targets of business ecosystems. According to Clarysse (2014), the thing which is not to be overlooked is the attainment of a competitive edge which is frequently accomplished through cooperation that results in economies of scale. He discussed a very specific sort of value creation: exchanges based on shared compatibility. Peripheral sources may be required to solve internal inadequacies when a firm is unable to market a product or service due to a lack of internal competences, skills, or assets (Eisenhardt and Galunic, 2000) and innovation resource synergy (Li and Garnsey, 2014). Riquelme-Medina et al. (2022) on the other hand, noted the presence of coopetition interactions, in which enterprises collaborate and compete at the same time.

2. **The Innovation Ecosystem**

In the last 15 years, the notion of innovation ecosystems has grown in popularity, with a fast expanding literature (Vasconcelos Gomes *et al.*, 2018), often with a strategy and business focus and origin. This emphasis contrasts with the dominating institution and policy focus in the literature on innovation systems, and despite both of the terms' grammatical proximity, the two literature streams have remained mostly isolated. Studies on innovation ecosystems as stated by Rong et al. (2021), is still in its early stages. Understanding the logic of value generation and capture is critical for the establishment of effective innovation ecosystems. Innovation ecosystems are a complicated process that includes the production of ideas, their transformation into products, and the marketing of these goods on a global scale. The success of this progression is dependent on a number of factors, including a business culture that encourages entrepreneurship, risk-taking, and a willingness to embrace change, a set of regulations and organizational norms that encourage this attitude, a rich knowledge sector (universities, research centers, and laboratories), and partnership between these knowledge institutions and commercial businesses (WEF, 2019). Innovation can be effectively directed toward applications that are very beneficial to society (e.g. green energy).

To grasp the knowledge of value generation and capture is fundamental for the growth of profitable and thriving innovation Ecosystems. According to Gastaldi & Corso (2016), no organization can create value by itself, and thus research in this sector frequently represents a major organization (in a high-tech sector) as the ecosystem orchestrator. The Ecosystem Orchestrators as defined by Adner (2006) are some of the important firms in the structure of ecosystem that strategize the flow of knowledge and are ready to face the challenges that arise in the joint network. The innovation ecosystem is made up of interconnected players like private bodies (NGOs), businesses, governments, and other kinds of resource providers (such as funders). One of the main reasons for an increased awareness in innovation research is the Innovation Ecosystem, which has simultaneously migrated and spread to social media from the corporate ecosystem notion and different online platforms. Nonetheless, the notion of the innovation ecosystem is continually spreading in new courses, whether they are platforms, virtual spaces, etc., based on keystone firms, which typically play a big role in the ecosystem's inception and continued growth practice.

3. Knowledge Ecosystem

The Knowledge Ecosystem can be defined as the flow of tacit information among enterprises and people freedom have been advocated as the primary benefits of spatial colocation that characterizes such hotspots. These hotspots are described as knowledge ecosystems, in which public universities and national research institutions perform a major role in fostering scientific innovation in a society (Clarysse *et al.*, 2014). Bhawe & Zahra (2019) drew a clear difference between a business ecosystem and a knowledge ecosystem. The fundamental distinctions are divided into 3 types: the ecosystem's focal activities, the connection of the participants, and the cornerstone player. The major activities of knowledge ecosystems are based on the institution and the extensive network of neighboring enterprises. These are often regionally localized/clustered (Bathelt *et al.*, 2017), and they focus on knowledge development alongside the major actor. Clarysse (2014) found from their research of creative Flemish start-ups that participation in a knowledge ecosystem, which could be defined as certain locations being sourcing knowledge, does not inevitably make a firm a participant of a business ecosystem. These business and knowledge ecosystems, however, are not mutually restricted. Van der Borgh et al. (2012) on the other hand, employed a knowledge-based business ecosystem frame to study how value is produced and supplied in justifiable manner. A knowledge-based business ecosystem is described by A. Chen et al. (2023) as an interdependent group of diverse and knowledge-intensive firms. The participating firms in their research are not geologically distributed in line with Iansiti & Levien (2004). The existence in the geological hotspot is a deliberate activity based on information.

4. Entrepreneurial Ecosystem

Around the world, entrepreneurs and new business start-ups are growing at an increasing rate. As a result of this dramatic increase, a surge of activities is underway to better understand how to effectively support these nascent businesses (Kuratko *et al.*, 2017). A supportive atmosphere is critical for innovation and entrepreneurial activities to flourish. According to the available literature, this type of environment is related with two distinct concepts: innovation and entrepreneurial ecosystem.

The terms innovation and entrepreneurial ecosystems initially appeared in the literature in the late 1990s, and both have grown in fame over the previous decade. Entrepreneurial ecosystems have risen to prominence as a result of the ongoing debate around entrepreneurship. In their search for explanations for entrepreneurship and its activities, academics began to cast doubt on the personality approach, and scholars recognized the critical role of the larger environment in which entrepreneurs or their businesses work (Carswell and Rolland, 2004); and (Spigel and Harrison, 2018). Past literature created a foundation for understanding how capitalists and their endeavors can evolve and be influenced by the political, sociocultural, and economic environments. Scholars and experts concerned with native and state economic growth have embraced the 'Entrepreneurial Ecosystem (EE) and the more recognized notion of innovation system (IS) (e.g. (Malecki, 2018); (Colombo *et al.*, 2019); (Van de Ven et al., 2021).

According to existing research, one of the most critical qualities of entrepreneurs is their capacity for innovation (Blankesteijn, Sam and van der Sijde, 2019). Additionally, invention has been acknowledged as a critical factor in encouraging macroeconomic growth. The procedure of taking concept from conception to commercialization comprises of a large number of stakeholders, and it is considered that the formation of entrepreneurial and innovation ecosystems is an efficient method of encouraging and supporting this procedure (Rabelo, Bernus and Romero, 2015). Malecki (2018) dates an emergence of EE to the beginning 1990s, citing researches from Moore and the notion of the 'entrepreneurial ecosystem,' (van de Ven *et al.*, 2021) concept of 'entrepreneurship infrastructure,' 'entrepreneurship of high technology' and concept of a local 'system of entrepreneurship' by Spilling. According to Malecki (2018), the term EE has displaced previous ideas such as entrepreneurial environment that place a premium on the cultures, mechanisms, networks and institutions which back entrepreneurship. Feld (2012) research has further fueled interest in this topic among policymakers and academia. These research reaffirmed the concept that entrepreneurs interact with a variety of actors within the ecosystem who can assist them in various ways (e.g., by providing funds, experiential and educational programs, or professional facilities). Since then, this approach has been considered as a strategy of promoting growth in economy, frequently with an emphasis over job creation and high-developing firms (Spigel and Harrison, 2018). Experts and researchers have placed a premium on examining the traits of ecosystems and determining ways to sustain them effectively.

The concept of EE is defined by a variety of factors or characteristics that encourage entrepreneurship. As defined by Blankesteijn (2019), an EE is a multifaceted collection of interactive components that mitigate the influence of entrepreneurship on growth of economy. Ben Spigel & Harrison (2018) emphasize on concurrent events that support one another through their interactions with other attributes, ecosystem attributes are preserved and reproduced. For instance, in an Entrepreneurial Ecosystem of low density, one feature may be more dominating and drive others, such as a strong local market supporting the influx of possibilities, however in one with high density, the factors are more balanced and powerfully supportive of one another. According to Isenberg (2018), the constituents of EE act together in complex and distinct styles, resulting in the formation of unique configurations of different EEs. Local networks are crucial for entrepreneurs' access to resources such as knowledge, funds, and human capital, according to the EE literature. According to Spigel (2017), the existence of social media is defined as the existence of social networks connecting entrepreneurs, investors, advisors, and employees and facilitating the unrestricted flow of skills and knowledge. Feld (2012) on the other hand, highlights the importance of interactions in a thriving venture group, as well as a high-link degree between players and federation of performers in which everyone seeks to add to the ecosystem. Organizations are viewed as key components of networks of entrepreneurship, and they can either facilitate or obstruct interactions between individuals, enterprises, and other organizations. Organizations can be more favorable to entrepreneurial activity in some regions than others, resulting in varying rates and types of entrepreneurial activity, as well as varying local paths of development (Romano, 2013). Cooke (2016) claims that 'Entrepreneurship Ecosystems' profit not just only from their natural proclivity for interaction, but also from local 'practice communities' and the free products of collaborative wisdom from peers in ecosystem, whether enterprises or mediators. Additionally, Cooke asserts that 'Entrepreneurship Ecosystems' can generate more societal value and relative financial effectiveness than the previous dominant paradigm of distinctive entrepreneurship of 'property rights'. The ecosystem of EE focuses the significance of site, which spatially and geographically clusters numerous interlinked actors and resources such as institutions, human capital, and networks, (Johannisson and Huse, 2000); (Qian, Acs and Stough, 2013). Numerous EE researches have been conducted to determine the characteristics that contribute to the success of successful high-tech areas in a variety of countries Feld, (2012), Mack & Mayer, (2016), and B. Spigel, (2017). Additionally, the study indicates a connection among EE and groups in terms of entrepreneurial potential, as evidenced by a specialized labor market and geographically concentrated spillovers of knowledge (Delgado, Porter and Stern, 2010). While few researchers emphasize the significance of universal links across distinctive EEs (Malecki, 2018), others emphasize the part of multinational corporations in bringing trained employees to a region (Brown and Mason, 2014).

2.5 SECTION 5: THEORETICAL FRAMEWORK & HYPOTHESES DEVELOPMENT

2.5.1 Theoretical Framework

From the literature review of the research, I come up to point where I determine the important elements that play a major role in the economic development of the country. Research and Development being the core of the study, is found to have rather an indirect impact on the economic growth. From different studies, I found multiple factors affecting the economic growth of a country and found that R&D itself is affected by the institutions as they play a major role in the regulation, implementation and execution of policies related to all sectors of economy. The institutions affect the R&D sector, the capital markets and human capital. This in turn affect the innovation capability of a country. As an innovation capability is affected, so does the economic growth of a country. On the basis of these theoretical findings, this impact cycle is given the term of R&D Ecosystem. The term R&D Ecosystem is self-produced as a result of thorough research on the different types of ecosystems. The 3 types of institutions in this Ecosystem that will collectively contribute to the economic development of the country are:

1. R&D Institutions (RDI)

A self-produced term which refers to the organizations (public or private) that focus on scientific research, technological development, and innovation in order to produce new or improve the quality of existing products and services they offer. Includes organizations such as educational institutions, public or private companies and non-profit organizations. The government plays a crucial role in facilitating research and development within a country by allocating funds appropriately to maximize resource utilization. Romer (1990) developed the Endogenous Growth Theory, which highlights research and development (R&D) as a major force behind technological advancement and long-term economic growth.

2. Financial Institutions (FI)

Refer to the organizations that are involved in different financial transactions including savings, loans, deposits, investments etc. in a country. Includes capital market such as Stock markets, banks (commercial and retail), brokerage companies, insurance companies/agencies, credit loan associations/firms etc. Institutional Economics (North, 1991) made the case that robust institutions foster innovation and investment by lowering transaction costs and uncertainty.

3. Labor Institutions (LI)

Refers to the organizations that determine the quality and education level of the labor force, as well as policies regarding employment and wage-related factors. Schumpeter Growth Model emphasizes the value of a trained labor force and the role that financial institutions play in fostering innovation (Schumpeter, 1942).

The figure 8 below shows the rough idea of how R&D Ecosystem might look like.

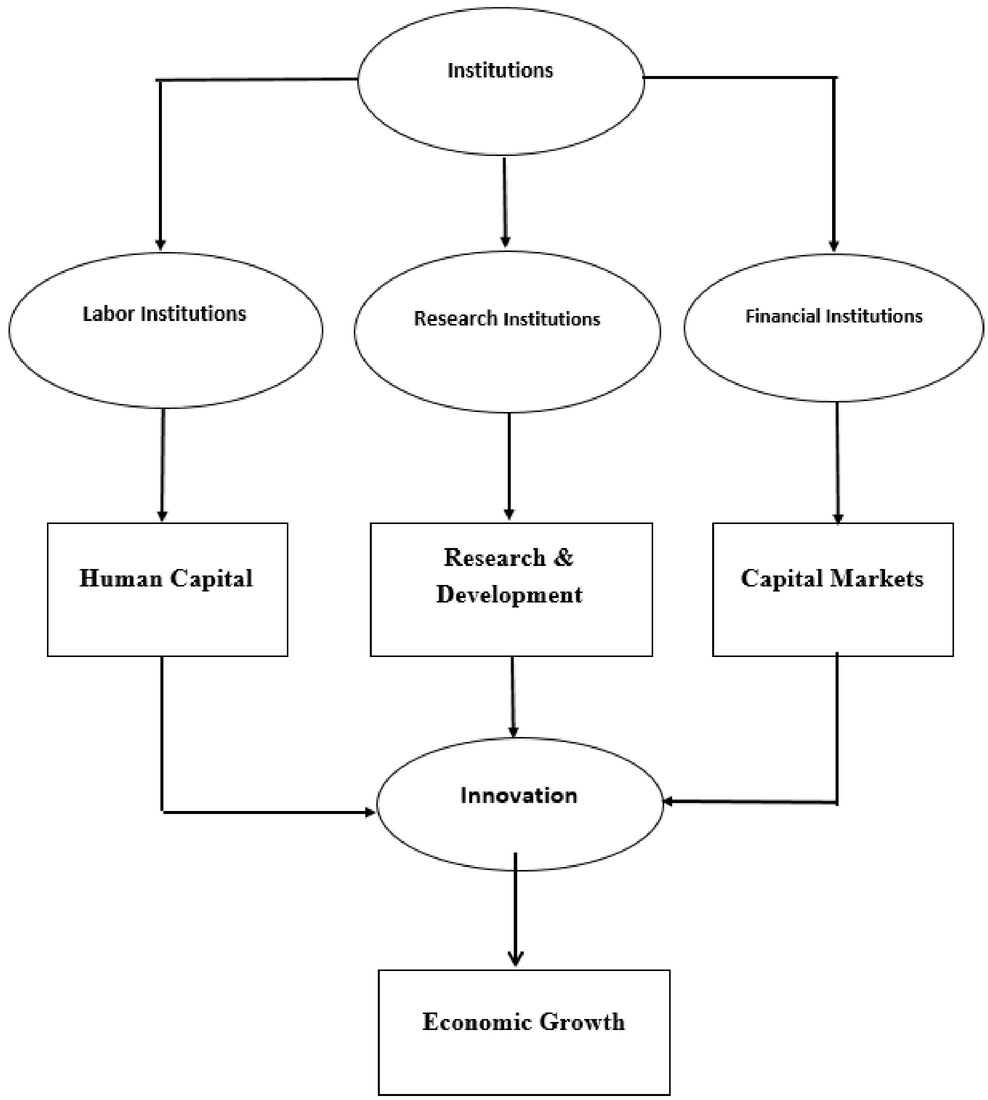

Figure 8: R&D Ecosystem (Theoretical Framework)

Source: Author's own work

2.5.2 Hypothesis Development

Following are the elements of the R&D Ecosystem which will make up the hypotheses of my study:

Institutions

Institutions are an important element of an economy. They regulate the setting in which the economy and society organize themselves by formal and informal check and balance. The formal check and balance means the legal framework which includes law enforcement and the informal constraints means the societal norms and standards (World Economic Forum, 2018). It is the mixture of many components such as security, social capital, corporate governance, transparency, property rights, checks and balance, ethics and performance of public sector of a country. Institutions affect the productivity and economic growth by delivering incentives and lowering uncertainties.

Research and Development (R&D)

Research and development encompasses fundamental research, applied research, and experimental research. R&D expenditures are a key indicator of both the public and commercial sectors' efforts to achieve a competitive edge in science and technology (National Science Foundation, 2018). Estimates of R&D resources are influenced by national characteristics such as the frequency and scope of national R&D surveys across institutional sectors and industries, as well as the sample and estimation techniques used. Due to the fact that R&D frequently involves a small number of key actors, R&D surveys employ a range of methodologies to maintain current registers of recognized actors while aiming to identify new or uncommon participants. As a proportion of GDP, gross domestic expenditure on research and development (R&D) encompasses both capital and current expenditure in the four primary sectors of industry, government, higher education, and not-for-profit organizations (Jones and Galmiche, 2005). So I derived the following hypothesis from this information:

H1: *Institutions investing in R&D have a significant impact on Innovation in lower middle income countries*

Human Capital

The term Human Capital refers to as skills, competencies and capabilities of individuals in population. It plays a significant role in the productivity and prosperity of an economy. It is produced by making sure that the individuals are in better health and they possess competencies and skills that are in demand. The labor market measures the human capital value by employment and productivity which is produced by educating the individuals in their initial life and providing training courses in their later career (Fu, Hsieh and Wang, 2019). To ensure, labor productivity and efficiency, a set of incentives and motivation is aligned between employers and their employees, which in turn creates a strong association between productivity and pay, professionalism and merits of pay in business management which act as a prerequisite for labor productivity (Report, 2020). Investment in Human Capital leads to the transformation of a traditional economy to an innovative economy by switching from the productivity processes to the innovative ideas and inventions (Perepelkin, Perepelkina and Morozova, 2016).

H2: *Institutions investing in Human Capital have a significant impact on Innovation in lower middle income countries*

Capital Market

Will (2019) defines Capital Market as the system that directs the savings into long-term investment. A capital market utilizes resources for different beneficial uses. An efficient capital market is an important driver of the commercial and industrial growth of an economy. Capital is provided for both short and long-term periods. A capital market fulfills the needs of the long-term debts and investments. Capital market is a fundamental regulating and collaborating system for balanced and free flow of economic resources into the financial system functioning in a country. From this, I can infer the following hypothesis:

H3: *Institutions investing in Capital Market have a significant impact on Innovation in lower middle income countries*

Innovation

The term innovation refers to the generation of new ideas and converting those ideas into products and services. The innovation is the capacity of the individuals to bring creative ideas and delivering those ideas in a meaningful form that could be utilized by other individuals and organizations in a country. It is an important element for productivity and economic growth. Many economies struggle to innovate at a meaningful level due to different factors such as the lack of commercialization opportunities. From this I infer following hypothesis:

H4: *Innovation have a significant impact on Economic Growth in lower middle income countries*

Gross domestic product growth (GDP Growth)

Gross value added is determined as the total of gross value added, manufactured goods and services produced, taxes, and any subsidies not included in the product value. It is estimated without regard for depreciation of produced items or for natural resource depletion and degradation. The change in the size of an economy or the actual income of its population over time is used to determine its growth (He *et al.*, 2019). The Gross Domestic Product (GDP) of an economy is the total value added by all producers. Before depreciation, value added equals the value of producers' gross output minus the value of intermediary products and services consumed in manufacturing. GDP is calculated as the sum of the value added by households, government, and businesses working in the economy at constant prices. GDP is calculated on the basis of all domestic output, regardless of whether income is generated by domestic or international firms.

3 CHAPTER 3: DATA COLLECTION AND METHODOLOGY

Data Collection and Methodology refers to an organized procedure of collecting and analyzing data for a specific purpose (McMillan and Schumacher, 2001). In this chapter, I will discuss the methods of data collection and the type of research I am conducting.

This chapter enlists all the detailed methodology utilized in this research. Following are the topics covered in the chapter:

1. Research Methodology
2. Sources of Data
3. Population
4. Sampling
5. Data Collection
6. Variable Operationalization
7. Research Setting and facilities available
8. Data Analysis Techniques

3.1 RESEARCH METHODOLOGY

In this research, descriptive research design was used. The descriptive research design is used to describe the data and its features about the analysis which is performed (Knupfer and McLellan, 1996). The descriptive research design usually obtain data and interpret it in a functional form. This form of data analysis method allows the researchers to interpret the data objectively, along with an increased validity and consistency of the results. This study used dependent variable and several independent variables. The Independent variable is that which the researcher used for experimentation, these changes or enacts in order to do the experiment. the dependent variable is that which will change when the independent mutable changes – the dependent variable will depend on the outcome of the independent flexible (MacCallum *et al.*, 2002).

3.2 SOURCE OF DATA

This research utilized the secondary sources of data. The Secondary sources of data are those which are obtained by someone else before. This data is collected by someone not directly involved in the research and obtained the data in the past for other purposes. If any researcher uses this data, then it is referred to as secondary data which is being used by the current researchers (Boslaugh, 2007). Some of the known secondary sources of data include corporate annual reports, websites, journals and their articles, books, along with the government records such as published content and reports (Choy, 2014). This research employed the data from the official websites for the world database and their relevant reports, so this research is said to be1 based1 on secondary sources of data.

3.3 CATEGORIZATION OF COUNTRIES

The research employed the World Bank classification of Income groups for countries (Figure 9). The World Bank's classification of country income categories is thought to be more reliable and suitable for economic research than the World Economic Forum's (WEF) classifications. To lessen the impact of exchange rate swings, the World Bank employs an impartial, open, and generally recognized approach based on gross national income (GNI) per capita, which is updated yearly using the Atlas technique. The World Bank is especially suitable for empirical research focused on economic development, growth, or structural comparisons, such as studies looking at the effect of R&D on economic results, because its explicit income levels enable more uniform comparisons between countries and studies (World Bank Group, 2020). This method offers a precise and reliable economic standard by which to compare countries over time. The WEF categories, on the other hand, are more directly related to innovation and competitiveness performance, which are more subjective and impacted by a wider range of qualitative indicators, even though they are useful for particular analysis. Therefore, employing the World Bank's income grouping offers a more reliable and widely accepted framework for classifying nations according to their economic standing.

The World Bank divides all 141 economies into four different income groups:

1. High Income Group
2. Upper Middle Income Group
3. Lower Middle Income Group
4. Low Income Group

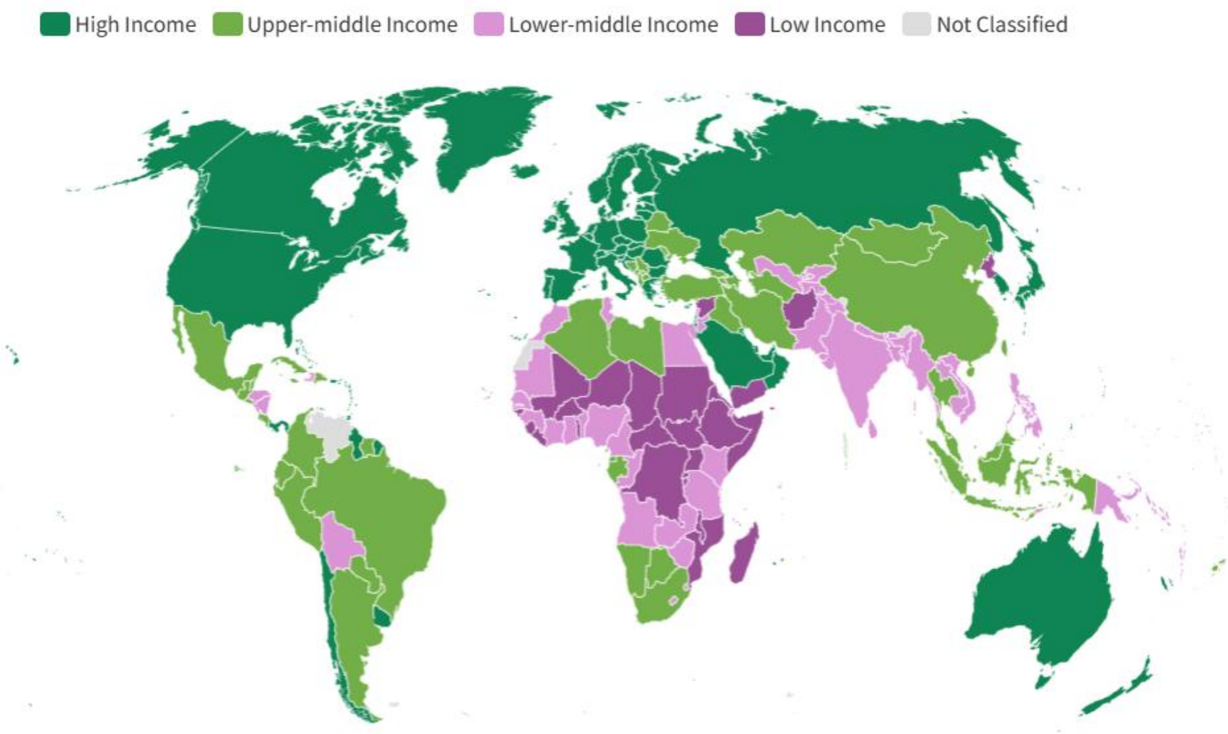

Figure 9: World Bank classification of Countries by Income Groups

Source: (The World Bank Group, 2023)

3.4 SAMPLING

The proposed research used the World Economic Forum indicators for the variables used. The population is the whole World (141 countries present in the database of the World Bank) (refer to Table 26 in the Annex). Stratified Sampling Technique was used in this research. This type of sampling technique is used when the entire population is categorized or divided into strata (or groups) based on different characteristics such as income, age, gender, etc. (Sampling Techniques, 1982). All the 141 countries were divided into four categories based on their income level segregation as provided by the World Bank. These groups are High Income Group, Upper Middle Income Group, Lower Middle Income Group and Low Income Group. For the research, I selected the Lower Middle Income Group of countries. It comprises of 32 countries. The reason for selecting this group of countries is that almost all the countries included in this group are exposed to (if not entirely same but) similar economic, political and legal environment.

Table 4: Lower Middle Income Group countries (The World Bank Group, 2023)

Angola	Cape Verde	Ghana	Kyrgyz Republic	Morocco	Philippines
Bangladesh	Côte d'Ivoire	Honduras	Lao PDR	Nicaragua	Senegal
Bolivia	Egypt	India	Mauritania	Nigeria	Tunisia
Cambodia	El Salvador	Indonesia	Moldova	North Macedonia	Ukraine
Cameroon	Eswatini	Kenya	Mongolia	Pakistan	Vietnam
Zambia	Zimbabwe				

Lower Middle Income Countries (LMICs)

According to the World Bank Atlas method, economies classified on the basis of their GNI per capita. Using the Atlas methodology, gross national income (GNI) per capita is calculated by dividing the total annual income of a nation by its population (Figure 13 and 14). Economies referred to as low-income have a gross national income (GNI) per capita of $1,085 or less in 2021; economies classified as lower middle-income have a GNI per capita that falls between $1,086 and $4,255; upper middle-income economies have a GNI per capita between $4,256 and $13,205; and the high-income countries have GNI per capita of $13,205 and above (The World Bank Group, 2023). According to Gill et al., (2007), middle-income nations are torn between competition from low-wage producers of finished goods and the quickly evolving advanced technologies of wealthy nations. According to the World Bank, 108 nations are currently trapped in the “middle-income trap,” including powerful economies like China, Brazil, Turkey, and India. Middle-income nations may find themselves torn between wealthy, inventive nations that dominate technology-intensive industries and low-wage, impoverished nations that dominate more established industries. This is because high-income economies have an advantage in industries that need a lot of capital and technology, while low-income nations often have a relative advantage in labor-intensive industries

(Zhou and Hu, 2021). Following graphs cover the comparative analysis of LMICs and the rest of the world on the basis of the indicators GNI, GDP and Population growth as annual percentage.

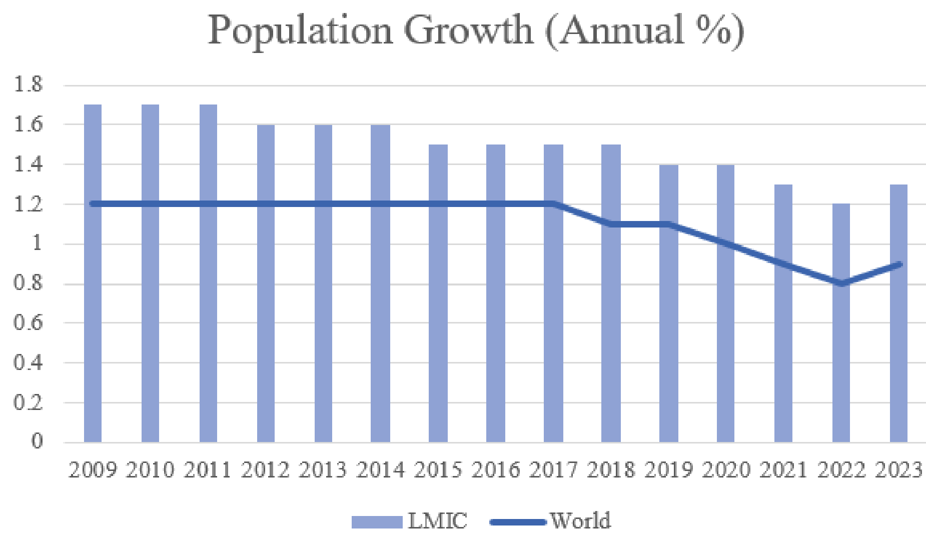

Figure 10: Population Growth (Annual %) - Comparison of LMICs with Rest of the World 2009-2023

Source: World Bank 2024

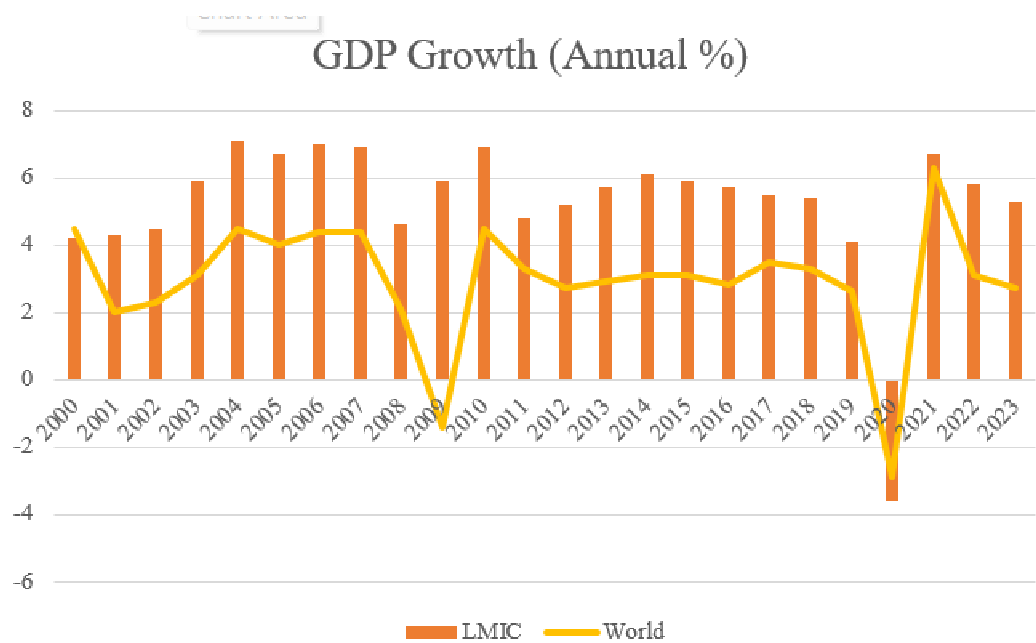

Figure 11: Gross Domestic Product (GDP) Growth (Annual %) of LMICs and Rest of the World for the Period (2000-2023)

Source: World Bank 2024

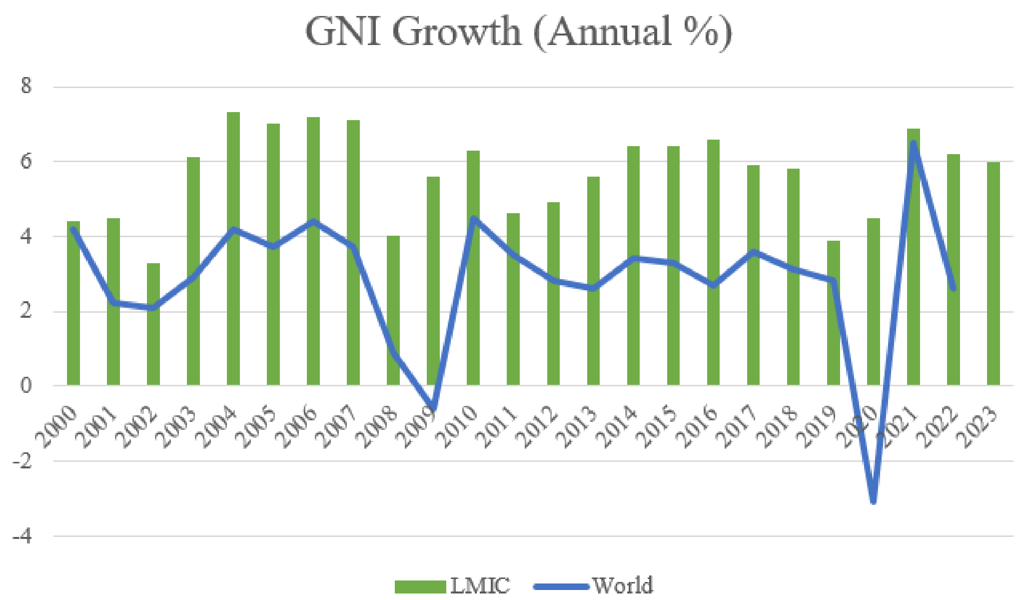

Figure 12: Gross National Income (GNI) Growth (Annual %) of LMICs and Rest of the World for the Period (2000-2023)

Source: World Bank 2024

Table 5: Gross National Income (GNI) by Atlas Method, Current Billion USD for Lower Middle Income Countries (LMIC) 2009-2023

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Angola	71.27	75.54	82.6	104.8	123.09	130.42	110.41	74.25	63.16	61.53	68.34	56.33	56.61	66.53	78.32
Bangladesh	106.13	118.31	133.33	146.83	158.81	171.23	191.34	225.59	266.74	329.85	366.47	385.24	435.56	483.37	493.93
Bolivia	16.05	17.9	20.43	23.31	27.26	30.35	32.21	33.49	34.58	38.24	40.54	37.21	39.8	42.67	44.65
Cambodia	9.82	10.82	11.86	13.08	14.37	15.52	16.56	18.08	19.96	22.8	25.21	25.14	26.27	28.37	30.7
Cameroon	27.82	28.54	29.66	30.56	32.72	34.57	34.93	34.41	34.11	37.69	39.76	40.32	43.31	45.42	47.32
Cape Verde	1.85	1.84	1.92	1.91	1.97	1.92	1.86	1.83	1.86	2.07	2.27	1.81	2	2.41	2.56
Côte d'Ivoire	23.77	25.19	23.34	26.81	29.77	45.71	47.54	48.92	50.06	55.13	59.85	61.17	68.3	73.7	77.06
Egypt	172.13	196.29	216.78	245.18	267.96	292.27	309.14	325.2	299.14	285.96	284.48	323.68	384.94	455.14	439.25
El Salvador	17.34	17.82	19	20.05	20.96	21.43	21.76	22.3	23.01	24.5	25.7	23.67	27.39	29.57	31.32
Eswatini	3.51	3.69	4.13	4.66	4.8	4.52	4.19	3.85	3.81	4.12	4.21	3.98	4.49	5.29	4.67
Ghana	28.75	30.63	35.14	39.84	49.03	51.23	53.9	51.69	54.86	63.16	67.72	71.86	74.96	79.66	79.82
Honduras	13.65	14.46	15.91	16.99	17.69	17.96	18.75	19.7	21.17	22.31	23.16	21.47	25.12	28.26	30.72
India	1360	1510	1700	1870	1940	2020	2100	2250	2440	2710	2880	2660	3060	3390	3630
Kenya	33.43	38.75	43.13	46.51	50.62	57.58	62.1	71.75	75.69	86.59	96.15	98.66	110.03	117.31	116.41
Kyrgyz Republ	4.65	4.64	4.85	5.81	6.83	7.28	7.03	6.74	6.9	7.73	8.19	8.17	8.7	10.42	12.07
Lao PDR	5.5	6.25	7.27	8.83	10.54	12.12	13.34	14.56	15.71	17.55	18.21	18.11	18.65	17.37	16.2
Mauritania	4.92	5.25	5.75	6.52	7.07	6.87	6.65	6.3	6.54	7.29	7.69	7.93	8.59	9.83	10.45
Moldova	5.6	6.8	7.8	8.97	10.36	10.66	9.33	8.89	9.1	10.43	11.97	11.5	13.68	13.97	15.19
Mongolia	4.78	5.44	7.17	10.31	12.49	12.39	11.4	10.68	10.08	11.71	12.41	12.27	112.47	14.47	17.07
Morocco	102.16	104.72	108.66	109.31	114.74	115.38	115.78	111.74	113.77	123.09	128.81	121.24	136.14	139.6	142.29
Nicaragua	7.95	8.53	9.29	10	10.56	11.24	11.77	12.33	12.95	12.75	12.5	11.88	13.48	14.51	16.02
Nigeria	317.53	342.34	359.94	416.38	471.59	533.51	525.53	463.85	403.83	400.47	429.27	440.49	461.01	471.25	432.5
North Macedor	9.53	9.74	9.96	9.82	10.38	10.8	10.62	10.36	10.24	11.42	12.24	11.99	12.95	13.73	13.88
Pakistan	197.43	198.26	208.27	230.7	254.82	267.58	279.06	299.99	323.24	353.58	349.84	321.9	340.95	369.1	360.73
Philippines	200.67	222.93	240.84	278.22	312.62	334.25	345.55	357.9	371.43	395.27	416.22	375.81	404.2	457	496.17
Senegal	16.37	16.91	16.95	17.63	18.53	19.36	19.15	19.11	19.68	22.06	23.42	24.15	26.41	28.09	29.42
Tunisia	42.83	44.61	44.2	46.83	47.87	48.57	47.04	45.27	43.12	43.58	42.65	39.26	43.8	47.04	46.91
Ukraine	130.98	139.03	143.75	166.42	179.85	153.13	119.86	100.78	100.2	116.38	139.08	149.17	169.97	151.67	174.92
Vietnam	96.71	119.48	144.22	176.78	198.88	218.74	228.4	240.49	255.48	290.78	319.51	333.83	350.32	394.87	412.94
Zambia	16.97	18.28	19.89	24.45	26.27	27.65	25.05	22.39	21.93	25.04	25.61	21.4	20.35	23.49	27.2
Zimbabwe	5.54	8.38	12.39	14.85	16.25	16.82	17.28	17.39	17.32	23.31	22.28	22.86	24.55	28	29.08

Source: World Bank, 2024

Table 6: Descriptive Statistics for variables used- case of LMICs- Author's own calculations

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
MYS	32	58.3	18.9	77.2	47.231	2.5270	14.2947	204.338	.112	.414	-.508	.809
QVT	32	36.8	25.6	62.4	45.347	1.4824	8.3856	70.319	-.013	.414	.155	.809
DSAP	32	43.6	24.1	67.7	48.256	1.5573	8.8097	77.610	-.301	.414	.770	.809
DCPS	32	97.1	2.9	100.0	42.366	4.1747	23.6156	557.697	.569	.414	-.169	.809
FSME	32	39.7	21.3	61.0	41.941	1.6758	9.4796	89.862	-.437	.414	.276	.809
VCA	32	40.9	11.8	52.7	29.075	1.7285	9.7778	95.605	.366	.414	-.030	.809
ScP	32	45.6	47.1	92.7	69.925	1.6624	9.4039	88.434	-.161	.414	.397	.809

RDE	32	83.5	.5	84.0	12.884	2.6129	14.7811	218.480	3.796	.414	17.811	.809
RIP	32	98.4	.0	98.4	5.963	3.0835	17.4427	304.248	5.108	.414	27.585	.809

Generally, LMICs have moderate to high GDP growth as shown in Figure 13, frequently powered by industries like manufacturing, services, and agriculture. While other countries, like Nigeria, are stagnating as a result of their reliance on unstable commodities, Vietnam and India have seen steady, rapid growth because of technical improvements and industrial expansion. Vietnam and other export-driven economies rely heavily on global supply chain and manufacturing. Zambia and other resource-dependent nations deal with issues like low diversification and price instability. Significant FDI is drawn to nations with stable governments and welcoming business environments such as Morocco. In countries like Sudan, political unrest discourages investment. A sizeable percentage of the population in several LMICs live below the poverty line. For instance, India still faces income inequality between rural and urban areas despite having made tremendous progress in reducing poverty.

Conflicts and a lack of strong institutional frameworks cause Sub-Saharan LMICs to make less progress. LMICs have a variety of educational systems; some, like the Philippines, place a great priority on higher education, while others have difficulty accessing primary education. Because of inadequate infrastructure and resources, health indicators like life expectancy and maternal mortality are frequently low. There are significant differences in governance; whereas some nations, like Ghana, exhibit robust democratic institutions, others, like Myanmar, struggle with authoritarianism and instability. While some states, like Indonesia, maintain relative peace, allowing for development, fragile others, like Yemen, struggle with continual conflicts. Cities like Lagos, Nigeria, and Dhaka, Bangladesh, are under infrastructure strain due to rapid urban growth. Because of their limited ability to adapt and their reliance on agriculture, LMICs are disproportionately impacted by climate change. While Kenya experiences protracted droughts, Vietnam is confronted with increasing sea levels. Emerging digital hubs include Egypt and India, but other nations lag behind because of a lack of investment in R&D and education.

3.5 DATA COLLECTION

The Quantitative method of data collection is being employed to gather data from my target population. The data for the proposed research is gathered through the direct observation of the World Economic Forum databases and reports present on the organization’s official website, through which1 the data for all the variables has1 been gathered and the time frame of the data gathered is for the year 2019 on the basis of results from the Global Competitiveness Report. The year 2019 was chosen with purpose and methodological strategy. My goal was to capture the level of R&D spending and how it related to economic indicators in lower-middle-income nations just prior to the 2020 worldwide disruption brought on by the COVID-19 pandemic. Significant economic instability, changes in policy objectives, and abnormalities in the data brought about by the pandemic may have obscured the underlying relationships between R&D and normal economic performance. By concentrating on 2019, I aimed to create a precise and unbiased standard by which to measure R&D’s contribution to economic growth in a stable macroeconomic setting. This eliminates the confounding effects of pandemic-related initiatives and shocks, giving a more accurate picture of the structural relationship between R&D and economic results in these nations.

The choice to concentrate on 2019 was also affected by the fact that reliable and consistent post-2019 data for all lower-middle-income nations were not consistently accessible at the time of research.

Variables

Six main constructs developed from my research are Economic Growth, R&D, Institutions, Human Capital, Capital Market and Innovation. Economic Growth is the target or dependent variable, is measured as the 10-year average annual GDP growth percentage (valued at Purchasing Power Parity – PPP, in billions of USD) from 2009 to 2018. Five independent variables are R&D, Human Capital, Capital Market and Innovation for which following indicators will be used i.e. Institutions, R&D, Human Capital, Capital Market and Innovation. Initially, all of the variables from WEF 12 pillars were tested with the CFA analysis. It is only when the analysis was conducted is when I had to come down in favor of the currently selected number and choice of the variables keeping in view the model fit indices. Before proceeding with CFA, I checked the correlations among the variables within each construct. As some variables had weak relationships, I reconsidered their inclusion. I evaluate factor loadings (ideally above 0.5) to confirm that each variable significantly contributes to its respective construct. If model fit was poor, I modified constructs by eliminating weak indicators. I used Structural Equation Modeling (SEM) to understand correlations and associations between the institutions and GDP growth. In case CFA results were not satisfactory, I explored Exploratory Factor Analysis (EFA) first to determine whether the data naturally supports my hypothesized structure.

Aggregated Constructs

For the computation of the indicators, the Global Competitiveness Index (GCI) of the World Economic Forum (WEF) have adopted the 'Aggregation' method. The scores are calculated from the most disaggregated (indicator) level to the most aggregated (highest) level. Each aggregated level is composed of different components. The overall score for each aggregated level is calculated by taking the arithmetic mean (average) of its component indicators. For individual indicators, prior to aggregation, raw values are transformed into a progress score ranging from 0 to 100, with 100 being the ideal state. In Table 5, I have listed down the most aggregated level provided by the GCI that gives the overall score of all of the components of which the indicator is composed of.

Table 7: Variable Operationalization
(Source: World Economic Forum, 2019, World Bank, 2020)

Major Indicator	**Abbreviation**	**Definition**	**Scale**	**Periodicity**	**Reference**
GDP growth	GDP	10-year average annual GDP Growth percentage (valued at Purchasing Power Parity or PPP in billion USD)	Weighted Average	**Annual, 2009-2018**	**World Economic Forum, 2019**

Institutions	Ins	Regulate the setting in which the economy and society organize themselves by formal and informal check and balance	Score: 0-100 (0=worst, 100= Frontier)	**Annual**	**World Economic Forum, 2019**
Innovation	Inn	The conversion of new ideas into product and services/improvement of existing ones	Score: 0-100	**Annual**	**World Economic Forum, 2019**

Breakdown of Major Variables

In the above chart, I have discussed the aggregated variables taken from the World Economic Forum. In the chart below, I will now list the underlying component variables under each aggregated level that closely support my research literature. R&D, CM, and HC constructs are built from 3-3 different indicators. This type of methodology is being adopted from the World Economic Forum (Schwab, 2019).

Table 8: Breakdown of Major Variables (Source: World Economic Forum, 2019)

Major Variable	Component Variables
Research & Development	• Scientific publications • R&D Expenditures • Research institutions prominence
Capital Market	• Domestic credit to private sector • Financing of SMEs • Venture capital availability
Human Capital	• Mean Years of Schooling • Quality of vocational training • Digital skills among active population

Research & Development: The effectiveness and accessibility of financial services inside an economy are measured by this construct. The variables that were chosen represent various aspects of financial support available for business.

- **Scientific publications (ScP):** This indicator symbolizes the nation's contributions to international scientific knowledge and research production. A limitation if tis indicator is that publications' quantity does not always indicate their caliber or significance.

Furthermore, despite robust industry-driven innovation, developing nations could produce fewer publications. It is calculated by the average number of publications and citations at the national level on a 0 to 100 scale from 2016 to 2018.

- **Research institutions prominence (RIP):** It represents the standing of a nation's research institutes internationally, which affects partnerships for innovation and the recruitment of talent. Data based on perception might not necessarily correspond with real research findings or developments in technology. It evaluates the status and reputation of both public and private research institutes on a 0 to 100 scale (2019).
- **R&D Expenditures (RDE):** It evaluates the amount of money spent on research projects, including grants from institutions, corporations, and governments. Since R&D spending efficiency varies, higher spending does not always translate into innovation. Additionally, private-sector contributions are not taken into separate account in this assessment. It is calculated as a percentage of GDP for the year 2016 or the most recent year available

Capital Market

- **Domestic credit to private sector (DCPS):** It symbolizes the availability of financial resources that banks offer to both individuals and corporations. A more advanced financial system is indicated by a higher percentage. This indicator however does not differentiate between credit given to profitable business endeavors and for non-profitable purposes (such as risky investments). The methodology is entire amount of funds supplied to the private sector, represented as a proportion of GDP | moving average for 2015–2017.
- **Financing of SMEs (FSME):** It evaluates the ease with which small and medium-sized businesses (SMEs) can obtain financing, which is essential for both economic growth and entrepreneurship. A limitation of this indicator is that it is predicated on survey data, which is subject to biases in perception and can be subjective. Methodology: Answer to the survey question: How much can small and medium-sized businesses (SMEs) in your country obtain from the financial sector the funding they require for their operations? [1 = not at all; 7 = significantly] | The most current period available, or the weighted average for 2018–2019 (Executive Opinion Survey by WEF)
- **Venture Capital Availability (VCA):** It evaluates how simple it is to get venture capital investment, which is essential for creative firms with high risk and high reward. A limitation of this indicator is that like SME financing, this depends on perception and might not accurately represent investment levels. Furthermore, rather than being dispersed equally throughout an economy, venture capital availability may be concentrated in particular industries. Methodology: Answer to the poll question: How easy is it for start-up entrepreneurs in your country to obtain equity funding for their innovative but risky projects? [1 = incredibly hard; 7 = incredibly easy] | The most current period available, or the weighted average for 2018–2019 (Executive Opinion Survey by WEF).

Human Capital

- **Mean Years of Schooling (MYS):** It represents the population's total level of education, which is correlated with economic growth and productivity. It does not take into consideration the standard of education or how well-suited the skills learnt are to the needs of the job market. It is calculated by taking into account average number of years that a person who is 25 years of age or older has completed their education, omitting years that they have spent repeating a single grade.

- **Quality of vocational training (QVT):** It evaluates how well technical and vocational training programs prepare people for the workforce. A limitation of this indicator is that data from subjective surveys might not accurately reflect training programs' real results or industrial relevance. Methodology: Answer to the poll question: How would you rate the quality of vocational training in your nation? [1 = very poor among the worst in the world; 7 = excellent among the best in the world] | The most current period available, or the weighted average for 2018–2019 (Executive Opinion Survey by WEF).
- **Digital skills among active population (DSAP):** It evaluates the workforce's degree of digital literacy, which is important in the current economy. Industry-specific digital skills differ greatly, and survey-based metrics could not accurately represent true competencies. Methodology: Answer to the poll question: How much of the working population in your country has basic computer skills, digital reading comprehension, and basic coding knowledge? [1 = not entirely; 7 = largely] | The most current period available, or the weighted average for 2018–2019 (Executive Opinion Survey by WEF).

3.6 RESEARCH SETTINGS AND FACILITIES AVAILABLE

The research is based on the Low Middle Income Group of countries as defined by the World Economic Forum. All the data is available on Internet and no such special study settings or facilities other than the provision of SPSS software facility were required to conduct the research.

3.7 DATA ANALYSIS TECHNIQUES

In this chapter, I will briefly discuss the methods of analysis which will be used to evaluate my data. Following are the methods which will be used in this study.

1. Descriptive Statistics
2. Correlation Analysis
3. Reliability Analysis
4. Factor Analysis
5. SEM Analysis

We used the SPSS software to perform the data analysis.

Descriptive statistics is used to describe the basic features of the data in study, where frequency distribution, mean, median and mode of the indices in the annual reports have been analysed (Rendón-Macías, Villasís-Keever, & Miranda-Novales 2016). Correlation Analysis has been used to check the relationship between the dependent variable, independent variables, and the moderator (Moutinho, Hutcheson and Moutinho, 2014). The important method of data analysis used for this study is Structural Equation Modelling or SEM. For conducting SEM analysis, the prerequisite is to perform Confirmatory Factor Analysis in order to confirm the relationship among the variables used. For results and analysis, I have mainly used SPSS software to get the good and accurate results.

1. Descriptive Statistics

The Descriptive Statistics is a common statistical analysis which is used to describe the basic features of the data which is being studied. It summarizes the representative characteristics of the data such mean, mode, median, standard deviation, maximum and minimum value range. Expressive statistics is used to define the basic types of the data in study. Descriptive analysis comprises on Mean value, Minimum value, Maximum value, Standard deviation and number of observations etc. (Rendón-Macías, Villasís-Keever, & Miranda-Novales 2016). Table 27 in the Annex provides the descriptive statistics of the data used in this research.

2. Correlation Analysis

The Correlation Analysis is used to determine the relationship among different variables under study. The value of 0.5 or higher represents an absolute value however the value below 0.5 represents a non-absolute value among the variables. Similarly, all the positive values represent positive relationship and the negative values propose the inverse relationship among the variables. Table 8 in Annex shows the figures for Pearson's correlation of the variables used.

3. Reliability Analysis

You can examine the characteristics of measurement scales and the components that make them up through reliability analysis. In addition to calculating a number of widely used scale reliability metrics, the Reliability Analysis process offers details on the relationships between the scale's constituent elements. Inter-rater reliability estimates can be calculated using intra-class correlation coefficients. The Cronbach's Alpha value ranges from 0 to 1. Generally, a value of 0.7 and above is considered to be a good value (Samuels, 2015).

4. Factor Analysis

Factor Analysis is the type of data analysis method which is used to simplify the data sets that are complex, as in, they have a lot of variables (Watkins, 2018). This method simplifies the data by compressing the large number of variables into just few so that working on the research gets easy. The idea behind this analysis is that there are deep-rooted factors underlying the main concept and that it is better to deal with these instead of dealing with the less-important factors.

There are two types of Factor Analysis:

1. **Confirmatory Factor Analysis:** This is the type of Factor analysis which is performed when the researcher has hypothesis in mind about the data which is to prove or disapprove. The confirmatory factor analysis will or will not confirm where the latent variables lie and how much is the variance between them.
2. **Exploratory Factor Analysis:** The Exploratory Factor Analysis is used when the researcher has no hypothesis designed. It investigates whether the relationship exists between the variables and if it does, where and how they are grouped.

We will use the Confirmatory Factor Analysis as I have designed the hypothesis with regard to my theoretical framework.

5. SEM Analysis

The SEM or Structural Equation Modeling is the technique which depicts the relationship between different independent and a target (dependent variable) through a measurement model and a path diagram. The advantage of using SEM analysis is that it has an ability to test and estimate the relationships between the constructs. It also helps to determine the construct validity of different constructs by utilizing different measures to depict constructs and estimate the measurement error, which otherwise is not determined by other linear models. I used SEM analysis as part of my research to understand causal relationships between different types of institutions and GDP growth.

4 CHAPTER 4: DATA ANALYSIS

Data Analysis refers to the process of evaluation of the collected data with the help of various Statistical methods and then interpreting the results. These methods of data analysis are performed on different statistical software packages such as SPSS, E-Views, Stata, etc. There are different methods of data analysis. The Quantitative method of Data collection is being employed to gather data from my target population (Caldas, 2003). The source of data utilized for this research is secondary. The data for the proposed research is gathered through the direct observation of the Global Competitiveness Report published by the World Economic Forum for the year 2019. According to (Sekaran, 2010), the objectives of data analysis are getting a feel for the data (descriptive analysis), testing the goodness of the data (scale measurement) and testing the hypothesis develop for the research.

4.1 DATA ANALYSIS TECHNIQUES

4.1.1 Descriptive Statistics

Table 29 in the Annex provides the descriptive statistics of the data used in this research.

4.1.2 Correlation Analysis

Table 30 in Annex shows the figures for Pearson's correlation of the variables used.

Pearson's r Heatmap

The Correlation Heatmap is a graphical representation of the correlation between multiple variables as a color-coded matrix. It's like a color chart that shows us how closely related different variables are. The darker color shows the strong relationship whereas the lighter color shows a weak relationship. The blue color shows the positive relationship; similarly, the brown color shows the negative relationship. The darker the color, the strongest the relationship.

Table 9: Pearson's r Heatmap

	Meanyearsofschooling	Qualityofvocationaltraining	Digitalskillsamongactivepopulation	Domesticcredittoprivatesector	FinancingofSMEs	Venturecapitalavailability	Scientificpublications	RDexpenditures	Researchinstitutionprominence	Innovation	Institutions	Grossdomesticproduct	RDInstitutions	LaborInstitutions	FinancialInstitutions
Meanyearsofschooling		-0.017	0.272	0.075	0.18	0.045	0.148	-0.005	-0.075	0.13	0.215	-0.126	0.208	-0.166	0.174
Qualityofvocationaltraining	-0.017		0.694***	0.112	0.453**	0.584***	0.356*	0.025	0.196	0.511**	0.485**	0.258	0.254	-0.057	0.217
Digitalskillsamongactivepopulation	0.272	0.694***		0.019	0.505**	0.634***	0.543**	0.08	0.286	0.678***	0.654***	0.189	0.31	-0.044	0.241
Domesticcredittoprivatesector	0.075	0.112	0.019		0.39*	0.394*	0.107	-0.178	0.068	0.234	0.222	0.034	-0.501**	0.582***	0.2
FinancingofSMEs	0.18	0.453**	0.505**	0.39*		0.838***	0.508**	-0.042	0.449**	0.617***	0.609***	0.174	0.025	0.183	0.382*
Venturecapitalavailability	0.045	0.584***	0.634***	0.394*	0.838***		0.538**	-0.184	0.543**	0.728***	0.58***	0.158	-0.095	0.359*	0.309
Scientificpublications	0.148	0.356*	0.543**	0.107	0.508**	0.538**		0.274	0.588***	0.88***	0.504**	0.279	0.184	0.255	0.192
RDexpenditures	-0.005	0.025	0.08	-0.178	-0.042	-0.184	0.274		0.107	0.162	0.191	0.031	0.542**	-0.099	-0.161
Researchinstitutionprominence	-0.075	0.196	0.286	0.068	0.449**	0.543**	0.588***	0.107		0.72***	0.358*	0.189	-0.16	0.664***	0.122
Innovation	0.13	0.511**	0.678***	0.234	0.617***	0.728***	0.88***	0.162	0.72***		0.617***	0.223	0.081	0.405*	0.23
Institutions	0.215	0.485**	0.654***	0.222	0.609***	0.58***	0.504**	0.191	0.358*	0.617***		0.075	0.178	0.128	0.258
Grossdomesticproduct	-0.126	0.258	0.189	0.034	0.174	0.158	0.279	0.031	0.189	0.223	0.075		-0.039	0.098	0.083
RDInstitutions	0.208	0.254	0.31	-0.501**	0.025	-0.095	0.184	0.542**	-0.16	0.081	0.178	-0.039		-0.518**	-0.464**
LaborInstitutions	-0.166	-0.057	-0.044	0.582***	0.183	0.359*	0.255	-0.099	0.664***	0.405*	0.128	0.098	-0.518**		-0.153
FinancialInstitutions	0.174	0.217	0.241	0.2	0.382*	0.309	0.192	-0.161	0.122	0.23	0.258	0.083	-0.464**	-0.153	

4.1.3 Reliability Analysis

Table 10: Reliability Analysis

	Coefficient ω	Coefficient α
RDI	0.789	0.752
FI	0.789	0.771
LI	0.771	0.765
total	0.845	0.879

Table 10 summarizes the reliability analysis of the research. Since all the values of Crobach's alpha is 0.7 and above, the test is considered to be reliable.

4.1.4 Factor Analysis

Table 11: Model Fit for Confirmatory Factor Analysis

Chi-square test

Model	X²	df	p
Baseline model	935.701	36	
Factor model	93.838	24	< .001

Chi-Square test is a statistical method for assessing the discrepancy between observed and expected data. You can also perform this test to see if it has any correlation with my data's category variables. Determining if a discrepancy between two categorical variables is the result of random variation or a relationship between them is helpful. The value of the test in this case is 935.701. The p-value is smaller than significance level, 0.05, so I can reject the null hypothesis and infer that there is a relationship between the independent variables of the study and the economic growth.

Table 12: KMO Test

Kaiser-Meyer-Olkin (KMO) test

Indicator	MSA
Scientific publications	0.788
RD expenditures	0.902
Research institution prominence	0.890
Domestic credit to private sector	0.949
Financing of SMEs	0.766
Venture capital availability	0.799
Mean years of schooling	0.874
Quality of vocational training	0.932
Digital skills among active population	0.881
Overall	0.859

Kaiser-Meyer-Olkin (KMO) test

Indicator	MSA

KMO is a test conducted to examine the strength of the partial correlation (how the factors explain each other) between the variables. KMO values closer to 1.0 are consider ideal while values less than 0.5 are unacceptable. Recently, most scholars argue that a KMO of at least 0.80 are good enough for factor analysis to commence. In the table above, the probability value of KMO is less than 0.859 which is closer to one and is considered a good value.

Table 13: Bartlett's Test of Sphericity

Bartlett's test of sphericity

X^2	df	p
905.826	36	< .001

The Bartlett's test of Sphericity is used to test the null hypothesis that the correlation matrix is an identity matrix. An identity correlation matrix means your variables are unrelated and not ideal for factor analysis. A significant statistical test (usually less than 0.05) shows that the correlation matrix is indeed not an identity matrix (rejection of the null hypothesis) as represented in the table below. In above table, the probability value of Bartlett's test is less than 0.05 which is considered to be a good value.

Parameter Estimates

When all other predictors are held constant, parameter estimates represent the change in the response corresponding to a one-unit change in the predictor. A predictor's coefficient reveals how much of an impact it has on the response; a coefficient close to 0 suggests the variable has minimal effect. The interpretation of the coefficient is not very helpful because it just reveals the direction of the relationship; nevertheless, if new terms are added to the model, the sign may change. Assuming normally distributed errors, a confidence interval indicates the uncertainty in the estimate. If the sample size is moderate, there is no issue with violating the normalcy assumption because of the central limit theorem.

Estimate: Estimates of the model coefficients

Standard Error (Std. Error): The estimates of the standard errors of the parameter estimates

Z-Value: Indication of how close the value is to mean

P-value: probability value of a hypothesis test

Lower 95%: The lower 95% confidence limit for a parameter estimate

Upper 95%: The upper 95% confidence limit for a parameter estimate

Table 14: Factor Loadings

Factor loadings

						95% Confidence Interval	
Factor	Indicator	Estimate	Std. Error	z-value	p	Lower	Upper
RDI	Scientific publications	10.014	1.064	9.408	< .001	7.928	12.100
	RD expenditures	25.946	2.037	12.736	< .001	21.953	29.938
	Research institution prominence	18.126	2.367	7.657	< .001	13.487	22.766
FI	Domestic credit to private sector	20.327	2.407	8.445	< .001	15.609	25.044
	Financing of SMEs	13.164	0.957	13.748	< .001	11.287	15.040
	Venture capital availability	13.870	0.878	15.805	< .001	12.150	15.590
LI	Mean years of schooling	13.108	1.693	7.743	< .001	9.790	16.426
	Quality of vocational training	9.787	0.810	12.089	< .001	8.200	11.373
	Digital skills among active population	11.532	0.842	13.691	< .001	9.881	13.183

Scientific Publications

Factor loading represents the correlation between an observed variable (indicator) and the underlying factor in factor analysis. Here's how I will interpret the parameters: Estimate Value of 10.014 indicates the strength and direction of the relationship between the indicator scientific publications and its underlying factor RDI. A factor loading of 10.014 suggests a strong positive relationship between the scientific publications and RDI. Standard Error indicates the precision of the factor loading estimate. In this case, a standard error of 1.064 suggests that the estimate of 10.014 is relatively precise. The z-value is the ratio of the factor loading estimate to its standard error. A z-value of 9.408 indicates that the factor loading estimate is 9.408 standard errors away from zero. This suggests that the factor loading estimate is highly statistically significant. The p-value indicates the probability of observing a z-value as extreme as 9.408 if the null hypothesis (i.e., no relationship between the indicator and the factor) were true. A p-value of < .001 indicates that the factor loading estimate is highly statistically significant. This interval provides a range of values within which I can be 95% confident that the true population parameter lies. In this case, I can be 95% confident that the true factor loading for the indicator falls between 7.928 and 12.100.

Overall, the factor loading estimate of 10.014 is statistically significant, indicating a strong positive relationship between scientific publications and its underlying factor RDI. This suggests a robust positive correlation between the RDI construct and scientific publications. This finding implies that countries with stronger R&D institutional development tend to produce more scientific publications, which is significant because scientific output is frequently regarded as a proxy for a nation's research capability.

R&D Expenditures

The estimate indicates a very strong positive relationship between the indicator and its underlying factor. A factor loading of 25.946 suggests a substantial correlation between the indicator and the factor. The standard error represents the precision of the factor loading estimate. In this case, a standard error of 2.037 suggests that the estimate of 25.946 is relatively precise. The z-value is a measure of how many standard errors the factor loading estimate is from zero. A z-value of 12.736 indicates that the factor loading estimate is highly statistically significant. The p-value indicates the probability of observing a z-value as extreme as 12.736 if the null hypothesis (no relationship between the indicator and the factor) were true. A p-value of less than .001 indicates that the factor loading estimate is highly statistically significant. This interval provides a range of values within which I can be 95% confident that the true population parameter lies. In this case, I can be 95% confident that the true factor loading for the indicator falls between 21.953 and 29.938. Overall, the factor loading estimate of 25.946 is highly statistically significant, indicating a very strong positive relationship between the indicator and its underlying factor. R&D investment is the best measure of institutional research strength since it has the largest loading of any RDI indicator. The high number indicates that more money for research and development has a major impact on both technological and economic advancement.

Research Institute Prominence

The estimate indicates a strong positive relationship between the indicator and its underlying factor. A factor loading of 18.126 suggests a substantial correlation between the indicator and the factor. The standard error measures the precision of the factor loading estimate. In this case, a standard error of 2.367 suggests that the estimate of 18.126 is relatively precise. The z-value indicates how many standard errors the factor loading estimate is from zero. A z-value of 7.657 suggests that the factor loading estimate is highly statistically significant. The p-value indicates the probability of observing a z-value as extreme as 7.657 if the null hypothesis (no relationship between the indicator and the factor) were true. A p-value of less than .001 suggests that the factor loading estimate is highly statistically significant. This interval provides a range of values within which I can be 95% confident that the true population parameter lies. In this case, I can be 95% confident that the true factor loading for the indicator falls between 13.487 and 22.766. Overall, the factor loading estimate of 18.126 is highly statistically significant, indicating a strong positive relationship between the indicator and its underlying factor. This emphasizes how crucial reputable research institutes are to building a robust R&D ecosystem. Impactful research, international collaboration, and innovation-led growth are more likely to occur in nations with internationally renowned research institutions.

RDI: Scientific productivity is greatly influenced by R&D institutions, and more R&D spending immediately results in increased research output and institutional prominence, both of which promote long-term economic growth.

Domestic credit to private sector

The estimate indicates a strong positive relationship between the indicator and its underlying factor. A factor loading of 20.327 suggests a substantial correlation between the indicator and the factor. The standard error measures the precision of the factor loading estimate. In this case, a standard error of 2.407 suggests that the estimate of 20.327 is relatively precise. The z-value indicates how many standard errors the factor loading estimate is from zero. A z-value of 8.445 suggests that the factor loading estimate is highly statistically significant. The p-value indicates the probability of observing a z-value as extreme as 8.445 if the null hypothesis (no relationship between the indicator and the factor) were true. A p-value of less than .001 suggests that the factor loading estimate is highly statistically significant. This interval provides a range of values within which I can be 95% confident that the true population parameter lies. In this case, I can be 95% confident that the true factor loading for the indicator falls between 15.609 and 25.044.

Overall, the factor loading estimate of 20.327 is highly statistically significant, indicating a strong positive relationship between the indicator and its underlying factor. A high loading indicates that the strength of the financial sector, and in particular the availability of credit, is a critical component in promoting R&D investment and business development. More innovative businesses are typically found in nations with easier access to capital.

Financing of SMEs

The estimate indicates a strong positive relationship between the indicator and its underlying factor. A factor loading of 13.164 suggests a substantial correlation between the indicator and the factor. The standard error measures the precision of the factor loading estimate. In this case, a standard error of 0.957 suggests that the estimate of 13.164 is relatively precise. The z-value indicates how many standard errors the factor loading estimate is from zero. A z-value of 13.748 suggests that the factor loading estimate is highly statistically significant. The p-value indicates the probability of observing a z-value as extreme as 13.748 if the null hypothesis (no relationship between the indicator and the factor) were true. A p-value of less than .001 suggests that the factor loading estimate is highly statistically significant. This interval provides a range of values within which I can be 95% confident that the true population parameter lies. In this case, I can be 95% confident that the true factor loading for the indicator falls between 11.287 and 15.040.

Overall, the factor loading estimate of 13.164 is highly statistically significant, indicating a strong positive relationship between the indicator and its underlying factor. Financing for SMEs is essential for encouraging innovation and entrepreneurship. The high factor loading indicates that one of the main factors influencing economic dynamism in LMICs is financial assistance for small enterprises.

Venture Capital Availability

The estimate indicates a strong positive relationship between the indicator and its underlying factor. A factor loading of 13.870 suggests a substantial correlation between the indicator and the factor. The standard error measures the precision of the factor loading estimate. In this case, a standard error of 0.878 suggests that the estimate of 13.870 is relatively precise. The z-value indicates how many standard errors the factor loading estimate is from zero. A z-value of 15.805 suggests that the factor loading estimate is highly statistically significant. The p-value indicates the probability of observing a z-value as extreme as 15.805 if the null hypothesis (no relationship between the indicator and the factor) were true. A p-value of less than .001 suggests that the factor loading estimate is highly statistically significant. This interval provides a range of values within which I can be 95% confident that the true population parameter lies. In this case, I can be 95% confident that the true factor loading for the indicator falls between 12.150 and 15.590.

Overall, the factor loading estimate of 13.870 is highly statistically significant, indicating a strong positive relationship between the indicator and its underlying factor. A strong and positive correlation between venture capital and FI suggests that a thriving venture capital market supports high-risk, high-reward innovation endeavors, which in turn promotes economic growth.

FI: The availability of financial resources, particularly for SMEs and startups, directly impacts innovation and business growth, reinforcing the role of financial institutions in fostering R&D-driven economic progress.

Mean Years of Schooling

The estimate indicates a strong positive relationship between the indicator and its underlying factor. A factor loading of 13.108 suggests a substantial correlation between the indicator and the factor. The standard error measures the precision of the factor loading estimate. In this case, a standard error of 1.693 suggests that the estimate of 13.108 is relatively precise. The z-value indicates how many standard errors the factor loading estimate is from zero. A z-value of 7.743 suggests that the factor loading estimate is highly statistically significant. The p-value indicates the probability of observing a z-value as extreme as 7.743 if the null hypothesis (no relationship between the indicator and the factor) were true. A p-value of less than .001 suggests that the factor loading estimate is highly statistically significant. This interval provides a range of values within which I can be 95% confident that the true population parameter lies. In this case, I can be 95% confident that the true factor loading for the indicator falls between 9.790 and 16.426.

Overall, the factor loading estimate of 13.108 is highly statistically significant, indicating a strong positive relationship between the indicator and its underlying factor. A high loading indicates that the quality of the labor market is greatly influenced by higher education levels. The favorable correlation emphasizes how crucial a workforce with a high level of education is to promoting innovation and economic expansion.

Quality of Vocational Training

The estimate indicates a strong positive relationship between the indicator and its underlying factor. A factor loading of 9.787 suggests a substantial correlation between the indicator and the factor. The standard error measures the precision of the factor loading estimate. In this case, a standard error of 0.810 suggests that the estimate of 9.787 is relatively precise. The z-value indicates how many standard errors the factor loading estimate is from zero. A z-value of 12.089 suggests that the factor loading estimate is highly statistically significant. The p-value indicates the probability of observing a z-value as extreme as 12.089 if the null hypothesis (no relationship between the indicator and the factor) were true. A p-value of less than .001 suggests that the factor loading estimate is highly statistically significant. This interval provides a range of values within which I can be 95% confident that the true population parameter lies. In this case, I can be 95% confident that the true factor loading for the indicator falls between 8.20 and 11.373.

Overall, the factor loading estimate of 9.787 is highly statistically significant, indicating a strong positive relationship between the indicator and its underlying factor. This suggests that nations with more robust vocational training systems have workers that are more talented and adaptive, fostering industrial and technological development.

Digital Skills among Active Population

The estimate indicates a strong positive relationship between the indicator and its underlying factor. A factor loading of 11.532 suggests a substantial correlation between the indicator and the factor. The standard error measures the precision of the factor loading estimate. In this case, a standard error of 0.842 suggests that the estimate of 11.532 is relatively precise. The z-value indicates how many standard errors the factor loading estimate is from zero. A z-value of 13.691

suggests that the factor loading estimate is highly statistically significant. The p-value indicates the probability of observing a z-value as extreme as 13.691 if the null hypothesis (no relationship between the indicator and the factor) were true. A p-value of less than .001 suggests that the factor loading estimate is highly statistically significant. This interval provides a range of values within which I can be 95% confident that the true population parameter lies. In this case, I can be 95% confident that the true factor loading for the indicator falls between 9.881 and 13.183.

Overall, the factor loading estimate of 11.532 is highly statistically significant, indicating a strong positive relationship between the indicator and its underlying factor. Technological literacy is crucial for economic advancement in the digital economy. According to this research, nations with greater levels of digital proficiency see more robust innovation-driven growth.

LI: Innovation and economic competitiveness are greatly aided by the development of human capital, which can be achieved through both formal education and specialized skill training.

The findings show that R&D institutions (scientific publications, R&D spending, research institution prominence) are important for economic growth driven by innovation. Financial institutions are essential for promoting R&D and entrepreneurship since they provide credit, SME financing, and venture capital. A nation's capacity to use technology innovations for economic growth is determined by its labor institutions, which include education, vocational training, and digital skills. These results are consistent with current economic theories of innovation-driven growth, including Endogenous Growth Theory and Schumpeter's theory of creative destruction, which highlight the need for robust institutions that support investment, innovation, and skill development in order to achieve long-term economic growth.

Factor Covariance

Factor Covariance in factor analysis describe the underlying relationship between the latent factors used in the research. The covariance estimate value ranges from 0 to 1. Values closer to 1 represents strong relationship between the factors whereas the values closer to 0 represents little to no relationship between the factors. Table 15 shows the factor covariance of my model.

Table 15: Factor Covariance

	Estimate	Std. Error	z-value	p	95% Confidence Interval Lower	95% Confidence Interval Upper
RDI ↔ FI	0.664	0.056	11.910	< .001	0.555	0.774
RDI ↔ LI	0.772	0.049	15.774	< .001	0.676	0.867
FI ↔ LI	0.853	0.032	27.022	< .001	0.791	0.915

1. RDI (Research & Development Institutions) and FI (Financial Institutions):

The covariance estimate between RDI and FI is 0.664 which is closer to 1, represents moderately strong relationship between the two constructs. The positive covariance shows that the constructs move in the same direction which means that the increase in the value of one causes increase in the value of the other. The standard error represents the Variability and uncertainty around the error. An SE of 0.056, suggests that the estimate (0.664) is precise, which means that there is less fluctuation in the estimate and a higher level of confidence that it is near to the actual population number. The Z value is calculated by dividing the estimate with Standard Error:

$$Z = \text{Estimate/S.E}$$

$$Z = 0.664/0.056$$

$$Z = 11.910$$

The z-value is used to determine the importance of the covariance. A high z-value means that the covariance is statistically significant. In SEM, a z-value more than 1.96 or less than -1.96 is usually considered significant at the 95% confidence level. Because 11.910 is substantially bigger than 1.96, the covariance is highly statistically significant, indicating that the association between these two factors is unlikely to be due to chance. The confidence interval (CI) specifies a range of values within which the genuine population covariance is expected to fall with 95% certainty. In this situation, the 95% confidence interval (CI) is 0.555 to 0.774, which excludes zero. This supports the statistical importance of the covariance estimate, since a CI that does not contain 0 indicates a consistent positive association between the components. The CI's relatively narrow range (0.555 to 0.774) indicates that the estimate is exact, and I may be quite confident in the strength of the covariance. The computed covariance between RDI and FI suggest that they have a relatively strong positive association. The low standard error and high z-value indicate that this estimate is statistically significant and credible. The 95% confidence range (0.555 to 0.774) demonstrates that the actual covariance is considerably different from zero, indicating that the link between the two variables is both positive and strong. In conclusion, the two latent components are positively and strongly connected, with a moderate-to-strong covariance estimate. This implies that changes in one element are likely to coincide with equivalent directional changes in the other.

2. RDI (Research & Development Institutions) and LI (Labor Institutions):

The covariance value of 0.772 indicates the degree of linear relationship between the two latent components. This positive score implies that the two elements are positively related—when one increases, the other tends to increase as well. The covariance of 0.772 indicates a significant positive link between the two parameters. While it does not specify the precise strength of the linear relationship (which would necessitate correlation), it does imply a significant association.

The modest SE of 0.049 implies that the estimate of 0.772 is exact and dependable, implying that there is little fluctuation in the estimated covariance across samples. A z-value of 15.774 is quite big, indicating that the covariance is highly statistically significant. A z-value greater than 1.96 is generally regarded significant at the 95% confidence level, therefore this high result indicates exceptionally strong evidence that the covariance is not attributable to chance. The 95% confidence interval (CI) is 0.676 to 0.867, which excludes zero. This validates the statistical significance of the covariance estimate, since a CI that excludes zero indicates that the link between the components is genuine and positive. The very narrow range of 0.676 to 0.867 implies that the estimate is precise, adding to confidence in the strength of the association between the two parameters. The 95% confidence interval confirms that the real covariance is considerably positive and that the estimate is quite reliable. RDI and LI are significantly and positively correlated. The high covariance value of 0.772, together with the small value of standard error shows there are hardly any chances of sampling error; and substantial z-value, indicates a strong association between these variables with low uncertainty. This is supported by the 95% confidence interval, which shows that the genuine covariance is within a reasonably limited and positive range.

3. FI (Financial Institutions) and LI Labor Institutions:

The covariance value of 0.853 suggests a significant positive link between the two constructs. A large covariance indicates that while one element increases, the other tends to increase strongly. While covariance does not offer the exact strength of the link (that would require a correlation coefficient), a score of 0.853 indicates a significant association. The standard error of 0.032 indicates how much the covariance estimate may differ if the model was applied to other samples. A small value of SE like this implies that the estimate is quite exact, implying that the covariance is consistently around 0.853 across samples or populations. A Z-value of 27.022 is extraordinarily high, suggesting that the covariance is very statistically significant. In general, Z-values larger than 1.96 imply statistical significance at the 95% confidence level, and such a significant Z-value provides exceptionally strong evidence that the covariance is not random chance. The CI of 0.791 to 0.915 implies that the real covariance between the two components is between these values, and because the range excludes zero, it verifies that the covariance is considerably positive. The small confidence interval indicates great precision and confidence in the estimate. The large CI limits (over 0.79) support the substantial association between the two components. The two latent components have a substantial, statistically significant positive covariance. The high covariance value of 0.853, modest standard error, and strong z-value suggest that this association is stable and consistent across samples. The small and positive confidence interval verifies the estimate's dependability.

Residual Variances

In factor analysis, residual variances are the proportion of variance in observed variables that cannot be explained by the underlying factors or latent variables. They denote the difference between the overall observed variation in a variable and the variance explained by the factors. Table 32 in Annex shows the residual variances of the model.

Model plot

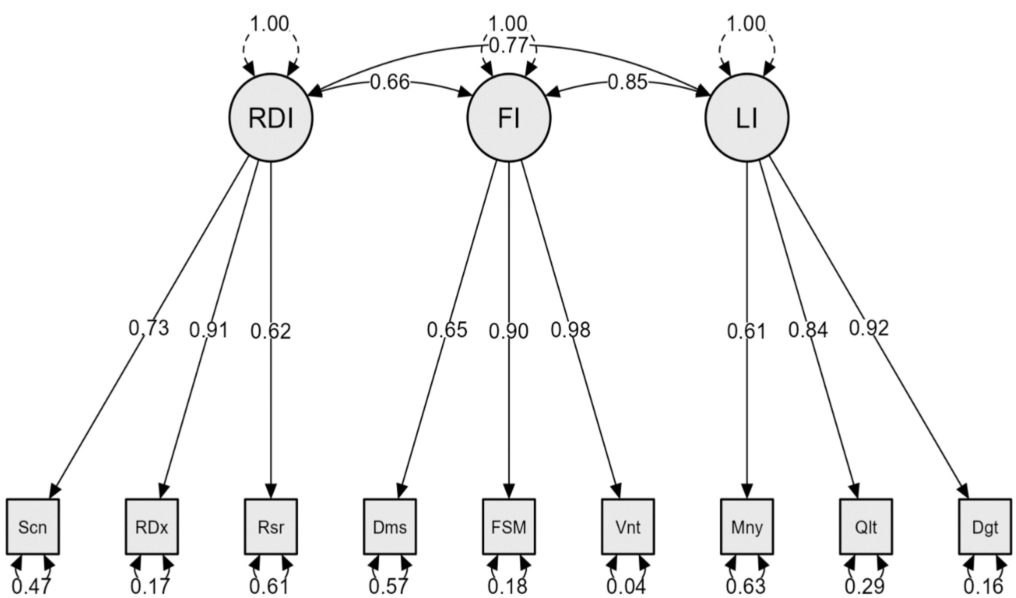

Figure 13: SEM Model Plot

***RDI: Research and Development Institutions**
***FI: Financial Institutions**
***LI: Labor Institutions**

***Scn: Scientific Publications**
***RDx: Research & Development Expenditures**
***Rsr: Research Institutions Prominence**

***Dms: Domestic Credit to Private Sector**
***FSM: Financing of SMEs**
***Vnt: Venture Capital Availability**

***Mny: Mean Years of Schooling**
***Qlt: Quality of Vocational Training**
***Dgt: Digital Skills among active Population**

The Model Fit of the Confirmatory Analysis shows the relationship between the observed and latent variables. The circles in the diagram shows the latent variables which are typically used to represent the constructs of the study. The rectangles show the observed variables. The arrow from the latent variable pointing towards the observed variable are called path coefficients which show that the latent variable predicts the observed variable. Higher values show the strong relationship between latent and observed variable. The curved arrows between the latent variables shows the correlation or covariance between these variables. And the small arrows pointing towards the observed variables are the error terms, the value of which represent the amount of variance not explained by the latent variables.

The covariance between RDI and FI is 0.66 which represents the moderately strong positive relationship between the two latent variables. This means if one variable increases, the other tend to increase as well. According to the squared correlation ($0.66^2 = 0.4356$), one latent variable shares 43.6% of its variance with the other latent variable. This demonstrates that although the two latent variables have their own unique variance, they do share a substantial number of factors that influence them. The closer the correlation is to 1, the stronger will be the relationship. Hence, the covariance between FI and LI is 0.85, represents very strong relationship between the two variables.

A path coefficient of 0.73 indicates that the latent factor RDI accounts for 73% of the variance in the observed variable *scientific publications*. This suggests that there is a substantial correlation between the latent and the observed variable. The stronger the relationship, the greater the coefficient. An error term of 0.47 indicates that variables other than the latent variable, such as measurement error or other unmeasured variables, account for 47% of the variance in the scientific publications. Since both the error term and the squared route coefficient account for the entire variance of the observed variable, their sum equals 1. The percentage of explained variance in the observed variable ($0.73^2 = 0.5329$, or roughly 53%) is represented by the route coefficient squared. The error term, or around 47% in this instance, denotes the unexplained variance. As a result, regarding this observed variable: RDI accounts for 53% of its variance. Of the variance, 47% is either not explained at all or is ascribed to measurement error. The degree to which the latent variable predicts the observed variable and the amount of measurement error or unmeasured impacts are indicated by the balance between the route coefficient and error term.

With a path coefficient of 0.91, 91% of the variance in the R&D expenditures (RDE) can be explained by latent variable RDI. This indicates that there is a substantial correlation between the RDE and the latent factor RDI. When measuring the latent factor, the observed variable is quite trustworthy, as indicated by the path coefficient of 0.91. Stated otherwise, the latent construct that underlies the observable variable can be accurately inferred from it. Path coefficients of more than 0.7 are typically regarded as strong. With a rating of 0.91, the predictive power appears to be quite strong. When the error term is 0.17, it indicates that 17% of the variation in the observed variable RDE cannot be explained by the latent variable RDI, measurement error, or other factors. The comparatively tiny error term suggests that RDI accounts for most of the variance of the RDE, leaving only a small amount unexplained. According to the squared path coefficient ($0.91^2 = 0.8281$), the latent variable accounts for 82.81% of the variance in the observed variable. With an error term of 0.17, the remaining 17% of the variance remains unexplained. When taken as a whole, these numbers support a robust model fit for this particular connection, in which RDI accounts for the majority of RDE variability with little error or variance that cannot be explained. An extremely strong correlation between RDI and the RDE is shown by a path coefficient of 0.91. With an error term of 0.17, the model is successfully capturing the connection because it only accounts for a small amount of the variance in the observed variable.

With a path coefficient of 0.62, the RDI accounts for 62% of the variance in the observed variable Research Institute Prominence (RIP). A relatively strong link between RDI and RIP is suggested by a coefficient of 0.62. The observed variable can be predicted by the latent variable with a moderate degree of accuracy. A 0.62 path coefficient shows a significant association even if it is not as strong as coefficients over 0.7, but there is still opportunity for other variables or factors to also play a role in explaining the variance in RIP. An error term of 0.61 indicates that measurement error or impacts from other variables not included in the model account for 61% of the variance in RIP that remains unexplained. A relatively large error term, such as 0.61, indicates that RDI is not explaining a significant amount of the variance in the RIP. This can point to an insufficient model specification, unmeasured parameters, or measurement error. RDI accounts for 38.44% of the variance in the observed variable RIP, according to the squared path coefficient of $0.62^2 = 0.3844$. The remaining 61% of the RIP variance that the model is unable to explain is accounted for by the error term of 0.61.The RDI explains an acceptable portion of the variation, as indicated by the path coefficient of 0.62, which indicates a moderate link between the RDI and RIP. A measurement error or additional factors not included in the model may be the cause of the observed variable's substantial unexplained variation, as indicated by the error term of 0.61. The subsequent constructs, their path coefficients with their respective observed variables are interpreted in the similar way.

4.1.5 SEM ANALYSIS

A. Path Diagram

The Path Diagram of SPSS Amos Graphics offers a number of noteworthy features. To begin with, it includes both observed (manifest) and unobserved (latent) variables. Second, it includes both causal linkages between unobserved variables (represented by single-headed arrows) and bi-directional or correlational relationships between many residuals. The dual-headed arrows linking e3 and e5 and e4 and e6, respectively, represent these. The residual correlations account for the additional shared variance. Figure 2 shows the path diagram of the proposed model. Each box represents the research construct of the model which are measured by the independent variable(s), the circles (round shapes) depict the residual errors for each variable, and the arrows shows the relationship between these constructs. The AMOS output gives results for three models (Berndt, 2020). The Default Model is the model which is proposed by the researcher. The Saturated model is the model that represents the perfect fit by using the maximum number of available parameters. The Independence Model, also called Null Model gives results for the poor fit model by correlating all measured variables with 0, without using latent constructs. Values for the default model will be accounted for in the study.

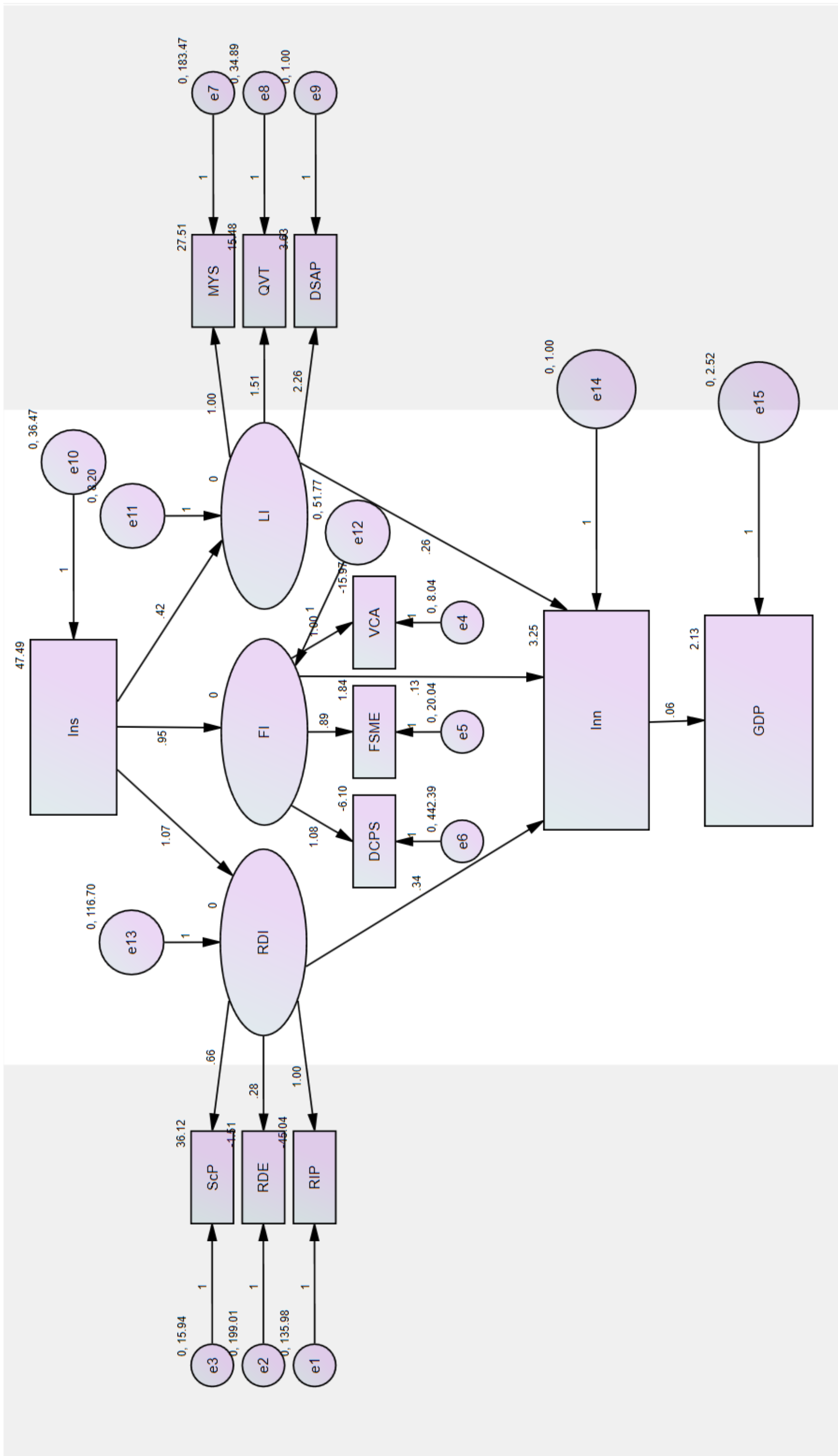

Figure 14: SEM Path Diagram

The model is recursive.
Sample size = 32

Number of variables in your model: 30
Number of observed variables: 12
Number of unobserved variables: 18
Number of exogenous variables: 15
Number of endogenous variables: 15

	Weights	Covariance	Variances	Means	Intercepts	Total
Fixed	18	0	2	15	3	38
Labeled	0	0	0	0	0	0
Unlabeled	13	0	13	0	12	38
Total	31	0	15	15	15	76

Number of distinct sample moments:	90
Number of distinct parameters to be estimated:	38
Degrees of freedom (90 - 38):	52

Table 16: Regression Weights (Author's own calculations)

			Estimate	**S.E.**	**C.R.**	**P**	**Label**
Research & Development Institution	<---	Institutions	1.074	.384	2.795	.005	**RDI**
Financial Institutions	<---	Institutions	.949	.229	4.146	***	**FI**
Labor Institutions	<---	Institutions	.415	.281	1.480	.139	**LI**
Innovation	<---	RDI	.344	.062	5.535	***	**Inn**
Innovation	<---	FI	.128	.047	2.698	.007	**Inn**
Innovation	<---	LI	.262	.200	1.312	.190	**Inn**
Research Institution Prominence	<---	RDI	1.000				**RIP**
RD Expenditures	<---	RDI	.282	.211	1.338	.181	**RDE**
Scientific Publications	<---	RDI	.663	.127	5.210	***	**ScP**
Venture Capital Availability	<---	FI	1.000				**VCA**

Financing of SMEs	<---	FI	.890	.134	6.622	***	**FSME**
Domestic Credit to Private Sector	<---	FI	1.076	.437	2.464	.014	**DCPS**
Mean Years of Schooling	<---	LI	1.000				**MYS**
Quality of Vocational Training	<---	LI	1.515	1.014	1.494	.135	**QVT**
Digital Skills among Active Population	<---	LI	2.263	1.457	1.553	.120	**DSAP**
Gross Domestic Product	<---	Innovation	.063	.053	1.192	.233	**GDP**

Regression weight represents the expected change in dependent variable because of an increase in independent variable of one of its standardized units with all other independent variables unchanged (Siegel and Wagner, 2022).

Table 16 shows the unstandardized coefficients and related test statistics. For every standardized unit change in the predictor, the degree of change in the dependent or mediating variable is represented by the unstandardized regression coefficient. Under the P column is the probability value corresponding to the null hypothesis that the test is zero. A P value that is higher than 0.05 suggests that there may not be a significant relationship between the variables included in the model (Dahiru, 2011). The level of institutional development measured by the WEF has s significant impact on R&D and Capital Markets. A change of one standardized unit in the Institutions indicator increases both by about unity (1.074 in case of R&D, and 0.949 in case of Capital Markets). The regression weight of 0.344 indicates a positive relationship between R&D and innovation. For every standardized one-unit increase in R&D, innovation is expected to increase by approximately 0.344 units, assuming all other factors remain constant. The critical ratio of 5.535 suggests that the relationship between the innovation and R&D is statistically significant. Thus, I can reject the null hypothesis that the regression coefficient is equal to zero, indicating that the R&D does have a significant effect on the innovation. Middle-income countries with higher R&D expenditures and more scientific publications are likely to have higher levels of innovation. There's a strong, positive correlation between R&D and research institution prominence, indicating a strong association between R&D activities and prominent research institutions. I have also detected a positive relationship between the Capital Markets and Innovation. For every standardized one-unit increase in Capital Markets, innovation is expected to increase by approximately 0.128 units, assuming all other factors remain constant. The relationship is significant at all standard levels (P=0.007). Venture capital availability, the financing of SMEs, and domestic credit availability are all significantly associated with Capital Markets, and therefore have an influence on innovation according to my model calculations. The model prompts to a positive connection between HC and Innovation (0.262), as well as between Innovation and Economic growth (0.063), but these connections are not statistically significant (P=0.19 & 0.233).

Intercepts

The intercepts in the SEM analysis is the predicted value of a dependent (observed) variable when the model's predictors (independent variables or latent components) are all zero. It may be thought of as the dependent variable's baseline value when no other factors in the model are influencing it. Table 33 in Annex shows the intercepts of the model.

Variances

In SEM analysis, Variance describes the degree of variability or dispersion in a variable, whether it is an observable variable or an undiscovered one. Variance in SEM is important because it helps us understand how much a variable deviates from its mean and how the model explains (or does not explain) this variation. Table 34 in the Annex shows the variances of the model.

Minimization History

In Structural Equation Modelling (SEM), the minimization history refers to the software's process of optimizing the model by altering parameter estimates (e.g., regression weights, variances, and covariance) to find the best fit to the data. This approach entails minimizing a certain fit function, usually the discrepancy function, which quantifies the difference between the observed and model-implied covariance matrices. Table 35 in Annex shows the minimization history of the model.

B. Model Fit Summary

Table 17 shows that the model is fit for testing the hypotheses.

Table 17: SEM Analysis Model Fit Summary

Measure	Estimate	Threshold	Interpretation
CMIN	63.165	-	-
DF	52	-	-
CMIN/DF	1.215	2	Excellent
NFI	0.756	Closer to 1	Good
RFI	0.690	1= Perfect Fit Closer to 1= Good fit	Good
IFI	0.946	1= Perfect Fit Closer to 1= Good fit	Good
TLI	0.926	1= Perfect Fit Closer to 1= Good fit	Good
CFI	0.942	1 = Perfect fit ≥ 0.95 = Excellent fit ≥ .90 = Acceptable fit	Good
PRatio	0.788	No cutoff value	-
PNFI	0.595	0.5 and above	Excellent
PCFI	0.742	0.6 and above	Excellent
NCP	0 to 35.39	-	-
FMIN	2	No cutoff value	-
RMSEA	0.08	0.05 or 0.08	Excellent
AIC	139.16	-	-
BCC	194.05	-	-
ECVI	4.48	No cutoff value	-
MCVI	6.26	No cutoff value	-
Hoelter 0.5	35	-	-
Hoelter 0.1	39	-	-

i. Chi-Square Statistic (CMIN)

Table 18: CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	38	63.165	52	.138	1.215
Saturated model	90	.000	0		
Independence model	24	258.445	66	.000	3.916

The Chi-square value, or CMIN, is used to determine whether a difference between the observed variables and the anticipated findings is statistically significant. In other words, CMIN reveals whether the hypothetical model and the sample data suit the analysis well. The NPAR refers to 'Number of Parameters' for all models (default, saturated, and independence). In this case, The NPAR is 38 for Default model, 90 for Saturated and 24 for Unsaturated. The CMIN refers to the Chi-square value. If insignificant, the model can be considered satisfactory. The Degree of Freedom or DF is used to measure the number of independent values that can deviate without interfering with any model limitations. P refers to the probability of achieving a discrepancy as high as value of CMIN in case the proposed model is correct.

CMIN/DF = discrepancy divided by degree of freedom.

The value of interest here is the ***CMIN/DF*** for the default model and is interpreted as follows:

- If the CMIN/DF value is **≤ 2** it indicates an good fit (Samuels, 2015).
- If the CMIN/DF value is **≤ 3** it indicates an acceptable fit (Samuels, 2015).
- If the value is **≤ 5** it indicates a reasonable fit (Marsh and Hocevar, 1985)

In this case, the CMIN/DF for default model is 1.215 which is considered to be an acceptable fit.

ii. Baseline Comparisons

Table 19: Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.756	.690	.946	.926	.942
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Baseline Comparisons refers to the default, saturated, and independence models that Amos automatically fits for each analysis. NFI, also known as Delta 1, is a measure of how well a model fits, ranging from the independence model (which fits poorly) to the saturated model (which fits exceptionally well). A score of 1 indicates a perfect fit, while models with values below 0.9 can typically be significantly improved (Bentler and Bonett, 1980). RFI stands for Relative Fit Index, which is derived from NFI. Values near to 1 denote a perfect fit, whereas 1 denotes a very excellent fit. IFI stands for Incremental Fit Index, and values near to 1 denote a very excellent fit and 1 a perfect one. The Tucker-Lewis coefficient (TLI), also known as the *Bentler-Bonett* non-normed fit index (NNFI), goes from 0 to 1, with a value closer to 1 signifying a perfect fit and a value closer to 0 a poor fit. According to McNeish & Wolf (2023), the Comparative Fit Index (CFI) has a range of values between 0 and 1, with values near to 1 indicating an extremely good fit and 1 indicating the ideal fit. Here, CFI for the default model represents the value of interest. According to Xia & Yang (2019), a CFI value of 0.95 or less indicates a model that fits the data very well. According to Parry (2020), it is deemed to be extremely good if it is equal to or higher than 0.95, good between 0.9 and 0.95, suffering between 0.8 and 0.9, and poor if it is lower than 0.8. In this case, the value of CFI is 0.94 which is considered to be a good value.

iii. Parsimony-Adjusted Measures

Table 20: Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.788	.595	.742
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

Parsimony-adjusted measures are relative fit indices that have been modified for the majority of the indices described thus far. The higher the fit index, the more complicated the model, as a more straightforward description of an occurrence is often preferred over a complex one. A PRatio score closer to 1 denotes poor model fit, whereas one greater than1 denotes the target model fits the data better than the null model. Effective model fit is indicated by a PRATIO value of 2 or higher (Bollen, 1989; Peter M. Bentler, 1992). The PNFI and PCFI indices are calculated using the Parsimony Ratio (PRatio), which also determines the amount of constraints in a model. Since it varies on the particular model and sample size, there is no set cutoff value for PRATIO. Parsimony Normed Fixed Index (PNFI) is the result of a parsimony modification to the Normed Fixed Index (NFI) (Williams, O'Boyle and Yu, 2020). Acceptable model fit is indicated by PNFI values of 0.5 or higher. The result of applying a parsimony adjustment to the Comparative Fit Index (CFI) is expressed by the acronym PCFI, or Parsimony Comparative Fix Index. Acceptable model fit is indicated by a PCFI value of 0.6 or higher. For PNFI and PCFI, there isn't a single agreed standard or reference value.

iv. Non-centrality parameter (NCP)

Table 21: NCP

Model	NCP	LO 90	HI 90
Default model	11.165	.000	35.394
Saturated model	.000	.000	.000
Independence model	192.445	146.784	245.677

NCP, or non-centrality parameter, is a measure of how incorrect a null hypothesis is. NCP stands for Non-Centrality Parameter, and the lower and upper limits of the 90% confidence interval for the NCP are designated as LO (NcpLo) and Hi (NcpHi), respectively. LO 90 denotes the lower limit of a 90% confidence interval for the NCP using the NcpLo technique. HI 90 denotes the upper limit of a 90% confidence interval for the NCP (NcpHi technique). In this case, the default model's population NCP ranges from 0 to 35.39 with a 90 percent confidence level.

v. Fit Model Index (FMIN)

Table 22: FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.038	.360	.000	1.142
Saturated model	.000	.000	.000	.000
Independence model	8.337	6.208	4.735	7.925

FMIN, or the Index of Model Fit or Function Minimum Fit Function, is employed when CMIN fails to achieve a favorable outcome, typically as a result of a higher sample size. FMIN stands for Index of Model Fit, with LO and Hi, the lower and upper limits of the 90% confidence interval, as its boundaries. With 0 indicating the ideal fit, a value nearer to 0 indicates a more accurate fit for the data being observed. Where F0 indicates Confidence interval. LO 90 is lower limit of the FMIN's 90% confidence interval. HI 90 is higher limit of the FMIN's 90% confidence interval. In this case, the FMIN is 2 which indicates a good model. The LO of FMIN is 0 whereas the HI of FMIN is 1.1.4

vi. Root Mean Square Error of Approximation (RMSEA)

Table 23: RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.083	.000	.148	.245
Independence model	.307	.268	.347	.000

RMSEA or Root Mean Square Error of Approximation is the difference between the observed and the anticipated covariance matrix for each degree of freedom (Chen, 2007). The common interpretation of RMSEA values are; values above 0.1 are regarded as poor, between 0.08 and 0.1 as borderline, between 0.05 and 0.08 as acceptable, and values below 0.05 as excellent (Adedia, Adebanji and Appiah, 2021). LO 90 is the lower limit (RMSEA Lo) of the RMSEA's 90% confidence interval. HI 90 is the upper limit (RMSEA Hi) of the RMSEA's 90% confidence interval. PCLOSE is the P-value for the null hypothesis. In this case, the RMSEA for default model is 0.08 which is an acceptable value for the model.

vii. Akaike Information Criterion (AIC)

Table 24: AIC

Model	AIC	BCC	BIC	CAIC
Default model	139.165	194.054		
Saturated model	180.000	310.000		
Independence model	306.445	341.112		

The Akaike Information Criterion, or AIC, was developed by Akaike in 1987 and is used to assess how well a statistical model fits the data sample. The AIC is a score that may be expressed as a single number that is used to assess which model fits the data set the best. Only when compared to other AIC values from the same data set is the Akaike Information Criterion score (AIC) helpful.

The AIC value should be as low as possible. BCC stands for Browne-Cudeck Criteria, which is used primarily to examine component structures and apply a heavier penalty for less constrained models. In comparison to AIC, BCC, and CAIC, BIC, BIC or Bayes Information Criterion imposes a heavier penalty on complex models, increasing its propensity to select frugal approaches. Consistent Akaike Information Criterion, or CAIC (Bozdogan, 1987), is only mentioned when the means and intercepts of a single group are not clearly stated. In comparison to AIC and BCC, but less severely than BIC, CAIC imposes a penalty for complicated models. In this case, the AIC value for default model is 139.16 and BCC value is 194.05.

viii. Expected Cross Validation Index (ECVI)

Table 25: ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	4.489	4.129	5.271	6.260
Saturated model	5.806	5.806	5.806	10.000
Independence model	9.885	8.412	11.602	11.004

Expected Cross Validation Index, or ECVI (Browne & Cudeck, 1993), quantifies how well a model can predict the future via a straightforward chi-square transformation, much like AIC (with the exception of the constant scale factor). Expected Cross Validation Index (ECVI) is a measurement of how well a model fits the data. Lower limit of a 90% confidence interval for the population’s ECVI is designated as LO 90. For the population's ECVI, HI 90 denotes the upper bound of a 90% confidence interval. MECVI = The MECVI is comparable to the Browne-Cudeck Criterion (BCC) with the exception of a scale factor employed in computation (Browne, 1993). In this case, the ECVI value of the default model is 4.48, the LO90 value is 4.12, HI90 value is 5.27, whereas the MECVI value is 6.26.

ix. HOELTER

Table 26: Hoelter Index

Model	HOELTER .05	HOELTER .01
Default model	35	39
Independence model	11	12

The Hoelter Index is used to determine if the chi-square is significant or not. For the default model, HOELTER.05 determines whether the sample size can be accepted at the 0.05 level. The default model must be rejected if sample size is greater than the value given for it at the 0.05 level. The Hoelter 0.1 determines whether the sample size for the default model may be accepted at the 0.01 level. Accordingly, I can reject the default model if the sample size exceeds the amount set for the default model at the 0.01 level. In this case, the Hoelter 0.5 value for the default model is 35 and Hoelter 0.1 value is 39.

4.2 THESES OF THE RESEARCH

SEM analysis was used to test the theoretical framework, and the test results suggest my model has a good fit. The SEM path diagram shows that institutions have significant and positive relationship with R&D, and the capital market (their connection with human capital is also positive, but not significant; p=0.139). To see the impact of different types of institutions on economic growth, I have designed an ecosystem approach in which different institutional factors including that of R&D, Human capital and capital market, each work together to impact the innovation in a country to eventually impact its economic growth. I found significant positive relationships between R&D, and innovation and also between capital markets and innovation; the relationships between human capital and innovation; and innovation and economic growth, however, are not significant. All of these relationships are shown in Table 27.

Table 27: Logical Framework (Source: Author's own calculations)

Sr. No.	Research Objectives	Research Questions	Hypotheses	Results
1	**To find out the impact of Institutions focusing on R&D on Innovation**	**R&D features have a significant impact on Innovation**	**H1**	**Supported**
2	**To find out the impact of Institutions focusing on Capital Market on Innovation**	**Capital Market features have a significant impact on Innovation**	**H2**	**Supported**
3	**To find out the impact of Institutions focusing on Human Capital on Innovation**	**Human Capital features have a significant impact on Innovation**	**H3**	**Not Confirmed**
4	**To find out the impact of Innovation on Economic Growth**	**Innovation has a significant impact on Economic Growth**	**H4**	**Not Confirmed**

4.2.1 The relationship between R&D and Innovation

To determine the validity of the suggested path, the statistical significance of this path within the model was evaluated during hypothesis testing. This hypothesis was accepted since the findings demonstrated a positive and statistically significant relationship between research & development and innovation ($r = 0.081$, $p = 0.659$).

Thesis 1: Research & Development have a positive and significant relationship with innovation in LMICs

The first hypothesis that there is a positive and significant relationship between R&D and innovation is supported by the results such that an increase in the former would result in increase in the latter. The regression weight estimate result show a relationship between R&D and innovation, such that with every unit rise in R&D, there is 0.34 unit rise in innovation. Therefore, the results support H1. These results, in my opinion, pave the way for more investigation into different forces that boost innovation in lower-middle-income economies.

The study contributes to this body of work by focusing on LMICs, where institutional and economic constraints may alter this relationship. Although previous studies have shown a high correlation between R&D and innovation in high income countries, my research indicates that in LMICs, this relationship is although positive, but not very strong. This might be the result of the factors such as low commercialization of R&D outputs, high dependence on foreign technology, inadequate policy support, and a limited absorptive capacity. My findings are consistent with previous research that emphasizes the difficulties in converting R&D expenditures into innovation in underdeveloped nations. With correlation values less than 0.3, Bate (2023) discovered that a number of characteristics, including R&D, exhibit a weak link with innovation outputs in lower-income countries. The R&D-innovation-productivity link was only weakly supported by research conducted by Fedyunina and Radosevic (2022) using data from emerging economies, indicating that R&D spending do not significantly predict innovation outcomes in these settings. From this, I conclude that the low R&D score in case of Lower Middle Income countries leads to low innovation. Many Lower Middle Income Countries (LMICs) have undeveloped higher education institutions and research centers that lack the infrastructure, equipment, and resources required for sophisticated research. This reduces their capacity to make meaningful contributions to R&D initiatives. The institutional framework of LMICs frequently lacks substantial networks for collaboration across academics, business, and the government. This seclusion can impede creativity and undermine the efficacy of research endeavors. Educational systems struggle to offer basic education, in addition to advanced scientific and vocational education. Poor access to excellent education impedes the development of a trained workforce capable of performing research and development. Universities in these countries frequently lack the capacity to provide advanced degrees in science, mathematics, engineering, and technology. Without a solid basis in these areas, there is a scarcity of researchers and scientists capable of driving R&D efforts. There may be an overall lack of understanding or appreciation for the importance of science and research in these countries. If the public and governments do not perceive immediate advantages from R&D, there is less incentive to prioritize and invest in it. The findings emphasize the necessity of more investigation into other possible sources of innovation in lower-middle-income nations, such as FDI, technology transfer, or human capital development.

4.2.2 The relationship between Capital Market and Innovation in LMICs

Capital Markets are found to have a significant and positive impact on innovation as proposed in second hypothesis and confirmed by the results ($r = 0.230$, $p = 0.205$).

Thesis 2: Capital markets have a significant and positive relationship with innovation in LMICs

Capital Markets are found to have a significant and positive impact on innovation as proposed in second hypothesis and confirmed by the results. The estimates show that for every unit rise in financial institutions, there is 0.12 unit rise in innovation. The p value for this relationship is 0.007 which means that there is 0.7% probability that the financial institutions' impact on innovation is by chance. Therefore, H2 is supported by the model results. Transparency in the financial institutions increases investor's confidence and bring about potential capital investments in the future. The results are in line with evidence from early empirical research by Shaw (1973) and (Degong *et al.*, 2021) showing a positive correlation between innovation and liberal financial policy. Capital markets are essential for fostering entrepreneurship by offering the financial support startups and innovative ventures need to succeed (Lerner, 1999). Entrepreneurship, in its essence, drives innovation as entrepreneurs are frequently pioneers in creating new products, services, and business approaches (Schumpeter, 2017). Additionally, innovative firms often capture substantial investments from capital markets due to their potential for significant growth and profitability. Thus, the synergy between capital markets, entrepreneurship, and innovation forms a dynamic framework that promotes economic expansion and technological progress. However, LMICs frequently experience budgetary limits, limiting their capacity to devote considerable resources to R&D. Governments may prioritize more urgent requirements, such as healthcare, education, and infrastructure, over long-term expenditures in research and development. In many LMICs, the private sector is dominated by SMEs, who frequently lack the financial resources to invest in R&D. These companies may prioritize short-term survival above long-term innovation, especially under unpredictable economic conditions. Venture money and other types of private investment in R&D are frequently scarce in low- and middle-income countries. Investors in these nations may be risk-averse, preferring secure investments over backing creative but risky R&D ventures. Because LMICs' domestic markets are limited, the high expenses of R&D may not be justified (Khan, 2022b). Firms may find it more cost effective to import innovations or goods created elsewhere rather than engage in domestic R&D. Many LMICs still have fledgling or undeveloped financial markets, which hinder their capacity to successfully fund innovation. A lack of depth, liquidity, and financial instruments might limit enterprises' access to capital. Poor regulatory frameworks, political turmoil, and inadequate investor protection can all hinder capital market operations, deterring investment in high-risk, creative areas. In many LMICs, the domestic investor market is minimal, with little participation from institutional investors. This may limit the access of long-term capital for innovation-driven businesses.

4.2.3 The relationship between Human Capital and Innovation in LMICs

The third hypothesis that Human capital is positively associated with innovation is not supported by the results ($r = 0.405$, $p = 0.022$). H3 cannot be confirmed based on the model. The labor markets of many developing nations differ significantly from those of developed countries due to factors including structural rigidities, under-employment, concealed unemployment, and unemployment.

Thesis 3: The relationship between Human Capital and Innovation in LMICs could not be confirmed

The third hypothesis that Human capital is positively associated with innovation is not supported by the results. H3 cannot be confirmed based on my model. My results indicate that the endogenous theories put forward by Lucas (1988), or Azariadis & Drazen (1990) may not apply to developing countries. While human capital is often perceived as a key driver of innovation, the correlation between them is not always clear-cut. Some research posits that increased human capital, characterized by higher education and skills, can foster innovation by enhancing individuals' ability to devise and execute new ideas (Acemoglu, 2002). Contrarily, other studies suggest that an excessive focus on human capital can inhibit innovation by fostering conformity and curbing risk-taking and creative thinking (Naylor and Florida, 2003). A study by Jones & Williams (1998) indicated that although human capital is crucial for productivity, it doesn't always translate into enhanced innovation. Likewise, research conducted by (Bessen and Hunt, 2007) observed that boosting human capital via education investments didn’t consistently correlate with elevated innovation levels across various industries. Hence, while human capital undeniably plays a role in driving innovation, its influence can be modulated by factors like organizational culture and incentives, resulting in a more intricate and multifaceted relationship between the two. Access to high-quality education remains a major barrier in many LMICs. Inadequate financing, inadequate infrastructure, and low teaching quality can all contribute to lower educational attainment and skill levels. Without robust educational systems, it is impossible to have a workforce capable of driving innovation. Talented individuals from low- and middle-income nations frequently relocate to higher-income countries in quest of better prospects, known as ‘brain drain’. This limits the pool of qualified individuals available to fuel local innovation, thereby depriving countries of those most capable of supporting economic growth and technological progress. There is a skill gap between the output of the educational system and the demand of the labor market. The Curriculum may not match the requirements of rapidly evolving sectors, particularly emerging businesses such as information technology, biotechnology, and renewable energy, restricting the workforce’s capacity to contribute to innovation. Many LMICs fail to invest in R&D. The absence of financing for universities, research institutions, and private-sector R&D efforts stifles innovation. Furthermore, the lack of research facilities, modern labs and innovation centers reduces researchers’ and entrepreneurs’ capacity to design and commercialize new technologies. Workers in fast changing industry must constantly upgrade their skills in order to stay competitive and inventive. However, many LMICs lack comprehensive systems for vocational education, continuous education, and upgrading skills, all of which are required to retain an innovative and adaptable workforce.

4.2.4 The relationship between Innovation and Economic Growth

I could not confirm the existence of a positive link between innovation performance and economic growth among the lower middle-income group of developing countries ($r = 0.223$, $p = 0.219$). This result could be interpreted as a sign of a middle-income trap (a growth failure identified by some studies in developing countries) among the lower middle-income group of countries.

Thesis 4: The relationship between Economic Growth and innovation in LMICs could not be confirmed

I could not confirm the existence of a positive link between innovation performance and economic growth among the lower middle-income group of developing countries. This failure adds to the ever-expanding literature of the middle-income trap (CM, Hoang and Yarram, 2024). The existence of the trap is not confirmed by all empirical studies, but the existing results suggest that in developing countries the connection between innovation, and the factors of innovation on the one hand and long-term economic growth on the other hand is not as obvious as suggested by NGT. Countries in the middle-income trap face institutional and political challenges, particularly related to upgrading productivity through human capital and innovation, which require significant investment in institutional capacity (Doner & Schneider, 2016); (Mickiewicz, 2023). My results could be the representation of the middle-income growth failure among developing countries. LMICs usually spend substantially less on R&D than high-income countries. This restricted budget limits public institutions’ capacity to undertake research and promote innovation. Governments may not have robust policies in place to encourage R&D, such as tax breaks, grants, or research subsidies. This inhibits both the public and commercial sectors from investing in innovation. Many LMICs' economies are primarily based on agriculture, low-tech manufacturing, or extractive industries. These sectors often have lesser R&D needs than high-tech businesses such as biotechnology, pharmaceuticals, and computer technology. The industrial base may not recognize the need for or have the capacity to absorb sophisticated R&D, since many firms rely on imported technology rather than creating their own. Firms may prioritize preserving established methods and making incremental changes over pursuing radical innovation. This conservative attitude stifles the desire for innovative R&D.

5 CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

The main reason behind conducting this study was to find out the impact of R&D on economic growth, mainly in the context of the lower middle income group of countries. Lesser developed institutions affects their ability to put investment into capital markets, and education, leading to the poor micro-economic performances of the firms. Eventually, firms do not invest enough into the human capital, not having enough to pay skilled labor, leading to little or no focus on R&D and bringing innovative ideas to the table. Poor micro-economic performance eventually affects the stock market capitalization of the country leading to the poor macroeconomic growth, and the cycle continues. This path is explained by the theoretical framework of my study which is called R&D Ecosystem. The research was conducted on the Lower Middle Income Group of countries as categorized by World Economic Forum for the year 2019. The statistical methods of CFA was conducted as a preliminary test for conducting SEM Analysis later on to find out the relationship between the dependent and the independent variables. The Chi-square value is 1.215 which is the indication of a good fit. My research confirmed that the research and development features and capital market institutions have a positive impact on innovation. These relationship between R&D features (regression weight estimate: +0.34, p=0.001) and innovation are insignificant. Lower Middle-income countries with higher reliance on foreign innovation and low R&D expenditures, and less number of scientific publications are likely to have lower levels of innovation. Whereas the relationship between capital market institutions (regression weight estimate: +0.12, p=0.007) and innovation is found to be significant. Venture capital availability, the financing of SMEs, and domestic credit availability are all significantly associated with CM, and therefore have an influence on innovation according to my model calculations. An economy must prioritize creating a strong financial system, strengthening the legal system, and having an honest and upright government. Deficiencies in institutional quality must be addressed by policymakers, especially concerning the burden of labor regulations. Policymakers should prioritize anti-corruption measures to build an atmosphere that would attract more R&D in the Lower Middle Income Group of countries. The literature have recognized the disparity in R&D capacity between developed and developing nations and have put out formal models of technological diffusion. But the disparity doesn’t stop with R&D capacity. Rather, it is widespread and affects a great deal of other facets of the economic system. A prime example is the labor markets of many developing nations, which differ significantly from those of developed countries due to factors including structural rigidities, under-employment, concealed unemployment, and unemployment. My model indicates that there is a positive relationship between innovation and economic growth, the result, however, is not significant. This result could be interpreted as a sign of a middle-income trap (a growth failure identified by some studies in developing countries) among the lower middle-income group of countries. In order to escape the Middle-Income Trap, middle-income countries must make two crucial transitions, according to the World Development Report 2024. To become competitive global suppliers, lower middle income countries must abandon an investment-driven strategy and adopt one that incorporates contemporary technology and international business practices.A limitation of my study is the low number of countries involved (32). SEM produces better and reliable results if the number of observations is increased. This number is determined by the research aim, to evaluate the role of the R&D ecosystem specifically within the lower middle-income group. The use of 2019 data may also be debatable. This decision was made so that I could focus on a period that was characterized by robust global growth and I could also avoid the distortionary impacts of COVID on my results.

5.2 IMPLICATIONS

Policy Implications

Research and development, or R&D, is a vital force behind innovation, economic expansion, and social advancement. Effective R&D activities are facilitated by an environment that is shaped in large part by policymakers. The results of my research provide specific policy recommendations that can help organizations and governments foster an atmosphere that is favorable to research and development:

1. Our research confirmed that the research and development features have a positive impact on innovation. This implies that governments should devote a sizeable percentage of their budget to R&D endeavors, especially in fields like basic science, public health, and environmental sustainability that are strategically vital but might not draw enough funding from the private sector. In high-risk, high-reward fields where private sector money is scarce, giving grants and subsidies to academic institutions, research centers, and private businesses can foster innovation. By guaranteeing that inventors can profit from their labors, bolstering the patent system to offer strong protection for new ideas promotes investment in R&D. To avoid the monopolies that impede competition, this must be balanced, though. By streamlining and expediting the patent application process, inventors can better safeguard their discoveries and cut down on the time and expense involved in introducing novel technology to the market. A greater range of discoveries can be protected by extending the rights to intellectual property to include enhanced protection for trade secrets and copyrights. To safeguard innovations worldwide, governments should endeavor to harmonize intellectual property rights across national boundaries. This will facilitate business expansion abroad and guarantee the protection of homegrown innovations in other markets.

2. Our results confirmed positive connection of Capital Markets and innovation. This implies that governments can lower the actual cost of research and promote greater investment from the private sector by providing tax credits or deductions from financial institutions to businesses that engage in research and development. Encouraging corporations to deduct capital expenditures connected to research and development at a faster rate can result in immediate tax benefit, which in turn encourages more investment in R&D capacity. By fusing public financing with the efficiency and market orientation of the private sector, policies that promote public-private partnerships can capitalize on the advantages of both industries. Co-funding agreements, joint ventures, or clusters of innovation are some of the ways that governments might help to encourage these relationships. Smaller businesses can get the financial and technological support they need to participate in R&D by taking advantage of these programs. Access to research facilities, tax breaks, and targeted funds are a few examples of this. By offering mentorship, finance, and access to networks, supporting accelerators and incubators that concentrate on early-stage businesses can aid in commercializing innovations.

3. The research results show that while human capital is often perceived as a key driver of innovation, the correlation between them is not always clear-cut in case of lower middle income countries. This implies that to guarantee that the current workforce is capable of adjusting to new technologies and procedures arising from research and development endeavors, policymakers ought to support programs for up-skilling and continuous learning. This can involve collaborations with business and government-funded training initiatives. Governments should place a high priority on STEM (Science, Technology, Engineering, and Mathematics) education in schools and universities. They should also update curricula to incorporate new topics like data science, artificial intelligence, and biotechnology. Offering STEM-related scholarships and fellowships might motivate more students to seek jobs in research and development, resulting in a constant supply of highly qualified scientists and inventors. By supporting international exchange programs for scholars and students, governments may promote global collaboration and expose homegrown talent to cutting-edge research and best practices from around the world. Simplified visa requirements for researchers and skilled workers can draw in talent from around the world and strengthen the nation's capacity for R&D.

4. The results of the research show a positive connection between innovation and economic growth but the relationship found is not significant in case of lower middle income countries. This implies that to evaluate the effects of R&D investments, governments should create thorough metrics that take into account not only financial returns but also societal advantages like social equity, environmental sustainability, and public health. Matching national standards with global standards can help new technologies be deployed globally and guarantee that innovations resulting from research and development are both globally competitive and comply with international laws. These specific policy ramifications demonstrate the government's complex role in supporting a healthy R&D ecosystem. Governments may foster an atmosphere that not only encourages the creation of new inventions and technologies but also makes sure that these developments contribute to societal progress, economic prosperity, and global sustainability by putting these policies into place.

Research Implications

Research and development, or R&D, is essential to producing new knowledge, advancing technology, and resolving difficult societal problems. The ramifications of R&D activities for research are extensive, including not just the regions of attention and methodology employed, but also the manner in which research outputs are evaluated and applied. The specific research consequences of R&D are listed below:

1. Our research confirmed that the research and development features have a positive impact on innovation. This implies that R&D aids in the identification of new disciplines like renewable energy, synthetic biology, and quantum computing that have the potential to have a significant impact on society. Prioritizing these areas in research agendas can help you remain ahead of global developments and meet future needs. Research methods and knowledge from one field can inform and improve research in another, a phenomenon known as the cross-pollination of ideas, which is facilitated by R&D activities and interdisciplinary research. R&D-driven research can aid in foreseeing and preparing for

issues that society may face in the future, such as pandemics, climate change, and cybersecurity threats. Prioritizing research in these fields proactively can result in creative fixes before emergencies arise. R&D emphasizes the importance of incorporating user demands and feedback into the research process. This approach can result in innovations that are more applicable and broadly adopted, especially in industries like consumer items, software development, and healthcare. R&D presents significant ethical questions, especially in fields like biotechnology, artificial intelligence, and data privacy. This is known as responsible research and innovation, or RRI. Ethical standards that guarantee innovations are created responsibly and with the good of society in mind must be followed by researchers.

2. Our results confirmed positive connection of Capital Markets and innovation. This implies that Research and development endeavors underscore the necessity of carefully allocating research funds to fields possessing the greatest capacity for inventive breakthroughs and financial gain. This guarantees that funds are allocated to studies that have the biggest possible potential impact. Research can draw attention to differences in access to opportunities, resources, and rewards. In particular, marginalized and underserved populations should benefit from the work of researchers, who should make an effort to incorporate varied perspectives.

3. The research results show that while human capital is often perceived as a key driver of innovation, the correlation between them is not always clear-cut in case of lower middle income countries. This implies that Research and development frequently need cooperation across organizations, industries, and nations. Building strong research networks that link government, business, and academia can improve the flow of information, resources, and skills. By combining resources and knowledge, consortia and partnerships around particular R&D objectives can support more ambitious and significant research projects than any one organization could carry out on its own.

4. The results of the research show a positive connection between innovation and economic growth but the relationship found is not significant in case of lower middle income countries. This implies that Research and Development (R&D) highlights the significance of converting research into commercially feasible goods and services. This is known as research commercialization. To get inventions onto the market, researchers must concentrate on the useful applications of their research and work in tandem with business partners. To transform research results into commercially viable products, efficient technology transfer methods, such licensing agreements and subsidiaries, are essential. Training in commercialization tactics and intellectual property management should be provided to Researchers. R&D promotes applied research that tackles practical issues. This move towards research that solves problems can result in discoveries that immediately enhance public services, private sector businesses, and overall quality of life. Research and development (R&D) should be conducted in accordance with international frameworks such as the Sustainable Development Goals (SDGs) of the United Nations, with a focus on problems including health, clean energy, and poverty alleviation. This guarantees that research makes a significant contribution to global development and advances global priorities.

Practical Implications

Research and development (R&D) has many real-world applications and is essential to advancing society, economic growth, and innovation. R&D operations directly affect industries, technologies, and people's daily lives. The following are specific real-world applications of R&D:

1. Our research confirmed that the research and development features have a positive impact on innovation. This implies that R&D can result in the creation of novel manufacturing processes or the enhancement of already-existing ones, which can cut production costs and produce goods of a higher quality. The introduction of automation technology, for example, can speed up production and reduce human error on production lines. Businesses can create distinctive goods or services that set them apart from rivals through research and development. When supported by creative R&D, a compelling USP can significantly increase market share and brand loyalty. Research and development can result in the creation of goods with a global market appeal, giving companies access to new export markets. Innovative goods frequently have a competitive advantage in global marketplaces, particularly in high-tech businesses. Trademarks, copyrights, and patents are three forms of intellectual property (IP) protection that should be incorporated into effective research and development. By doing this, businesses can guarantee the exclusive rights to their inventions, giving them a competitive edge and possible sources of income through licensing or commercialization. Managing trade secrets and secrecy is essential in R&D, especially when working on sensitive or proprietary ideas that could be readily copied by rivals, in addition to formal IP protection. For businesses with robust R&D departments, licensing deals can be a sizable source of income. Businesses can make money while letting others develop and commercialize their innovations by licensing patents or technologies to other companies. To prevent disagreements and guarantee that everyone benefits from the innovation, precise agreements on IP ownership and usage rights are crucial when R&D is carried out cooperatively, as in joint ventures or public-private partnerships.

2. Our results confirmed positive connection of Capital Markets and innovation. This implies that Research and development (R&D) is the foundation of new product development, resulting in the creation of cutting-edge goods that can address new customer demands or open up completely new markets. Staying ahead of market trends is critical in areas like technology, pharmaceuticals, and consumer products, therefore this is especially vital. By introducing new features, boosting productivity, or cutting expenses, ongoing research and development enables businesses to enhance their current goods. By providing customers with a better value and ensuring that the product line remains current, this can help sustain a competitive edge.

3. The research results show that while human capital is often perceived as a key driver of innovation, the correlation between them is not always clear-cut in case of lower middle income countries. This implies that Research and development (R&D) operations frequently necessitate a highly trained workforce, which results in the creation of lucrative positions in technical, engineering, and research domains. This makes the labor force more skilled and can lower unemployment, especially in developed economies. As new procedures and technologies are created by research and development, workers must

constantly adapt and learn new skills. This increases the need for reskilling and up-skilling programs, which are necessary to keep the workforce competitive.

4. The results of the research show a positive connection between innovation and economic growth but the relationship found is not significant in case of lower middle income countries. This implies that R&D expenditures increase economic activity. R&D-derived innovations have the potential to expand already-existing sectors and launch new ones, hence promoting economic growth. Sustained investments in research and development, for instance, are substantially responsible for the computer industry's rapid expansion. Innovations created by R&D enhance productivity in a number of industries. Because companies can now create more with the same or fewer resources, profitability and incomes rise, which in turn spurs economic growth. R&D-driven innovation can cause outmoded industries or technology to fade away, but it can also provide doors for new ventures to flourish. Long-term economic growth and innovation depend on this process of creative destruction. The research results confirmed R&D may spur social innovation by creating answers to urgent societal issues including inequality, poverty, and educational access. For instance, advances in education technology (EdTech) have increased global access to educational possibilities. Research and development methods that are inclusive guarantee that inventions benefit all facets of society, including underprivileged and marginalized groups. This may result in the creation of goods and services that cater to certain requirements, such reasonably priced healthcare options for those with modest incomes.

Through consistent innovation and enhancement of products, procedures, and services, businesses can guarantee consistent expansion and the capacity to adjust to evolving economic and market circumstances. R&D promotes an innovative and continuous improvement culture, which aids in the development of resilience within organizations. This adaptability is essential for surviving market upheavals, technological advancements, and economic downturns.

5.3 LIMITATIONS OF RESEARCH

While my research provides useful insights, there are certain inherent limits that must be acknowledged:

1. In many lower middle-income countries (LMICs), data on R&D investments, operations, and outputs may be few, incomplete, or inaccurate. This may restrict the accuracy of my analysis and the generalization of my results. Different countries may have different definitions and classifications of what comprises R&D, resulting in inconsistencies when comparing statistics between countries. LMICs vary greatly in terms of institutional frameworks, levels of industrialization, economic structure, and political stability. These distinctions may limit the applicability of my findings to all LMICs. The influence of R&D on economic growth can differ greatly depending on the particular context, such as the existence of complimentary elements such as infrastructure, education, and institutional quality. As a result, my findings may be more relevant to some countries than others.

2. R&D investments frequently have a delayed impact on economic growth, as the advantages of innovation, technical improvements, and greater productivity can take years, if not

decades, to materialize. This temporal lag can make it difficult to capture the entire impact of R&D within the scope of my research. This lag may only be identified with panel regression analysis for which data are only available for short periods, and so the possibility to adopt this method is extremely limited. R&D can produce non-market benefits such as social welfare improvements, public health advances, and environmental improvements, which are difficult to measure in economic growth models. These factors may be under-represented in my analysis.

3. The World Economic Forum (WEF) indicators are subjective mainly because they are based on qualitative evaluations from surveys that measure perception, such as the Executive Opinion Survey. Business executives and leaders from different nations are surveyed on a variety of subjects, including infrastructure efficiency, innovation capacity, corruption, and institutional quality. These insights are subjective by nature, even while they offer insightful, contextual information that might not be obtained from only quantitative data. Individual experiences, cultural standards, media representation, and national sentiment can all have an impact on the replies, and these factors can differ greatly throughout nations and eras. Additionally, each country may have a different sample size and representativeness of respondents, which could distort the results and cause inconsistent cross-country comparisons. The validity and reliability of these measures are called into question by their subjectivity, particularly when they are incorporated into composite indices like the Global Competitiveness Index (GCI), which are used to rank countries and inform policy choices. As a result, even though the WEF's survey-based indicators provide distinctive viewpoints, it is difficult to critically evaluate their subjectivity when analyzing the results or extrapolating conclusions regarding national competitiveness.

4. Although composite indicators are helpful for summarizing intricate multidimensional phenomena into a single index, they come with a number of methodological issues that may affect the accuracy and interpretability of the findings. The choice and weighting of individual indicators is one of the main problems. The final rankings may be greatly impacted by the subjective judgment or arbitrary choices made when deciding which criteria to include and how much weight to give each. Assigning equal weights, for example, makes the assumption that each dimension contributes equally to the broader idea being measured, which may not be the case in practice. On the other hand, determining weights by statistical techniques like principal component analysis could make it more difficult to compare studies and obscure the index's interpretability. The process of data normalization, which is required to make indicators with various scales and units equivalent, is another crucial obstacle. The distribution and relative placement of nations within the index may be impacted by the normalization method selected (e.g., min-max scaling, z-scores). Furthermore, the aggregation technique, be it geometric, additive, or another, has a significant impact on the results. Additive approaches may not be suitable in all situations since they presuppose complete compensability among dimensions, which means that a good score in one area can completely offset a low score in another. Additionally, composite indicators are frequently susceptible to outliers and missing data, which, if not well controlled, can skew conclusions.

5. The fact that this study only used data from 2019 rather than using a time-series analysis is another significant limitation of this research. The dynamic character of the relationship between R&D and economic growth over a number of years is not captured by cross-sectional data, despite the fact that it might offer a useful glimpse of the relationship at a certain moment in time. Short-term or one-year data may not accurately reflect the true impact of R&D spending and economic growth because these factors usually take time to manifest. Furthermore, using data from only one year leaves the analysis more susceptible to abnormalities or year-specific external shocks, which could skew the results. Lack of longitudinal data makes it more difficult to see patterns, causality, and lag effects, all of which are frequently essential for comprehending how R&D supports economic growth. This limitation should be taken into consideration when interpreting the study's conclusions, as they may lack temporal depth. This study can only find correlations between R&D spending and economic growth, not a causal relationship, because it uses cross-sectional data from a single year (2019). It is impossible to notice the temporal sequencing or lag effects that are sometimes required to infer causality in the absence of evidence spanning various time periods. To examine whether shifts in R&D investment result in shifts in economic performance over time, a time-series or panel data method would be more appropriate. Therefore, the results should not be regarded as proof of a direct causal relationship, even though they may indicate a correlation between R&D activity and economic growth across countries.

6. This study's use of factor analysis based on data from a single year is another drawback. The underlying correlation structure of the variables, which might change dramatically over time, affects factor analysis. It is quite possible that distinct factor loadings and possibly distinct factor structures would surface if factor analysis were carried out independently for various years. This is the reason why only one year was selected for the research. Because the linkages between factors like R&D investment, innovation outputs, and economic performance are impacted by shifting policy contexts, external shocks, and economic conditions, all of which can vary from year to year, this fluctuation arises. Because of this, the factor loadings found for 2019 might not be consistent or typical of other time periods. Because the data used for the research was just for one year, the factors that were retrieved only represent the associations that existed in that particular year, which restricts how broadly the findings may be applied. Over time, shifts in national or international economic trends, technology advancements, and events may change how variables relate to one another. Consequently, rather than being generally applicable, the factor structure found in this study should be understood as time-specific. A more thorough knowledge of the stability and change of these characteristics over time would be possible with future studies that use panel data or many years.

7. Another key limitation is that the study used the small number of countries (32). The research goal, which was to evaluate R&D ecosystems primarily in LMICs, dictated the sample size we used, even though SEM benefits from bigger samples for increased reliability. Type II Error, or false negatives, are more likely to occur with this smaller sample, which means we can miss correlations that already exist. In particular, smaller samples have a lower chance of successfully rejecting a false null hypothesis (i.e., discovering a true effect) at a 5% significance level. This probability is somewhat reduced

by the normal distribution of our variables, but there is still a chance that actual impacts will be missed. The CMIN/DF (Chi-Square divided by degrees of freedom) value of our model (1.215) also indicates a strong fit, and exact fit tests like the Chi-Square Test are more accurate in assessing model fit. The model fit results still suggest that the possibility of a Type II error is not huge. And because the target countries was Lower Middle Income Group of countries so the sample size could also not increase.

5.4 Recommendations for Future Research

1. Future academics should endeavor to establish or advocate for more extensive and standard databases on investments in research and development, outputs, and results in low- and middle-income countries. Collaboration with national statistics agencies, international organizations, and research institutes will be critical for improving the quality, uniformity, and accessibility of R&D data. Combine quantitative data with qualitative insights gained from case studies, interviews, and field observations. This technique can give a deeper comprehension of how R&D influences economic growth in various LMIC environments.

2. Future study should consider Sector analysis, a technique that looks into how R&D affects specific sectors in LMICs, such as manufacturing, agriculture, and services. Analyzing sector-specific trends can help determine where R&D efforts are most productive and where innovation can have a substantial impact on growth. Future study should also look at how certain forms of R&D, such as biotechnology, information and communication technology (ICT), and renewable energy technologies, affect economic growth. These studies can assist determine which technical breakthroughs have the most potential to foster economic growth in low- and middle-income countries.

3. Consider how cultural and social elements affect R&D activity and economic progress. Researchers might look into how social attitudes towards innovation, educational levels, and cultural norms influence the efficacy of R&D spending.

4. Conduct longitudinal studies to examine the long-term effects of research and development on economic growth, taking into account the time lag between R&D investments and economic consequences. These studies can help to capture the delayed advantages of R&D while also providing insights into long-term economic growth. Future researchers should perform comparison studies among LMICs or between LMICs and high-income nations to uncover best practices, shared obstacles, and successful R&D-led economic growth methods.

5. Future study should look at the social and ethical consequences of R&D-driven economic growth, especially in terms of equity and inclusion. Researchers might investigate how R&D can help reduce poverty, inequality, and social inequities in LMICs. Future Researchers can look at how research and development might help promote sustainable development. Future study might look at how R&D investments connect with the SDGs and contribute to environmental sustainability, social well-being, and economic resilience.

6. R&D output can be measured with several other indicators representing the countries performance better and in a more comprehensive manner such as High-Tech Exports, Innovation Indices such as Global Innovation Index (GII). Future research can measure the R&D output through these indicators as well.

7. Future study should look into how global economic trends including trade policy, foreign direct investment (FDI), and global cooperation affect R&D effectiveness in low- and middle-income countries. Understanding these external influences can help countries improve their position in the global innovation scene. Future Research can look at the impact of international technology transfer and collaboration in increasing R&D capability in LMICs. Future studies should look into how partnerships with developed countries, international organizations, and multinational firms benefit local R&D and economic growth. Addressing these recommendations will allow future researchers to get a better understanding of the link between R&D and economic growth in LMICs, giving significant insights that can be used to improve policy and practice in order to promote sustainable development and innovation.

8. Implementing suggested strategies to enhance research and development (R&D) in LMICs can make use of a number of resources, such as government financing, private sector involvement, and international cooperation. Budgetary support can be given by governments to areas that are strategically important, such as environmental sustainability, public health, and cutting-edge technology like quantum computing. Though technology is still in its infancy, quantum computing has the potential to transform a number of sectors, including healthcare, banking, and logistics, by resolving complicated issues at previously unheard-of speeds. By investing in high-performance computing infrastructure, forming alliances with international research organizations, and receiving specific subsidies, these nations may promote quantum research. Building a talented workforce also heavily depends on public education; a pipeline of qualified professionals may be ensured by giving STEM education top priority, providing specialized training in cutting-edge sectors, and promoting information sharing through international academic collaborations. In order to encourage technology transfer methods that incorporate regional companies into global value chains, promote innovation clusters, and match R&D projects with national economic objectives, industrial policy can play a crucial role. To ensure that firms and inventors can benefit from their research while preserving a balance that keeps monopolies from restricting competition, robust intellectual property protection is also crucial for encouraging innovation. These nations may increase global competitiveness in technology-driven industries, encourage entrepreneurship, and draw in foreign investment by harmonizing their intellectual property laws with international norms and expediting the patent application process.

5.5 THESIS SUMMARY

Part I: Brief Summary of the Research Task

R&D is an important engine of innovation, productivity, and long-term economic growth. R&D initiatives have the ability to greatly increase a country's competitive edge in the global market by advancing technology, developing new products, and improving processes. Despite the crucial necessity of R&D for the success of an economy, R&D sector in Lower middle income countries has largely escaped policymakers' attention. LMICs frequently confront structural barriers to economic growth, such as poor infrastructure, limited access to modern technology and hence, low levels of innovation. These nations often devote a lesser proportion of GDP to R&D than high and middle income countries, and they frequently face challenges such as poor institutional frameworks, inadequate human capital, and limited capital investment in innovation. The goal of this research is to find out whether 'Research and Development' impacts directly on the economy of a country or are there other factors that influence its impact. Numerous studies has found that this impact is influenced by other factors in the economy such as institutions (Doloreux & Turkina, 2023; Chen & Song, 2024)). Institutions play a key role in the stability of an economy as they regulate different sectors of an economy. This research is expected to make an important contribution towards the crossroads of strategy by focusing on research & development and innovation by an Ecosystem approach. A critical notion of this approach is that the members of the ecosystem are affected by each other such that it will help resolve the issues at both the micro-economic level (exchange of resources between ecosystem players) and macro-economic level (institutional culture and a shared idea that innovation is an important element of an ecosystem). This perspective will contribute to highly efficient alignment between the players of the ecosystem.

Part II: Brief Description of Conducted Research and Experiments, the Methods of Collecting Material, the exploration and use of resources

To see the impact of different types of institutions on economic growth, I have designed an ecosystem approach in which different institutional factors including that of R&D, Human capital and capital market, each work together to impact the innovation in a country to eventually impact its economic growth. In this research, descriptive research design was used. Secondary sources of data were employed, mainly from World Economic Forum. WEF categorized 141 countries into 4 income groups namely; High-Income, Upper Middle Income, Lower Middle Income and Lower Income. I selected the Lower Middle Income Group of countries. It comprises of 32 countries. The reason for selecting this group of countries is that almost all the countries included in this group are exposed to (if not entirely same but) similar economic, political and legal environment. The1 Quantitative method of data collection is being employed to gather data from my target population. The data for the proposed research is gathered through the direct observation of the World Economic Forum databases and reports present on the organization's official website, through which1 the data for all the variables has1 been gathered and the time1 frame of the data gathered is for the year 2019 on the basis of results from the Global Competitiveness Report. The reason for using the year 2019 is that the that the research was designed to mainly focus on the economic and strategic shortcomings of the countries before the onset of Covid-19 pandemic in early 2020, therefore data belonging to 2019 was exclusively utilized for the study. Six main constructs developed from my research are Economic Growth, R&D, Institutions, Human Capital, Capital Market and Innovation. Economic Growth is the target or dependent variable, and the indicator which will be used for this is GDP Growth and five independent variables are R&D, Human Capital, Capital Market and Innovation. Following are the methods which are used in this study. I used the SPSS software to perform the data analysis.

1. Descriptive Statistics 2. Correlation Analysis 3. Reliability Analysis

4. Factor Analysis 5. SEM Analysis

The statistical methods of CFA was conducted as a preliminary test for conducting SEM Analysis later on to find out the relationship between the dependent and the independent variables.

Part III: Brief Summary of Scientific Results and their possible practical application

SEM analysis was used to test the theoretical framework. The Chi-square value is 1.21 suggest my model has a good fit. The SEM path diagram shows that institutions have significant and positive relationship with R&D, and the capital market (their connection with human capital is also positive, but not significant). I found insignificant weak relationships between R&D, and innovation and positive between capital markets and innovation; the relationships between human capital and innovation; and innovation and economic growth, however, are not significant. My model indicates that there is a positive relationship between innovation and economic growth, the result, however, is not significant. This result could be interpreted as a sign of a middle-income trap (a growth failure identified by some studies in developing countries) among the lower middle-income group of countries.

My research confirmed that the research and development features have an insignificant and weak relationship with innovation. This implies that governments should devote a sizeable percentage of their budget to R&D, giving grants and subsidies to academic institutions, research centers, and private businesses can foster innovation. My results confirmed positive connection of Capital Markets and innovation. This implies that governments can lower the actual cost of research and promote greater investment from the private sector by providing tax credits or deductions through financial institutions to businesses that engage in research and development. As new procedures and technologies are created by research and development, workers must constantly adapt and learn new skills. This increases the need for reskilling and up-skilling programs, which are necessary to keep the workforce competitive.

Part IV: List of Publications related to Dissertation Topic

1. Fayyaz, A. (2021). Dynamic Capabilities in a Nutshell. 4th Smart Communities Academy: Building Smart Communities for the Future/ http://smartcommunities.eu/en/activities/smart-communities-2-0/smart-academy/4-th-smart-communities-academy

2. Fayyaz, A. (2021). Total Quality Management and its Implementation in context of Pakistan. ‘Review of Business & Management’ TMP Vol. 17, Nr. 2, pp. 45-51. 2021/ https://doi.org/10.18096/TMP.2021.03.04/ http://tmp.gtk.uni-miskolc.hu/index.php?i=4306/

3. Fayyaz, A. (2022). Latest Trends in Social Marketing. *Business and Management Horizons* *https://doi.org/10.5296/bmh.v10i1.19985*

4. Fayyaz, A. (2022). Economic Systems and Institutions. *International Journal of Management and Economics Invention*, *8*(12), 2762–2767. https://doi.org/10.47191/ijmei/v8i12.06/

5. Ayousha, Fayyaz, *Connecting R&D and Growth through a Theoretical Model*/ HANTOS PERIODIKA 4: 2 pp. 291-303. , 13 p. (2023)/ Full document

6. (Accepted for Q2 Journal) Research and Development as a Driver of Innovation and Economic Growth; Case of Developing Economies/ *Journal of Social and Economic Development*/2025

Declaration

I, Ayousha Fayyaz, honestly declare the use of AI in this research for the sole purpose of proofreading/improving grammatical mistakes.

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7 ANNEX

Table 28: Classification of countries based on Income Groups (World Economic Forum, 2024)

High Income	Upper Middle Income	Lower Middle Income	Low Income
Australia	Albania	Angola	Benin
Austria	Algeria	Bangladesh	Burkina Faso
Bahrain	Argentina	Bolivia	Burundi
Barbados	Armenia	Cambodia	Chad
Belgium	Azerbaijan	Cameroon	Congo
Brunei Darussalam	Bosnia and Herzegovina	Cape Verde	Ethiopia
Canada	Botswana	Côte d'Ivoire	Gambia
Chile	Brazil	Egypt	Guinea
Croatia	Bulgaria	El Salvador	Haiti
Cyprus	China	Eswatini	Lesotho
Denmark	Costa Rica	Ghana	Malawi
Estonia	Dominican Republic	Honduras	Mali
Finland	Ecuador	India	Mozambique
France	Gabon	Kenya	Nepal
Germany	Georgia	Kyrgyz Republic	Rwanda
Greece	Guatemala	Lao PDR	Tajikistan
Hong Kong	Iran	Mauritania	Tanzania
Hungary	Jamaica	Moldova	Uganda
Iceland	Jordan	Mongolia	Yemen
Ireland	Kazakhstan	Morocco	Yemen
Israel	Lebanon	Nicaragua	
Italy	Malaysia	Nigeria	
Japan	Mauritius	North Macedonia	
Korea	Mexico	Pakistan	
Kuwait	Montenegro	Philippines	
Latvia	Namibia	Senegal	
Lithuania	Paraguay	Tunisia	
Luxembourg	Peru	Ukraine	
Malta	Romania	Vietnam	

Netherlands	Russian Federation	Zambia	
New Zealand	Serbia	Zimbabwe	
Norway	South Africa		
Oman	Sri Lanka		
Panama	Thailand		
Poland	Turkey		
Portugal	Venezuela		
Qatar			
Saudi Arabia			
Seychelles			
Singapore			
Slovak Republic			
Slovenia			
Spain			
Sweden			
Switzerland			
Taiwan			
Trinidad and Tobago			
United Arab Emirates			
United Kingdom			
United States of America			
Uruguay			

Table 29: Descriptive Statistics

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
MYS	32	58.3	18.9	77.2	47.231	2.5270	14.2947	204.338	.112	.414	-.508	.809
QVT	32	36.8	25.6	62.4	45.347	1.4824	8.3856	70.319	-.013	.414	.155	.809

DSAP	32	43.6	24.1	67.7	48.256	1.5573	8.8097	77.610	-.301	.414	.770	.809
DCPS	32	97.1	2.9	100.0	42.366	4.1747	23.6156	557.697	.569	.414	-.169	.809
FSME	32	39.7	21.3	61.0	41.941	1.6758	9.4796	89.862	-.437	.414	.276	.809
VCA	32	40.9	11.8	52.7	29.075	1.7285	9.7778	95.605	.366	.414	-.030	.809
GDP	32	6.8	.1	6.9	4.119	.2926	1.6550	2.739	-.222	.414	-.453	.809
ScP	32	45.6	47.1	92.7	69.925	1.6624	9.4039	88.434	-.161	.414	.397	.809
RDE	32	83.5	.5	84.0	12.884	2.6129	14.7811	218.480	3.796	.414	17.811	.809
RIP	32	98.4	.0	98.4	5.963	3.0835	17.4427	304.248	5.108	.414	27.585	.809
Inn	32	32.1	18.8	50.9	31.738	1.0418	5.8932	34.730	.895	.414	2.664	.809
Ins	32	23.6	36.4	60.0	47.494	1.0847	6.1359	37.649	.091	.414	-.742	.809
RDI	32	1.9	-1.5	.4	-.698	.0739	.4178	.175	.294	.414	.243	.809
LI	32	3.4	-1.2	2.2	-.251	.1185	.6706	.450	1.768	.414	4.965	.809
FI	32	4.2	-1.4	2.8	.033	.1942	1.0987	1.207	1.206	.414	.860	.809
ED	32	4.0	-1.4	2.6	-.062	.1802	1.0194	1.039	.779	.414	.226	.809
Valid N (listwise)	32											

The average value of MYS is 47.2 as provided by the mean value of the Mean Years of Schooling with the maximum value of 77.2 and a minimum value of 18.9 which indicated that its minimum and maximum value ranges from 18.9 to 77.2, and standard deviation of 14.29 indicating an average variation in the mean years of schooling for the individuals.

Table 30: Pearson Correlations

Pearson's Correlations

			Pearson's r	**p**	**Lower 95% CI**	**Upper 95% CI**
MYS	-	QVT	-0.017	0.928	-0.363	0.334
MYS	-	DSAP	0.272	0.132	-0.085	0.567
MYS	-	DCPS	0.075	0.683	-0.281	0.413
MYS	-	FSME	0.180	0.323	-0.180	0.498
MYS	-	VCA	0.045	0.808	-0.309	0.387
MYS	-	ScP	0.148	0.418	-0.211	0.472
MYS	-	RDE	-0.005	0.980	-0.353	0.345
MYS	-	RIP	-0.075	0.684	-0.413	0.281

MYS	-	Inn	0.130		0.478	-0.229	0.458
MYS	-	Ins	0.215		0.238	-0.145	0.524
MYS	-	GDP	-0.126		0.493	-0.454	0.233
MYS	-	RDI	0.208		0.253	-0.151	0.519
MYS	-	LI	-0.166		0.365	-0.486	0.194
MYS	-	FI	0.174		0.340	-0.186	0.493
MYS	-	ED	0.172		0.345	-0.188	0.492
QVT	-	DSAP	0.694	***	< .001	0.455	0.839
QVT	-	DCPS	0.112		0.543	-0.247	0.443
QVT	-	FSME	0.453	**	0.009	0.124	0.692
QVT	-	VCA	0.584	***	< .001	0.295	0.775
QVT	-	ScP	0.356	*	0.045	0.009	0.627
QVT	-	RDE	0.025		0.892	-0.327	0.370
QVT	-	RIP	0.196		0.281	-0.163	0.510
QVT	-	Inn	0.511	**	0.003	0.198	0.730
QVT	-	Ins	0.485	**	0.005	0.165	0.713
QVT	-	GDP	0.258		0.154	-0.100	0.557
QVT	-	RDI	0.254		0.161	-0.104	0.554
QVT	-	LI	-0.057		0.755	-0.398	0.297
QVT	-	FI	0.217		0.234	-0.143	0.526
QVT	-	ED	-0.185		0.310	-0.501	0.175
DSAP	-	DCPS	0.019		0.918	-0.332	0.365
DSAP	-	FSME	0.505	**	0.003	0.189	0.726
DSAP	-	VCA	0.634	***	< .001	0.366	0.805
DSAP	-	ScP	0.543	**	0.001	0.240	0.750
DSAP	-	RDE	0.080		0.664	-0.277	0.417
DSAP	-	RIP	0.286		0.112	-0.069	0.577
DSAP	-	Inn	0.678	***	< .001	0.431	0.830
DSAP	-	Ins	0.654	***	< .001	0.396	0.817
DSAP	-	GDP	0.189		0.301	-0.171	0.504
DSAP	-	RDI	0.310		0.084	-0.043	0.594
DSAP	-	LI	-0.044		0.812	-0.387	0.310
DSAP	-	FI	0.241		0.184	-0.118	0.544
DSAP	-	ED	-0.160		0.382	-0.482	0.200
DCPS	-	FSME	0.390	*	0.027	0.048	0.650
DCPS	-	VCA	0.394	*	0.026	0.053	0.653
DCPS	-	ScP	0.107		0.562	-0.251	0.439
DCPS	-	RDE	-0.178		0.330	-0.496	0.182
DCPS	-	RIP	0.068		0.710	-0.287	0.407
DCPS	-	Inn	0.234		0.197	-0.125	0.539
DCPS	-	Ins	0.222		0.222	-0.137	0.530
DCPS	-	GDP	0.034		0.855	-0.319	0.378
DCPS	-	RDI	-0.501	**	0.003	-0.723	-0.185
DCPS	-	LI	0.582	***	< .001	0.292	0.773
DCPS	-	FI	0.200		0.272	-0.160	0.513
DCPS	-	ED	0.727	***	< .001	0.506	0.858
FSME	-	VCA	0.838	***	< .001	0.690	0.918
FSME	-	ScP	0.508	**	0.003	0.193	0.728
FSME	-	RDE	-0.042		0.819	-0.385	0.311
FSME	-	RIP	0.449	**	0.010	0.119	0.690
FSME	-	Inn	0.617	***	< .001	0.342	0.795
FSME	-	Ins	0.609	***	< .001	0.331	0.790
FSME	-	GDP	0.174		0.341	-0.186	0.493
FSME	-	RDI	0.025		0.891	-0.326	0.371
FSME	-	LI	0.183		0.317	-0.177	0.500
FSME	-	FI	0.382	*	0.031	0.039	0.645

FSME	-	ED	-0.056		0.762	-0.397	0.299
VCA	-	ScP	0.538	**	0.002	0.232	0.746
VCA	-	RDE	-0.184		0.314	-0.500	0.176
VCA	-	RIP	0.543	**	0.001	0.240	0.750
VCA	-	Inn	0.728	***	< .001	0.508	0.859
VCA	-	Ins	0.580	***	< .001	0.290	0.772
VCA	-	GDP	0.158		0.387	-0.202	0.480
VCA	-	RDI	-0.095		0.605	-0.430	0.262
VCA	-	LI	0.359	*	0.043	0.012	0.629
VCA	-	FI	0.309		0.085	-0.045	0.594
VCA	-	ED	0.037		0.840	-0.316	0.381
ScP	-	RDE	0.274		0.129	-0.083	0.568
ScP	-	RIP	0.588	***	< .001	0.302	0.778
ScP	-	Inn	0.880	***	< .001	0.766	0.940
ScP	-	Ins	0.504	**	0.003	0.189	0.725
ScP	-	GDP	0.279		0.122	-0.077	0.572
ScP	-	RDI	0.184		0.312	-0.176	0.501
ScP	-	LI	0.255		0.160	-0.103	0.554
ScP	-	FI	0.192		0.293	-0.168	0.507
ScP	-	ED	-0.348		0.051	-0.621	8.560×10^{-4}
RDE	-	RIP	0.107		0.561	-0.251	0.439
RDE	-	Inn	0.162		0.377	-0.198	0.483
RDE	-	Ins	0.191		0.296	-0.169	0.506
RDE	-	GDP	0.031		0.866	-0.321	0.376
RDE	-	RDI	0.542	**	0.001	0.238	0.749
RDE	-	LI	-0.099		0.589	-0.433	0.258
RDE	-	FI	-0.161		0.378	-0.483	0.199
RDE	-	ED	-0.262		0.148	-0.559	0.096
RIP	-	Inno	0.720	***	< .001	0.495	0.854
RIP	-	Ins	0.358	*	0.044	0.010	0.628
RIP	-	GDP	0.189		0.299	-0.171	0.505
RIP	-	RDI	-0.160		0.381	-0.482	0.200
RIP	-	LI	0.664	***	< .001	0.411	0.822
RIP	-	FI	0.122		0.507	-0.237	0.451
RIP	-	ED	-0.286		0.113	-0.577	0.070
Inn	-	Ins	0.617	***	< .001	0.343	0.795
Inn	-	GDP	0.223		0.219	-0.136	0.531
Inn	-	RDI	0.081		0.659	-0.275	0.418
Inn	-	LI	0.405	*	0.022	0.065	0.660
Inn	-	FI	0.230		0.205	-0.129	0.536
Inn	-	ED	-0.157		0.391	-0.479	0.203
Ins	-	GDP	0.075		0.681	-0.281	0.413
Ins	-	RDI	0.178		0.330	-0.182	0.496
Ins	-	LI	0.128		0.486	-0.231	0.456
Ins	-	FI	0.258		0.154	-0.100	0.557
Ins	-	ED	-0.033		0.856	-0.378	0.319
GDP	-	RDI	-0.039		0.833	-0.382	0.314
GDP	-	LI	0.098		0.593	-0.259	0.432
GDP	-	FI	0.083		0.651	-0.274	0.420
GDP	-	ED	-0.151		0.408	-0.475	0.208
RDI	-	LI	-0.518	**	0.002	-0.734	-0.207

RDI	-	FI	-0.464	**	0.007	-0.699	-0.138
RDI	-	ED	-0.494	**	0.004	-0.719	-0.176
LI	-	FI	-0.153		0.403	-0.476	0.207
LI	-	ED	0.376	*	0.034	0.031	0.641
FI	-	ED	-0.024		0.896	-0.370	0.327

*** p < .05, ** p < .01, *** p < .001**

Table 31: Factor Variance

Factor variances

					95% Confidence Interval	
Factor	**Estimate**	**Std. Error**	**z-value**	**p**	**Lower**	**Upper**
RDI	1.000	0.000			1.000	1.000
FI	1.000	0.000			1.000	1.000
LI	1.000	0.000			1.000	1.000

Factor variances show how much of the total variability in the observed variables is explained by the underlying factors.

Table 32: Residual Variance

					95% Confidence Interval	
Indicator	**Estimate**	**Std. Error**	**z-value**	**p**	**Lower**	**Upper**
Scientific publications	87.929	13.089	6.718	< .001	62.275	113.583
RD expenditures	140.673	48.381	2.908	0.004	45.848	235.498
Research institution prominence	517.778	69.357	7.465	< .001	381.840	653.716
Domestic credit to private sector	554.599	69.814	7.944	< .001	417.766	691.432
Financing of SMEs	39.257	6.197	6.335	< .001	27.111	51.403
Venture capital availability	7.987	4.996	1.599	0.110	-1.806	17.780
Mean years of schooling	288.562	36.403	7.927	< .001	217.213	359.911
Quality of vocational training	38.732	6.083	6.367	< .001	26.809	50.656
Digital skills among active population	25.670	6.249	4.108	< .001	13.422	37.917

Table 33: Intercepts

	Estimate	**S.E.**	**C.R.**	**P**	**Label**
Institutions	47.494	1.085	43.786	***	Ins
Innovation	3.248	5.725	.567	.571	Inno
Research institution prominence	-45.036	18.470	-2.438	.015	RIP
RD expenditures	-1.507	11.705	-.129	.898	RDE
Scientific publications	36.125	11.141	3.242	.001	SP
Venture capital availability	-15.974	10.954	-1.458	.145	VCA
Financing of SMEs	1.841	10.680	.172	.863	FSME
Domestic credit to private sector	-6.096	22.710	-.268	.788	DCPS
Mean years of schooling	27.512	13.555	2.030	.042	MYS
Quality of vocational training	15.476	8.388	1.845	.065	QVT

Digital skills among active population	3.628	9.334	.389	.698	DSAP
Gross domestic product	2.128	1.694	1.256	.209	GDP

Table 34: Variance

	Estimate	S.E.	C.R.	P	Label
e10	36.472	9.264	3.937	***	
e11	8.196	10.755	.762	.446	
e12	51.768	16.533	3.131	.002	
e13	116.702	50.328	2.319	.020	
e14	1.000				
e9	1.000				
e1	135.983	36.391	3.737	***	
e2	199.010	50.688	3.926	***	
e3	15.935	5.019	3.175	.001	
e4	8.035	9.069	.886	.376	
e5	20.037	8.702	2.303	.021	
e6	442.387	114.140	3.876	***	
e7	183.468	46.649	3.933	***	
e8	34.887	8.973	3.888	***	
e15	2.521	.640	3.937	***	

Table 35: Minimization History

Iteration	Negative eigenvalues	Condition #	Smallest eigenvalue	Diameter	F	NTries	Ratio
e0	5		-139.596	9999.000	2068.726	0	9999.000
e1	6		-1.130	.926	512.268	16	.303
e2	5		-1.199	.787	297.965	5	1.060
e3	5		-1.448	.531	213.272	5	1.003
e4	4		-1.041	.486	168.714	5	.888
e5	4		-2.558	.603	140.345	5	.661
e6	3		-.606	.301	121.048	5	.763
e7	3		-.051	.309	109.459	5	.720
e8	2		-.360	.848	94.964	7	.897
e9	1		-.003	.482	86.177	5	.893
e10	1		-.398	.489	79.747	5	.834
e11	0	644243.469		.314	76.798	5	.687
e12	2		-.142	3.444	71.752	4	.000
e13	1		-.054	.269	68.966	5	.849
e14	0	197418.336		.289	67.959	5	.719
e15	2		-.011	5.287	65.427	1	.635
e16	0	224727.716		.201	64.170	5	.927
e17	0	318315.765		.543	63.741	1	.922

e18	0	251441.574		.174	63.479	1	1.156
e19	0	336227.317		.316	63.449	1	.255
e20	0	324817.572		.098	63.274	1	1.071
e21	0	353773.496		.193	63.235	2	.000
e22	0	375154.673		.114	63.199	1	1.271
e23	0	400540.252		.206	63.186	1	.769
e24	0	430418.977		.063	63.170	1	1.114
e25	0	448956.485		.152	63.168	1	.586
e26	0	453040.046		.022	63.165	1	1.028
e27	0	467397.727		.032	63.165	1	1.001
e28	0	463532.500		.001	63.165	1	1.003
e29	0	460172.821		.000	63.165	1	1.000