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Economic Study on Determinants of Innovation Activities: The Case of Ethiopian Manufacturing Sector

혁신 활동의 결정 요인에 대한 경제 연구:

에티오피아 제조업 분야의 경우를 중심으로

2016 년 8 월

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Abstract

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Innovation positively affects different aspects of firm performance. More specifically, innovative firms are likely to enjoy production, market and revenue growth, regardless of the industry in which they operate. There are financial and non-financial factors that constrain the ability of enterprises to innovate successfully. This paper primarily investigates the effect of internal and external financial constraint on the likelihood of abandoning or not stating innovation activities in the Ethiopian manufacturing sector. In the empirical analysis, we used the Ethiopian innovation survey data collected for the period from 2012 to 2014. We use the recursive bivariate probit model to take into consideration the simultaneity of the decision to abandon innovation projects and the probability to face financial

constraint. Our result shows that a lack of external finance, lack of information on technology and perception of no demand to innovation mostly affect the decision to abandon innovation at the concept stage, to seriously slow down, and not to start innovation projects, respectively. Moreover, firms engaged in acquisition of machinery and equipment are more sensitive to a lack of finance as their size gets smaller. The result of the study will contribute to make informed policy decision.

Keywords: innovation stage; innovation obstacles; decision making; manufacturing sector, Ethiopia

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Chapter 1. Introduction

This section of the research covers the overall introduction, purpose and motivation of the research, objectives and research questions. It also introduces the methodology, major findings and overall outline of the research.

1.1. Overall Introduction

Competition and the growing need for differentiation is a feature that characterizes industrial markets. Companies respond to such situations by engaging in continuous innovation activities in order to sustain their competitive position in the market (Andreas Eggert et al., 2011), thereby enhancing product and service innovation (Ettlie and Rosenthal, 2011).

The OECD Oslo manual (3rd edition, 2005) defines innovation as 'the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations'. Similarly, the manual defines a potentially innovative firm as 'one type of "innovation active firm" that has made innovation efforts but not achieved results'. The manual also distinguishes four types of innovation namely: product, marketing, process, and organizational innovations.

According to Hunt and Morgan (1997), an innovative firm is one that is efficiently and effectively engaged in the creation or assembly of resources in order to produce value-added market offerings. Similarly, other researchers also refer to innovation as a process that brings to market new offerings that were not previously available to a firm's customer (Parasuraman, 2011). A number of numerical analyses confirmed the positive impact of product innovation over firm performance. In particular, product innovation results in revenue growth and profitability, ranging from moderate to strong level. In this research innovation is defined as the implementation of existing proven product, process, marketing or organizational method; in order to increase monetary value of manufacturing firms, thereby their improving production capability.

Innovation exhibits an asymmetrical, heterogeneous and accumulative nature (Benedetti, 2009). Heterogeneity is the nature of innovation, whereby different firms carry out various kinds of innovation. Some might focus on a specific type of innovation such as the process, marketing, product or product innovation, and others might perform different types of innovation, and still some firms do not engage in innovation. In addition, innovation is accumulative by nature in which previous innovation activity affects the one that follows it and keeps adding up. Thus, the financial constraint necessary to carry out an innovation project is linked with the nature of innovation (B.H. Hall and J. Lerner, 2010).

The ability of a firm to innovate successfully might be constrained by the market or other factors (Stockdale, 2002). Some perceived obstacles to innovation are excessive perceived economic risk, high innovation cost, lack of financial resource, organizational rigidity, lack of skilled personnel, lack of market information, lack of technological information, and lack of clients' responsiveness (P. Mohnen et al., 2008; Iammarino et al., 2009).

An enterprise might encounter obstacles just before engaging in innovation projects or while carrying out innovation activities (Gabriele Pellegrino, 2015). Pablo D'Este et al. (2012) tried to differentiate the effect of obstacles to innovation. The first effect that firms face while undertaking innovation activity is called revealed effect of barriers. The second effect is described as deterring effect, which refers to the perception of the impediment to innovation by firms that otherwise, would be keen to engage in innovation activity.

Among the different types of obstacles to innovation, prior studies identified access to finance as one critical determinant due to the possible macroeconomic consequences (Segarra et al., 2008; Hölzl and Janger, 2013; D'Este et al., 2012). In essence, financial obstacles affect innovation active firms more intensely; this might diminish the new knowledge required for economic growth. This in turn inhibits economic development. For instance, financial constraints might motivate firms in high-tech industries to under-invest in new R&D activities (R.E. Carpenter and B.C. Petersen, 2002).

Furthermore, financial obstacles reinforce other innovation barriers, particularly those categorized as knowledge and market factors (P. Mohen et al., 2008). Therefore, analyzing the effect of financial barriers on innovation activities is quite relevant.

The inherent characteristic associated with innovation activities makes the financial problem more acute. Unlike physical investment, innovation projects are risky in nature and therefore compel outside financial providers to demand a risk premium to finance the innovation activity. In addition, the problem of appropriability makes innovators reluctant to disclose information about their innovation to outside investors. This asymmetric information problem hinders the financing of innovation. The use of the intangible asset as a collateral has its own limitation, since it increases the cost of external capital in the form of risk premium. In the case of innovation, the difference between external and internal cost of capital makes firms prefer using internal sources over external debt and ultimately new equity to provide fund for innovation projects.

The riskiness of innovation activities in particular might worsen the financial problem of young SMEs. The situation results in some innovation projects being abandoned or not started due to the risk of bankruptcy. The issue of getting additional equity to support the financing of innovation activity is constrained, as this is likely to intensify the moral hazard and agency problem on the part of the innovator. The separation of the management of the firm and ownership could make the inventor reluctant to invest in risky business

due to risk aversion (Jensen and Meckling, 1976). The difference in tax treatments that arises by either using external finance or retained earnings to finance innovation projects as well as moral hazard and information asymmetry brings about a positive gap between external and internal cost of capital. This in turn influences the preference of financing innovation projects through one's own internal sources.

Innovation active firms in particular face higher external financial constraints to invest on new innovation projects, since their specific characteristics increase risk and reinforce information asymmetry with external investors (Hall, 2002). Thus, innovative firms face persistent constraint to get access to external financial support. Getting access to external funds allows firms to take advantage of bringing innovative ideas at the concept stage towards real implementation. This is because the external fund helps to absorb the high start-up costs in conjunction with design and proof of innovative goods and services at the concept stage.

1.2. Purpose of Research

Ethiopia registered a remarkable economic growth average of 10.9 percent per year from 2004 to 2014, while the average of sub-Saharan Africa region remained 5.4 percent (World Bank, 2015). As indicated on the Ethiopian industrial development roadmap for the period of 2013 to 2025 (MoI, 2013), in 2013, the manufacturing sector accounts for only 5 percent of GDP as compared to 17 percent of GDP of the model middle-income country

(MMIC). Thus, it is clear that Ethiopia should enhance its manufacturing capabilities in the coming future. Without rapid manufacturing growth, Ethiopia will face limited growth, which results in vulnerable economy to external shocks, adverse changes in terms of trade, and climate change. Thus, we take into account the impact of financial constraint in the failure of innovation activities.

This paper focuses on investigating the effect of innovation-hampering factors on the decision to abandon or fail to start innovation activities in the Ethiopian manufacturing sector. There are a number of prior studies that revealed the effect of financial and non-financial obstacles to innovation performance. However, no similar research paper is found in the Ethiopian context so far.

The occurrence of financial obstacles in the innovation projects of firms is well recognized by the existing economic theories and empirical studies. There is ample empirical evidence on the characteristics of innovative firms and determinants of innovation. Nevertheless, studies in the area of failure of innovation activities have received little attention. There is scarcity of empirical evidence on the effect of financial obstacle on the likelihood of a firm's decision to abandon or fail to start innovation activities. The Ethiopian innovation survey conducted for the years 2012 to 2014 shows that, out of 812 potentially innovative firms, 48 percent (396) of them do not start innovation, and 15.2 percent (124) abandon innovation during the concept stage.

The main objective of this research is to analyze the effect of financial and non-financial factors on the decision to abandon or not-start innovation activities in Ethiopian manufacturing sector. The research questions are as follows: to what extent does an obstacle to innovation, such as lack of finance, lack of technological information, presence of a dominant firm in the market and perception of no demand to innovation, affect the decision of firms to abandon or not to start innovation? Apart from innovation-hampering factors, what other variables influence the same decision? Do firms of different sizes respond differently to the same factors at different stages of innovation?

1.3. Outline of Research

The Ethiopian manufacturing sector represents an interesting case in which to analyze the extent to which financial constraint affects the probability of the decision to abandon or not start innovation activities during the period of 2012-2014. The data is extracted from an Ethiopian enterprise innovation survey conducted for the years 2012 to 2014. The total data covers 1200 enterprises, out of which 893 are manufacturing firms. In line with prior studies, we excluded 81 firms that are not engaged in innovation projects or did not report to face any innovation barriers (Savignac, 2008; Mohnen et al., 2008; D'Este et al., 2012). This is done to correct the selection bias problem that can occur when firms covered by the survey are asked about obstacles to innovation.

A total of 812 manufacturing firms selected for further analysis are called "potential innovative firms". These include firms who engaged in innovation projects, or firms did not do so because they face one or more obstacles. Accordingly, our data comprises 416 innovation active firms and 396 manufacturing firms that are discouraged from doing so.

The empirical analysis is done using the recursive bivariate probit model to take into consideration the simultaneity of the probability to decide to abandon or not start innovation and the likelihood to face financial constraint. In other words, the model helps to measure the probability that a potentially innovative firm abandons innovation activities due to the existence of financial constraints. The recursive bivariate probit model is only valid when the correlation coefficient between the equations of the probability of abandoning and likelihood of facing financial constraint is significant or different from zero. In a situation in which the null hypothesis holds true for the correlation coefficient, we estimate the two equations independently using the probit model.

The analysis is done by categorizing the financial source into a lack of funds within the firm and a lack of finance from an external source. Different stages of innovation are also taken into account to examine the decision to abandon innovation at the concept stage, after the project has begun, to seriously slow down innovation or not to start innovation activities at all. Moreover, the results from the analysis of potentially innovative firms and innovation active firms were compared to check whether there is a variation between the two

groups. All of the above-mentioned approaches provided an opportunity to illustrate the effect of financial and non-financial barriers from different perspectives.

The result of the analysis shows that a lack of external finance affects the decision to abandon innovation at the concept stage for innovation-active firms. Also, small-sized firms and manufacturing firms engaged in the acquisition of machinery and equipment are more sensitive to financial constraints. Surprisingly, the perception of no demand to innovation is found as a crucial factor to discourage Ethiopian manufacturing firms from starting innovation activities.

This paper analyzed the effect of financial and non-financial factors on the decision to abandon as well as not to start innovation activities. In this regard, it will contribute to the existing innovation management knowledge domain by illustrating the case of countries in similar economic situations to that of Ethiopia. Prior research conducted in this field has not focused on the effect of the perception of no demand to innovation. This paper showed how influential the perception of no demand to innovation is on affecting the probability of a firm's decision not to start innovation activities. This is an illustration of developing countries like Ethiopia, which are characterized by a lack of strong competition in the market, where export items are mainly concentrated on primary products.

This paper also contributed to this strand of empirical research by distinguishing the effect of financial and non-financial obstacles on potential innovative firms and innovation active firms. Apart from its academic contribution, the result of this study can provide useful input to design appropriate policy measures to promote innovation activities in the Ethiopian manufacturing sector.

The remainder of this paper is structured as follows. Chapter 2 presents the briefly manufacturing sector of Ethiopia to give an overview of the existing situation. Chapter 3 summarizes prior research results in relation to obstacles to innovation and presents our main hypotheses. Chapter 4 describes the data and the methodology used for numerical analysis. The next Chapter states the major findings and practical contribution of the research result. The last Chapter states the main conclusion.

Chapter 2. Ethiopian Manufacturing Sector

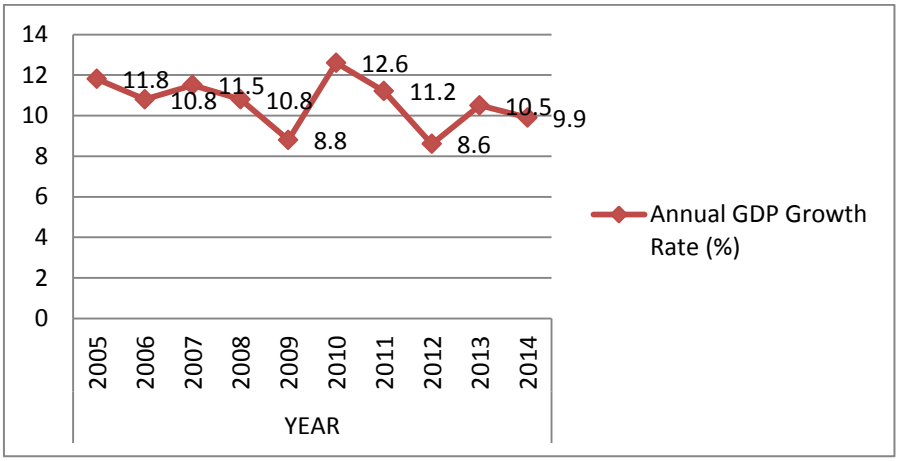
This chapter covers an overview of Ethiopian manufacturing sector. First, it illustrates the economic structure of the country and then it presents the current status, export performance, priority areas identified by government, industrial road map and five year plan of the manufacturing sector. In addition it also includes science and technology indicators that directly or indirectly represent the sector.

2.1. Ethiopian Economic Structure

Ethiopian government adopted agricultural development led industrialization (ADLI)[1] strategy since 1990's. Developing countries in the same economic level like that of Ethiopia; have a great capital shortage, but abundant labour and agricultural land. As confirmed by the development experience of many countries, efficient allocation of resources and rapid development can be achieved by using the most abundant resource extensively and economizes on the scarcest resource. In this regard, no sector can be compared with agriculture in economizing on capital and utilizing labour.

[1] Adopting the ADLI strategy means that economic activities in general and industrial development in particular are led by agriculture. It means that agricultural development plays the leading role, determining the pace and direction of industrial development. It does not mean that industrial development should be at standstill or move at slow pace. Hence, it underlines that ADLI means agricultural development should be carried out in parallel with industrial development in a mutually supportive manner. As a result, industrial development strategy to follow ADLI strives to attain industrial growth following the direction determined by agriculture and in a way mutually supportive with it.

Ethiopia registered a remarkable economic growth (World Bank, 2015) averaged 10.9 percent per year (see fig 1) from 2004 to 2014 compared to the regional sub-Saharan Africa average 5.4 percent. The high economic growth during this time has been fueled due to agriculture and service sectors, which together account for almost 90 percent of the GDP. In 2014 the three sectors shares in GDP were: Service 45.5 percent, agriculture 40.2, and industry 14.3 percent.



Source: World Bank

Figure 1: Annual GDP growth rate (%) of Ethiopia

2.2. Overview of Ethiopian Manufacturing Sector

In this sub-section overview of Ethiopia manufacturing sector is presented from the perspective of STI indicator, participation of export market, second growth and transformation plan (2016-2020), and industrial development roadmap (2013-2025).

A) Ethiopian Industrial Sector

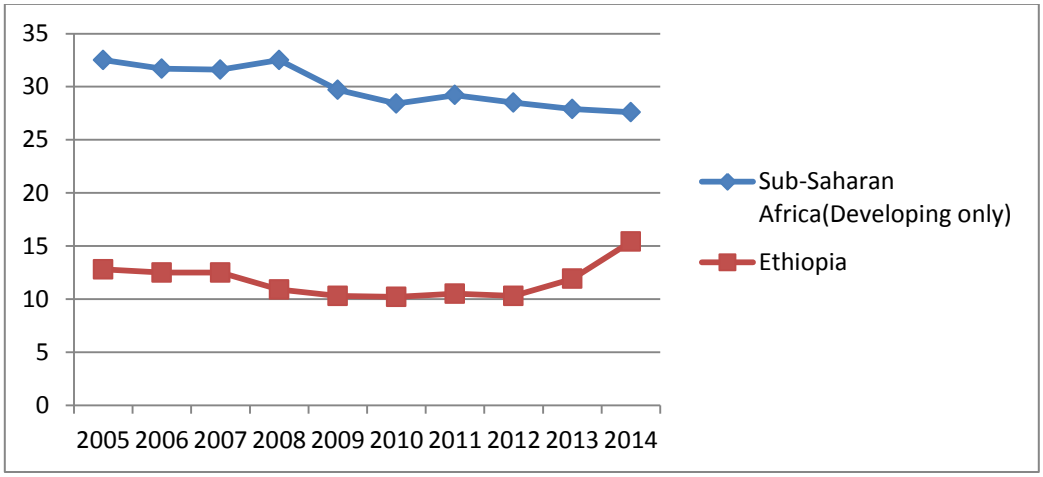
According to World Bank manufacturing refers to industries belonging to ISIC divisions 15-37. The following diagrams shows the share of industry, value added (% of GDP) of Ethiopia as compared to other sub-Saharan African countries. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs.

Manufacturing sector, which is mostly associated with structural change of economy, contributes only 4.6 percent of the total Gross Value Added (GVA). The economy of Ethiopia needs to undergo fundamental transformation. The gaps are spread even further, in terms of employment and productivity. The share of employment in manufacturing sector remained for long, below 5 percent of total employment. The labor force engaged in low productivity sectors such as agriculture need to be reallocated to manufacturing and service, economic sectors with higher productivity(Dinh et al., 2012). For instance if we look at economic growth registered in 2014; real GDP growth of 10.3 percent, service sector contributed 5.3 percent and industry sector 2.8 mainly as a result of construction boom. Nevertheless, the contribution of manufacturing sub-sector accounted only 0.5 percent to the real GDP growth[2].

Besides abundance of natural resources, Ethiopia is a country with a broad base of low wages and labor cost, compared to its competitors in Sub-Saharan African countries. At this point of time, light manufacturing sector is an ideal

[2] Country Partnership Strategy Report for the Federal Democratic Republic of Ethiopia for the Period FY12 to FY16. Ethiopia Country Management Unit, Africa Region, IFC and MIGA. October 2014. (Report no. 90893-ET)

choice to Ethiopian context, not only as a sole substitute to agriculture, but also to absorb the vast majority of low-skilled laborers. Manufacturing does not require large capital investment. Ethiopian government puts special focus on some manufacturing sectors such as: footwear and leather products; textiles and garments; metal and engineering; sugar; and cement industries; so as to take advantage of the country's endowment and comparative advantage (MoI, 2013). Nevertheless; the national economic plan has not been able to bring structural economic transformation and the contribution of the manufacturing sector to the GDP remained stagnant at rather low level.



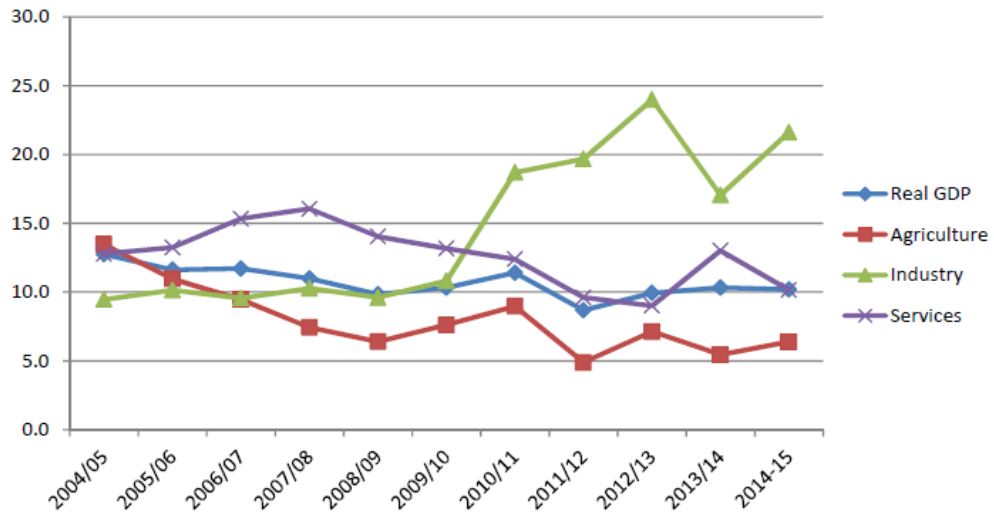
Source: World Bank[3]

Figure 2: Comparison, value added share of industry to GDP

As depicted in fig-3; in 2015 the industrial sector of Ethiopia showed 21.6 percent growth. The sector contributed 29.4 percent to the overall economic

[3] http://data.worldbank.org/indicator/

growth during the same fiscal year and accounted for 15.2 percent of the real GDP. This indicates, despite the rapid growth of industrial sector compared to agriculture and service sector, the share of the sector to the GDP remained very low. Similarly, the manufacturing sector increased by 15.8 percent, and constitutes 31.8 and 4.6 percent of industrial output and real GDP growth respectively. Moreover, construction sector, contributed 8.5 percent to GDP growth and 56.1 percent to industrial sector growth. Taking its competitive advantage of the country needs to enhance its investment in manufacturing sector[4].



Source: MoFED, 2015

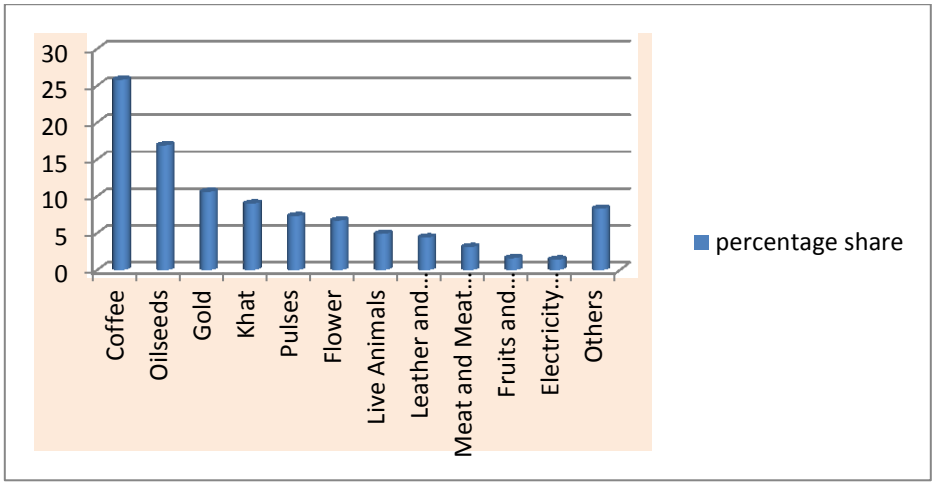
Figure 3: Real GDP growth by major sectors

[4] National Bank of Ethiopia, 2015 Annual Report

B) Exports and direction of trade

Export-oriented economic growth is becoming widely popular development strategy among government officials and scholars in the field. Developing countries flood the market with the same goods, resulting in a decrease in the prices of these goods and less profits. To be free from adding-up problem, the product needs to be differentiated through building innovation capabilities (Keun Lee, 2013). For instance, a number of sub-Saharan African countries remain dependent for long on few primary commodities in international market. Since, the demand for primary commodities is price-inelastic, an increase in production volume and expansion of export market, would result in decrement of price followed by the reduction of net export revenue (T.Akiyama and F. Larson, 1994).

In 2015, total export income amounted to USD 3 billion USD. Compared to 2014 fiscal year the export income showed decrement by 8.5 percent. More than 90 percent of the export income is primarily from agricultural products and minerals. The share of export income from products derived from manufacturing sector such as meat and meat products, and footwear and leather products only account to 7.5 percent of the total earnings. Table-1 shows the list of major export items, values and percentage contribution to export income. (Annex-1: values of major export items in 2015).



Source: NBE, 2015

Figure 4: Percentage share of major export items

Out of a total of merchandise export about 38.4 and 33.6 percent went to Asian (mainly China) and European countries respectively. Textile and garment as well as leather and leather products are mainly exported to US market using the advantage of African Growth and Opportunity Act (AGOA market).

Table 1: Export contribution of major industrial sub-sectors

Manufacturing Sub-sector	**percentage share**
Mining and Quarrying	5.6
Manufacturing	31.8
• Large and medium (24.6%)	
• Small scale manufacturing (7.2%)	
Electricity and water	6.5
Construction	56.1
Total	**100**

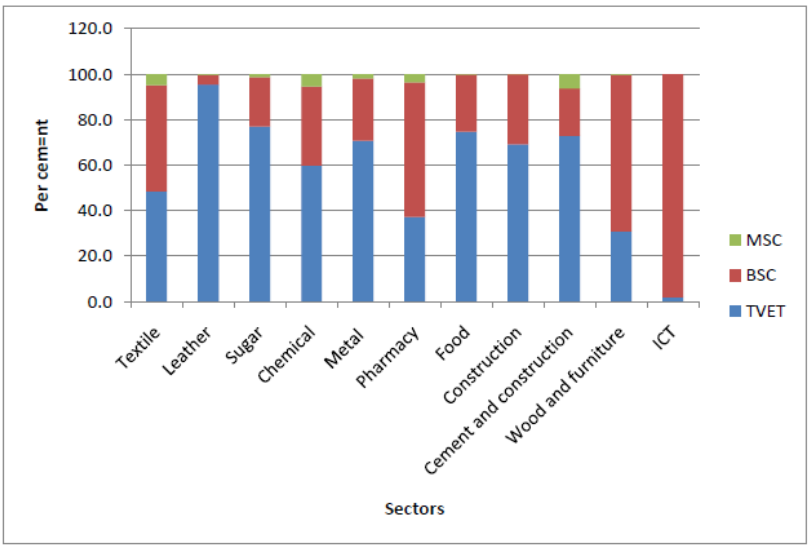
Source: NBE (2015)

C) Science & Technology Indicators

According to science and technology indicator report (STIC, 2014), gross domestic expenditure on research and development (GERD) to the GDP, in 2013 was 0.61 percent. The report indicated that government is an important and dominant source of R&D fund (79.1 percent). In terms of the performance of GERD by sector about three-fourth (76 percent) of the R&D fund has been spent on public sector with reported R&D intensity of 0.60 percent. However, the aggregated investment on R&D fund to higher education institutions and government sector accounted to 98.4 percent.

The innovation survey conducted on Ethiopian enterprises for the year 2012 to 2014 revealed that (STIC, 2015) Ethiopian enterprises were more involved in non-technological innovation; rate of non-technological innovation estimated at 56.4 percent. Marketing innovation was the most implemented innovation constituting 49.5 percent while product innovation accounted the least share of 19.5 percent. Enterprises that had organizational innovation comprised 34.9 percent share, while 24.6 percent of enterprises had process innovation. Product only innovative enterprises took 0.7 percent share, whereas process only innovative enterprises accounted 1 percent share. Enterprises that had all types of innovations (process, product, organizational, and marketing) comprised 8.2 percent.

Currently, among the total employees in Ethiopian manufacturing sector 61 percent are graduates from technical and vocational schools or higher in science and technology fields (EAS, 2015). The remaining percentage is dedicated for social science fields. The number of labor force with technical school diploma, first degree, and master degree amount to 70, 26 and 4 percent of the total respectively. The sector distribution of the workforce in different manufacturing sectors along with their qualification is depicted in Fig-5; we can observe that there is a variation in terms of science and technology education qualification in different sub-sectors. It also implies that R&D personnel with higher degree of qualification are scarcely available in Ethiopian manufacturing sector.



Source: EAS (2015)

Figure 5: Science and technology employees by levels of education in different sectors

D) Ethiopian Industrial Development Roadmap (2013-2025)

The share of the Ethiopian industry sector to GDP is lagging behind almost by 20 points from that of the model income country (MMIC). The situation is not different in the case of the Ethiopian manufacturing sector which currently accounts for only 4.6 percent (NBE, 2015) as compared to 17 percent of GDP of the MMIC. The share of manufacturing is targeted to attain 67 percent of the total industry sector by the year 2025(MoI, 2013). At the same time the value of the contribution of manufacturing to the GDP is expected to reach 35.2 billion USD from the current 2.7 billion USD. In general, the share of the manufacturing sector to the GDP is target to reach 17 percent by the end of 2025.

To bring about manufacturing sector transformation five development directions are envisaged. These are upgrading and capacity enhancement of major priority industries, diversification of manufacturing sector to new sectors, enterprise cultivation, private and public investment, and industrial zone development. According to industrial development plan of Ethiopia, the share of labor intensive industries will be reduced gradually and diversification of the existing industry takes place along with emerging of new key industries.

E) Second growth and transformation plan(2016-2020)

Even if industry sector showed 21.2 percent growth in 2015; the export income (398million USD) remained very low compared to the target set.

According to the second five year (2016-2020) growth and transformation plan (GTP-II); the overall GDP is expected to continue its growth by 11%. Accordingly, the industry sector is expected to show average annual growth of 20 percent and its contribution to the GDP is planned to reach 22 percent. Similarly manufacturing expected to show average annual growth of 22 percent in order to account 11 percent of the GDP. During this time increasing the share of new key industries such as ICT, electronics, petrochemicals, and biotechnology is also given due attention besides diversifying existing labor intensive industries.

The export income from manufacturing sector is projected to reach 4.6billion USD in 2020 from 0.39billion in 2014. Sugar, garment and textile, and footwear and leather product industries are expected to generate 1.2, 1.0, and 0.8 billion USD export income respectively.

In 2012, out of the registered total capital 37.3 percent is spent for building construction and 48.2 percent expended for purchase of production materials. This indicates the need to speed up the construction of industrial parks and importation of production technologies. Out of the total expense for production inputs 44.3 percent spent for industrial inputs imported from abroad. Manufacturing subsectors such as: food and beverage, textile and garment, footwear, chemical, pharmaceutical, metal and engineering spent 30.4, 34.1, 54.6, 49.5, and 61.8 percent of their total capital for importation of raw materials respectively.

Since the output of the manufacturing industry is mostly sold in local market, the high expense for importation of raw materials is affecting the trade balance significantly. Therefore, in addition to creating strong linkage among industries along the value chain; Ethiopia shall build a capacity to produce capital goods and accessories locally. Even though the manufacturing sector is showing an increment in terms of number, production volume, and employment opportunity; its contribution to export income is far less than excepted.

For instance, textile In terms of labor productivity it is only 50 percent as compared to international standard of 12min man/t-shirt. The major reasons for low performance of textile and garment industry are: lack of qualified personnel, outdated production facilities, and weak linkage along production value chain. In 2015 there were 70 footwear and leather product industries. Production capacity is 6 pair shoes man/ day, quite low compared to international standard of 200 shoe man/day.

In 2013 there were 243 metal and engineering industries (33 basic metals, 194 equipment and machinery, 11 car and lorry trailer assembly industries). The sector is faced with major constraints such as: limited knowledge and experience to manufacture spare parts, low design capability, difficulty to compete with quality products in export market.

In 2014 the number of pharmaceutical industries reached 22. The demand for pharmaceutical products increased to 500million USD in 2014. The local industries only cover 20 to 25% of the total demand. All drugs produced

locally are categorized under essential drugs. Major constraints of the sub-sector are: inadequate R&D practices, low level of good manufacturing practices (GMP), and primarily dependent on raw materials imported from abroad.

With a focus on promoting export market and creating employment opportunity; there is a plan to establish agro industrial parks. Expansion of existing industry zones and establishment of a new one is also underway. Table-2 shows target set in the second growth and transformation plan for some of manufacturing sub-sectors. Taking the year 2015 as a baseline the sub-sectors set a target for different indicators to be achieved during the plan period.

Table 2: Manufacturing sector GTP-II(2016-2020)

Sub-sector	Indicator	Baseline (2015)	Target (2020)
Textile and garment	Export(million USD)	150	1000
	New employment	12,200	99,653
Footwear and leather products	Export(million USD)	170.2	800
	New employment	48,000	94,000
Metal and Engineering	Per capita (Kg)	27.75	81.41
	Export (million USD)	197	740
	New employment	7,000	23,000
Cement	Export(million USD)	15	55.5
	New employment	--	7,500
Pharmaceutical	Export(million USD)	15	105
	Share of local mkt (%)	20	50
	New employment	1000	6900
Honey, meat and diary	Export (million USD)	120	470
	New employment	3920	9560

Source: MoFED (2015)

Chapter 3. Literature Review and Hypothesis

This chapter presents a summary of prior research related to innovation-hampering factors. The summary of the literature is grouped into four categories. The first part deals with how the subject of obstacles to innovation became the area of interest for researchers in the field. Part two shows another relevant dimension of study, which focuses on factors affecting perceived obstacles to innovation. Parts three and four explain the effect of innovation-hampering factors on the propensity to innovate and on the decision to abandon innovation activities, respectively. The main focus of this paper is on the fourth part, which shows similar work done by other researchers. Five main hypotheses are formulated at the end of the fourth sub-section, in line with our research objective and questions.

3.1. Obstacles to innovation

Innovation requires the firm to combine its capability, to understand the need of the market, to get access to financing, to recruit and retain qualified personnel and to establish strong interactions among the major actors. However, the path to successful innovation is full of challenges, which demand firms to cope with different types of barriers to innovation. The reaction of firms differs, in the sense that some firms do try to innovate and engage in formal and informal activities, even if they fail to bring new goods

and services to the market, while others are discouraged from engagement in innovation and forced to remain with business as usual. This phenomenon implies the need to distinguish the different types of obstacles and to treat them accordingly (Pable D'Este, 2012).

Firms that fall behind the technological frontier may face difficulty investing in innovation projects due to high cost of innovation (Aghion et al., 2015). On the other hand, firms with cutting-edge technologies see little incentive to innovate, since their technology keeps them in a better position ahead of their competitors, which is termed as an incumbent trap. The investment of a firm on R&D activity is positively and significantly correlated with the likelihood that it will innovate. In developing countries, R&D activity is mostly oriented towards absorbing the existing knowledge instead of developing new technology.

After analyzing the barriers of innovation perceived by high-growth firms in 18 European countries, Werner HÖlzl & Jűrgen Janger (2013) came to the conclusion that barriers to innovation are perceived more frequently in developing countries than in advanced countries. Furthermore, the effect of innovation barriers on manufacturing firms is more significant than in non-manufacturing firms.

Obstacles to innovation are perceived not only by firms engaged in innovation activities but also by firms who are willing to innovate but are discouraged to do so. It is important to distinguish between the two different impacts of the obstacles that firms encounter in undertaking innovation projects. These can

be obstacles that the enterprises encounter while engaging in innovation activities as well as the factors hindering innovation (Pablo D'Este et al., 2012, and Gabriele Pellegrino, 2015). The first effect that firms face while undertaking innovation activity is called revealed effect of barriers. The second effect is described as deterring effect, which refers to a situation in which a firm willing to undertake innovation activity is refrained from doing so due to the perception of the impediments.

In addition to the commonly known approach of identifying factors that promote firms' innovation performance, it is quite important to analyze factors that constrain the ability of enterprises to innovate successfully (Stockdale, 2002). Some perceived obstacles that became important dimensions of policy analysis are excessive financial risk, high innovation cost, lack of financial resources, lack of organizational flexibility, lack of skilled personnel, lack of information technological information, lack of market information, regulation rigidities and lack of clients' responsiveness (P. Mohnen et al., 2008 and S. Iammarino et al., 2009).

From an innovation policy point of view, it is important for decision makers to identify obstacles to innovation. These facilitate understanding to what extent firms are exempted from innovation contest. Policy makers can design appropriate measures that tackle systemic failures that hinder firms from engaging in innovative projects (Woolthuis et al, 2005). Similarly, from an innovation management perspective, it is also crucial to clarify the obstacles

most commonly encountered by firms engaging in innovation projects. Especially, identifying those obstacles that result in failure of introduction of new goods and services in the market provides useful insight to managers to design corporate strategies that enable firms to overcome the barriers to innovation (Pable D'Este, 2012).

Usually at the beginning of research projects, innovation activities are accompanied by a high degree of uncertainty. Even though most innovation survey-based research contributions tilt towards financial constraints, there are also non-financial obstacles that need to be considered. Those obstacles that are important in the context of innovation management and policy are related to barriers in regulation, market and knowledge factors.

The emerging branch of research that focused on firms' obstacles to innovation so far has focused on three distinct empirical approaches. The first one focused on the impact of market and firm characteristics on firms' perception of impediments to innovation (Iammarino et al., 2009; D'Este et al., 2014). The second one centered its attention on the effect of obstacles, primarily financial constraints, on a firm's propensity to innovate (Savignac, 2008; Blanchard et al., 2012). The third area of study concentrates on the effect of obstacles to the decision to abandon or not start innovation activities (P. Mohen et al., 2008; Garcia-Vega and Lopez, 2010; Segarra et al., 2013).

3.2. Factors affecting perceived obstacles to innovation

The perception of obstacles to innovation depends on different factors. The types of the firm, the extent to which the firm is engaged in innovative projects, and the region in which the firm is located bring a difference on the level of their perception towards obstacles to innovation (Simona Iammarino et al., 2009). Firm age can affect a firm's perception of the obstacles that hamper and delay innovation (Gabriele Pellegrino, 2015). Young firms seem to be less sensitive to the lack of qualified personnel when initiating an innovative project than when they are already engaged in such activities. By contrast, the attempts of mature firms to engage in innovation activity are significantly affected by the lack of qualified personnel.

A firm's perception of the importance of obstacles to innovation depends on different factors that are mainly related to market and firm behavior. As illustrated in table 3, firm characteristics such as size, firm age and type of sector are found to be relevant in explaining perceived obstacles to innovation. The cooperation agreement the firm has with other enterprises or institutes, firm's affiliation to a large group and the origin of the large group are also considered as important matters in perceiving the obstacles. Furthermore, engagement in R&D activities, participation in international market, and external pressure from competitors are also crucial to perceive barriers, particularly financial constraints, as important.

Table 3: Review of prior researchers on factors affecting perceived obstacles to innovation

Factors	Authors						
	Mohen and Rosa (2000)	**Baldwin and Lin(2001)**	**Galila and Legros (2004)**	**Tourigny and Le (2004)**	**Iammarino et al (2007)**	**D'Este et al (2008)**	**Holzl and Janger (2011)**
Sector	✓	✓	✓	✓	✓	✓	✓
firm size	✓	✓	✓	✓	✓	✓	✓
Group membership			✓		✓	✓	✓
nation of the group		✓	✓		✓		✓
R&D	✓		✓				✓
Competitor's pressure	✓	✓		✓			
international market					✓		✓
age of the firm		✓					
cooperation agreement			✓				

3.3. The effect of obstacles on firms propensity to innovate

Financial constraint has negative and significant effects on the propensity to innovate (Pierre Blanchard et al., 2012). Lack of finance mostly affects innovation in low-technological manufacturing sectors. The most significant barriers to innovation in SMEs are associated with high innovation costs (Aminreza Kamalian et al., 2011). Brain Stockdale (2002) also reported that financial constraint is the second most important barrier for innovation-active firms, next to high innovation cost. In particular, obtaining affordable finance is more often a problem for SMEs than for large enterprises.

Firms that engaged in innovation activities encounter obstacles more frequently and more strongly than firms that did not engage in an innovative project (Pierre Blanchard et al., 2012). In particular, firms engaged in product development usually confront obstacles such as excessive cost associated with innovation projects and uncertainty of market acceptance (Isidre March-Chorda et al, 2012). However, technical uncertainty, failure rate of product innovation, lack of top management support and conservative attitude of the market has no significant impact on product innovation.

Lack of finance and high investment costs discourage and deter firms' effort to innovate (D'Este et al., 2012). For instance, service innovation requires major organizational change, a significant amount of investment in acquiring new capabilities and skills as well as qualified human resources in the field. A type of service innovation that incurs substantial costs has high financial

risk and uncertainty, which might become an entry barrier for new startups, thereby protecting the market share of the incumbents. On the contrary, organizations which are familiar with product innovation have a better possibility of assessing the costs and financial risks due to their previous experience. However, still the cost of overcoming obstacles affects the profitability growth of product innovation.

This considerable risk and uncertainty influence the possibility of getting funds from external sources. In essence, the presence of externalities, appropriability problem with the return on innovation activities and informational asymmetry force firms to encounter obstacles, more specifically financial constraints. Experiencing high costs for innovation activities coupled with high sunk cost induce under-investment in innovation projects as a consequence. Different reasons could contribute to the under-investment of financial institutions for firms' innovative projects. Low return expectation on the profit that can be generated from innovation, presence of free-riders and externalities could be mentioned as a basic reason in this regard (Hall, 2002).

Innovativeness depends on the size and type of sectors (Savignac, 2008). Larger firms have a better probability of having innovative activities. Among the empirical analyses made so far on the effect of financial obstacles in R&D and innovation activities, Savaganac (2008) and Blanchard et al. (2012) showed that financial constraints negatively affect the propensity of firms to innovate. Savignac (2006) and Tiwari et al. (2007), using Dutch and French

CIS data, respectively, estimated the effect of financial constraint on R&D investment. They found that the likelihood that the firms implement innovation projects is significantly deterred by the presence of a lack of finance. In this line of research, some authors claimed reverse causality between innovativeness and facing financial constraints that may result from the endogeneity of the regressors (Mancusi and Vezzulli, 2010).

Nevertheless, most prior empirical studies reported a positive correlation between engagement in innovation activity and perception of barriers. Some authors justified such counterintuitive results as a firm's capability to overcome obstacles (Baldwin and Lin, 2002; Mohnen and Röller, 2005). In other words, as firms engage more and more in innovation activities, they become aware of the risks and hence are able to handle them by preparing themselves in advance. Savignac (2008), on the other hand, attempted to come up with a convincing theory that the positive spurious correlation between perception of obstacles and innovation intensity is due to the inappropriate selection of the sample data for the empirical analysis. He suggested that, as this is a recurrent problem associated with data collected in the framework of community innovation survey, the analysis should be limited to potential innovators.

The group of potential innovators comprises firms who invest in innovation activity (even though they didn't achieve the result yet) and firms who did not engage in innovation activity but reported facing the obstacles (Blanchard et al., 2012; Pellegrino and Savona, 2013). Correcting the selection problem is vital to ensuring a consistent result.

3.4. The effect of obstacles on the decision to abandon innovation activities and the main hypothesis

Financial obstacles play a crucial role in determining the likelihood of abandoning an innovation project. In particular, low-technological manufacturing sectors are more sensitive to financial constraints. The impact of a lack of finance significantly affects the probability of the decision to abandon innovation projects. Specifically, financial constraints have a significant and positive impact on abandoning innovation at the concept stage, seriously slowing down, stopping and even not starting innovative projects (P. Mohnen et al., 2008; Augsti Segarra et al., 2013). The well-being of a firm in terms of finance makes relevant other constraints such as market uncertainty and economic uncertainty. This means the effect of financial obstacles and their interactions within the market and economic uncertainty significantly affect the decision to abandon innovation.

Innovation is the result of knowledge generated internally or knowledge transferred from external sources. The different source of knowledge has an impact on firms' innovation performance. Compared to bought-in R&D and intra-company knowledge transfer, collaborative agreement is less likely to be effective in increasing innovation performance.

Garcia-Vega and Lopez (2010), after analyzing Spanish firms with positive innovation expenditure during 2005 to 2007, revealed that the most important barriers to the failure of innovation projects are market-related factors. In particular, for SMEs, the main factor that affects the likelihood of deciding to abandon innovation is completion by established dominant firms and market uncertainty of demand.

Those firms which are part of a corporate group might not suffer as such to get funds from external sources (Savignac, 2008). The CEOs of the large group might provide a guarantee to ensure the ability of its subsidiary firms to pay back their credit.

Main Hypotheses

Despite the scarcity of specific evidence on the determinants of failure of innovative projects, some empirical findings point out the effect of financial constraints on the probability of the failure of innovation projects (Mohnen et al., 2008). Financial constraints limit the capability of firms and deter their attempt to close the gap between themselves and their technological leaders. According to Garcia-Vega and Lopez (2010), who analyzed Spanish firms,

lack of funds is a significant factor that affects positively the probability of the decision to abandon innovative projects.

Another strand of empirical findings indicates some mixed results regarding the effect of financial constraints on the probability of hampering or deterring innovative projects. For instance, Hölzl and Janger (2012) illustrated the different effect of a lack of finance for different countries. Using CIS data of 18 European countries, Hölzl and Janger (2012) indicated that South Eastern European countries are hampered by financial constraints, whereas countries with cutting-edge technology are less affected. Using CIS data, Galia and Legros (2004) also showed that financial obstacles are not among the major impediments for French manufacturing firms.

Financial obstacles may be external when firms are unable to get access to external funding and internal when firms' own resources are not sufficient to cover the cost of innovation projects. Facing external or internal lack of finance may have different effects on the likelihood of deciding to abandon innovation activities at different stages. There might be stages at which firms consider it suitable to abandon an innovation project. So far, the theoretical literature does not provide clear evidence as to which stage firms decide to abandon their innovation activities. Nevertheless, the characteristics of innovation projects and R&D activities indicate the existence of possible differences.

Firstly, it is widely known that high sunk and fixed cost are features of R&D projects. Therefore, once firms made a decision to start an innovation activity, the likelihood that they abandon it due to financial constraints is less. Secondly, the information asymmetric problem with external financial providers, the state at which firms become unable to create a reliable image about the quality of their innovation project, is more prevalent at the inception stage. Once an innovation project has started, the uncertainty to get the returns will be less compared to the concept stage, and it requires a relatively lower risk premium to get funds from external sources (Segarra et al., 2013).

Furthermore, at the concept stage, firms mostly apply to get public funds for their R&D projects and may abandon their project if the subsidy is not granted. Empirical analyses revealed that financial obstacles have positive and significant effects on the likelihood of prematurely stopping, seriously slowing down and not starting innovation activities (Mohen et al., 2008). As we observed previously, empirical evidence and economic theory have emphasized the existence of financial obstacles in R&D and innovation projects (Hall, 2002).

Although in general facing financial constraint affects the probability of abandoning innovation, we need to differentiate the effect of a lack of internal sources and external funds. The literature on financing R&D projects reveals that, due to the existence of information asymmetry, specific features of R&D investment and other limitations in capital markets, the source of finance matters most. In a model of firm-level R&D investment, a firm confronts an

upward slope of marginal cost of capital schedule. The upward slope indicates that, upon an increase of R&D volume, the firm moves from financing projects by its own funds to alternative external sources where the capital cost is higher (Segarra et al., 2013).

Therefore, the argument suggests that, compared to a lack of internal finance, facing external financial constraints might have a greater impact on the decision to abandon or not start innovation, particularly for an innovation project with a greater risk tendency. Furthermore, public subsidy providers, a major source of external funds, have their own criteria to choose risky innovation projects with greater impact, which firms fail to finance by internal sources. Therefore, based on the literature on financial constraint and probability of the decision to abandon innovation activities, we therefore hypothesize the following:

> H1: Lack of external finance affects the probability of deciding to abandon innovation at the concept stage positively and significantly.

Referring to the respondents of the innovation survey question, we observe that obstacles to innovation do not exist independently. Prior studies also reported the joint occurrence of the constraints. Mohen and Rosa (2002) and Galia and Lagros (2004) independently confirmed the coexistence of the obstacles in Canadian and French enterprises. After observing the complementarities among different obstacles, both authors recommended a

policy mix to tackle innovation-hampering factors as a package instead of dealing with individual constraints. In our study, in addition to financial constraints, we also tried to examine the effect of other obstacles on firms' decision to abandon or not start innovation. Accordingly, we hypothesize the following:

> H2: The perception of lack of information on technology has a positive and significant effect on the probability of deciding to abandon innovation projects.

> H3: The more firms perceive no demand to innovation, the more likely they are to decide not to start innovation activities.

Different types of firms are likely to confront different kinds of obstacles to innovation. For instance, depending on firm size, there is a strong consensus that small and new firms are better equipped to come up with radical innovation, and large firms are suited for incremental innovation. The difference in innovation profile brings about a difference in the type of innovation obstacle that they face. The type of obstacles that larger firms face is related to their inclination towards an "incumbent trap". Organizational inertia may limit the ability of incumbents to identify new opportunities and adapt to the dynamism of environmental changes (Dougherty, 1992). Larger firms are reluctant to engage in radical innovation to refrain from destabilizing core competencies and cannibalizing existing products (Henderson, 1993).

On the other hand, the obstacles related to small and new firms may be related mainly to a lack of internal resources and market structure. The lack of resources consists of knowledge and organizational skills and a lack of finance. New firms are likely to face market structure barriers, in that they face higher obstacles in big and less competitive markets. This is because incumbents are in a better position to capitalize on the ability to coordinate complementary assets. Garcia-Vega and Lopez (2010), who analyzed only those firms who invested money to their innovative projects, found out that larger firms are more affected by financial barriers, since they invest in large projects that demand quite a big amount of money.

The risky nature of innovative projects might raise financial difficulties, especially to young and small and medium enterprises. Firms might decide not to start, delay or abandon some of their innovative projects. This is because of the low-level intangible assets when liquidation occurs (Gomes et al., 2006) and also the risk of bankruptcy. Firms also refrain from attracting additional equity to invest in innovation projects, as this is likely to worsen the agency problem (which arises from the separation of ownership and management of the firm) and moral hazard, which makes the inventor reluctant to invest by itself, rather than try to avoid the risk (Jensen and Meckling 1976).

Based on the report of prior studies on the effect of the size of the firm on the probability of decision to abandon innovation activities, we therefore hypothesize:

> H4: The smaller the size of the firm, the more likely to abandon innovation at the concept stage.

Similarly, for the linkage between the degree of engagement in innovation activity and perception of financial obstacle, we hypothesize:

> H5: The more firms engaged in equipment acquisition, the more likely they are to perceive financial constraints.

Chapter 4. Data and Methodology

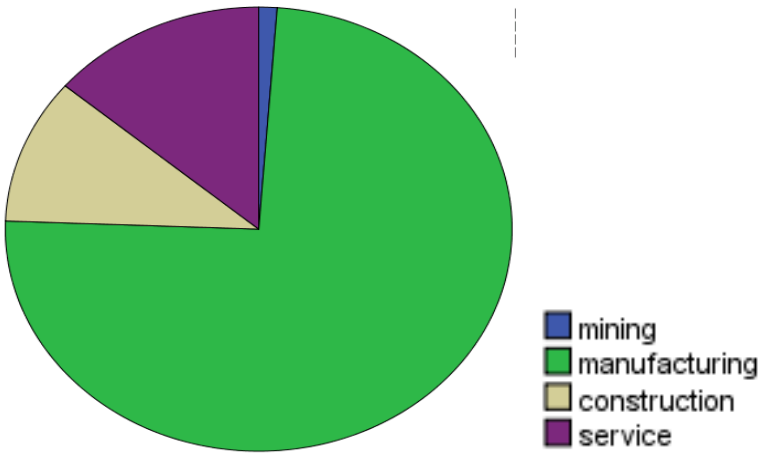
This section of the paper introduces what type of data and approach we used to respond to our research question. In this respect, this part briefly presents the data and describes the research methodology we applied, such as classifying the source of finance, grouping firms as innovation potential and innovation active firms source, conducting the analysis in different stages of innovation and usage of two statistical models accordingly. Finally, it summarizes the basic statistics, namely descriptive statistics, correlation matrix and multicollinearity test.

4.1. Data and Sample

The data for empirical analysis is obtained from the national innovation survey (EIS) conducted by the Ethiopian science & technology information center (STIC). EIS was collected for the years 2012 to 2014 based on the 3rd edition Oslo manual published by the OECD. The innovation survey offers variables related to firms' economic characteristics, such as size, participation in the international market, sector, group membership, and various variables data related to innovation activity[5], impediments to innovation and decision to abandon or not to start innovation. The survey covers a total 1200 enterprises, out of which 893 (74.4 percent) are manufacturing firms and the rest are

[5] EIS includes as innovation activities the acquisition of machinery, equipment, software, and licenses; engineering and development work, training, marketing and R&D when they are specifically undertaken to develop and/or implement a product or process innovation.

enterprises from the mining, construction and service sectors. Among the 893 manufacturing firms, we considered 812 potentially innovative manufacturing firms for further analysis.



Source: STIC 2014

Fig- 6: Sectors included in EIS survey

Potentially innovative firm is a term that represents two groups of firms which are engaged in innovation activities or did not do so when they come across one or more barriers to innovation. The first group consists of 416 firms that are actually engaged in at least one innovation activity listed in Table 4. The second group comprises 396 firms which are not engaged in innovation projects but reported facing obstacles to innovation. In other words, firms in the second group are willing to participate in innovation activities but

discouraged from doing so, due to facing constraints. A total of 81 manufacturing firms that are not engaged in at least one type of innovation activities, or those who did not experience barriers to innovation are excluded from the data. Excluding those firms helps to correct the sample selection bias that resulted while asking firms about obstacles to innovation (Savignac 2008; Augusti Segara et al, 2013).

Table 4: Frequency of innovation activities(2012-2014)

Innovation activity	Frequency	%
In house research and experimental development	70	16.8
Outsourced R&D	35	8.4
Acquisition of machinery	331	79.8
Acquisition of software	70	16.8
Acquisition of external knowledge	124	29.8
Training	189	45.4
Market introduction of innovation	153	37
Design	231	55.5
Other innovation activities	62	14.9

Source: STIC 2014

4.2. Research Methodology

Empirical analysis is classified into different categories:

A) Source of funds

Although in general facing financial constraint affects the probability of abandoning innovation, we need to differentiate the effect of lack of internal sources and external funds. Large own funds as well as a high ratio of gross operating profit margin or good past performance diminishes the likelihood of coming across with financial constraints. On the contrary, having a higher banking debt increases the probability of encountering financial constraints. The literature on financing R&D projects reveals that, due to the existence of information asymmetry, specific features of R&D investment and other limitations in the capital markets, source of finance matters most (P.Mohen et al., 2008; Savignac, 2008; Segarra et al., 2013). Hence, our analyses examine the lack of internal and external finance independently.

B) Stages of innovation abandonment

The cross tabulation of obstacles to innovation against the decision to abandon innovation illustrated that there exists variation along different stages of innovation (see Appendix 2). According to EIS data, 124 manufacturing firms abandon projects at the concept stage, while 63 firms decided to abandon the project after the project was begun. In addition, 66 firms were

compelled to seriously slow down innovation activities while 396 firms were discouraged from starting innovation projects.

There might be stages at which firms consider it suitable to abandon an innovation project. So far, the theoretical literature does not provide clear evidence as to which stage firms decide to abandon their innovation activities due to financial constraints. Nevertheless, the characteristics of innovation projects and R&D activities indicate the existence of possible differences. Firstly, high sunk and fixed costs are the features of R&D projects. Therefore, once the firm decided to begin an innovation project, it is less likely to abandon it due to a lack of finance. Secondly, once the project has started, the asymmetric information problem will no longer be significant to get funds from external sources, as was the case at the concept stage. Hence, we decided to examine the effect of financial and non-financial obstacles on the decision to abandon innovation at the concept stage, after the project was begun, to seriously slow down innovation activities and also the decision not to start innovation (P.Mohen et al, 2008; Segarra et al., 2013).

C) Engagement in innovation activity

Among a total of 893 manufacturing firms, we excluded 81 firms which are not engaged in innovation activities or did not report facing any innovation barriers (Savignac, 2008; Mohnen et al., 2008; D'Este et al., 2012). This is done to correct the selection bias problem that can occur when firms covered by the survey are asked about obstacles to innovation. A total of 812 manufacturing firms selected for further analysis are referred to as potential

innovative firms. These include firms that engaged in innovation projects or firms did not do so because they faced one or more obstacles. If the sample data includes those firms which are not interested in innovating, it can inflate the role of revealed barriers and underestimate deterrents (Savignac, 2008; Mancusi and Vezzulli, 2010). Hence, our data comprises 416 innovation active firms and 396 manufacturing firms that are discouraged from doing so. In our research, the analysis for potential innovative firms and innovation active firms is done independently.

D) Statistical Model

The model is chosen on the basis of the endogeneity problem that exists between facing financial constraints and engaging in innovation activities (Savignac, 2008; Blanchard et al., 2012; Agusti Segarra et al., 2013). Such counter-intuitive positive spurious correlation is induced as a result of a number of sources of bias (endogeneity). There is a possibility that both the probability of facing financial constraint and decision to abandon or not start innovation activities are affected by unobservable common factors. The uncertainty associated with the final result of the innovative activity is an unobservable firm-specific risk factor that may worsen the lack of finance. In addition, since we have no information about the duration needed to take an innovative project to the market, it could also contribute to both decisions to abandon innovation and the likelihood to face financial obstacles.

The second reason is attributed to the probability that the decision to abandon innovation and a financial constraint will occur simultaneously. Hence, there is a tendency for both variables to affect one another simultaneously. On one hand, the existence of financial constraints affects the likelihood of deciding to abandon or not to start innovation activities, and on the other hand, the decision to abandon or not to start a project affects the likelihood of facing financial constraints. Therefore, our aim is to determine how financial and non-financial constraints affect the decision to abandon or not to start innovation activities while using traditional control factors such as size and group membership. The probability to decide to abandon or not to start innovation and the probability to face a lack of finance are simultaneously determined by the recursive bivariate probit model.

The following simultaneous equation represents the relationship that exists between facing financial constraints and the decision to abandon innovation activities:

$$Z_{1i} = \boldsymbol{\mu} x_i + \boldsymbol{\beta} Z_{2i} + \boldsymbol{\varepsilon}_{1i} \ldots\ldots\ldots\ldots \ldots (1)$$

$$Z_{2i} = \boldsymbol{\delta} y_i + \boldsymbol{\varepsilon}_{2i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The error terms in the simultaneous equation are assumed to have normal distribution, and together provide a correlation parameter (ρ). The value of the bivariate normal distribution function gives the probability of each event. For instance, the probability at which both decision to abandon innovation and

facing of financial constraint becomes true is estimated without endogeneity, as follows:

$$\Pr(Z_1=1, Z_2=1)= \Phi(\boldsymbol{\mu}x + \beta, \boldsymbol{\delta}z, \rho)$$

This model is applied only if the correlation coefficient is significant, and different from zero. If the null hypothesis holds true, then we estimate the two equations independently using a simple probit model.

Dependent Variable

Two groups of dependent variables are considered. The first equation represents the decision of a firm to abandon or not to start innovation activities, and the second equation captures the probability at which a firm faces financial constraints (P.Mohen et al., 2008; Savignac, 2008; Segarra et al., 2013). The first equation is further divided into four in order to see the difference of the decision to abandon innovation at the concept stage, after the project was begun, to seriously slow down and not to start innovation projects.

Explanatory Variables

Among the 16 innovations hampering factors, grouped under five components, on the EIS questionnaire we selected factors with higher loading factors in their respective components. These are a lack of finance, lack of information on technology, presence of a dominant firm in the market and perception of no demand to innovation.

For the first equation, the explanatory variables are as follows:

- Lack of finance is a dummy variable and assumes a value of 1, if the firm perceives a high level of financial barriers (Lopez, 2010; P. Mohen et al., 2008; Segarra et al., 2013).

- Lack of technology information is a dummy variable and assumes a value of 1, if the firm perceives a high level of barriers (Lopez, 2010; P.Mohen et al., 2008; Segarra et al., 2013).

- A dominant firm in the market is a dummy variable and assumes a value of 1, if the firm perceives a high level of barriers (Lopez, 2010; P.Mohen et al., 2008; Segarra et al., 2013).

- No demand to innovation is a dummy variable and assumes a value of 1, if the firm perceives a high level of barriers.

- Cooperation is a dummy variable that assumes a value 1 if the firm has a cooperation arrangement with other agents (Savignac, 2008; Segarra et al., 2013).

- Firm size serve as a control variable and its value is determined by the natural logarithm of total number of employees in a firm (P.Mohen et al., 2008; Savignac, 2008; Segarra et al., 2013).

- International market is a dummy variable that takes a value of 1 if the firm is engaged in an overseas market (Segarra et al., 2013).

- Equipment acquisition is a dummy variable that captures whether the firm is engaged in acquisition of machinery and equipment or 0 otherwise.

Similarly, for the second equations:

- R&D is a dummy variable that holds a value 1 if a firm is engaged in in-house and outsourced R&D or 0 otherwise (Savignac, 2008; Segarra et al., 2013).

- Firm size serve as a control variable and its value is determined by the natural logarithm of total number of employees in a firm (P.Mohen et al., 2008; Savignac, 2008; Segarra et al., 2013).

- Group is a dummy variable and assumes a value of 1, if the firm belongs to a large group (Savignac, 2008; Tiwari et al., 2008; D'Este, 2012).

- Equipment acquisition is a dummy variable that holds a value 1 if a firm is engaged in the acquisition of machinery and equipment or 0 otherwise.

Given the above simultaneous equation, the computation of the average marginal effects in the model is determined as follows (Greene, 2003):

- The difference between the conditional probabilities, measure the average marginal effect of qualitative variables.

$$\Pr(Z_1 = 1 | Z_2 = 1, x, y) - \Pr(Z_1 = 1 | Z_2 = 0, x, y)$$

- For a continuous variable that appear in both equations, such as size, the total effect on the probability to abandon innovation activity is given by:

$$\Pr(Z_1 | Z_2, x) + \Pr(Z_2 | y)$$

Basic statistics

Table 6 shows the correlation matrix as well as the value of mean and standard deviation for explanatory variables. The value on spearman's correlation matrix is relatively low. Hence, we checked for the existence of multicollinearity among the predictors. We used the method of variance inflation factor (VIF), since it is a more rigorous check for collinearity than correlation coefficient (see Table 5). According to the rule of thumb, VIF=1 means no collinearity and if VIF >5 collinearity exists. Note that VIF is a property of the predictors and the particular regression model being fit is irrelevant in this case.

Mathematically, VIF is given by:

$$VIF = \frac{1}{(1 - R_i^2)}$$

In the regression model:

$$Z = a_0 + a_1 y_1 + a_2 y_2 + a_3 y_3 + e$$

R_1^2 is obtained from regressing y_1 on y_2 and y_3. The same applies for the rest.

Table 5: Variance inflation factor test

Variable	**VIF**
firm size	1.32
Equipment acquisition	1.19
Group	1.15
Cooperation	1.14
Rand D	1.11
Lackfinance	1.09
International market	1.08
Dominant firm	1.07
Lack of tech info	1.04
No demand	1.03
Mean VIF	**1.12**

Table 6: Spearman's rank correlation matrix and descriptive statistics

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*Mean(SD)*
(1) Lackfinance	1.00										0.54(0.49)
(2) lacktechinfo	0.099*	1.00									0.21(0.41)
(3) dominatfrm	0.174*	0.152*	1.00								0.23(0.42)
(4) Nodemand	0.046	0.078*	0.089*	1.00							0.03(0.17)
(5) fsize14(ln)	-0.247*	0.003	-0.053	0.010	1.00						3.11(0.88)
(6) Eqptaqus	0.038	0.018	0.020	-0.094*	0.102*	1.00					0.39(0.49)
(7) RandD	-0.092*	-0.022	-0.049	-0.061	0.254*	0.254*	1.00				0.08(0.27)
(8) Int'lmkt	-0.005	0.032	-0.003	-0.002	0.259*	0.032	0.117*	1.00			0.03(0.16)
(9) Cooperation	0.012	0.033	-0.053	-0.016	0.110*	0.350*	0.114*	0.055	1.00		0.13(0.33)
(10) group	-0.106*	-0.023	-0.058	0.024	0.370*	0.084*	0.128*	0.074*	0.143*	1.0	0.12(0.32)

Significance at 5%

Chapter 5. Result and Discussion

This chapter covers the major findings and implications for practice. The findings of the research are presented for internal finance and external finance separately; each consists of innovation active and potential innovative firms. The consistency of the result is checked against economic theory and the results of prior studies. Finally, policy implication is formulated based on major findings.

5.1. Major Finding

The bivariate probit model we used for the econometric analysis is estimated by taking into consideration the weight element. This is to account for the EIS data for small and medium enterprises collected using stratified sampling. The result of the analysis is elaborated under the categories of internal and external finance. Within the broad categories, again we summarized the major findings under innovation active firms and manufacturing firms with innovation potential. Then the effects of financial and non-financial obstacles are illustrated under each stage of innovation.

5.1.1. Internal Finance

For manufacturing firms with innovation potential, the recursive bivariate probit model is fit for the decision to abandon innovation at the concept stage after the project was begun, and to seriously slow down innovation activities. Nevertheless, for the decision not to start innovation, we found the null

hypothesis to hold true for the correlation coefficient of the two equations. Hence, the result for the probability of deciding not to start innovation is obtained from the probit model.

For innovation active firms, the recursive bivariate probit model is fit only for the decision to abandon innovation at the concept stage. Therefore, we estimated the probability of deciding to abandon the project after it was begun and the decision to seriously slow down using the probit model. The probability of facing financial constraints is also determined independently for the latter.

A) Manufacturing firms with innovation potential

The finding for innovation potential firms presented for each stage of innovation as follows:

At the concept stage

The result of the analysis, shown in Table 7, indicates a lack of internal finance, size, international market, equipment acquisition and cooperation agreement are found to be significant on the probability of decision to abandon at the concept stage. Contrary to our expectation, a lack of finance doesn't affect the probability of the decision of a firm to abandon innovation at the concept stage. At this stage, firms which entered into cooperation agreement, engaged in acquiring machineries, were involved in the international market and were of smaller size are more likely to abandon innovation activities.

At the concept stage, firms that do not belong to a large group and engaged in the acquisition of machinery are more likely to face financial constraints as their size gets smaller. Surprisingly, as firms engaged more in R&D activities, the probability of facing financial constraint continues to decrease.

After the project was begun

The result of the analysis, shown in Table 7, indicates a lack of internal finance, equipment acquisition and cooperation agreement is found to be significant in the probability of a decision to abandon after innovation projects were begun. Contrary to our expectation, the lack of finance doesn't affect the probability of decision of a firm to abandon innovation after it was begun. At this stage, firms which entered into a cooperation agreement and engaged in acquiring machineries are more likely to abandon innovation projects.

After innovation projects are begun, firms that engaged in acquisition of machinery are more likely to face financial constraints as their size gets smaller.

Serious slowdown

The analysis in Table 7 shows a lack of internal finance, size and equipment acquisition is found to be significant to the probability of the decision to seriously slow down innovation projects. Contrary to our expectation, a lack of finance doesn't affect the probability of the decision of a firm to seriously

slow down innovation activities. Firms engaged in acquiring machinery and those of smaller size are more likely to decide to seriously slow down innovation activities. At this stage, firms that do not belong to a group, and those engaged in the acquisition of machinery are more likely to face financial constraints as their size gets smaller.

Not start

The result of the analysis on Table 7 shows a lack of internal finance, size and perception as if there is no demand for innovation found to be significant to the probability of the decision not to start innovation projects. Contrary to our expectation, a lack of finance doesn't affect the probability of the decision of a firm not to start innovation activities. Interestingly enough, firms of smaller size, who perceive that there is no need to innovate because no demand to innovation is more likely to cause a firm not to start innovation projects.

In connection with the decision not to start innovation, firms engaged in the acquisition of machineries are more likely to face financial constraints as their size gets smaller.

Table 7: Result of internal fiancé for firms with innovation potential (812 manufacturing firms)

Recursive Bivariate Probit Model				Probit Model
Average Marginal Effect(AME) for probability of abandoning at different stage				Marginal Effect(ME) for probability of not starting
	Abandon concept	Abandon after	Seriously Slowdown	Not start
lackintrfina	**-0.164*** (0.027)**	**-0.258**(0.110)**	**-0.309***(0.096)**	**-0.078**(0.38)**
lacktechinfo	-0.019(0.018)	-0.002(0.011)	0.015(0.009)	-0.021(0.045)
dominatfrm	-0.009(0.018)	0.005(0.010)	-0.007(0.012)	-0.009(0.044)
Nodemand	**---**	---	-0.024(0.028)	**0.271***(0.086)**
fsize(ln)	**-0.033*** (0.010)**	-0.008(0.006)	**-0.013**(0.006)**	**-0.046**(0.021)**
Intlmkt	**0.070*(0.040)**	0.030(0.024)	0.007(0.023)	-0.097(0.114)
Eqptaqus	**0.101*** (0.020)**	**0.037***(0.013)**	**0.043***(0.012)**	---
Cooperation	**0.060***(0.021)**	**0.028**(0.014)**	0.016(0.013)	---
AME for probability to suffer internal financial constraint				ME for financial constraints
fsize(ln)	**-0.115***(0.020)**	**-0.121***(0.020)**	**-0.115***(0.020)**	**-0.127***(0.023)**
Eqptaqus	**0.075**(0.036)**	**0.077**(0.036)**	**0.076**(0.036)**	**0.076**(0.038)**
RandD	**-0.122**(0.060)**	-0.086(0.064)	-0.096(0.060)	-0.074(0.073)
group	**-0.100*(0.053)**	-0.049(0.053)	**-0.088*(0.049)**	-0.048(0.061)
rho(ρ)	0.786***(0.177)	0.810**(0.152)	0.881***(0.105)	
	Standard errors in parenthesis ***p<0.01, **p<0.05, *p<0.1			

B) Innovation active manufacturing firms

The finding for innovation active firms presented for each stage of innovation as follows:

At the concept stage

The result of the analysis in Table 8 shows a lack of internal finance, size and cooperation agreement are found to be significant on the probability of decision to abandon a project at the concept stage. Contrary to our expectation, lack of finance doesn't affect the probability of decision of a firm to abandon innovation at the concept stage. At this stage, firms which entered into cooperation agreement and those of smaller size are more likely to abandon innovation activities. At the concept stage, firms that do not belong to a large group are more likely to face financial constraints as their size gets smaller.

After the project was begun

The analysis as shown in Table 8 indicates only that firm size is significant in the decision to abandon after innovation projects were begun. Larger firms engaged in at least one innovation activity are found to abandon innovation projects after it was begun.

Serious slowdown

The analysis, as shown in Table 8, indicates a lack of information on technology, and firm size is found to be significant in the probability of the decision to seriously slow down innovation projects. Innovation-active larger firms faced with a lack of information on technology are more likely to decide to seriously slow down their innovation activities.

Table 8: Result of internal fiancé for innovation active firms (416 manufacturing firms)

Recursive Bivariate Probit Model		Probit Model	
Average Marginal Effect(AME) for probability of abandoning innovation		Marginal Effect(ME) for probability of abandoning innovation	
	Abandon concept	Abandon after	Slowdown
lackintrfina	**-0.349***(0.092)**	0.027(0.037)	0.018(0.037)
lacktechinfo	-0.022(0.035)	0.009(0.045)	**0.095*(0.052)**
dominatfrm	-0.012(0.036)	0.046(0.047)	-0.015(0.043)
Nodemand	---	---	-0.020(0.115)
fsize(ln)	**-0.044**(0.019)**	**0.043**(0.017)**	**0.030*(0.016)**
Intlmkt	0.072(0.075)	0.012(0.088)	-0.082(0.057)
Eqptaqus	-0.033(0.040)	-0.073(0.050)	-0.011(0.045)
Cooperation	**0.056*(0.034)**	0.062(0.044)	0.044(0.42)
AME for probability to face internal financial constraint		ME for probability of facing financial constraints	
fsize(ln)	**-0.101***(0.026)**	**-0.109***(0.029)**	**-0.109***(0.029)**
Eqptaqus	0.007(0.060)	0.006(0.064)	0.006(0.064)
RandD	-0.094(0.061)	-0.104(0.075)	-0.104(0.075)
group	**-0.131**(0.066)**	-0.071(0.083)	-0.071(0.083)
rho(ρ)	0.787***(0.145)		
	Standard errors in parenthesis ***p<0.01, **p<0.05, *p<0.1		

5.1.2. External Finance

For manufacturing firms with innovation potential, the recursive bivariate probit model is fit for the decision to abandon innovation at the concept stage, after the project was begun and to seriously slow down innovation activities. Nevertheless, for the decision not to start innovation, we found the null hypothesis to hold true for correlation coefficient of the two equations. Hence, the result for the probability of deciding not to start innovation is obtained from the probit model.

For innovation active firms, the recursive bivariate probit model is fit only for the decision to seriously slow down innovation projects. Therefore, we estimated the probability of deciding to abandon a project at the concept stage, and after the project was begun using a probit model. The probability of facing financial constraints is also determined independently for the latter.

A) Manufacturing firms with innovation potential

The finding for innovation potential firms presented for each stage of innovation as follows:

At the concept stage

The analysis, as presented in Table 9, shows a lack of external finance, size, equipment acquisition and cooperation agreement is found to be significant on the probability of the decision to abandon a project at the concept stage. Contrary to our expectation, a lack of finance doesn't affect the probability of the decision of a firm to abandon innovation at the concept stage. At this stage, firms which entered into cooperation agreement, engaged in acquiring machineries and are of smaller size are more likely to abandon innovation activities.

At the concept stage, firms that do not belong to a large group and are engaged in the acquisition of machinery are more likely to face financial constraints as their size gets smaller. Surprisingly, as firms engaged more in R&D activities, the probability of facing financial constraint keeps on decreasing.

After the project was begun

The analysis, presented in Table 9, shows a lack of external finance, size, engagement in equipment acquisition and cooperation agreement are found to be significant on the probability of decision to abandon after innovation projects was begun. Contrary to our expectation, a lack of external finance doesn't affect the probability of decision of a firm to abandon innovation after it was begun. At this stage, firms which entered into a cooperation agreement

and engaged in acquiring machinery are more likely to abandon innovation projects as their size gets smaller.

After innovation projects are begun, firms that engaged in acquisition of machinery are more likely to face financial constraints as their size gets smaller. Surprisingly, as firms engaged more in R&D activities, the probability of facing external financial constraint continues decreasing.

Serious slowdown

The results of the analysis, shown in Table 9, indicate that a lack of external finance, size, presence of dominant firm in the market and equipment acquisition are found to be significant in the probability of the decision to seriously slow down innovation projects. Contrary to our expectation, a lack of finance and presence of a dominant firm in the market does not affect the probability of the decision of a firm to seriously slow down innovation activities. Firms engaged in acquiring machineries and those with smaller size are more likely to decide to seriously slow down innovation activities. At this stage, firms that are engaged in the acquisition of machinery are more likely to face financial constraints as their size gets smaller. Surprisingly, as firms engaged more in R&D activities, the probability of facing external financial constraint continues decreasing.

Not to start

The result of the analysis, shown in Table 9, indicates size and perception as if there is no need demand for innovations are found to be significant on the probability of decision not to start innovation projects. Interestingly enough, firms with larger size that perceive that there is no need to innovate because there is no demand for innovation are more likely to decide not to start innovation projects.

In connection with the decision not to start innovation, firms engaged in acquisition of machinery are more likely to face financial constraints as their size gets smaller. Surprisingly, as firms engaged more in R&D activities, the probability of facing external financial constraints continues decreasing.

Table 9: Result of external fiancé for firms with innovation potential (812 manufacturing firms)

Recursive Bivariate Probit Model				Probit model
Average Marginal Effect(AME) for probability of abandoning at different stage				Marginal Effect (ME)
	Abandon concept	Abandon after	Slowdown	Not start
lackintrfina	-0.331***(0.074)	-0.232**(0.102)	-0.311***(0.049)	-0.060(0.038)
lacktechinfo	-0.013(0.013)	-0.004(0.011)	0.013(0.008)	-0.021(0.045)
dominatfrm	-0.005(0.013)	0.002(0.010)	-0.019**(0.009)	-0.012(0.044)
Nodemand	---	---	-0.024(0.027)	0.272***(0.086)
fsize(ln)	-0.026***(0.008)	-0.005(0.007)	-0.011**(0.005)	0.042**(0.020)
Intlmkt	0.047(0.036)	0.023(0.024)	-0.008(0.024)	-0.089(0.115)
Eqptaqus	0.079***(0.019)	0.037***(0.013)	0.043**(0.012)	---
Cooperation	0.045***(0.016)	0.025*(0.013)	0.008(0.011)	---
AME for probability to suffer internal financial constraint				ME for finance
fsize(ln)	**-0.079***(0.021)**	**-0.087***(0.021)**	**-0.079***(0.020)**	**-0.086***(0.022)**
Eqptaqus	**0.087**(0.035)**	**0.087**(0.035)**	**0.090**(0.034)**	**0.089**(0.380)**
RandD	**-0.178***(0.052)**	**-0.119*(0.064)**	**-0.121**(0.053)**	**-0.133**(0.064)**
group	**-0.087*(0.046)**	-0.025(0.051)	-0.065(0.041)	-0.024(0.059)
rho(ρ)	0.920**(0.094)	0.897**(0.016)	0.971***(0.031)	
Standard errors in parenthesis ***p<0.01, **p<0.05, *p<0.1				

A) Innovation active manufacturing firms

The finding for innovation active firms presented for each stage of innovation as follows:

At the concept stage

The result of the analysis, shown in Table 10, indicates that a lack of external finance is found to be positive and significant on the probability of the decision to abandon at the concept stage. In line with our expectation, a lack of external finance affects the probability of the decision of a firm to abandon innovation at the concept stage. At this particular stage, firms that are not engaged in R&D activities are more likely to face external financial constraints as their size gets smaller.

After the project was begun

The result of the analysis, shown in Table 10, indicates that firm size and external financial constraint are positive and significant in the decision to abandon after innovation projects were begun. Larger firms engaged in at least one innovation activity and those faced with financial constraints are found to abandon innovation projects after they were begun.

Serious slowdown

The result of the analysis, shown in Table 10, indicates that a lack of finance, lack of information on technology, presence of a dominant firm, participation

in the international market and firm size are found to be significant on the probability of decision to seriously slow down innovation projects. Contrary to our expectation, a lack of external finance and the presence of a dominant firm in the market do not affect the probability of the decision of a firm to seriously slow down innovation projects. Innovation-active smaller firms faced with a lack of information on technology are more likely to slow down innovation activities. In addition, as innovation-active firms engaged more in the overseas market, they are less likely to decide to seriously slow down innovation projects.

At this stage, smaller firms are more likely to face financial constraints. Surprisingly, as firms engaged more in R&D activities, the probability of facing external financial constraints continues decreasing.

Table 10: Result of external finance for innovation active firms(416 manufacturing firms)

Recursive Bivariate Probit Model		Probit Model	
Average Marginal Effect(AME) for probability of abandoning innovation		Marginal Effect(ME) for probability of abandoning innovation	
	Slowdown	Abandon concept	Abandon after
lackintrfina	**-0.387***(0.025)**	**0.089*(0.051)**	**0.116**(0.039)**
lacktechinfo	**0.028**(0.014)**	-0.037(0.057)	-0.001(0.042)
dominatfrm	**-0.031**(0.014)**	-0.034(0.057)	0.023(0.043)
Nodemand	---	---	---
fsize(ln)	**-0.016*(0.009)**	-0.002(0.025)	**0.051***(0.017)**
Intlmkt	**-0.054**(0.023)**	0.103(0.135)	-0.007(0.081)
Eqptaqus	0.023(0.025)	-0.071(0.062)	-0.082(0.051)
Cooperation	-0.006(0.010)	0.090(0.057)	0.045(0.042)
AME for probability to face external financial constraint		ME for probability of facing financial constraints	
fsize(ln)	**-0.072***(0.027)**	**-0.082***(0.029)**	**-0.082***(0.029)**
Eqptaqus	0.070(0.064)	0.078(0.063)	0.078(0.063)
RandD	**-0.081*(0.047)**	**-0.147**(0.069)**	**-0.147**(0.069)**
group	-0.061(0.047)	0.020(0.082)	0.020(0.082)
rho(ρ)	0.999**(0.002)		
	Standard errors in parenthesis		
	***p<0.01, **p<0.05, *p<0.1		

5.2. Discussion and Policy implication

Based on the major findings stated in previous sub-sections, we observed that all five hypotheses are accepted. We now check whether the results are consistent with economic theory and the findings of prior studies. Policy implication is formulated to make use of our research findings to solve the practical problems associated with the Ethiopian manufacturing sector.

5.2.1. Discussion

First, lack of external finance is found to be significant and positive in affecting the likelihood of the decision to abandon innovation at the concept stage for innovation-active firms. This result is consistent with economic theory of information asymmetry problem and moral hazard. The uncertainty of innovation activity makes inventors look for external funds to take advantage of risk aversion. Since it is difficult to prove the quality of innovation projects at the inception stage, firms will face the challenge of securing funds from external sources.

The result is also in agreement with Blanchard et al. (2012) and Segarra et al. (2013), who assert that firms that invest in innovation activities and R&D projects will be more likely to face financial constraints, particularly external funds. The most likely explanation for abandoning projects at the concept stage could be related to the existence of high sunk R&D and fixed costs (Segarra et al., 2013). Similarly, Lopez (2010) also reported that larger firms abandon innovation projects due to lack of lack of external funds. He added

that larger firms might be engaged in extensive innovative projects that require huge amount of funds than small or medium firms do.

Second, for innovation-active firms, the lack of information on technology has a positive and significant impact on seriously slowing down innovation activities. The result indicates that firms that manage to handle constraints at the initial stage successfully couldn't maintain the momentum due to a lack of technological information. Since equipment acquisition is one of the major innovation activities that Ethiopian manufacturing firms are engaged in, they could face a shortage of information about parts and components of machineries for proper operation and troubleshooting. A shortage of qualified personnel could also contribute to technological information to be perceived as a major constraint. The result is in agreement with the findings of Lopez (2010) and Segarra et al. (2013), who reported the effect of the knowledge factor on the decision to abandon innovation.

Third, for innovation potential firms, the perception of no demand to innovation has a positive and significant effect on the likelihood of deciding not to start innovation activities. This result can be explained in relation to the export market participation of Ethiopian manufacturing firms. According to the annual report of the National Bank of Ethiopia (2015), more than 90 percent of the export income is primarily from agricultural products and minerals. The share of export income from products derived from the manufacturing sector such as meat and meat products and footwear and leather products only account for 7.5 percent of the total earnings. This

implies that most manufacturing firms are focused on local market characterized by less completion, which may reduce the incentive of incremental profit from innovating. Similarly, fierce completion in international markets may also reduce innovation incentive for laggards (Aghion et al., 2002).

Fourth, for both potential innovators and innovation-active firms, the size of the firm is found to be significant to affect the probability of the decision to abandon innovation projects at the concept stage. In the Ethiopian manufacturing sector, small-sized firms are more likely to abandon innovation at the inception stage as they perceive a lack of financial constraints. The probability of facing a lack of finance depends on the firm's ex-ante financial structure, and it increases as the firm's size gets smaller (Savignac, 2008). The problem associated with asymmetric information increases as the firm size gets smaller, and as a result, smaller firms experience strong barriers to get access to external resources (P. D'Este et al., 2012; Segarra et al., 2013). This fact might compel smaller Ethiopian manufacturing firms to abandon innovation activities during the concept stage.

Fifth, for innovation-potential firms, the more they engage in the acquisition of machineries and equipment, the perception of financial constraints is affected positively and significantly. This result is consistent with the findings of Blanchard et al. (2012), who reported that firms face strong obstacles as they engage more in innovative projects. The result is also in line with P. D'Este et al. (2012), who illustrated a non-linear relationship between engagement in innovation activity and the probability of facing financial

constraints. According to his result, firms that are discouraged from starting innovation and those firms engaged in more innovation activities perceive strong financial constraints (the phenomena is termed as the deterring and revealed effect, respectively).

In general, the result reconfirmed the need to classify financial resource, stages of innovation, and engagement in innovation activities. It provided a target group for preferential treatment, for government agencies at the federal and regional levels, in charge of supporting innovation activities. For instance, manufacturing firms that have innovation potential, smaller size and engagement in equipment acquisition and that are not part of large group abandon innovation at the concept stage.

5.2.2. Implication for Practice

Following the discussion of our findings, we hereby present four implications for practice. The first implication is the combination of the result on external finance and equipment acquisition. Firms engaged in machinery acquisition perceive financial constraints and a lack of external finance affects the probability of the decision of innovation-active firms to abandon innovation projects at the concept stage. In Ethiopia, apart from research financial grants for individuals and enterprises on a competitive basis, there are no dedicated public institutes solely established to support innovation activity in financial terms. Furthermore, private venture capitalists that are ready to invest in risky innovative projects have not emerged yet. Hence, our finding implies the need

to implement a system that serves as a major source of financing innovation activity.

To support innovation projects in Ethiopian manufacturing firms, we propose two alternative solutions, namely the venture capital fund program (VCFP) and technology acquisition and development fund (TADF). Many special innovation-financing schemes are available in different countries. In the early days of Korean development, rapid industrialization was achieved mainly due to export-oriented strategy adopted in 1960's. Initially, the strategy promoted labor-intensive manufacturing firms. The Korean government addressed the problem of industrial investment by arranging long-term, large-scale foreign loans. The allocation of foreign investment enabled selected firms, which later formulated a business conglomerates called "Chaebol", to massively import foreign capital goods and turn-key plants.

Unlike traditional financial intermediaries, the Small Business Innovation Research (SBIR) and Small Business Investment Companies (SBIC) program are typical examples of venture capital initiatives by the US government (Svensson, 2007). The federal government has played a leading role in financing technology-intensive industries. In the US, venture capital (VC) plays a crucial role in professionalizing start-ups (Hellmann and Puri, 2002) through active engagement with the enterprises and through enhanced leverage, thereby reducing information asymmetry and moral hazard.

SBICs are basically government-sponsored venture capital owned by private investors. These networks of private companies provide management assistance, long-term loans and equity capital to small businesses. Currently there are about 300 SBICs throughout the US, which are licensed and regulated by the Small Business Administration (SBA). As a regulatory body, the SBA does not provide cash to the SBICs directly. Rather, it guarantees loans that the SBICs take out with the aim of enhancing the amount of capital they are able to make accessible to companies. Well-known companies such as Apple, Intel, Costco, Jenny Craig and FedEX are considered success stories of the SBIC program.

One of the arguments for the necessity of the presence of public venture programs, despite the existence of venture capital is the certification of new technology intensive firm to outside investors. As discussed earlier, the information asymmetry problem makes it difficult for firms to get funds that cover all positive net present value of their innovation project. The certification by public entities guarantees the quality of the technology, consequently diminishing information asymmetry. In addition, private venture funds mostly concentrate on certain areas of technology. For example, in the US, in 2002, more than 90 percent of the funds go to IT and healthcare fields. Government programs are needed to cover the areas neglected by private venture capitalists (Devenow and Welch, 1996).

Some of the factors that affect venture capital development in different countries are the structure of the institutional setup, the availability of funds, transparency levels, interest rates, tax benefits, transaction costs and the cultural and political situation. There are situations whereby the purpose of government subsidies are distorted by politicians or particular interest groups who seek to redirect the funds in a way that benefits them (Becker, 1983). Direct and indirect subsidies could be captured by free riders who have access to lobbying political party affiliated groups (Peltzman, 1976).

For firms in developing countries with low levels of internal R&D capacity, technology acquisition from external sources is the most preferred option. Acquisition of technology enables firms to get access to state-of-the-art technology and facilitates speedy development and placement of commercial technologies and products. In 2011, the Indian government established the Technology Acquisition and Development Fund (TADF)[6] as part of the implementation of the national manufacturing policy.

The TADF is established mainly to support the financial acquisition of technologies by SMEs in selected technology areas. TADF has different support schemes, such as the reimbursement of the 50 percent technology

[6] http://www.gita.org.in/Tadf/TADFInfo.aspx

transfer fee and a subsidy of up to 10 percent of the capital expenditure incurred on new plants and machinery. Some of the criteria to be eligible to get support from the TADF are that at least 51 percent of SMEs' stake should be held by Indian citizens, and the firm shall confirm prior engagement in similar fields covered by the support scheme.

Malaysia also has similar experience in establishing and effectively running the technology acquisition fund (TAF)[7]. This fund was established to support acquisition of proven strategic foreign technologies for immediate implementation into company's manufacturing activity. The purpose of the fund is to enable Malaysian manufacturing firms to enhance their technological level and production capability.

The second implication emanates from the result of a lack of information on technology. For innovation-active Ethiopian manufacturing firms, the probability of the decision to seriously slow down innovation activity is affected by a lack of technological information. In Ethiopia, the government agency called Science and Technology Information Center (STIC) is mandated to provide scientific and technological information for enterprises.

[7] http://www.mtdc.com.my/index.php/the-right-support/

Hence, our result calls for the attention of the STIC to approach innovation-active firms and provide sufficient technological information based on their demand.

The third implication emanates from the result of "no need to innovate". Such a perception affects the likelihood of the decision by innovation potential firms not to start innovation. This unique finding implies the orientation of Ethiopian manufacturing firms towards the local market characterized by less competition. This implies the need for creating a more competitive environment in the Ethiopian economy so that firms could have greater incentives to engage in innovation activities. This can be achieved by enhancing openness to trade and promoting FDI in order to increase the presence of competitors from abroad, which would in turn encourage local firms to get exposure, search for and adopt more advanced technologies (Schiff and Wang, 2006).

On the other hand, innovativeness can be induced through participation in the foreign market. Lederman (2009), using a cross-country enterprise survey, revealed that the probability of a firm's innovativeness is positively correlated with the firm's export status. German manufacturing sector is well known for its high level of labor productivity. J. Matthias and K. Hussinger (2005), revealed that, the high labor productivity affects positively and significantly the exporting of German manufacturing firms. On the other hand, as Ethiopian leather exporters start participating in the overseas market, they realized the minimum standards that they should meet to get access to the

market. The signals from their customers initiated the exporters to adopt methods and technologies to become and remain competitive in the market. Our finding urges Ethiopian manufacturing firms to encourage themselves and engage in innovation activity in order to exploit the opportunity provided by the US and Europe to get access to a market with preferential tax and tariff-free access.

The fourth implication of our study drives from our finding on firm size. The probability of the decision to abandon innovation at the concept stage has an inverse relationship with the size of the firm for both innovation potential and innovation active firms. Our finding calls for attention from policy makers to reexamine the existing STI policy, which actually skewed its support towards large enterprises. Neoclassical growth model presented by Robert Solow (1956) is in favor of large firms and argues that economic growth is generated by combining efficiently deployed large-scale capital with low-cost unskilled labor. However, this theory was later amended and shifted the focus from capital towards knowledge as a crucial source of economic growth (Paul Romer, 1986) and entrepreneurship as a stimulant (David B. Audretsch, 2004). Therefore, providing preferential treatment for small Ethiopian manufacturing firms is necessary, especially during the stage of preparing to launch innovation projects. In addition to addressing the constraints of innovative SMEs, preferential treatment may include taxation incentives, such as investment tax credit, exemption from value-added taxes and lower corporate income tax rate (Duanjie Chen et al., 2002).

This paper analyzed the effect of major hampering factors on the decision to abandon as well as not to start innovation activities. In this regard, it will contribute to the innovation management knowledge domain by illustrating the case of countries in similar economic situations to that of Ethiopia. This paper showed how influential the perception of no demand to innovation is on a firm's decision not to start innovation activities. This is an illustration of developing countries like Ethiopia, which are characterized by a lack of strong competition in the market, and export items are mainly concentrated on primary products. In addition to its academic contribution, the result of this study can be used as a useful input to design appropriate policy measures to promote innovation activities in the Ethiopian manufacturing sector.

Concerned Ethiopian government agencies can integrate the implication drawn from the major findings of the research into their respective growth and transformation plan (2016-2020). In particular; Ministry of Science and Technology has a vital role to practically implement the recommendations as part of five years STI strategic plan.

Chapter 6. Conclusion

6.1. Overall Conclusion

The major aim of this paper is to analyze the extent to which financial and non-financial constraints affect the probability of the decision of firms to abandon or not start innovation activities. Prior studies provided empirical evidence for how financial constraints increase the probability of failure innovation activities (P. Mohen et al., 2008; Segarra et al., 2013).

Our interest lies in presenting the case of Ethiopia, one of Africa's developing economies, to the existing literature in the field of innovation management. We used statistical information from enterprise innovation from surveys conducted in Ethiopia during the years from 2012 to 2014. We have studied the effect of innovation-hampering factors on firms' decision to abandon projects at the concept stage, to stop prematurely after the project was begun and to seriously slow down or to desist from starting innovation activities.

The result of the analysis shows that a lack of external finance affects the decision to abandon innovation at the concept stage for innovation-active firms. Also, small-sizes firms and manufacturing firms engaged in the acquisition of machinery and equipment are more sensitive to financial constraints. Surprisingly, the perception of no demand to innovation is found as a crucial factor to discourage Ethiopian manufacturing firms from starting innovation activities. Our finding, except for the unique result regarding the perception of no demand to innovation, is in line with prior research result

(See P. Mohen et al., 2008; Segarra et al., 2013). The flexibility of the methodology we used enabled us to test our main hypothesis from different perspectives.

The analysis result leads us to conclude that obstacles faced by innovative firms are crucial and have had a significant negative impact on innovation activity. Our finding, particularly the lack of external finance, calls for the attention of CEOs of innovation-active firms to take strategic measures to close the gap of information asymmetry. Taking into account that banks commonly do not have proper tools to quantify the risk of innovation projects, the existence lack of external financial justifies the intervention of the government (Schneider and Veugelers, 2010).

The effect of the obstacles on Ethiopian manufacturing firms can be mitigated by taking appropriate policy measures as deemed necessary. Introduction of tax credit scheme, establishment of technology acquisition fund coupled with the provision of technological firms will be helpful while targeting innovation-active firms. Other ways of financing, such as venture capital and business angel finance, in particular to small-sized firms, can also be potential alternative solutions to be applicable in the future.

An innovation-hampering factor such as the perception of no demand to innovation has not been mentioned in any similar prior works. Our finding regarding this factor as a major cause of the decision not to start innovation requires further studies to come up into certain conclusion. Hence, this area

calls for further research by collecting more refined data regarding the obstacle and its impact on innovation activity in particular and on economic impact in general. Innovation survey takes a stratified sampling for small firms. However, the effect of obstacles to innovation is more severe for firms of small size. Hence, we suggest conducting future research with more representative figures of the total population of small firms. Given the Ethiopian context, similar studies can be conducted to examine if differences exist among firms in different sectors and in different regional states.

6.2. Limitation and Future Study

Before completing our conclusion, we must mention the limitations of this research. First, the information regarding obstacles to innovation is subjective by nature; which actually rely on the personal perception of the respondents. Nevertheless, we consider a manufacturing firm suffering from obstacles when the respondents report high levels of barriers. Second, we neglected the number of innovation projects that are abandoned. Hence, an innovation-active firm with one innovation activity is considered identical to other firms engaged in two or more innovation activities. However, variables such as group membership and engagement in it may capture the capacity of a firm to carry out innovation activities. Third, the Ethiopian innovation survey has missing observations for statistical information such as sales revenue, R&D expenditure and establishment date. This drawback shall be addressed in similar future studies, as variables such as R&D intensity and age of the firm are quite important in capturing firms' ability to engage in innovation projects.

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Appendices

Appendix 1: Values of major export items in 2015

Major export items	**export income** (million USD)	**%**
Coffee	780.5	25.8
Oilseeds	510.1	16.9
Gold	318.7	106
Khat	272.4	9.0
Pulses	219.9	7.3
Flower	203.1	6.7
Live animals	148.5	4.9
Leather and leather products	131.6	4.4
Meat and meat products	92.8	3.1
Fruits and vegetables	47.6	1.6
Electricity(estimate value)	42.8	1.4
Others	251.4	8.3
Total	3,019.3	100.0

Source: Ethiopian Revenue and Customs Authority

Appendix 2: Cross tabulation: obstacles to innovation and decision to abandon or not start innovation activities (2012-2014)

Innovation Hampering factors		Decision at different stages			
		at concept stage	after project begun	Seriously slowdown	not start
Cost factor	Lack of internal finance	73	33	33	181
	Lack of external finance	64	39	38	151
	Innovation cost too high	35	21	20	139
	EPER	23	15	13	77
Knowledge factor	Lack of qualified personnel	22	15	17	94
	Lack of info on technology	24	14	19	81
	Lack of info on markets	18	12	10	70
	Difficulty in finding cooperation partners	25	11	15	76
Market factor	Market dominated by established enterprise	26	16	12	86
	Uncertain demand	20	11	10	51
	Innovation easy to imitate	19	13	10	62
Other factors	Organizational rigidities	4	3	2	29
	Insufficient flexibility of regulation and standards	8	7	3	45
	Limitation of STI policy	17	8	15	58
No need	No need due to prior innovation	4	1	4	24
	No demand for innovation	0	0	1	20

Source: STIC 2015

Appendix-3: Definition of the variables

Variable	Definition
Lack of finance	• For innovation barriers respondents are asked to express their perception in four different scale (3=high, 2=medium, 1=low, 0=not relevant). • In our analysis, we used dummy variables for each obstacle to innovation. i.e. 1 if the firm responded its perception as high and 0 otherwise (medium, low, or not relevant).
Lack of information on technology	
Dominant firm in the market	
No demand to innovation	
firm size	• Natural logarithm of total number of employees in 2014.
R&D	• The variable is constructed by combining the response of the respondents for internal R&D and out-sourced R&D. • 1 if the firm engaged either in internal or out-sourced R&D and 0 otherwise.

Appendix 4: Frequency distribution, for perception of innovation obstacles by Ethiopian manufacturing firms (2012-2014)

Innovation Hampering Factors		Frequency	% (from a total of 893 firms)
Cost factor	Lack of internal finance	807	90.4
	Lack of external finance	742	83.1
	Innovation cost too high	747	83.7
	EPER	689	76.9
Knowledge factor	Lack of qualified personnel	738	82.8
	Lack of info on technology	730	81.9
	Lack of info on markets	764	85.7
	Difficulty in finding cooperation partners	665	74.5
Market factor	Market dominated by established enterprise	772	86.4
	Uncertain demand	680	76.1
	Innovation easy to imitate	675	75.5
Other factors	Organizational rigidities	583	65.3
	Insufficient flexibility of regulation and standards	674	75.5
	Limitation of STI policy	673	75.3
No need	No need due to prior innovation	520	58.3
	No demand for innovation	515	57.8

Source: STIC, 2015

Appendix-5: Part of Ethiopian innovation survey (EIS) questionnaire

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Addis Ababa

National Innovation Survey 2014

About this survey

This survey collects information about product and process innovation as well as organisational and marketing innovation during the three-year period 2012 to 2014 inclusive.

Scope

The statistical unit for the survey is the **enterprise**. An enterprise refers to a business, company or firm and can range from a very small concern with only one or two employees to a much larger and more formal business or firm.

Authority

The Federal Science and Technology Information Center (STIC)

PART 1: General information about the enterprise, business, company or firm

1.0.	**Name of enterprise:**_____ **Address:**_____ **Main activity (equivalence from ISIC):**_____ **Year of establishment:**_____
1.1	**Short description of your main business activity:**

- **Type of the firm:**

Small ☐

Medium ☐

Large ☐

		Yes	No
1.2	Is your enterprise part of a larger group? A group consists of two or more legally defined enterprises under common ownership. Each enterprise in the group may serve different markets, as with national or regional subsidiaries, or serve different product markets. The head office is also part of an enterprise group.		
		If yes, in which country is the head office of your group located?	
		……..	

If your enterprise is part of an enterprise group, please answer all further questions only for your enterprise in Ethiopia.

Do not include results for subsidiaries or parent enterprises outside of Ethiopia

1.3	**In which geographic markets did your enterprise sell goods or services during the three years 2012 to 2014?**	**Yes**	**No**	(specify if necessary and applicable but not compulsory)
	Ethiopia (only some regions)			
	Ethiopia (national)			
	Rest of Africa			
	Europe			
	United States			
	Asia			
	Other countries			

1.4	What was your enterprise's total number of employees in 2012 and 2014? Annual average number of employees, both full-time and part-time. If not available, give the number of employees at the end of each year.	
	2012	
	2014	

1.4.1	Approximately what percentage of your total employees had a university degree or diploma in 2014?	%

1.5	What was your enterprise's approximate total turnover (revenue) for 2012 and 2014? Turnover is defined as the market sales of goods and services (Include all taxes except VAT).	
	2012	Local currency
	2014	Local currency

PART 4: Ongoing or abandoned innovation activities

Innovation activities include the acquisition of machinery, equipment, software and licenses; engineering and development work, training, marketing and research and experimental development (R&D) *[Basic R&D not specifically related to product and/or process innovation should be included]* when they are specifically undertaken to develop and/or implement a product or process innovation.

4.1	**During the three years 2012 to 2014 did your enterprise have any innovation activities to develop product or process innovations that were**	Yes	No
	→ Abandoned during 2012 to 2014 before completion		
	→ Still ongoing at the end of 2014		

PART 5: The most important and performed innovation activities and expenditures

5.1	**During the three years 2012 to 2014, did your enterprise engage in the following innovation activities?**	**Yes**	**No**
A	Intramural or in-house Research and Experimental Development (R&D) Creative work undertaken on a systematic basis within your enterprise to increase the stock of knowledge and its use to devise new and improved products and processes (including software development in-house that meets this requirement).		
	If yes, did your firm perform R&D during 2012 to 2014:		
	Continuously?		
	Occasionally?		

B	Extramural or outsourced R&D Same activities as above, but purchased by your enterprise and performed by other companies (including other enterprises within your group) or by public or private research organisations.		
C	1. Acquisition of machinery, equipment and hardware Acquisition of advanced machinery, equipment and computer hardware to produce new or significantly improved products and processes.		
	2. Acquisition of software Acquisition of software to produce new or significantly improved products and processes.		
D	Acquisition of other external knowledge Purchase or licensing of patents and non-patented inventions, know-how, and other types of knowledge from other enterprises or organisations.		
E	Training Internal or external training for your personnel specifically for the development and/or introduction of new or significantly improved products and processes.		
F	Market introduction of innovations Activities for the market introduction of your new or significantly improved goods and services, including market research and launch advertising.		
G	Design Activities to design, improve or change the shape or appearance of new or significantly improved goods or services		
H	Other activities Implementation of new or significantly improved products and process such as feasibility studies, testing, routine software development, tooling up, industrial engineering, etc.		

"Reverse engineering" could also be considered as category

PART 6: Sources of information and co-operation for innovation activities

6.2	**During the three years 2012 to 2014, did your enterprise co-operate on any of your innovation activities with other enterprises or institutions?** Innovation co-operation is active participation with other enterprises or non-commercial institutions on innovation activities. Both partners do not need to benefit commercially. Exclude pure contracting out of work with no active co-operation.	Yes ☐	No ☐ ⇩

PART 8: Factors hampering innovation activities

8.1	During the three years 2012 to 2014, were any of your innovation activities or projects:	Yes	No
	→ Abandoned in the concept stage		
	→ Abandoned after the activity or project was begun		
	→ Seriously delayed		

QUESTIONS 8.2, 9 and 10 TO BE ANSWERED BY ALL ENTERPRISES:

8.2	During the three years 2012 to 2014, how important were the following factors in hampering your innovation activities or projects or influencing a decision not to innovate?				
	Hampering factors	**Degree of importance** Please also indicate particular factors that were not experienced.			
		High	**Medium**	**Low**	**Factor not experienced**

Cost factors	Lack of funds within your enterprise or group	☐	☐	☐	☐
	Lack of finance from sources outside your enterprise	☐	☐	☐	☐
	Innovation costs too high	☐	☐	☐	☐
	Excessive perceived economic risks	☐	☐	☐	☐
Knowledge factors	Lack of qualified personnel	☐	☐	☐	☐
	Lack of information on technology	☐	☐	☐	☐
	Lack of information on markets	☐	☐	☐	☐
	Difficulty in finding co-operation partners for innovation	☐	☐	☐	☐
Market factors	Market dominated by established enterprises	☐	☐	☐	☐
	Uncertain demand for innovative goods or services	☐	☐	☐	☐
	Innovation is easy to imitate	☐	☐	☐	☐
Other factors	Organisational rigidities within the enterprise	☐	☐	☐	☐
	Insufficient flexibility of regulations or standards	☐	☐	☐	☐
	Limitations of science and technology public policies	☐	☐	☐	☐
No need to innovate	No need due to prior innovations	☐	☐	☐	☐
	No need because of no demand for innovations	☐	☐	☐	☐

THANK YOU FOR YOUR PARTICIPATION. IT IS SINCERELY APPRECIATED.

Approved by _____

Job Title _____

Telephone _____

Email _____

Signature _____

Date _____

Stamp

초록

혁신은 다양한 측면에서 기업의 성과에 긍정적인 영향을 미친다. 특히 혁신적인 기업들은 그 기업이 속한 산업에 관계없이 생산, 판매, 매출 증대로 이어지는 일련의 과정을 즐기는 경향이 있다. 또한 그 과정에는 기업이 성공적으로 혁신할 수 있는 능력을 저해하는 재정적인 요소와 비재정적인 요소들이 있다. 본 연구는 먼저 에티오피아 제조 분야에서 기업이 혁신 활동을 단념하거나 피력하지 않게 하는 내부적, 외부적 재정적인 제약들의 영향에 대해 조사한다. 실증 분석을 위해서는 2012년부터 2014년까지 수집된 에티오피아 혁신 조사 데이터를 활용하였다. 혁신 프로젝트를 포기하는 의사결정과 재정적인 문제에 직면할 가능성을 동시에 고려하기 위하여 재귀적 이변량 프로빗 모델을 사용하였다. 연구의 결과는 외부자금의 부족과 기술에 관한 정보의 부족, 그리고 혁신에 대한 수요가 없다는 인식이 각각, 개념 단계에서부터 혁신 활동을 단념시키고, 심각하게 과정을 둔화시키며, 혁신 프로젝트를 시작하지 못하도록 하는 데에 주된 영향을 끼쳤음을 보여줬다. 뿐만 아니라, 회사 규모가 작을수록 기계류 및 장비 도입에 있어 자금 부족에 더 민감하게 반응하는 것으로 나타났다. 본 연구의 결과는 정보에 입각한 정책 수립에 기여할 것이다.

키워드: 혁신 단계; 혁신 장애물; 의사결정; 제조업 부문; 에티오피아