The Effect Of Innovation Input On Innovation Output And Firm Performance

Hunduma Sori

A Thesis Submitted to the Department of Technology and Innovation Management

School of Humanities and Social Science

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Technology and Innovation Management

Office of Graduate Studies

Adama Science and Technology University

June 2024

Adama Ethiopia

The Effect of Innovation Input on Innovation Output and Firm Performance

Hunduma Sori

Advisor: Moges Tufa (PhD)

A Thesis Submitted to the Department of Technology and Innovation Management

School Of Humanities and Social Science

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Technology and Innovation Management

Office of Graduate Studies

Adama Science and Technology University

June 2024

Adama Ethiopia

Declaration and Recommendation

Declaration

I hereby declare that this Master Thesis entitled "**The Effect of Innovation Input on Innovation Output and Firm Performance"** is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation

Hunduma Sori_____ _____ _____

Name of Student Signature Date

Recommendation

I, the advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled "**The Effect of Innovation Input on Innovation Output and Firm Performance"** prepared under my guidance by **Hunduma Sori** submitted in partial fulfillment of the requirements for the degree of Mater's of Science in Technology and Innovation Management.

Therefore, I recommend the submission of revised version of the thesis to the department following the applicable procedures.

_____	_____	_____
Major Advisor	Signature	Date
_____	_____	_____
Co-advisor	Signature	Date

Approval Page of M.Sc. Thesis

I, the advisor of the thesis entitled **"The Effect of Innovation Input on Innovation Output and Firm Performance"** and developed by By Hunduma Sori, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

Major Advisor	Signature	Date
Co-advisor	Signature	Date

We, the undersigned, members of the Board of Examiners of the thesis by Hunduma sori have read and evaluated the thesis entitled "**The effect of innovation input on innovation output and firm performance"** and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Technology and Innovation Management.

Chairperson	Signature	Date
Internal Examiner	Signature	Date
External Examiner	Signature	Date

Final approval and acceptance of the thesis is contingent upon submission of its final Copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

Department Head	Signature	Date
School Dean	Signature	Date
Office of Postgraduate Studies,	Dean Signature	Date

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

OECD = Organization for Economic Cooperation and Development

GII = The Global Innovation Index

WIPO = World Intellectual Property Organization

CIS4 = Fourth Community Innovation Survey

CIS2 = second Community Innovation Surveys

CDM = Crepon, Duguet & Mairesse

GSEM = General structural equation model

RandD = Research and development

Etrain = Employees training

Prdin = Product innovation

Prsin = Process innovation

firmage = Firm age

Fperformance = firm performance

Totalsale = Total annual sale of all products

Ininput = innovation input

Inoutput = innovation output

ACKNOWLEDGEMENT

First of all "I would like to express my deepest gratitude to my advisor, Moges Tufa (PhD), for his unwavering support throughout my academic journey and thesis. I also extend my thanks to Tsegaye Mulugeta (PhD), the head of the Department of Technology and Innovation Management, and all the instructors at Adama Science and Technology University (ASTU) for their invaluable contributions to my education and thesis. I am also thankful to Adama Science and Technology University (ASTU) for granting me a full scholarship during my academic pursuits. Lastly, I want to express my appreciation to my family and friends for their enduring support at all.

ABSTRACT

For developing countries like Ethiopia innovation is very important to implementing the design and modify a things from developed elsewhere. However, there is quite limited theoretical studies and empirical evidence in the countries regarding to the innovation. In addition, among Ethiopian firms there is a gap of understanding about the effect of innovation inputs on innovation outputs and firm performance. To fill this gap, the study proved empirical evidence about the effect of innovation inputs on innovation outputs and firm performance for Ethiopian firms. we used firm-level data from the World Bank enterprise survey data-set at the year of 2015; evidence from Ethiopian firm level data including 848 total firms from four regional states and two administrative cities, encompassing firms of all sizes. To effectively analyze the relationship between innovation inputs, innovation outputs, and firm performance, the CDM model was most appropriate and has been widely adopted by scholars for its ability to link innovation inputs with outputs and subsequent firm performance. The study used the General Structural Equation Modeling (GSEM) to estimate how innovation inputs affect innovation outputs and firm performance. The results show that innovation inputs such as spend expenditure on formal R&D activities, providing formal programs training for employees, use of E-mail to communicate with clients and suppliers have a positive and highly significant effect on technological innovation outputs (product and process innovation). On the other hand, spend expenditure on formal R&D activities, formal programs training for employees, use of E-mail to communicate with clients and suppliers ,and product and process innovation also exhibit a positive and significant effect on firm performance. Generally,innovation inputs have a positive and highly significant effect on innovation outputs and firm performance. Based on the findings, further emphasis on making conducive environment for innovation inputs would help Firms to enhance their innovation outputs and firm performance.

Keyword: innovation input, innovation output, firm performance, CDM model, GSEM, Ethiopia

CHAPTER ONE
INTRODUCTION

1.1 Background of the study

Schumpeter (1934), the German economist and political scientist, was among the first to define innovation as "the driving force for development." In his definition, he proposed five manifestations of innovation: the creation of new products or qualitative improvements in existing products, the use of new industrial processes, new market openings, the development of new raw-material sources or other new inputs, and new forms of industrial organizations. In addition, from the Schumpeter idea, innovation is an engine growth that comes from entrepreneurial activities with investment in significant factors such R&D and many others with the expectation of getting economical outcomes. Moreover, to be innovative; entrepreneurs need to be in an incentive environment in which political institutions, economic policies, financial structures, and infrastructures constitute the key determinants. Indeed innovation is what enhance competition and help to improve products and services. But taking advantage of innovation and seizing the opportunities it comes with depends on the ability of economies to implement and develop potent inputs, and their capacity of using these inputs to obtain outputs (Tchamekwen, 2019).

According to the Organization for Economic Cooperation and Development (OECD,2010) defines innovation more broadly as the implementation of a new or significantly improved product (that is, a physical good or service), a process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations (OECD,2010). According to this definition, the product, process, marketing method or organizational method in the firm should be new or significantly improved in order for the effort of the company to be considered innovative. Based on this definition, four types of innovations can be identified: (1) product innovation, (2) process innovation, (3) marketing innovation, (4) organizational innovation. The first two are considered to be technological innovations, while the last two are non-technological innovations (Hussen & Çokgezen, 2019). Innovation provides the foundation for new companies, new workplaces, and productivity growth and hence is an essential driver for economic growth. Innovation can help address the social and global issues associated with demographic changes, resource shortage, and the shifting climate, all at a lower cost (OECD,2010).

For developed and developing economies innovation is a fundamental driver of competitiveness. It is a vital criterion for countries to maintain competitiveness, produce high-technology products and services, and achieve superiority in the global market. From the perspective of developing countries, innovation involves mastering and implementing the design and production of goods and services, as well as the adoption and potential modification of products and technologies developed elsewhere (Egbetokun et al., 2016; Kassa and Mirete,2022) . African leaders have over the past years reiterated their determination to end poverty, improve social life and economic stability and Countries in Africa have a common goal policy of industrialization that is expected to be driven by investing in innovation that yields efficiency (Laura Barasa 2018). Innovation has become a new set of hope for Africa to finally integrate the global economy dynamic, and address the new global business world competition (Tchamekwen, 2019).

In Africa, Ethiopia is among the developing countries. Enterprises firm are playing a crucial role in contributing to economic growth of Ethiopia by supporting science, technology,and innovation activities through research, technology transfer, and diffusion for policy formulation framework (The Federal Democratic Republic of Ethiopia (FDRE) 2010). However, its Innovation activity is still relatively weak. Several studies on Ethiopia report that the level of technological innovation in the county's industrial sector is low. For instance, Habtewold, T. M. (2023); and Talegeta, (2021). Wakeford et al. (2017) also revealed low rates of product and process innovation among firms in Ethiopia. The empirical evidence Wakeford et al. (2017)) confirms that the Ethiopian manufacturing sector is characterized by low technological know-how, lack of industry knowledge, low rates of technological production and innovation, and weak links with universities and research institutions. By contrast,Gebreeyesus (2011) showed that larger firms and those in the manufacturing sector are more likely to engage in innovation activities in Ethiopia. Despite its relatively low innovation performance, Ethiopia faces economic challenges compared to countries like China, Kenya, and other low-income countries. For instance, the Global Innovation Index (GII) ranks world economies according to their innovation capabilities. Global innovation index recognizing that innovation is a key driver of economic development and aims to provide an innovation ranking and rich analysis referencing around 130 economies. As GII Consisting of roughly, 80 indicators grouped into innovation inputs and outputs. As its report in 2023,

ranking of countries by region of Sub-Saharan Africa including Ethiopia. According to GII report in 2023, Ethiopia ranked around lowest level in terms of innovation inputs and innovation outputs performance. For instance, Ethiopia ranked; 21th among the 28 economies in Sub-Saharan Africa; 7th among the 12 low-income group economies, and 125th among the 132 economies featured in the GII 2023. Rating figure was computed on average of the following factors: innovation inputs (human capital & research, infrastructure, business sophistication, market sophistication and institutions) and innovation outputs (Knowledge &Technology-based Products and Creative Products).

Table 1 : GII reports in the year of (2020-2023) innovation performance in Ethiopia

	GII position	Innovation inputs	Innovation outputs
2020	127th	130th	110th
2021	126th	129th	107th
2022	117th	126th	100th
2023	125th	130th	109th

Source : GII (2023)

1.1.1 Innovation inputs

According to the Global Innovation Index (GII) definition, innovation input is associated with a conducive innovation environment, including human capital and research, infrastructure, business sophistication, market sophistication, and institutions. Sohn et al., (2015) re-evaluated the GII using a structural equation model for 2013 data. They identified the elements of innovation input as follows: (1) human resources and research; (2) infrastructure; (3) business sophistication; (4) market sophistication; and (5) political institutions (Tchamekwen, 2019).

There are numerous studies on the definition of innovation. However, According to this study innovation input is the engine power of innovation output and firm performance. As well as it highly affect the innovation outputs and firm performance of Ethiopian firms. The significant portion of our study is based on the GII definition of innovation and its tracking elements of innovation inputs and technological innovation output (Hussen & Çokgezen, 2019). These elements include human capital and research (R&D),business sophistication (employee training) and infrastructure (use of email), and product and process innovation (Lau, 2012). By consolidating the theories mentioned above, we

evaluated the impact of innovation input on innovation output and firm performance among Ethiopian firms by focusing on innovation inputs elements such as spending expenditure on formal R&D, formal employee training programs and use of E-mail to communicate with clients and suppliers as independent variables.

Human capital and Research (R & D activities)

According to the Global Innovation Index (GII), the sub-pillars of human capital and research encompass research and development (R&D),education and tertiary education. Human capital refers to a set of individual skills, knowledge, and abilities. Tchamekwen, (2019),and Pérez et al., (2012) good level of education plays a crucial role in enhancing knowledge acquisition and boosting individual capacity to generate, process, and disseminate innovation-related information for businesses. Particularly in modern industries, human capital is imperative for driving innovation, and it is acquired through formal education (primarily general skills) as well as through workplace training and experience or primarily specific skills (Blundell et al., 1999). Human resources Managers also play a vital role in innovation activities since they are responsible for choosing the right innovation model for their entities and finding effective strategies for the resources allocation. Workers who are more highly educated and skilled are a direct source of innovation.

The OECD, (2010) report emphasizes that empowering individuals to innovate depends not only on broad and relevant education but also on the cultivation of diverse skills that complement formal education. Human resources, or employees, are deemed a crucial factor in organizational performance.

Business sophistication

According to GII definition business sophistication regarding knowledge workers, innovation linkages, and knowledge absorption. Moreover, business sophistication can be viewed in terms of the Knowledge workers that enhance and commercialize innovation. In addition offering formal program training for employees categorized under knowledge workers. In this study employees training is one of the innovation inputs element that highly affect the innovation inputs and firm performance. In the current era of globalization, investing in a more knowledgeable workforce and managing this knowledge (Hassan & Raziq, 2019) gives for businesses a competitive advantage in

innovation. Training and development initiatives contribute to enhancing the skill adaptability of employees, enabling them to adeptly navigate changes in technology, markets, and organizational structures,(Knoke et al., 2015).

Infrastructure

The Global Innovation Index (GII) classifies infrastructure into sub-pillars such as Information & communication technologies (ICT), general infrastructure and ecological sustainability . In addition ICT access, ICT use, government online services and E-participation categorized under Information & Communication Technologies (ICT). Infrastructure encompasses various physical structures used as inputs for the production of goods and services (Chan et al., 2010). Moreover, infrastructures play a pivotal role in driving innovation by operating firms, facilitating information exchange, promoting collaboration, and disseminating knowledge (Razzaq et al., 2021). Email is a way to reach consumers directly via electronic mail and use to promote products and service. it helps develop the relationships with potential customers and clients, to build customer loyalty, trust in a product or company brand recognition. In the era of globalization, African countries, particularly Ethiopia, are grappling with competitiveness challenges due to inadequate infrastructure (The UK National Infrastructure Plan, 2010). The development of innovative infrastructures is crucial for enhancing economic performance worldwide and fostering collaboration in innovation, especially by enhancing the quality of research institutions, education systems, energy supply, communication, and logistics infrastructures. Furthermore, they contribute to expanding market reach and opening avenues for the development of new products, services, processes, and business models.

1.1.2 Innovation outputs (technological innovation)

Innovation output refers to the outcomes of innovation, encompassing knowledge and technology-based products as well as creative products (GII, 2020). All innovation types are innovation outputs (Lau, 2012). The innovation types are extended from product and process innovation as put forward by existing literature (Li, Chen, & Shapiro, 2010), to the updated definition of innovation proposed by the Organization for Economic Co-operation and Development (OECD).

Product innovation relates to the introduction of a new or significantly improved good or service, where the term “product” is used to cover both goods and services. Product

innovations can be linked to the utilization of new knowledge or technologies, or it can be related to new uses or combinations of existing knowledge or technologies. New products refer to goods and services that either differs substantially in their features or the intended use compared to the firm's previous produced products. Even products that have only minor changes to its technical characteristics is referred to as product innovation, as long as the development includes a new intended use (OECD/Eurostat, 2005). Existing products can have significant improvements in the materials, components or other attributes contributing to improvements in the product's performance.

In services, product innovations can be significant enhancements in the way services are provided, new features that are added to existing services, or the implementation of services that are entirely new to the firm. However, as the changes have to be significant, product innovations exclude minor changes or improvements as well as routine upgrades and regular changes (OECD/Eurostat, 2005). In addition, OECDs,(2015) Oslo Manual, product innovation refers to products or services that are either new to the establishment or show case significant improvements in capabilities, user-friendliness, components, or sub-systems. Such improvements encompass new or significantly enhanced products in terms of (i) capabilities or other functions; (ii) technical specifications; (iii) components and materials; (iv) incorporated software; and (v) user-friendliness.

Conversely, process innovation is described as the introduction of new or significantly improved processes within the establishment, covering (a) methods for manufacturing products or offering services; (b) logistics, delivery, or distribution methods for inputs, products, or services; and (c) supporting activities. It can be applied with the intention of decreasing the production or delivery costs per unit, improving the quality of an existing product, or implementing new or improved products. Production methods include routines, equipment, and software solutions, whereas delivery methods involve the firm's logistics and involve equipment, software solutions and routines used in the supply chain and delivery system (OECD/Eurostat, 2005). It may further include new or significantly improved routines, equipment, and software related to the creation and provision of services as well as in ancillary support activities, such as auditing, maintenance, and procurement.

Lau, (2012) conducted a study to explore the correlation between innovation activities (inputs) and types of innovation (outputs) by analyzing data from the Fourth Community Innovation Survey (CIS4) involving 492 companies in Hong Kong. In his research, innovation outputs are linked to innovation types (product, process, marketing, and organizational innovation) as indicated in figure 1. According to Hussen & Çokgezen, (2019), product and process are classed as technological innovations, while marketing and organizational innovation fall into the non-technological category. For the purposes of this study, we take technological innovation (product and process innovation) as dependent variables in terms of innovation inputs. However in terms of firm performance it considered as independent variable.

1.1.3 Firm performance

Nowadays, firm performance has become a relevant concept in strategic management research and is frequently used as a dependent variable. Although it is a very common notion in the academic literature, there is hardly a consensus about its definition and measurement. Successful firms represent a key ingredient for developing nations. Many economists consider them similar to an engine in determining their economic, social, and political development. To survive in a competitive business environment, every firm should operate in conditions of performance (Taouab & Issor, 2019) .

Firm performance can include different aspects of an organizations performance principally focused on the capability and ability of an organization to efficiently exploit the available resources to achieve accomplishments consistent with the set objectives of the company, as well as considering their relevance to its users (Peterson, Gijsbers, & Wilks, 2003). Firm performance was considered as the equivalent of organizational efficiency, which represents the degree to which an organization, as a social system with some limited resources and means, achieves its goals without an excessive effort from its members. The criteria used for assessing performance are productivity, flexibility, and inter organizational tensions (Georgopoulos & Tannenbaum, 1957). Einfeldt & Hasle, (2019) examined the relationship between innovation input, innovation output, and firm performance by considered innovation activities, innovation types and sales as innovation inputs, innovation outputs, and firm performance as shown in Figure1

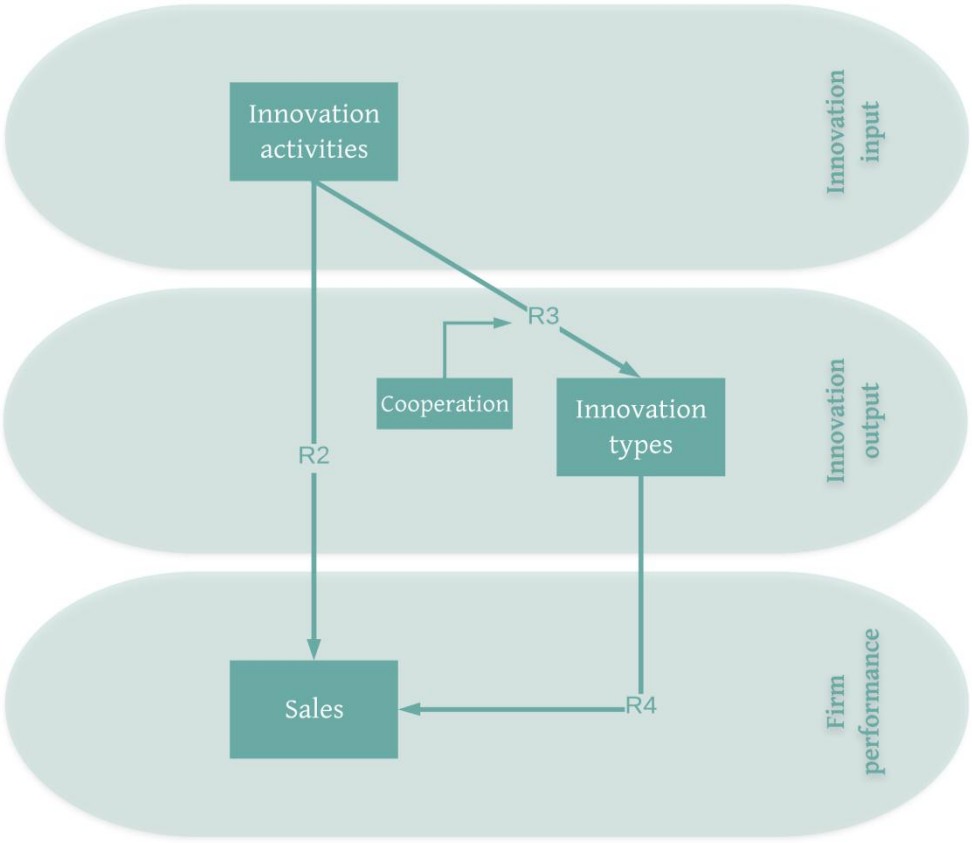

Figure1: The relationships between innovation inputs,innovation outputs and firm performances through innovation activities,innovation types and firm performance respectively.

Source : Research framework of (Einfeldt & Hasle, 2019)

1.2 Statement of the Problem

Innovation is important for developed and developing countries in the competitive global economy and it is one of the main criteria for countries to be superior, to remain competitive, and to produce high technology products and services (Egbetokun et al., 2016). Developing countries have become increasingly aware of the important role of innovation and its efficiency play in driving economic growth and development (Laura Barasa,2018). Accordingly, Ethiopian government aims to continue the rapid pace of economic growth and reach lower-middle-income status by 2025 (world bank group 2015). In this regard, as it is widely acknowledged to be the main engine of growth, innovativeness will play a decisive role in sustaining its positive economic growth and accelerating poverty reduction. So far, however, the country has not succeeded in enhancing innovation capabilities of the firms in the economy. Innovativeness of

Ethiopian firms is still well below the firms of other African countries with similar levels of income (Hussen & Çokgezen, 2021). The main reason for this problem is that the country's low income and including government the lack of attention by the relevant authorities and researchers to innovation have exacerbated the problem. In this regard, examining the factors affecting innovation firm performance and identifying what the Ethiopian country can do to encourage innovation is thus of particular interest. Despite its importance, the issue of innovativeness of Ethiopian firms has received scant academic attention (Ayele and Gebreeyesus, 2010).

In addition, in Africa, particularly in Ethiopia, there is relatively limited theoretical studies and empirical evidence regarding to innovation (Abdu and Jibir 2017a; Adebowale et al. 2014). This increases the significance of our study, as it deals with the importance of innovation for developing countries like Ethiopia in driving economic growth and development to attaining middle-income countries.

However, the following researchers have conducted their studies on innovation in different ways among developing countries particularly in Ethiopia. Hussen & Çokgezen, (2021) investigate the relationship between R&D, innovations, and productivity in 15 African countries. Gebreeyesus, (2009) assesses the relationship between innovations and profitability using cross-sectional data for the manufacturing sector in Ethiopia. Cirera et al., (2019) also investigate the relationship between ICT, innovations, and labor productivity across countries using a cross-sectional data-set.

Furthermore, some scholars have identified the barriers or determinants of innovation within Ethiopian enterprises. For instance, Daksa et al., 2018) analyzed the determinants of enterprise innovation in Ethiopia using a multivariate probit (MVP) model and found that engagement in R&D, on-the-job training, and website ownership significantly determined enterprise innovation. Talegeta, (2021) identified various barriers to innovation, including the lack of skilled personnel, inadequate R&D, firm size, and high costs of innovation expenditure as significant obstacles. Kassa & Mirete, (2022) revealed that government support, access to infrastructure, employee training, and the leadership of owners significantly affected firm innovation. Ayinaddis, (2022) revealed that cost of innovation, human resources, firm size, and R&D factors most likely to affect the technological innovation of the enterprises at statistically significant level.

From this review of prior research, it is evident that previous studies have primarily focused on analyzing the factors affecting Ethiopian firms' ability to innovate. Based on this gap, we examined the effect of innovation inputs on innovation outputs and firm performance of Ethiopian firms by focusing on the elements of innovation inputs such as (human capital & research, business sophistication and infrastructure) (GII, 2020), and innovation outputs such as (product and process innovation) (Hussen & Çokgezen,(2021) as the independent variable, and firm performance as the dependent variable. On the other hand, many researchers have focused only on R&D activities among innovation inputs, which affect the innovation outputs and firm performance (Keupp et al., 2011). However,there are non-R&D activities within innovation inputs, such as employee training and infrastructure, which are considered critical for generating effective innovation outputs and firm performance (Sohn et al., 2015).

Generally, given the above research gap, this paper contributes to the narrow literature on innovations of firms in Ethiopia in the following ways. First, it analyzes the effect of innovation inputs on technological innovation outputs (product and process innovation) and firm performance. Second, to identify the effect of innovation inputs on firm performance directly (separately) and indirectly (jointly with technological innovation outputs). Third, contrasting to most of the earlier studies, another thing that makes this study unique is that it examines innovation inputs with relating to innovation outputs and firm performance.

1.3 Research questions

In this paper, we answered the following three questions:

What is the effect of innovation inputs on innovation output?

What is the effect of innovation inputs on firm performance?

What is the effect of innovation outputs on firm performance?

1.4 Objective of the Study

1.4.1 General objective

The general objective of this research is:

To investigates the effect of innovation input on innovation output and firm performance in the context of Ethiopian firms.

1.4.2 Specific Objective

In addition to the general objective, the specific objectives of the study include:

To identify the effect innovation inputs on innovation outputs

To analyze the effect innovation inputs on firm performance

To explore the effect innovation outputs on firm performance

1.5 Significance of the study

Ethiopia is one of the slowest growing economies in the world, and to reach the list of developed countries, understanding the impact of innovation on economic growth and implementing it is the first option to start economic growth. Especially,while innovation inputs is the engine power of innovation output and firm performance it is necessary to identify the impact of innovation inputs on innovation outputs and firm performance. Therefore, this study excepted to offer great promotion about the role of innovation in economic growth for all Ethiopian firms and Ethiopian governments to prioritize for innovation at the local, regional, and national levels. In addition,This study give well understanding of how innovation inputs affect innovation outputs and firm performance and to contribute positively relationship between them among Ethiopian firms.

1.6 Limitation of the study

The study is titled "The Effect of Innovation Input on Innovation Output and Firm Performance: Evidence from Ethiopian Firms firm-level data". It is based on secondary data collected from the World Bank enterprise survey among Ethiopian firms in 2015. The limitations of the study are as follows: 1) The data used is not recent, and 2) It was not collected in consecutive years. Additionally, there is a lack of data sources and previous research on the relationship between innovation input, innovation output, and firm performance in the context of Ethiopian firms. Furthermore, in order to analyze and interpret the results, the study requires access to the latest version of software such as stata and others, which is currently unavailable due to financial constraints.

1.7 Scope of the study

The concept of innovation is a broad subject. This research aims to evaluate the impact of innovation input on innovation output and firm performance in Ethiopian firms and to introduce new perspectives on the effects of innovation input on innovation output and firm performance. However, the data was only collected from four Ethiopian regional

states and two administrative cities, limiting the scope to those specific areas and not encompassing all firms in Ethiopian regional states and cities.

CHAPTER TWO
LITERATURE REVIEW

2.1 Theoretical Literature Review

The concept of innovation is widely defined in the literature, yet its core meaning was globally described (Amara, 2005). In its broadest sense, the term comes from the Latin innovare, meaning 'to make something new. This broad definition contains several possible innovations, and the OECDs/Eurostat (2005) is further classifying innovation as four innovation types: product innovation, process innovation, organizational innovation, and marketing innovation. Innovations are about implementing something new with the aim of value creation. That is, in order to be qualified as an innovation, two requirements must be met: (1) the product, process, marketing method or organizational method must be either new or significantly improved to the firm, (2) and it must be implemented in practice. Furthermore, innovation is a key tool for firms to gain competitive advantage and to survive (Karabulut, 2015). Innovative firms are proving to be more productive, more robust to shock and more adaptable to change. As a result that may improve their performances, overcome competitors and provide value to their stakeholders (OECD, 2010). Innovation offers opportunity to definitely embrace the path towards industrialization, Competitiveness, national and cross border performance, as it also generates technological progress (Tchamekwen,2019). Today the importance of innovation measures is acknowledged by several countries and international organizations, which are in a continuous process of collecting innovation data following the guidelines.

The Oslo Manual is primarily directed at supporting producers of innovation statistics, such as offices for national statistics, but is also suitable for users of the innovation information (OECDs/Eurostat 20018). The Oslo Manual aims to provide a directory with common terminology, applied conventions, and principles agreed upon to collect and report innovation data. It has since 1922 been the international guide book for measuring innovation, providing a base for discussing innovation activities and supporting innovation as well as innovation outcomes at a universal language (OECDs/Eurostat 2018).

Innovation is widely regarded as one of the most important sources of sustainable competitive advantage in an increasingly changing environment, because it leads to

product and process improvements, makes continuous advances that helps firms to survive, allows firms to grow more quickly, be more efficient, and ultimately be more profitable than non-innovators (Murat Atalay et al.2013). As stated by the UK Department of Trade and Industry (2007) innovation is broadly understood as the process of transforming opportunity into new ideas and implementing them into widespread practice.

Innovation activity is the key source of long term firm success. But firms which fail to engage in innovation are putting themselves at great risk (Murat Atalay et al.2013). Due to the heightened level of competition and shortened product life cycles, firm ability to generate innovations may be more important than ever in allowing firms to improve performance and maintain competitive advantage (Artz et al., 2010). The ultimate innovative results (output) also depend on the degree of innovation in the internal organization/ firm processes, in which the innovative inputs are transformed into innovative outputs (kemp et al., 2003). The Community Innovation Surveys present a three-stage innovation process approach (Van Leeuwen, G., & Klomp, L. 2001). First, there is the input to the innovation process of an industry or firm (e.g. R&D expenditures, people involved in innovation, national subsidies). Second, the innovation output of the industry or firm (e.g. productivity, new products or processes). Third, when it comes to facilitating the operations of the firm, industry or economy (e.g. partner cooperation, innovation in the mission statement). Numerous sources emphasize the necessity of innovation for any firm to succeed and endure (Background, 2005; and Wolfe, 1994) and gain sustainable competitive advantage (Ã, 2008; Mumford & Licuanan, 2007; Standing & Kiniti, 2011).

Performance was defined as an organization's ability to exploit its environment for accessing and using the limited resources (Yuchtman & Seashore, 1967). Colase (2009) considers the word performance as a bag-word because it covers various and different notions such as growth, profitability, return, productivity, efficiency, and competitiveness. Bartoli and Blatrix (2015) believed that the definition of performance should be achieved through items such as piloting, evaluation, efficiency, effectiveness, and quality.

Murphy et al., (1996) claimed that firm performance is a multidimensional concept, and three indicators can be production, finance, or marketing (Sohn et al., 2007), along side

outcomes like growth and profit (Wolff & Pett, 2006). Ultimately, all firms engaged in innovation aim to enhance their performance relative to non-innovating firms. The assessment of firm performance encompasses various metrics, including sales per employee, exports per employee, sales growth rates, total sale, total assets, total employment, operating profit ratio, turnover, and return on investment (Hatzikian, 2013).

The firm may either develop the innovation itself or adopt it from other firms or institutions OECD/Eurostat (2005). Further, it follows from the OECD/Eurostat (2005) that a new or enhanced product is implemented when it is launched, while new processes, marketing approaches or organizational approaches are implemented when they are put into use in the firm's business. A firm that has implemented an innovation in the form of product, process, marketing method or organizational method during the observation period, is referred to as an innovative firm. The Oslo Manual developed by Eurostat and the OECD is the main international provider of guidelines for the collection and use of innovation data and creates a platform for research and testing on innovation measurement.

Innovation is very important for firms themselves in increasing competitiveness, creating a value, determining the long-term survival, and raising productivity (Mohnen and (Anderson and Potočnik 2014; Beyene et al. 2016). The ability of a country to sustain rapid economic growth, in the long run, also depends on the effectiveness with which its institutions and policies support the knowledge generation, technological transformation, and innovativeness of its enterprises firm (Ethiopian Science and Agency Technology (ESTA) 2006).

2.1.1 Innovation inputs and innovation outputs (product and process innovation)

Innovation is measured as the expected mean share of sales resulting from new or improved products conditional on the innovation input, the way innovation is organized, and some characteristics of the firm and its environment" (Mohnen and Dagenais, 2002) . This composite indicator combines the estimated probability to innovate and the estimated percentage of sales resulting from new products. Lau, (2012) conducted a study that assess the correlation between innovation activities (inputs) and types of innovation (outputs) by analyzing data from the Fourth Community Innovation Survey (CIS4)

involving 492 companies in Hong Kong. In his research, innovation inputs are linked to innovation activities, sources, and expenditures as indicated in figure 1.

Innovation is a process that may occur across a series of activities initiated by a company aimed at developing specific innovations and may be related to science, technology, organization, development, finance, and business(OECD/Eurostat, 2018). The innovation process involves not only activities included in R&D , which is a crucial step in the process, but also other key components such as development activities, support activities, capital purchases, and other current innovation-related expenditures. Being able to identify such factors, referred to as innovation activities, is critical for firms to innovate and improve their ability to innovate. These innovation activities are considered as investments, as they are meant to enhance the innovation performance and ultimately provide future returns to the firm. Indeed, such results tend to exceed the specific innovation to which the activity is directed (OECD/Eurostat, 2005).

Innovation activities may be performed within the company, or it may involve the purchase of goods, services or knowledge from external sources. The acquisition of external knowledge or technology, regardless of where the activity is performed, may lead to a specific innovation itself or it may be necessary for the implementation of other innovations. This includes elemental research activities that are not directly associated with the development of a particular innovation (OECD/Eurostat,2005). Innovation activities are divided into activities related to R&D and non-R&D , distinguished in the way that R&D activities “result in new knowledge or use of knowledge to devise new applications”(OECD, 2002).

Furman, J. L., Porter, M. E., & Stern, S. (2002) suggested that national innovative output can be accompanied by the innovative activity and that the innovation factors are divided into three categories: common innovation infrastructure; cluster-specific conditions which support innovation, such as automotive conditions; and the contributions of corporate efforts with regard to technology and skilled personnel. Most output indicators in empirical research are closely related with product innovations. The main indicators for innovative output are new products and new processes, innovative sales (as percentage of total sales), the conditional expected share in sales of innovative products, and the number of patents(kemp et al., 2003). The innovation output is determined by the

efficiency and/or the absolute value of the innovative input, i.e., the transformation of input into output. Finally, the innovative output is related to the firm performance. For example, the growth of total sales may be higher for innovating firms than for non-innovating firms (kemp., et al, 2003).

Many scholars seem to agree that there exists a positive relationship between innovation input and innovation output in the innovation process but that ‘‘the ‘slope’ of this relationship likely differs among organizations (Duran, Kammerlander, van Essen, & Zellweger, 2015). In other words, firms are heterogeneous not only in their level of innovation input (e.g., R&D) but also in their conversion of said input into output. kemp., et al, (2003) argues that investing more in innovative inputs leads to more innovative outputs, and innovation outputs are associated with firm performance. As a result, firms that invest more in innovative inputs are able to achieve higher levels of innovative output compared to firms that refrain from these investments. This means that firms can actively influence their innovative output by investing in inputs. A high degree of input, without a matching level of integration in the innovation process, will generate new technologies faster that they can be developing into marketable products. Higher inputs and a greater degree of integration, therefore, can be conceived as complementary and beneficial to innovation frequency. Achieving the optimal input level is not difficult. In fact, most firms operating in an innovation-critical environment can be expected to have a high R&D intensity that is similar to each other.

The innovation process refers to the efficiency of the transformation process of innovative input into innovative output. This efficiency is influenced by several aspects like long term R&D, subsidies, various information resources, cooperation with other firms, customers or universities, stated innovation ambitions, innovation centers, and organizational change (kemp et al., 2003). Innovative output is directly influenced by the innovative input and the innovation process. Several studies investigate this relationship. As Schumpeter put forward the theory of innovation, the innovation input is not only improves the core competitiveness of the enterprise but also significantly increases its productivity. Meanwhile, the innovation input brings new technologies or new products to the enterprise, thus making the enterprise show differentiation, which helps to increase the market share and bring excess profits.

2.1.2 Innovation inputs and firm performance

The topic of understanding innovations and their relationship with firm performance has become more relevant since the EU stated, in March 2000 in Lisbon, the ambition to become the world's most competitive and innovative region by 2010. Several studies have linked innovation to firm performance (Exposito and Sanchis-Llopis, 2018). Ramadani et., al. (2017) use the instrumental variable (IV) technique that enables controlling the endogeneity between innovation activities and firm-performance. The Oslo Manual (OECD/Eurostat, 2005) notes that measures of innovation input, although related to technical change, are not its direct measures. Studies from the early period of research on innovation have typically reported a positive relationship between innovation and measures of firm performance. Most of these studies used innovation expenditure as the principal measure of innovation at the firm level.

Many scholars have studied the topic of innovation, and widespread academic literature exists on the innovation-performance relationship. Moreover,they find that investing in innovation activities ultimately enhances a firm's performance (Levinthal,2017; Dosi et al., 2012; Baldwin & Johnson, 1996; Wieser, 2005; Kafouros et al., 2008; Lau et al., 2012).Using cross-sectional data for US firms between 1972 and 1977 Griliches (1986) finds that the higher R&D investment leads to higher rates of productivity growth among firms. The underlying rationale is that encouraging firms to innovate will lead to a better economic performance ; higher growth, more jobs and higher wages (Sirelli, 2000). According to Favre, et al., (2002) study of from French firms , there is a positive impact of innovations on firm profits. Meanwhile R&D intensity and co-operation, capital intensity, sales, innovative exports, market share, and industry concentration, and national and international R&D spill-overs exert a significant influence on a firm's profits. Einfeldt & Hasle, (2019) examined the relationship between innovation input, innovation output, and firm performance among Danish enterprises using longitudinal data from the Innovation Survey in Denmark. In their analysis all innovation activities except acquisition of external rights suggest a substantial influence on the implementation of either one of the different types of innovation.

2.1.3 Innovation output and firm performance

In measuring firm performance, various concepts are found: sales per employee, export per employee, growth rates of sales, total assets, total annual sale, total employment,

operation profit ratio, turnover and return on investment (Evangelista & Sirilli,1995). On the other side, Klomp & Leeuwen, (2017) studied the relationship between innovation output and firm performance and found that process innovation is both strongly and positively associated with firm performance (sales, productivity, and employment growth). A negative relationship between product innovation and employment growth was found; however, this connection proved to be insignificant. Loof et al. (2001), using the same CIS2 data from manufacturing firms in Finland, Norway, and Sweden, found a positive relationship between product and process innovation and firm productivity.

Einfeldt & Hasle (2019), study the relationship between innovation input, innovation output, and firm performance for Danish enterprises using a longitudinal study of the Innovation Survey in Denmark. These authors associated innovation inputs with innovation activities, sources of innovation, and expenditures, whereas product, process, marketing, and organizational innovation are related to innovative outputs and total sales as firm performance. In which studies, innovation inputs and innovation outputs directly affect firm performance in terms of total sales.

2.1.4 Human capital and Research , innovation outputs and firm performance

Investment in human capital affects the ability, skills, and knowledge of the workforce of the firm. These investments affect innovation of the firm. Several studies proliferated this issue. For instance, van Uden et al(2017). Analyzed the impact of human capital innovation in developing countries (Kenya, Tanzania, and Uganda) using data from the Enterprise Surveys of the World Bank and found that human capital spurs innovation. Nafi'Maula, N. H., & Anas, M. (2023) also argued that human capital affects innovation abilities of firm in Java. Further he showed that different combinations of human capital affect innovative output depending on the context in which these combinations are implemented (manufacturing or service sector).

Moreover, Audretsch et al. (2016) added that academic-based human capital encourages innovativeness of firm while business-based human capital does not play a role. A significant amount of innovation and improvements originates from design improvements like "learning by doing" and "learning by using"Arrow (1962) and such informal efforts are embodied in people and organizations (Teece,1986). Many literature stress an importance of the experience of the firms that emanates from the on-the-job training.

Reis., (2021) study the relationship between innovation input and innovation output. This author found that innovation inputs such as human resources and research (R&D and education) and infrastructure positively and significantly influence innovation outputs (knowledge and technology-based products; creative products). Laura et al., (2006) found that R&D input was positively associated with process and product innovation, which in turn had a significant impact on the productivity of Italian firms. Crepon et al.,(2010) Using a cross-section of French firms in the manufacturing sector, they found a positive effect of R&D activity on innovation output measured by the number of patents and a positive and significant effect on firm productivity.

Mohnen, (2014) linked R&D as innovation input to innovation output and productivity, using firm-level data from the second Community Innovation Surveys (CIS2) of France, Germany, Spain, and the United Kingdom. They found a positive effect of R&D intensity on the process and product innovation. Generally, R & D activity is an indispensable part of firm innovation activities. Battisti and Stoneman (2010) ,Crepon et al.(1998), Hashi and Stojcic (2013), and Janz et al. (2004) found that R&D leads to product/process innovation. In this, Vona & Consoli, (2014) argue that continual adjustments in training and education are vital for nurturing innovation. While research and development are closely tied to innovation rates and innovation capacity, it's important to note that R&D is just one of the many methods used for innovation. Firms innovate through a wide array of activities that may not necessarily involve formal R&D (Arundel et al., 2008).

However, some scholars argue these theories, for example: Firms innovate through a wide range of activities that do not necessarily require formal R&D (Arundel, Bordoy & Kanerva, 2008). According to (Dehoff & Bordia, 2005) R&D activities do not necessarily increase profits. R&D expenditures are risky and increase the volatility of future operative performance. R&D activities may not always be able to achieve their set goals (Baker & Freeland, 1975). Mitchell et al., (2018) found that R&D expenditure boosts a firm's innovation activity, but that not all R&D projects are necessarily beneficial for a firm's performance, as some projects might be unsuccessful.

2.1.5 Business sophistication ,innovation outputs and firm performance

According to Kirikkaleli and Ozun (2019), business sophistication and innovation are essential components of competitiveness in innovation-driven economies. Liu & Buck, (2007) in their analysis, found that education in China positively affects innovation output.

At the firm level, effective training has a positive effect on innovation outputs (Schneider et al., 2010). Rosli, & Mahmood, (2013) find that there is a positive relationship between employee training, innovation outcomes, and firm performance. In contrast, Robson et al., (2009) argue that in the case of Ghana, there is no positive relationship between training and innovation. Razavi et. al. (2012) found a significant positive relationship between innovation and business sophistication.

2.1.6 Infrastructure, innovation outputs and firm performance

The importance of economic infrastructure for innovation and development is well known (Foster & Briceño-garmendia 2010; Ridley & Street, 2006; Yepes & Foster, 2009). Foundations can lead to reducing production costs and increasing productivity (Tchamekwen, 2019). They also extend the geographic reach of markets and provide opportunities to develop new products and services, new processes and new business models. However, at the global level, there is a significant gap in the amount of infrastructure needed to support economic activities and, more so, to deliver on the sustainable development goals (D. Paper et al., 2017).

Most business firm in developing countries like Ethiopia are small and medium-sized and face various challenges including lack of processed technological information, inadequate training capabilities at technical and vocational education training (TVET) centers, lack of access to financial and other resources and absence of consultancy support (FDRE 2010), poor infrastructural base, and unfavorable government policies which weaken their innovation activities (Abdu and Jibir 2017; Adebowale et al. 2014; Dotun 2015; Egbetokun et al. 2016). It is interesting to observe that despite all the difficulties, a large share of firms can still innovate in the African context (Abdu and Jibir 2017; Egbetokun et al. 2016).

E-mail can be used for various marketing purposes, for example to share information about products and services, to promote them, to build brands, to guide customers to web sites, to alert customers, and to tell the status of orders. Marketers today use various e-mail techniques, such as newsletters, reward programs and community building (Brondmo, 2000; Roberts et al., 2001). Generally, this study as the aim of to explore the the relationship between Innovation input, output and firm performance, we identify conceptually and empirically to bring about the concept of innovation impact on firm

performance among Ethiopian firms. Moreover, the conceptual frame work of their relationships are indicated in figure 2.

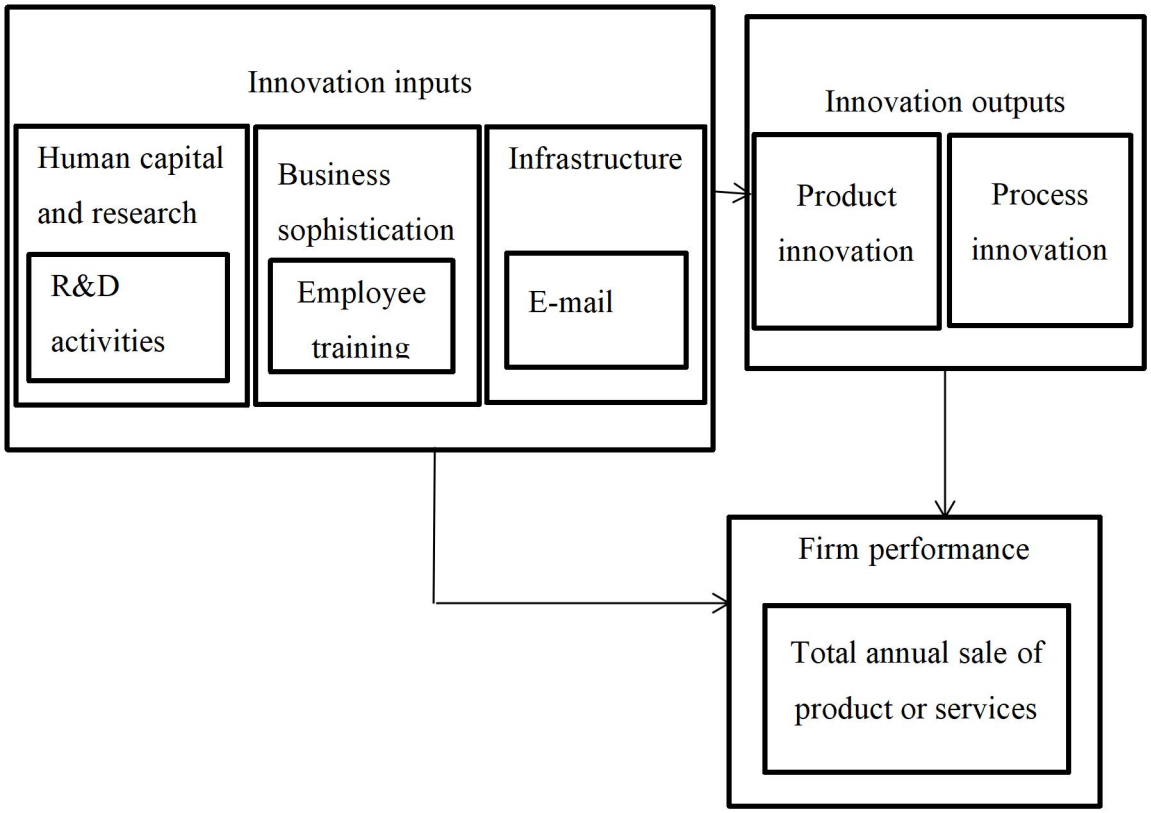

Figure 2: Conceptual Framework Of Innovation Input, Innovation Output And Firm Performance

Source: Author's schematic diagram

CHAPTER THREE
MATERIALS AND METHODS

3.1 Data

We used quantitative data types approach. The data utilized in this study is secondary data source collected by the World Bank Enterprise Surveys (ES) data sate of year 2015; evidence from Ethiopian firms level data. The 2015 Ethiopia enterprise survey sample was chosen using a stratified sampling method based on data availability. The country's stratification involved three levels: industry, firm size, and region. Industry stratification encompassed manufacturing, retail, and other services, while size stratification included micro (less than 5 employees), small (5 to 19 employees), medium (20 to 99 employees), and large (more than 99 employees). Regional stratification for the 2015 Ethiopia ES was carried out across the four most populous Ethiopian regional states and two administrative cities: Oromia, Amhara, Tigray, and Southern Nation Nationalities and People (SNNP), along with Addis Ababa and Dire Dawa, respectively. For this study, a total of 848 firms were included across the four most populous Ethiopian regional states and two administrative cities, encompassing all firm sizes. To analysis our dependent and independent variables we apply descriptive and inferential analysis. The dependent and independent variables relevant for this study are represented and defined in table 2.

3.2 Econometric model and Model specification

In the empirical analysis, we first estimate the probability that the observed firm has innovation input, innovation output and firm performance. Innovation input is measured as R&D expenditures, employee training and using email to communicate with clients and suppliers. Innovation output is measured as firm product and process innovation. Firm performance is measured as total annual sale of all products in 2014 last fiscal complete year as shown in figure 3. In this study, we analysis how innovation inputs affect innovation outputs and firm performance. To analyze the effect of innovation on firm performance, one of the most appropriate equation model is the Crepon, Duguet & Mairesse (CDM) model (Crepon et al.,2010). Crepon, Duguet & Mairesse (CDM) is useful for measuring innovation and firm performance. It employs the Cobb-Douglas production function to incorporate the element of knowledge and connect R&D activity to innovation and firm performance. The Crepon, Duguet & Mairesse (CDM) model is rooted in the traditional knowledge production function approach (Griliches, 1979), but it

refines the standard approach in one important way: instead of directly studying the impacts of R&D investments on the productivity performance of enterprises, it analyses the various stages of the innovative process (Fulvio Castellacci, 2010).

More precisely, the CDM model studies four interrelated stages of the innovation chain: the choice of a firm whether or not to engage in innovative activities; the amount of resources it decides to invest in R&D; the effects of these R&D investments on innovation output; the impacts of innovation output on the productivity of the firm.

Table 2:variable description

Independent variable	**Description**
RandD	Dummy coded 1 if firm i spends on formal R&D activities and 0 otherwise
Etrain	Dummy coded 1 if firm i proved formal Training Program for employees and 0 otherwise
email	Dummy coded 1 if firm i use email to communicate with clients and suppliers and 0 otherwise
Control variable	
firmage	Natural logarithm age of firm formally registered began operation
Dependent variable	**Description**
Prdin	Dummy coded 1 if firm i has introduced products or Service that are new or have significant improvements and 0 otherwise
Prsin	Dummy coded 1 if firm i has introduced new or significantly improved processes in the last three years and 0 otherwise
Totalsale	Total annual sale of all products in 2014 last fiscal complete year

Many scholars have found this model useful for measuring innovation and firm performance ((Lööf, Mairesse., & Mohnen,. 2017; Baum, Lööf, Nabavi & Stephan, 2017; Asunka et,.al, 2020 and Lööf,H., & Heshmati, A. 2006). The model is commonly used due to its ability to overcome some difficulties encountered in measuring innovation and productivity (Asunka et,.al, 2020).

Today the CDM model has become the workhorse in the empirical literature on innovation and productivity and been applied to micro data of over 40 countries (Asunka et,.al, 2020). The original Crepon, Duguet & Mairesse (CDM) paper and papers inspired by its framework have received hundreds of citations. The CDM framework introduces a structural model that explains productivity by innovation output and the latter by research investment, and it suggests a method of correcting for the selectivity and the endogeneity inherent in the model (Baum, Lööf, Nabavi & Stephan, 2017). Over the years a number of variations of the original CDM model have been proposed depending on whether they use continuous or discrete data for innovation input and output, various measures of those variables, and various estimation methods are; Asymptotic least squares (ALS),Third sequential least squares (3SLS), second sequential least squares (2SLS) and maximum likelihood (Baum, Lööf, Nabavi & Stephan, 2017). The original cross-sectional model has been extended to panel data, dynamic models, and applications on multiple types of innovation activities and economic outcome measures.

The classical CDM model contains four stages (Asunka et,.al, 2020). According to Crepon et al.,(1998) four-equation model innovation process as consisting of four stages: (1) the decision to innovate, (2) the decision on how much to spend on innovation activities, (3) the relation between expenditure on innovation and innovation output, and (4) the relation between innovation output and performance. However, the decision to innovate and the intensity to invest in innovation as innovation input (kemp et al., 2003). The first and second steps seek to describe the firm's efforts to innovate (the level of innovation input). The third step analyzes the level of innovation output, and the fourth step describes the firm performance of the novel idea. However, in this study, we apply a modified version of the (Crepon et al.,2010) by (Lööf,H., & Heshmati, A. (2006) structural model. In addition, this proposed three equation system by (Pakes, 1985) links innovation input to innovation output and innovation output to firm performance.

Based on three equation system proposed by (Pakes, 1985) this study links innovation input to innovation output and innovation output to firm performance as specified in blow equations (1) and (2). Mean that, first we measure the effect of innovation input on innovation output. The estimated innovation outputs equation is:

$$(\text{Inoutput})_{it} = (\text{Ininput})_{it} + \beta_1 X_{1it} + \varepsilon_{1i} \quad (1)$$

Where: $(Inoutput)_{it}$ represent innovation outputs of firm i at time t, $(Ininput)_{it}$ expresses the innovation input for firm i at time t, X_{1it} represent explanatory variables, β_1 is the coefficient of explanatory variables; and ε_{1i} the error term.

Second we measures the effect of innovation output on firm performance. The estimated firm performance equation is:

$$(Fperformance)_{it} = (Inoutput)_{it} + \beta_2 X_{2it} + \varepsilon_{2i} \quad (2)$$

Where: $(Fperformance)_{it}$ is the performance of firm i at time t (dependent variable), $(Inoutput)_{it}$ represents innovation output of firm i at time t, X_{2it} represents explanatory factors of firm performance, and ε_{2i} is the error term.

In addition, in this study we estimated the effect of innovation inputs on firm performance. The direct estimated firm performance equation from innovation inputs is:

$$(Fperformance)_{it} = (Ininput)_{it} + \beta_3 X_{3it} + \varepsilon_{3i} \quad (3)$$

Where: $(Fperformance)_{it}$ is the performance of firm i at time t (dependent variable), $(Ininput)_{it}$ expresses the innovation input for firm i at time t, X_{3it} represent explanatory variables, β_3 is the coefficient of explanatory variables; and ε_{3i} the error term.

According to Asunka et,.al, (2020) the extended CDM model are as follows:

3.2.1 Innovation outputs estimation model

At this stage we estimate innovation outputs as product innovation (model 1) and process innovation (model 2) respectively.

Model 1

$$Prdin_{it} = \beta_0 + \beta_1 RandD_{it} + \beta_2 Etrain_{it} + \beta_3 email_{it} + \beta_4 firmage_{it} + \varepsilon i$$

Model 2

$$Prsin_{it} = \alpha_0 + \alpha_1 RandD_{it} + \alpha_2 Etrain_{it} + \alpha_3 email_{it} + \alpha 4\ firmage_{it} + \varepsilon i$$

3.2.2 Firm performance estimation model

At this stage we estimate the effect of innovation inputs on firm performance jointly through innovation output(model 3) and separately (model 4) respectively. In addition,we estimate the effect of innovation outputs on firm performance (model 5).

Model 3

$$Totalsale_{it} = \theta_0 + \theta_1 RandD_{it} + \theta_2 Etrain_{it} + \theta_3 email_{it} + \theta_4 Prdin_{it} + \theta_5 Prsin_{it} + \theta_6 firmage_{it} + \varepsilon_i$$

Model 4

$$Totalsale_{it} = \theta_0 + \theta_1 RandD_{it} + \theta_2 Etrain_{it} + \theta_3 email_{it} + firmage_{it} + \varepsilon_i$$

Model 5

$Totalsale_{it} = \theta_1 Prdin_{it} + \theta_2 Prsin_{it} + \theta_3 firmage_{it} + \varepsilon_i$

Note: firm age is a vector of control variables in all model

Baum, Lööf, Nabavi & Stephan, (2017) estimate the traditional CDM model but use a more general estimation method, known as Generalized Structural Equation Model (GSEM), which allows to include a latent variable created by factor analytical methods to capture unobserved factors. A full information maximum likelihood estimator of a seemingly unrelated equation system is applied to estimate coefficients for each of the including sectors simultaneously within the recursive system allowing for cross-correlation of some of the disturbances.

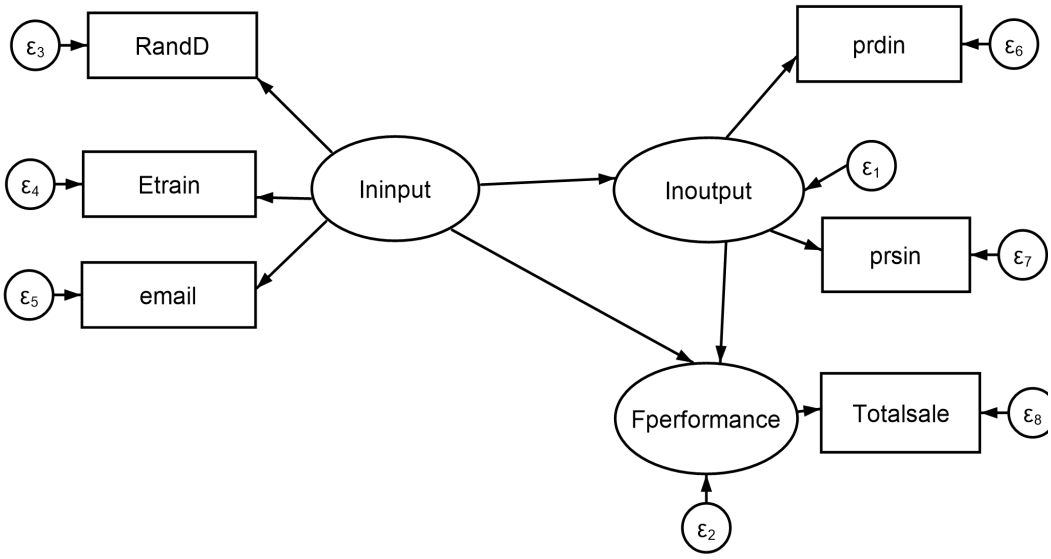

Figure 3: Conceptual model

In this study based on Baum, Lööf, Nabavi & Stephan, (2017) by matching traditional Crepon, Duguet & Mairesse (CDM) with general estimation methods ,We apply a generalized structural equation model approach to the estimation of the relationship between innovation inputs, innovation outputs and firm performance that focuses on the potentially crucial heterogeneity across sectors. The model accounts for selectivity and handles the endogeneity of this relationship in a recursive framework which allows for feedback effects from firm performance to innovation. A detailed discussion of these aspects of the GSEM framework is provided by Roodman (2011); Rabe-Hesketh, Skrondal,& Pickles (2004) earlier implementation of GSEM. These models are based on the generalized linear model (GLM) framework. Stata's GSEM extends that framework to

incorporate multiple equation systems and latent variables. The original CDM model as a recursive system of equations using GSEM including latent variable created by factor analytical methods representing covariance between observed dependent variables. The latent variable captures a set of unobserved factors that may be relevant in each equation as indicated in figure 3.

CHAPTER FOUR
DISCUSSION AND RESULT

4.1 Descriptive statistics analysis

We start our analysis by outlining key statistics of firm frequency (the degree of firms to engage on innovation). A selected variables for this study are firm spend expenditures on formal R&D activities, formal program employee training, and use of email to communicate with clients and suppliers as innovation inputs. Technological innovation (product and process innovation) as innovation outputs. As well as total annual sale of all products as firm performance.

Table 3: The degree of firm engagement on innovation

R & D	Freq.	Percent
No	778	91.85
Yes	69	8.15
Total	847	100.00
Employees training		
No	720	85.21
Yes	125	14.79
Total	845	100.00
E-Mail		
No	358	42.47
Yes	485	57.53
No	534	62.97
Yes	314	37.03
Total	848	100.00
Process innovation		
No	653	77.19
Yes	193	22.81
Total	846	100.00

As a result, Table 3 shows that Ethiopian firms, around 92% did not spend on formal R& D activities , 85.21% did not proved formal program training for their employees, 43 did not use email to communicate with clients and suppliers, 63% did not introduced new or significantly improved products or services and 77.19% did not introduced new or significantly improved logistics ,delivery or distribution methods for products services. In contrast 8.15%,14.79%, 57% 37.03% and 22.81% do have R & D, employee training , email , product innovation and process innovation respectively.

4.2 Regression analysis

In this section, we present the results of our estimations. First, we estimate the effect of innovation input elements on innovation outputs (product and process innovation) in equation (1) and model 1 & 2. Mean that,the innovation outputs where measured at two levels: (i) product innovation (model 1) and (ii) process innovation (model 2), both serving as dependent variables in terms of innovation inputs. second we estimate the effect of innovation input elements and innovation outputs on firm performance jointly in equation (2) and model 3.Third, we estimate the effect of innovation inputs on firm performance separately (directly) in equation (3) and model 4.

4.2.1 Innovation input effect on innovation outputs

At this stage, our findings from the GSEM regression results presented in Table 4 regarding to the innovation input effect on innovation outputs is as follows: First; Research and Development (R&D) has a positive impact on both product and process innovation. This result indicate that, firms that spend expenditure on formal R&D activities witness a 24.2% increase in product innovation and a 40.4% boost in process innovation. This result is confirmed by different scholars. Parisi et al. (2006) discovered a positive association between R&D investment and both process and product innovation. Laura et al., (2006) found that R&D input was positively associated with process and product innovation, which in turn had a significant impact on the productivity of Italian firms. Crepon et al.,(2010) Using a cross-section of French firms in the manufacturing sector, they found a positive effect of R&D activity on innovation output measured by the number of patents and a positive and significant effect on firm productivity. Mohnen, (2014) linked R&D as innovation input to innovation output and productivity, using firm-level data from the second Community Innovation Surveys (CIS2) of France, Germany,

Spain, and the United Kingdom. They found a positive effect of R&D intensity on the process and product innovation.

Second, formal program employees training has a positive and significant effect on both product and process innovation. The results show that, providing formal program training for employees leads to increase 17.1% and 15.1% of product and process innovation of Ethiopian firms respectively. Research conducted by Jibir &Abdu, (2019) on the determinants of firm innovation in Nigeria supports these findings, highlighting the positive and highly significant impact of formal program training on both product and process innovation. In their analysis, Liu & Buck, (2007) discovered that education in China has a positive impact on innovation output. Additionally, Schneider et al., (2010) found that effective training at the firm level leads to increased innovation outputs.

Third, use of email to communicate with clients and suppliers has a positive and significant effect on both product and process innovation. As a result,as firms use email to communicate with clients and suppliers, leads to increase by 17% and 15% of product innovation and process innovation respectively.

4.2.2 The innovation inputs and outputs effect on firm performance jointly

In this stage, we evaluate the impact of innovation inputs and outputs on firm performance jointly (model 3). mean that we measure the effect of innovation inputs on firm performance through innovation outputs (indirect effect of innovation inputs on firm performance. Then based on Table 4 GSEM regression results specification our finding is noted as follows:

First, Research and Development (R&D) has a notably positive and highly significant effect on firm performance. This result Specifically indicate, firms that invest expenditure in formal R&D activities experience a substantial 81.3% increase in annual sales (profit) of their products or services compared to their counterparts. This finding aligns with the research of (Mohnen, 2014) who established a positive link between R&D investment, innovation output, and productivity using data from the second Community Innovation Surveys (CIS2) of France, Germany, Spain, and the United Kingdom. Furthermore, Wieser, (2005) conducted a meta analysis of earlier research with mixed results and found on average a strong and positive relationship between R&D expenditures and firm performance. However, some scholars argue encounter side, for instance, according to

Dehoff & Bordia, (2005) R&D activities do not necessarily increase profits. R&D expenditures are risky and increase the volatility of future operative performance.R&D activities may not always be able to achieve their set goals (Baker & Freeland, 1975). Mitchell et al., (2018) found that R&D expenditure boosts a firm's innovation activity, but that not all R&D projects are necessarily beneficial for a firm's performance, as some projects might be unsuccessful.

Second, from our GSEM regression result specification, we found that providing formal program training for employees also yields a positive and significant effect on firm performance,with a 46.3% rise in the total annual sales of the firm's products and services. According to Zhou et al, (2011) in the Netherlands, both training and R&D play a significant role in enhancing a firm's innovation performance by increasing sales of new products. Similarly, Rosli & Mahmood,(2013) discovered a positive correlation between employee training and innovation outcomes, as well as firm performance. They concluded that training has a beneficial impact on firm growth, including improvements in competitive advantages (Fairfield-Sonn, 1987) and overall growth (Bartel,1994). Conversely, Robson et al., (2009) argued that, in Ghana, there is no discernible positive relationship between training and innovation.

Third , use of email to communicate with client and suppliers has positive and highly significant effect on firm performance by 162.8%. This result indicate that as use of email to communicate with clients and suppliers increase, firm total annual sale of products or process increase by 162.8% indirectly. In this study the result show that innovation inputs such as formal R&D activities,formal employee training and use of email have a positive indirect effect on firm performance. Fourth , both product and process innovation have positive and significant effect on firm performance by 44.7 and 57.7 respectively jointly with innovation outputs.

4.2.3 Innovation inputs effect on firm performance separately (directly)

To explore the direct effect of innovation inputs on firm performance, as shown in table 5 we estimate innovation inputs elements as independent variable and firm performance as dependent variable separately. As a result, spending expenditure on formal R&D activities has a positive and highly significant effect on firm performance by 114.5 %.

This result indicate that, spending expenditure on formal R&D activities directly increase 114.5 % firm total annual sale of products or services.

Table 4: Innovation inputs and outputs effect on firm performance jointly: GSEM regression results

VARIABLES	(Model 1) prdin	(model 2) prsin	(model 3) Totalsale
R and D	0.242***	0.404***	0.813***
	(0.060)	(0.050)	(0.262)
Etrain	0.171***	0.151***	0.463**
	(0.046)	(0.039)	(0.196)
email	0.170***	0.152***	1.628***
	(0.033)	(0.028)	(0.147)
prdin			0.447***
			(0.156)
prsin			0.577***
			(0.184)
firmage	0.002**	-0.000	0.043***
	(0.001)	(0.001)	(0.005)
var(e.tas)	0.210***	0.149***	3.513***
	(0.010)	(0.007)	(0.181)
Constant	0.193***	0.089***	13.588***
	(0.029)	(0.024)	(0.128)
Observations	839	837	757

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Providing formal program employees training has a positive and highly significant effect on firm performance. This result show that Providing formal program training for employees leads to increase firm profit by 62.1% annually. In addition, using email to communicate with clients and suppliers has a positive and highly significant effect on firm performance and as using email to communicate with clients and suppliers increases, firm annual profit (total annual sale of products or services directly increased by 178%.

Table 5: Innovation inputs effect on firm performance separately (directly): GSEM regression result

VARIABLES	Model 4 Totalsale
R and D	1.145***
	(0.258)
Etrain	0.621***
	(0.197)
E-mail	1.779***
	(0.146)
firmage	0.045***
	(0.006)
var(e.tas)	3.633***
	(0.187)
Constant	13.734***
	(0.126)
Observations	758

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The results of this study show that innovation inputs elements such as spending expenditure on formal R&D activities, Providing formal program employees training and use of email to communicate with clients and suppliers have a positive and highly direct significant effect on firm performance

4.2.4 Innovation output effect on firm performance separately

The impact of innovation output on firm performance is outlined in equation 3 and model 5. The findings from the Generalized Structural Equation Model (GSEM) regression analysis in table 6: revealed that both product and process innovation have a significant and positive effect on firm performance, as evidenced by a 72.7% and 112.2% increase in annual firm sale of product and process, respectively. This aligns with the research of

(Asunka., & Anaba., 2020) who also emphasized the positive effects of both types of innovation on firm performance. Additionally, (Klomp & Leeuwen, 2017) established a strong positive correlation between process innovation and firm performance.

Table 6: Innovation output effect on firm performance separately: GSEM regression result

	(model 5)
VARIABLES	Totalsale
prdin	0.727***
	(0.169)
prsin	1.122***
	(0.193)
firmage	0.055***
	(0.006)
var(e.tas)	4.282***
	(0.219)
Constant	14.267***
	(0.124)
Observations	764

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Moreover, Loof et al. (2001) observed a favorable link between product and process innovation and firm productivity using CIS2 data from manufacturing firms in Finland, Norway, and Sweden. Fagerberg (2004) argued that while the introduction of new products is commonly assumed to have a strong and positive effect on the growth of income and employment, process innovation may have a more vague effect due to its cost-cutting nature. Murat Atalay,(2013)(2001) for Turkish automotive supplier industry analysis technological innovation (product and process innovation) has significant and positive impact on firm performance, but no evidence was found for a significant and

positive relationship between non-technological innovation (organizational and marketing innovation) and firm performance

CONCLUSION AND RECOMMENDATION

Conclusion

The objective of this study is to examine the impact of innovation inputs on innovation outputs and firm performance evidence from Ethiopian firms level-data collected by World Bank enterprise survey, encompassing all sizes of firms micro, small, medium, and large across the four most populous regional states and two administration cities. we used quantitative data type approach. Our data is based on secondary data source from the 2015 World Bank enterprise survey data set, including 848 firms operating in manufacturing, retail, and various service sectors across these regions. We used Crepon, Duguet & Mairesse (CDM) model equation to link innovation inputs with innovation outputs and innovation outputs to firm performance. To evaluate the effect of innovation inputs on innovation outputs and firm performance we applied General Structural Equation Model (GSEM) approach regression analysis to answer the research question of this study .

First, we analyze the effect of innovation inputs on innovation outputs in table 4 and we concluded Our finding as follows: The finding reveal that all innovation input elements selected variables for this study have positive and highly significant effect on innovation outputs (product and process innovation). Mean that, firms that spend expenditure on formal R&D activities, providing formal program training for their employees and use of email to communicate with clients and suppliers re strongly contribute for firms product and process innovation improvement.

Second, we estimate the effect of innovation inputs on firm performance jointly (indirect effect of innovation inputs on firm performance) in table 4. At this level we measured the effect innovation inputs on firm performance through innovation outputs and the result show that all innovation inputs variable of this study have positive indirect effect on firm performance. On the other hand, we explore the the effect innovation inputs on firm performance separately. At this stage we measured the effect innovation inputs on firm performance directly. As a result,all innovation inputs variable of this study have strongly positive direct effect on firm performance. Finally ,in this study innovation inputs have highly direct effect than indirect effect on firm performance. Also innovation outputs have strong positive effect on firm performance.

Recommendation

Despite importance of innovation for economic growth of developing countries, Ethiopia should give prioritize for innovation to accelerate its economic growth at the regional and national level. Therefore by understanding the benefits of innovation, all stakeholders, including the government, should be give priority to innovation. On the other hand, from the result of this study, innovation output and firm performance depends on innovation inputs. So that at firm level to enhance their innovation outputs and firm performance, all firms should be improve first their innovation inputs.

Suggestions for further researchers

This study's scope is restricted to Ethiopian firms, making it challenging to apply its findings to all developing countries, Future researchers may study to all developing countries. Consequently, this study used secondary data source only, future researchers may explore innovation and firm performance relationships by incorporate primary data sources into their work.

REFERENCE

Ã, J. J. (2008). *International Journal of Information Management Organisational innovation as part of knowledge management*. *28*, 403–412. https://doi.org/10.1016/j.ijinfomgt.2008.04.007

Abdu, M., & Jibir, A. (2018). Determinants of firms innovation in Nigeria. *Kasetsart Journal of Social Sciences*, *39*(3), 448-456.

Achim, M. V. (2010). Business performances: between profitability, return and growth. *Annals of the University of Craiova, Economic Sciences Series*, *2*.

Adebowale, B. A., Diyamett, B., Lema, R., & Oyelaran-Oyeyinka, O. (2014). Innovation research and economic development in Africa. *African Journal of Science, Technology, Innovation and Development*, *6*(5), V-XI.

Amara, N. (2005). *Sources of information as determinants of novelty of innovation in manufacturing firms : evidence from the 1999 statistics Canada innovation survey*. *25*, 245–259. https://doi.org/10.1016/S0166-4972(03)00113-5

Anderson, N., Potočnik, K., & Zhou, J. (2014). Innovation and creativity in organizations: A state-of-the-science review, prospective commentary, and guiding framework. *Journal of management*, *40*(5), 1297-1333.

Arlet, J. (2015). *Doing Business Research Notes*.

Arrow, K. J. (1962). The economic implications of learning by doing. *The review of economic studies*, *29*(3), 155-173.

Artz, K. W., Norman, P. M., Hatfield, D. E., & Cardinal, L. B. (2010). A longitudinal study of the impact of R&D, patents, and product innovation on firm performance. *Journal of product innovation management*, *27*(5), 725-740.

Arundel, A., Bordoy, C., & Kanerva, M. (2008). *Neglected innovators : How do innovative firms that do not perform R & D innovate ? 215*, 1–38.

Asunka, B. A., Ma, Z., Li, M., & Anaba, O. A. (2020). Linking Innovation to Firm Performance in Developing Countries: the Role of Trade Liberalization. *European Journal of Business and Management Research*, *5*(3).

Atalay, M., Anafarta, N., & Sarvan, F. (2013). The relationship between innovation and firm performance: An empirical evidence from Turkish automotive supplier industry. *Procedia-social and behavioral sciences*, *75*, 226-235.

Ayinaddis, S. G. (2022). Exploring firm-specific deterrents of innovation in micro and small enterprises in Ethiopia. *Journal of Innovation and Entrepreneurship*, *11*(1), 57.

Background, T. (2005). *RELATIONSHIP BETWEEN INNOVATIVENESS , QUALITY , GROWTH , PROFITABILITY , AND MARKET*. *575*(November 2004), 555–575. https://doi.org/10.1002/smj.461

Baker, N., & Freeland, J. (1975). *Recent Advances in R & D Benefit Measurement and Project Selection Methods*. *September 2015*.

Baldwin, J. R., & Johnson, J. (1996). *Business strategies in more- and less-innovative firms in Canada*. *25*, 785–804.

Barasa, L., Vermeulen, P., Knoben, J., Kinyanjui, B., & Kimuyu, P. (2019). Innovation inputs and efficiency: manufacturing firms in Sub-Saharan Africa. *European Journal of Innovation Management*, *22*(1), 59-83.

Bartoli, A., & Blatrix, C. (2015). *Management dans les organisations publiques-4e édition: Défis et logiques d'action*. Dunod.

Battisti, G., & Stoneman, P. (2010). How innovative are UK firms? Evidence from the fourth UK community innovation survey on synergies between technological and organizational innovations. *British Journal of Management*, *21*(1), 187-206.

Beyene, K. T., Shi, C. S., & Wu, W. W. (2016). Linking culture, organizational learning orientation and product innovation performance: The case of Ethiopian manufacturing firms. *South African Journal of Industrial Engineering*, *27*(1), 88-101.

Blundell, R., Dearden, L., Meghir, C., & Sianesi, B. (1999). *Human Capital Investment : The Returns from Education and and the Economy*. *20*(1), 1–23.

Branch, B. (1974). *Research and Development Activity A Distributed Profitability : Lag Analysis*. *82*(5).

Briggs, D. C. (2004). Causal inference and the Heckman model. *Journal of Educational and Behavioral Statistics*, *29*(4), 397-420.

Bartel, A. P., Asefa, S., & Huang, W. C. (1994). Workplace Training in the United States: Is It Underprotected?.

Baum, C. F., Lööf, H., Nabavi, P., & Stephan, A. (2017). A new approach to estimation of the R&D–innovation–productivity relationship. *Economics of Innovation and New Technology*, *26*(1-2), 121-133.

Castellacci, F., & Zheng, J. (2010). Technological regimes, Schumpeterian patterns of innovation and firm-level productivity growth. *Industrial and Corporate Change*, *19*(6), 1829-1865.

Chan, A. P. C., Lam, P. T. I., Chan, D. W. M., Asce, M., Cheung, E., & Ke, Y. (2010).

Critical Success Factors for PPPs in Infrastructure Developments : Chinese Perspective. *136*(May), 484–494.

Cirera, X., Sabetti, L., World, T., Group, B., & Street, H. (2019). *The effects of innovation on employment in developing countries : evidence from enterprise surveys*. *2004*, 1–16. https://doi.org/10.1093/icc/dty061

Collard-wexler, A., & Connell, S. D. O. (2014). *HOW DO ELECTRICITY SHORTAGES AFFECT INDUSTRY ? EVIDENCE FROM*.

Crepon, B., Duguet, E., & Mairessec, J. (n.d.). *Economics of Innovation and New Technology Research , Innovation And Productivi [Ty : An Econometric Analysis At The Firm Level*. *March 2013*, 37–41.

Daksa, M. D., Yismaw, M. A., Lemessa, S. D., & Hundie, S. K. (2018). *Enterprise innovation in developing countries : an evidence from Ethiopia*.

Dehoff, K., & Bordia, R. (2005). *strategy + business*. *41*.

Dosi, B. G., Arcangeli, F., David, P., Engelman, F., Freeman, C., Moggi, M., Nelson, R., Orsenigo, L., & Rosenberg, N. (2012). *Sources , Procedures , and Microeconomic Effects of Innovation*. *26*(3), 1120–1171.

Duran, P., Kammerlander, N., Van Essen, M., & Zellweger, T. (2016). Doing more with less: Innovation input and output in family firms. *Academy of management Journal*, *59*(4), 1224-1264.

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (Eds.). (2020). *Global innovation index 2020*. Johnson Cornell University.

Dutta, S., Lanvin, B., Rivera León, L., & Wunsch-Vincent, S. (Eds.). (2023). *Global Innovation Index 2023: Innovation in the face of uncertainty*. WIPO.

Egbetokun, A., Atta-ankomah, R., & Jegede, O. (2016). *Firm-level innovation in Africa : overcoming limits and constraints*. *9318*. https://doi.org/10.1080/2157930X.2016.1224619

Einfeldt, T., & Hasle, M. H. (2019). *Innovation and firm performance A longitudinal study of the Innovation Survey in Denmark Supervisor :*

Evangelista, R., & Sirilli, G. (1995). *Service sector Measuring innovation in services*. *5*(3), 207–215.

Exposito, A., & Sanchis-Llopis, J. A. (2018). Innovation and business performance for Spanish SMEs: New evidence from a multi-dimensional approach. *International Small Business Journal*, *36*(8), 911-931.

Fagerberg, J., Mowery, D. C., & Nelson, R. R. (Eds.). (2005). *The Oxford handbook of innovation*. Oxford university press.

Fairfield-Sonn, J. W. (1987). A strategic process model for small business training and development. *Journal of Small Business Management*, *25*(1), 11.

Folkeringa, M. (2003). *Innovation and firm performance*.

Foster, V., & Briceño-garmendia, C. (n.d.). *Africa ' s Infrastructure A Time for Transformation*.

Furman, J. L., Porter, M. E., & Stern, S. (2002). The determinants of national innovative capacity. *Research policy*, *31*(6), 899-933.

Gebreeyesus, M. (2011). Innovation and microenterprises growth in Ethiopia. *Entrepreneurship, innovation, and economic development*, *31*, 1-30.

Georgopoulos, B. S., & Tannenbaum, A. S. (1957). A study of organizational effectiveness. *American sociological review*, *22*(5), 534-540.

Gopalakrishnan, S., & Damanpour, F. (1997). *A Review of Innovation Research in Economics , Sociology and Technology Management*. *25*(I), 15–28.

Griliches, Z., Pakes, A., & Hall, B. H. (1986). The value of patents as indicators of inventive activity.

Habtewold, T. M. (2023). Impacts of internal R&D on firms' performance and energy consumption: Evidence from Ethiopian firms. *International Journal of Innovation Studies*, *7*(1), 47-67.

Hashi, I., & Stojčić, N. (2013). The impact of innovation activities on firm performance using a multi-stage model: Evidence from the Community Innovation Survey 4. *Research Policy*, *42*(2), 353-366.

Hatzikian, Y. (2013). *Exploring the Link between Innovation and Firm Performance*. https://doi.org/10.1007/s13132-012-0143-2

Hussen, M. S., & Çokgezen, M. (2019). Analysis of Factors Affecting Firm Innovation : An Empirical Investigation for Ethiopian Firms Analysis of Factors A ff ecting Firm Innovation : An Empirical Investigation for Ethiopian Firms. *Journal of African Business*, *00*(00), 1–24. https://doi.org/10.1080/15228916.2019.1625020

Hussen, M. S., & Çokgezen, M. (2021). Relationship between innovation , regional institutions and firm performance : Micro-evidence from Africa. *African Journal of Science, Technology, Innovation and Development*, *0*(0), 1–17.

https://doi.org/10.1080/20421338.2020.1866148

Jibir, A., Abdu, M., Bello, F., & Garba, I. (2019). Do Institutions Promote Firm Performance? Evidence from Sub-Saharan Africa. *Review of Market Integration*, *11*(3), 111-137.

Kafouros, M. I., Buckley, P. J., Sharp, J. A., & Wang, C. (2008). *The role of internationalization in explaining innovation performance*. *28*, 63–74. https://doi.org/10.1016/j.technovation.2007.07.009

Karabulut, A. T. (2015). Effects of innovation types on performance of manufacturing firms in Turkey. *Procedia-Social and Behavioral Sciences*, *195*, 1355-1364.

Kassa, E. T., & Mirete, T. G. (2022). Exploring factors that determine the innovation of micro and small enterprises : the role of entrepreneurial attitude towards innovation in Woldia , Ethiopia. *Journal of Innovation and Entrepreneurship*. https://doi.org/10.1186/s13731-022-00214-7

Kemp, R. G., Folkeringa, M., De Jong, J. P., & Wubben, E. F. (2003). *Innovation and firm performance* (No. H 200207). Zoetermeer,, The Netherlands: EIM.

Keraga, M. N., Araya, M., & Group, F. (2022). R & D , innovations , and firms ' productivity in. *African Journal of Science, Technology, Innovation and Development*, *0*(0), 1–14. https://doi.org/10.1080/20421338.2022.2088046

Keupp, M. M., Palmié, M., & Gassmann, O. (2011). *The Strategic Management of Innovation :* https://doi.org/10.1111/j.1468-2370.2011.00321.x

Klomp, L., & Leeuwen, G. Van. (2017). *Linking Innovation and Firm Performance : A New Approach Linking Innovation and Firm Performance : A New*. *1516*(April). https://doi.org/10.1080/13571510110079612

Van Leeuwen, G., & Klomp, L. (2001, September). On the contribution of innovation to multifactor productivity growth. In *Eindhoven Centre for Innovation Studies (ECIS) Conference*.

Knoke, D., Kalleberg, A. L., & Knoke, D. (2015). *American Sociological Review,*. *59*(4), 537–546.

Lau, A. K. W. (2012). *Innovation activities , sources of innovation and R & D cooperation : evidence from firms in Hong Kong and Guangdong Province , China Naubahar Sharif *, Erik Baark and* (Vol. 59).

Laura, M., Schiantarelli, F., & Sembenelli, A. (2006). *Productivity , innovation and R & D : Micro evidence for Italy*. *50*, 2037–2061.

https://doi.org/10.1016/j.euroecorev.2005.08.002

Levinthal, D. A. (2017). *Absorptive Capacity : A New Perspective on Learning and Innovation Copyright © 2001 All Rights Reserved*. *March*. https://doi.org/10.2307/2393553

Li, J., Chen, D., & Shapiro, D. M. (2010). Product innovations in emerging economies: The role of foreign knowledge access channels and internal efforts in Chinese firms. *Management and Organization Review*, *6*(2), 243-266.

Liu, X., & Buck, T. (2007). *Innovation performance and channels for international technology spillovers : Evidence from Chinese high-tech industries*. *36*, 355–366. https://doi.org/10.1016/j.respol.2006.12.003

Lööf, H., & Heshmati, A. (2006). On the relationship between innovation and performance: A sensitivity analysis. *Economics of Innovation and New Technology*, *15*(4-5), 317-344.

Lööf, H., Mairesse, J., & Mohnen, P. (2017). CDM 20 years after. *Economics of Innovation and New Technology*, *26*(1-2), 1-5.

Mitchell, G. R., Hamilton, W. F., Mitchell, G. R., Managing, W. F. H., Mitchell, G. R., & Hamilton, W. F. (2018). *Managing R & D As a Strategic Option MANAGING R & D AS A STRATEGIC OPTION*. *6308*(January). https://doi.org/10.1080/08956308.1988.11670521

Mohnen, P. (2014). *R & D and productivity : a reexamination in light of the innovation surveys*. *January 2003*.

Mohnen, P., & Dagenais, M. (2002). Towards an innovation intensity index: the case of CIS 1 in Denmark and Ireland. In *Innovation and firm performance: Econometric explorations of survey data* (pp. 3-30). London: Palgrave Macmillan UK.

Mumford, M. D., & Licuanan, B. (2007). *Leading for innovation : Conclusions , issues , and directions*. *15*(2004), 163–171. https://doi.org/10.1016/j.leaqua.2003.12.010

Murphy, G. B., Trailer, J. W., & Hill, R. C. (1996). *Measuring Performance in Entrepreneurship*. *2963*(95), 15–23.

Nafi'Maula, N. H., & Anas, M. (2023, October). The Effect of Human Capital Expenditure on Labor Productivity in Central Java Province. In *International Conference on Economics and Business Studies (ICOEBS-22-2)* (pp. 798-810). Atlantis Press.

OECD/Eurostat. (2018). *Oslo manual 2018: Guidelines for collecting, reporting and*

using data on innovation (4th ed.). OECD Publishing, Paris. doi:https://doi.org/10.1787/9789264304604-en

OECD/Eurostat. (2005). *Oslo manual: Guidelines for collecting and interpreting innovation data* (3rd ed.). OECD Publishing, Paris. doi:https://doi.org/10.1787/9789264013100-en

OECD. Publishing, & Organisation for Economic Co-operation and Development. (2010). *The OECD innovation strategy: Getting a head start on tomorrow*. Organisation for Economic Co-operation and Development.

Pakes, A. (1985). *On Patents , R & D , and the Stock Market Rate of Return Rate of Return*. *93*(2), 390–409.

Paper, D., With, I. N. C., & Practice, I. (2017). *BRIDGING INFRASTRUCTURE GAPS HAS THE WORLD MADE PROGRESS ? October*.

Paper, W. (2001). *Innovation and performance in manufacturing industries : A comparison of the Nordic countries*. *457*.

Paper, W., & Nations, T. U. (2009). *Innovation and microenterprises growth in Ethiopia Research Paper No . 2009 / 51 Innovation and Microenterprises Growth in Ethiopia Mulu Gebreeyesus **.

Parisi, M. L., Schiantarelli, F., & Sembenelli, A. (2006). Productivity, innovation and R&D: Micro evidence for Italy. *European Economic Review*, *50*(8), 2037-2061.

Pérez, R. M. M., Alvarez, M. M. T., & Alvarez, M. T. G. (2012). *Cuadernos de economía The relevance of human capital as a driver for innovation*. *35*, 68–76. https://doi.org/10.1016/S0210-0266(12)70024-9

Peterson, W., Gijsbers, G., & Wilks, M. (2003). An organizational performance assessment system for agricultural research organizations: concepts, methods, and procedures.

Rai, A., Conference, J., Conference, J., & Sougiannis, T. (2009). *The Effect of Research and Development (R & D) Inputs and Outputs on the Relation between the Uncertainty of Future Operating Performance and R & D Expenditures*.

Ramadani, V., Abazi-Alili, H., Dana, L. P., Rexhepi, G., & Ibraimi, S. (2017). The impact of knowledge spillovers and innovation on firm-performance: findings from the Balkans countries. *International entrepreneurship and management journal*, *13*, 299-325.

Razzaq, A., Ajaz, T., Claire, J., Irfan, M., & Suksatan, W. (2021). Investigating the

asymmetric linkages between infrastructure development , green innovation , and consumption-based material footprint : Novel empirical estimations from highly resource-consuming economies. *Resources Policy*, *74*(January), 102302. https://doi.org/10.1016/j.resourpol.2021.102302

Reis, D. A. (2021). *The Linkage between Input and Output in the Innovation Ecosystem*.

Ridley, T., & Street, J. F. K. (2006). *Infrastructure , innovation and development Lee Yee-Cheong Calestous Juma *. 2*, 268–278.

Robson, P. J. A., Haugh, Æ. H. M., & Acquah, Æ. B. (2009). *Entrepreneurship and innovation in Ghana : enterprising Africa*. 331–350. https://doi.org/10.1007/s11187-008-9121-2

Rosli, M. M., & Mahmood, R. (2013). *Moderating Effects of Human Resource Management Practices and Entrepreneur Training on Innovation and Small-Medium Firm Performance*. *4*(2), 60–69. https://doi.org/10.5430/jms.v4n2p60

Shumpeter, J. (1934). Theories of economic development. *Cambridge, MA*, *225*.

Schneider, L., Günther, J., & Brandenburg, B. (n.d.). *Economics of Innovation and New Technology Innovation and skills from a sectoral perspective : a linked employer – employee analysis*. *October 2012*, 37–41.

Sohn, S. Y., Gyu, Y., & Kyu, H. (2007). *Structural equation model for the evaluation of national funding on R & D project of SMEs in consideration with MBNQA criteria*. *30*, 10–20. https://doi.org/10.1016/j.evalprogplan.2006.10.002

Sohn, S. Y., Kim, D. H., & Jeon, S. Y. (2015). *Technology Analysis & Strategic Management Re-evaluation of global innovation index based on a structural equation model*. *7325*(November). https://doi.org/10.1080/09537325.2015.1104412

Standing, C., & Kiniti, S. (2011). Technovation How can organizations use wikis for innovation ?*Technovation31*(7),287–295. https://doi.org/10.1016/j.technovation.2011.02.005

Talegeta, S. (2021). *Innovation and Barriers to Innovation : Small and Medium Enterprises in Addis Ababa Innovation and Barriers to Innovation : Small and Medium Enterprises in Addis Ababa*. *March 2014*.

Taouab, O., & Issor, Z. (2019). Firm performance: Definition and measurement models. *European Scientific Journal*, *15*(1), 93-106.

Tchamekwen, A. M. (2019). *Innovation Input-Output Analysis of African Countries*. *54*, 69–77. https://doi.org/10.7176/JAAS

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research policy*, *15*(6), 285-305.

The UK National Infrastructure Plan 2010. (2010).

Thi, H., Trang, T., Thi, P., & Hong, T. (2021). *Measuring the Impact of Infrastructure Quality on Firm Performance : a Review of Literature , Metrics , and Evidence*. *196*(ICECH), 211–220.

Van Uden, A., Knoben, J., & Vermeulen, P. (2017). Human capital and innovation in Sub-Saharan countries: A firm-level study. *Innovation*, *19*(2), 103-124.

Vona, F., & Consoli, D. (2014). *Innovation and skill dynamics : a life-cycle approach*. 1–23. https://doi.org/10.1093/icc/dtu028

Wan, G., & Zhang, Y. (2017). NU SC. *China Economic Review*. https://doi.org/10.1016/j.chieco.2017.04.010

Wakeford, J. J., Gebreeyesus, M., Ginbo, T., Yimer, K., Manzambi, O., Okereke, C., ... & Mulugetta, Y. (2017). Innovation for green industrialisation: An empirical assessment of innovation in Ethiopia's cement, leather and textile sectors. *Journal of Cleaner Production*, *166*, 503-511.

Wieser, R. (2005). *RESEARCH AND DEVELOPMENT PRODUCTIVITY AND SPILLOVERS : EMPIRICAL EVIDENCE AT THE FIRM LEVEL*. *19*(4).

Wolfe, A. (1994). *Organizational innovation: review, critique and suggested research directions**. *May*.

Wolff, J. A., & Pett, T. L. (2006). *Small-Firm Performance : Modeling the Role of Product and Process Improvements **. *44*(June 2005), 268–284.

Yepes, T., & Foster, V. (2009). *Making Sense of Africa ' s Infrastructure Endowment A Benchmarking Approach*. *April*.

Yuchtman, E., & Seashore, S. E. (1967). A system resource approach to organizational effectiveness. *American sociological review*, 891-903.

Zhou, H., Dekker, R., & Kleinknecht, A. (2011). Flexible labor and innovation performance: evidence from longitudinal firm-level data. *Industrial and corporate*

APPENDIX

Tabulation of Industry Sampling Sector

Industry Sampling Sector	Freq.	Percent
Food	76	8.96
Tobacco	1	0.12
Textiles	42	4.95
Garments	45	5.31
Wood	8	0.94
Paper	8	0.94
Publishing, printing, and Recorded media	29	3.42
Chemicals	18	2.12
Plastics & rubber	21	2.48
Non metallic mineral products	77	9.08
Basic metals	22	2.59
Fabricated metal products	11	1.30
Machinery and equipment (29 & 30)	11	1.30
Electronics (31 & 32)	5	0.59
Precision instruments	2	0.24
Transport machines (34&35)	3	0.35
35	1	0.12
Furniture	12	1.42
Recycling	2	0.24
Construction Section F:	35	4.13
Services of motor vehicles	26	3.07
Wholesale	124	14.62
Retail	117	13.80
Hotel and restaurants: section H	50	5.90
Transport Section I: (60-64)	93	10.97
it	9	1.06
Total	848	100.00