IMPACT OF HUMAN AND PHYSICAL CAPITAL ON ECONOMIC GROWTH: AN EMPIRICAL STUDY FOR TANZANIA WITH CAUSAL LINK ANALYSIS

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN ECONOMICS OF THE OPEN UNIVERSITY OF TANZANIA

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CERTIFICATION

The undersigned certifies that he has read and here by recommends for acceptance by the Open University a dissertation titled; ñImpact of Human and Physical Capital on Economic Growth: An Empirical Study for Tanzania with Causal link Analysisò in partial fulfilment for the requirement of the degree of Master of Science in Economics.

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Supervisor

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Date

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DECLARATION

I, Elinzuu Nicodemo, do hereby declare that this dissertation is my own original work and that it has been not presented and will not be presented to any other University for similar or any other degree award.

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....
Date

DEDICATION

This work is dedicated to my lovely Father Nicodemo Napegwa, my husband Joseph Jacob Mbogo and my Children Ephraim and Faith Joseph Mbogo.

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ABSTRACT

The aim of the study is to empirically investigate the effect of human capital and physical capital on economic growth of Tanzania for the period of 1990-2015. The study aims at empirically test the relevance of the Solow Growth Model (1957) and Augmented Solow Growth Model. This study employed Ordinary Least Square (OLS) techniques and annual time series data across the years 1990-2015 to shed some intuitive light on evaluating influence of the key drivers of economic growth by using unrestricted Cobb-Douglas Production Function. The study findings show that the measures of responsiveness of GDP with respect to infinitesimal changes in physical capital stock and labour force have turned out to be in line with Cobb and Douglas (1928) findings in terms of theoretical signs; however, there is disparity in the magnitudes of coefficients. Two types of models were estimated. In this report, the Basic Solow Model turned out to be partially relevant to the Tanzaniaα̂s economy context, the Augmented Solow Model was also partially acquiescent with prescriptions by Mankiw et al. (1992). The study also performed Granger Causality analysis to determine variables causal links. The results show that there are no clear causal links between the three variables: GDP, GFCF and LABOUR FORCE. However, the results suggest further that there is unidirectional causation that runs from capital per labour to GDP per capita; this implies that increase in the physical capital per unit of skilled labour leads to increased economic growth. In view of the foregoing findings, the results suggest that the country under study need to optimally allocate national resources to the drivers of economic growth and devising consistent human resource policies, investment policies and population policies that are in particular targeting to accelerate GDP growth.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABREVIATION

GDP	National Gross Product
GFCF	Gross Fixed Capital Formation
FYDP I	Five Year Development Plan I
FYDP II	Five Year Development Plan II
HDI	Human Development Index
MKUKUTA II	Mkakati wa Kukuza Uchumi na Kupunguza Umaskini (II)
NBS	National Bureau of Statistics
OLS	Ordinary Least Squares
SDG8	Sustainable Development Goals
2015-16 TDHS/MIS	Tanzania Demographic and Health Survey and Malaria
Indicators	Survey
UN	United Nations
UNDP	United Nations Development Program

CHAPTER ONE

INTRODUCTION

1.1 Overview

This study is designed to investigate the impact of human and physical capital stock on economic growth in Tanzania. This chapter is presents the background, statement of research problem, significance, objectives, hypotheses and scope of the study.

1.2 Background of the Study

In late 1980s and early 1990s, economic growth attracted empirical macro-economists' attention. In this perspective, endogenous growth theories which emphasized the importance of human capital on economic growth emerged. According to Lucas (1993), accumulation of human capital was considered as the main engine of economic growth as well as the main reason for differences in standards of living globally. According to Barro (1991), human capital was directly related to the par capital growth rate while share of government consumption in GDP was negatively associated with growth. Different approaches have been used to compare contribution of variety of economic and political theories of the economic growth, though the modelling invariably included some measure of human capital.

Erk and Ates (1999) conducted an empirical study on developed countries and confirmed that key aspects of production (physical and human capital) are strong proxies in explaining GDP growth rate while Bergheim (2005) findings underlined the importance of human capital in production in today's economies and that its increase is fundamental in the growth of GDP. The empirical investigation results from selected developed countries are in line with results of Johnson (2011) whose study in Nigeria found that a unit increase in government outflow on education would raise the GDP by approximately 54%. A study in Morocco by Hadir and Lahrech (2015) underscore the implication of quality of human capital in growth of the economy, where they found that high level of human capital development was the key to the social and economic improvement of the country.

On the other hand Mincer (1981) argued that the contribution of physical capital is different to human capital, as growth of human capital raises a marginal product of physical capital stimulate accretion of physical capital, therefore lead to, raise of total output together directly and indirectly. In harmony with Jacob Mincer; Lucas Jr. (1993) considered accumulation of human capital knowledge as stimulating engine of economic growth, and this together with physical capital accretion are among the sources of dissimilarity in living standards among countries. From the preceding and forthcoming sections of empirical literature review, it is apparent that numerous literature are one sided either human capital versus economic growth or physical capital stock versus economic growth. In view of the foregoing reality, it is therefore imperatively important to conduct an investigative study on the impact of both factors; human capital and physical capital stock on the economic growth of the country so as to help the bureaucrats and policy makers to allocate national resources appropriately for stimulating the economic growth.

1.3 Significance of the Research Problem

Various socio-economic growth models include human capital and physical capital as key factors of production and the growth of human and physical capitals are considered as the proxy for development. The Tanzanian economy to continue grows at an average rate of 6 - 7% per years over the last decade (World Bank, 2017). Through this period, the government has been implementing several development programmes including the current Five Year Development Plan 2016/17-2020/21(FYDP II), which followed-up on interventions items which fell short under MKUKUTA II and FYDP I.

Currently, Sustainable Development Goal 8 (SDG8) promotes sustained, inclusive and sustainable economic growth full and productive employment and decent work (UN Statistical Commission, 2016). It is obvious from the above, it would be useful to explore and investigate the extent to which human and physical capital contributed to the recorded sustained GDP growth over the last decade and further determine causal links that exist between human capital, physical capital and GDP growth of Tanzania.

In principle, socio-economic growth of any nation requires optimal allocation of the national resources, and for the national to optimally allocate its scarce resources; it requires to explore and identify the key drivers of socio-economic growth. This study will add to bureaucrats, academicians and decision makers in considerate of how the GDP change due to accumulation of human capital and physical capital so they can formulate appropriate economic policies to stimulate productivity and ultimately economic growth.

1.4 Research Objectives

1.4.1 General Objective

The aim of the study is to empirically investigate the effect of human capital and physical capital on economic growth of Tanzania for the period of 1990-2015.

1.4.2 Specific Objectives

The specific objectives of the study are:

i. To examine the impact of human capital on economic growth;

ii. To examine the impact of physical capital on economic growth; and

iii. To examine the causal link between economic growth and explanatory variables (human capital and physical capital).

1.5 Research Hypotheses

Throughout this paper I will attempt to test the following Null hypotheses:

Hypothesis (H_o)1: There is a positive relationship between human capital stock and economic growth.

Hypothesis (H_o) 2: There is a positive relationship between Physical capital stock and economic growth

Hypothesis (H_o) 3: There is complementarily between human and physical capital stock

1.6 Data

This dissertation use time series date from four sources spanning from 1990 - 2015. The datasets are National Bureau of Statistics (NBS), United Nations Development Programs (UNDP), World Bank and UNSTAT. The Types of data used gathered include; Labour force, Gross Secondary School Rate (GSSR); Gross Fixed Capital Formation (GFCF) and real GDP; and real GDP per capita for the period of twenty five years (1990-2015).

1.7 Organization of the Study

This dissertation consists of four chapters: a first chapter provides information on background of the research, statement of the problem, objectives, scope and limitations and organization of the research. Second chapter is devoted to the literature review while the third chapter discusses the methodology, chapter four is devoted for discussion and conclusion and chapter five present the summary, conclusion and policy implication.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter reviews literature concerning the proposed study. The review considered similarly diverse economic studies worldwide. The literature enabled to gather the various macro - economic variables associated to economic growth particularly in Tanzania from a variety of theoretical perspectives. Likewise, it helps to highlight some issues based on the research problem. The chapter has sections on theoretical review, the empirical review and the conceptual framework of the study.

2.2 Conceptual Definitions

GDP: is the market value of all final goods and services produced within a countryside in a particular time (Brooks, 2014).

Gross Fixed Capital Formation (Physical capital): This refers to the net increase in physical assets within the specific period. This measure does not consider the consumption of fixed capital, and also exclude land purchases.

Labour (Human capital): This is a proportion of a countryǿs working age population that are employed actively in the labour market, either by working or searching for work. It provides the proportion of population (labour force) by sex and age group (15-64 years) available to participate into the production of goods and services, relative to the population at labour force, (NBS, 2014).

2.3 Theoretical Literature Review

2.3.1 Economic Growth Theories

Theories of economic growth were developed to show the nature of the exogenous variables which ultimately contribute to the shedding of light on the effect of human and physical capital on the general level of economic growth. However, popularity of the classical theories of economic growth collapsed. Since 1970 and early 1980 few new findings were produced, such as the use of neoclassical growth model to the economics of exhaustible resources.

2.3.2 Classical Growth Theories

Adam Smith, documented three factors of production which include labour, capital and land. He algebraically presented this relationship as a function of output;

$Y = f(K, L, N)$ where K is physical capital stock, L is labour force and N represents land.

He noted that, subject to continually growth of division of labour, any additional in capital stock will lead into additional increase in the output. Furthermore, classical growth theory argues that, output growth results from increase of one or more of the factors of production and technological changes. It further concludes that in closed economies with low savings rates, the growth is slow in the short-run and convergence is reached at lower per capita income level while in open economies convergence is at higher levels of per capital income.

2.3.3 Neoclassical Growth Theories

The latest growth theory extended the neo-classical model by taking into consideration the stable rate of growth as itself endogenous. Arrival of Solow in this discussion, he responds critically in both theoretical and empirical part of latest growth economics on 1992 which revised in his growth theory 2000 and economic growth in 2005. By the mid 1990 textbooks initiated conversation on endogenous growth models in depth (Barro and Salai M. 1995, Jones 1998, Aghion and Howitt 1998), yet taken the basic neoclassical growth model as their initial point.

Solow (1956) set out an aggregative, competitive general equilibrium perfect foresight growth model where by three equations were constructed. A constant returns to scale production function with smooth substitution and diminishing returns to capital and labor, an equation describing capital accumulation on the assumption of a constant rate of savings (investment) as a fraction of output, and a labor supply function in which labor (population) grows at an exogenously given rate. The system generated a first order differential equation which showed how the current level of the capital labor ratio and the savings rate and the rate of population growth resolve the issue. Solow on his first analysis used a phase diagram to determine the dynamic stability of equilibrium using qualitative data. Later on, he provided quantitative solutions for specific constant returns production functions.

The phase diagram depicting the equilibrium value of the capital labor ratio became known as the ñSolow diagram.ò To determine the increasing income per capita, Solow introduced technological change and worked out the solution for the Cobb Douglas case, by which realised that along the balanced growth path, there is same growth rate between output per worker and capital per worker with technological progress. Therefore, it offsets diminishing returns to capital accumulation, permitting steadily rising labor productivity and output per worker. The trend is volatility which dissatisfies any methodology to explain long run problems, the Solow (1956) and Swan (1956) used neoclassical production functions with differently shares of labour and capital inputs. These methodologies gave the primary neoclassical model of long run economic growth and spot out the initial point for various studies on economic growth till today.

2.3.4 Economic Theories Versus Human Capital

Human capital growth is one of the key factors of economic improvement around the world. The work produced by Schultz (1961), education has been considered as investment in human capital while is measured to be a consumption good under Keynesô convince. Economists used Human capital as education, health and other human capacities that can increase production (Miyanda, 2017). The United Nations defined human capital as productive wealth in material forms including: labour, skills and understanding (UN, 2009). This comprises of knowledge and skills gained through education, and also their strength and energy, which are dependent on their health. Investment in health is one of the essential responsibilities of any country, but also a crucial priority for most societies in the world. In a nutshell, despite the pace of technology, health became an essential part of labour force and also a key factor which supports economic improvement (Duggal, 2007, Lopez-Casanovas et al. 2005, Mehrotra and Jolly, 1998).

Bloom and Canning (2000) assert that educated and healthier people live longer life and their higher motivated to invest in their abilities because the current values of their investments are higher. Furthermore, a nation with a labour force with some low levels of education and health status, the respective country is competent for sustainable economic growth (Lopez Casasnovas, et al., 2005). Mankiw et al. (1992)

augmented the late Solow growth model by including the accretion of these two key factors of production. Their model determined the economies that congregate to their steady states where by levels of both key factors per worker increase, while human capital is supposed to be personified as knowledgeable workers.

Numerous other researchers on economic improvement debate argue that human capital has a positive effect on economic improvement (Barro, 1991 and 1996). Nevertheless, currently some studies have started to investigate the consequence of health on economic improvement rapidly. In the study of the impact of health and human productivity on long term economic improvement, Arora (2001) examined the development paths of ten developed nations over the period of 25 years. The results indicated that positive improvements in health raised the countriesô rate of growth by 30 to 40 percent.

According to Behrman and Deolalikar (1988), observed that enhanced human wellbeing leads to increase labour productivity, and in turn makes a way to higher economic growth. Various investigators who employed dissimilar methodologies verified the positive relationship between human wellbeing and economic improvement. However, the positive effect of economic growth on health has been highlighted (Pritchett and Summers (1996), the presence of observed facts for the reverse on the positive effect of economic improvement on human capital (Rivera and Currais, 1999).

2.3.5 Physical Capital and Economic Growth

Marx (1872) believes that production to be interlink with reproduction, he differentiated two things; saving versus consumption by separating the accounts for downgrading and technological improvement so as to form a model called physical capital accretion. In line with other discussion above on literature realise that, as more you invest in GDP forecast level of output per worker in the stable country, also this shows that grow of the share of savings forecast an increase of growth rate of output per worker, both in the short-run and long-run particularly in the stable country.

This situation contains growth rates effects which is quantitatively an essential and has statistical meaning. This also obtainable particularly in Labour and physical capital (AK) model (Steve B. et al 2004). Jones (1995) findings show that physical capital and human capital concentration ratio is a strong proxy in explaining GDP growth of selected urbanized nations. Divergence between neoclassical and endogenous and our hypothesis is potentially accounted for by the positive trend in labour (A), human capital (L) and physical capital (K) trend between countries including Tanzania. To conclude this, we noted that theories of economic improvement (conventional, neoclassical and endogenous) are independent in terms of inputs, taking consideration on physical capital and human capital as key factors for economic growth in Tanzania. Lucas (1988, 1990) discusses the importance of these factors of production, and he noted that, as more you invest in education part generate positive results which enable escalating income.

2.4 Empirical Literature Review

This part holds different empirical studies that show the impact of physical - human capital in development. Preceding findings shows the impact of physical-human capital to economic improvement explored if the situation applied whether in the long-run or just a short-run observable fact, to know the relationship in causal direction, whether this connection is linear or non-linear and so alike. Lucas (1988, 1990) discusses the meaning of human capital versus physical capital. He noted that, providing education to a certain society generates positive externalities in order to facilitate growth rate.

Becker, et al. (2016) and Baro (1960-1980) conducted studies in 98 countries shows that, an average expansion rate of output per worker is 2.24% annually, of which two third (0.76%) can be described by changes in physical capital and more than a third (0.45%) from changes in the accumulation of human capital. Ogujiuba Kanayo (2013) studied the impact of human capital accumulation in Nigeria, the results shown that, labour force had a positive and statistically significant impact on GDP improvement. Investing in human capital in form of education and capacity building through primary and secondary levels have positive significant on economic improvement.

Kalio, et al. (2012) who investigated economic improvement in Kenya and found out that Kenyan economy is propelled by factors (Labour and Capital) of production accumulation. Kenyan situation shows that accretion of the typical inputs contributed 71.4%, where capital (25%) and labour (3.6%), became an essential than total factor productivity improvement. Tahmina Khatun and Sadia Afroze (2016) who explored the relationship between real GDP and factors of production (Labour and Capital) using Cobb-Douglas Production Function for selected Asian Countries and findings revealed that, there is a strong positive and significant relationship between real GDP and factors of production (Labour and Capital) for all selected Asian countries ranges 93% to 99%. Also the study showed that there is growing of returns in the production process in all remarkable countries.

Ndambiri et al. (2012) examine the determinants of economic growth specifically for Sub Saharan Africa and findings show that physical capital accumulation was positive determinant of economic improvement within economies of these states. Ahuru, R. and James, U. (2015) and Habtamu, F. (2014); the former tested the Basic Solow Model performance in Nigeriaós economy and found out that symbols of the coefficients of reserves rate and population growth rate obey rules of Solowós theoretical prophecy. Kilishi et al.(2013) explored the relevance of Augmented Solow Model for Africaós economic growth and found out that human capital had a positive and statistical meaning on the GDP per capita and increasing in population had no significant effect on the GDP per capita. However, the empirical results above, Kilishi et al. (2013) found the same and thus conformed to prior expectation.

2.5 Research Gap

Even though, this research on the impact of key factors of on economic improvement has attracted many literatures, it remains amongst the controversial studies in the world economy these days. In fact, a literature discusses the impact of physical capital stock and human capitals on economic improvement differ across the countries at a different time. It is recognized that previous researches have made positive debate on importance of investment in the economy by considering key drivers of the economy. Some of these studies applied a cross country studies in this circumstance these heterogeneous results difficult to generalize. In reality, they have failed to show up the reason for number cases. This can be well explained using a country specific study.

In view of the above, the study plan to close methodological gap marked by prior authors by using current econometric methodology for time series data and investigating the causality between key factors of production (human capital and physical capital) and economic growth for the Tanzania economy.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

This research methodology consists a systematic way of conducting the research. This chapter represents research design, models employed, how models are estimated, types and sources of data used and also present analysis of the data.

3.2 Research Design

A research design can be defined as the way of an arrangement of techniques for collection and investigation of data with aims to join relevance to the research intention in a system of economy (Kothari, 2004). According to Kothari, if the research is well designed make a research as professional produce many and accurate information by using low costs of efforts, time and money. This study employed statistical research design and involved secondary data for twenty five yearsô time series data from 1990 to 2015.

3.3 Models Employed

3.4 Basic Solow Model

In this theoretical framework, I have taken the reputed unrestricted Cobb-Douglas Production Function and Robert Solow economic growth model as building blocks of my theoretical model and estimation model. Most of economic models, single factors (either capital or labour) is presented as the essential economic variable.. Considering one variable of interest in the model that is designed, For all economic models, the Solow growth model, major variable is Labour output i.e. to what extent the average worker in the country is capable to generate, where by proxy measure is the level of economy as a real GDP per capita (Y/L). This is the uncomplicated proxy for the living standard and level of wealth of the economy. According to Solow (1956) the output is generated created by two key factors of production, capital (K) and labour (L), whose rate of input is L (t). Technological possibilities are represented by a production function as shown in equation 1:

$Y = F(K, L)$..(1)

He further assumed that population grows exogenously and that the labour force rises at a constant rate '*n'*. In absence of change in technology '*n'* is Harrod's natural rate of growth thus, $L(t) = L_0 e^{nt}$which implies $\frac{L(t)}{L_0} = e^{nt}$.

By introducing logarithm on the above equation, the constant relative rate *n* will be:

$\frac{1}{t}\ln\left(\frac{L(t)}{L_0}\right)$

and that the fraction of output saved is a constant '*s',* so that the rate of saving is *s*Y(t) . The net investment is the rate of increase of capital stock $\frac{\partial K}{\partial t} = sY(t)$ and then

$\frac{\partial K}{\partial t} = sF(K, L_0 e^{nt})$

He further noted that, the above basic equation is one which decide the time path capital formation that should used if the entire accessible labour force is employed.

Solow (1956) in his extension introduced technological change in this function as a factor in an increasing level. Thus, the above equation (1) is altered to read as it appears in equation 2:

$Y = A(t)F(K, L)$..(2)

We therefore assume a Cobb-Douglas production function, so that the aggregate output at time t is given by:

$Y(t) = K(t)^{\alpha}(A(t)L(t))^{1-\alpha}$..(3)

Where: Y (t) is aggregate out at time t whose proxy measure is GDP at time t

K (t) is Capital stock at time t whose proxy measure is Gross Fixed Capital Formation (GFCF)

L (t) is Labour force at time t

A (t) is the level of technology at time t.

L (t) and A (t) are assumed to grow exogenously at rates *n* and *g* respectively. The number of effective units of labour; A (t) L (t) rises at rate n+g.

This model further assumes that a constant fraction of output is s, is invested. Defining $K = \frac{K}{AL}$ as the stock of capital per effective units of labour, y$= \frac{Y}{AL}$ as the level of aggregate output per effective units of labour, the evolution of *n* is governed by

$$\frac{\partial\left(\frac{K}{AL}\right)/\partial t}{\left(\frac{K}{AL}\right)} = s\left(\frac{K}{AL}\right) - (n + g + \delta)\frac{K}{AL} \quad \text{...(4)}$$

Where δ is the rate of depreciation of capital stock.

Assuming that $\frac{K}{AL}$ converges to a steady state value, where $\frac{\partial\left(\frac{K}{AL}\right)/\partial t}{\left(\frac{K}{AL}\right)} = 0$, then

$s\left(\frac{K}{AL}\right) = (n + g + \delta)\frac{K}{AL}$, however, we know that $\frac{K}{AL} = \left(\frac{Y}{AL}\right)^{\alpha}$

Then, $s = \left(\frac{K}{AL}\right)^{\alpha} = (n + g + \delta)\frac{K}{AL}$

$s = (n + g + \delta)\left(\frac{K}{AL}\right)^{1-\alpha}$

$$\frac{Y}{L} = A(t) \times \left(\frac{s}{n+g+\delta}\right)^{\frac{\alpha}{1-\alpha}} \quad \text{..(5)}$$

By taking logs the equation (5) above, we find noted that steady state income (output) per capita as shown in equation 6:

$$ln\left(\frac{Y}{L}\right) = lnA(t) + \left(\frac{\alpha}{1-\alpha}\right)\ln(s) - \left(\frac{\alpha}{1-\alpha}\right)\ln(n + g + \delta) \text{ ....(6)}$$

Thus, the innermost hypothesis of Solow edition of neoclassical growth model realized that the stead state level of income per capital is verified by savings, labour force, growth rate and the technological factor. Regard to these causes Solow foreseen that as savings rate rise the output per worker also increases while a high labour force growth rate reduces the growth of output per worker.

3.5 Augmented Solow Model

According to Mankiw et al. (1992), the Solow Model accurately predicts the tips of the effects of saving and population enlargement; however, it doesn't accurately forecast the level. And that to know the relation between savings, population expansion and revenue are must go beyond Solow's model. Therefore, Mankiw et al.(1992) Augmented the Solow model by including accretion of human as physical capital stock. In any given rate of human capital stock, higher savings cause a increase income level therefore raise the level of human capital accretion. In this circumstance accretion of physical capital stock and population expansion have greater impacts on income when accretion of human capital will be taken into consideration.

Human capital accretion probably concurrent with savings rates and population growth rates. To test the Augmented Solow model, we include a proxy for human capital accretion as extra explanatory variables in the regressions involved. We assume a Cobb-Douglas production function so aggregate output at time t is given by equation 7;

$$Y(t) = K(t)H(t)(A(t)L(t))^{1-\alpha-\beta}$$

$0< \alpha + \beta <1$..(7)

Where, H = Human capital while other variables are defined as previous. The assumption of $\alpha+\beta<1$ signify the decreasing returns to scale.

Let, S_k= Fraction of income invested in human capital

S_h= Fraction of income invested in human capital

Therefore, the evolution of the economy is expressed by;

$$\left.\begin{aligned} S_t &= S_k Y_t-(n+g+\delta)K_t \\ h_t &= S_h Y_r-(n+g+\delta)H_t \end{aligned}\right\} \text{...(8)}$$

Mankiw et al. (1957) assume that there is same production function be appropriate to human capital, physical capital stock and consumption as; $y=\frac{Y}{AL}$, $k=\frac{K}{AL}$ and $h=\frac{H}{AL}$ which are quantities per efficient unit of worker. The steady state value of physical capital and human capital will be obtained by working out the above equations (8).

$$k=\left[\frac{s_k^{1-\beta} s_h^{\beta}}{n+g+\delta}\right]^{\frac{1}{1-\alpha-\beta}} \text{and } h=\left[\frac{s_k^{c} s_h^{1-\alpha}}{n-g+\delta}\right]^{\frac{1}{1-\alpha-\beta}}$$

Substituting the above equations into the Augmented Solow production function, rearranging by taking logs yields the stead income per worker.

$$\ln=\left(\frac{Y(t)}{L(t)}\right)=\ln A(0)+gt-\frac{\alpha-\beta}{1-\alpha-\beta}\ln(n+g+\delta)+\frac{\alpha}{1-\alpha-\beta}\ln S_k+\frac{\beta}{1-\alpha-\beta}\ln S_t \text{.....................................9}$$

The log linear equation above realise the GDP per capital is explained by population expansion, physical capital stock and human capital. If capital share is one third thus imply that the elasticity income per worker with respect to saving with (n + g+ δ) is plus 0.5 and minus 0.5 correspondingly.

3.6 Estimation Model

The empirical testing of economic growth theories by applying time series data is useful for confirmation in realistic. The estimated the Solow growth models employ time series from 1990 to 2015. I look upon yearly data of real *GDP* constant in 2000, investment constant in 2000, labour force (15 to 64 years old) and working individuals with secondary school level of Tanzania in the period of 1990-2015. Labour force and secondary schooling data are obtained from World Bank Development Indicator (2012). Based on the obtain labour force data, common labour force growth rate n is calculated by taking the difference between the natural logarithms of total labour force at the end and beginning of each year and dividing by the number of years.

Mankiw et al. (1957) and Islam (1995), we assume g and s as a constant. The 'g' is the innovation of knowledge and machinery which is not country specific issue. The computation of reduction rate (δ) and labour force expansion rate (n) is thought to be 0.05 where the natural logarithm of n and 0.05 is estimated by the variable ln $(n+g+\delta)$. Having reviewed the Basic Solow Model and Augmented Solow Model and known, there is a connection between resources and production, but we still do not know what that connection is, since we cannot compute much of anything: we cannot give quantitative answers to any questions about the effects of changes in economic policy and the economic situation on economic growth. In order to make the model more useful, I put forth a simple algebraic form to the Basic Solow production function: the Cobb Douglas production form. Which I choose primarily because using it, it makes relatively easy to empirically test the effects of the economic variables of interest since it can be ñtunedò to fit any of a wide variety of different economic situations. I therefore present the Cobb Douglas production function as equation 10;

$Y(t)=K(t)^{\alpha}L(t)^{\beta}$ 10

To test the relationship of the above model, we transform the above Cobb Douglas production function into a log-linear regressive model by introducing natural logs, which is a helpful mathematical simplification. Therefore, the testable model can symbolically be expressed as in equation 11:

$\ln Y_t = \mu + \alpha \ln K_t + \beta \ln L_t + u_t$..11

The above model (11) is used to generate unrestricted estimates of the regression $Y(t)=K(t)^{\alpha}L(t)^{\beta}$

And it is always true that:

$\frac{Y}{L} = \left(\frac{K}{L}\right)^{\alpha-\beta}$ Then a log-linear equation is

$\ln\left(\frac{Y}{L}\right)=a+(\alpha-\beta)\ln\left(\frac{K}{L}\right)+\varepsilon$..12

Which is used to generate the estimates of the regression in per capita terms and no restriction is imposed as Cobb-Douglas estimated it initially.

Based on the behavioural relationship of output and factor of productions K and L, we postulate that $\alpha > 0$ and $\beta > 0$ and because $\beta > 0,$ it is further postulated that Y will increase if K increases and L improves.

Where α and β is elasticity of real GDP per capita with respect to Capital Stock (K) and Human Capital Stock (L).

$$\ln\left(\frac{Y}{L}\right) = \ln A(t) + \left(\frac{\alpha}{1-\alpha}\right)\ln(s) - \left(\frac{\alpha}{1-\alpha}\right)\ln(n+g+\delta) \qquad 13$$

It assumed that $A(t)=A(0)e^{gt}$ and $\ln A(t)=\ln A(0)+gt$ and further simplified to be equal to constant (a) plus residuals (ε), i.e., lnA(0) = a+ ε at time t = 0. Thus, the above equation can be re-written as shown in equation 14:

$$\ln\left(\frac{Y}{L}\right) = a + \left(\frac{\alpha}{1-\alpha}\right)\ln(s) - \left(\frac{\alpha}{1-\alpha}\right)\ln(n+g+\delta) + \varepsilon \qquad 14$$

The above equations (11) and (12) are estimated, first, by the method of Ordinary Least Squares (OLS) regression. Nevertheless, using this simple approach, which often ignores the non-stationary properties of the time series data. When both error term and dependent variable contain stochastic trends, our regression is spurious. Therefore, OLS often misleads us into believing that dependent variable and explanatory variables are related even when they are not. With this fact could cause misleading statistical inference and thus entail us to use other statistical methods. It is therefore necessary to ensure that the time series is stationary before proceeding to econometric estimation.

Two methods are applied to examine the time series properties of the economic variables of interest. The formal Augmented Dickey-Fuller (ADF) test is applied to test for the presence of unit root. Nevertheless, the conclusion of the order of the variables, 1(1) or 1(2), from this test are inconclusive because the critical values for unit roots tabulated by Fuller (1976) or Dickey and Fuller (1981) have a sample size of at least 50, whilst the sample size of data available for this study is only 25 observations. The critical values for smaller sample sizes are not presently available. The common formal method (Durbin Watson Test) performed for testing the autocorrelation. The null hypothesis in this test is that ɉ = 0 thus means no serial correlation, the alternative hypothesis will depend on the situation, but could be 0 < ɉ < 1 as positive autocorrelation or ï 1 < ɉ < 0 as negative autocorrelation.

With the assumption that the variables of interest are integrated of the same order 1(1), two methods, Engle-Granger (EG) test is applied to test for the existence of the long run and short run equilibrium between the variables of interest. Where evidence of a long run equilibrium is found, the error correction model (ECM) contributed by Granger (1986), and Engle and Granger (1987) is estimated by OLS, incorporating the short run dynamics of the system with the information from the long run co-integration relationship. Nevertheless, these procedures are not applied when it is assumed that the variables are integrated of order two, I(2) due to the limitation of small sample size.

Further to the above tests, the method for testing statistical causality between dependent variable and explanatory variables is the direct "Granger-causality" test proposed by C. J. Granger (1969). It suggests that while the past can cause or predict the future, the future cannot cause or predict the past. According to Granger, explanatory variables (K, L) cause dependent variable of interest (Y) if the past values of K or L can be used to predict Y more accurately than simply using the past values of K or L. In other words, if past values of Y statistically improve the prediction of K or L, then we can conclude that Y "Granger-causes" K or L.

The above production function provides a systematic relationship between output per worker $y/_1$ whose best proxy measure is the real GDP per worker and the economyôs available resources $k/_1$ whose best proxy measure is the Gross Fixed Capital formation (GFCF).

3.7 Type and Sources of Data

The data used in this dissertation is time series across 1990-2015 in Tanzania. The data obtained from four main sources; National Bureau of Statistics (NBS), United Nations Development Programs (UNDP), World Bank and UNSTAT. The Types of data gathered include; Labour force which comprises individuals ages 15 and older who provide labour for the production of goods and services; it also includes people who are currently working and people without a job but seeking work as well as first time job-searchers, Physical Capital Formation whose proxy measure is Gross Fixed Capital Formation (GFCF) and Aggregate and per capita real GDP for the period of twenty five years (1990-2015).

The researcher, gathered and used a number of sources. Aggregate investment rate whose proxy measure is Gross Fixed Capital Formation-GDP ratio (GFCF/GDP); Human Capital Formation whose proxy measure is Secondary Scholl enrolment and composite variable $(n+g+\delta)$ represents population growth (n); physical capital depreciation rate (δ) and rate of technological development (g). Population expansion rate is estimated as $n=\frac{1}{t}\log\left(\frac{L_t}{L_{t-1}}\right)$; t=1; t is the number of years and L represents labour force, $g+\delta$ are exogenously determined and it is assumed to be 0.05 throughout this study.

3.8 Data Analysis

Throughout the dissertation, we estimate both basic and augmented Solow models for the period 1990 to 2015. On the part of Solow model, per worker productivity expansion depends on the primary value of per worker output, savings and labour force expansion rate δ and g. In the Augmented-Solow model, we added the basic Solow model by imputing a measure of schooling. The variables considered presented on Table below which give you an idea about the summing up and express statistics of these variables.

Output per worker (Y/L): This is used as an alternative of output per capita during checking the Solow model. It will be wealth while to employ per worker returns where practically not all individuals in a state have nothing to add in production. Therefore, to compute Y/L, we will divide real GDP by the working age population.

Labour force expansion rate (n): n will be calculated as the average growth rate of working age population in percentage points.

Rate of savings (s): we use the ratio of real investment and real GDP to measure 's'

Human capital (secondary gross enrolment rate): we use human capital accumulation as proxy by the proportion of labour force that has secondary school level. By this dimension, it keeps out the possible bias from poor proxy as discussed by Gemmell (1996) and Temple (1999). Instead of considering secondary school enrolment (as used by MRW, Caselli et al., 1996, Bond et al., 2001), we have used percentage of population aged 15 to 64 who have secondary schooling years. By this dimension, it excludes the potential bias from poor proxy as argued by Gemmell (1996) and Temple (1999). We took the focus on human capital investment measuring in the form of education and ignoring investment in health and training.

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF FINDINGS

4.1 Overview

The chapter is dedicated to empirical analysis and interpretation of findings. This section among other things will present and discuss findings of Unit Root tests of data series and find out order of integration of variables under observation and further present co-integration test results and its corresponding discussion. In this section, we will further present Solow Growth model, Augmented Solow Model and unrestricted Cobb Douglas Production Function model estimates and succinctly discuss them. And conclude this section by presenting Granger Causality tests results and provide corresponding results discussions.

Table 4.1: Summary of Variable Description

Variable	Unit of Measurement	Data source
GDP		NATIONAL BUREAU OF STATISTICS
GFCF		UNITED NATIONS DEVELOPMENT PROGRAM
LABOUR FORCE	NUMBER	UNITED NATIONS DEVELOPMENT PROGRAM

Source: research, 2018

Table 4.2: Correlation Matrix

	lnGDP	LnGFCF	LnLABOUR
lnGDP	1.0000		
lnGFCF	0.9411	1.0000	
lnLABOUR	0.9613	0.8683	1.0000

Source: research, 2018

Table 4.3: Results of Cobb-Douglas Production Function

A: OLS Results of Estimation of Production Function in Level Form

Dependent Variable: ln GDP

Variable	Coefficient	Standard error
Observation	26	
CONSTANT	-17.5027	2.8919
ln GFCF	0.3812***	0.0641
ln (LABOUR FORCE)	1.9509***	0.2421
R^2	0.97	

Source: research, 2018

Table 4.4: OLS Results of Estimation of Production Function per Capita Level Form: Dependent Variable: ln(GDP per Labour Force)

Variable	Coefficient	Standard error
Observation	26	
CONSTANT	2.8033	0.3912
ln (GFCF/ LABOUR FORCE)	0.7298***	0.0708
Adjusted R^2	0.82	

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

In principle, GDP or output elasticity measures the responsiveness of GDP output to a small percent in levels of either labour force or capital formation used in production *ceteris peribus*.

The above results show that the Cobb-Douglas Production Function coefficient of determinant R^2 is approximately 0.97 which indicate that about 97% of the variations in GDP are explained by the function. The flexibility of GDP versus unit change in investment stock above is 0.3812 which is statistically significant at 1% of significance level and the elasticity of GDP with respect to unit change in labour force alone is 1.95 which is statistically significant at 1% of significance level. The results have turned out to be consistent with the Cobb-Douglasôs theoretical prediction in sign. The foregoing results imply that a 1% raise in labour force would cause 1.95% increase in GDP while a 1% increase in capital formation would lead to approximately 0.38% increase in GDP. The per capita stock of physical capital is a positive and it is a significant factor of GDP per capita at the 1 percent rank. Since both factors of production (Labour Force and Physical Capital) have become positive and significant, thus, implies that the GDP increase for the that time under observation is attributed to rise labour force and physical capital.

From Table 4.2 estimation model coefficient of determination (R^2) is 0.82; which shows that 82% of disparities in GDP per capita are explained by the function. Further to the degree of fitness; the flexibility of output produced by labour versus capital-labour ratio is almost 0.94 and is statistically meaning at 1% of significance level. These findings are consistent with Ogujiuba K, (2013) who investigated the impact of human capital formation in Nigeria and found that the labour force had a positive and statistically significant impact on GDP growth.

The CDF results are also consistent with Kalio, A. M. et al. (2012) who conducted a study of economic development in Kenya. He found out that the Kenyan economy is propelled by factors (Labour and Capital) of production accumulation. The foregoing study results show that there is increasing returns to scale in the production process for Tanzania since the total of GDP elasticities with respect to capital stock and labour force is higher than 1. These results are consistent with Tahmina Khatun and Sadia Afroze (2016) who explored the relationship between real GDP and factors of production (Labour and Capital) using Cobb-Douglas

Production Function for selected Asian Countries and found out that there is a strong positive and significant bond between real GDP and factors of production (Labour and Capital) for all selected Asian countries and the coefficient of determinant (R^2) of the model ranged between 0.93 to 0.99, indicating that most of variations in real GDP in all selected Asian countries are explained by labour and capital alone. They further revealed that there is increasing returns to scale in the production process for all selected Asian countries.

These empirical results are also consistent with Ndambiri et al. (2012) who looked at determinants of economic expansion in Sub Saharan Africa and found that physical capital creation was an essential positive determinant of economic enlargement among economies in Sub Saharan Africa. They also found out that a unit increase in the physical capital formation was likely to increase growth in GDP by 3.3% at a 99% confidence level. Their study also revealed that human capital had a positive impact on GDP escalation that means a unit increase in human capital probably will improve GDP status by 35.9% at a 99% confidence level.

4.2. Durbin-Watson Test for Serial Correlation

Serial autocorrelation is a violation of the Classical Linear Regression Modelõs (CLRM) key assumption that the error terms are uncorrelated between various observations. This often occurs in time series statistics data, where the error terms from at a particular period may have relationship to the error terms in following periods. However, serial correlation does not cause OLS be biased, though coefficients of independent variables will be inefficient in the sense that it is possible to obtain estimators with lower variance. This inefficiency stems from the fact that the OLS ignores the information about the relationship between the disturbances.

Durbin and Watson (1950) propose testing for correlation in error terms between adjacent observations. Based on the preceding sections; a linear regression model for CDPF is $\ln Y_t = \mu + \alpha \ln K_t + \beta \ln L_t + u_t$Where K_t is physical capital stock and L_t is a labour force (independent variables), Y_t , is a national GDP; α and β are constant parameters. By employing Durbin-Watson test we can check the significance of the autocorrelation. James and Geoffrey(1950) propose this test, in order to discover if the series holds autocorrelation or not. The necessary formula is as follow:

$$d = \frac{\sum_{t=}^{T}(u_t - u_{t-1})^2}{\sum^{T} (u_t)^2}$$

Where T= number of observations, u_t is contemporary time period return, u_{t-1} is prior time period return. The Durbin-Watson is roughly same to 2(1 -ɟ), means p is predictable parameter whose value is -1 < ɟ <1, *d* at all times lies amid of 0 and 4. If the statistically is substantially < 2 means +serial correlation and if the >2 means -serial correlation. As a rough rule of thumb, if *d* is <1.0 then there is strong positive correlation and if *d* is greater than 3.0 then there is strong negative correlation.

The results in Table 4.5 shows that DW-statistic is approximately 0.557 which is substantially lower than 2 and ɟ = 0.72 and revealed to be statistically significant at less than 1% level. Thus, there is evidence of positive serial correlation. This serial correlation is likely to have been caused by data for GDP (Y) and GFCF (K) due to the fact that they may have high interdependence in between successive values, which as a result has led to the error terms to also be highly interdependent.

Table 4.5: Results for Serial Correlation

Variable	Coefficient	t-Statistic	$p > \|t\|$
$\ln K_t$	0.3812	5.95	0.000
$\ln L_t$	1.9509	8.06	0.000
Constant	-17.5026	-6.05	0.000
R^2	0.97		
Prob > F	0.000		
Durbin-Watson d-statistic (3,26)	0.557		
u_{t-1}	0.7211	5.00	0.000
R_u^2	0.52		

Source: research, 2018

4.3 Testing for Long-run Relationship Between GDP, Capital and Labour Force

4.3.1 Estimation of Unit Root

A time series can be immobile if its mean and variance are does not depend on time. If the time series is mobile, means a mean and or a variance varying over time, that have a unit root (Johannes et al., 2011). Also, Augmented Dickey Fuller method is did a research to confirm for a unit root for every variables. If the calculated ADF test statistics is larger than Mackinnon Critical values you reject null hypothesis of non-stationary agree to the alternative of stationarity, otherwise, accept the null hypothesis of non-stationarity.

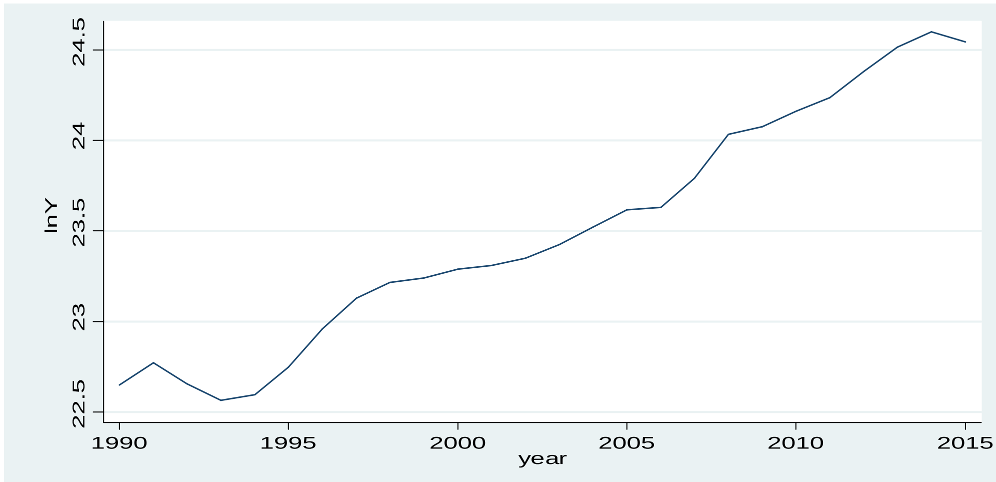

Figure 4.1: Gross Domestic Product (GDP) Time Series

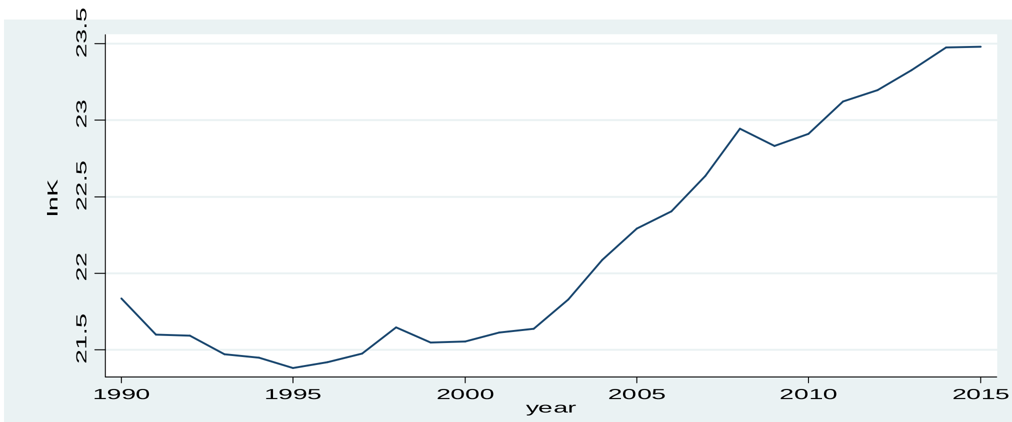

Figure 4.2: Gross Fixed Capital Formation (GFCF) Time Series

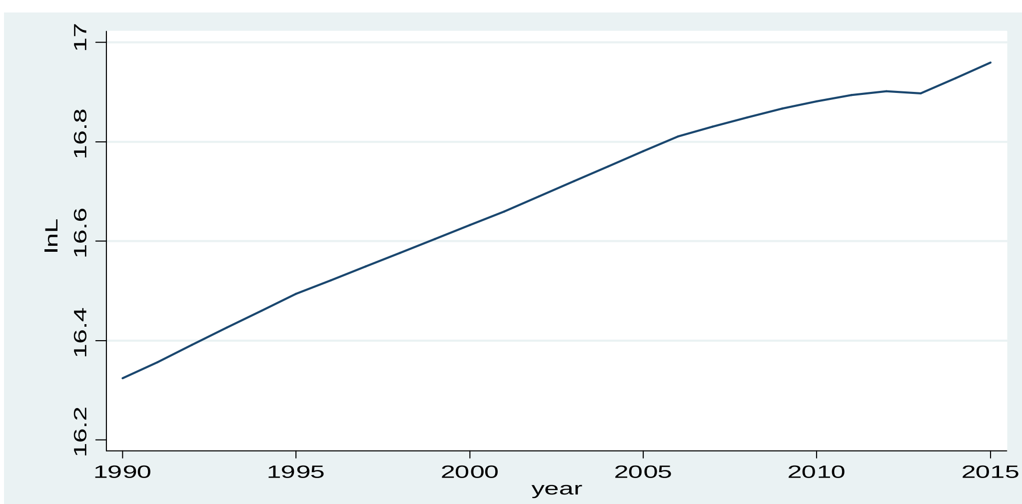

Figure 4.3: Labor Force Time Series

Figures 4.3 show logarithmic GDPôs time series, GFCFôs time series and Labour Force time series respectively as preliminary statistical diagnosis of Unit Root in the variables under observation. The above graphs show that all variables under observation trend upwards over time, which imply that are not integrated of I(0) or stationary.

Table 4.6: Results of Unit Root Tests

Variable	First Order Correlations (ɟ -1)	ADF Test Statistical Value	MacKinnon Critical Value at	MacKinnon Critical Value at 5%	MacKinnon Critical Value 10%	MacKinnon approximate p-value for Z(t)
GDP	-0.009	-0.299	-3.750	-3.000	-2.630	0.9257
GFCF	-0.027	-0.490	-3.750	-3.000	-2.630	0.8939
LABOUR FORCE	-0.032	-1.588	-3.750	-3.000	-2.630	0.4897

Source: research, 2018

Based on the result above, we accept H_0 hypothesis at all significance levels (1%, 5% and 10%) for GDP, GFCF and LABOUR FORCE, since the t-statistic values are significantly larger than critical values and these results are further confirmed by estimated first order autocorrelations of -0.299 implies that ɟ = (1-0.299) = 0.701 for GDP; -0.490 for GFCF; which implies ɟ = 0.510and -1.588; whereas the absolute value of ɟ = 0.588 for Labour Force. Therefore, we conclude that GDP, GFCF and labor force exhibit unit root and thus trend over time (non-stationary).

The foregoing results are consistent with Mehrara and Musai(2013) and Firat(2016); where the former inspected the causal link between education and GDP in developing nations; including Tanzania and revealed that GDP and human capital were unit root variables of I(1) and the latter performed unit root tests in Real GDP data series for 35 developed countries and found out that Real GDP was non-stationary and that it was a unit root variable which is also in line with findings of

Anoruo and Ahmad (2001) and Sultan Kuzu and Emrah Onder (2014).

4.3.2 Co-Integration Tests

According to Engle, R.F. and Granger, C.W. (1987); if both Y_t and X_t are integrated of order *d*; then it is commonly true that the linear combination $Z_t = X_t - aY_t$ will also be integrated of order *d* and that the variables Y_t and X_t are said to be co integrated. Also, we can say that, the variables are said to be co-integrated if variable Y_t and X_t contain variable trends but the residual; Z_t, doesn't. In order to know the presence of long-run relationship linking variables involved, we first apply Co-integrating Regression Durbin Watson (CRDW) as proposed by Bhargava (1984). In view of the foregoing co-integration test, we consider the following equation:

$$\ln Y_t = \alpha + \gamma \ln K_t + \beta \ln L_t + u_t$$

Based on CRDW, after running the co-integrating regression the Durbin Watson statistic is tested to see if the residuals appear stationary. If they are non stationary the DW will approach zero and thus the test rejects non co integration and it finds co integration if the DW is too big. Secondly, we study the long-run relationship of variables involved by using Engle and Granger test (1987), the two consider the problem of testing the null hypothesis of non co-integration between a set of integrated of order one I(1) variables. The process involves estimation of coefficients of a statistic relationship between these variables by OLS and then applies well-known unit root tests, such as Dickey Fuller (DF) and Augmented Dickey-Fuller (ADF) to the residuals. In this test we examine residuals from the co-integrating regression by running an auxiliary regression:

DF: $\Delta u_t = (\rho - 1)u_{t-1} + \varepsilon_t$; H_0: $\rho = 1$, H_a: $\rho < 1$

ADF: $\Delta u_t = \delta u_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta u_{t-i} + \varepsilon_t$; H_0: $\delta = 0$, H_a: $\delta < 0$

Rejecting the null hypothesis of a unit root is evidence in favor of co-integration.

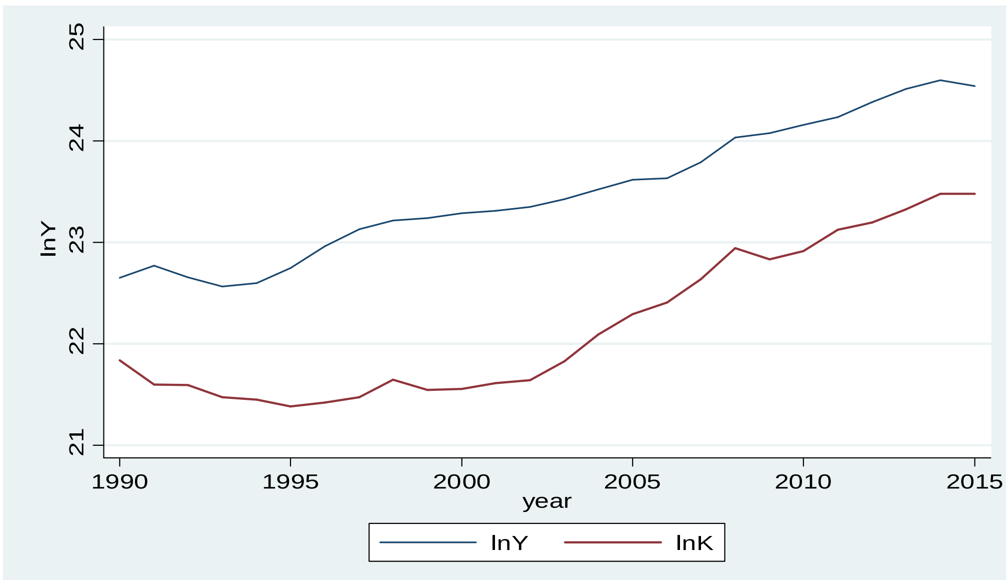

Figure 4.4: GDP and GFCF Time Series

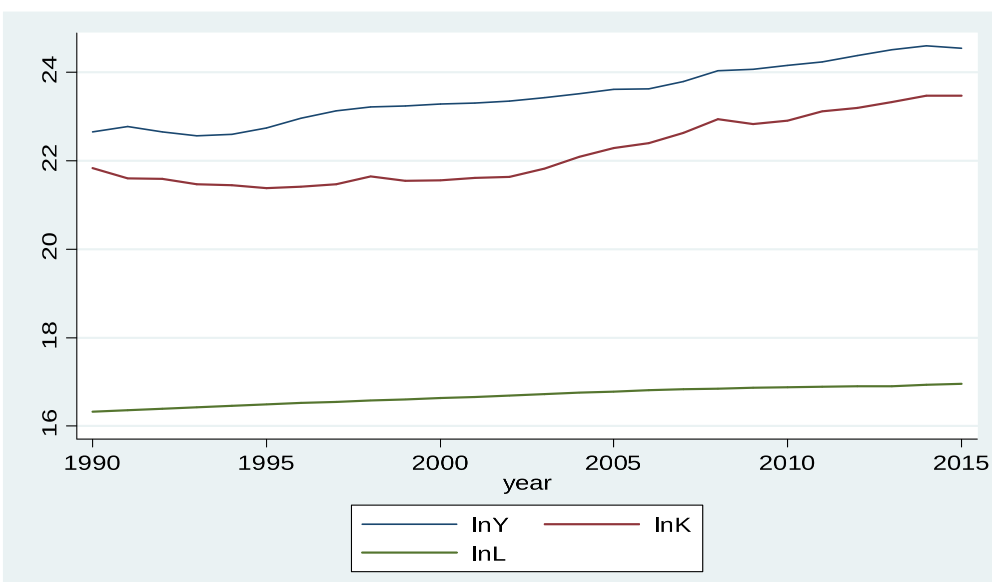

Figure 4.5: GDP, GFCF and Labour Force Time Series

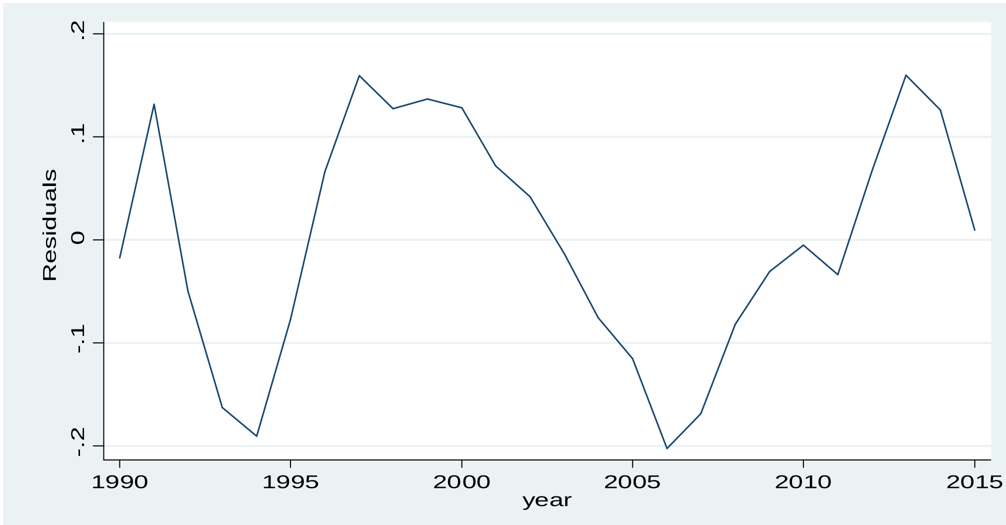

Figure 4.6: Residuals Time Series

Figures 4.5 and 4.6 shows logarithmic GDP and GFCF time series graphs and logarithmic GDP, GFCF and Labour Force time series respectively; whilst Figure 4.6 shows Residuals time series as preliminary statistical diagnosis of co-integration in variables under observation. The Figures 4.4.5-6 shows that variables under observation trend upwards together over time, thus, showing signs of these variables being co-integrated. Residuals time series graph shows a mean reverting trend, which implies that residuals are integrated of order zero; I(0).

Table 4.7: CRDW Test Results

Dependent variable:				
Observations: 26				
Variables	Coefficie	Standard	t-	Prob.
CONSTANT	-17.5027	2.8919	-6.05	0.000
ln GFCF	0.3812	0.0641	5.95	0.000
ln (LABOUR FORCE)	1.9509	0.2421	8.06	0.000
R^2	0.97			
Durbin-Watson statistic	0.5570			

Source: research, 2018

The study tested the long run co-integration properties between the variables. This was to help identify any equilibrium relationship between variables in the system. We understand that the DW statistic is obtained as $DW=2(1-\hat{\rho})$; where $\rho=\hat{\rho}$ is the estimated first order autocorrelation. The variable in matter is considered to be a random walk if $\rho=1$ and the DW statistic equals zero. The null hypothesis that the variable in question is a random walk H_0:$DW=0$ and its alternate is H_0:$DW>0$. From Table 4.7 results, the DW statistic is 0.5570 which is considerably different from zero. As such reject this null assumption to the residuals exhibit a unit root and thus conclude that the residuals are stationary. Therefore the results confirm the existence of co-integration between GDP, GFCF and Labor force.

Table 4.8: Engle-Granger ADF Test for Co-integration

Dependent variable: Δu_t				
Method: Least squares				
Sample: 1990-2015				
Variables	First Order Auto correlation	Standard error	t-statistic	Prob.
Lagged Residuals (u_{t-1})	-0.4644	0.1664	-2.791	0.014
Mackinnon: p-value for Z(t) = 0.0596				
significance (Critical values) levels	1%	5%	10%	
t-critical values	-0.3750	-0.3000	2.630	

Source: research, 2018

From the above Table 4.8 results, possible to reject the null hypothesis that residuals exhibit a unit root at only 10% significance level. Regarding the regression results, the estimated coefficient of lagged residuals of -0.4644 implies that ρ = 1-0.4644 = 0.5356, that is $\rho < 1$. Therefore, we can conclude that variables involved: GDP, GFCF and labor force co-integrated (exhibit long run relationship). The foregoing co-integration test results show that the present a long term relationship between the GDP, physical capital as proxied by GFCF and Labor force.

4.3.3 Error Correction Model (ECM)

The results from the co-integration tests indicate that the variables in the CDPF are co integrated, which implies that there is a long run equilibrium relationship between them. However, in the short run, perhaps there is dis-equilibrium. Therefore, the error term u_t can be treated as the ñequilibrium errorò. This error term can be used to link the short-run behavior of the dependent variables to their long-run values. The error correction process (ECM) initially used by Sargan, 1983 and later popularized by Engle and Granger(1956), adjusts the co integrated variables to each otherôs locations and thus, corrects the short-run disequilibrium (Gujarati, 1995). This is known as *Granger representation theorem*, which in this case says that X_t and Y_t are considered to be generated by ECMs of the form presented in equation 15:

$$\Delta y_t = \alpha + \sum_{j=1}^{p} \varphi_j \Delta x_t + \gamma (y_{t-1} - \sum_{i=1}^{n} \beta_i x_{t-1}) + \eta_t \quad ....15$$

y_t and x_t adjust towards their long-run relationship at speeds of γ

The $\gamma(y_{t-1} - \sum_{i=1}^{n} \beta_i x_{t-1}$ term is an error correction mechanism to keep y_t and x_t close to their long-run relationship or equilibrium. When $\gamma = 0$; implies that $\gamma(y_{t-1} - \sum_{i=1}^{n} \beta_i x_{t-1}) = 0$, which means that y_t and x_t are in their equilibrium, since there are no deviations detected by the error correction mechanism. Δy_t and Δx_t adjust towards their very short run relationship at speed of γ_1.

The $\gamma_1(\Delta y_{t-1} - \sum_{i=1}^{n}\beta_{1i}\Delta x_{t-1})$ term is the error correction mechanism to keep Δy_t and Δx_t close to their immediate short-run relationship. When $\gamma_1 = 0$; implies that $\gamma_1(\Delta y_{t-1} - \sum_{i=1}^{n}\beta_{1i}\Delta x_{t-1}) = 0$, which means that Δy_t and Δx_t are in their equilibrium, since there are no deviations detected by the error correction mechanism.

The larger γ is, the greater the response of x_t to the previous periodôs deviation from long-term equilibrium. On the other hand, a very small γ implies that x_t does not respond to the last periodôs equilibrium error. In this case, γ is zero and nothing about error correction, and equations 15 include nothing more than vector auto-regression in first differentiation. In principle, if this error correction mechanism method is relevant, then $1 < \gamma < 0$, where β estimates the long term effect that a one-unit increase or decrease in x has on y .

4.3.4 Error Correction Model Results

$$\Delta \ln Y_t = \lambda \Delta \ln K_t + \mu \Delta \ln L_t - \gamma(\ln Y_{t-1} - \beta_1 \ln K_{t-1} - \beta_2 \ln L_{t-1}) + e_t$$

Where the error correction mechanism is the segment of the equation in parentheses and γ captures the rate of return to the long run equilibrium. This model is estimated as follows:

$$\Delta \ln Y_t = \alpha + \lambda \Delta \ln K_t + \mu \Delta \ln L_t + \gamma ecm_{t-1} + e_t$$

The results of the model appears as:

$$\Delta lnY_t - 0.1540 + 0.0407 \times \Delta lnK_t - 3.289 \times \Delta lnL_t - 0.365 \times ecm_t + e_t$$

[0.009] [0.756] [0.090] [0.021]

$R^2 = 0.32$ $Prob > F = 0.0486$

Note: values in the parentheses represents significance levels

The ECM provides that the short run dynamic elasticity of GDP relative to GFCF and LABOUR are +0.0407, -3.289 respectively. The error correction method is negative and significant at 5% level, suggestive of that differences from equilibrium are corrected at about 37% per year. Nevertheless, capital formation (GFCF) have no significant effects on GDP, while LABOUR appear to have significant short-term effects on GDP at 10% level. This result implies that the GFCF does not have significant effect on the GDP in the short-run in the Tanzanian economy while LABOUR FORCE has important consequence on GDP in short-run.

4.3.5 Estimating Basic Solow Model

According to the this method, estimates on the equation (14) considered both with and without by impressive the restrictions that the coefficient of ln (*GDP)* and ln(n + *g* + δ*)* are same in size and opposite in sign. Assuming that, (g + δ) is 0.05 and capital consumption allowance is about 10 percent of GDP and capital-output ratio is 3, that means *5* is close to 0.03. It also embrace the Romer (1989) that *5* is about 0.03 or 0.04 for the sample.

Table 4.9: Results of Basic Solow Model 1990-2015

Variable	Coefficient	Standard error
Observation	25	
CONSTANT	-26.069^{***}	1.2400
ln(GFCF/GDP)	0.089	0.0698
$\ln(n_t + 0.05)$	-13.084^{***}	0.4788
R^2	0.97	
Restricted OLS:		
CONSTANT	5.824^{***}	0.4184
ln(GFCF/GDP)- $\ln(n_t + 0.05)$	0.853^{**}	0.3452
R^2	0.21	
p-value	0.0213	
Implied Č	0.46	

Source: research, 2018

The results presented in Table 4.9 show that, the estimated Solow Model has come out with a coefficient of determinant (R^2) of 0.97, which implies that 97% of the variations in GDP per unit of Labour is explained by the variations in population growth rate and investment rate; this imply that these rates are plausible determinants of Tanzaniaǿs economic expansion proxy by GDP per unit of labour force. Other estimated Basic Solow Model results are analyzed as follows: Firstly, the result depicts that the elasticity of output per worker (ln(GDP/LABOUR FORCE)) with respect to the saving rate ln(GFCF/GDP) is approximately 0.089 but it is statistically not significant even at 10% level.

However, it has turned out to be in line with the Solowǿs theoretical prediction in sign, though it is significantly different in magnitude. The coefficient (+0.089) of ln(GFCF/*GDP)* means 1 percent add to savings increase the amount produced per worker by 8.9%. Secondly, elasticity of amount produced per worker regarding to the population growth rate; i.e. ln(n+g+ŭ) is approximately -13.08 and it is statistically meaning of increase at 1% level of significance. However, its magnitude has turned out to be significantly higher than Solowǿs prediction of -0.50. The coefficient (-13.08) of ln(n + g + ŭ) represent that a bigger population increase rate lower the amount produced per worker significantly. These results are consistent with former findings by Ahuru, R. and James, U. (2015) and Habtamu, F. (2014); the former tested the Basic Solow Model performance in Nigeriaǿs economy and found out that signs of the coefficients of investment rate and population increase rate obey the rules of Solowǿs theoretical prediction whilst the latter assessed the impact of institutions on economic growth in Africa by employing classical growth models.

Thirdly, we can't reject the restrictions on the coefficients on ln(GFCF/*GDP)* and ln(n + *g* + ŭ *)* are equal in magnitude and opposite in sign as a whole. The results have turned out to have the same sign as theoretically predicted, however, the magnitude of the coefficient of 0.85 is significantly higher than theoretically predicted magnitude of 0.50. The estimates, however, imply an Ŭ of 0.46 which is much higher than theoretical prediction of 0.33.

4.3.6 Estimating the Augmented Solow Model

Table 4.10 illustrates the regression of log of income per working age people *(Y / L*) on the log of investment rate (*GFCF / GDP*), log of (*n* + *g* + δ*)* and log of the percentage of labour who have secondary education (*SCHOOL*).

Table 4.10: Results of Augmented Solow Model

Dependent Variable: Log of GDP in 1990-2015

Variable	Coefficient	Standard error
Observation	23	
CONSTANT	-16.1969***	2.0993
ln(GFCF/GDP*)*	-0.1819***	0.0626
ln(n+g+ŭ)	-9.2103***	0.8156
ln(SCHOOL)	0.2103***	0.0400
R^2	0.99	
Restricted OLS:		
CONSTANT	7.1633***	0.1765
ln(GFCF/GDP*)*- ln(n+g+ŭ)	-0.4737***	0.1518
ln(SCHOOL *)*- ln(n+g+ŭ)	0.6204***	0.0417
R^2	0.93	
Implied Ŭ	-0.32	
Implied ɓ	0.82	

Source: research, 2018

The findings represented in Table 4.10, providing an estimates of Augmented Solow Model show that the inclusion of human capital has improved the goodness of fit from 0.97 to 0.99, which implies that after augmenting basic Solow Model with human capital 99% of the difference in GDP per worker is determined by the regressors, which is consistent with Ahuru and James (2015) findings and Romer et al.(1992) proposition. Other estimated Augmented Solow Model results are analyzed as follows: First, the elasticity of income per capita (ln(GDP/LABOUR FORCE)) with respect to the saving rate ln (GFCF/GDP) is approximately -0.18 and it has statistically meaning at 1 percent level. However, it has turned out to be contrary to the Solowøs theoretical prediction in both sign and magnitude. Secondly, the elasticity of income per capita with respect to the population growth rate; i.e. ln(n+g+ŭ) is approximately -9.21 and it statistically meaning at 1 percent. However, its magnitude has turned out to be significantly higher than Solowøs prediction of -0.50.

Thirdly, the elasticity of income per capita with respect to human capital; i.e. ln(SCHOOL) is approximately +0.21 and has turned out to be statistically significant at 1% level and its magnitude is relatively lower than Mankiw et al. (1992) result. Based on the foregoing results, total of the coefficients on ln(GFCF/GDP), ln(n+g+ŭ) and ln(SCHOOL) is approximately -9.18 which is opposite to a previous prospect of zero. The latter two explanatory variables (human capital as proxied by school enrolment and population growth) are resemble to Kilishi et al. (2013) who explored the relevance of Augmented Solow Model for Africaøs economic growth and found out that human capital had a positive and significant impact on the GDP per capita and population expansion had a negative and significant effect on the GDP per capita. However, contrary to empirical results above, Kilishi et al. (2013) found out that physical capital had a positive and major effect to the GDP per capita and thus conformed to the priori expectation. These results partially confirm the relevance of Augmented Solow Model in explaining Tanzaniaôs economic growth.

Fourthly, ln (SCHOOL) and ln(n + *g* + ŭ *)* are equal in magnitude and opposite in sign is not wholly rejected as the former coefficient has turned out to have a different sign from the theoretically predicted one and the later coefficient turned out to have the same sign as theoretically predicted, however, the magnitude of the coefficient of 0.62 is slightly higher than theoretically predicted magnitude of 0.50. The estimates, however, imply Ŭ of -0.32 and ɓ of 0.82 which are not in line with the theoretical prediction of 0.33.

4.3.7 Granger Causality Test

The foregoing co-integration result implies that causal relations exist data, however, it does not point out the path of the causal relationship. It is imperatively essential to find out the direction of causality between GDP, physical capital as proxied by GFCF and Labour Force for decision making. This is very important because literature review has revealed a disagree with result on the relationship between human capital as proxied by Labour force, physical capital as proxied by GFCF and economic growth as proxied by GDP.

No matter how a dependent variable may be statistically related to a set of independent variables, the existence of causality between these variables is not really guaranteed (Rhee, H., 2015). According to Granger, C.W. (1969); Physical capital (K_t) is causing GDP (Y_t) provided coefficient of K_t is significantly different from zero, similarly Y_t is causing K_t if coefficient of Y_t is not zero; so applies for Labour force (L_t) and GDP, Labour force and physical capital. The foregoing definition is implemented for empirical testing by using the following VAR Model-1 whose results are presented in Table 4.9:

$$\ln Y_t = \sum^{m} \alpha_{1j} \ln Y_{t-j} + \sum^{m} \beta_{1i} \ln K_{t-j} + \sum^{m} \mu_{1i} \ln L_{t-j} + u_{1t}$$

$$\ln K_t = \sum^{m} \alpha_{2j} \ln Y_{t-j} + \sum^{m} \beta_{2i} \ln K_{t-j} + \sum^{m} \mu_{2i} \ln L_{t-j} + u_{2t}$$

$$\ln L_t = \sum^{m} \alpha_{3j} \ln Y_{t-j} + \sum^{m} \beta_{3i} \ln K_{t-j} + \sum^{m} \mu_{3i} \ln L_{t-j} + u_{3t}$$

Second set of Granger Causality test is performed on Marginal Productivity of Labour, in which the empirical testing is performed using the following VAR Model-2 whose results are presented in Table 4.11 below:

$$\ln\left(\frac{Y}{T}\right) = \sum^{m} \delta_{1j} \ln\left(\frac{Y}{T}\right) + \sum^{m} \gamma_{1i} \ln\left(\frac{K}{T}\right) + v_{1t}$$

$$\ln\left(\frac{K}{T}\right) = \sum^{m} \delta_{2j} \ln\left(\frac{Y}{T}\right) + \sum^{m} \gamma_{2i} \ln\left(\frac{K}{T}\right) + v_{2t}$$

Table 4.11: Granger Causality Wald Test

Lag Level **Null hypothesis (*H_0*)**	**2**		**4**		**Results**
	F-Stat.	**Prob.**	**F-Stat.**	**Prob.**	
GFCF doesnǭt Granger cause *GDP*	0.9154	0.4192	0.9284	0.4890	Do not reject H_0
LABOUR FORCE doesnǭt Granger cause *GDP*	15.878	0.0001	3.2121	0.0674	Reject H_0
GFCF & LABOUR FORCE doesnǭt Granger cause GDP	8.3273	0.0007	2.0088	0.1595	Reject H_0
GDP doesnǭt Granger cause GFCF	0.6977	0.5114	0.2577	0.8978	Do not reject H_0
GDP doesnǭt Granger cause LABOUR FORCE	1.3523	0.2851	0.8344	0.5363	Do not reject H_0
LABOURCE FORCE doesnǭt Granger cause GFCF	3.4832	0.0540	1.3465	0.3253	Reject H_0
GDP & LABOUR FORCE doesnǭt Granger cause GFCF	2.717	0.0646	0.9849	0.5031	Reject H_0
GFCF doesnǭt Granger cause LABOURCE FORCE	1.1937	0.3273	1.2608	0.3533	Do not reject H_0

Source: World Bank, UN statistics

The VAR (2) and VAR (4) models are used to find out the direction of causality. Table 4.9 shows the results the null hypothesis that physical capital (GFCF) does't Granger cause Gross Domestic Product (GDP) is not rejected at 10 percent level of significance; it implies that physical capital as proxied by GFCF has no effect on the GDP, which is consistent with results of Mohammad et al. (2014). The null hypothesis that LABOUR FORCE does't Granger cause Gross Domestic Product (GDP) is rejected at lower than 1 percent level of significance for VAR (2) and at lower than 10% level for VAR (4), implying that Labour Force has effect on the GDP, which is not consistent with findings of Mohammad et al. (2014) and Mirza et al. (2015).

The null hypothesis that LABOUR FORCE and GFCF does't Granger cause GDP is rejected at lower than 1 percent level of significance for VAR Model (2), thus, implying that the combination of the two economic inputs have effect on the GDP, though physical capital without Labour force has no effect on the GDP, which is again consistent with conventional wisdom. The Granger causality test has also revealed that GDP and LABOUR FORCE cause physical capital accumulation (GFCF) at lower than 10% level for VAR Model (2) and LABOUR FORCE alone cause GFCF at 5% level for VAR Model (2), which is same with results of Mohammad et al.(2014) and findings of Zivengwa(2012). Based on the Granger Causality test results above, there is a clear causal relationship between labour force alone and GDP and if labour force is combined with capital has a unidirectional effect to GDP.

Table 4.12: Results of Granger Causality Wald Test

Lag Level / **Null hypothesis (H_0)**	**2**		**4**		**Results**
	F-Stat.	**Prob.**	**F-Stat.**	**Prob.**	
GFCF/LABOUR FORCE does not Granger cause	2.7394	0.0901	4.1264	0.0225	Reject H_0
GDP/LABOUR FORCE does not Granger cause *GFCF/LABOUR FORCE*	1.4758	0.2536	1.5587	0.2434	Do not reject H_0

Source: research, 2018

In this context of VAR Model-2, the null hypothesis that the ratio of physical capital (GFCF) to LABOUR FORCE does't Granger cause the ratio of Gross Domestic Product (GDP) to LABOUR FORCE is rejected at 5 percent level of significance for VAR(2) but we can't reject the null hypothesis that the ratio of GDP to LABOUR FORCE does't Granger cause the ratio of GFCF to LABOUR FORCE at 10 percent level for both VAR(2) and VAR(4), implying that there is unidirectional causality that runs from GFCF per worker to GDP per capita, which is consistent with findings of Pathania, R.(2013) who found a unidirectional causality that runs from domestic capital formation to economic growth (GDP) in India and Alfa, A.B. and Garba, T. (2012) who explore the feedback causality consecutively from domestic investment to economic increase in Nigeria. These results suggest unidirectional causation that runs from capital per unit of labour to GDP per labour.

CHAPTER FIVE

SUMMARY, CONCLUSION, POLICY RECOMENDATIONS AND AREAS FOR FURTHER RESEARCH

5.1 Summary

Every country seeks to improve the wellbeing of their people and this dream can't be realized if there is lack of enough economic growth. Tanzania, like any other less developed countries don't have adequate resources for execute his development projects, as a result the country requires prudent and specific socio-economic policies for optimal allocation of the national resources at disposal for socio-economic development. This paper has investigated the impact of human capital and physical capital accumulation on the economic expansion of Tanzania. It further examined the causal links between human capital, physical capital accumulation and economic growth by testing hypotheses whether these key factors of production have positive relationship with economic growth. In course of testing and estimating the economic relationship, two alternative models have been used: Solow Growth model and Cobb Douglas Function model.

5.2 Conclusion

Considering the estimates of unrestricted Cobb-Douglas Production Function; labour force has revealed to be the main factor in explaining GDP expansion followed by physical capital. It is further supported by results under marginal productivity of labour, which shows that increase of approximate 0.94% of capital formation per labour (worker) will trigger an increase of 1% on the output per worker. In other words, there is same representation among capital per labour and productivity per labour. However, this relationship is not in long term equilibrium because variables are not co-integrated. These results are consistent with former findings by Kanayo, (2013); Kailo et al. (2012); Khatun, T. and Afroze, S. (2016); Ndambiri et al.(2012) and Sharma, H. (2007).

Secondly, the estimation of Basic Solow Model express that expansion in labour force significantly lower the productivity per worker, where about 9% increase in savings rise the productivity per worker up by 1%, though the results have turned out to be statistically not significant. Thirdly, when human capital assessment is added also Augmented Solow model is estimated, the result suggests that GDP per labour is well presented by Augmented Solow growth model with degree of fitness (R^2) of 0.99 as compared to 0.97 under Basic Solow model. The findings shows that the elasticity of GDP per worker (ln(GDP/LABOUR FORCE)) with respect to the saving rate ln(GFCF/GDP) is approximately 0.089; which is consistent with Solowôs theoretical prediction though turned out to be statistically not significant. The foregoing result implies that higher savings rate leads to higher GDP in steady state which again increases the level of human capital even if the rate of human capital accumulation is constant.

The elasticity of productivity per labour regarding to the population growth rate augmented with 0.05 (ln(n+g+ŭ)) is approximately -13.08 and it is statistically significant. The foregoing result suggests that the expansion rate of working age population has a negative impact on output per labour, thus, further implies that increase of working age population by approximate 13% will trigger a reduction of output per worker of 1%, unless the physical capital accumulation increases at a higher rate than working age population growth rate. These findings are consistent with former findings by Ahuru and James (2015) and Habtamu(2014).

Based on the Granger Causality test results show that there are no clear causal links between the three variables: GDP, GFCF and LABOUR FORCE while Granger Causality Wald test results suggest unidirectional causation that runs from capital per unit of labour to GDP per labour to economic growth. However, the descriptive influence of the restricted regression i.e. R^2 is 0.21 which is substantially lower than Mankiw et al. (1992) coefficient of determination of about 0.59. The foregoing results are plausible and consistent with Solowȸs theoretical prediction in sign, despite the model explanatory power being significantly low.

5.3 Policy Implication

Economic theory suggests that, human capital stock and physical capital accretion are still key factors for economic development, and empirical evidence from diverse sources confirm this relation. Countries with a higher level of educational attainment and higher level of investment grow faster for a given level of initial per capita GDP and for given values of policy related variables.

The study results have revealed that physical capital as proxied by GFCF and Labour forces are important determinants of economic growth as proxied by GDP in Tanzania. This implies that government should prioritize skill development and investment in physical capital formation. Furthermore, the study tried to explore the both long-run and short-run impact of investment rate as proxied by savings rate; population growth and human capital as proxied by students enrolled secondary school level on economic growth, our findings revealed that there is a positive relationship between GDP per capita and human capital.

In view of the foregoing findings, Tanzania's government needs to optimally allocate national resources to human capital; i.e. improve school enrolments with intention of up lifting the marginal productivity of labour and thus to stimulate economic growth. The study also revealed that population growth negatively impact on the GDP per capita, thus, for government to achieve growth in GDP per capita; it has to devise population policy that will stimulate GDP growth. Findings further reveal that there investment rate has a positive impact on the per capita GDP, thus, government has to devise investment policy that is aimed at fostering the GDP of the country and thus improve the welfare of its citizens.

There are other factors which influence economic expansion such as inflows and outflow of foreign direct investment, technological progress, financial systems, geographical circumstance of the country as well as governmental policies like good governance, rule of law and so on; to achieve and maintain high economic expansion as proxied by GDP; policy makers are encouraged to make every effort to stimulate the key drivers of economic growth (physical capital and human capital).

5.4 Areas for Further Research

The above findings are not conclusive since might have influenced by the data used and statistical tools applied. In the view of the foregoing, it is imperatively important to note that these findings are open for further research by taking consideration of other economic factors that may attribute to economic growth.

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APPENDIX

APPENDIX 1: Data used

year	GFCF (USD)	GDP (USD)	LABOUR	n+g+ŭ
1990	3,040,146,389.88	6,863,303,205.64	12,284,689.00	0.0500
1991	2,398,762,262.91	7,757,198,579.57	12,690,442.00	0.0825
1992	2,383,911,461.30	6,904,494,979.99	13,134,737.00	0.0835
1993	2,111,106,518.62	6,300,101,899.15	13,603,179.00	0.0840
1994	2,065,655,505.98	6,501,949,419.46	14,081,298.00	0.0841
1995	1,929,763,575.88	7,574,893,037.46	14,559,780.00	0.0840
1996	2,005,009,126.60	9,363,641,300.31	14,969,163.00	0.0829
1997	2,119,512,193.85	11,075,534,133.29	15,385,426.00	0.0822
1998	2,516,609,731.02	12,081,805,241.02	15,812,974.00	0.0816
1999	2,277,464,491.82	12,393,095,907.66	16,256,665.00	0.0811
2000	2,294,369,601.31	13,016,641,916.12	16,719,818.00	0.0808
2001	2,431,292,683.14	13,269,384,378.89	17,187,443.00	0.0805
2002	2,494,758,197.14	13,808,718,850.40	17,724,121.00	0.0805
2003	3,020,273,058.12	14,899,461,012.44	18,265,670.00	0.0805
2004	3,913,808,170.72	16,390,379,737.40	18,822,642.00	0.0805
2005	4,802,737,277.07	18,072,274,282.43	19,401,799.00	0.0805
2006	5,372,639,242.06	18,314,200,299.18	19,986,223.00	0.0804
2007	6,769,033,459.32	21,501,742,378.35	20,385,153.00	0.0798

2008	9,220,455,092.82	27,388,319,158.86	20,778,406.00	0.0792
2009	8,243,308,453.34	28,574,171,780.76	21,141,500.00	0.0786
2010	8,921,062,301.35	31,105,429,966.90	21,460,671.00	0.0779
2011	11,020,029,211.82	33,561,501,421.59	21,728,469.00	0.0772
2012	11,867,407,047.02	38,808,658,076.56	21,902,561.00	0.0763
2013	13,512,079,482.99	44,333,455,762.69	21,806,751.00	0.0750
2014	15,700,592,375.06	48,197,218,056.94	22,486,750.00	0.0752
2015	15,740,268,642.98	45,628,248,022.54	23,202,254.00	0.0754