KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF ECONOMICS
(FACULTY OF SOCIAL SCIENCES)

SOURCES OF GROWTH IN THE GHANAIAN MANUFACTURING SECTOR (1965-2006)

--A Bounds Testing Approach

BY:

ROBERT BRANDFORD-MENSAH
MASTER OF PHILOSOPHY (ECONOMICS)

JANUARY, 2011

SOURCES OF GROWTH IN THE GHANAIAN MANUFACTURING SECTOR (1965-2006)

--A Bounds Testing Approach

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF ECONOMICS

SOURCES OF GROWTH IN THE GHANAIAN MANUFACTURING SECTOR (1965-2006)

--A Bounds Testing Approach

BY:

ROBERT BRANDFORD-MENSAH

A THESIS PRESENTED TO THE DEPARTMENT OF ECONOMICS, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF PHILOSOPHY DEGREE IN ECONOMICS,

MPhil. (ECONOMICS)

JANUARY, 2011

DECLARATION

I declare that I have personally, under supervision, undertaken the study herein submitted.

Date: 19-12-2011 ....

ROBERT BRANDFORD-MENSAH
(STUDENT)

I confirm that I have supervised the student in undertaking the study submitted herein and that the student has my permission to present it for assessment.

Date: ....

PROF. JOSEPH OHENE-MANU
(SUPERVISOR)

ACKNOWLEDGEMENT

Much warmest gratitude goes to Prof. Joseph Ohene-Manu and Dr. Hadrat M. Yusif, lecturers at the Department of Economics, Kwame Nkrumah University of Science and Technology, under whose supervision, guidance, suggestions and encouragement helped to bring this study to a successful accomplishment. I will also like to acknowledge with much gratitude my indebtedness to all persons and organizations that helped in divers' ways to assist me in this project.

I will again like to thank the Department of Economics as a whole for the provision of enabling environment for this project work to be accomplished successfully.

DEDICATION

I wish to dedicate this project to my dear son Robert Brandford-Mensah jnr.

ABSTRACT

This study examines the major determinants of manufacturing growth in Ghana, emphasizing the importance of trade. Trade therefore is put into three sections namely, exports, imports and economic liberalization. It further considered the question as to whether the removal of trade barriers has been able to promote industrial convergence. Annual time series data covering the period 1965 to 2006 was used. The researcher applied the bounds testing approach to co-integration and error correction models, developed within an autoregressive distributed lag (*ARDL*) framework, to investigate whether a long-run relationship exist. Using this approach the researcher found evidence of long-run relationship between growth and its determinants. The results indicate that economic liberalization has positive impact on growth while imports have negative impact and this result is in consistence with other findings. Again, there is sufficient evidence to conclude that smaller firms are growing faster relative to large firms.

TABLE OF CONTENTS

LISTS OF TABLES

LISTS OF TABLES:

LISTS OF FIGURES

CHAPTER ONE

INTRODUCTION

1.0 Background of the Study

Manufacturing in Ghana accounts for about 25.3 percent of total *GDP*, and total industrial production is rising at 7.8 percent which rates Ghana the 38th rising industrial economy in the world. (*CIA* Fact Book, 2008).

After independence the objectives of development policies were to: diversify the agricultural economy; create employment for the rapidly growing population; raise per capita incomes; improve the balance of payments and achieve rapid growth. This objective of catching up with the industrialized countries, compelled the government to undertake import substitution strategies. The focus was on the establishment of large-scale, capital-intensive industries owned and managed by the state.

By 1965 there had been the creation of relatively wide range of manufacturing enterprises, the largest including the Volta Aluminum Company (*VALCO*) smelter, sawn mills and timber processing plants, cocoa processing plants, cement manufacturing, oil refinery, vehicle assembly plants, breweries and textile manufacturing operations. The result of such initiative was significant in the sense that it actually portrayed a move towards structural changes which are prerequisites for economic growth and development. The Industrial Review Series of the United Nations Industrial Development Organization described it as one of industrial growth (*UNIDO*, 1986).

Manufacturing growth came to a standstill from 1971 to 1977 and was followed by a declined from 1978 to 1983. These occurred because the state owned enterprises were protected from foreign competitions through restrictive trade policies. Trade policy instruments which included quantitative import restrictions; foreign exchange rationing, high tariffs of imported consumer goods, import licensing and domestic price controls were instituted. Administrative fixing of wages, rents and interest rates were other measures employed.

By 1982 the manufacturing sector was characterized by the following; serious underutilization of installed capacity, obsolete machinery which were performing inefficiently, over-dependence on imported industrial raw materials for industrial operations, high and uncompetitive prices of manufactured products and low labour productivity

Several reasons have been given in explanation of the standstill and decline in manufacturing growth for that period. Ghana Country Studies (1994) reported that the rise in industrialization became stagnant from 1970 to 1977 and then declined from 1977 to 1982; due to the fact that many of these industries survived mainly through protection. Baa-Nuakoh (1997), explained that the attempt at industrialization had only been made through import substitution which allowed policies that provided protection for domestic industries against competing imports. Riddell (1990), on the other hand, argued that the problem was not with import substitution policies, but the nature of the protection; the use of quotas rather than tariffs ensured a lack of competition which was imitable both to firm level efficiency and product quality.

Studies on countries which adopted import substitution strategies reveal that beyond some initial stage, growth cannot continue. Riddell (1990) stated that there were some evidence which seemed very clear that the import substitution policies from the 1960's to the 1980's failed to provide the bases for the growth of manufacturing firms in Africa. Similarly, Harvey and Pahlavani (July, 2006) wrote that the import substitution policies which were emphasized by South Korea was a mistake. The failure of policies of trade restrictions to promote the growth of the Ghanaian manufacturing sector is well documented; in the period 1971 to1983 when aggregate real *GDP* fell by 30 percent the share of manufacturing in *GDP* fell from 11 to 3 percent, Rimmer (1992,). During that same period wages for workers in the manufacturing sector was reduced by 50 percent, Teal (1998).

With a view to rectifying the adverse effects of import substitution policies, the Economic Recovery Programme (*ERP*) was launched in 1983, under the guidance of the World Bank and the International Monetary Fund *(IMF*). Most African countries have undergone structural adjustment programmers' and the aim is to correct their anomalies. Generally recovery programs are based on two premises; sound money and free market. The monetary policy is aimed at balancing the aggregate budget to achieve a realistically valued exchanged rate. Then the free market always took the form of trade liberalization and the elimination of government controls on relative prices within the economy.

The *ERP* of Ghana was implemented in two stages: the first stage was from 1983-1986 and the second was after 1986 and continued till 1991. The objective of the *ERP* as stated by the Library of Congress Studies (1994), was focused on the restoration of productivity at minimum cost to the government, and this included the following policies: lowering inflation through stringent fiscal, monetary and trade policies; increasing the flow of foreign exchange into Ghana and directing it to priority sectors; restructuring the country's economic institutions; restoring production incentives; rehabilitating infrastructure to enhance conditions for production and export of goods. In short, it was with the view to creating favourable economic climate conducive to the generation of capital.

The *ERP* and other trade policies which were implemented during the 1990's helped greatly to improve upon the conditions of the economy. Encyclopedia Britannica (2007) stated among other things, that the Ghanaian industrial development was hampered by lack of capital and official industrial development policies in the early 1980's, and recognizing the importance of attracting investors, a move that privatized Ghana's state owned enterprises in the 1990's and 2000's helped to increase production and succeeded in attracting foreign exchange. The *LCS* (1994) reported that by the end of 1991, the *ERP* efforts had improved the country's international financial reputation because of its ability to make loan repayments and had made its first entry into the international capital market after almost two decades.

Despite the gains from the *ERP* all was not too well for all the firms. There were however, certain challenges some manufacturing firms' encountered during the implementation of the *ERP*, which either impeded their growth or made them shut down. During the program there were drastic currency devaluations after 1983 which made it expensive to purchase inputs from abroad and also for businessmen to obtain bank credit. Liberalization of trade made it impossible for some firms to compete with cheap imports. Local press reports have estimated the closure of at least 120 factories from 1988 to 1994. Those hard hit included the garment, leather, electrical, electronics, pharmaceuticals and the only safety match company in the country.

1.1 Statement of the Problem / Research Questions

It is the vision of Ghana to achieve the millennium development goals by the year 2015 and reach a middle income status by 2020. One of the major strategies adopted is agro-processing under the manufacturing sector, (*GPRS* II 2006 – 2009). However, different macroeconomic policies aiming at growth of the manufacturing sector have been adopted since independence, all aimed at fostering growth within the manufacturing sector. Import substitution policies were implemented from the 1960's to 1983. There were liberalization and stabilization policies which were all aimed at establishing new macro-economic policy framework to reverse the downward trend of the economy and to put it back on the path of growth.

During the second phase of the *ERP* there were the removals of all forms of trade restrictions. Teal (1998) wrote that the period from 1983 to 1991 saw the sweeping away of all forms of trade restrictions. When trade restrictions are removed local firms are exposed to competitions which help them to improve factor allocations across sectors and increase the value of domestic production. Again when economies open up to international competitions it induces efficiency in the local market through productivity gains. Local firms are then able to adapt to new and efficient methods of production which are mostly imported from abroad.

Riddell (1990) had argued that before 1983 administrative discretions attached to trade policies in Ghana favoured large firms and crippled the growth of smaller ones. If it were so, it is therefore expected that after the removal of all trade restrictions smaller firms will be able to grow faster relative to larger firms.

It is in the light of these discussions on the effects of trade and its policies on the manufacturing sector in Ghana that the study seeks to ascertain. The study will also investigate whether the removal of trade restrictions has been able to bring about industrial convergence within the manufacturing sector. Alternatively, the research study seeks to answer the following questions:

- What impact has trade and its policies had on the growth of manufacturing in Ghana?
- Have small firms been able to grow faster relative to larger firms after the removal of all trade restrictions?

1.2 Objectives of the Study

The main objectives of this study are to provide an analysis of the sources of growth within the Ghanaian manufacturing sector for the period 1965 to 2006. The study has the following objectives:

- To assess the impact of trade and its policies on growth of the manufacturing sector.
- To investigate whether during the trade reforms, the removal of trade barriers and administrative discretions (which were believed to have favoured large firms in the manufacturing sector over smaller firms) has helped to promote industrial convergence.

1.3 Statement of Hypothesis

In view of the primary objectives of this study the researcher postulates the following two hypotheses;

H_0 That free trade has not contributed positively towards growth in the manufacturing sector.

H_1 That free trade has contributed positively towards growth in the manufacturing sector.

and

H_0 That the removal of trade barriers and administrative discretions have brought about no convergence effect within the manufacturing sector.

H_1 that the removal of trade barriers and administrative discretions' have helped smaller firms in the manufacturing sector to grow faster relative to large firms.

1.4 The Significance of the Study

The researcher strongly believes that the result of this work shall help manufacturing firms to evaluate their input combinations and improve upon them to increase output and hence growth within the economy.

The study will add to existing literature and provide current analysis of the impact of trade and its reforms on growth of the manufacturing sector in Ghana.

Then lastly, other researchers may find this work very useful. This may serve as a basis upon which further research works may be conducted.

1.5 Methodology

The sample for this study covers annual data for 42 years. The number of firms used in this analysis is not even. It comprises of all manufacturing firms (in operation at the time of survey) in Ghana from the period 1965 to 2006. The method of estimation is the Bounds Testing Approach to Co-integration which was developed recently by Peseran and Shin (2000). The methodology is found useful due to the small sample size, and a mixture of stationary and non-stationary time series which this approach is found to perform best among other methodologies. Further inferences are made on the relevance of each explanatory variable towards growth of manufacturing by simulating impulse response functions and variance decompositions.

1.6 Organization of the study

This work is divided into five chapters. Chapter one is the introduction of the study and it provides the overview of the entire study. It gives a brief background summary of the manufacturing sector since independence and attempts to explain some of the major targets aimed at its growth. It is followed up with statement of the problem upon which this study is being undertaken. The statement of hypothesis and problems associated with data collection close it. Chapter two, the literature review, it reviews some literature on growth models. It discusses three most important theories of growth; the Harrod-Domar Growth Model, Solow Growth Model or otherwise referred to as the Neo-classical Growth Model and the New Growth Theory. Chapter three presents the data and models as well as econometric methodology used in this study. Chapter four, deals with the results and findings from this study. Then lastly, chapter five presents the summary of findings and recommendations.

1.7 Problems Encountered

The first problem is that associated with data collection; various sources give different figures for the same data. This was leveled by using official government data. The second problem lies with availability of empirical works to use as foundation; most researches made, especially by Ghanaians on manufacturing are for sale on the internet which are not easily obtainable. Then lastly, financial constraint posed the greatest challenge to travelling and acquisition of relevant materials to carry on. This last problem mentioned could not allow the work to be completed within the required time.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter treats three growth models: the Harrod-Domar, Solow or neoclassical and the New Growth Theory. The Harrod-Domar model is treated here because it is the simplest and best known production function used in the analysis of economic development. The Solow model is also used because it serves as a standard growth model from which most growth models are used to compare. The model serves as a starting point for all analyses of growth. Even models that depart fundamentally from Solow's are often best understood through comparison with the Solow model, (Romer, 2006). For this reason the Solow growth model is treated in more detailed than the other two. The third is the New Growth Theory that attempts to correct some of the shortfalls in the Solow model.

2.1 The Theory of Growth

The theory of growth attempts to explain how an economy, industry or firms produce and use their outputs. It enables the explanation of why national incomes grow, and why some economies grow faster than others. The theory explaining the relationship between inputs and growth is based on production functions. At the individual firm or microeconomic level, the production function relates the output of a firm or factory to inputs used. At the national level, production function describes the relationship of the size of a nation's labour force and its stock of capital with the level of that nation's gross national or domestic product.

2.2 Harrod-Domar Growth Model

The Harrod-Domar growth model was developed independently by economist Roy Harrod (1939) of England and Evsey Domar (1946) of MIT. The model was to aid explain the relationship between growth and unemployment in advanced capitalist societies, (Harrod, 1939). It has however, been used extensively in developing countries to investigate the relationship between growth and capital requirements. The Harrod-Domar model was the precursor to the Exogenous Growth Models. The basic assumption of the model is that the output of any economic unit, whether a firm or an industry or a whole economy depends upon the amount of capital invested in that unit.

The theory is based on three concepts of growth, according to the model. First, the Warranted growth, which is the rate of output growth at which firms believe they have the correct amount of capital and therefore, do not need to increase or decrease investments, given expectations of future demand. Again, there is Natural rate of growth that is the rate at which the labour force expands; a larger labour force generally means a larger aggregate output. Then there is Actual rate of growth, which is the actual aggregate output change.

According to the model two possible problems are observable. First, the relationship between the natural and actual growth rates can cause disparities between the two, since factors that determine natural growth are different from those of actual growth. Factors determining natural growth include birth controls, culture and general tastes, while those of actual growth include the marginal propensities to save and consume. Therefore, there is no guarantee that an economy will achieve sufficient output growth to sustain full employment in the context of population growth. The second problem identified in the model is the relationship between actual and warranted growth. If it is expected that demand will grow, investment will increase to meet that extra demand. A problem then arises when actual growth either exceeds or fails to meet warranted growth expectations. A vicious cycle can be created where the difference is exaggerated by attempts to meet the actual demand, causing economic instability.

2.2.1 *Assumptions of the Model*

The Harrod-Dormar model makes the following a priori assumptions:

1. Output is a function of capital; $Y = f(K)$
2. The marginal product of capital is a constant; the production function exhibits constant returns to scale. This assumption implies that capital's marginal and average products are equal; $\frac{dY}{dK} = c \Rightarrow \frac{dY}{dK} = \frac{Y}{K}$
3. Capital is necessary for output; without capital there can be no output; $f(0) = 0$
4. The change in the capital stock equals investment less the depreciation of the capital stock; $\Delta K = I - \delta K$

2.2.2 *Analysis of the Model*

The analysis of the model is as follows:

Let Y represent output which equals income, and K equals the capital stock, then output can be related to capital stock as;

[2.1] $$k = K/Y$$

Where k is a constant called the capital output ratio. The growth rate of output can therefore be represented as;

[2.2] $$\Delta Y = \Delta K/k$$

The notation Δ is used to represent increases in output and capital. The growth rate of output, g, is simply the increment in output divided by the total amount of output $\Delta Y/Y$. By dividing both sides of the equation by Y then

[2.3] $$g = \frac{\Delta Y}{Y} = \Delta K/Y \times 1/k$$

For the whole economy, [ΔK] is the same as investment, I, which must equal savings, S. Therefore, $\Delta K/Y$ is equal to S/Y, and can be designated by the saving rate, s, a percentage of national product. Equation [2.3] can be re-written as

[2.4] $$g = s/k$$

Equation [2.4] is the basic Harrod-Dormar relationship for an economy. The equation has the underlying view that capital created by investment in plant and equipment is the main determinant of growth and that it is the saving by people and organizations that make investment possible. The capital-output ratio is a measure of the productivity of capital. In the study of growth we are interested in the impact on output of additional or incremental capital, therefore; economists often use the term incremental capital-output ratio or otherwise abbreviated as *ICOR*.

2.2.3 *Criticisms of the Model*

The main criticism of the model is the level of assumption, one being that there is no reason for growth to be sufficient to maintain full employment: this is based on the belief that the relative price of labour and capital is fixed and that they are used in equal proportions. The model also explains economic boom as bust by the assumption that investors are only influenced by output; this is the accelerator principle which is now not accepted by economists.

2.3 Solow Growth Model

The Solow growth model is named after Robert Solow (1990) who developed it in the 1950's and the 1960's and applied it to growth problems. The model is used in this work to show how savings, population growth and technological progress affect the levels of outputs of economies, industries and firms and their growth over time. This model was the first ever to introduce efficiency in production functions.

2.3.1 *Extension to the Harrod-Domar Model*

Solow extended the Harrod-Domar model by;

- Adding labour as a factor of production
- Requiring diminishing returns to labour and capital separately and constant returns to scale by both factors combined

- Introducing a time-varying technology variable distinct from capital and labour

2.3.2 *The Accumulation of Capital*

In order to understand what determines the amount of output produced at any given time and how this output is allocated among alternative uses, there is the need, first and foremost, to consider the influence of supply and demand for goods and the accumulation of capital.

2.3.2a *The supply of goods and the production function*

In the Solow model the supply of goods or output depends on the capital stock and the labour force:

[2.5] $$Y = F(K, L)$$

Y is output, K is capital stock and L is the labour force. A second assumption is that the production function exhibits constant returns to scale. In other words, if we multiply both capital and labour by any positive constant t, we also multiply the amount of output by t i.e.

[2.6] $$tY = F(tK, tL)$$

Apart from the fact that the assumption of constant returns to scale, helps to simplify the analysis, it also allows us to analyze all quantities in the economy relative to the size of the labour force. For example, if we set $t = 1/L$ in equation [2.6] above we have;

$$Y \times \frac{1}{L} = F(K \times \frac{1}{L}, L \times \frac{1}{L})$$

[2.7] or $$\frac{Y}{L} = F(\frac{K}{L}, 1)$$

What equation [2.7] state is that the amount of output per worker Y/L is a function of the amount of capital per workerK/L. In the above, the size of the economy as measured by the number of workers does not affect the relationship between output per worker and capital per worker.

The theory proceeds by the assumption that any increase in output Y could come from any of three sources:

i an increase in L of which may bring a reduction in output per worker due to diminishing returns to labour.

ii an increase in K, the capital stock, which would increase both output and output per worker, $\frac{Y}{L}$.

iii an increase in A, or in residual factor productivity, (not yet introduced), could also increase output per worker or $\frac{Y}{L}$.

This assumption of $t = \frac{1}{L}$ therefore, enables equation [2.7] to be written in a new form by letting lower case letters $y = Y/L$ as output per worker, and $k = K/L$ as capital per worker. The equation therefore, becomes;

[2.8] $y = f(k)$

The number 1 in equation [2.7] is omitted here, since it is a constant, so $f(k) = F(k, 1)$.

The slope of the production function shows how much extra output a worker produces when given an extra unit of capital. This extra output is the marginal product of capital,(MP_k). Mathematically it is expressed as:

[2.9] $$MP_k = f(k+1) - f(k)$$

From a diagram, the production function becomes flatter, as the amount of capital increases. This implies that it exhibits diminishing marginal product of capital. When k is low in quantity, the average worker has only a little capital to work with, so an extra unit of capital becomes very useful and produces a lot of additional output. If however k is high, the average worker has a lot of capital so an extra unit does not increase output much.

2.3.2b *The demand for goods and the consumption function*

In the Solow model the demand for goods is determined simultaneously by the actions of both consumption and investment. Output per worker y is divided between consumption per worker c and investment per worker i, and can be stated mathematically as:

[2.10] $$y = c + i$$

Equation [2.10] assumes that each year individuals save a fraction s of their income and consumes$(1-s)$. The equation also assumes a closed economy and without government spending. The consumption function therefore, is of the form:

[2.11] $$c = (1-s)y$$

Where s is the rate of savings and assumes any number between zero and one. Equation [2.11] also states that investment equals savings, and this is shown by substituting $(1-s)y$ for c in equation[2.10], thus:

[2.12] $$y = (1-s)y + i$$

Re-arranging the terms:

[2.13] $$i = sy$$

Therefore the rate of saving is also the fraction of output that is devoted to investment. From the above discussions, the production function $y = f(k)$ determines how much output an economy produces, and the saving rate s determines the allocation of that output between investment and consumption.

2.3.3 *Growth in the Capital Stock and the Steady State*

In the model the capital stock at any time is a major determinant of the economy's output, it however, changes over time, and the changes may lead to economic growth. Capital stock itself is dependent on two factors, namely, investment and depreciation. Investment is the expenditure on new plant and equipment and this causes capital stock to rise. On the other hand, depreciation, which is the wearing out of old capital, causes capital stock to fall. From equation [2.13] where investment per worker is given by:

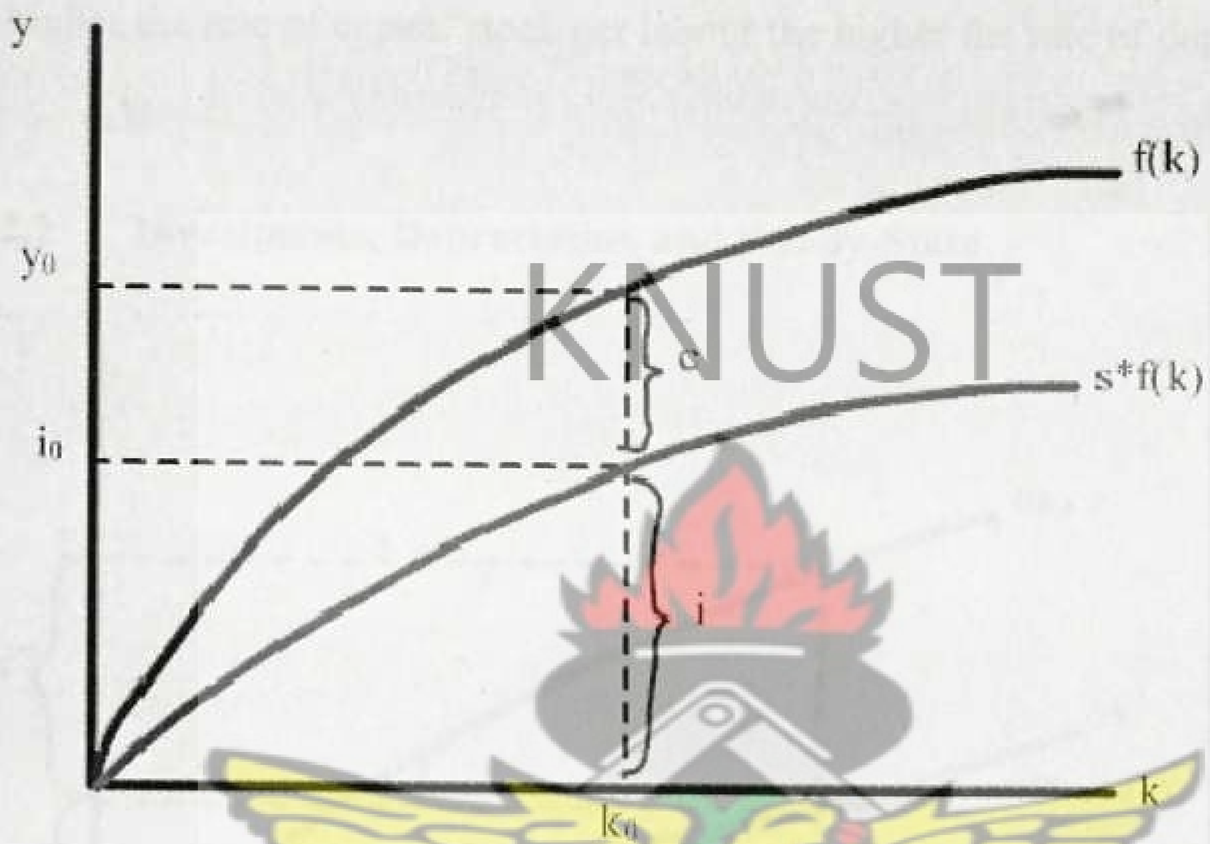
$i = sy$, it implies that

[2.14] $$i = sf(k)$$

Equation [2.14] relates existing capital stock k to the accumulation of new capital i. Investment is therefore created through savings. This is illustrated in figure 2.1 below.

Figure 2.1 illustrates that the higher the level of output, the greater the amount of investment. Output per worker is k_0y_0 and this is made up of both i and c.

Figure 2.1 Output, Consumption and Investment



In order to consider depreciation into the model we assume that a certain amount of capital stock is consumed each period or year. That is to say, depreciation which can be designated by the letter δ takes away from the capital stock each period, so that δ is the depreciation rate. In this case δk is the amount of capital that is consumed each year. The effect of investment and depreciation, therefore, on capital stock can be represented as:

[2.15] $\Delta k = i - \delta k$

This implies that a change in capital stock equals investment minus depreciation. The equation also explains that the stock of capital increases due to additions (created by investment) and decreases due to subtractions (caused by depreciation). Equation [2.15] can be re-written as

[2.16] $$\Delta k = sf(k) - \delta k$$

Figure (2.2) below shows depreciation is a constant fraction of the capital stock. It shows that the higher the rate of capital stock per labour the higher the rate of depreciation.

Figure 2.2 Investments, Depreciation and Steady-State

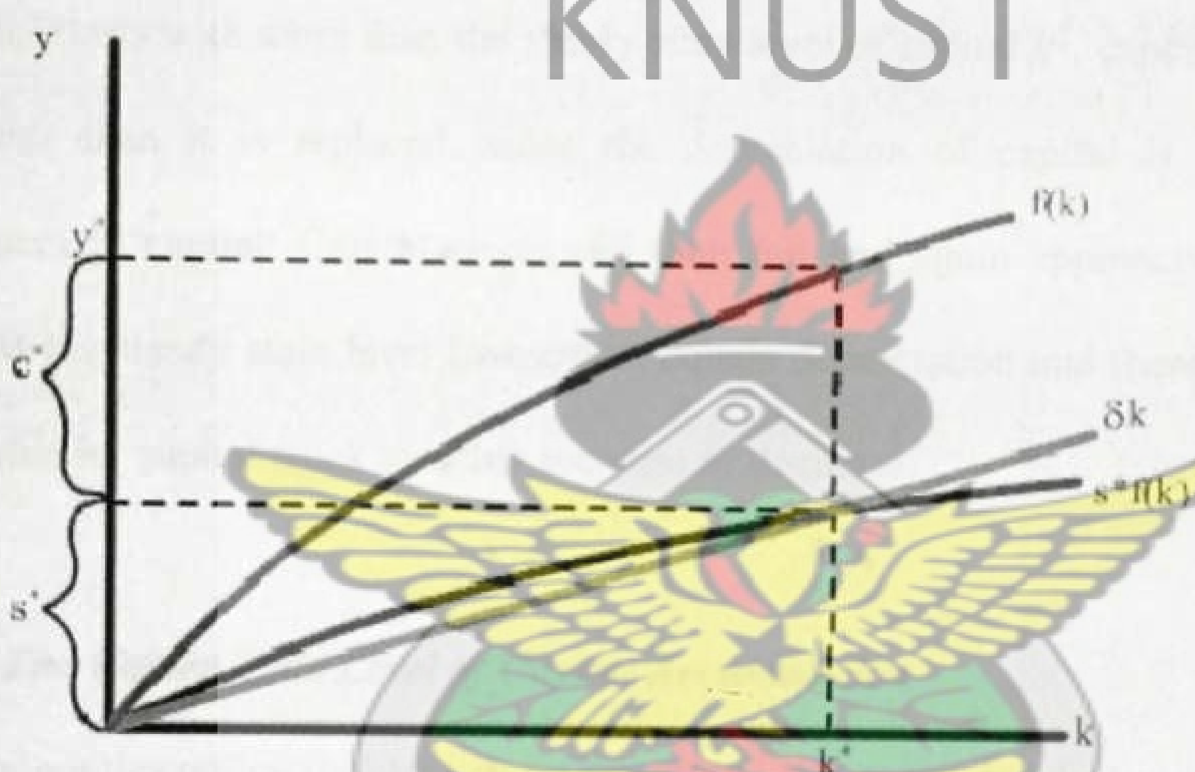


Figure 2.2 above shows the graph of equation[2.16], investment, depreciation and different levels of capital stock. The graph shows that when capital stock is high output levels are high with greater investment. On the other hand, the higher the output level the greater the amount of depreciation, since more capital is used up during higher output.

There is only a unique level of capital stock, k^*, at which the amount of investment equals that of depreciation. At this output level where $k = k^*$, change in capital stock equals zero, i.e. $\Delta k = 0$. This is the steady state level of capital, because at this level investment and depreciation are equal, therefore, there is no tendency for a change in capital stock. Capital stock k and output $f(k)$ are steady, at least for some time.

The steady state represents the long-run equilibrium of the economy. Suppose an economy starts with less than the steady state level of capital k^*, investment $sf(k)$ exceeds the amount of depreciation. In this situation the capital stock rises and output $f(k)$ also rises till it approaches the steady state level k^* of capital. Suppose also that the economy starts with more than the steady state level of capital k^*, capital stock will wear out faster than it is replaced, since the depreciation of capital is greater than the investment in capital. Capital stock will then fall and again approach the steady state level. At the steady state level investment equals depreciation and there is, therefore, no tendencies for capital stock to either increase or decrease.

2.3.4 *The Golden Rule Level of Capital Accumulation*

In all economies policy makers can set the saving rate at any level. By so doing the policy maker determines the economy's steady state. The aim is to maximize the well being of the individuals in the society. The steady state value of k that maximizes consumption is called the Golden Rule Level of Capital Accumulation. In order to choose the steady state at which consumption is maximized, policy makers first determine steady state consumption per worker. The saving rate is changed as follows; from equation [2.10] where

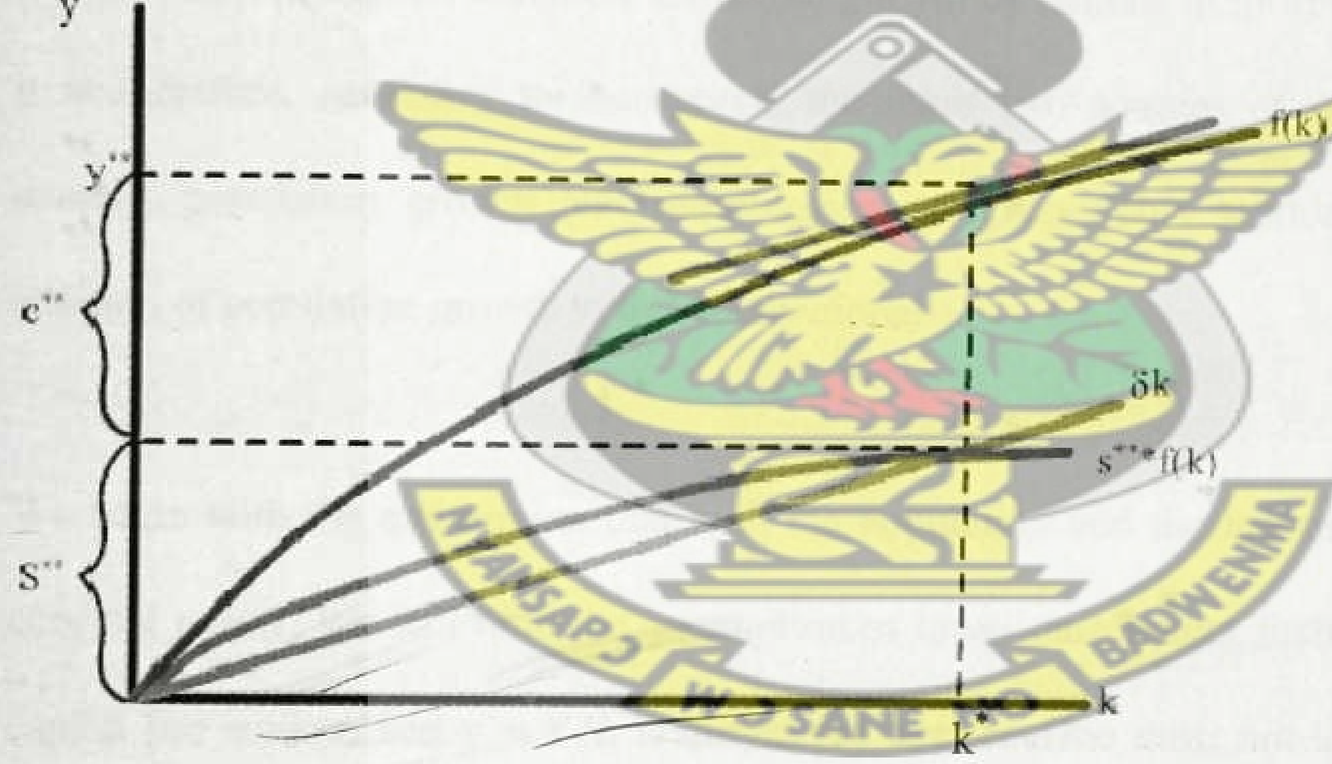
$$y = c + i$$

To find steady state consumption, there is the need to substitute steady state values for output and investment. Steady state output per worker is   where the steady state capital per worker is k^*. Again at steady state investment equals depreciation δk^*. By substituting $f(k^*)$ for y and δk^* for i in equation [2.17] we have:

[2.18] $$c^* = f(k^*) - s f(k^*)$$

[2.19] or $$c^* = f(k^*) - \delta k^*$$

Figure 2.3 Study State output, depreciation and investment per worker



In order to maximize consumption there is the need to find the greatest difference between output and depreciation. In maximization of $c^* = f(k^*) - \delta k^*$, we take the first derivative and set it equal to zero:

[2.20] $$dc^* = \frac{df}{dk}dk - \delta\delta k^* = 0$$

Incremental changes in k, $dk = 1$, the conclusion, therefore, is that at the Golden Rule level of capital, the marginal product of capital must equal the rate of depreciation, i.e. $MP_k = \delta$. In figure 2.3 above, the economy's output is y^{**}, savings is s^{**}, and this is where it is at its maximum and it is equal to depreciation. That part of output that is devoted for consumption is c^{**}. At this level there is the greatest difference between output and depreciation.

2.3.5 *Introducing Population Growth*

The Solow model, by nature holds both labour and technological changes constant. The growth in savings which propels a temporary high growth till it reaches a steady state, is not sufficient to explain sustained economic growth by nations in most part of the world. It is therefore, necessary to incorporate the other two sources of economic growth, namely, population growth and technological progress. This section deals with the addition of population growth to the Solow model.

We begin with the assumption that both the population and the labour force grow at a constant rate n. We still hold the assumption of lower case letters such that $k = K/L$ is capital per worker, and $y = Y/L$ is output per worker. One must not loose sight on the fact that as there is growth in the labour force n, L increases, therefore $k = K/L$ declines and $y = Y/L$ also declines.

As L grows, the change in capital stock per worker k now becomes:

[2.21] $$\Delta k = i - (\delta + n)k$$

Equation [2.21] states that investment, depreciation, and population growth all influence the per-worker capital stock. Investment increases k, both depreciation and population growth decrease k. The term $(\delta + n)k$ is the amount of investment necessary to keep the capital stock per worker constant. It is the breakeven investment. It includes the depreciation of existing capital which equals δk, and also the amount of investment necessary to keep new workers with capital, which is nk. At the steady state the positive effect of investment on capital stock per worker exactly offsets the negative effects of both depreciation and population growth. In effect, at k^*, $\Delta k = 0$ and $i^* = \delta k^* + nk^*$.

There are three principal reasons why the introduction of population growth in the model is very important. Firstly, it helps in the explanation of sustained growth of economies. This is because although in the steady state with population growth, capital per worker and output per worker remain constant, the population grows to increase the number of workers, and therefore, both the total output and total capital do grow at rate n. Secondly, it shows that an increase in population growth reduces the steady state level of capital per worker, and because output per worker is also dependent on capital per worker, output per worker also falls. Then lastly, it reduces the consumption maximizing level, since from

[2.22] $$c^* = f(k^*) - (\delta + n)k^*$$

The level of k^* that maximizes consumption is at: $MPK = \delta + n$ or $MPK - \delta = n$, $(but\ n\ is\ positive)$ which is greater than the model without population growth where $MPK - \delta = 0$.

2.3.6 *Introducing Technological Progress*

When technological progress is introduced in the Solow model it is exogenous. It is assumed that it occurs due to increased efficiency of labour. The production function can now be written as:

[2.23] $$Y = F(K, L \times E)$$

Where E represents the efficiency of labour, and grows at a constant rate of g. The efficiency of labour is used to denote the fact that as available technology improves the efficiency of labour rises. Increases in the efficiency of labour E are, in effect, like increases in the labour force L. The term $L \times E$ in equation [2.23] measures the number of effective workers, where L is the number of workers and the efficiency of each worker is E. This production function states that total output Y depends on the number of units of capital K and on the number of effective workers $L \times E$. The form of technological progress introduced here is called labour augmenting. The labour force L grows at the rate n, and the efficiency of each unit of labour also grows at rate g, therefore, the number of effective workers $L \times E$ grows at rate $n + g$.

In the explanation of a steady state with technological progress, we still need to maintain the assumption of constant returns to scale. Then we redefine our variables as:

$k = K/(L \times E)$ which represents capital per effective labour and $y = Y/(L \times E)$, also to represent output per effective labour. From these, a production function can be written as:

[2.24] $$y = \frac{Y}{L \times E} = f\left(\frac{K}{L \times E} \times \frac{L}{L \times E}\right) = f(k)$$

The definition of $y = f(k)$ still holds if we assume an arbitrary constant value of 1 for E. In order to see the evolution of capital over time, consider equation [2.25] below:

[2.25] $$dk = \frac{1}{L \times E} dK - \frac{K}{L^2 \times E} dL - \frac{K}{L \times E^2} dE$$

$$= \frac{K}{L \times E}\frac{dK}{K} - \frac{K}{L \times E}\frac{dL}{L} - \frac{K}{L \times E}\frac{dE}{E}$$

$$= k\delta - kn - kg$$

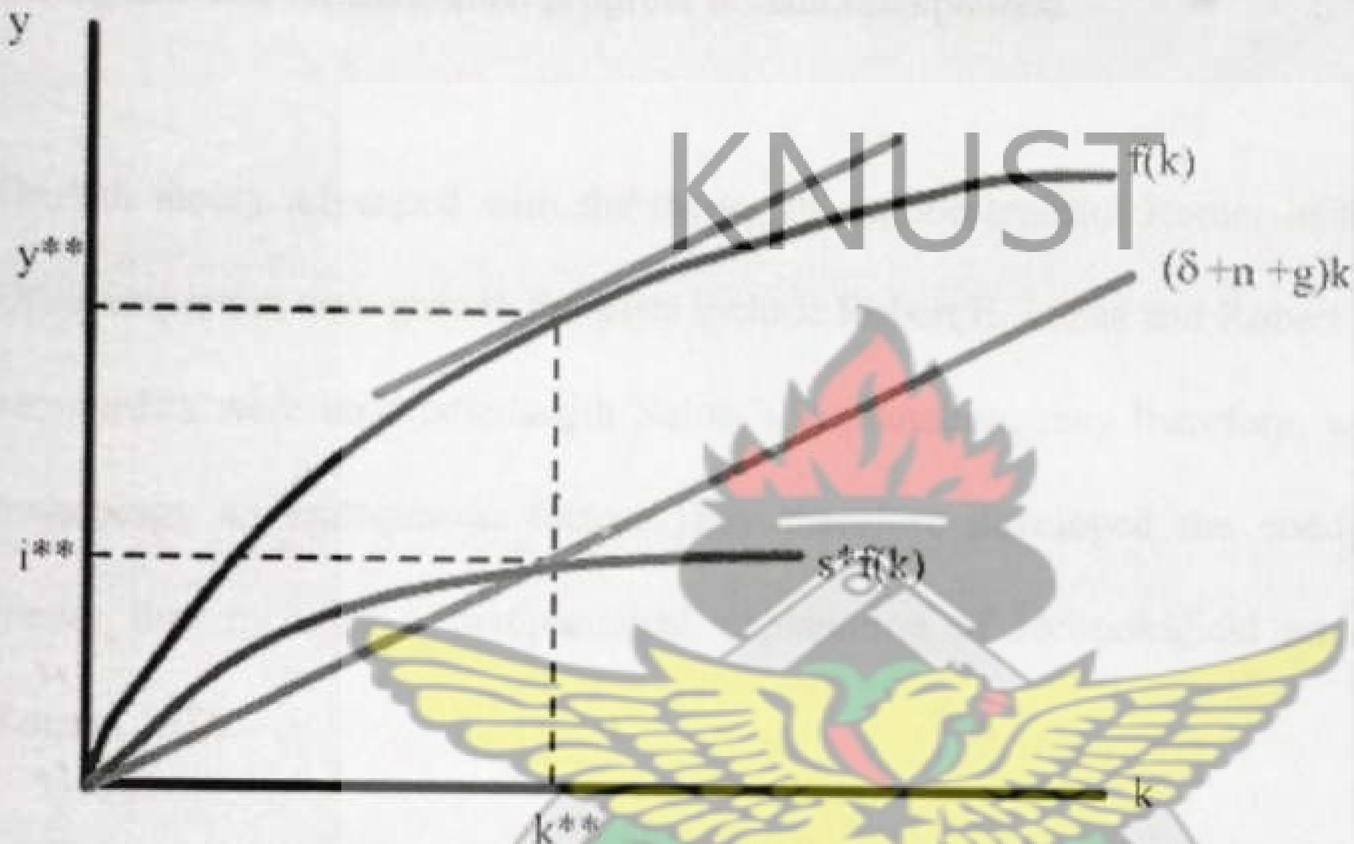
From the last equation, capital is being consumed by depreciation, so $\frac{dK}{K} < 0$, therefore the first term $k\delta$ is negative. When the steady state condition is modified to reflect the technological change we have:

[2.26] $$\Delta k = sf(k) - (\delta + n + g)k$$

Equation [2.26] states that a change in capital stock Δk equals investment $sf(k)$ minus break-even investment $(\delta + n + g)k$. Figure 2.4 below is a graphical representation of equation [2.24]. The steady state output level is y^{**} and that of capital is k^{**}.

The major significance of the introduction of technological progress in the Solow model is its ability to explain the sustained increases in standards of living that we can observe today. It is able to show sustained growth in output per worker. To explain the above, at the steady state $y = f(k)$, both capital per effective labour and output per effective labour are constant at the steady state. However, efficiency of each worker grows at rate g, therefore, output per worker $(\frac{Y}{L} = y \times E)$ also grows at rate g. Total output which is $Y = y \times (E \times L)$, therefore, grows at rate $n + g$. Therefore, with the Solow model, only technological progress can explain the persistent rise in living standards.

Figure 2.4 Technological Progress and Steady State



2.3.7 *Criticism of the Model*

The main criticism of the model is that the typical Solow model takes technology as given, fails to explain how or why technological progress occurs. It therefore fails to explain the persistence rise in the standard of living as it is observed in the world today. This failure has led to the development of Endogenous Growth Models.

2.4 Endogenous Growth Theory

Endogenous growth theory or New Growth Theory was developed in the 1980's as a response to criticisms of the neo classical growth models. In the neoclassical models the long-run rate of growth is exogenously determined by either assuming a saving rate (Harrod-Dormar model) or a rate of technological progress (Solow model). However the saving rate and technological progress remain unexplained.

Growth theory advanced with the theory of economist Paul Romer in the late 1980's. Other important new growth theorists include Robert E. Lucas and Robert J. Barro. These economists were unsatisfied with Solow's explanation; they therefore, worked to make technology an endogenous factor. They therefore developed the endogenous growth theory that includes a mathematical explanation of technological advancement, e.g. Romer, 1986.

The new growth theory also incorporates a new concept of human capital; the skill and knowledge that make workers productive. Unlike physical capital, human capital has increasing rates of returns. Therefore, overall, there are constant returns to capital and economies never reach a steady state. Growth does not slow as capital accumulates, but the rate of growth depends on the type of capital a country invests in.

Researches done in this area has focused on increases in human capital (e.g. education) or technological changes (e.g. innovation). Recent empirical analysis suggest that differences in cognitive skills, related to schooling and other factors, can largely explain variations in growth rates across countries, Hanushek, and Wossman, (2008).

2.4.1 *The Basic Model*

Let Y be output, K is capital and A is a constant measuring the amount of output produced for each unit of capital. Then the function can be specified as:

[2.27] $$Y = AK$$

The production function above does not exhibit the property of diminishing returns to capital. One extra unit of capital produces A extra unit of output, regardless of how much capital there is. The absence of diminishing returns to capital is the key difference between the endogenous growth models and the neoclassical.

Assume also a fraction s of income is saved and invested. Capital accumulation can now be described as:

[2.28] $$\Delta K = sY - \delta K$$

Equation [2.28] above states that the change in the capital stock (ΔK) equals investment sY minus depreciation(δK). Combining this with equation [2.27] above we obtain:

[2.29] $$\frac{\Delta Y}{Y} = \frac{\Delta K}{K} = sA - \delta$$

Equation [2.29] above shows what determines the growth rate of output $\frac{\Delta Y}{Y}$. From the equation as long as $sA > \delta$, the economy's income grows faster, even without the assumption of exogenous technological progress.

The definition of capital in the model goes beyond the traditional definition as plant and equipment. This includes human capital as well, therefore, capital is assumed to have constant rather than diminishing returns. This is because human capital in the form of knowledge has increasing returns, considering the increasing pace of scientific and technological innovation over the past few centuries.

2.4.2 *Implications of Endogenous Growth Theory*

The main implication with recent growth theory is that policies which embrace openness, competition, change and innovation will promote growth. Conversely, policies which have the effect of restricting or slowing change by protecting or favouring particular industries or firms are likely, over time, to slow growth to the disadvantage of the community.

2.5 EMPIRICAL LITERATURE

Harvey and Pahlavani (2006) examined the major determinants of *GDP* growth in South Korea emphasizing the importance of investment, trade and human capital. They used time series data covering the period 1980Q1 to 2005Q3.

They applied different cointegration techniques. Firstly, the time series properties of the data was analysed using the Zivot-Andrews (1992) model. Empirical results indicated that there was insufficient evidence against the null hypothesis of unit roots for all the variables under consideration. They therefore, applied Gregory-Hansen (1996) cointegration technique and found the existence of cointegration.

The *ARDL* procedure was then employed to specify the short-run and long-run determinants of economic growth.

The model was of the form;

$$y = \alpha_1 lnk + \alpha_2 lnhc + \alpha_x lnx + \alpha_m lnm$$

where y is GDP, K represents physical capital, hc is human capital, x and m are exports and imports respectively.

Empirical results showed that while the effects of physical and human capital as well as exports were highly significant, total imports were found to be non-significant. It was also found that the speed of adjustment in the estimated model was relatively high and had the expected significant and negative sign.

Leung, (1996) estimated the sources of growth of Newly Industrialised East Asian economies. He emphasised on residual factor productivity (*RFP*) growth which he labelled total factor productivity (*TFP*) growth. His emphasis was on human capital which he proxied with "cumulative output", remuneration-per-employee for the quality of labour, "capital-labour ratio" as a proxy for capital intensity. Others were export orientation and foreign ownership.

He found that cumulative output does not contribute positively to *RFP* growth in Singapore, this he found surprising, for it had a negative sign and was significant. He concluded therefore, that industries with a fast output growth had slowed *RFP* growth. He attributed this to the fact that capital input were accumulated so quickly, that technology was not properly absorbed (learned). Capital intensity also had a negative coefficient. However, industries with greater degree of export orientation showed faster *RFP* growth.

His findings were consistent with other researches that *RFP* did not contribute to growth in the newly industrialised Asian economies, but rather increases in inputs.

Baah-Nuakoh (1997) estimated the growth of factor inputs and the residual factor productivity of the Ghanaian economy from 1957 to 1969. He utilized the production function approach to measure the contributions of factor inputs to growth in the economy. He used the model;

$$Q_t = R_t K_t^a L_t^b D_t^c$$

where Q_t is real output, R_t is index of technology or total productivity, K_t is capital stock or capital services, L_t is labour input, D_t is land, a, b, and c are partial elasticities of output with respect to capital, labour and land respectively.

The coefficients of factors were used as weights and land was omitted on grounds that it was neither scaree nor were there major increase in land under cultivation. Q was taken as gross domestic product (*GDP*) in constant 1960 prices. Labour input was measured by employment; no adjustments were made for the quality of the input which may be affected by such factors as education, health, housing security etc. K was taken as the fixed capital stock in constant 1960 prices; therefore the capital share of 0.18 estimated by Brown (1960) was adopted and used. Other factor shares used were at the beginning of the period and the average factor shares for the period.

Estimation covered the entire period from 1957-1969 and also for three sub-periods of 1957-61, 1962-65 and 1966-69. He concluded that the growth rates of the residual factor productivities were -17 percent for the economy and -52 percent for the non-agricultural sector. He also explained that the growth of the residuals had varied between periods; and 1962-65 period had been the worst offender. However positive growth rates were recorded for the 1966-69. He referred to Leith (1974) too, who used the factor shares approach and obtained a residual of -16 for the economy.

Teal (1998) investigated into firm growth, productivity and convergence of the Ghanaian manufacturing sector for the period 1991-1995. The production function used in the estimation was of the form;

$$y_{it} = \alpha_0 + \alpha_1 k_{it} + \alpha_2 l_{it} + \alpha_3 h_{it} + \text{ sectoral controls} + \text{ ownership controls} + \text{ time dommies}$$

Y_{it} is the log of real value added; k_{it} is the log of the real physical stock, l_{it} is the log of employment and h_{it} is the log of human capital. Lagged values of y_{it} ($y_{i(t-1)}$) was later introduced in the function to test for convergence; if small firms had been growing faster than larger ones. Explanatory values used to determine $y_{i(t-1)}$ were used as instrumental variables on $y_{i(t-1)}$ to determine its real values.

He concluded that real value-added from the sector had grown by 17 percent over the period 1991 to 1995 which implied an annual growth rate of 4 percent. However, the growth had occurred with no increases in productivity. Evidence also compelled him to conclude that there had not been any convergence; there was no significant difference between the sectors in growth rates.

Oteng-Abayie and Frimpong, (2006), investigated into the long-run impact of foreign direct investment and trade on economic growth in Ghana. An augmented production function (*APF*) was used in the form of:

$$\ln Y_t = c + \alpha \ln K_t + \beta \ln L_t + \phi \ln FDI_t + \delta \ln TRP_t + \psi D + \varepsilon_t$$

Where Y_t is real *GDP* per capita, K_t, L_t, FDI_t, and TRP_t are the capital stock, the stock of labour, foreign direct investment inflows and trade respectively. Data span for the study was from 1970 to 2002, and the econometric methodology used was the bounds testing approach to co-integration.

They concluded that the impact of FDI on growth was negative and that was consistent with other past studies. They however found trade to have significant positive impact on growth.

2.6 Conclusion

In this chapter, five empirical literatures on sources of growth have been reviewed. They were all based on production functions and the sources included the traditional inputs of capital and labour.

CHAPTER THREE

THE METHODOLOGY

3.0 Introduction

This chapter introduces and explains the framework used in this research, and components of the models are also explained. The approach in this paper is to estimate directly the rate of growth using an econometric production function. The primal problem is used, therefore not relying on measures of prices. Among the various advantages accruing to the econometric approach is that it recognizes the importance of the role of market power. In general, the econometric framework proceeds by estimating a production function without imposing any restriction. Thus for example, one avoids imposing the relationship between production elasticities and income shares as in other cases.

3.1 The Models

Three models are specified in this section. The first is the general model that is used to identify the production sector. The second model is used to identify the sources of growth, and the third is used to test the convergence of growth of firms.

3.1.1 Model 1: *The Framework*

Growth in output is what is being determined here. There are two distinct sources of growth. The first is input-driven; this is by adding more and more resources into the same production function. Such growth is hard work, and by the law of diminishing returns, cannot be sustained indefinitely. The second is technology-driven; this invokes increasing returns and can be sustained. The growth in output therefore, can be separated into that growth or portion which can be attributed to factor inputs, and that which arises because growth in output exceeds the growth in inputs; this is otherwise referred to as the residual factor productivity, (*RFP*). The residual is regarded as a measure of increased efficiency, that is, a measure of increased productivity per unit of input. It is that portion of growth in output that is not accounted for by the inputs used in the model.

The Solow model is adopted here because of its ability to explain sustained growth in economies when technological progress is introduce as endogenous variable. Unlike the Solow model, it relaxes the assumption of constant returns to scale which pre-supposes a perfect competition. It also avoids the equation of marginal products of inputs to their shares in output due to disequilibrium in factor markets.

A production function relates production inputs (e.g. capital, labour and material) to outputs. The analysis therefore, proceeds by assuming the existence of an aggregate industry production function (F) that relates productive inputs to outputs. In this case, the maximum quantities of outputs Q are related to primary inputs i.e. capital K, labour L, as well as intermediate inputs M. It also contains a parameter A, which represents a measure of technology or otherwise referred to as the efficiency with which factors are used, and finally there is the assumption that the production function is affected by time (t) and the industry (j) in which the firm operates. This is given by the equation below:

[3.1] $$Q_{it} = F(U, K, L, M, A, i, j, t)$$

Technological growth or residual factor productivity *RFP*, as it is often referred to, is not observable. It represents the growth in output that is not accounted for by input growth. There are three ways of introducing technological progress into a production function; these are Harrod-neutral, Solow-neutral and Hicks-neutral. This research uses the Hicks-neutral because of its obvious advantage of not attributing changes in output to any specific input, but to a combination of all inputs. Equation [3.1] is now modified to become;

[3.2] $$Q_{it} = A_{it}F(U_{it}K_{it}, L_{it}, M_{it})$$

Equation [3.2] assumes that there is output-augmenting technical change, in the sense that technical change raises the maximum output that can be produced with a given level of inputs without changing the relationship between them.

At the industry level, output measures do not include only 'final output', but also intermediate inputs produced within the industry that is used internally, therefore, the problem of double counting arises. Economists do agree that output measures at the industry level must be adjusted for intra-industry transactions. Equation [3.2] is therefore modified to become:

[3.3] $$Y_{it} = A_{it}F(U_{it}K_{it}, L_{it})$$

where Y_{it} is real value added output. In equation [3.3], it is assumed that Y_{it} (real value added) is a function of primary inputs with value added augmenting technical change. Real value added Y_{it} is calculated by subtracting purchases of intermediate inputs from the value of real gross output.

Manufacturing refers to industries belonging to the International Standard Industrial Classification (*ISIC*) 15-37, and in Ghana it covers sixteen broad divisions. This implies that output under manufacturing is not homogenous. In order to solve the problem of heterogeneous output aggregation, output is added up in 'constant price' (2000) money values. Therefore in equation [3.3], value added output at any time t is defined as;

[3.4] $$Y_{it} = \sum_{i=1}^{\infty} P_{it} Q_{it} - \sum_{i=1}^{\infty} P_{it}^{M} M_{it}$$

Where P_{it} and P_{it}^{M} are the prices of gross output and intermediate inputs respectively. To arrive at real value added, the single deflation method was adopted, and the 2000 *GDP* deflator was used as a proxy for gross value added output deflator.

In equation [3.3] $K_{it} = K_{it}^{e} + K_{it}^{v}$, where K_{it}^{e} and K_{it}^{v} are the sum of capital stock of equipment and vehicles respectively. Capital services are expressed as a function of the capital stock K_t and the rate of utilization of capital in production U_{it}, thus, $U_{it}K_{it}$. The capital stocks at any particular time (t) are therefore, the outcome of past investment decisions by industry firms and of depreciation due to use according to the following equations;

[3.5a] $$K_{it}^{e} = \sum_{\tau-1}^{\infty}\left(1-d_{it-1}^{e}\right)I_{it-1}^{e}$$

[3.5b] $$K_{it}^{v} = \sum_{\tau-1}^{\infty}\left(1-d_{it-1}^{v}\right)I_{it-1}^{v}$$

Where K_t *is* capital and I_t is investment. In equation [3.5] it is assumed that there is 'time to build', therefore, investment (I), becomes productive with a lag of one period. Technical efficiencies of different vintages of machinery equipment are not considered here. The capital stocks are defined as machinery and transport equipment. This definition of capital stock constitutes the *ISIC* definition for capital groups 382-384.

Labour services can be described in terms of number of employees, N_t. Employees are people who work for a public or private employer and receive remuneration in any form. This is the tabulation category C through F, (*ISIC* revision 3). Labour services L_t , can therefore, be expressed by the following equation;

[3.6] $$L_{it} = \sum_{i=1}^{\infty} N_{it}$$

Labour input here is therefore, measured by size of employment without making any adjustment for the quality of the input, which may be affected by such factors as education, health, housing or security. It is therefore assumed that the quality of labour is homogenous among firms.

Residual factor productivity or technology as it is represented by A_t in equation [3.3] captures the differences in output across firms and over time that is not accounted for by changes in the traditional inputs. It represents the deviations of the actual, observed output growth from the growth rate implied by the growth of factor inputs.

It has been a convention that some researchers adopt the use of Aggregate Production Function (*APF*), this function however, assumes that, along with 'conventional inputs' of labour and capital used in the neo-classical production function, 'unconventional inputs' such as trade, economic liberalization and foreign competition, etc. are included in the model to capture their contributions to economic growth. Lipsey, (2001) however, establishes that the impact of such unconventional inputs on economic growth may possibly operate through *RFP*, (A_t). This research captures some 'unconventional inputs' from *RFP* in order to be able to explain better, the growth in output. These include foreign competition and trade liberalization.

Inserting foreign competition as well as trade liberalization in equation [3.3] and using a Cobb-Douglas production function it can be expressed as:

$$[3.7] \qquad Y_{it} = A_{it}K_{it}^{\alpha}L_{it}^{\beta}EX_{it}^{\delta}IM_{it}^{\gamma}D_{it}^{\lambda}\varepsilon_{it}$$

Where $EX, and\ IM$ are exports and imports of manufactured goods respectively; to represent foreign competition and D is a dummy variable to represent trade liberalization. The trade liberalization variable is to account for the period during which all forms of trade restrictions were removed. $\alpha, \beta, \delta, \gamma$ and λ are elasticity coefficients of output with respect to capital, labour, manufactured exports, manufactured imports and trade liberalization respectively. Equation [3.7] represents the long run equilibrium relationship.

3.1.2 Model II: *Sources of growth Specifications*

From equation[3.7], growth in output is divided into six deferent sources: increases in capital, labour, foreign competition, good trade policies and that part of growth that is not accounted for by the inputs used here, or otherwise referred to as the contribution made by a rise in the efficiency with which inputs are used. The marginal product of an input tells how much output increases when that input increases by one unit. Therefore, when an input, say Z increases by ΔZ units, output increases by approximately $MP_Z \times \Delta Z$. Where MP_Z is the marginal product of the factor Z. Relating this to the variables;

[3.8] $\Delta y = (MP_K \times \Delta k) + (MP_L \times \Delta l) + (MP_{ex} \times \Delta ex) + (MP_{im} \times \Delta im) + \lambda D + (\Delta A/A)$

Equation [3.8] can now be used to relate the growth rate of output y, to the growth rates of the inputs. Lower case letters denote the natural logarithms of the variables with exception of y.

[3.9] $\frac{\Delta y}{y} = c + \left(\frac{MP_K \times k}{y}\right)\frac{\Delta k}{k} + \left(\frac{MP_L \times l}{y}\right)\frac{\Delta l}{l} + \left(\frac{MP_{ex} \times ex}{y}\right)\frac{\Delta ex}{ex} + \left(\frac{MP_{im} \times im}{y}\right)\frac{\Delta im}{im} + \lambda D + \left(\frac{\Delta A}{A}\right)$

It is usually the case that in growth accounting the marginal product of a factor multiplied by that factor, and divided by output is equated to total compensation to that factor. But due to disequilibrium in factor markets, especially in the Ghanaian contest, the researcher allows this portion to be estimated directly. Equation [3.9] therefore takes the form:

[3.10] $$\frac{\Delta y}{y} = c + \alpha\frac{\Delta k}{k} + \beta\frac{\Delta l}{l} + \delta\frac{\Delta ex}{ex} + \gamma\frac{\Delta im}{im} + \lambda D + \frac{\Delta A}{A}$$

Where $\alpha, \beta, \delta, \gamma$ and λ are the elasticities of output with respect to capital, labour, exports, imports and trade policies.

Equation [3.10] is what this study used in the estimation of the growth rate in manufacturing output; there is however, the introduction of a dummy variable (*D*) that caters for the period during which all forms of trade restrictions were removed. Again, there is no data on the contributions made by rises in the efficiency with which inputs are used; therefore, it can be estimated as a residual in the form:

[3.11] $$\frac{\Delta A}{A} = \frac{\Delta y}{y} - c - \alpha\frac{\Delta k}{k} - \beta\frac{\Delta l}{l} - \delta\frac{\Delta ex}{ex} - \gamma\frac{\Delta im}{im} - \lambda D$$

3.1.3 Model III: *Test for Convergence Model*

Many researchers on the Ghanaian economy, such as Riddell (1990), attributed the fall in manufacturing output prior to 1983 to trade restrictions and mostly administrative discretions which favoured large firms over smaller ones. If it were so, it must therefore be expected that during the implementation of the economic recovery program, when these trade restrictions were removed, smaller firms should grow faster relative to larger ones.

This study uses a more formal test based on Gibrat's law of proportional effect to test for convergence. The law hypotheses that firm growth is independent of firm size.

Prais (1976) shows that the use of this law can predict the growth in the degree of concentration in UK firms over the period 1910 to 1970.

In the application of this law to this work the model that results is as follows;

[3.12] $$\Delta y_t = c + \alpha \cdot \Delta k_t + \beta \cdot \Delta l_t + \delta \cdot \Delta ex_t + \gamma \cdot \Delta im_t + \lambda D_t + \omega y_{i(t-1)} + v_{it}$$

The term on $y_{i(t-1)}$ is interpreted as test for convergence. It is the sign and significance of $y_{i(t-1)}$ which is the focus of attention in convergence literature. A positive coefficient explains that the variance of growth rates is either constant or increasing over time, and a negative coefficient implies that smaller firms grow more rapidly than larger ones. Estimation of the coefficient may be bias, and this may come from measurement error in the lagged term. In order to correct this problem, it is instrumented. Instruments which are correlated with the levels of output but not with its growth rates are normally used.

3.2 Data Sources and Expectations of Co-efficients

This section explains the sources of data used in this study and goes on to explain the expected signs of co-efficients.

3.2.1 *Data Sources*

The data covers the years from 1965 to 2006 and are aggregates computed from plant-level data contained in the Quarterly Digest of Statistics (various issues), of the Ghana Statistical Service and the World Development Indicators (2008 tables) of the World Bank. All monetary values are in constant 2000 *US* dollars.

3.2.2 Expectations of Co-efficient

Aggregate capital services are expected to have a positive impact on real output. This is because on a priori grounds the higher the rate of investment, the higher the real level of output. Due to this the co-efficient of capital must correlate positively with the growth of real value added output, i.e.($\propto > 0$).

Aggregate labour services should also be positively correlated with real value added. An increase in labour input should at least not decrease output; it should bring about an increase in real value added. Labour services therefore, must have a positive relationship with the growth of output, i.e. ($\beta > 0$).

The coefficient of lagged values of output y_{t-1}, is expected to be either positive or negative. When positive, the rate of growth of firms with respect to firm size either remains the same or increases over time. When negative, smaller firms grow more rapid in relation to larger firms($\omega \lesseqgtr 0$).

Aggregate manufactured exports breeds' foreign competition; this enables firms to acquire the necessary inputs and technology to increase both output and quality. It enables firms to access broader markets that allow them to increase efficiency in production through competition. It must therefore impact positively on growth of output. It is expected that its co-efficient must relate positively with output growth, i.e. ($\delta > 0$).

Aggregate manufactured imports rather competes with the domestic products, in this wise it suppresses local manufacturing activities. It is therefore, expected that as it increases, growth in domestic value added manufacturing output also decreases. Its coefficient therefore, is expected to be negative, i.e. $(\gamma < 0)$.

3.3 Econometric Methodology

3.3.0 *Introduction*

Many studies on sources of growth have been adopting conventional likelihood approach to cointegration such as Engle and Granger (1987), Johannsen (1988), and Johannsen and Julius (1990). All these approaches require the same order of integration of all variables in the system, $I(1)$ to be specific, which may be hardly satisfied, (MacDonald and Taylor, 1991). The purpose of this research is to fill the gap in the literature by contributing another study for the case of the Ghanaian economy using a state-of-the-art econometric technique, namely, Autoregressive Distributed Lag (*ARDL*) to co-integration. Previous studies on long-run relationship between output growth and input variables, which were conducted based on Engle and Granger (1987), Johansen (1988) or Johannsen-Juselius (1990) cointegration technique, suffer from a number of deficiencies. By using any of the previous techniques, the power of explanation might not be good enough because of the assumption that all variables are $I(1)$. All variables need to be integrated at the same order of one. Also, given the low power of unit root test there will always remain a certain degree of uncertainty with respect to the order of integration of the underlying variables. For this reason, the researcher made use of the bounds testing (or otherwise referred to as Autoregressive Distributed Lag (*ARDL*)) cointegration procedure, which is an econometric technique developed by Pesaran and Shin (1995, 1998); Pesaran et al (1996); and Pesaran et al., (2001), to test for the existence of a level, linear long-run relationship between a dependent variable and a set of regressors when the orders of integration of underlying regressors are not known with certainty.

Additionally, the ARDL approach to cointegration is preferred for the following reasons: firstly, its estimation is simple as compared to other methodologies; once the lag orders of the model are identified, the co-integrated relationship is estimated by the use of *OLS*, and the result covers both the long-run and short-run relationships of the variables tested. Secondly, this research uses annual sample size of 42, and the bounds testing procedure is very efficient in small or finite sample data sizes, especially in testing for long-run relationships among variables; this makes it more appropriate than the Johansen-Juselius multivariate approach, (Pesaran et al. 2001). Lastly, this approach does not require the same order of cointegration, i.e. $I(1)$ of all variables as in the case of Engle and Granger or Johansen-Juselius techniques. Such requirement compels researchers to make assumptions even to the extent of assuming stationary series to be non-stationary, and this bears serious repercussions on coefficient estimates, (Long and Samreth, 2008). Apart from the reasons above, the *ARDL* model requires a priori knowledge or estimation of the order of the extended *ARDL*. This appropriate modification of the orders of the *ARDL* model is sufficient to simultaneously correct the residual serial correlation and the problem of endogenous regressors, (Pesaran and Shin, 1998, p. 386). Additionally, regarding stability issues, Bahmani-Oskooee and Chomsisengphet (2002) examined the money demand function in industrial countries and found that even though there were evidence of co-integration relationships in those selected countries, when incorporating the *CUSUM* (Cumulative Sum of Recursive Residuals) and *CUSUMQ* (Cumulative Sum of Squares of Recursive Residuals) stability test to co-integration procedure, some signs of instability were found in the cases of Switzerland and the UK, (Long and Samereth, 2008). For these reasons, the *ARDL* procedure has become increasingly popular in recent years and this is what the researcher used in the empirical analysis.

3.3.1 *Estimation Model Specification*

The procedure involves the formulation of an unrestricted error-correction model (*ECM*). For example, for regressions of y_i on x_i, the first step involves estimating the following model:

$$\Delta y_t = \alpha_{0y} + \alpha_{1y} \cdot t + \phi y_{t-1} + \delta_1 x_{1,t-1} + \delta_2 x_{2,t-1} + \ldots + \delta_k x_{k,t-1} + \sum_{i=1}^{p-1} \psi_i \Delta y_{1,t-i} + \sum_{i=0}^{q_1-1} \varphi_{1i} \Delta x_{1,t-i} + \sum_{i=0}^{q_2-1} \varphi_{2i} \Delta x_{2,t-i} + \ldots + \sum_{i=0}^{q_k-1} \varphi_{ki} \Delta x_{k,t-i} + \xi_{ty} \qquad [3.13]$$

With ϕ and δ's as long-run multipliers, ψ's and φ's as short-run dynamic coefficients, (p,q) as the order of the underlying *ARDL* model (*p* refers to *y*, *q* refers to *x*), *t*, as a deterministic time trend, *k* as the number of 'forcing variables' and the error term is ξ, which is uncorrelated with the Δx_t and also the lagged values of x_t and y_t. Based on $[3.13]$ the conditional *ECM* pertaining to our variables of interest can be specified as:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{p-1} \psi_{1i} \Delta y_{t-i} + \sum_{i=0}^{q_1-1} \varphi_{1i} \Delta k_{t-i} + \sum_{i=0}^{q_2-1} \varphi_{2i} \Delta l_{t-i} + \sum_{i=0}^{q_3-1} \varphi_{3i} \Delta ex_{t-i} + \sum_{i=0}^{q_4-1} \varphi_{4i} \Delta im_{t-i} + \lambda_1 y_{t-1} + \lambda_2 k_{t-1} + \lambda_3 l_{t-1} + \lambda_4 ex_{t-1} + \lambda_5 im_{t-1} + \lambda_6 D_t + \varepsilon_t \qquad [3.14]$$

Where the lower case letters represent the logarithmic form and λ_i and φ_i are the long-run and short-run parameters respectively, α_0 is the drift and ε_t is white noise or error term.

3.3.2. *Bounds Testing Procedure*

There are two steps in the implementation of the *ARDL* approach to cointegration procedure, (Pesaran and Pesaran, 1997). In the first step, we test for the existence of a long-run relationship between the variables in the system. This is to estimate $[3.14]$ by ordinary least squares (*OLS*) and testing for the existence of long-run relationship among the variables by conducting an *F*-test for the joint significance of the coefficients of the lagged levels of the variables. In this estimation, the coefficients of all lagged values are restricted to be equal to zero. In particular, the null hypothesis of having no integration or long-run relationship among variables in the system, which has a testable form of:

$[3.15a]$ $\quad H_0: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = 0,$

this is tested against the alternative hypothesis of:

$[3.15b]$ $\quad H_1: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq \lambda_6 \neq 0,$

by judging from the *F*-statistics. The distribution of *F*-statistic here, is non-standard irrespective of whether the variables in the system are *I*(0) or *I*(1), we therefore use appropriate critical values of *F*-statistics that is reported in Pesaran and Pesaran (1997), and Pesaran et al. (2001), for different number of regressors (five in this case), and whether the *ARDL* model contains intercept and/or trend terms. The test which normalizes on y is denoted by $F_y\left(y \mid k, l, ex, im, D\right)$. Pesaran and his co-authors provide two sets of asymptotic critical values; one set assuming that all the regressors are $I(1)$; and another set assuming that they are all $I(0)$. These two sets of critical values provide a band covering all possible classifications of regressors into $I(0)$, $I(1)$ and (fractionally integrated or even mutually cointegrated). Values of the calculated F-statistics above the appropriate upper level of the band indicate rejection of the null of no cointegration, whereas values below the lower level of the band support the conclusion of no cointegration. If however it lies within the lower and upper critical values, the result is inconclusive; in this case, following Kremers, et al. (1992) and Bannerjee et al. (1998) the error correction term will be a useful way of establishing cointegration.

3.3.3 *Long-run Estimation*

Once the existence of the co-integration between variables is confirmed, the conditional *ARDL* $(p_1, q_1, q_2, q_3, q_4)$ long-run model for y_t can be estimated. The conditional *ARDL* long-run model can be estimate as:

[3.16] $$y_t = c_0 + \sum_{i=1}^{p} \lambda_1 y_{t-i} + \sum_{i=1}^{q_1} \lambda_2 k_{t-i} + \sum_{i=0}^{q_2} \lambda_3 l_{t-i} + \sum_{i=0}^{q_3} \lambda_4 ex_{t-i} + \sum_{i=0}^{q_4} \lambda_5 im + \lambda_6 D_t + \varepsilon_t$$

where $_i$ are the long-run parameters and ε_t is white noise.

3.3.4 *Short-run Estimation*

In the second step the short-run model is estimated. The appropriate short-run model can be estimated as:

[3.17]

$$\Delta y_t = \beta + \sum_{i=1}^{p} \psi_i \Delta y_{t-i} + \sum_{i=1}^{q_1} \varphi_{1i} \Delta k_{t-i} + \sum_{i=1}^{q_2} \varphi_{2i} \Delta l_{t-i} + \sum_{i=1}^{q_3} \varphi_{3i} \Delta ex_{t-i} + \sum_{i=1}^{q_4} \varphi_{4i} \Delta im_{t-i} + \vartheta ecm_{t-1} + \varepsilon_t$$

Where ψ_i and φ_i are the short-run dynamic coefficients of the model's convergence to equilibrium. ϑ is the speed of adjustment.

In the final stage of the ARDL methodology the tests for stability of coefficients estimated is conducted. Both the Cumulative Sum of Recursive Residual (CUSUM) and the Cumulative Sum of Squares of Recursive Residuals (CUSUMQ) are used. In both plots, the graphs should lie within the 5% level of significance for coefficients estimated to be said to be stable.

3.4 Impulse Response and Variance Decomposition

For further inferences, The researcher adopted an innovation accounting by simulating variance decompositions (*VDC*) and impulse response functions (*IRF*). *VDC* and *IRF* serve as tools for evaluating the dynamic interactions and strength of causal relations among variables in the system. The *VDC* indicate the percentages of a variable's forecast error variance attributed to its own innovations and innovations in other variables. Therefore, the *VDC* can measure the relative importance of capital, labour, exports and imports fluctuation in the growth of manufacturing. Also the *IRF* traces the directional responses of a variable to a one standard deviation shock of another variable. This implies that one can observe the direction, magnitude and persistence of growth in manufacturing to variation in capital, labour, exports and imports.

3.5 Conclusion

The discussions contained in this chapter provide the basis for assessment and evaluation of available data obtained, the analysis of which is discussed in the next chapter, chapter four.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Introduction

This chapter presents the results and discussions of the estimated co-efficients. It starts with the presentation of the unit roots results and followed by co-integration tests. Both the long-run and short-run results are also presented. It closes with further inferences from the use of impulse response function and variance decomposition.

4.1 Tests for Unit Roots

Even though the *ARDL* framework does not require pre-testing of variables to be done, the unit root test could also convince us whether or not the *ARDL* model should be used. The lagged orders are then selected to help in the tests for co-integration and presentation of the short-run model. It is therefore, advisable to take a glance at a pictorial presentation of the variables shown in Figure 4.1. From the figure, with exception of growth in manufacturing value added all other variables seem to be trending. While both capital and labour trend downwards, both exports and imports do trend upwards. Tests for stationarity are therefore, essential, this will provide evidence of whether some variables are $I(2)$ in order to prevent the use of the model to provide spurious results.

Figure 4.1 Graphical Presentations of Variables in levels

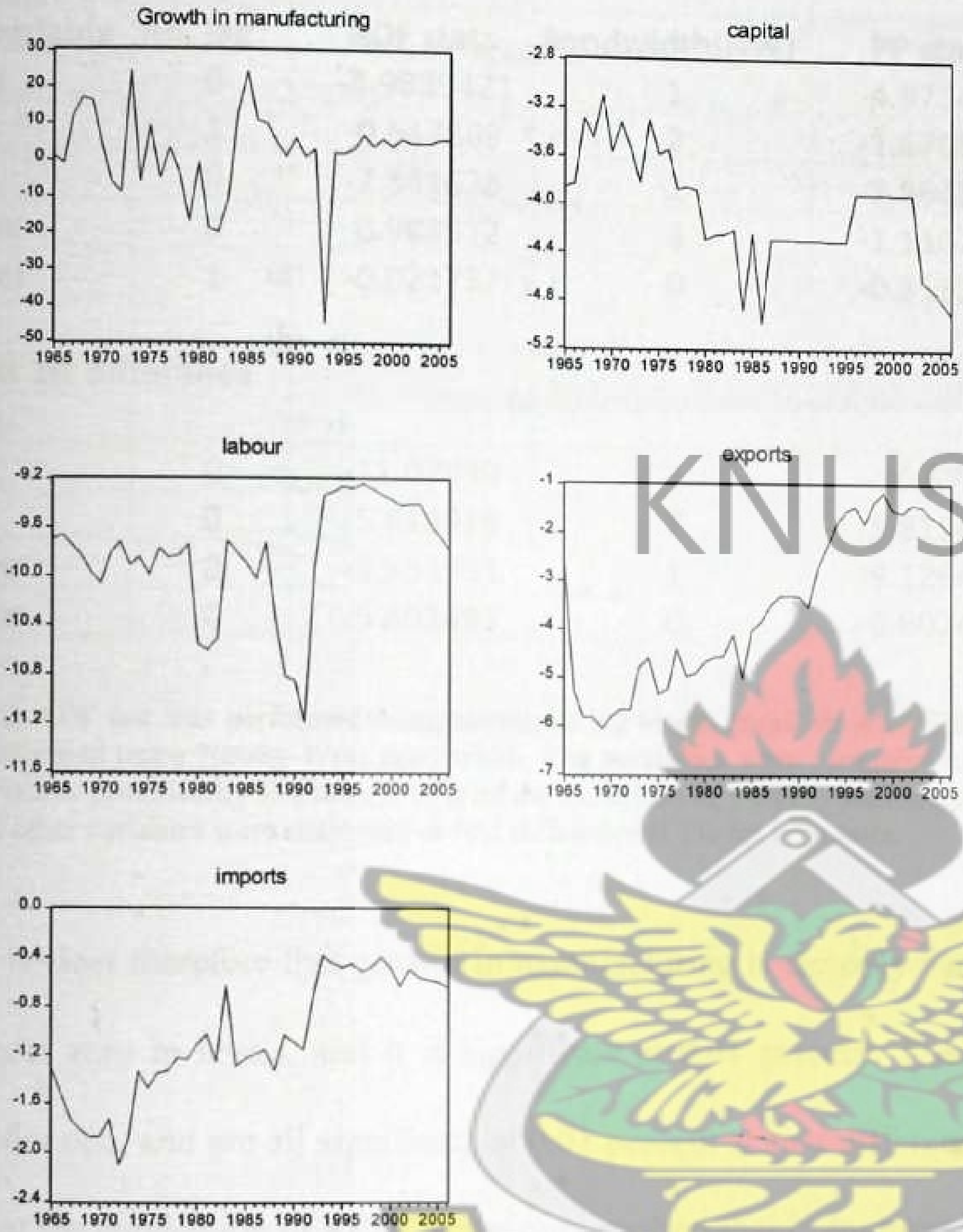


Table 4.1 shows a test of stationarity status of the variables using the Augmented Dicky Fuller based on *AIC* and confirmed by Phillips-Perron using the Newey-West bandwidth.

Table 4.1 ADF and PP unit root tests on variables.

Log (Z) i.e. at levels					
variable	AIC lag	ADF stats	Bandwidth(NW)	PP stats	$I(d)$
y	0	-4.9889421	1	-4.975402	$I(0)$
k	1	-0.647869	2	-1.670836	
l	0	-2.341628	2	-2.564544	
ex	0	-0.988522	3	-1.110241	
im	1	-0.021737	0	-0.353361	
At 1st difference					
y					$I(0)$
k	0	-11.07439	2	-10.6766	$I(1)$
l	0	-5.613916	7	-5.818455	$I(1)$
ex	0	-8.531951	1	-9.128408	$I(1)$
im	0	-6.602493	0	-6.602493	$I(1)$

The ADF test was performed using automatic lag length based on AIC. The Phillips-Perron test was also performed using Newey-West band width. The t-statistics were compared to Mackinnon (1996) one-sided p-values provided by E-Views 5.1. With the exception of y that is stationary in levels for both tests at 1%, all other variables were stationary at first difference at 1% for both tests.

It is clear therefore that growth in manufacturing is the only variable that is integrated of order zero in levels, and it is significant at 0.01 percent. The rest are all integrated of order one, and are all significant at 0.01 percent at first difference. It is therefore, evident that the application of *ARDL* is the only method that is appropriate.

4.2 Test for Co-integration

4.2.1 Bounds Tests for Co-integration

Once the stationarity status of variables have been ascertained; the variables are either $I(0)$ or $I(1)$ stationary. The researcher proceeded therefore, with the *ARDL* approach. Based on the small sample size and annual observations, the lag orders of the variables were selected using the Schwarz Criterion and a maximum lag length of 2, as suggested by Pesaran and Shin (2009) and Narayan (2004). It is always better to use the criterion with the least order of lags, (E Views 5.1). Although most researchers recommend the use of the Akaike Information Criterion, from the researcher's own observations, or for this series in particular, the *SC* gives more stable coefficient estimates than the Akaike Information Criterion.

The bounds testing procedure is based on the *F* or Wald-statistics and is the first stage in the *ARDL* cointegration method. The researcher then went ahead to test for the existence of long-run relationships among the variables by testing the hypothesis in [3.15] using equation[3.14]. The *F*-statistic test for the joint null hypothesis that the coefficients of the lagged level variables are zero (i.e. no long-run relationship exists between them) is presented in table 4.2.

Table 4.2 reports the results of the calculated *F*-statistics when each variable is considered as a dependent variable (normalized on) in the *ARDL-OLS* regression. All what is needed from this table is the *F* calculated which must be compared to the upper boundary of the Pesaran upper boundary, in order to identify if co-integration exists. The calculated *F*-statistic $F_y(y|ka, la, ex, im, D)$ of 5.934366 is higher than the upper bound critical value of 4.43 at 1 percent given by Pesaran, Shin and Smith, (2001, table). All other variables used as dependent variables were rejected at the 10 percent level, indicating they are exogenous variables. This result supports the direction of long-run (co-integration) relationship when growth of output is used as a dependent variable. It also indicates that the null hypothesis of no long-run relationship can be strongly rejected.

Table 4.2 Results from bounds tests on equation 3.14

Dependent variable	F-statistic	Probability	Outcome
$F_y(y\| k, l, ex, im, D)$	5.429563***	0.0002	Co-integration
$F_k(k\| y, l, ex, im, D)$	1.936067	0.075	No co-integration
$F_l(l\| k, y, ex, im, D)$	1.438161	0.0211	No co-integration
$F_{ex}(ex\| k, l, y, im, D)$	2.340539	0.033	No co-integration
$F_{im}(im\| k, l, ex, y, D)$	2.389380	0.029	No co-integration

***significant at 1% level, **significant at 5 percent level and * significant at 10% level.

Asymptotic critical value bounds are obtained from Table CI (iii) Case III: unrestricted intercept and no trend for k = 6 (Peseran, Shin and Smith, 2001). Lower bound $I(0) = 3.41$ and Upper bound $I(1) = 4.68$ at 1% significance level.

4.2.2 Granger Causality Test

An alternative measure is also employed to confirm the direction of co-integration. This is the *VAR* Granger Causality Test. This test provides a measure of testing whether an endogenous variable can be treated as exogenous. From the results two endogenous variables are identified as opposed to only one variable identified by the *ARDL* approach. These variables are the growth of manufacturing (*y*) and exports (*ex*), both of which have probabilities of 0.05 each. This however, confirms that manufacturing growth rates can be used as endogenous variable.

4.3 Long-run Coefficients Estimation

Once it has been established that a long-run relationship exists, the researcher proceeded to estimate equation [3.16] using the estimated *ARDL* lag lengths of $(p,q_1,q_2,q_3,q_4) = (0, 2,1,1,1)$. The results are reported in Table 4.3.

Table 4.3 The long-run estimation results

Dependent variable is y_{t-1}

Dependent Variable: (y_{t-1})	Independent Variables					
	c	k_t	l_t	ex_t	im_t	D
	22.99498 (32.82545)	1.688510 (3.306005)	4.157154 (3.734459)	4.634609 (2.778389)	-31.69108** (11.90296)	15.63304*** (5.178243)

Note: 1 standard errors in parenthesis

2 ***significant at 1% level, **significant at 5 percent level and * significant at 10% level

The results indicate that the dummy variable representing economic liberalization has a positive and statistically significant impact on the growth of manufacturing firms. This is the evidence of the important role played by the trade regime switches of 1983 on the growth of manufacturing firms in Ghana. This means that emphasis on good trade policies has the potential to induce growth within the sector. The coefficient of imports as proxied by the share of imports in total demand for manufactured goods also has the expected negative sign and has statistically significant impact on the growth of manufacturing. The coefficient of imports is high but negative and this implies that all other related things being equal, a unit decrease in imports have the tendency to increase growth by about 3,169 percent. This result emphasizes the high costs of importation of machinery and transport equipment in their finished states, instead of the establishment of assembly plants to reduce such costs.

The contributions of aggregate traditional inputs of capital and labour towards the growth in manufacturing are not statistically significant although they possess their expected signs. Capital is a very good contributor to growth in most researches. Oteng-Abayie and Frimpong (2006), found aggregate physical capital to be significant in the Ghanaian context, but Teal (1998), in the manufacturing sector and *ISSER* (2000) in the industrial sector did not find physical capital to be statistically significant. All the above quoted research works never found aggregate labour to be significant. Oteng-Abayie and Frimpong (2006) even had a negative coefficient for labour. There are several factors that may contribute towards the insignificant contribution of aggregate labour in the Ghanaian economy; the most pronouncing may be due to low compensation, which breeds job dissatisfaction. Once workers are not happy with their jobs they do not work efficiently. Another is the conditions of service of workers. When workers are not satisfied with their conditions of service they frequently leave jobs. This affects the conditions with which they perform particular tasks, since there is the absence of learning by doing the same tasks. This effect on the contribution of labour may adversely affect capital with which labour works with. Teal (1998) found that average job creation and destruction within the Ghanaian manufacturing sector were 11 percent and 7.2 percent annually, respectively. The 7.2 percent rate of job destruction within the manufacturing sector is too high for labour to learn on particular tasks.

The statistically insignificance of capital's contribution towards growth may be attributed to the rate of capital acquisition. Given the rate of technological advancement, capital might be acquired so rapid that labour has no sufficient time to work with particular capital to gain experience with its use before the acquisition of new capital. Exports, which is proxied with the share of exports in total manufacturing value added, also has the exported positive sign but it is not significant. This is an indication that no new manufacturing firms have entered the export business apart from the traditional aluminum and processed wood firms.

The results of the short-run dynamic coefficients associated with the long-run relationships obtained from the *ECM* in equation [3.17] are presented in Table 4.4. With exception of imports all other signs have changed. And none of the regressors is significant. However, the error correction term (ecm_{t-1}) has the right negative sign and significant at 5 percent level, and this is the most essential.

4.4 Estimation of Short-run Coefficients

Table 4.4 Error correction representation for the selected ARDL model

ARDL(0,2,1,1,1,) selection based on SC. Dependent variable is Δy_t

Dependent variable Δyt	
Independent variables	**Coefficients**
Constant	9.500989** (2.140503)
Δk_t	-8.136126 (1.105323)
Δk_{t-1}	-2.201598 (-0.378637)
Δk_{t-2}	3.769231 (0.526917)
Δl_t	-5.946185 (-0.861334)
Δl_{t-1}	3.115963 (0.250763)
Δex_t	-1.501524 (-0.220042)
Δex_{t-1}	-5.878757 (-0.923516)
Δim_t	-9.622019 (0.855709)
Δim_{t-1}	-9.559658 (-0.637194)
ecm_{t-1}	-0.616773** (-2.507871)
Note: t-statistic in parenthesis	
Diagnostic tests	
R-squared 0.412590	
F-statistic 1.966686 (0.077423)	CBT 2.082808 (0.084358)
D-W 2.084573	Kurtosis 3.290379
B-God 4.438724 (0.021957)	JB 0.4737127 (0.803672)
R-set 0.075161 (0.786052)	
Note: p-values in parenthesis	

Note :

1. $ecm = y_t - 2299498 - 1.688510*ka - 4.151154*la - 4.634609*ex + 31.69108*im - 15.63304*D$
2. D-W is Durbin Watson statistic, CBT is the F-statistic of Chow-Breakpoint test, JB is the Jarque-Bera normality test statistic, B-God is the F-statistic of Breusch-Godfrey serial correlation LM test and R-set is the F-statistic of Ramsey RESET test.
3. ***significant at 1% level, **significant at 5 percent level and * significant at 10% level

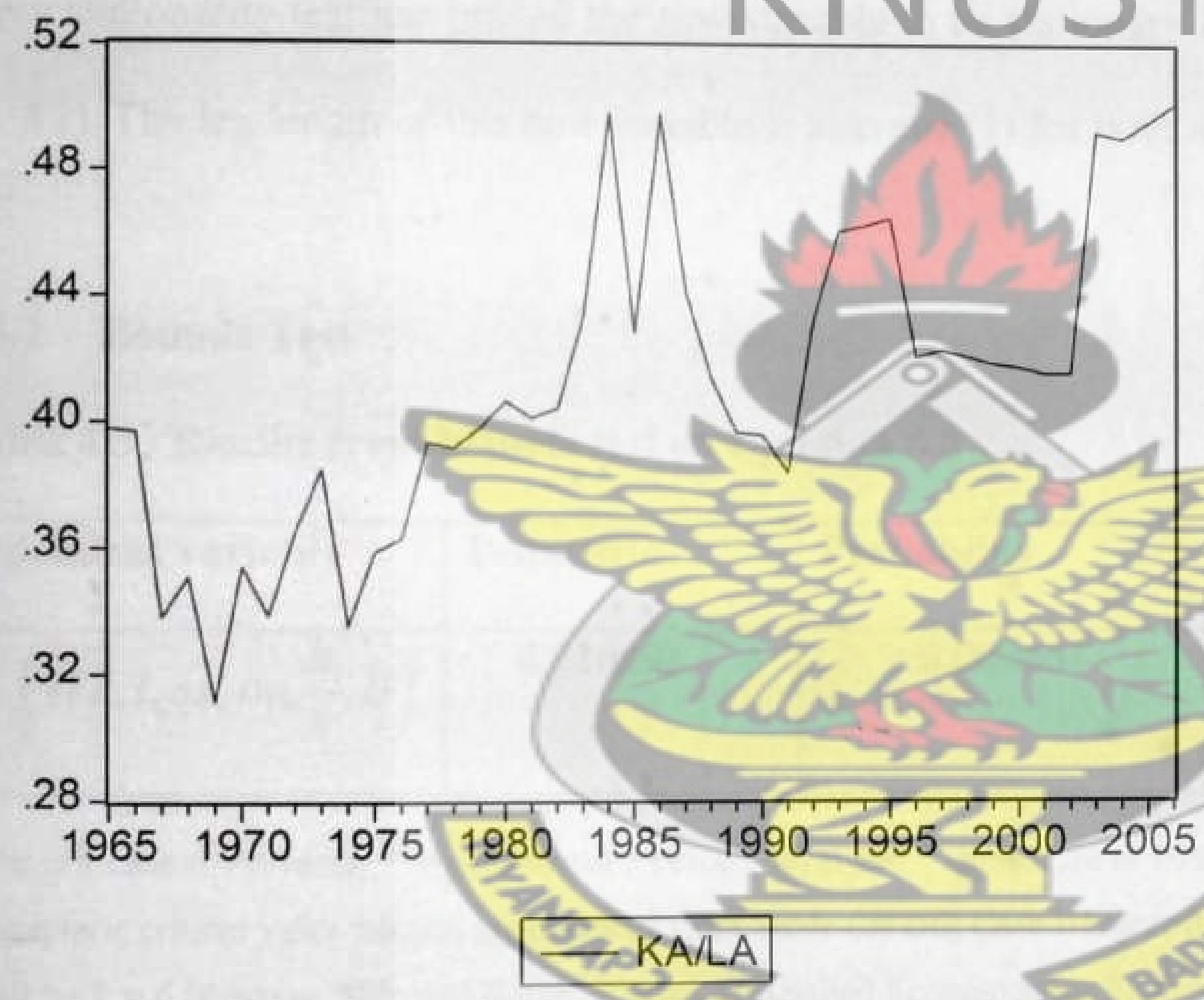
Although variables do not seem to be contributing in the short-run, the equilibrium error correction coefficient (ecm_{t-1}) estimated at -0.616773 with a probability value of 0.0182 is significant at 5% level. Bannerjee et al. (1998) explains that it is the evidence of cointegration relationship among variables in the model. The speed of adjustment to the long-run shocks of the previous period is 61 percent. Approximately 61 percent of disequilibria from the previous year's shock converge back to the long-run equilibrium in the current year. With exception of the constant and error correction term all co-efficient are insignificant. The constant term in this research reinforces the findings of some researches such as *ISSER* (2002), that growth in the industrial sector cannot be attributed to increases in inputs but to residual factor productivity.

From Table 4.4 the coefficient of determination is 0.412590, this implies that the overall goodness of fit of the ARDL model is good. Also from the results all regressors collectively help to explain variations in the dependent variable. Again from the diagnostic test results (Table 4.4), the short-run model passes the functional form misspecification, non-normal errors and serial correlation tests at 5 percent. All these indicate that the model is well specified.

4.5 Capitals-Labour Ratio

The study proceeded to inquire into the relationship between capital and labour, their behavior in the model and why they are normally not significant in aggregate Ghanaian models. Capital-labour ratio (*k/l*), defined as capital per labour was introduced in the model. This was used as a proxy for capital intensity; the rate at which capital is combined with and used by labour. In other words the amount of capital with which labour works with. The ratio of capital to labour was first used as an explanatory variable in a growth model by Solow (1956), and that was the first time increasing capital intensity was distinguished from technological progress. Leung, (1996), applied it in the estimation of sources of growth in the Newly Industrialized Asian economies. This ratio is presented graphically in Figure 4.2; in order to study its behaviour.

Figure 4.2 Capital-Labour Ratio



The graph trends upwards, showing lower levels from 1965 to 1978, beyond which it starts to trend upwards. Very high trends between 1983 and 1987 may be attributed to the redeployment exercise during the economic recovery programme. The stable period between 1996 and 2003 marked the period of manufacturing growth that induced Ghanaian policy makers to subscribe to the millennium development goals and planned to usher the economy into a middle income status by the year 2020.

4.5.1 Introducing Capital-Labour Ratio

Introducing the capital-labour ratio (*k/l*) into the general model of equation [3.7] we have:

$$[4.0] \quad Y_{it} = A_{it}K_{it}^{\alpha}L_{it}^{\beta}EX_{it}^{\delta}IM_{it}^{\gamma}\frac{K}{L}_{it}^{\vartheta}D_{it}^{\lambda}\varepsilon_{it}$$

Where all variables are as defined earlier, and lower case letters denoting the variables in their logarithmic forms as have been explained earlier. Using this new model implies going through all the previous *ARDL* steps. The graph in Figure 4.2 has shown a trend and a stationarity test has proved the new variable to be stationary at the first difference, i.e. *I*(1). The lag length of this new variable is also one (1) for both *AIC* and *SC*.

4.5.2 Bounds Test

Table 4.5 Results from bounds test on equation 4.0

Dependent variable	F-statistic	Probability	Outcome
$F_y\left(y\mid k, l, ex, im, \frac{k}{l}, D\right)$	4.916998^{***}	0.000461	Co-integration

***significant at 1% level, **significant at 5 percent level and * significant at 10% level.
Asymptotic critical value bounds are obtained from Table CII (iii) Case III: unrestricted intercept and no trend for k = 6 (Pesaran, Shin and Smith, Journal of Applied Econometrics, J. Appl. Econ. 16: 289-326 (2001), p.300. Lower bound *I* (0) = 3.15 and Upper bound *I* (1) = 4.43 at 1% significance level.

From table 4.5, *F*-statistic of 4.916998 is greater than the upper bound of 4.43; cointegration therefore, exists among the variables when the equation is normalized on *y*. The long-run coefficients can therefore, be estimated.

4.5.3 Long-run Coefficients Estimation

Table 4.6 The long-run estimated results including *k/l*

Dependent variable is y_t

Dependent Variable (y_t)	Independent Variables						
	C	k_t	l_t	ex_t	im_t	k/l_t	D
	42.61553 (44.40203)	-0.378144 (4.614529)	5.282128 (3.771380)	4.264482 (2.935893)	-29.73227** (13.58756)	-40.09098 (65.77106)	16.44950*** (5.039720)

Note: 1 standard errors in parenthesis
2 ***significant at 1% level, **significant at 5 percent level and * significant at 10% level

Two variables are significant; imports which is significant at 5% and the dummy variable which is also significant at 1% level. This result is comparable to equation [3.16], the long-run model without capital per labour, where only these two variables are significant and possess the same level of significance. Capital-labour ratio does not possess the expected positive sign and it is at the same time not significant. This is an indication of under capacity utilization of existing plants, machines and vehicle equipment within the manufacturing sector. A difference between the estimation with and that without capital-labour ratio is that capital has a negative coefficient in the estimation of the model with capital-labour ratio. The implication here is that capital is in uneconomically large quantities. Therefore it pays to either decrease or improve upon the usage of capital to improve upon the significance of capital per labour ratio. It may also be the case that capital is acquired so rapid that labour has no sufficient time to learn on it. The error correction term of this model needs examination before any meaningful inferences and comparisons of the two models could be done.

4.5.4 Estimation of Short-run Coefficients

Table 4.7 Error correction representation for ARDL model

ARDL(0,2,1,1,1,1) selection based on SC. Dependent variable is Δy_t

Dependent Variable: Δy_t	
Independent variables	**Coefficients**
Constant	-2.677736 (-1.147314)
Δk_t	98.94574 (0.432559)
Δk_{t-1}	-1.911080 (-0.273423)
Δk_{t-2}	5.502848 (0.613139)
Δl_t	109.8674 (1.467853)
Δl_{t-1}	-151.6947 (-1.679367)
Δex_t	-1.863980 (-0.316165)
Δex_{t-1}	-4.262130 (-0.612408)
Δim_t	-6.596466 (-0.681880)
Δim_{t-1}	-11.45303 (-0.815089)
$\Delta k/l_t$	-2918.596 (-1.572120)
$\Delta k/l_{t-1}$	3935.937* (1.775708)
ecm_{t-1}	-0.510548*** (-2.927343)
Note: t-statistic in parenthesis	
Diagnostic tests	
R-squared	0.515474
F-statistic	2.305061 (0.036334)
D-W	2.042567
B-God	2.745602 (0.084377)
CBT	2.436053 (0.060547)
R-set	0.000498 (0.982367)
Kurtosis	2.310689
JB	2.067487 (0.355673)
Note: p-values in parenthesis	

Note :1. $ecm = y_t - 42.61553 + 0.378144*ka - 5.282128*la - 4.264482*ex + 29.73227*im + 40.09098*k/l - 16.44950*D$

2. D-W is Durbin Watson statistic, CBT is the F-statistic of Chow-Breakpoint test, JB is the Jarque-Bera normality test statistic, B-God is the F-statistic of Breusch-Godfrey serial correlation LM test and R-set is the F-statistic of Ramsey RESET test.

3. ***significant at 1% level, **significant at 5 percent level and * significant at 10% level

Both labour and capital have the right signs but their lagged values do not. Imports and its lag have their right signs. However, none of the inputs is significant apart from the lag of capital per labour and the error-correction term. The implication here is that the only explanatory variable that contributes towards the correction of disequilibria from previous years shock is the value of previous year's capital per labour. This is an indication of how capital intensity is vital towards the growth of manufacturing.

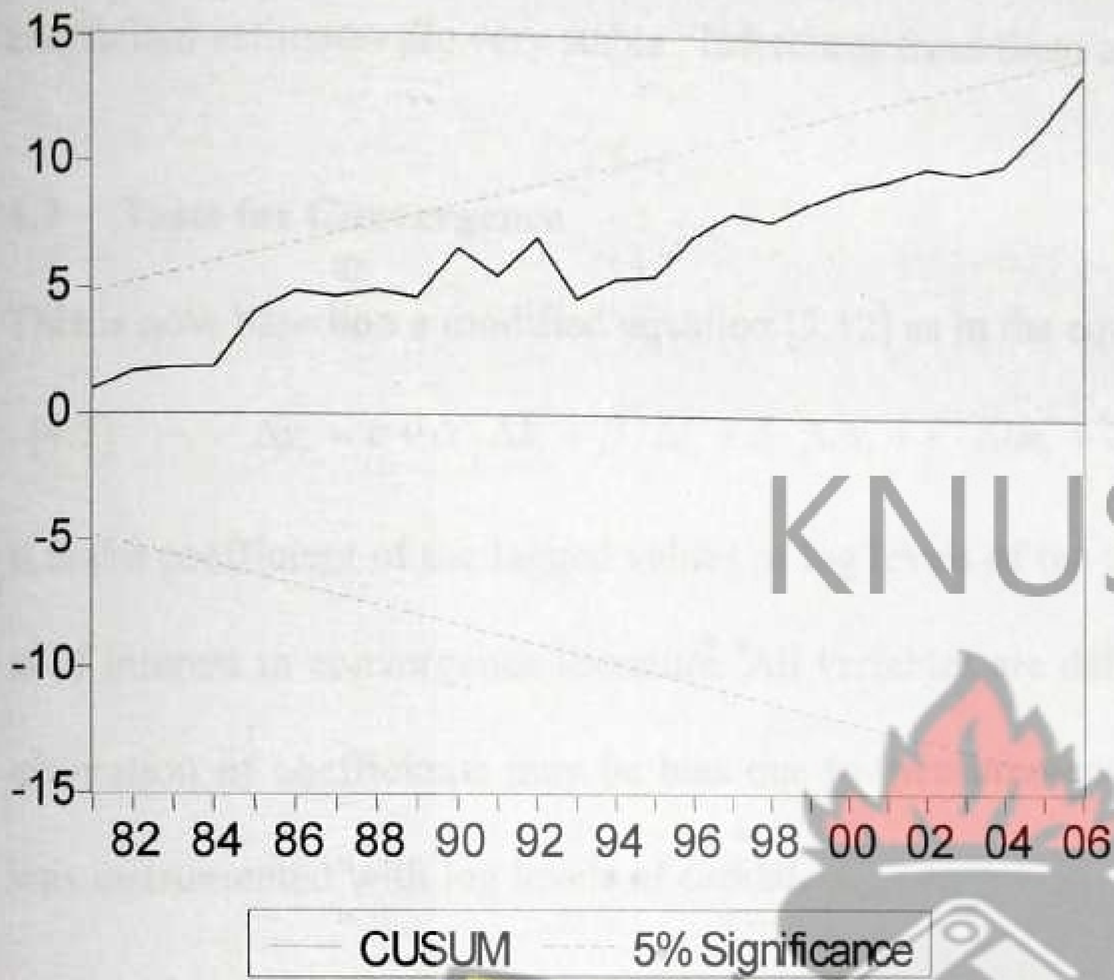
The error-correction term is significant at 1% level, as compared to the previous model with 5% level of significance. In this new model R-squared has improved from 0.41259 to 0.515474. *F*-statistic which was significant at 8 percent level is now significant at 5 percent; all these improvements in the diagnostic tests emphasize the relevance of the introduction of capital per labour in the model. In the first model serial correlation is at 5% level of significance, while in the second model the null hypothesis of serial correlation is rejected at 5% level of significance. Ramsey's tests for both models reject the null of incorrect functional form specification at the 5% level. From the above analysis, the second model, therefore, is better specified than the first. The model with capital per labour as an explanatory variable is preferred to the first; therefore the study continues the rest of the discussions with the second model i.e. equation [4.0].

4.6 Tests for Stability

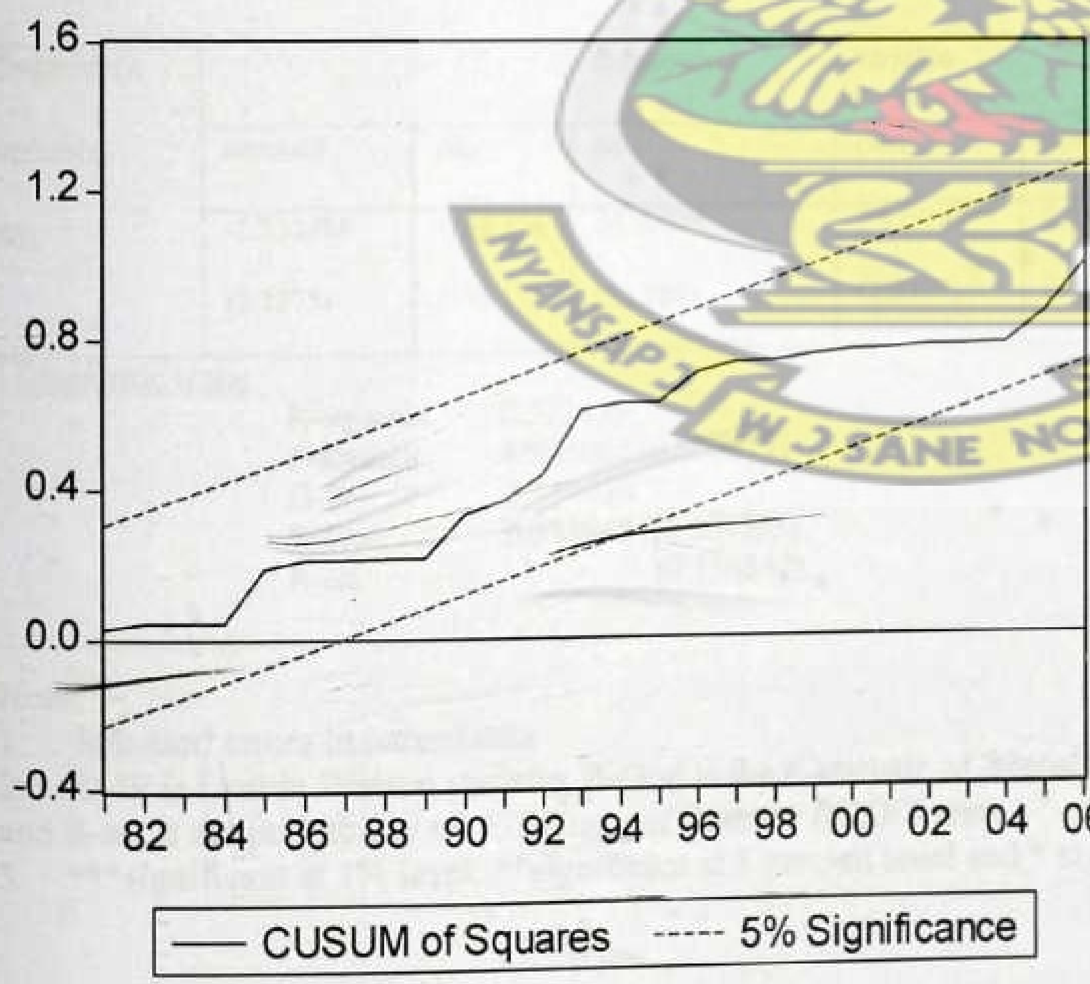
The final stage in the *ARDL* approach is the tests for stability of coefficient estimates. These tests involve the plotting of the Cumulative Sum of Recursive Residuals and the Cumulative Sum of Squares of Recursive Residuals. These are plotted in Figure 4.3 below.

Figure 4.3 CUSUM and CUSUMQ Plots of Stability

Plots of Cumulative Sum of Recursive Residual



Plot of Cumulative Sum of squares of Recursive Residual



All the two graphs lie within 5% level of significance. The *CUSUMQ* however shows a very high stability in coefficient estimates. Based on these it can be concluded that coefficient estimates are very stable. Inferences from them are very reliable.

4.7 Tests for Convergence

This is now based on a modified equation [3.12] as in the equation below:

$$\Delta y_t = c + \alpha \cdot \Delta k_t + \beta \cdot \Delta l_t + \delta \cdot \Delta ex_t + \gamma \cdot \Delta im_t + \varnothing \cdot \Delta k / l_t + \lambda D_t + \omega y_{i(t-1)} + v_{it} \qquad [4.5]$$

It is the coefficient of the lagged values of log levels of the dependent variable, y_{t-1} which is of interest in convergence literature. All variables are defined as previously. Since the estimation of coefficients may be bias due to measurement errors in the lagged term, it was instrumented with log levels of capital.

Table 4.8 A Test for Convergence

Dependent variable	Independent variable							
	constant	Δk_t	Δl_t	Δex_t	Δim_t	$\Delta k/l_t$	D_t	y_{t-1}
Δy_t	-1.333984 (2.8975)	-156.376 (175.17)	56.70675 (72.388)	5.075147** (2.0393)	0.25963 (4.6595)	-1519.43 (1712.4)	4.1795 (3.756)	-0.7241*** (0.1170)

Diagnostic tests:

R-squared	0.512459
F-statistic	4.805065 (0.000879)
D-W	2.154930
B-God	0.573649 (0.569525)
R-set	(0.556547)

Note:

1. Standard errors in parenthesis
2. D-W is Durbin Watson statistic, B-God is the F-statistic of Breusch-Godfrey serial correlation LM test and R-set is the probability of *F*-statistic of Ramsey RESET test.
3. ***significant at 1% level, **significant at 5 percent level and * significant at 10% level

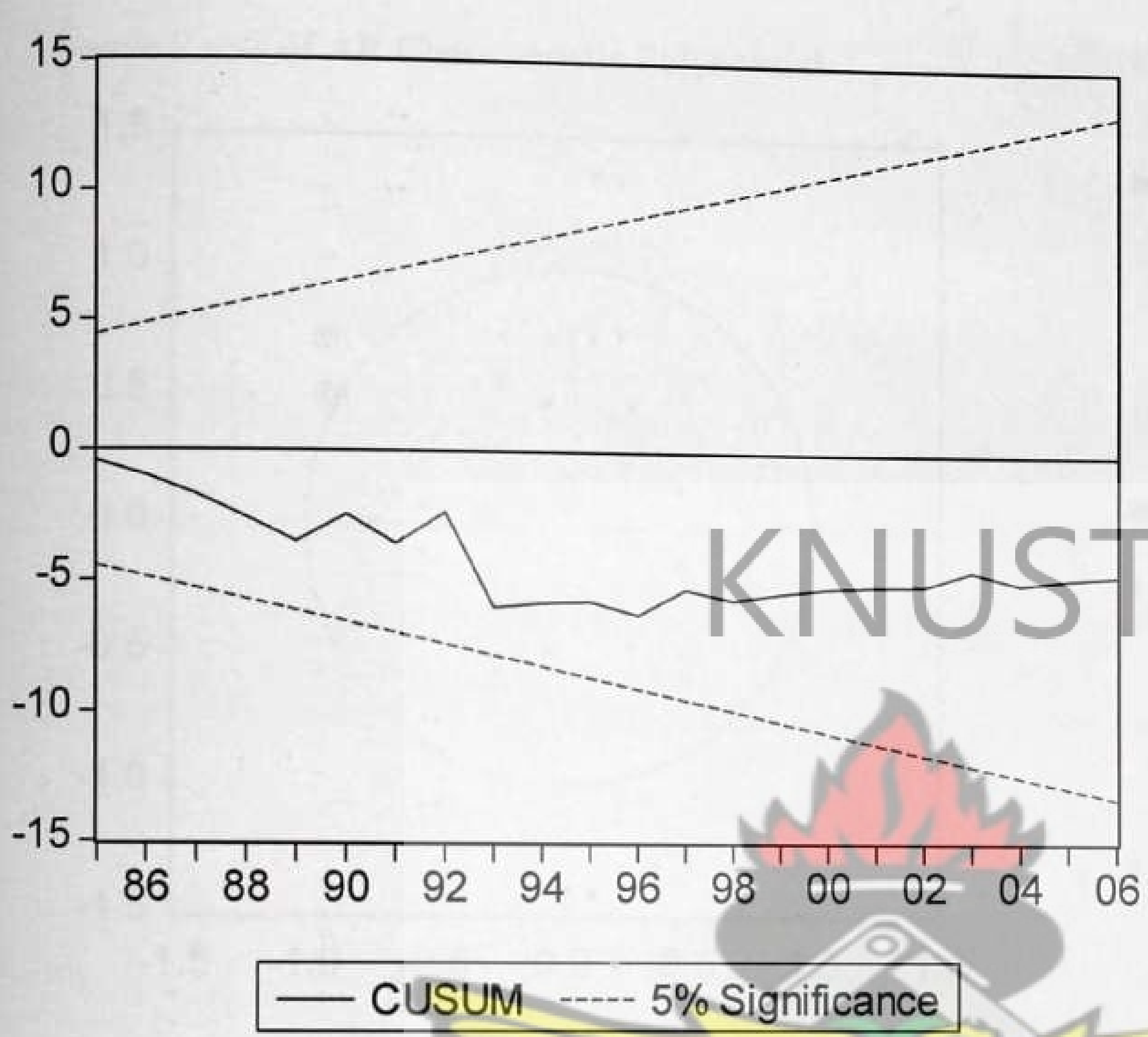
This is a good instrument because the log levels of capital do correlates with manufacturing output but not with its growth rates. Table 4.8 is a presentation of the estimation of equation [4.5]. About 51% of total variations in the dependent variable is explained by the explanatory variables. Collectively all the explanatory variables help to explain total variations in the dependent variable as indicated by the probability of the *F*-statistic. From B-God there is no higher level serial correlation, and the Ramsey Reset Test also rejects the null of incorrect functional form specification. Therefore, the function is well specified.

The negative value of the coefficient of the lagged values of log levels of the dependent variable shows convergence in growth of firms. It is also significant with very high probability. It can, therefore, be concluded that there is evidence of convergence among Ghanaian manufacturing firms over the sample period. On the contrary, Teal (1998) examined the growth and convergence within the Ghanaian manufacturing sector from 1991 to 1995 and found no evidence of convergence. It may however, be tempting to conclude that the removal of government interference after 1983 has not helped in the growth of smaller firms. This was due to the fact that the large manufacturing *SOE's* were previously not efficient themselves; an example was the Tema Food Complex Corporation. Therefore once they were privatized they got into the hands of multilateral, bilateral and other entrepreneurs' with requisite technologies, capital and expertise to make those firms more productive than before. Smaller firms also grew faster than previously, after the removal of administrative discretions. *GCS* (1994) reported that between 1986 and 1990, out of 621 projects approved by the Ghana Investment Center to assists in creating new enterprises, 441 were in the manufacturing sector. These firms were mostly medium sizes, therefore, helped the growth of medium size firms, since their establishment involved foreign capital, requisite technology and expertise; their presence rather increased the growth of medium size firms. Small size firm, also taking the advantage of the removal of administrative discretions were able to import raw materials and other machinery equipment. If there are any productivity spillovers, they might also have taking advantage of. Therefore, it is possible for the variance of the mean of growth rates of firms to decrease over time. This is also a confirmation of the results of the Chow's Breakpoint Test that there have been some structural changes within the economy of Ghana after 1983.

4.7.1 Stability of Convergence Coefficients

In verification of how stable the coefficients in Table 4.7 are, the Cumulative Sum of Recursive Residuals is used. This is presented in table Figure 4.4. Since the graph lies within the 5% level of significance, coefficients estimated are stable. Therefore they are reliable, and can be used in forecasting.

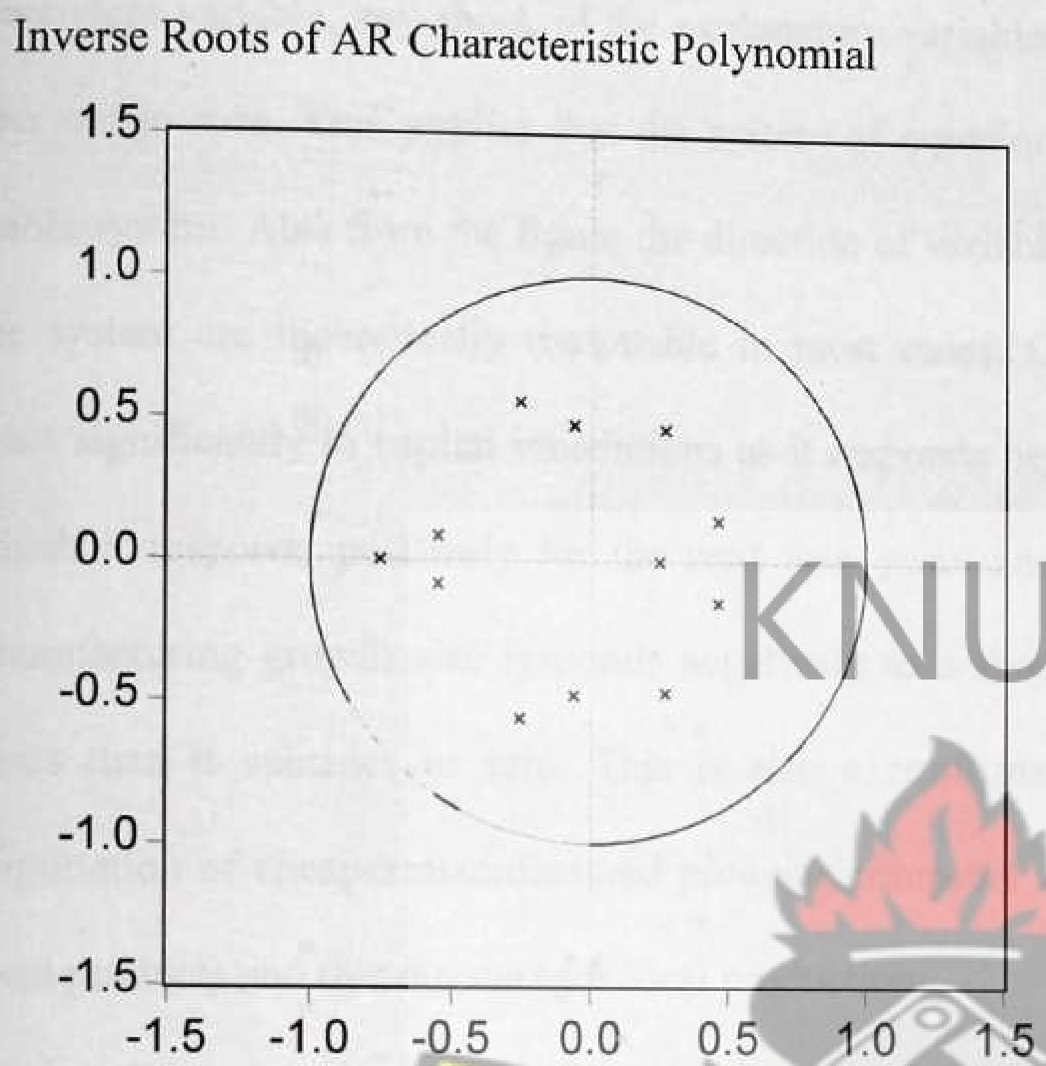
Figure 4.4 Plot of Cumulative Sum of Recursive Residuals



4.8 Impulse Response Functions and Variance Decomposition

The results of impulse response function and variance decomposition are given in Figure 4.6 and Table 4.9 respectively. An estimated *VAR* must be stable; otherwise certain results such as impulse response standard errors will not be valid. It is therefore, important to check the stability status of the *VAR*. *AR* roots graph is used, and the estimated *VAR* is stable or stationary if all roots lie inside the unit circle. Stability condition is checked using figure 4.5 below, and all roots have modules less than one, also no root lies outside the unit circle. The estimated VAR is therefore, very stable and inferences can be done from the *VDC* and *IRF*.

Figure 4.5 VAR Stability Condition Check



In simulating variance decompositions and impulse response functions, the *VAR* innovations may be contemporaneously correlated. The implication here is that responses of a variable to innovations in another variable of interest cannot be adequately represented, since isolated shocks to individual variables cannot be identified due to contemporaneous correlation, Lutkepohl, (1991). Therefore this work uses Sims (1980) which suggests the use of Cholesky factorization that requires a pre-specified causal ordering of the variables. Cholesky ordering from the variables are: k, k/l, im, l, ex and y. the ordering starts from the most exogenous variable to the most endogenous.

Impulse Response function (*IRF*) tracks the impact of any variable in the system due to shocks from all other variables. From Figure 4.6, the *IRF* produces the time path of dependent variables in the *VAR*, to shocks from all the explanatory variables. At any dependent variable, any shock of the explanatory variables makes the impulse responses dies out to zero. This implies that the system of equation developed, i.e. the *ECM* is a stable system. Also from the figure the direction of variables' responses to innovations in the system are theoretically reasonable in most cases. Growth in manufacturing does react significantly to capital innovations as it responds negatively for the first year after which it responds positively for the next four years and subsides to zero afterwards. Manufacturing growth also responds negatively to a shock in imports for the first five years then it subsides to zero. This is also a confirmation of economic theory; the importation of cheaper manufactured products competes with relatively more expensive local products and this discourages local production.

The variance decomposition is an alternative method to *IRF* for examining the effects of shocks to the dependent variable, over a series of time horizons. Usually own series shocks explain most of the error variance, although the shock will also affect other variables in the system.

From Table 4.9 the *VDC* substantiate the significant role played by capital, labour, exports, imports and capital per labour in accounting for fluctuations in Ghanaian manufacturing growth. At one year horizon, the Ghanaian manufacturing growth forecast attributed to all variables is mostly explained by capital-labour ratio which is 9.98. The explanatory power of all variables increases further at 4-year horizon, but the percentage of growth in manufacturing forecast variance explained by innovations in labour is smaller than explained by innovations in other variables. All variables, with exception of capital per labour increase steadily to eight-year horizon then either fall or become constant. Obviously, at longer time horizon, percentage of forecast variance in manufacturing growth is largely explained by innovations in capital per labour and imports, among other variables, as they maintain higher percentages of 19.79% and 13.78% respectively. This confirms the important role play by capital per labour in the model and the statistical significance of imports in the long-run estimation. The result again strengthens the findings earlier that both capital and labour play insignificant roles in the determination of long-run growth of manufacturing in the Ghanaian economy. This is because at the twelve year horizon they explain the least in percentages of forecast variance in the manufacturing growth.

From the main diagonal of *VDC*, the results reveal that the own shock is relatively higher for imports and capital, of 77.99% and 68.16% respectively. This implies the exogeneity of imports and capital in variance decompositions, because after the first year after their shocks, their variances appear to be less explained by innovations in other explanatory variables. The result also explains that own shock is relatively very low for exports (ex) and labour, and this confirms the Granger causality tests that recognizes exports as an endogenous variable.

Figure 4.6 Impulse Response Functions

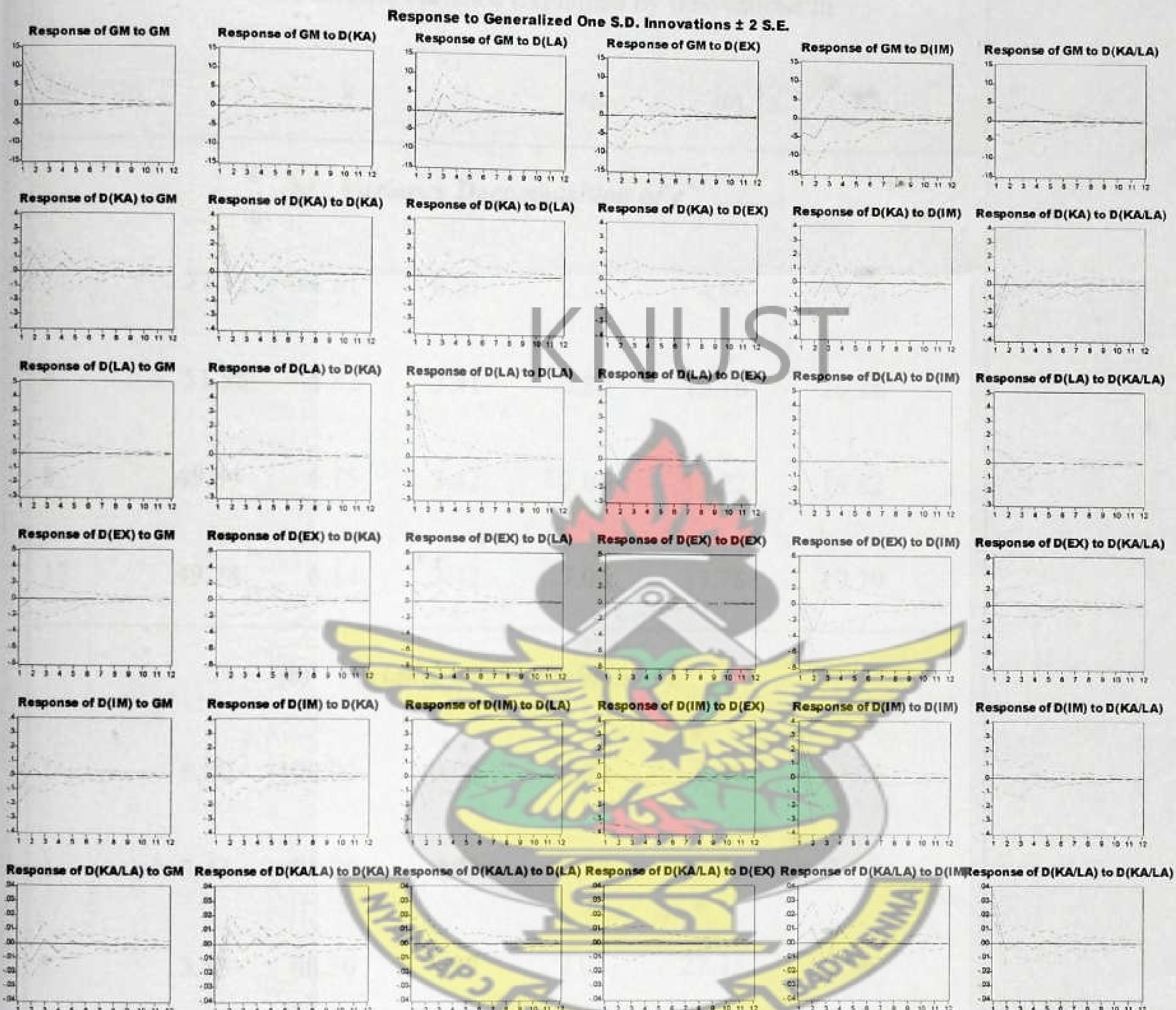


Table 4.9 Variance Decompositions

	% of Forecast Variance Explained by innovations in					
Horizon	y	k	l	ex	im	k/l
			(a) Variance Decomposition of y			
1	77.12	4.61	0.81	2.62	4.86	9.98
4	51.55	5.82	3.41	6.80	12.16	20.26
8	49.84	6.15	3.42	7.04	13.72	19.82
12	49.78	6.14	3.42	7.04	13.78	19.79
			(b) Variance Decomposition of k			
1	0.00	100.00	0.00	0.00	0.00	0.00
4	3.43	71.75	0.93	0.77	20.75	2.36
8	3.53	68.50	0.98	2.08	22.35	2.56
12	3.56	68.16	0.99	2.16	22.57	2.53
			(c) Variance Decomposition of l			
1	0.00	6.77	0.57	0.00	0.01	92.66
4	2.88	7.71	2.68	2.73	3.88	80.11

8	2.82	7.66	2.65	2.87	6.03	77.96
12	2.82	7.67	2.65	2.88	6.07	77.91
		(d) Variance Decomposition of ex				
1	0.00	2.39	2.10	82.00	1.49	12.01
4	2.08	2.42	2.42	38.76	43.33	10.97
8	2.27	3.32	2.40	38.39	42.78	10.83
12	2.27	3.32	2.40	38.40	42.78	10.83
		(d) Variance Decomposition of im				
1	0.00	0.85	0.00	0.00	88.05	11.10
4	0.55	4.55	1.14	3.94	78.34	11.48
8	0.70	4.82	1.19	4.01	78.05	11.23
12	0.72	4.86	1.19	4.02	77.99	11.21
		(e) Variance decomposition of k/l				
1	0.00	73.06	0.00	0.00	0.00	26.93
4	5.36	49.25	0.89	1.89	23.00	19.67

8	5.37	48.46	0.96	3.04	23.26	18.91
12	5.38	48.33	0.96	3.11	23.40	18.81

Cholesky Ordering: **k, k/l, im, l, ex, gm**

4.12 Conclusion

In this chapter, results of estimations have been presented. An impulse response function has been used to emphasize on the stability of the model. Further inferences have been made from variance decompositions, and capital per labour $\left(k/_{l}\right)$has proven to be a valuable explanatory variable in the determination of both the long-run and short-run growth of manufacturing.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the summary of findings of this research study and the conclusions made on the hypotheses stated in the introductory chapter. Some recommendations are also presented for future research study and for policy makers.

5.1 Summary of Findings

Chapter one is the introduction to this study. It outlines the importance and motivations for the study. The hypotheses, objectives and methodology of the study are all stated in this chapter. It closes with the structure of the study. Chapter two is the literature review. It presents three theoretical literature reviews of which one was modified and used for this study. In addition it presents a summary of five empirical literature related to the study. Chapter three presents the models and methodology used in identifying the sources of growth within the manufacturing sector. Three models are presented; the first is the model that identifies the production sector, the second identifies the sources of growth while the third is used for testing convergence. The chapter closes with the econometric methodology of Autoregressive Distributed Lag (ARDL) to cointegration that this study applies to identify the sources of growth in the manufacturing sector. Chapter four presents the empirical findings of the study. The dummy variable representing economic liberalization impacts positively on growth while imports impacts negatively as expected.

Both capital and capital intensity possess negative signs, however their expected signs are suppose to be positive. Both labour and exports have the right positive signs but they are not statistically significant. Further inferences from variance decomposition reveal that capital intensity $\left(k/_{l}\right)$ is the variable that has the greatest impact on growth both in the short-run and the long-run. The test of convergence indicates that there is sufficient evidence to conclude that smaller firms grow faster relative to larger firms.

5.2 Conclusion

The questions which this research paper sought to answer were the sources of growth within the manufacturing sector that can be promoted to enhance national growth, and whether the removal of government interference in trade after 1983, has been able to bring about convergence within that same sector. These issues are of paramount importance to policy makers as the manufacturing sector is the key sector they are looking up to achieve a middle income status by the year 2020.

The survey uses data on manufacturing growth rates, capital, imports and exports all at constant 2000 prices from *WDI* tables as well as labour from the Ghana Statistical Service. Data span from 1965 to 2006. The study employed the *ARDL* approach to cointegration. The reason for this approach is obvious; the requirement of other approaches that all variables in the system should be $I(1)$ is not satisfied as the growth rate of manufacturing is $I(0)$.

A test for the presence of unit roots was carried on all variables using the Augmented Dicky Fuller Test and confirmed by Phillip Perron Test. It was revealed that while the growth in manufacturing is stationary in levels all other variables are stationary at the first difference. A cointegrated test was performed using the critical values reported in the Persaran *et al* (2001) table. The critical *F*-statistic $\left[F_Y\left(y_t/k_t, l_t, ex_t, im_t, \frac{k}{l_t}, D\right)\right]$ of 4.916998 for ARDL (0,2,1,1,1,1) is higher than the upper bound critical value of 4.43 at 1 percent significance level. This result shows that in using the growth of manufacturing as the dependent variable then manufacturing growth, capital, labour, exports, imports and capital intensity are co-integrated. That is a long-run relationship exists among the variables. Further inferences are made using variance decompositions.

One main conclusion that can be drawn from the empirical result is that capital intensity impacts on manufacturing growth both in the long-run and the short-run. A major policy implication that can drawn from this analysis is that by enticing labour to work its maximum, capital will be at its optimal use and capital intensity will improve to improve growth of the manufacturing sector.

The empirical finding has also found strong evidence to conclude that, within the manufacturing sector, over the sample period, smaller firms are growing faster relative to larger firms, since the co-efficient of the term of convergence is negative (-0.7241) and significant at one percent. The implication here is that smaller firms are growing at the rate of 72 percent relative to larger firms.

5.3 Recommendation

Results from the long-run model reveal that capital has a negative co-efficient, which implies that, a reduction in capital will improve growth. Also from the results labour has the expected positive coefficient but it is not statistically significant. However the results from variance decomposition shows that capital intensity plays the most significant in accounting for fluctuations in manufacturing growth in both the short-run and the long-run. The implication here is that in order to improve upon capital intensity policies should be geared towards improvement in the contributions of labour.

There are several ways of improving the contributions of labour. Firstly, policies should be geared towards a reduction in labour turnover. A high labour turnover does not help labour acquire the necessary skills in an employment to work with particular capital. Once a worker is able to stay for long in a particular employment to undertake a particular assignment he gains the necessary knowledge and skills in performing the same task.

Again, policies may target a reduction in labour unemployment rate. One way of doing this is to give incentives to firms to establish plants to meet some targeted employment figures. For instance incentives may be granted to firms to establish plants that will be able to meet an employment target of say 3000 workers. In 1994, the state of Alabama in the USA, offered Mercedes an incentive package of approximately US$230 million for a new plant that planned to employ 1500 workers (Head, 1998). As the rate of unemployment is being reduced, the demand for labour will rise against its supply, and the price of labour will increase toward efficiency wage. Workers will be satisfied and work the maximum.

Lastly, a policy measure that will index wages and salaries (either fully or partially) to inflation will help greatly to improve labour conditions and entice it to work. If there are quarterly adjustment of wages and salaries to inflation, through may be cost of living allowances, this will protect workers income in the short-run; there will be stability in real income of labour and labour will be able to increase performance which will in turn increase the contribution of capital and capital intensity as a whole.

Other policies should be directed towards a reduction in manufactured imports. The long-run model has established a negative expected coefficient of imports. However, the bulk of manufactured imports are made up of machines and vehicle equipment which are necessary for development. Policies therefore should be directed towards the establishment of assembly plants to avoid the importation of some finished manufactured goods at high prices.

The empirical results of this study might be useful for policy making and a starting point for future research works.

REFERENCES

Baa-Nuakoh, 1997. "Studies on the Ghanaian Economy; Vol. 1, The Pre- Revolutionary Years." *Cambridge University Press.*

Bahmani-Oskooe and Chomsiengphet, 2002. "Stability of M2 Money Demand Function in Industrial Countries." *Applied Econometrics*, 34. 2075-2083.

Banerjee, A., Dolado, J. and Mestre, 1995. "Error –Correction Mechanism Tests in a Single Equation Framework." *Journal of Time Series Analysis*, No. 19, 267- 285.

Black, D. A., and Hout, W. H. 1998, "Bidding Firms" *American Economic Review*, 79(5) pp.1246-1256.

Briggs, T. and Pradeep, S., 1992. "Structural Aspect of Manufacturing in Sub-Saharan Africa." *Discussion Paper, Africa Technical Department*, Series No. 346 World Bank, Washington D.C.

Central Intelligence Agency, 2008. "The World Factbook". CIA Washington DC, October, 2008.

Chow, G., 1960. "Tests of Equality Between Sets of Co-efficients in Two Linear Regressions" *Econometrica,* Volume 28, 1960.

Danquah, Michael, 2006."*Sources of Growth in Ghana*". Institute African de Development Economique et de Planification, Dakar. www.unidep.org

Dinye, R. and Nyaba, C., 2001, "Trade Policy and Domestic Manufacturing in Ghana." Sapri Research Report.

Engle, R. and Granger, C., 1987. "Cointegration and Error Correction Representation: Estimation and Testing". *Econometrica*, 55, 1987, pp. 251-276

Ghana Statistical Service, "*Quarterly Digest of Statistics*". Various Issues, Accra.

Growth and Poverty Reduction II, "*Policy Framework, Vol. I*" National Development Planning Commission, Accra.

Gujurati, D. N., 2003. "Basic Econometrics, 4th ed." Boston, McGraw Hill Publishing.

Hanushek, E. and Wossman, L., 2008. "The Role of Cognitive Skills in Economic Development" *Journal of Economic Literature*, 46(3), Sept. 2008, pp.607-668

Harris, R. 1995. "Using Cointegration Analysis in Econometric Modeling, London". London, Prentice Hall, London.

Harvey, C. and Pahlavani, M. 2006. "Sources of Economic Growth in South Korea: AnApplication of the ARDL Analysis in the Presence of Structural Breaks, 1980-2005". Working Paper 06-07, University of Wollongong.

Harvey, C. and Lee, H. H. 2003a. "Korea's Economic Miracle: Fading or Reviving?". Palgrave Macmillan, Basingstoke, UK.

Harvey, C. and Lee, H. H. 2003b. "Export-Lead Industrialization and Growth. Korea's Economic Miracle 1962-89" *Australian Economic History Journal*, Vol. 43(3) 256-86.

Head, Keith, 1998. "Comment on Doms and Jensen" in Baldwin, R. and Lipsey, R. "Geography and Ownership as Basis for Economic Accounting". The University of Chicago Press, pp.255-258.

ISSER "*The State of the Ghanaian Economy*" Various issues, University of Ghana Press, Legon

Jayaraman, T. K. and Ward, B. D., 2006. "Economic Growth in a Vulnerable Island Nation: An Empirical Study of the Aid-Growth Nexus in Vanuata". *Asia-Pacific Development Journal*, Vol.13, No.2, Dec. 2006

Kremers, J. J., Ericson, N. E. and Dolado, J. J., 1992. "The Power of Cointegrated Tests". *Oxford Bulletin of Economics and Statistics*, Vol. 54, pp.325-348.

Krugman, Paul, 1991. "Geography and Trade". Cambridge, Massachusetts Institute of Technology Press.

Kunitomo, N. 1996. "Tests of Unit Roots and Cointegration Hypotheses in Econometric Models". *Japanese Economic Review*, 47(1): 79-109

Leith, J. C. 1974. "*Foreign Trade Regimes and Economic Development: Ghana*", NBER, New York, p.82-86

Leung, H. M., 1997. "Total Factor Productivity Growth in Singapore's Manufacturing Industry". *Applied Economics Letters, Vol. 4*, No. 8, Aug. 1997.

Library of Congress Studies, 1994. "*Ghana Manufacturing and Tourism*" File://D:/GCS.htm pp.1-3

Long and Sameth, 2008. "The Monetary Model of Exchange Rate: Evidence from the Phillipines Using ARDL Approach". *Economic Bulleting, Vol.6*, No.31, 2008.

Mim, B. and Shrestha, 2005. "ARDL Modeling Approach to Cointegration Test" Quoted from *Pakistan Economic and Social Review, Vol.45*, No.1, Summer 2007.

Ng, S. and Perron,2001. "Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power". *Econometrica, 69*: 1519-1554.

Olusegun O. A., 2008. "Energy Consumption and Economic Growth in Nigeria- A Bounds Testing Cointegration Approach". *Journal of Economic Theory, 2(4)* 118-123, 2008.

Oteng-Abayie E. O. and Frimpong J. M., 2006. "Bounds Testing Approach to Cointegration: An Examination of Foreign Direct Investment, Trade and Growth Relationships". *American Journal of Applied Sciences, 3(11)* 2079-8085

Pahlavani, M. 2005. "Sources of Economic Growth in Iran: A Cointegration Analysis in the Presence of Structural Breaks" *Applied Econometrics and International Development,* 5(4), 2005

Pahlavani, M. 2005. "Cointegration and Structural Change in Exports-GDP Nexus: The Case of Iran". International *Journal of Applied Econometrics and Quantitative Studies, 2(4),* 2005

Pesaran, M., Shin, Y. and Smith, R. J., 2001. "Bounds Testing Approaches to the Analysis of Level Relationships". *Journal of Applied Econometrics, J. Appl. Econ. 16*:289-326

Ranis, G. 1971. "*The Role of the Industrial Sector in Korea's Transition to Economic Maturity*" Paper Preserved at the ILCORK Conferences, 22-29 August, Seoul, Korea.

Romer, David 2006. "*Advanced Macroeconomics*". McGraw-Hill, Irwin, Boston.

Statistical Service, Ghana. "*Quarterly Digest of Statistics, 1975-2007*"

Teal, Francis, 1998. "*The Ghanaian Manufacturing Sector, 1991-1995: Firm Growth Productivity and Convergence*". Center for the Studies of African Economies, Oxford, WPS/9817

Trades Union Congress, Ghana, 2004. "*Incomes in Ghana, Policy discussion Paper, May 2004*". http://www.gpn.org

World Bank, "*WDI Indicators, 2008 Tables.*"

Appendix

Data

YEAR	y	k	l	ex	im	k/l
1965	1	-3.857215	-9.699329	-2.685713	-1.325606	0.397679
1966	-1	-3.835862	-9.664989	-5.265885	-1.533591	0.396882
1967	12	-3.295837	-9.74838	-5.831394	-1.735563	0.338091
1968	17	-3.449988	-9.835103	-5.830027	-1.819288	0.350783
1969	16	-3.10608	-9.976506	-6.058348	-1.874998	0.311339
1970	4	-3.562466	-10.06328	-5.815874	-1.871713	0.354006
1971	-6	-3.325036	-9.82367	-5.666412	-1.732938	0.338472
1972	-9	-3.54818	-9.722661	-5.680018	-2.099327	0.364939
1973	24	-3.814043	-9.911328	-4.77819	-1.8832	0.384816
1974	-6	-3.303217	-9.848874	-4.60334	-1.336037	0.33539
1975	9	-3.583519	-9.991946	-5.341655	-1.473973	0.358641
1976	-5	-3.54818	-9.778437	-5.240656	-1.347356	0.362858
1977	3	-3.871201	-9.847067	-4.417188	-1.332703	0.393132
1978	-4	-3.850148	-9.832798	-4.978533	-1.221203	0.391562
1979	-17	-3.878121	-9.741787	-4.915982	-1.238845	0.398091
1980	-1	-4.290459	-10.55616	-4.674502	-1.118108	0.406441
1981	-19	-4.255613	-10.60694	-4.591719	-1.026963	0.40121
1982	-20	-4.248495	-10.51088	-4.553163	-1.253911	0.4042
1983	-11	-4.212128	-9.713478	-4.117643	-0.629514	0.433637
1984	13	-4.882802	-9.804812	-5.001283	-1.290247	0.498001
1985	24	-4.241327	-9.896849	-4.016241	-1.229817	0.428553
1986	11	-4.990433	-10.02066	-3.8406	-1.195294	0.498014
1987	10	-4.290626	-9.726414	-3.51742	-1.16025	0.441131
1988	5	-4.290459	-10.36506	-3.31138	-1.329587	0.413935
1989	1	-4.290459	-10.81741	-3.308415	-1.03747	0.396626
1990	6	-4.297285	-10.8531	-3.316598	-1.093883	0.39595
1991	1	-4.297285	-11.19516	-3.547083	-1.158838	0.383852
1992	3	-4.297285	-9.937322	-2.740286	-0.70406	0.432439
1993	-45	-4.304065	-9.337271	-2.286783	-0.38213	0.460955
1994	2	-4.304065	-9.302372	-1.817301	-0.446149	0.462685
1995	2	-4.304065	-9.257876	-1.547645	-0.479556	0.464908
1996	3	-3.905334	-9.275433	-1.453827	-0.452375	0.421041
1997	7	-3.905334	-9.235623	-1.808854	-0.513035	0.422856
1998	4	-3.905334	-9.273528	-1.349985	-0.478703	0.421127
1999	6	-3.905334	-9.326595	-1.163165	-0.391557	0.418731
2000	4	-3.912023	-9.366579	-1.531427	-0.485351	0.417658

2001	6	-3.912023	-9.410365	-1.581531	-0.631	0.415714
2002	5	-3.907974	-9.400415	-1.422841	-0.497016	0.415724
2003	5	-4.63222	-9.40122	-1.45538	-0.563	0.492725
2004	5	-4.68788	-9.55411	-1.65211	-0.5862	0.490666
2005	6	-4.78777	-9.65542	-1.77856	-0.5992	0.495863
2006	6	-4.89899	-9.76665	-1.99522	0.63622	0.501604