UNIVERSITY OF GHANA

INNOVATION AND LABOUR DEMAND IN GHANA’S MANUFACTURING AND SERVICE FIRMS

BY

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JULY, 2017
DECLARATION

I, ESTHER ANNOR, hereby declare that this thesis is an original research undertaken by me under the guidance of my supervisors; and with the exception of references to other people’s work which have been dully cited, this thesis has neither in part nor in whole been submitted for another degree elsewhere.

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(SUPERVISOR)

DATE
DEDICATION

This thesis is dedicated to God Almighty, and to my lovely husband, Mr. Godfred Kwasi Azigi who has been the anchor behind my MPhil programme, and finally to everyone who has imparted knowledge in me through teaching and research.
ACKNOWLEDGEMENT

I am most grateful to God for His protection and guidance throughout my life. His unmerited favour and love remains bountiful in all my endeavours. He never forsakes me in times of troubles, bringing the right people my way to support and provide for me.

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# TABLE OF CONTENTS

DECLARATION .................................................................................................................. i  
DEDICATION ................................................................................................................... ii 
ACKNOWLEDGEMENT ................................................................................................ iii 
TABLE OF CONTENTS ................................................................................................... iv  
LIST OF TABLES ........................................................................................................... viii 
LIST OF FIGURES ........................................................................................................... ix  
ACRONYMS ....................................................................................................................... x  
ABSTRACT ....................................................................................................................... xii 

## CHAPTER ONE ............................................................................................................. 1 
INTRODUCTION .............................................................................................................. 1  

1.1 Background of the study ................................................................. 1  
1.2 Research Motivations and Questions .................................................. 3  
1.3 Research Objectives .......................................................................... 6  
1.4 Justification of the Study ................................................................. 7  
1.5 Organisation of the Study ............................................................... 7  

## CHAPTER TWO ......................................................................................................... 9 
OVERVIEW OF THE SERVICE AND MANUFACTURING FIRMS IN GHANA ...... 9  

2.1 Overview of the Service and Manufacturing Sub-sector in Ghana ........................................ 9  
2.1.1 Contribution of Industrial and Manufacturing Sub-Sector to GDP ................................ 12  
2.1.2 Employment in the Industrial Sector of Ghana ................................................... 13  
2.1.3 Structure and Performance of the Service Sector .............................................. 14  
2.1.4 Employment Generated by the Service Sector ................................................ 17  
2.2 Industrial Policy of Ghana .............................................................. 18  
2.3 Innovation Policy in Ghana ............................................................ 20
2.4 The Extent of Innovation in Ghana ................................................................. 23
  2.4.1 Firm Size and Innovation Activity in Ghana .............................................. 23
  2.4.2 Employment and Turnover Capacity of Innovative and Non-innovative Firms ...... 25
  2.4.3 Firm Ownership and Innovation Activity in Ghana ...................................... 25
  2.4.4 R&D Expenditure and Innovation Activity in Ghana .................................... 26
  2.4.5 Motivation for Innovation in Ghana ............................................................ 27
  2.4.6 Effects of Innovation in Ghana ................................................................. 28
  2.4.7 Factors Hampering Innovation Activities in Ghana .................................... 29

CHAPTER THREE .......................................................................................................... 30
LITERATURE REVIEW ................................................................................................ . 30
  3.1 Theoretical Literature ....................................................................................... 30
    3.1.1 Theoretical Determinants of innovation ....................................................... 30
    3.1.2 The Theory of Labour Demand ................................................................. 32
    3.1.3 The Theory of Innovation and Labour Demand ........................................... 34
    3.1.4 Innovation and Quality of Labour Demand ............................................... 38
  3.2 Empirical Literature .......................................................................................... 39
    3.2.1 Determinants of Innovation ................................................................. 39
    3.2.2 Effects of innovation on the Quantity and Quality of Labour ...................... 40
  3.3 Conclusion ........................................................................................................ 43

CHAPTER FOUR ............................................................................................................. 44
METHODOLOGY AND DATA SOURCES .................................................................. 44
  4.1 Theoretical Framework ...................................................................................... 44
    4.1.1 Determinants of Innovation ................................................................. 44
    4.1.2 Innovation and Labour Demand ............................................................. 45
    4.1.3 Innovation and Quality of Labour Demand ............................................. 46
LIST OF TABLES

Table 1: Percentage Share of Services Sector’s Contribution to GDP (2008 to 2016) ........ 16

Table 2: Economically Active Population, 15 Years and Older Employed in the Service Sector (%), by Gender, 2010 ................................................................. 17

Table 3: Firms by Type of Activity and Innovation Status ............................................... 23

Table 4: Type of Activity and Firm Size ......................................................................... 24

Table 5: Turnover of Innovative and non-innovative firms ............................................ 25

Table 6: R&D Expenditure and Type of Innovation ......................................................... 27

Table 7: A priori Signs of Regressors ........................................................................... 59

Table 8: Determinants of Innovation in Ghana using Bivariate Probit Model ............... 62

Table 9: Marginal Effects of Bivariate Probit Model on Determinants of Innovation ........ 63

Table 10: Effects of Innovation on Labour Demand using OLS Estimation Technique .... 65

Table 11: OLS Results on Effects of Innovation on Quality of Employment ................. 66

Table 12: Descriptive Statistics ..................................................................................... 79
LIST OF FIGURES

Figure 1: GDP, Industrial and Manufacturing Growth Rates in Ghana, 2007-2015 .......... 12
Figure 2: Employment by the Industrial Sector and Gender in Ghana, 2014 (%).............. 14
Figure 3: Motivation for Innovation in Ghana ................................................................. 27
Figure 4: Effects of Innovation in Ghana ........................................................................ 28
Figure 5: Factors Hampering Innovation Activities in Ghana ......................................... 29
<table>
<thead>
<tr>
<th>ACRONYMS</th>
<th>Definition/Full Form</th>
</tr>
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<tbody>
<tr>
<td>AGI</td>
<td>Association of Ghana Industries</td>
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<tr>
<td>CDM</td>
<td>Crepon, Duguet and Mairesse</td>
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<td>CES</td>
<td>Constant Elasticity of Substitution</td>
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<td>CPP</td>
<td>Convention People’s Party</td>
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<td>ERP</td>
<td>Economic Recovery Programme</td>
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<td>EDIF</td>
<td>Export Development and Investment Fund</td>
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<td>FAGE</td>
<td>Federation of Association of Ghanaian Exporters</td>
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<td>FAL</td>
<td>Final Act of Lagos</td>
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<td>FDI</td>
<td>Foreign Direct Investment</td>
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<td>GAAS</td>
<td>Ghana Academy of Arts and Sciences</td>
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<td>GEPC</td>
<td>Ghana Export Promotion Council</td>
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<td>GFZB</td>
<td>Ghana Free Zones Board</td>
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<td>GMMD</td>
<td>Difference Generalized Method of Moments</td>
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<td>GMM-SYS</td>
<td>System Generalised Method of Moments</td>
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<tr>
<td>GNCCI</td>
<td>Ghana National Chamber of Commerce and Industry</td>
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<td>GRATIS</td>
<td>Ghana Regional Appropriate Technology Industrial Service</td>
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<td>GSGDA</td>
<td>Ghana’s Shared Growth and Development Agenda</td>
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<td>GSB</td>
<td>Ghana Standards Board</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>GMM</td>
<td>Generalised Method of Moments</td>
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<td>IES</td>
<td>Institute for Employment Research</td>
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<td>ICTs</td>
<td>Information, Communication and Technologies</td>
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<td>IMF</td>
<td>International Monetary Fund</td>
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<td>ISI</td>
<td>Import Substitution Strategy</td>
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<tr>
<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>ISO</td>
<td>International Standard Organisation</td>
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<tr>
<td>MRT</td>
<td>Marginal Rate of Transformation</td>
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<tr>
<td>MIST</td>
<td>Ministry of Industries, Science and Technology</td>
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<tr>
<td>NBSSI</td>
<td>National Board for Small Scale Industries</td>
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<tr>
<td>NRC</td>
<td>National Research Council</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<tr>
<td>OLS</td>
<td>Ordinary Least Squares</td>
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<tr>
<td>PEF</td>
<td>Private Enterprise Foundation</td>
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<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
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<td>SAP</td>
<td>Structural Adjustment Programme</td>
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<td>SBTC</td>
<td>Skill Biased Technological Change</td>
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<tr>
<td>S&amp;T</td>
<td>Science and Technology</td>
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<tr>
<td>SPRU</td>
<td>Science Policy Research Unit</td>
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<tr>
<td>STI</td>
<td>Science, Technology and Innovation</td>
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<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural</td>
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ABSTRACT

Innovation is widely considered as an important source of firm-level productivity and growth. However, the effect of innovation at the firm level in terms of employment is not clear, literature suggest innovation can create or destroy jobs for which reason the net effect on employment is ambiguous. This study seeks to provide evidence on the determinants of innovation in Ghana and its effects on employment at the firm level on a number of small, medium and large firms. Specifically, the study examines the effects of innovation on the quantity and quality of employment in both manufacturing and service firms.

Using the World Bank Enterprise Survey conducted in 2013, the study adopts a bivariate probit regression model to examine the determinants of innovation in Ghana. Subsequently, the study adopts the ordinary least squares estimates to investigate the effects of innovation on the quantity and quality of labour employed. The results indicate that product innovation is positively associated with employment in Ghana. In terms of innovation and employment quality the study reveals that the skill biased technological change that favours skilled labour over unskilled labour is not confirmed in the Ghanaian context.
CHAPTER ONE
INTRODUCTION

1.1 Background of the study

A feature common to firms in most developed countries is their ability to engage in innovation activities to achieve economic development and global competitiveness. This feature is partly attributed to the introduction of Information, Communication and Technology (ICTs), Research and development as well as globalization. According to OECD (2007a), a common feature of innovation in the business context is that a change must have been implemented by the firm and introduced on the market. Aside the global effects of innovation, studies by Lachenmaier and Rottmann (2007) at the firm level reveal that innovation also improves or destroys employment through its direct and indirect effects.

In relation to innovation activities in Ghana, the use of internet, international quality certification, website and emails are some of the indicators of innovation employed in Ghana. Information from World Bank Enterprise Survey (2013) of 720 firms reveals that in 2012, about 15% of firms in Ghana used technology licensed from foreign countries compared to about 12% in 2007 while about 33% of firms had their own website compared to about 8% in 2007. This relatively high rate of engagement in technology by firms has effect on employment in the Ghanaian economy.

Innovations presented at the firm level affect employment. They could also destroy jobs on account of the unusual idea of its impact on employment. The Compensation hypothesis has demonstrated that few remuneration instruments however exist to balance the underlying impact of innovation and render the last impact indistinct (Vivarelli, 2012). Thus innovation can create or destroy employment depending on market structure, institutional setting and the type of innovation a firm introduces.
The impact of innovation on employment is typically carried out by differentiating between product as well as process innovations. Product innovation is the invention of an original product or significantly improved good while process innovation as ‘the invention of an original way of producing a product or an original way of managing a product profitably (Schumpeter, 1934). Such qualification remains imperative on account of diverse effects both sort of innovation has on labour employed. Product innovation shifts the demand curve by increasing consumers’ willingness to pay, while process innovation leads to a reduction in the unit cost of production. Pianta (2003) notes that process innovations lead to greater efficiency of production, with savings in labour and/or capital, and as such results in prices reductions. This usually results in higher productivity and loss of jobs. However, given that process innovations increase product quality or reduce prices, a rise in demand (when elasticity is high) may result in more jobs. Product innovations on the other hand usually increase the variety and quality of goods with new market opportunities that leads to greater production and employment.

Innovation is a crucial determinant of firm level competitiveness and survival in relation to the intense competition experienced in local and international markets. Many researchers, including Schumpeter (1943), Ahuja and Lampert (2001), and many others attest to the fact that innovative firms are more successful than non-innovative firms. For instance, between 2000 and 2009, about 27% of labour productivity growth in the United Kingdom was directly linked to private investment in innovation. Reports have shown that since the mid-1990’s the level of innovative activities in countries like China, Malaysia, South Korea, Singapore and the United States have grown rapidly and experienced dramatic economic growth (OECD, 2007a). This rapid and dramatic growth could better be explained by the advantages that innovation brings. The advantages that accrue to such innovative firms and the countries in which they operate include economic growth, employment, wealth creation, firm level
competitiveness and high corporate performance. These advantages that come along with innovation has prompted international bodies including the World Bank as well as researchers, policy makers, government, industries and firms to engage and promote innovative activities at all levels.

In relation to the effect that innovation poses on employment, several researchers have come up with mixed results with regards to product and process innovation. For example, Rottmann and Ruschinski (1998) employed data between 1980 and 1992 to inspect the connection amongst innovation and employment. They utilized an Anderson-Hsiao dynamic board approach and discovered constructive outcomes of product innovation on employment yet no noteworthy impact for process innovation. A beneficial outcome for product innovation was observed by Entorf and Pohlmeier (1990) at the firm-level data, while process innovations demonstrated no critical impact. Zimmerman (1991) perceived a negative impact of innovation on employment in the German economy in the 1980's. Blanchflower and Burgess (1998), notwithstanding, found a positive link between process innovation and labour employed using firm-level data as of 1990 in the UK and 1989/1990 in Australia.

On the subject of innovation and skill levels, the skill biased technological change predicts that technological change will prompt a higher interest for skilled relative to unskilled labour. Hamermesh (1993) noticed that technological change is complementary with the quality of labour employed. For example, a positive and critical connection between Research and Development and quality of labour employed was ascertained by Berman et al. (1994), at the industrial level and Dunne et al. (1996), at the business level in the US.

1.2 Research Motivations and Questions

Innovation activities are a very important part of the Ghanaian economic setup and the economy of manufacturing and service firms. As such, their relative importance apart from
its immediate impact on firms in relation to survival and global competitiveness has a major consequence on the potential development and aspirations of the country. It is therefore not surprising that improving innovation activities with regards to labour demand have gained prominence in development research and policy cycles.

The practice of engaging in innovative activities is an integral part of determining the effects that innovation poses on labour demand as well as on firm level productivity and performance. Estimates from World Bank Enterprise Survey (2013) of 720 firms demonstrate that about 65% of firms in Ghana utilized email to speak with customers or providers in 2012 contrasted with 27% in 2007. Notwithstanding, there exist few studies that have endeavoured to inspect the practice of innovation by firms in Ghana. These few studies are quantitative in nature and have contributed immensely to our comprehension of the encounters of firms occupied with such innovative activities.

The role of innovative activities at the firm level is compelled primarily by research and development, firm size and openness to new markets (Zoltan and Audretsch, 1990). Vahter, Love and Roper (2012) assert that firm size and openness to new markets influence both the direction and motives for engaging in innovative activities. With respect to number of employees in a given firm, studies have found that newly established firms innovate more than older firms which more often than not obtain technologies as opposed to innovating (Zoltan and Audretsch, 1990). Two strands of studies have emerged in the economic analysis of innovative activities in the global perspective. The first attempts to understand the internal and external factors that motivate firms to engage in innovative activities. The second strand of debate focuses on the relationship between innovation and labour demand.

If reviews have perceived innovation as the impetus of industrial growth as Baek and Randall (2005) hypothesizes, then what are the possible factors that inspire firms to participate in
innovative activities? Conversely, what are the possible factors that will encourage businesses to innovate despite economic challenges in addition to resource constraints? Assessing the determinants and effects of innovation on labour demand is an empirical issue.

The second strand of economic research on innovative activities has focused on the effects that innovation poses on labour demand. Of what particular interest does innovation poses on employment? The consequences of engaging in innovative activities are partly a result of the motive for innovation and the direction of the process. For instance, countries such as China, Malaysia, South Korea and Singapore (the Asian Tigers) that were poised towards rapid industrial growth and competitiveness engaged in innovative activities to compete with the ever changing global economy (Baek and Randall, 2005). The multiplicity of motives for innovation requires that the consequences of innovation be thoroughly investigated.

Empirical evidence of innovation on labour demand has produced ambiguous results as a result of product and process innovations. A positive relation between product innovation and employment was obtained by Jaumandreu (2003). Also, Zimmerman (1991) finds that product innovation negatively affects employment. Other studies have come up with mixed results with regards to both innovation processes. Entorf and Pohlmeier (1990) and Rottmann and Ruschinski (1998) in their studies report a positive effect of product innovation and no major effect of process innovation on employment. Blanchflower and Burgess (1998) in their study find that process innovation positively affects employment. Such cross country differences should not be surprising as innovative activities are strongly governed by research and development, openness to new market and firm size. The diversity of economic systems and research institutions among countries requires that firm level studies are undertaken to assess the determinants and effects of innovation on labour demand.
To date, there exists few research works of the effects of innovation on employment in Ghana. This study is necessitated by the need to fill existing gaps in the economic literature on determinants and effects of innovation on labour demand by providing evidence on the phenomenon from Ghana and contribute to our understanding of the economic dimensions and dynamics of such a widely accepted initiative in the manufacturing and service firms. The key research questions to respond to are:

(i) What is the extent of innovation in the manufacturing and service firms of Ghana?

(ii) What are the factors that determine innovation activities in the manufacturing and service firms of Ghana?

(iii) What is the relationship exists between innovation and labour demand in the manufacturing and service firms of Ghana?

(iv) What is the relationship exists between innovation and quality of labour employed in the manufacturing and service firms of Ghana?

1.3 Research Objectives

The main objective of this paper is to assess the relationship that exists between innovation and labour demand. Thus, the paper seeks to assess the effect of innovation on the quantity and quality of labour. In relation to the quality of labour, labour will be disaggregated into skilled and unskilled to examine if the Skill Biased Technological Change hypothesis exists in Ghana.

The other part of this research work is to analyze economic factors that determine innovation in the manufacturing and service firms in Ghana.
1.4 Justification of the Study

The importance of this study is to carry out firm level empirical studies to deepen our understanding of its determinants and the effects that it poses on the quantity of labour employed. Since innovation is a crucial determinant of firm level competitiveness and survival, knowledge of the economic determinants and its effects on labour demand is relevant for designing policies that aim at influencing the welfare outcomes of labour employed.

Most studies on skill biased technological change which tried to examine the relation between innovation and skill levels have mostly focused on the developed world. Hence there is the need to carry out a study on the relationship between innovation and skill levels in a developing country setting to ascertain the outcomes. Results on the relationship between innovation and skill levels quality of employment however show that in the Ghanaian setting, the skill biased technological change is not well explained in that, despite the fact that product innovation increases the business likelihood of highly skilled workers, process innovation has no impact on both skilled and unskilled workers. The fundamental commitment of this paper is to examine the impact of innovation on labour demand and skill levels using firm level data.

1.5 Organisation of the Study

The paper comprises of six chapters. The other chapters of the study are as follows: Chapter Two provides an overview of the manufacturing and service firms in Ghana. The chapter discusses the performance and significance of the manufacturing and service firms in Ghana. Industrial and innovation policies as well as the extent of innovation in Ghana are also discussed. Chapter three contains the theoretical and empirical review on the determinants of innovation and the relationship between innovation and labour demand. The fourth chapter
takes a look at the firm level data and the estimation procedure employed for this study. The fifth chapter presents the results and discussions of the empirical enquiry of the study. The final chapter summarizes the paper and recommends attainable policies as well as plans for further research works.
CHAPTER TWO

OVERVIEW OF THE SERVICE AND MANUFACTURING FIRMS IN GHANA

This chapter provides an outline and performance of the industrial and service sectors as well as the manufacturing sub-sector of Ghana. Furthermore, the chapter provides a synopsis of Ghana’s Industrial Policy in Ghana. Finally, Innovation Policy and the extent of innovation in Ghana are discussed in this chapter.

2.1 Overview of the Service and Manufacturing Sub-sector in Ghana

Ghana’s post-independence industrial development was highly dependent on imports from other countries especially Britain. It has evolved from an import substitution industrialization (ISI) strategy to the current programme of private sector-led industrialization. Before Ghana attained independence in 1957, the industrial sector was small (Killick, 2010). It was made up mainly of the domestic manufacturing sector such as bead-making, kente weaving, basket weaving, among others and as such contributed very little to economic growth. The inherited industrial sector was underdeveloped mainly because the colonial rulers had focused on the extraction of raw materials from the Gold Coast (Ghana) while at the same time creating an economic system heavily dependent on manufactured products from Britain (Killick, 2010).

When Ghana gained independence from the British in 1957, the Nkrumah-led Convention People’s Party (CPP) government considered the industrial sector to be a key factor in the modernization and development of the country. This was stated categorically in the seven-year development plan of the CPP government. The CPP government in their plan sort to develop the industrial sector considerably by:

- Establishing firms to provide variety of goods for consumers;
- Handling exported primary products such as cocoa, timber and gold;
Creating firms to provide resources for construction works;

Establishing agro-based firms in the areas of metals and chemicals;

Organizing plans to grow the local firms in accordance with the progress of other African states.

According to Killick (2010), the CPP government prioritized import substitution because it was believed that it would eliminate the distortions of the earlier system, provide an escape from the dependence on primary exports, correct the balance of payment problems and break the vicious circle of poverty.

After a period of persistent decline in real GDP and growth rates over the last decades, the government in April 1983 launched an Economic Recovery Programme (ERP) together with a Structural Adjustment Programme (SAP), which was agreed between the World Bank/IMF and the Government of Ghana. The initial phase of the ERP and the supporting SAP covering the period 1983-1988 focused on stabilization and liberalization of the economy in order to arrest and reverse the downward trend of the economy. The objectives of the ERP in relation to the industrial sector was to restore production incentives, rehabilitate infrastructure to enhance conditions for the production and exports of goods as well as increase the availability of essential consumer goods. The programme also centered on fiscal, industrial and monetary policy reforms to reduce the level of inflation and rationalization of exchange rate to stimulate exports. The Economic Recovery Programme (ERP) laid the foundation for Ghana’s industrial sector recovery. During 1984-1988, that is, the first five years after the ERP launch, the industrial sector expanded at an annual average of 14.5 percent, compared to the -12.0 percent growth rate per annum during the three year period prior to the ERP introduction in 1984.
The implementation of the ERP also made positive impacts on the manufacturing sub-sectors. The manufacturing sector grew at a rate of 14.5 percent between 1984 and 1987, compared with the rate of – 1.1 percent between 1971 and 1979, but was not sustained as it registered a growth rate of 3.6 percent between 1988 and 1995 (Asante, Nixson & Tsikata, 2000). The mean growth rates for both the manufacturing and industrial sectors were significantly higher for the post-ERP period than for the pre-ERP period (Asante et al., 2000). According to Asante et al. (2000), the sub-sectors that recorded a remarkable output increase in the post – adjustment period were beverages, sawmill and wood products, cement, textile and garment, iron and steel industries.

After the initiation of the ERP, Ghana’s financial sector incurred serious difficulties. The devaluation of the cedi had raised the external liabilities of the banks, and at the same time weakened many of their customers who depended on imported material. The financial sector reform program was initiated in 1988. Its main elements were the introduction of a new regulatory base with new capital adequacy rules, a clean-up of the banks’ balance sheets through a swap of all non-performing loans against government loans, and individual restructuring for some distressed banks. The largest commercial banks have been privatized, and in 1990 a stock exchange was established.

In recent times, Ghana’s service sector has been the fastest growing sector of the economy. The bulk of service activities are in trading, public and financial services. Trading in particular is one of the activities that benefited from the contraction of the manufacturing services and absorbed part of their unemployed workers. Transportation services have grown only slowly because of substantial structural problems, such as a poor road and railway system. One of Ghana’s promising service sectors is tourism, which has become the country’s third largest foreign exchange earner.
2.1.1 Contribution of Industrial and Manufacturing Sub-Sector to GDP

The industrial sector, given the contribution it makes to GDP, continues to support the growth of the Ghanaian economy. Industrial sector products are also crucial foreign exchange earners. In terms of its contribution to GDP, industry overtook agriculture in 2011 as the second largest sector. Figure 1 shows that the industrial sector’s contribution to GDP is small. The sector’s dwindling contribution to GDP clearly shows its diminishing importance in comparison to the service and agricultural sectors. Industry’s contribution to GDP amounted to 41.6 percent as this is attributed to the commencement of crude oil mining in 2010, which quadrupled the shares of mining and quarrying to GDP (from about 2 per cent to over 8 per cent). The manufacturing sub-sector has however been experiencing negative growth rates since 2013. This could be attributed to high cheap imports of goods coupled with the energy crisis and depreciation of the Ghanaian cedi.

Figure 1: GDP, Industrial and Manufacturing Growth Rates in Ghana, 2007-2015

2.1.2 Employment in the Industrial Sector of Ghana

Employment growth in Ghana has generally been slower than economic growth, raising concerns about the quality of Ghana’s growth. Overall employment levels in Ghana are marginally higher. Within the industrial sector, the major driving force behind Ghana’s strong growth has been strong growth in extractives. For instance, between 2000 and 2014, the extractive sub-sector (mining and quarrying) of the industrial sector grew annually by 20.3% on average, and in the last eight years that growth accelerated to 34.1% (Tetteh and Essegbey, 2014).

Figure 2 presents information on persons engaged by the industrial sector and gender. Of the 3,383,206 persons engaged, the industrial sector engaged 614517 persons, which represents 18.2 percent of the total number of persons engaged in all sectors. For the sub-sectors, the manufacturing sub-sector engaged the largest number of persons (12.9%) followed by construction with 2.6 percent, and mining and quarrying and water supply, sewerage, waste management with 1.3 percent and 1.1 percent respectively. The electricity and gas sub-sector engaged the least number of persons representing 0.3 percent of the total number of persons engaged by all sub-sectors. With regards to gender, nearly equal proportions of males and females are engaged in the manufacturing sub-sector representing 12.9 percent and 13.0 percent respectively.
2.1.3 Structure and Performance of the Service Sector

The service sector has become the biggest sector in Ghana’s economy in this era of lower middle-income status. It contributes significantly to GDP, foreign exchange and employment. It comprise of ten main sub-sectors, namely: Trade, Repair of Vehicles, Household goods, Hotels and Restaurants, ICT, Financial Intermediation, Education, Health and Social work, among others. In recent times, it has received attention from foreign and national investors.

The service sector accounts for more than half of Ghanaian gross domestic product (GDP) and a substantial share of Ghanaian trade. Analysis of the statistical figures, spanning 2009 to 2016, shows that the services sector is the largest contributor to GDP, and growth rate in the sector, with the exception of 2009 and 2011, outpaced the other two sectors, agriculture and industry, for at least, two quarters every year. During 2006–16, the service sector share of Ghanaian GDP rose from 48.8% to 56.9%, overtaking agriculture as the largest segment of Ghana’s economy. In 2011, the production of oil resulted in industry out-pacing the other two
sectors in terms of growth rate. However, the services sector maintained its position as the largest contributor to GDP with 49.1 percent.

The leading sub-sector of the services sector is the transport and storage with its share of GDP accounting for 10.5% in 2009 and 13.3% in 2016. The transport industry increased at a slower average annual rate (6.8%) than overall Ghanaian GDP during 2009–13. This is attributed to poor road networks and insufficient rural road span.

The hotel and restaurants segment—a component of the tourism industry—grew at a slower average annual rate (8.8%) than total Ghanaian GDP (9.6%) during 2009–13, with the segment’s share of GDP falling from 6.2 to 5.2%. However, tourism is a key source of foreign exchange, and based on data reported in the WTO’s Trade Policy Review, receipts and employment in the sector more than doubled during 2006–13, reaching about $1.9 billion and 319,000, respectively.

Ghana’s finance and insurance industry grew at an average annual rate of 15.4% during 2009–13, with the industry’s share of Ghanaian GDP growing from 4.3% to 6.4%. During the last 25 years, Ghanaian banking sector reforms have, among others, lowered interest rates, raised capital requirements, established standard procedures for accounting and reporting, and increased the Bank of Ghana’s supervisory abilities. These reforms have led a number of domestic and foreign banks to enter the market, increasing competition in the industry.

Ghana’s information and communication industry grew at an average annual rate of 26.5% during 2009–13, and grew as a share of total Ghanaian GDP from 1.8% to 2.4%. Due to the link between robust ICT infrastructure and the country’s ability to attract investment and foster private sector growth, the Ghanaian government has supported the ICT industry through favorable policies and investment in the sector. For example, the government-
established Ghana Investment Fund for Electronic Communications to support ICT investment in rural areas.

Table 1 below indicates the service sector share of GDP from 2008 to 2016. The table reveals that Ghana’s education sector grew as a share of total Ghanaian GDP from 3.6% to 4.0% during the period 2013-16. The table further reveals that the Transport and Storage sub-sector recorded the highest year-on-year growth rate of 8.6% while the Community, Social and Personal Activities sub-sector recorded the lowest growth rate of -1.0%.

Table 1: Percentage Share of Services Sector’s Contribution to GDP (2008 to 2016)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade, Repair of Vehicles, Household goods</td>
<td>6.0</td>
<td>5.9</td>
<td>6.2</td>
<td>5.9</td>
<td>5.6</td>
<td>5.8</td>
<td>5.6</td>
<td>6.1</td>
<td>6.4</td>
</tr>
<tr>
<td>Hotels and Restaurants</td>
<td>6.0</td>
<td>6.2</td>
<td>6.0</td>
<td>5.4</td>
<td>4.8</td>
<td>5.8</td>
<td>5.6</td>
<td>5.8</td>
<td>5.9</td>
</tr>
<tr>
<td>Transport and Storage</td>
<td>11.4</td>
<td>10.5</td>
<td>10.6</td>
<td>10.7</td>
<td>11.0</td>
<td>11.2</td>
<td>12.3</td>
<td>13.0</td>
<td>13.3</td>
</tr>
<tr>
<td>Information and Communication</td>
<td>2.2</td>
<td>1.8</td>
<td>1.9</td>
<td>1.8</td>
<td>2.2</td>
<td>1.7</td>
<td>2.3</td>
<td>2.7</td>
<td>3.3</td>
</tr>
<tr>
<td>Financial Intermediation</td>
<td>3.8</td>
<td>4.3</td>
<td>5.2</td>
<td>4.4</td>
<td>4.7</td>
<td>6.5</td>
<td>8.4</td>
<td>8.9</td>
<td>9.4</td>
</tr>
<tr>
<td>Business, Real Estate and Other Services</td>
<td>4.1</td>
<td>4.1</td>
<td>4.5</td>
<td>4.6</td>
<td>4.8</td>
<td>3.9</td>
<td>3.6</td>
<td>3.9</td>
<td>4.0</td>
</tr>
<tr>
<td>Public Administration and Defense; Social Security</td>
<td>6.3</td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
<td>6.8</td>
<td>5.9</td>
<td>5.4</td>
<td>5.3</td>
<td>5.4</td>
</tr>
<tr>
<td>Education</td>
<td>3.7</td>
<td>4.2</td>
<td>4.3</td>
<td>4.1</td>
<td>4.3</td>
<td>3.6</td>
<td>3.6</td>
<td>3.7</td>
<td>4.0</td>
</tr>
<tr>
<td>Health and Social Work</td>
<td>1.3</td>
<td>1.4</td>
<td>1.6</td>
<td>1.3</td>
<td>1.3</td>
<td>1.1</td>
<td>1.0</td>
<td>1.2</td>
<td>1.4</td>
</tr>
<tr>
<td>Other Community, Social And Personal activities</td>
<td>3.6</td>
<td>3.7</td>
<td>4.0</td>
<td>3.9</td>
<td>3.7</td>
<td>4.3</td>
<td>4.1</td>
<td>3.8</td>
<td>3.7</td>
</tr>
<tr>
<td><strong>Services</strong></td>
<td><strong>49.2</strong></td>
<td><strong>51.1</strong></td>
<td><strong>49.1</strong></td>
<td><strong>49.1</strong></td>
<td><strong>49.8</strong></td>
<td><strong>51.9</strong></td>
<td><strong>54.6</strong></td>
<td><strong>56.9</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Institute of Statistical, Social and Economic Research (ISSER), 2016
2.1.4 Employment Generated by the Service Sector

The 2010 Population and Housing Census provide data on total employment, in relation to industry and the various sub-sectors in 2010. As shown in Table 2 in 2010, the service sector

Table 2: Economically Active Population, 15 Years and Older Employed in the Service Sector (%), by Gender, 2010

<table>
<thead>
<tr>
<th>Item</th>
<th>Total Number of Workers (%)</th>
<th>Male (%)</th>
<th>Female (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade, Repair of Vehicles, Household goods</td>
<td>18.9</td>
<td>12.3</td>
<td>25.1</td>
</tr>
<tr>
<td>Hotels and Restaurants</td>
<td>5.5</td>
<td>1.3</td>
<td>9.4</td>
</tr>
<tr>
<td>Transport and Storage</td>
<td>3.5</td>
<td>6.9</td>
<td>0.3</td>
</tr>
<tr>
<td>Information and Communication</td>
<td>0.4</td>
<td>0.6</td>
<td>0.2</td>
</tr>
<tr>
<td>Financial Intermediation</td>
<td>0.7</td>
<td>0.9</td>
<td>0.5</td>
</tr>
<tr>
<td>Business, Real Estate and Other Services</td>
<td>1.6</td>
<td>2.3</td>
<td>1.0</td>
</tr>
<tr>
<td>Public Administration and Defense; Social Security</td>
<td>1.5</td>
<td>2.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Education</td>
<td>3.9</td>
<td>4.5</td>
<td>3.3</td>
</tr>
<tr>
<td>Health and Social Work</td>
<td>1.2</td>
<td>1.1</td>
<td>1.3</td>
</tr>
<tr>
<td>Other Community, Social and Personal activities</td>
<td>5.9</td>
<td>5.0</td>
<td>6.7</td>
</tr>
<tr>
<td>Total Number of Workers in the Services Sector in 2010</td>
<td>43.1</td>
<td>37.1</td>
<td>48.8</td>
</tr>
<tr>
<td>Total Number of Workers in the Whole Economy in 2010</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Institute of Statistical, Social and Economic Research (ISSER), 2013
employed 4,460,682 out of the 10,373,678 employed people in the country, thus 43.0 percent of the employed adult population. This indicates that the service sector was the largest employer in 2010 as compared to the agricultural and industrial sectors.

Table 2 above shows that in 2010, the largest service sub-sector employer is the trade, repairs of vehicles and household goods category. In terms of employment, the trade, repairs of vehicles and household goods sub-sector, employed about one-quarter of all females. Even though transport and storage services were the largest service sub-sector, its share of employed people was relatively low at 3.5 percent. In terms of gender and the form of service sub-sectors, females are much more in the hospitality and trade sub-sectors compared to males, but are grossly underrepresented in transport and storage sub-sector.

2.2 Industrial Policy of Ghana

To achieving middle income status by 2020, Ghana’s Industrial Policy was developed by the Ministry of Trade and Industry to complement the existing one. The policy was designed to achieve long-term strategic vision through its transformation into an industry-driven economy capable of delivering decent jobs with widespread, equitable and sustainable growth and development. The Policy was set to provide clear and transparent guidelines for the implementation of Government’s industrial development agenda, with particular respect to the growth, diversification, upgrading and competitiveness of Ghana’s manufacturing sector. The Industrial Policy is fully aligned with Ghana’s Trade Policy, reinforcing each other in ensuring that a consistent and stable environment is in place for accelerated industrial development.

Ghana’s Industrial Policy was designed to promote increased competitiveness and enhanced industrial production, with increased employment and prosperity for all Ghanaians. It also sought to provide a broader range of fair-priced, better quality products for the domestic and
international markets. To achieve this, several key development objectives of the Industrial Policy were put in place. The objectives are to expand productive employment and technological capacity in the manufacturing sector as well as promote agro-based industrial development and spatial distribution of industries to achieve reduction in poverty and income inequalities.

The industrial policy was mainly developed to address the following needs of the country, namely:

- Workforce and firm level relation.
- Provision of subsidies for industrial growth.
- Engaging in public private partnership.
- Innovation and industrial growth.
- Gender equality in industrial sector.
- Avoidance of health hazards in industrial sector.
- Micro, small and medium firms’ development.

The Ministry of Trade and Industry executes its strategies, projects and special projects through its implementing agencies. These incorporate the Export Development and Investment Fund (EDIF), Ghana Export Promotion Council (GEPC), Ghana Free Zones Board (GFZB), Ghana Standards Board (GSB), National Board for Small Scale Industries (NBSSI) and the GRATIS Foundation. There are several other institutions rendering support services to the manufacturing sector. These, among others, include: The Association of Ghana Industries (AGI), The Ghana National Chamber of Commerce and Industry (GNCCI), the Private Enterprise Foundation (PEF) and the Federation of Association of Ghanaian Exporters (FAGE).
2.3 Innovation Policy in Ghana

Ghana as a typical developing country has seen little improvement in the area of innovation as this translates in the poor performance of the industrial sector. This has been attributed to low technological know-how and the inability of firms to continually engage in innovation. Innovation is perceived as major tool for rapid social and economic development. For instance, China, South Korea, India, Malaysia and Singapore, and a few other countries have applied innovation to develop their economies. The very rapid economic transformation that has taken place in the Republic of Korea, for example, in contrast to Ghana is generally attributed to Korea’s greater success in acquiring and using innovation based on science and technology. This means that well-structured innovation policies and institutions in Ghana would assist firms to advance and increase their global competitiveness.

Since the country attained independence in 1957, several policies, structures, and institutions have been put in place to encourage the development of science and technology. In February 1959, the Research Act of 1958 (No. 21) was enacted and this led to the eventual establishment of the National Research Council (NRC). The National Research Council was established to operate full-time scientific research institutions to study and develop appropriate technologies to support the country’s development. The Ghana Academy of Learning, a learned society, was established in 1959, which became the Ghana Academy of Sciences in 1961. It was later renamed as the Ghana Academy of Arts and Sciences (GAAS) following the overthrow of Dr. Nkrumah in 1966. In September 1979, the then Ministry of Industries, Science and Technology (MIST) was established. In the quest for development, Ghana took part in the Lagos Plan of Action for the Economic Development of Africa (1980 – 2000) and the Final Act of Lagos (FAL) in 1980. In April 2006, the Ministry for Science and Technology was changed to Ministry of Environment and Science (MES). Ghana Atomic Energy Commission, Environmental Protection Agency, Noguchi Memorial Institute for
Medical Research, the Ghana Standards Board, among others are the scientific and technological institutions established over the years.

Universities were also established to train the high level human resource to run and manage the various structures and institutions established. The University of Ghana began in 1948, as the University College of the Gold Coast. The Kwame Nkrumah University of Science and Technology began as the Kumasi College of Science and Technology in 1951. The University of Cape Coast started in 1961. As of 2009, Ghana has seven public universities, ten polytechnics and 25 small private universities. To improve private sector competitiveness domestically and globally, Ghana’s Shared Growth and Development Agenda (GSGDA) has also emphasized modern skills and competencies, science, technology and innovation and technology transfer as one of the key drivers for Ghana’s growth and economic transformation (GSGDA, 2010).

However, in spite of the post-independence efforts to create innovation capacity, little progress was seen in ensuring that Science, Technology and Innovation drove socio-economic activities. The vision for science-led development came to a standstill after the fall of the first nationalist government of Dr. Kwame Nkrumah in 1966. Although, subsequent governments attempted to revive the idea of innovation, there was absence of a definitive and prescriptive National Science, Technology and Innovation (STI) policy to define the vision, goals, objectives and priorities for investment in STI. Such a policy would have committed the subsequent governments, public and private sector organizations, as well as science and technology institutions to targets for production, processing, research and development (R&D) and innovation.

A clear policy on innovation was a recent phenomenon even though the country has been nursing the dream of rapid social and economic development that depends on the knowledge
and tools derived from science and technology. In 2010, the first national science, technology and innovation policy was developed in Ghana. Amongst several other objectives, this policy was designed to aid the achievement of national objectives such as poverty reduction, competitiveness of enterprises, sustainable environmental management and industrial growth. Specifically concerning innovations, the policy seeks to create conditions for the improvement of scientific and technological infrastructure for research and development and innovation. The ministry now responsible for the national science, technology and innovation policy is the Ministry of Environment, Science and Technology (MEST).

The STI policy document contains several sector-specific objectives. With regards to the country’s industrial development, several programmes and activities have been laid out to enhance the development of indigenous firms. Some of these industries are rooted in the informal sector and operate with indigenous technologies whose capacities can be enhanced using STI. The role of STI is to increase the national capacity for industrial production and value-addition. Fish storage and consumption patterns in Ghana before and after cold stores were installed is one example of how new technologies change social and consumption patterns.

To analyse if these objectives have been achieved is difficult due to little or no substantive evaluation of such policies by the sector ministries. However, certain key sectors have experienced tremendous growth in recent times due to Science, Technology and Innovation. For instance, Baffour et al (2016) noted that the rate of expansion in the ICT sector grew substantially from 17% in 2011 to about 23.4% in 2012, while the rate of telephone penetration increased by about 16% between 2011 and 2012. The capacity for broadband more than tripled between 2011 and 2012. These significant improvements in infrastructural development presume that firms and industries which apply these technologies may also
experience rapid growth and development. Conversely, Baffour et al (2016) found that the proportion of Ghanaians with access to internet declined by about 7% between 2011 and 2012.

2.4 The Extent of Innovation in Ghana

The extent of innovation in the service and manufacturing sub-sector is discussed using data from the World Bank Enterprise survey 2013 of 720 firms in Ghana. Out of this, 58% were manufacturing while 42% were in the service sector. About 51% of the firms were engaged in some aspects of innovation but 49% were not. Out of the innovating firms, 32% belong to the manufacturing category while 19% were service firms. For the non-innovative firms, about 27% were manufacturing while 22% were service sector firms as shown in Table 3. The indication is that innovation in Ghana is more prevalent in the manufacturing sub-sector than the service sector.

Table 3: Firms by Type of Activity and Innovation Status

<table>
<thead>
<tr>
<th>Type of Activity</th>
<th>Innovative Firms (%)</th>
<th>Non innovative Firms (%)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing firms</td>
<td>31.8</td>
<td>26.4</td>
<td>58.2</td>
</tr>
<tr>
<td>Service sector firms</td>
<td>19.2</td>
<td>22.6</td>
<td>41.8</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>49</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Author’s computation from World Bank Enterprise Survey, 2013.

2.4.1 Firm Size and Innovation Activity in Ghana

The World Bank Enterprise Survey, 2013 categorizes firm size into three folds. Firm size is measured by the number of employees in each firm. These include small, medium and large firms. Small firms are those with 5-19 employees while medium firms engage 20-99 workers.
Large firms are those that engage 100 or more employees. Computations from the World Bank Enterprise Survey, 2013 indicates that about 67% of firms are classified as small firms, 25% as medium firms and about 8% as large firms in Ghana. This demonstrates that greater part of the employment in Ghana happens within small firms.

Firm size also varies by the type of activity. This study found that most of the establishments in the manufacturing sub-sector are considered small firm with 5-19 employees. Estimates from the World Bank Enterprise Survey, 2013 reveals that about 46% of manufacturing firms are small, 16% are medium while 5% are large. For the service sector firms, about 21% are small, 9% are medium whereas 3% are large as shown below.

<table>
<thead>
<tr>
<th>Table 4: Type of Activity and Firm Size</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of Activity</strong></td>
</tr>
<tr>
<td>Manufacturing</td>
</tr>
<tr>
<td>Service</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Source: Author's computation from World Bank Enterprise Survey, 2013.

On the subject of firm size and innovation activity, data from Enterprise Survey, 2013 reveals that about 33% of the innovative firms are small, 14% are medium and 5% are large firms. This finding is similar to Zoltan and Audretsch (1990) observation that small firms perform more innovative activities than large firms. Chesbrough (2010) posit that the critical innovation challenge for small firms is lack of capacity to both seek and absorb external knowledge. Despite these difficulties, Vahter, Love and Roper (2012) have also noted that
innovation performance is stronger for small firms than for larger firms. This suggests that any attempt to encourage innovation in Ghana would have to focus on small firms.

2.4.2 Employment and Turnover Capacity of Innovative and Non-innovative Firms

Ghanaian firms that engage in innovation activities employ more people compared to non-innovative firms. Tetteh and Essegbey (2014) found that employment capacity of innovative firms was higher than the non-innovative firms. Their study also revealed that turnover for innovative firms’ accounted for about 98% and 96% of the total turnover of the firms in 2008 and 2010 compared to 2% and 4% of the non-innovative firms as shown in Table 5. This is because innovation improves product or service quality and enhances entry into new markets. The high turnover for the innovation firms suggests that such firms were able to improve on their products and processes and were also able to access new markets.

Table 5: Turnover of Innovative and non-innovative firms

<table>
<thead>
<tr>
<th>Type of firm</th>
<th>Turnover (%) 2008</th>
<th>Turnover (%) 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovative firms</td>
<td>97.8</td>
<td>96.2</td>
</tr>
<tr>
<td>Non-innovative firms</td>
<td>2.2</td>
<td>3.8</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>


2.4.3 Firm Ownership and Innovation Activity in Ghana

Firms in Ghana are mainly owned by private domestic individuals than foreign individuals. Estimates from the World Bank Enterprise Survey, 2013 indicates that about 86% of firms in Ghana are owned by Ghanaians while 14% are owned by private foreign individuals, companies or organisations. Out of this, about 58% of domestic firms engage in some aspects
of innovation while 42% do not. In relation to innovation and foreign ownership, about 53% of private foreign firms engage in innovation while 47% do not. This suggests that the relationship between innovation and firm ownership should be well examined to make domestic firms competitive on both domestic and international markets.

2.4.4 R&D Expenditure and Innovation Activity in Ghana

Stoneman (1996) noted the three stages in the process of innovation, as was identified by Schumpeter (1934), to include the creation of new ideas; the translation of the new idea into marketable products and processes; and the spreading of the new products and processes across the potential market. R&D is used to create new ideas, making it a major input to innovation. Morck and Yeung (2001) noted that R&D is widely used as a measure of a firm’s investment in innovation.

Firm is defined to have engaged in R&D if businesses spent on formal R&D in 2010. Estimates based on World Bank Enterprise Survey, 2013 indicates that about 22% of the firms engaged in R&D activities but 78% were not. Of those establishments that disbursed funds for R&D activities, there are notable differences by the number of employees and the type of firm ownership. Out of the firms that spent on R&D activities, about 55% of the firms are small, 30% are medium and 15% are large. In relation to R&D activities and type of ownership, about 86% Ghanaian-controlled firms disbursed funds on R&D activities while about 14% of foreign-controlled establishments spend on R&D. Also, the data indicates that about 66% of manufacturing firms disbursed funds on R&D activities whereas 34% of service sector firms spent on R&D activities. The data also revealed that about 81% of the firms disbursed funds on R&D activities also engaged in product innovation whereas 78% engaged in process innovation as shown in Table 6. This finding suggests that more resources
should be assigned to research resources of firms in Ghana due to the positive relation between R&D expenditure and innovation.

Table 6: R&D Expenditure and Type of Innovation

<table>
<thead>
<tr>
<th>Type of Innovation</th>
<th>R&amp;D (%)</th>
<th>No R&amp;D (%)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>81.1</td>
<td>18.9</td>
<td>50</td>
</tr>
<tr>
<td>Process</td>
<td>77.9</td>
<td>22.1</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>79.5</td>
<td>20.5</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Author’s computation from World Bank Enterprise Survey, 2013.

2.4.5 Motivation for Innovation in Ghana

Data on innovation collected by UNESCO Institute for Statistics (UIS), 2013 solicited from entrepreneurs the factors that motivate their innovations. Figure 3 shows that improvement of

Figure 3: Motivation for Innovation in Ghana

Source: Source NEPAD/STEPRI, 2012
goods and services as well as increasing the range of goods and services motivated about 64% and 52% of the innovation firms to initiate innovative activities. Other motivation factors for innovation include increase in market share, entry into new markets, improvement in health and safety conditions, and capacity building in production processes as shown in figure 3. This is against the backdrop that most firms in Ghana are driven primarily by the urge for profit and survival rather than competing in the global market.

2.4.6 Effects of Innovation in Ghana

Innovative firms were asked to qualitatively assess the benefits they derived as a result of their innovation activities based on data collected by UNESCO Institute for Statistics (UIS), 2013. Out of this, about 64% of the innovative firms indicated improvement in the quality of goods and services while more than half increased the range of their goods and services as shown in Figure 4. Besides, 39% and 38% of the firms increased the capacity of their production and met government regulatory requirements respectively as shown in figure 4. These findings echo the findings of the motivation for innovation. Clearly, the effects of innovation are tied to the motivation and what firms aim to achieve in their innovation effort.

Figure 4: Effects of Innovation in Ghana

Source: Source NEPAD/STEPRI, 2012
2.4.7 Factors Hampering Innovation Activities in Ghana

In relation to factors hampering innovation activities of the firms, data on innovation collected by UNESCO Institute for Statistics (UIS), 2013 find lack of funds to be the main obstacle to innovation. This was followed by high cost of innovation, lack of qualified personnel and lack of information on technology in that order. Other obstacles mentioned include the domination of the local market by well-established multinational firms, difficulties in finding innovation partners and perceived economic risks as shown in figure 5.

In order to improve firm level innovation in Ghana, there is the need for a government-backed credit guarantee scheme easily accessible to growth and innovation oriented firms to reduce their lending risks. In addition, it is important to encourage and strengthen firm level associations to provide opportunities for their members to continuously learn about new technology developments and opportunities.

Figure 5: Factors Hampering Innovation Activities in Ghana

![Bar chart showing factors hampering innovation activities in Ghana]

Source: Source NEPAD/STEPRI, 2012
CHAPTER THREE
LITERATURE REVIEW

This chapter provides a review of literature on the determinants of innovation and the relationship between innovation and labour demand. The chapter focuses on the theoretical foundations for explaining the determinants of innovation as well as its effects on the quantity and quality of labour. Empirical studies on the determinants and effects of innovation on labour will also be reviewed.

3.1 Theoretical Literature

3.1.1 Theoretical Determinants of innovation

Key to the study of innovation research is the theoretical factors that influence firms’ decision to engage in innovation activities. Schumpeter (1912) who introduced the modern usage of the word innovation came up with some of the factors that determine innovation. His first argument was that firm size affects innovation. Schumpeter (1912) argued that there is a positive relationship between firm size and innovation. This positive relationship is expected because large firms can benefit from economies of scale. Other advantages of firm size are that many projects can be undertaken at the same time thus reducing the risks associated with R&D. Large firms are less likely to be credit constrained and will have access to a broader knowledge and human skills base than small firms.

The age of the firm has also been found to be a significant determinant of innovation. Younger firms are more likely to innovate because older firms may be more set in their ways and have routines that are not flexible enough to encourage innovation. On the other hand, older firms may have the advantage because of experience through accumulated learning.
Human capital also determines innovation activities at the firm level. It is the knowledge and skills that people have to help improve productivity and economic growth. Becker (1962) considered human capital as a critical input to production as well as innovation. He further explained that human capital could be enhanced through education, both on and off-the-job training as well as other traditional investments in human capital. He thus concluded that human capital, as measured by educational achievement or formal training, appears to determine the pace of innovation of an economy.

Foreign Direct Investment (FDI) also affects innovation at the firm level. FDI occurs because foreign firms have an advantage in terms of technology, organisational and managerial skills, over local firms that allow them to compete successfully in foreign markets. This is one reason why it is expected that firms with foreign capital ownership are more likely than local firms to innovate. Another reason firms with foreign participation are more likely to innovate is because they are more attractive than domestic firms to lenders and are therefore less likely to face credit constraints that can hamper investing in innovation activities (Harrison & McMillan, 2003).

It is expected that firms that export are more likely to innovate (Martinez-Ros, 2000). Exporting firms are exposed to competition and will innovate in order to stay competitive and maintain market shares. They are also more likely to have access to foreign technology and can benefit from economies of scale.

The innovation activity is an investment that will require firms to utilise retained earnings and/or loans to finance the undertaking. As such, firms that are financially sound are more likely to invest in innovation activities that will increase their profit margins.
3.1.2 The Theory of Labour Demand

Until Hicks (1932) published work on The Marginal Productivity Theory of wages, studies on labour demand had provided little theoretical foundation for explaining and examining the factors that influence firm decisions to demand for labour. Hicks (1932) model the firm decision to demand for labour as a reflection of the firm’s short-run demand for labour. The model could be extended to include the general case of n-inputs. In the theory of one-factor labour demand, the model proposed is premised on the assumption that a profit maximising (cost minimising) firm is competent to alter the amount of labour used in production at no price.

Hicks (1932) Marginal Productivity Theory of Wage states that the price of labour, i.e., wage rate, is determined according to the marginal product of labour. The term marginal product of labour is interpreted in three ways: Marginal Physical Product of Labour (symbolized by MPPL), Value of the Marginal Product of Labour (symbolized by VMPL) and Marginal Revenue Product of Labour (symbolized by MRPL). When marginal product of labour is expressed in money terms we obtain Value of the Marginal Product of Labour, VMPL. MRPL is the change in total revenue following a change in the employment of labour. Marginal productivity theory of wage states that price of labour equals VMPL (= MRPL). Employer will employ labour up to the point until market wage equals value of the marginal product (VMP) and marginal revenue product (MRP).

The important assumptions of this theory are:

- Perfect competition prevails in products market and in labour market. Perfect competition in product market implies that products are homogeneous and the price of the goods is given for all firms in the market. Perfect competition in labour market also implies that labour as well as firms behave as ‘wage-takers’; no one can influence the wage rate.
Consequently, labour supply curve, SL, becomes perfectly elastic. Since wage rate does not change, labour supply curve incidentally, becomes the average cost curve of labour (ACL) and it coincides with the marginal cost curve of labour (MCL).

- The theory also assumes that technology is exogenous within this framework.
- Law of variable proportions operates.
- The firm aims at profit-maximization.
- All labourers are homogeneous, mobile and are substitutable to capital and other inputs.
- Resources are assumed to be fully employed.

Wage rate will be determined by the interaction of demand and supply curves of labour in the market. Labour demand curve is explained by the VMPL curve. Since perfect competition exists in the product market, VMPL curve coincides with the MRPL curve. VMPL = MRPL curve is the firm’s demand curve for labour. This curve slopes downward because of diminishing marginal returns. Further, as perfect competition exists in the labour market, the labour supply, SL = ACL = MCL, and is perfectly elastic. The equilibrium point is attained at the point where labour demand equals labour supply.

This neo-classical theory of wage determination is subject to a large number of criticisms. Most of the criticisms of this theory are directed against the assumptions. Most of the assumptions are unrealistic.

The Main Criticisms are:

- In the real world, perfect competition does not exist—both in the product market and in the labour market. Imperfect competition is found in all the markets. This theory, therefore, has limited applicability in the real world. If it is applied to the imperfectly
competitive market, the workers will be subject to exploitation.

- Labour can never be homogeneous—some may be skilled and some may be unskilled. Wage rate of a worker is greatly influenced by the quality of labour. A higher wage rate is enjoyed by the skilled labour compared to the unskilled labour. This simple logic has been totally ignored by the authors of this theory.

- Perfect mobility of labour is another unrealistic assumption. Mobility of labour may be restricted due to socio-political reasons.

- The marginal productivity theory of wage ignores the supply side of labour and concentrates only on the demand for labour. It is said that labour is demanded because labour is productive. But why labour is supplied cannot be answered in terms of this theory. This is because of the fact that, at a given wage rate, any amount of labour is supplied. But we know that the higher the wage rate, the higher is the supply of labour. This positive wage-labour supply relationship has been ignored by the makers of this theory.

- Full employment of resources is another unrealistic assumption.

- Finally, this theory ignores the usefulness of trade union in wage determination. Trade union, through its collective bargaining power, also influences wage rate in favour of the members of the organization.

In view of all these criticisms, the marginal productivity theory of wages has become useless.

3.1.3 The Theory of Innovation and Labour Demand

Theory of innovation and labour demand mentions Marx (1961) theory of compensation which looks at the market components due to innovation and their impact on the demand for labour. Marx (1961) compensation theory attempted to dispel concerns about the direct harmful effects of technological change by pointing to some market mechanisms that are able
to counterbalance the direct impact of process innovation and the job creating effects of product innovations. The explanations mostly evolve around six different market mechanisms that are caused by technological change. These mechanisms work through the following: additional employment in the capital goods sector, decreases in prices, new investments, decreases in wages, increases in income (generated through increased productivity) and new products.

Process innovation is the introduction of a new or significantly improved production technology and methods of delivering products. By definition, process innovation is an improvement in the production process, which aims at improving the productivity of inputs, for example, labour. So the firm is able to produce the same level of output with fewer workers. This implies therefore a direct negative effect of process innovation on labour employed. Marx’s (1961) theory was premised on the fact that “technological unemployment” caused as a result of the labour-saving impact of process innovation could be compensated through six different market mechanisms.

➢ The compensation mechanism "via new machines".

The same process innovations which displace workers in the user industries create new jobs in the capital sectors where the new machines are produced.

➢ The compensation mechanism "via decrease in prices".

On the one hand, process innovations involve the displacement of workers. On the other hand, these innovations themselves lead to a decrease in the unit costs of production and - in a competitive market - this effect is translated into decreasing prices. These decreasing prices stimulate a new demand for products and so additional production and employment is generated.
The compensation mechanism "via new investments".

In a world where the competitive convergence is not immediate, it is observed that during the gap between the decrease in costs - due to technological progress - and the consequent fall in prices, extra-profits may be accumulated by the innovative entrepreneurs. These profits are invested and so new productions and new jobs are created.

The compensation mechanism "via decrease in wages".

As with other forms of unemployment, the direct effect of labour-saving technologies may be compensated within the labour market. In fact, in a neoclassical framework - with free competition and full substitutability between labour and capital - technological unemployment implies a decrease in wages and this could lead to a reverse shift back to more labour-intensive technologies.

The compensation mechanism "via increase in incomes".

The reduction in the cost of production due to process innovation can be translated into higher income and hence higher consumption. This increase in demand leads to an increase in employment which may compensate the initial job losses due to process innovation.

The compensation mechanism "via new products".

Technological change is not only process innovation, but it can assume the form of creation and commercialization of new products; in this case, new economic branches develop and additional jobs are created. This concept gave a clear revelation of the other form of innovation; product innovation.

Product innovation is the introduction of a new or significantly improved good or service which leads to new products on the market and thus stimulates new demand. This increasing demand allows innovating firms to hire more workers. Thus, from the direct effect of product innovation on labour demand, a positive relationship is expected.
But there is also a less obvious indirect effect of product innovation on labour demand. When a firm introduces a product which is new to the market, there are no direct competitors yet and thus the innovating firm profits from a temporary monopoly position until other firms introduce similar or better products. In this market position the firm can exploit its monopoly power and maximize its profits. This can lead to a reduction in output and thus to a reduction in employment. Especially, if the new products are substitutes for existing products of the firm, the effect is not clear. New workers could simply replace old workers. Even a decrease is possible if the production of the new products requires fewer workers than the production of the old products. This effect is in the opposite direction to the direct effect. Thus, the overall effect of product innovations on labour demand is unclear in theory.

In spite of the insightful revelation of the theory above, the main weaknesses of the compensation theory can be singled out as follows:

- Labour-saving technologies spread around in the capital goods sector and so this compensation is an endless story which can be only partial. Also, the new machines can be implemented either through additional investments or simply by substitution of the obsolete ones. In the latter case, there is no compensation at all.

- Also the compensation mechanism “via new investments” strongly relies on the assumption that the accumulated profits due to innovation are entirely and immediately translated into additional investments. However, pessimistic expectations may imply the decision to postpone investments even in the presence of cumulated profits obtained by innovation. Hence, a substantial delay in compensation may generate structural technological unemployment.

- Again the mechanism “via decrease in wages” contrasts with the Keynesian theory of effective demand. On the one hand, a decrease in wages can induce firms to hire
additional workers, but - on the other hand - the decreased aggregate demand lower employers’ business expectations and so they tend to hire fewer workers.

3.1.4 Innovation and Quality of Labour Demand

Beyond the quantitative effect of new technologies on the number of employees, the study seeks to investigate the qualitative effect of technological change on the different categories of workers. The basic intuition here is that innovations are skill biased, therefore replacing tasks traditionally carried out by unskilled workers with new jobs demanding qualified workers. Indeed, the concept focusing on the complementary between technological change and skilled labour was put forward by the “Skill Biased Technological Change” (SBTC) hypothesis.

Griliches (1969) and Welch (1970) introduced the theory of capital skill complementarity or Skill-Biased Technological Change (SBTC). Skill-Biased Technological Change (SBTC) is a move in the creation innovation that favours skilled labour over unskilled labour thereby increasing the efficiency and the demand of such skilled workers. In this way, a worker may be more skilled than the other through the kind of occupation, training or inborn capacity. The real contention of the impact of the SBTC on the quality of labour demand is that it expands the profitability of skilled workers through its labour-saving process innovation concept. The main conclusion of the SBTC is that technological change is associated to productivity improvement that does not benefit all workers but only skilled workers to the detriment of unskilled workers.
3.2 Empirical Literature

This section presents a review of empirical studies on the determinants of innovation as well as the relationship between innovation and labour demand.

3.2.1 Determinants of Innovation

Studies on the economic determinants of firms’ decision to engage in innovation activities have gained considerable attention as a way to achieve faster growth among innovating firms in recent times. Tetteh and Essegbey (2014) evaluate the status of development among small, medium and large firms in Ghana. They made utilization of essential information through survey, and then analysed using descriptive and inferential statistics. Tetteh and Essegbey (2014) found that innovation in Ghana was more common in small firms compared with medium and large firms. Their discoveries affirmed Schumpeter (1934) contention that small firms are best at innovating than large firms.

In a related investigation of Spanish manufacturing and service sector firms, Coad et al. (2015) investigated the connection amongst innovation and firm growth for firms of various ages. They postulated that younger firms attempt more risky innovation activities which may have more noteworthy execution benefits (if effective), or more prominent misfortunes (if unsuccessful). Employing a broad Spanish Community Innovation Survey test for the period 2004–2012, Coad et al. (2015) connected board quintiles relapses to ponder the impact of R&D exercises on firm development. Their outcomes uncovered that younger firms confront bigger execution profits by R&D at the upper quintiles of the development rate appropriation, yet confront bigger decline at the lower quintiles. Coad et al. (2015) subsequently reasoned that R&D ventures by younger firms appear to be significantly riskier than R&D speculation by vast firms.
Baldwin and Sabourin (1999) analyzed the factors that contribute to innovation activity in the Canadian food processing sector using the logistic model. They discovered that business practices, R&D, and firm size essentially influence the likelihood that a firm innovates. Their analysis likewise found that expanding firm size and diminishing business sector competition would prompt more innovation. They found that foreign controlled firms in the food processing sector are more likely to present innovation.

Dachs and Ebersberger (2007) attempted to check whether foreign ownership impacts innovation and performance of firms using kernel-based matching approach as a non-parametric test. Their results revealed that the impact of foreign ownership on innovation is not significant in most cases.

The findings from the various empirical studies suggest there exist substantial variability in the determinants of firms’ decision to innovate. These conflicting results in part reflect differences in the methodological strategies and definitions adopted by the various authors. These differences in the determinants of innovation activities across countries may also be attributable to differences in firms’ characteristics towards the practice of innovation.

### 3.2.2 Effects of innovation on the Quantity and Quality of Labour

The relationship between innovation and labour demand is of two strands. The first strand focuses on innovation and the quantity of labour demand while the other strand is on innovation and the quality of labour demand. Empirical results on both categories of labour have produced ambiguous results. This therefore calls for further study in this study area.

Elejalde et al. (2015) apply a model delivered by Harrison et al (2014) to inspect the connection amongst employment and innovation at the firm level in Argentina utilizing information from the Second National Innovation Survey (ENITO1) in the vicinity of 1998.
and 2001. With the impact of innovation on employment, Elejalde et al. (2015) demonstrates that while product innovation has a positive and significant impact on employment, process development does not have a critical impact. Another essential finding by Elejalde et al. (2015) is that product innovation is skilled biased. Their discoveries uncover that while product innovation creates both skilled and unskilled businesses, it makes a higher extent of skilled businesses. On account of process development, they find that there is no impact on skilled or unskilled employments. Their discoveries on skill levels in this manner affirm the Skill Biased Technological Change theory.

In France, Greenan and Guellec (2000) investigate a panel analysis on 15,186 manufacturing firms over the 1986-1990 periods. As indicated by this examination, innovating firms form a great number of businesses than non-developing ones, however the converse ended up being valid at the sectoral level, where the general impact was negative and just product innovation was uncovered to be job-creating.

Piva and Vivarelli (2004 and 2005) apply a system Generalized Method of Moments (GMM-SYS) approach to a panel dataset of 575 manufacturing firms in Italy over the period 1992-1997. They discover confirm for a beneficial outcome of innovation on employment. Specifically the authors gave confirmation of a positive, albeit small in size, effect of company's gross innovative venture on employment. Besides, Hall et al. (2008) on a panel of Italian manufacturing firms over the period 1995-2003, found a positive business commitment of product innovation and no proof of job lost because of process innovation.

Lachenmaier and Rottmann (2011) employ an exceptionally thorough dataset of manufacturing firms in Germany over the period 1982-2002. The system Generalized method of moments (GMM-SYS) demonstrates an essentially positive effect of various innovation
measures on employment, in any case, mostly conversely with desires and past commitments, the authors found a higher positive effect of process as opposed to product innovation.

Ciriaci et al. (2016) coordinate eight waves of the yearly Spanish Community Innovation Survey (CIS). Their examination utilized quantile regressions employing a longitudinal dataset of 3,304 Spanish firms over the period 2002-2009. Their outcomes demonstrated that innovative, smaller and younger firms will probably encounter high and continuous employment growth than non-innovative firms.

Utilizing firm level information from Community Innovation Survey in four European nations (Germany, France, UK, and Spain), Harrison et al. (2014) set forward a testable model able to recognize the relative business effect of process and product innovations. The authors infer that process innovation has a tendency to displace jobs, while product was labour-friendly.

Dachs et al. (2015) likewise apply the model postulated by Harrison et al. (2005 and 2014) to examine the work effect of product process innovation over the diverse periods of the business cycle. Employing firm level pooled data from five Community Innovation Survey waves in 26 European nations over the period 1998-2010 (EUROSTAT information) and running IV regressions, they find that product innovations creates more jobs of the periods of the business cycle, while process innovation display a work displacing nature amid both upturn and downturn periods.

Piva et al. (2003) propose a dynamic panel data analysis which uses a unique firm-level dataset to test the importance of the Skill Biased Organisational Change with respect to the more traditional “Skill Biased Technological Change” in driving the skill composition of workers in the Italian machinery sector. Their results show that both skilled and unskilled workers are negatively affected by technological change, while organizational change is
positively linked to skilled workers. Their examination uncovers the part of R&D alone in
deciding skill bias is not affirmed by their econometric estimations.

3.3 Conclusion

The chapter provided a review of the theoretical and empirical literature on the determinants
and effects of innovation on the quantity and quality of labour. Empirical literature noted
several factors that determines innovation in support of the theoretical evidence –

- Firm size (Tetteh and Essegbey, 2014)
- Foreign Direct Investment (Dachs and Ebersberger, 2007);
- R&D expenditure (Baldwin and Sabourin, 1999);
- Access to loan from financial institutions (Alena and Eva, 2012);
- Age of the firm (Damijin and Kostevc, 2002); and
- Training of human capital (Falck et al, 2009).

The available empirical literature also provide evidence in support of the various effects of
innovation on labour demand –

- Product innovation was found to have a positive employment contribution (Hall
et al., 2008);
- Process innovation has negative effect on employment (Dachs et al. (2015));
- Both process and product innovation were found to be positively related to
employment (Monge-Gonzalez et al, 2011; Crespi and Tacsir, 2013); and
- Skill biased technological change led to the demand for highly skilled university
graduates in Germany (Falk, 1999) while Piva et al, 2003 found that both skilled
and unskilled workers are negatively affected by technological change.
CHAPTER FOUR
METHODOLOGY AND DATA SOURCES

This chapter provides a discussion of the methodology adopted and the data used for the study. Specifically, the chapter presents the theoretical framework and the model specification for the analysis. In addition, data sources, description of the variables and the estimation strategy are employed to empirically assess the determinants and relationship between innovation and labour demand in Ghana.

4.1 Theoretical Framework

4.1.1 Determinants of Innovation

Recent theories of economic growth draw primary attention to endogenous technological change to explain the growth patterns of world economies. From the endogenous growth model, Romer, (1986 and 1990a) and Aghion and Howitt, (1992) show that human capital is one of the main engines of growth through innovation. Romer, (1990a) indicates that, innovation is driven by people who are intentionally searching for new ideas motivated by market incentives.

The model like Solow model (1957) involves four variables: labour (L), capital (K), technology (A) and output (Y). The model is set in continuous time. There are two sectors, a goods-producing sector where output is produced and an R&D sector where additions to the stock of knowledge are made. Fraction $a_L$ of the labour force are used in the R&D sector and fraction $1-a_L$ in the goods-producing sector; similarly, fraction $a_K$ of the capital stock is used in the R&D and the rest in goods production. Both sectors use the full stock of knowledge, A.
The production of new ideas depends on the quantities of capital and labour engaged in research and on the level of technology:

\[
\dot{A} = G(a K(t), a L(t), A(t))
\]

(4.1.1a)

Under the assumption of generalized Cobb-Douglas production, this becomes:

\[
\dot{A} = B[a K(t)]^\beta [a L(t)]^\gamma A(t)^\theta, \quad B>0, \quad \beta\geq0, \quad \gamma\geq0, \quad \theta\geq0
\]

(4.1.1b)

By augmenting the endogenous conceptual framework in equation (4.1.1b) to introduce other important variables into the model, this study postulates that innovation at the firm level is influenced by firm size, age of the firm, foreign direct investment, manufacturing dummy, training, loan from financial institutions and research. From the above postulation, a simple innovation equation at the firm level is then stated as:

\[
\text{Inno} = f(\text{AGEF, FSIZE, FDI, MANU, TRAINING, LOAN, RESEARCH})
\]

(4.1.1c)

Where, Inno is a binary innovation response, AGEF-Age of the firm (in years), FDI-Foreign Direct Investment (in percentage), MANU-Manufacturing dummy, TRAINING-Formal training by firms, LOAN-Loan for financial institutions, RESEARCH-Formal research engaged by firms.

4.1.2 Innovation and Labour Demand

Zimmerman (2009) analyses the relationship between innovation (product or process) and labour demand in terms of the existing jobs at the firm level. His enquiry begins with the specification of a labour demand function. The labour demand function of a firm \(i\) in the
model was dependent on factors such as technology T, product quality Q, as well as additional observable variables X and non-observable variables λ. The labour demand function of firm i is specified as:

\[ L = f(T_i, Q_i, X_i, \lambda_i), \]  

(Eqn. 4.1.2a)

The equation (4.1.2a) means that changes in product quality are viewed as product innovations whereas changes in manufacturing processes are seen as process innovations in the model.

Zimmerman (2009) employed the logarithm of equation (4.1.2a) to yield the following:

\[ \ln L_i = \varepsilon_{LT} \ln T_i + \varepsilon_{LQ} \ln Q_i + \varepsilon_{LX} \ln X_i \]  

(Eqn. 4.1.2b)

Where, \( \varepsilon \) represents the respective elasticities of labour demand.

### 4.1.3 Innovation and Quality of Labour Demand

Griliches, (1969) and Welch (1970) extend the literature on innovation and labour demand to include the theory of creating innovation that promotes skilled labour. Griliches (1969) indicates that the move in the creation of innovation favours skilled labour over unskilled labour thereby increasing the efficiency and the demand of such skilled workers. The concept reveals that the profitability of skilled workers is enhanced through its labour-saving process innovation. In this regard, the labour demand function (Eqn. 4.1.2a) is disaggregated into skilled and unskilled labour demand functions dependent on factors such as technology T, product quality Q, as well as additional observable variables X and non-observable variables λ. The relationship between innovation and quality of labour demand is postulated as:

\[ SK_i = f(T_i, Q_i, X_i, \lambda_i), \]  

(Eqn. 4.1.3a)

\[ UNSK_i = f(T_i, Q_i, X_i, \lambda_i), \]  

(Eqn. 4.1.3b)
The equations (4.1.3a and 4.1.3b) mean that the quality of labour (skilled or unskilled) depends on technology T, product quality Q, as well additional observable variables X, and non-observable variables, λ.

4.2 Models Specification

4.2.1 Determinants of innovation

From equation (4.1.1c), the innovation models to be estimated are therefore written as:

**Product innovation (INpdt):**

\[ \text{INpdt}_i = \alpha_0 + \alpha_1 \text{AGEF}_i + \alpha_2 \text{FSIZE}_i + \alpha_3 \text{FDI}_i + \alpha_4 \text{MANU}_i + \alpha_5 \text{TRAINING}_i + \alpha_6 \text{LOAN}_i + \alpha_7 \text{RESEARCH}_i + \mu_i \]  

(Eqn. 4.2.1a)

**Process innovation (INpdt):**

\[ \text{INprs}_i = \beta_0 + \beta_1 \text{AGEF}_i + \beta_2 \text{FSIZE}_i + \beta_3 \text{FDI}_i + \beta_4 \text{MANU}_i + \beta_5 \text{TRAINING}_i + \beta_6 \text{LOAN}_i + \beta_7 \text{RESEARCH}_i + \mu_i \]  

(Eqn. 4.2.1b)

Where \( \text{INpdt}_i \) and \( \text{INprs}_i \) denotes product and process innovations of firm \( i \) regressed on a set of covariates that include AGEF-Age of the firm (measured in years), FSIZE-Firm Size, FDI-Foreign Direct Investment, MANU-Manufacturing Dummy, TRAINING-Formal Training engaged by firms, LOAN-Loan from Bank and Research. \( \beta_0, \beta_1, \ldots, \beta_7 \) represent the parameters to be estimated and \( \mu_i \) denotes the error term.

4.2.2 Innovation and Labour Demand

From equation (4.1.2b), the labour demand function to estimate is given as:

\[ \ln L_i = \beta_0 + \beta_1 \text{INprs}_i + \beta_2 \text{INpdt}_i + \beta_3 \ln \text{AGEF}_i + \beta_4 \ln \text{ASSETS}_i + \beta_5 \text{MANU}_i + \beta_6 \ln \text{COST}_i + \beta_7 \ln \text{LABOUR2010} + \beta_8 \text{FDI}_i + \mu_i \]  

(Eqn. 4.2.2a)
Where $\ln Li$ denotes the logarithm of total employment level of firm $i$ regressed on process innovation ($\lnINprs$), product innovation ($\lnINpdt$), log of age of firm, log of assets, manufacturing dummy, log of cost per worker, log of lag value of labour demand and foreign direct investment.

### 4.2.3 Innovation and Quality of Labour Demand

From equations (4.1.3a and 4.1.3b), the skilled and unskilled labour demand functions to estimate is given as;

$$\lnSK_i = \beta_0 + \beta_1\lnINprs_i + \beta_2\lnINpdt_i + \beta_3\lnAGEFi + \beta_4\lnASSETS_i + \beta_5\text{MANUi} + \beta_6\text{FDHi} + \beta_7\text{TRAININGi} + \mu_i \quad (Eqn. 4.2.3a)$$

$$\lnUNSK_i = \beta_0 + \beta_1\lnINprs_i + \beta_2\lnINpdt_i + \beta_3\lnAGEFi + \beta_4\lnASSETS_i + \beta_5\text{MANUi} + \beta_6\text{FDHi} + \beta_7\text{TRAININGi} + \mu_i \quad (Eqn. 4.2.3b)$$

Where $\lnSK_i$ and $\lnUNSK_i$ denotes the logarithm of skilled and unskilled labour of firm $i$ regressed on a set of covariates that include process innovation ($\lnINprs$), product innovation ($\lnINpdt$), log of age of the firm, log of assets, manufacturing dummy, foreign direct investment and formal training.

### 4.3 Data Source

The study employs data from the second phase of Enterprise Survey (ES) collected in Ghana in 2013, an initiative of the World Bank. Two phases of the Enterprise Survey have been completed up to date with each phase covering a nationally representative sample of firms spread over a period of nineteen months. The second phase of the Enterprise Survey covers a sample of 720 firms. Firms surveyed were sampled from the service and manufacturing sub-sector. Regional stratification for the Ghana Enterprise Survey was defined in four regions: Accra, North (Kumasi and Tamale), Takoradi, and Tema.
The World Bank Enterprise Survey (WBES, 2013) employed stratified sampling technique. Firms were stratified by sector of activity, firm size and geographical location. The degree of stratification by sector of activity is determined by the size of the economy as measured by the Gross National Income (GNI). Firm size is stratified on the basis of number of employees as follows: small firms (5-19 employees), medium firms (20-99 employees) and large firms (100 or more employees). Under geographical location, firms were stratified based on the distribution of non-agricultural economic activity of the country which takes place mostly in the urban economic centres of the country.

The Enterprise Survey (2013) studies only non-agricultural firms which are formal and privately owned. The firms covered by the survey are those in the manufacturing, retail and service industries including hospitality, construction, transportation and communication firms. Firms excluded from the survey are agricultural, extractive and fully government owned firms. In addition, firms were with less than 5 employees were excluded because of lack of adequate data in their operations. This is due to the fact that most of these micro firms operate in the informal sector.

The World Bank Enterprise Survey (WBES, 2013) assesses the business environment in which enterprises in the private sector operates for purposes of impact assessment of reforms. This includes the constraints on enterprise’s performance and growth in these economies based on the firm owners’ experiences and perceptions of the business environment. The survey therefore provides information concerning the business environment and factors that are challenges to the firms’ growth such as infrastructure, competition and bribery, land and permit, and government business relations. Other obstacles reported by firms include the cost of inputs and capacity utilization, taxation and informality.
The WBES (2013) data also provides information on the characteristics of the firms such as the composition of labour force, type of ownership, sector of operation, location, sales performance, among others. Also, information on labour demand of firms, such as total cost of labour, value of assets, lag value of employment are provided in the data. In addition, information on skilled and unskilled labour is also provided in the data.

A major limitation of the WBES (2013) is that in most cases the resulting data represent only firms that were willing to participate in the survey. Respondents were reluctant in providing data on their performance such as sales, employment, cost of labour, cost of intermediate inputs and raw materials, net book value of fixed assets, and purchase value of fixed assets. The problem of non-response to the survey questionnaires was however solved by substituting with respondents who were more willing to answer them.

On product and process innovation, the study provides information on factors that affects innovation such as Research and Development, age of the firm, firm size, sector dummy, firm ownership and training. In addition, the survey also provides information on how firms finance their innovation activities through loans from financial institutions such as banks. The survey also reports the relationship between innovation and labour demand.

The study adopts the definition of SMEs based on the number of employees, as given in the World Bank Enterprise Survey (2013). Small enterprises are defined as firms employing 5-19 workers. Medium firms are defined as firms employing 20-99 workers whereas large firms employ 100 or more workers. This definition captures a large number of enterprises under the SMEs category. This definition is in sharp contrast with the current definition used in Ghana by the NSBBI, which defined small firms as those employing between 6-29 as well as the definition used by the Ghana Statistical Service (GSS) which also defines small firms as
those employing up to 9 workers, medium firms as those employing 10-25 workers and large firms as those employing 30 or more employees (Gockel 2003).

4.4 Description of Variables

4.4.1 Dependent Variables

Product Innovation: The introduction of product innovation is measured as dummy variable that takes the value 1 if the firm introduced new or significantly improved products or service during the last three years, and 0 otherwise.

Process Innovation: The introduction of process innovation is measured as dummy variable that takes the value 1 if the firm has introduced new or significantly improved methods of manufacturing products or offering service during the last three years, and 0 otherwise.

Labour demand: The demand for labour by a firm is defined based on total individual workers who offered their service in a given firm at the end of the fiscal year, 2012. These include production and non-production workers.

Skilled Labour demand: Labour is defined as skilled based on the type of occupation. This includes the sum of management, professionals, sales personnel, supervisors and skilled production workers in a given firm.

Unskilled Labour demand: Labour is defined as unskilled based on the type of occupation. Unskilled labour is the summation of maintenance workers, production and support workers, masters and apprentices in a given firm.
4.4.2 Explanatory Variables

**Firm Characteristics**

**Firm Age:** This is the number of years the firm started operations. Older firms have a tendency to have accrued learning and different assets to gain while newly established firms, and along these lines more younger firms, seem, by all accounts, to be more creative on the grounds that they by standard need to present new goods when they introduce their organizations. The paper in this manner explores which of these impacts rule the outcomes.

**Firm Size:** The size of the firm is measured by the number of employees in each firm. Small firm is a dummy variable which takes the value 1 if the firm employs 5-19 workers in 2012 whereas medium firm is a dummy variable that takes the value 1 if the firm employs 20-99 in 2012. Large firm is a dummy variable that takes the value 1 if the firm employs 100 or more workers in 2012. The size of the firm gives an insight into the value of the assets which can be used as collateral in assessing credit in order to innovate (Pandula, 2011).

**Foreign Direct Investment** is a dummy variable that takes the value 1 if a firm engages in foreign direct investment in 2012 and 0 otherwise. Foreign portfolio investment is investment in shares of a company not exceeding 10 percent of the total paid up capital of the company while investment above 10 percent is foreign direct investment.

**Manufacturing** is a dummy variable that takes the value 1 if a firm operates in the manufacturing sector and 0 otherwise.

**Industry Characteristics**

**Formal Training** is a dummy variable that captures whether a given firm organized formal training programmes for its employees over the fiscal year, 2012.
**Loan from Bank** is a dummy variable that takes the value 1 if a firm received loan from formal financial institution in 2012 and 0 otherwise.

**Labour 2010** refers to total individual workers who were employed in a given firm in the last three fiscal years, 2010. The lag values of innovation and labour demand will be employed as well since current level of labour demand depends on previous labour demand.

**Research** is a dummy variable that takes the value 1 if a firm spent on formal Research and Development activities in 2012 and 0 otherwise.

**Cost per Labour** is obtained by dividing total annual labour cost by total number of employees. In the estimation procedure, log of cost per labour is employed.

**Value of Assets** is depends on detailed market estimations of all benefits claimed by the firm. They are used as a substitute for firm size on the grounds that the explained variable, labour demand is required to be emphatically identified with firm size. In the estimation system, log of value of assets is utilized.

### 4.5 Estimation Strategy

#### 4.5.1 Determinants of Innovation

The firm’s decision to engage in innovation is specified as dichotomous variables. Due to the binary nature of the dependent variables, a bivariate probit model is employed to examine the predictors of the firm innovation decision. Bivariate probit model emerges from a 2-equation structural latent variable framework, where the first condition \( y_1 = (\beta_0 + \beta_1 y_2 + \varepsilon_1 > 0) \) portrays the variable \( y_1 \) as a function of a binary variable \( y_2 \) and latent error \( \varepsilon_1 \), whereas the second equation, \( y_2 = (\pi_0 + \pi_1 z + \varepsilon_2 > 0) \). The model is completed by assuming that the latent errors \( \varepsilon_1 \) and \( \varepsilon_2 \) have a bivariate standard normal joint distribution with correlation \( \rho \). If
\( \rho = 0 \), separate estimation of a simple probit model is employed. If \( \rho \neq 0 \), the effect is said to be “endogenous”, and joint estimation is required.

The bivariate probit model takes into account the categorical nature of the dependent variables as well as the fact that product and process innovation (and, as a consequence, the error terms of the models performed) are likely to be correlated (Greene 2012). The correlation may be due to product innovations that involve the modification of the production process or to process innovations that aims at reducing costs. To solve this problem, the study applies the bivariate probit model to analyse the relationships between types and determinants of innovation as related studies have shown that product and process innovations are related, but are largely driven by different factors (Rouvenin, 2002).

To begin with, let the unobserved variables, product innovation \( Y_{i1}^* \) and process innovation \( Y_{i2}^* \) be defined by linear regression relationships such that;

\[
Y_{i1}^* = \beta_1 X_{i1} + \theta_1 Z_{i1} + \mu_{i1} \quad \text{(Eqn. 4.5.1a)}
\]
\[
Y_{i2}^* = \beta_2 X_{i2} + \theta_2 Z_{i2} + \mu_{i2} \quad \text{(Eqn. 4.5.1b)}
\]

But what is observed are events represented by binary variables, \( Y_{i1} \) and \( Y_{i2} \), and these can be defined by;

\[
Y_{i1} = 1 \text{ if } Y_{i1}^* > 0 \quad \text{(Firm \( i1 \) engages in product innovation)} \quad \text{(Eqn. 4.5.1c)}
\]
\[
Y_{i1} = 0 \text{ if } Y_{i1}^* \leq 0 \quad \text{(Firm \( i1 \) does not engage in product innovation)} \quad \text{(Eqn. 4.5.1d)}
\]
\[
Y_{i2} = 1 \text{ if } Y_{i2}^* > 0 \quad \text{(Firm \( i2 \) engages in process innovation)} \quad \text{(Eqn. 4.5.1e)}
\]
\[
Y_{i2} = 0 \text{ if } Y_{i2}^* \leq 0 \quad \text{(Firm \( i2 \) does not engage in process innovation)} \quad \text{(Eqn. 4.5.1f)}
\]

Where \( X_{i1} \) and \( X_{i2} \) are vectors of firm characteristics, \( Z_{i1} \) and \( Z_{i2} \) are vectors of industry characteristics and \( \mu_{i1} \) and \( \mu_{i2} \) are the error terms with means of zero and assume the standard normal distribution function.
The study adopts the estimation strategy proposed by Rouvenin (2002) for analysing the determinants of innovation. Firms innovate because it is profitable for them to do so as expected returns exceed associated costs. Expected profits of an innovating firm $i$ must be higher with innovation ($\prod^I_i$) than without innovation ($\prod^N_i$), that is;

$$y_i^* = \prod^I_i - \prod^N_i > 0 \quad \text{(Eqn. 4.5.1g)}$$

However, expected profits $y_i^*$ is not observed. What is observed is whether the firm innovates.

The observed counterpart to $y_i^*$ is $y_i$, which takes a value of either zero (does not innovate) or one (innovates) as follows:

$$y_i = \begin{cases} 1 \text{ if and only if } y_i^* > 0 \\ 0 \text{ otherwise} \end{cases} \quad \text{(Eqn. 4.5.1h)}$$

The regression model is specified as:

$$y_i = \beta X_i + \epsilon_i \quad \text{(Eqn. 4.5.1i)}$$

Where $\beta$ is a vector of coefficients, $X_i$ is a vector of explanatory variables, and $\epsilon_i$ is the error term. Specifically, the product and process innovation functions to estimate are given as;

**Product innovation (INpdt):**

$$\text{INpdt}_i = \alpha_0 + \alpha_1 \text{AGEFi}_i + \alpha_2 \text{FSIZE}_i + \alpha_3 \text{FDI}_i + \alpha_4 \text{MANU}_i + \alpha_5 \text{TRAINING}_i + \alpha_6 \text{LOAN}_i + \alpha_7 \text{RESEARCH}_i + \mu_i \quad \text{(Eqn. 4.5.1j)}$$

**Process innovation (INpdt):**

$$\text{INprs}_i = \beta_0 + \beta_1 \text{AGEFi}_i + \beta_2 \text{FSIZE}_i + \beta_3 \text{FDI}_i + \beta_4 \text{MANU}_i + \beta_5 \text{TRAINING}_i + \beta_6 \text{LOAN}_i + \beta_7 \text{RESEARCH}_i + \mu_i \quad \text{(Eqn. 4.5.1k)}$$
Where \( \text{INpdt}_i \) and \( \text{INprs}_i \) denotes product and process innovations of firm \( i \) regressed on a set of covariates that include age of the firm, firm size, foreign direct investment, manufacturing dummy, formal training, loan from bank and research.

### 4.5.2 Innovation and Labour Demand

The labour demand decision (\( \text{LD}^* \)) of an innovative firm is unobserved. As such the ordinary least squares regression equation is specified as one that depends on the labour demand function of an innovative firm. Least squares estimate of an OLS regression equation corresponds to the maximum likelihood solution and as such helps to obtain the guarantees of maximum likelihood estimates. This then permits hypothesis testing and also obtains confidence intervals for estimated regression coefficients.

The regression model for the labour demand function is written as a linear relationship dependent on the firm and industry characteristics:

\[
\text{LD}^*_i = X'_i \theta + Z'_i \theta + \mu_i \tag{Eqn. 4.5.2a}
\]

The observed variable, aggregate labour demand function of an innovative firm (\( \text{LD}_i \)) is defined such that;

\[
\text{LD}_i = X'_i \theta + Z'_i \theta \tag{Eqn. 4.5.2b}
\]

Where \( X_i \) is a vector of firm characteristics, \( Z'_i \) is a vector of industry characteristics and \( \mu_i \) is the error term with a mean of zero and assumes the standard normal distribution function.

The study employs the estimation strategy proposed by Zimmerman (2009) for analysing the relationship between innovation and labour at the firm level. From the theoretical point of view, the labour demand function of firm \( i \) is specified as;

\[
L = f (\text{Ti}, \text{Qi}, \text{Xi}, \lambda_i), \tag{Eqn. 4.5.2c}
\]
Specifically, the labour demand function to estimate is given as;

\[ \ln L_i = \beta_0 + \beta_1 \ln \text{INprs}_i + \beta_2 \ln \text{INpdt}_i + \beta_3 \ln \text{AGEF}_i + \beta_4 \ln \text{ASSETS}_i + \beta_5 \text{MANU}_i + \beta_6 \ln \text{COST}_i + \beta_7 \ln \text{LABOUR2010} + \beta_8 \text{FDI}_i + \mu_i \]  

(Eqn. 4.5.2d)

Where \( \ln L_i \) denotes the logarithm of total employment level of firm \( i \), process innovation (INprs), product innovation (INpdt), log of age of firm, log of assets, manufacturing dummy, log of cost per worker, log of lag value of labour demand and foreign direct investment.

### 4.5.3 Innovation and Quality of Labour Demand

The skilled and unskilled labour demand decision (SK* and UNSK*) of an innovative firm is unobserved. As such the ordinary least squares regression equation is specified as one that depends on the skilled and unskilled labour demand function of an innovative firm. The regression model for the skilled and unskilled labour demand is written as a linear relationship dependent on the firm and industry characteristics:

\[ \text{SK}^*_i = X'_i \theta + Z'_i \theta + \mu_i \]  

(Eqn. 4.5.3a)

\[ \text{UNSK}^*_i = X'_i \theta + Z'_i \theta + \mu_i \]  

(Eqn. 4.5.3b)

The observed variable – skilled and unskilled labour demand functions of an innovative firm (SK\(_i\) and UNSK\(_i\)) is defined such that:

\[ \text{SK}_i = X'_i \theta + \mu_i \]  

(Eqn. 4.5.3c)

\[ \text{UNSK}_i = X'_i \theta + \mu_i \]  

(Eqn. 4.5.3d)

Where \( X_i \) is a vector of firm characteristics, \( Z_i \) is a vector of industry characteristics and \( \mu_i \) is the error term with a mean of zero and assumes the standard normal distribution function.

Measure of skill levels in this study is based on occupation. Skilled labour is defined as non-production workers made up of management, administration, sales personnel, supervisors and skilled production workers such as technicians. On the other hand, unskilled labours include
only unskilled production workers. Unskilled labours constitute maintenance workers, production and support workers, masters and apprentices. Innovation and skill levels are investigated by estimating equation (4.5.2d) above for both skilled and unskilled labour as proposed by Zimmerman (2009). This is achieved by disaggregating the labour demand function into skilled and unskilled labour.

Specifically, the skilled and unskilled labour demand function to be estimated is given as:

\[
\ln SK_i = \beta_0 + \beta_1 \ln \text{INprs}_i + \beta_2 \ln \text{INpdt}_i + \beta_3 \ln \text{AGEF}_i + \beta_4 \ln \text{ASSETS}_i + \beta_5 \text{MANU}_i + \beta_6 \text{FDI}_i + \beta_7 \text{TRAINING}_i + \mu_i \quad \text{(Eqn. 4.5.3e)}
\]

\[
\ln UNSK_i = \beta_0 + \beta_1 \ln \text{INprs}_i + \beta_2 \ln \text{INpdt}_i + \beta_3 \ln \text{AGEF}_i + \beta_4 \ln \text{ASSETS}_i + \beta_5 \text{MANU}_i + \beta_6 \text{FDI}_i + \beta_7 \text{TRAINING}_i + \mu_i \quad \text{(Eqn. 4.5.3f)}
\]

Where \( \ln SK_i \) and \( \ln UNSK_i \) denotes the logarithm of skilled and unskilled labour of firm \( i \) regressed on a set of covariates that include process innovation (\( \text{INprs} \)), product innovation (\( \text{INpdt} \)), log of age of the firm, log of assets, manufacturing dummy, foreign direct investment and formal training.

Based on the above literature and specifications, the following a priori signs are expected from the regressors.
### Table 7: A priori Signs of Regressors

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Innovation</td>
<td>Positive</td>
</tr>
<tr>
<td>Process Innovation</td>
<td>Indeterminate</td>
</tr>
<tr>
<td>Cost per worker</td>
<td>Negative</td>
</tr>
<tr>
<td>Log of Age of firm</td>
<td>Positive</td>
</tr>
<tr>
<td>Log of Assets</td>
<td>Positive</td>
</tr>
<tr>
<td>Sector dummy</td>
<td>Indeterminate</td>
</tr>
<tr>
<td>FDI</td>
<td>Positive</td>
</tr>
<tr>
<td>Firm Size</td>
<td>Positive</td>
</tr>
<tr>
<td>Training</td>
<td>Positive</td>
</tr>
<tr>
<td>Research</td>
<td>Positive</td>
</tr>
</tbody>
</table>

### 4.6 Conclusion

The chapter focused on the methodology and data for this study. The chapter highlighted the theoretical framework, the model specification, data sources, description of the variables and the estimation strategy for the study. The study adopts the estimation strategy for assessing the innovation decisions of firms proposed by Rouvenin (2002). In relation to the effect of innovation on total labour demand and skill levels, the study adopts the theoretical model proposed by Zimmerman (2009). Different econometric models and estimation procedures are employed to achieve the objectives set up in this study.
CHAPTER FIVE
DISCUSSION OF RESULTS

5.1 Determinants of Innovation in Ghana

Tables 8 and 9 present the results of the bivariate probit regression model for the determinants of both product and process innovations. The results obtained show that product innovation is significantly influenced by training, loan from bank and research whereas process innovation is significantly influenced by training, manufacturing dummy and research.

Formal training significantly influences both product and process innovations. Positive and significant coefficient implies that firms that organised formal training for their workers are more likely to engage in both product and process innovations than firms that do not. The results from marginal effects of the bivariate probit regression estimates show that firms that organised formal training for their workers exhibits a 10% probability of engaging in both types of innovation at a 1% significance level. This outcome is normal since formal training of workers can make up for the lower level of training of workers and enhance profitability. This finding confirms the results by Santamaría et al. (2009), where a significant effect of training on both product and process innovations is obtained in Spain.

Access to finance from formal institutions such as banks, savings and loans and microfinance institutions has a positive and significant effect on product innovation. Although the coefficient of access to finance from bank variable is positively signed it is not statistically significant in the process innovation model. The results from marginal effects of the bivariate probit regression estimates show that firms that obtained loan from banks exhibits an 8% probability of engaging in both types of innovation at a 5% significance level. This is
different in cases where firms engage in either types of innovation or do not innovate at all. Studies on the link between access to finance and innovation suggest that firms are less likely to utilise external resources to finance process innovation since it may involve sharing information on the innovation with lenders which could be leaked to competitors.

There is a positive huge connection between firms' association in Research and Development and both types of innovation. Results from the bivariate probit regression estimates show that firms that engage in research and development activities are more likely to engage in both types of innovation than firms that do not. While the research dummy exhibits 32% percent probability of engaging in both types of innovations at a significance level of 1%, the probability of engaging in only product innovation is lower for research activities (2%), although not significant. This finding confirms the study by Baffour et al. (2016) that research and development significantly influence firms innovation activities in Ghana.

The significant and positive coefficient of correlation (Rho = 0.8714) indicates that both types of innovation are influenced by the same unobservable firm and industry characteristics. (Rouvenin, 2002) studies also confirms this results. Hence, bivariate probit model provides reliable estimates than two separate standard probit models.
Table 8: Determinants of Innovation in Ghana using Bivariate Probit Model

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Std. Err.</th>
<th>Coefficients</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of firm</td>
<td>0.0036</td>
<td>0.0049</td>
<td>-0.0004</td>
<td>0.0048</td>
</tr>
<tr>
<td>Medium (20-99)</td>
<td>0.1226</td>
<td>0.1234</td>
<td>-0.0051</td>
<td>0.1226</td>
</tr>
<tr>
<td>Large (&gt; 100)</td>
<td>0.1304</td>
<td>0.2326</td>
<td>-0.1235</td>
<td>0.2282</td>
</tr>
<tr>
<td>Training</td>
<td>0.2432**</td>
<td>0.1096</td>
<td>0.3313***</td>
<td>0.1092</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0.1632</td>
<td>0.1032</td>
<td>0.2501***</td>
<td>0.1026</td>
</tr>
<tr>
<td>FDI</td>
<td>0.1009</td>
<td>0.1493</td>
<td>0.1027</td>
<td>0.1481</td>
</tr>
<tr>
<td>Loan from Bank</td>
<td>0.2867**</td>
<td>0.1212</td>
<td>0.1593</td>
<td>0.1198</td>
</tr>
<tr>
<td>Research</td>
<td>0.9569***</td>
<td>0.1366</td>
<td>0.8477***</td>
<td>0.1335</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.5301***</td>
<td>0.1144</td>
<td>-0.4544***</td>
<td>0.1129</td>
</tr>
</tbody>
</table>

Number of observations | 686 | 686  
Wald chi2(22)         | 115.12 |   
Prob > chi2           | 0.0000 |   
Rho                   | 0.8714*** | 

Note: *, **, *** indicate significance at 10%, 5% and 1% confidence levels respectively. 
Source: Author’s computation from World Bank Enterprise Survey, 2013.
Table 9: Marginal Effects of Bivariate Probit Model on Determinants of Innovation

<table>
<thead>
<tr>
<th>Variables</th>
<th>Margins, dydx(*)</th>
<th>Std. Err.</th>
<th>Margins, dydx(*)</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>predict (p00)</td>
<td></td>
<td>predict (p10)</td>
<td></td>
</tr>
<tr>
<td>Age of Firm</td>
<td>-0.0006</td>
<td>0.0015</td>
<td>0.0007</td>
<td>0.0009</td>
</tr>
<tr>
<td>Medium (20-99)</td>
<td>-0.0208</td>
<td>0.0381</td>
<td>0.0226</td>
<td>0.0223</td>
</tr>
<tr>
<td>Large (≥100)</td>
<td>-0.0005</td>
<td>0.0707</td>
<td>0.0453</td>
<td>0.0429</td>
</tr>
<tr>
<td>Training</td>
<td>-0.1036***</td>
<td>0.0334</td>
<td>-0.0165</td>
<td>0.0196</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>-0.0746**</td>
<td>0.0315</td>
<td>-0.0160</td>
<td>0.0186</td>
</tr>
<tr>
<td>FDI</td>
<td>-0.0366</td>
<td>0.0459</td>
<td>-0.0006</td>
<td>0.0271</td>
</tr>
<tr>
<td>Loan from Bank</td>
<td>-0.0799**</td>
<td>0.0371</td>
<td>0.0222</td>
<td>0.0216</td>
</tr>
<tr>
<td>Research</td>
<td>-0.3232***</td>
<td>0.0391</td>
<td>0.0162</td>
<td>0.0226</td>
</tr>
</tbody>
</table>

Cont. Table 9: Marginal Effects of Bivariate Probit Model on Determinants of Innovation

<table>
<thead>
<tr>
<th>Variables</th>
<th>Margins, dydx(*)</th>
<th>Std. Err.</th>
<th>Margins, dydx(*)</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>predict (p01)</td>
<td></td>
<td>predict (p11)</td>
<td></td>
</tr>
<tr>
<td>Age of Firm</td>
<td>-0.0007</td>
<td>0.0009</td>
<td>0.0006</td>
<td>0.0015</td>
</tr>
<tr>
<td>Medium (20-99)</td>
<td>-0.0227</td>
<td>0.0025</td>
<td>0.0209</td>
<td>0.0378</td>
</tr>
<tr>
<td>Large (≥100)</td>
<td>-0.0457</td>
<td>0.0433</td>
<td>0.0009</td>
<td>0.0703</td>
</tr>
<tr>
<td>Training</td>
<td>0.0173</td>
<td>0.0198</td>
<td>0.1028***</td>
<td>0.0332</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0.0167</td>
<td>0.0188</td>
<td>0.0739**</td>
<td>0.0314</td>
</tr>
<tr>
<td>FDI</td>
<td>0.0008</td>
<td>0.0273</td>
<td>0.0364</td>
<td>0.0456</td>
</tr>
<tr>
<td>Loan from Bank</td>
<td>-0.0218</td>
<td>0.0219</td>
<td>0.0795**</td>
<td>0.0368</td>
</tr>
<tr>
<td>Research</td>
<td>-0.0141</td>
<td>0.0234</td>
<td>0.3212***</td>
<td>0.0363</td>
</tr>
</tbody>
</table>

Note: *, **, *** indicate significance at 10%, 5% and 1% confidence levels respectively.

Source: Author’s computation from World Bank Enterprise Survey, 2013.
5.2 Effects of Innovation on Labour Demand

The result on the effect of innovation on labour demand is presented in Table 10. The lag estimations of innovation and labour demand are employed since current level of business to a great extent relies upon past employment. The results demonstrate that the product innovation dummy is positive and significant, signifying the likelihood of high demand impacts in the long run outcomes on employment. Process innovation again is negative and significant. As per past studies, this implies firms might be settling on more labour-saving options in their choice to process innovate.

Manufacturing sector dummy is included in the estimation procedure to control for industry specific effects since employment and level of innovation may be higher in a few sectors than in others. The outcomes demonstrate that manufacturing firms employ more labour than service firms despite the fact that the results are not significant.

Also, labour demand has an overall positive relationship with age of the firm. The positive relationship between labour demand and the age of the firm reveals that older firms tend to employ more labour than younger firms from the labour market. The relationship between labour demand and cost per labour is negative although not significant. This indicates that increases in cost per labour will discourage labour employment. The result from the OLS estimation technique shows that cost per labour is not important in the determination of employment within the manufacturing and service firms. This result is similar to the findings by Teal (1997).
Table 10: Effects of Innovation on Labour Demand using OLS Estimation Technique

<table>
<thead>
<tr>
<th>Labour demand</th>
<th>Coefficient</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>0.2439**</td>
<td>0.0928</td>
</tr>
<tr>
<td>Process</td>
<td>-0.1721**</td>
<td>0.0872</td>
</tr>
<tr>
<td>ln(Cost)</td>
<td>-0.0291</td>
<td>0.0238</td>
</tr>
<tr>
<td>Age of firm</td>
<td>0.1344**</td>
<td>0.0556</td>
</tr>
<tr>
<td>ln(Assets)</td>
<td>0.0281</td>
<td>0.0175</td>
</tr>
<tr>
<td>Labour2010</td>
<td>0.9171***</td>
<td>0.0416</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0.1122</td>
<td>0.2822</td>
</tr>
<tr>
<td>FDI</td>
<td>0.0666</td>
<td>0.0886</td>
</tr>
<tr>
<td>Constant</td>
<td>0.4203</td>
<td>0.3875</td>
</tr>
</tbody>
</table>

Number of observations 121
Adjusted R-Squared 0.9048
Prob>F 0.0000

Dependent variable in this model is log of labour demand.
Source: Author’s computation from World Bank Enterprise Survey, 2013.

The goodness of fit for innovation and labour demand regression is measured by the Adjusted R-squared. Adjusted R-squared always lay within the unit interval zero (0) and 1. If the model provides no predictive power, Adjusted R-squared is zero (0) but as its fitness improves, Adjusted R-squared approaches unity (1). From Table 10, OLS regression results of innovation and labour demand has an Adjusted R-squared of 0.9048. This means that the OLS regression for innovation and labour demand is good for prediction. Hence, the results are robust to the estimation technique.

5.3 Effects of Innovation on Skilled and Unskilled Labour

The outcomes from the OLS regression on quality of labour employed introduced in Table 11 additionally show the significance of product innovations amongst firms in Ghana. The outcome reveals that the introduction of product innovation leads to demand for highly skilled workers. Also, log of assets and the lag value of labour employed tend to increase the demand for highly skilled workers among Ghanaian firms.
Table 11: OLS Results on Effects of Innovation on Quality of Employment

<table>
<thead>
<tr>
<th>Variables</th>
<th>Skilled Labour</th>
<th></th>
<th>Unskilled Labour</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficients</td>
<td>Std. Err.</td>
<td>Coefficients</td>
<td>Std. Err.</td>
</tr>
<tr>
<td>Product</td>
<td>0.0555**</td>
<td>0.1131</td>
<td>0.1146</td>
<td>0.2157</td>
</tr>
<tr>
<td>Process</td>
<td>-0.0534</td>
<td>0.1069</td>
<td>-0.1951</td>
<td>0.2075</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>-0.1625</td>
<td>0.3451</td>
<td>0.4133</td>
<td>0.4818</td>
</tr>
<tr>
<td>Age of firm</td>
<td>-0.0446</td>
<td>0.0035</td>
<td>-0.0606</td>
<td>0.0066</td>
</tr>
<tr>
<td>ln(Assets)</td>
<td>0.0572*</td>
<td>0.0207</td>
<td>0.0114</td>
<td>0.0396</td>
</tr>
<tr>
<td>FDI</td>
<td>0.1305</td>
<td>0.1113</td>
<td>0.1566</td>
<td>0.1881</td>
</tr>
<tr>
<td>Training</td>
<td>0.0843</td>
<td>0.1018</td>
<td>0.2968**</td>
<td>0.1753</td>
</tr>
<tr>
<td>Labour2010</td>
<td>0.6733***</td>
<td>0.0514</td>
<td>0.9041***</td>
<td>0.0903</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.5646</td>
<td>0.3842</td>
<td>-0.4219</td>
<td>0.5756</td>
</tr>
<tr>
<td>Number of observations</td>
<td>115</td>
<td></td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>Prob&gt;F</td>
<td>0.0000</td>
<td></td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.6781</td>
<td></td>
<td>0.8321</td>
<td></td>
</tr>
</tbody>
</table>

Note: *, **, *** indicate significance at 10%, 5% and 1% confidence levels respectively.

Dependent variables in this model are logs of skilled and unskilled labour demand.

Source: Author’s computation from World Bank Enterprise Survey, 2013.

The sign of the coefficients of both product and process innovations and skilled labour is as expected, however, the signs of the coefficients of both product and process innovations and unskilled labour are not as expected. The results reveal a positive and significant effect of product innovation on the demand for skilled labour but a negative relationship between process innovation and skilled labour although not significant. The positive relationship between skilled labour demand and firms that engage in product innovation reveals that product innovative firms tend to employ more skilled labour than non-product innovative firms from the labour market. This result obtained does not confirm the SBTC hypothesis.
In addition, a positive and insignificant relationship is observed between product innovation and unskilled labour demand whereas a negative and insignificant relationship is observed between process innovation and unskilled labour demand. This study is intended to test the Skill Biased Technological Change (SBTC) hypothesis among manufacturing and service firms in Ghana using the OLS regression model. The econometric study does not prove the existence of a technological bias in favour of the skilled labour. This study contradicts the findings of Falk (1999) that both types of innovation introduced at the firm level affect the quality of labour in Germany.

5.4 Chapter Summary
The results derived from this study show that innovation is an important determinant of labour demand by manufacturing and service firms in Ghana. The determinant of innovation among manufacturing and service firms in Ghana were estimated using the probit regression model. The results obtained show that product innovation is significantly influenced by formal training, loan from financial institutions and research at the firm level. On the other hand, process innovation is significantly influenced by formal training, manufacturing sector dummy and research at the firm level.

In relation to the effect of innovation on labour employed, the study employed the OLS regression model on the quantity and quality of labour. The results obtained reveal that both product and process innovation, age of firm and the lag value of labour employed significantly influenced the quantity of employment. With regards to the quality of employment, the results revealed that product innovation, log of assets and the lag value of labour employed significantly influenced the demand for skilled labour whereas formal training and the lag value of labour employed influenced the demand for unskilled labour. In this study, the Skilled Biased Technological Change hypothesis in not confirmed.
CHAPTER SIX
SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

This chapter presents the summary and conclusion of this study. Recommendations based on the findings of this study are also provided. These recommendations would be of significance to manufacturing and service firms, government policy makers and other stakeholders who are committed to curb the unemployment situation in Ghana. The limitations of this study are also provided at the end of the chapter.

6.1 Summary of Study findings
The study examined factors that determine innovation in Ghana. The specific objectives is to find the factors that influence manufacturing and service firms to engage in innovation as well as factors that determine innovation and labour demand. The study focused on firm and industry characteristics as factors that influence innovation and labour demand.

The study used a firm level survey of 720 firms conducted in Ghana by the World Bank in 2013. The study employed bivariate probit regression model in considering the factors that influence innovation whereas the OLS regression model was employed to examine the effect of innovation on the quantity and quality of labour employed.

The study finds that product innovation is significantly influenced by formal training, loan from financial institutions and research. On the other hand, process innovation is significantly influenced by formal training, manufacturing dummy, active website and research.

The study also finds that both product and process innovation, age of firm and the lag value of labour significantly influenced the quantity of labour employed.
In the terms of innovation and the quality of labour employed, the results reveal that product innovation, log of assets and the lag value of labour employed significantly influenced skilled labour demand whereas formal training and the lag value of labour employed influenced unskilled labour demand.

On the contrary, firm’s size, age of the firm, and FDI do not bear any significant relationship with either product or process innovation. Also, cost per labour, assets, manufacturing dummy and FDI do not show any significant relationship between innovation and the quantity of labour employed. Moreover, process innovation, manufacturing dummy, age of the firm, FDI and ISO certification do not also bear any significant relationship between either skilled or unskilled labour employed.

6.2 Conclusions of the Study

Several conclusions can be drawn from the findings on innovation and labour demand in Ghana which are the specific objectives of the study.

To begin with, the study finds evidence to support the case that innovation in Ghana is highly influenced by research and development by firms. Also, the study finds that innovation and the quantity of labour employed is influenced mostly by firm and industry characteristics of the firm such as age of firm and the lag value of labour.

Finally, the study concludes that innovation and the quality of labour is influenced by a mixture of industry characteristics of the firm such as product innovation, lag value of labour and formal training.
6.3 Policy Recommendations

To solve the high unemployment rate facing Ghanaian populace, both demand and supply side factors in relation to innovation need to be identified and tackled through private sector involvement and policy initiatives. Hence, the following steps are recommended.

Firstly, manufacturing and service firms should be encouraged to embrace innovations in order to improve on the quality of labour employed. This requires building the capacity and development of firms so that they can easily adapt to new technologies and innovations.

The successful implementation of these recommendations however requires effective mechanism for coordination between government’s effort and that of the private sector including financial and research institutions and other stakeholders who are contributing to improve the level of innovation among firms in Ghana.

Engaging in research is important for both types of innovation. Policies that will promote research activities will be important measures to facilitate both product and process innovations among firms.

6.4 Limitations of the study

One of the major limitations of this study is that the data used does not include many characteristics of non-production workers such as the educational levels and wages of managers, supervisors, sales personnel and professionals which are also important factors that are considered in the skill levels concept.

Also, the data is a cross sectional data which does not allow comparison of the effect of innovation on labour demand over different periods of time. In this regard, there is the need for future studies to consider time series data in order to make well-informed conclusions on
the subject of innovation and labour demand among manufacturing and service firms in Ghana.

Moreover, the study includes only firms in the urban centres and cities such as Accra, Kumasi, Tamale, Takoradi and Tema. Rural firms are not covered by the survey. However, studies of these rural firms would help make comparison with the urban firms. Despite these limitations, the findings of this study will be useful in providing insight for further studies.
REFERENCES


APPENDIX I

Descriptive Statistics

Data from the World Bank Enterprise Survey, 2013 is employed to provide descriptive analysis on all the variables used in this study. Table 12 presents descriptive statistics on the variables.

Table 12: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Number of Observations</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>717</td>
<td>0.5146</td>
<td>0.5001</td>
</tr>
<tr>
<td>Process</td>
<td>717</td>
<td>0.5118</td>
<td>0.5002</td>
</tr>
<tr>
<td>Firm size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small (5-19)</td>
<td>718</td>
<td>0.6671</td>
<td>0.4715</td>
</tr>
<tr>
<td>Medium (20-99)</td>
<td>718</td>
<td>0.2576</td>
<td>0.4376</td>
</tr>
<tr>
<td>Large (≥ 100)</td>
<td>718</td>
<td>0.0752</td>
<td>0.2639</td>
</tr>
<tr>
<td>ln(Age of firm)</td>
<td>710</td>
<td>2.4443</td>
<td>0.7714</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>720</td>
<td>0.5847</td>
<td>0.4931</td>
</tr>
<tr>
<td>FDI</td>
<td>719</td>
<td>0.1599</td>
<td>0.3668</td>
</tr>
<tr>
<td>Research</td>
<td>717</td>
<td>0.2217</td>
<td>0.4157</td>
</tr>
<tr>
<td>Training</td>
<td>715</td>
<td>0.3986</td>
<td>0.4899</td>
</tr>
<tr>
<td>Loan from Bank</td>
<td>708</td>
<td>0.2387</td>
<td>0.4265</td>
</tr>
<tr>
<td>ln(Labour demand)</td>
<td>718</td>
<td>2.6535</td>
<td>1.0832</td>
</tr>
<tr>
<td>ln(Labour 2010)</td>
<td>646</td>
<td>2.5311</td>
<td>1.1413</td>
</tr>
<tr>
<td>ln(Cost per worker)</td>
<td>555</td>
<td>7.3848</td>
<td>1.5591</td>
</tr>
<tr>
<td>Log of Assets</td>
<td>137</td>
<td>11.4677</td>
<td>2.9043</td>
</tr>
<tr>
<td>ln(Skilled)</td>
<td>367</td>
<td>2.4569</td>
<td>1.1229</td>
</tr>
<tr>
<td>ln(Unskilled)</td>
<td>218</td>
<td>1.6113</td>
<td>1.3062</td>
</tr>
</tbody>
</table>

Source: Author’s computation from World Bank Enterprise Survey, 2013.
The table above reveals that about 51 percent of manufacturing and service firms engaged in either product or process innovation. In relation to firm size, about 67 percent of firms are small in size employing a minimum of five and a maximum of 19 workers whilst 26 percent are medium firms employing a minimum of twenty and a maximum of 99 workers. About 7 percent are large firms employing 100 or more workers. Firms with foreign ownership comprise about thirteen percent of the sample. Out of which, foreign direct investment firms comprise about 16 percent of the sample whilst foreign portfolio investment firms comprise about 84 percent. About nine percent of firms produce some of their output for export.

About 40 percent of firms provide training to their workers. This includes on the job training and the participation of workers in training programmes provided by other firms and organisations. With respect to indicators of technological capability, 22 percent of firms conduct research and development that is either in-house or contracted with other companies. About 33 percent of firms have active websites. Average age of a firm in the sample is 15.5 years. Out of the firms, about 58 percent are manufacturing firms while the remaining are service firms.