

**JIMMA UNIVERSTIY**  
**SCHOOL OF GRADUATE STUDIES**

Human capital and economic growth: causality and co –  
integration analysis

Tewodros Zerihun

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**Jimma, Ethiopia**

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Tewodros Zerihun

**A thesis submitted to the school of Graduate Studies of Jimma University in partial fulfillment of the requirements for the Degree of Masters of Science in Economics (Economic Policy Analysis).**

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## **Abstract**

In this study, the relation between education and health that are accepted as an indicator of human capital and economic growth is tested empirically. The study aimed at decomposing the relationship between human capital (using health index and education index as a proxy) and economic growth using time series data from 1971- 2011 in Ethiopia using modern econometrics technique. Long-run relationship among variables is confirmed through Johnson co-integration analysis whereas the long-run and short-run dynamics are observed by VECM specification. For causality purpose both VECM based causality tests are employed. The finding indicates that in the long run investment on education and health would affect further economic growth. Hence policy makers and / or the government should strive to create institutional capacity that increase school enrolment and improved basic health service by strengthening the infrastructure of educational and health institutions that produce quality manpower. In addition to its effort, the government should continue its leadership role in creating enabling environment that encourage better investment in human capital (education and health) by the private sector. So any countries policy designed to promote economic growth should have to consider priority in health and education.

## ACRONYM

<b>ADF</b>	<b>Augmented Dickey Fuller</b>
<b>CSA</b>	<b>Central Statistics Agency</b>
<b>FIML</b>	<b>Full Information Maximum Likelihood</b>
<b>GDP</b>	<b>Gross Domestic Product</b>
<b>GNP</b>	<b>Gross National Product</b>
<b>MoE</b>	<b>Ministry of Education</b>
<b>MoH</b>	<b>Ministry of health</b>
<b>NBE</b>	<b>National bank Ethiopia</b>
<b>NLCCC</b>	<b>National Literacy Campaign Coordinating Committee</b>
<b>OECD</b>	<b>Organization for Economic Cooperation and Development</b>
<b>OLS</b>	<b>Ordinary Least Square</b>
<b>US</b>	<b>United States</b>
<b>VAR</b>	<b>Vector Auto Regressive</b>
<b>VEC</b>	<b>Vector Error Correction</b>
<b>VECM</b>	<b>Vector Error Correction Model</b>

# **Chapter One**

## **Introduction**

### **1.1 Background of the study**

As an economic concept human capital is at least two centuries old, but its incorporation into the mainstream of economic analysis and research is a new and lively development. The need for this development became apparent in the 1950's, when the application of empirical economic research to the concerns about economic growth and about income distribution revealed major defects not only in our understanding of each but also in our way of thinking about these matters. Human capital refers to education, health, on-job training and the skills acquired through interaction of people or societies. In more technical term human capital is defined as the aggregation of the innate abilities and the knowledge and skills that individuals acquire and develop throughout their lifetime (Laroche and Merette, 1999).

According to Fisher (1906) the development of human capital theory was a response to twin challenges, which merely involved the abolition of two simplifying: (1) the restriction of the concept of capital to physical capital, and (2) the assumption of homogeneous labor which underlies both the concept of functional income distribution and the measurement of labor input in man-hours. Fisher's definition of capital as any asset that gives rise to an income stream requires the inclusion of human capital, even if it cannot be bought and sold (it is, of course, rented), and even though investments in such capital often involve non—market activities. To the extent that they involve costs and returns, whether explicit or implicit, they are amenable to economic analysis, even if measurement problems are difficult. The payoff is now apparent in both of the problematic contexts: (1) at the macroeconomic level, the social stock of human capital and its growth are central to the process of economic growth. (2) At the microeconomic level, differences in individual human capital stocks and

in their growth can explain much of the observed variation in the wage structure and in the personal distribution of income.

On the contrary theories of Neo-classical growth theory that was dominant until 1980s and it identifies the source of economic growth with technology and increase in population which is considered as external in the model. Alternatives to this The Neo-classical growth theories, which take shape depending upon savings, capital-labor and income variables, pro- pound that there will be no long-term discrepancy between countries in terms of level of development. The endogenous growth theories bring forward the idea that endogenous conditions like human capital, foreign trade policies, financial development and public expenditures of a country can affect economic growth (Strauss, 1986).

It is also emphasized by the endogenous growth theories that in the development process, health care and education expenditures play an important role in the formation of human capital and have a significant contribution to the sustainable economic growth in long- term. The indicators of human capital are taken as public expenditures on education and health which are much broader than conventional literacy rate, average no. of schooling years or health facilities provided. Human capital is also taken as an index of human welfare as health and education are not only means to accelerate economic growth but are also recognized as the principal indicators of economic development, considering this recent findings uses education and health index as proxy to deal with the relation (Ferid and Zefer, 2013).

Considering this During the Imperial period; in the initial phase and the more planned and coordinated expansion of education after 1941, the primary objective of education had been to produce trained manpower that could run the emergent state bureaucracy. Particularly after 1941, the Government's main concern was to replace expatriates that worked at various levels in the state missionaries by Ethiopian nationals. Hence the Ethiopian Government

continued to believe that education held the key to Ethiopia's development. To meet this need, reconstruction began with the re-establishment of the Ministry of Education in 1942. To enhance expansion, a Board of Education was established in each region and an educational tax was also introduced to partly finance education. To supplement government efforts, private and voluntary organizations were encouraged to open schools. The missionaries were also, for the first time, officially invited to participate in providing educational services. From 1942 until 1955, the Ethiopian Government was engaged in the expansion of the education system. The high expenditure on education in relation to total expenditure, as well as the rapid growth of student enrolment showed the commitment of the Ethiopian government to the expansion of education (Ayalew, 1989).

During the DERG regime the structure and organization of educational activities were changed alongside the objectives of the socialist government which states, "There will be an educational program that will provide free education, step by step, to the broad masses". The military regime worked toward a more even distribution of schools by concentrating its efforts on small towns and rural areas that had been neglected during the Imperial regime. With technical assistance from the Ministry of Education, individual communities performed all primary school construction. The regime also nationalized all private schools, except church-affiliated ones, and made them part of the public school system. One of the success stories in the socialist regime has been the achievement in terms of reduction of illiteracy rate in the country. Even though the Derg has greater achievement on expanding on distribution of education it failed to build on what was already achieved in the past. That is Private sector development and the development of the market incentive structure both in the education sector and in the labor market were highly discouraged (woubet, 2006).

According to the Transitional Government of Ethiopia (1994), it was necessary to replace the educational system that serves "the old discarded order by the

new one” The development of the education sector in Ethiopia has been at an early stage. On the eve of the ongoing educational reform process, which began in 1994 following the endorsement of the New Education and Training Policy, enrollment in primary education stood at about 2.81 million. The new strategy presupposes the overall lack of coordination between education, training, research and development efforts in the country. The regimes emphasis has shifted to the formal education; addressing the problems of low enrolment in the formal schools, rectifying gender imbalance and the like. The government has done greater achievement in higher education in which reached up to 31 universities, though the quality in doubt (Woubet 2006).

## **1.2 Statement of the Problem**

According to Harbison and Myers (1964) Human resource development is one of the necessary conditions for all kinds of growth: social, political, cultural, or economic. The concept that investment in human capital promotes economic growth actually dates back to the time of Adam Smith (1776) and the early classical economists who emphasized the importance of investing in human capital. Sustained economic growth accompanied with social development is one of the notable macroeconomic objectives of every country and in this regard human capital is deemed as an essential ingredient.

Therefore, it can be concluded that human capital has gained significant importance in growth theories. However, its measurement is not addressed properly in economic literature. Various researchers have utilized different proxies for human capital, e.g. Mankiw et al. (1992) utilize secondary education enrollments. Barro and Lee (1993) and Bosworth et al. (1995) have used average years of schooling. The existing literature on human capital reveals that while acknowledging the role of human capital in economic growth macroeconomists express human capital solely in the form of education

whereas micro economists consider health as another important component of human capital beside education. They believe that health plays significant role in the formation of human resources because in order to ensure growth in productivity, people need to be healthy or protected from sickness. It means health and education both are primary ingredients of human capital formation.

However human capital theory as well as endogenous growth theory suggests that there are substantial economic effects of education on the micro and macroeconomic level. The interrelationship between education and economic growth has been the subject of public debates, enjoying a wide interest since the era of Plato. According to Dikens et al. (2006), Zoega (2003) and Barro (1991), education has a high intrinsic economic value since the investments in education led to the formation of human capital, which is one of the causes of economic growth. According to Stevens and Weale (2003), life quality has substantially increased in the last millennium in most countries of the world, and particularly in European countries, the development of educational field has been contributing to it. One of the main motivations for studying education from economic point of view is its impact on reducing income inequalities (Ram, 1990), and the relationship between education and labor market (Benito and Oswald, 2000).

Empirical studies including Schultz (1960, 1963), Denison (1962, 1974), Becker (1961), Harbison and Myers (1964), Tilak (1989), Nadiri (1972), Barro (1991), Mankiw, Romer and Weil(1992), Benhabib and Spiegel (1994) and many others have shown that increased education of the labor force appears to explain a substantial part of the growth of output in both developed and developing countries. However a study by Lant Pritchett (1996) showed that (especially for developing countries) the growth of educational capital per worker has had a mildly negative or no impact on the growth of these economies Due to its quality, schooling may not actually raise cognitive skill or productivity and also Expanding the supply of education in the presence of stagnant demand for educated labor causes the economic return to education

to fall rapidly and due to the institutional set up in these countries, the improved cognitive skills acquired through education engage in privately remunerative but socially dysfunctional or wasteful activities so that aggregate output stagnates or even falls. The recommendation in this perspective was not actually “don’t educate” rather “reform so that investments (past and present) in education will pay off”.

In Ethiopia Woubet (2006) investigated the impact of human capital on economic growth over the period 1971-2005 through the application of an Error-correction methodology. In its variable definitions he uses total output, gross capital formation, average human capital, gross exports, labor force, and official development assistance. The finding indicates the average level of human capital appears to have no significant impact on the evolution of total level of output. And reasons for the low performance of the economy in terms of output growth may be attributed to Ethiopia's poorly developed human capital base lagging far behind the Sub-Sahara African average. This study differs from the previous studies in approach to causality and co integration for determination of long-run relationships and tries to answer the dynamic nature of relationship between human capital and GDP. This paper bases its variable definition on the recent researches of health index and education index to analyze the interaction between human capital and economic growth.

### **1.3 Hypotheses of the study**

Becker (1962), who believes that human capital is just like physical capital and one, can invest in it by means of education, health and training which, in turn, will raise output and contribute to economic growth. Proponents of endogenous growth theory lay emphasis on human capital formation and regard it a factor which explains difference in growth performance of under developed and



developed nations (Rebelo, 1991). In the empirical findings of the study possible relationships between human capital and economic growth are:

- (i) Unidirectional causality from human capital to economic growth;
- (ii) No causality between human capital and economic growth;

#### **1.4 Objectives of the study**

The core objective of the study is to assess the relationships between human capital and economic growth in Ethiopia. Under this specific objective of the study are:

To examine the short run as well as long run relationships between economic growth and health in Ethiopia

To examine the short run as well as long run relationships between economic growth and education in Ethiopia

To derive possible policy option based on the empirical findings that promote economic growth

#### **1.5 Significance of the study**

It is obvious that academies and institutions that are expanding education are instrumental to promote higher economic growth. Unfortunately, there has not yet been clear and tangible empirical evidence to describe the contribution of education and health to economic integration. The paper assesses the particular conditions for Ethiopia.

However, the theoretical arguments are usually really on empirical evidences which deal the direct and indirect efforts of education on economic growth. But

this must be analyzed from more directive or vast perspective in which researches show interactive relationship between human capital and economic growth. Due to this one basic way to respect is analyzing the strategy and policy frame work in which education and health the vacuum which has been lacking empirical studies that analyzed the contribution of human capital to economic growth. So, this study help for the appropriate policy option regarding the subject area of health, education and economic growth in Ethiopia.

## **1.6 Scope of the study**

The study examines the long run as well as short run relationship between human capital formation and economic growth in Ethiopia between 1971 to 2011 fiscal years. Even though human capital formation includes education, training, health, social capital, and more. The study confines itself by considering health index and education index as a proxy for human capital development.

## **1.7 Organization of the study**

The whole paper organized in to five chapters. The first chapter contains: introduction of the study, statement of the problem, research hypothesis, and significance of the study, and the organization of the paper itself. In chapter two, theoretical and empirical findings and education and health policy in Ethiopia are discussed. In Research methodology part of chapter three, model specification, data issues and estimation procedures are discussed in detail. In Chapter four empirical results of data analysis are evaluated. In the last chapter Discussion and Implications with possible policy proposition are forwarded based on empirical findings of the study.

## **Chapter Two**

### **Literature Review**

#### **2.1. Theoretical Literature Review**

There is a vast literature on the benefits of education and health stretching back to antiquity. Although the concept of investing in oneself to improve productivity is seemingly intuitive, the entire theory of human capital hinges on the paramount assumption that investments such as education and health do in fact translate into higher worker productivity. Hence the interaction between human capital and economic growth has been an object of investigation for several decades, both in macroeconomic (Pereira and Aubyn, 2009; Odit et al., 2010) and microeconomic literature (Psacharopoulos, 1995; Bouaissa, 2009), (Ahmed, 2009).

Schultz (1971) and Becker (1962) both have developed and analyzed growth models augmented with human capital and find significant positive association between economic growth and human capital formation

The literature relating to human capital theory distinguishes among several types and means of education: formalized education at primary, secondary, and higher levels; informal education at home and work (Schultz, 1981), on the job training and apprenticeships (Mincer, 1974).

While the types and means of education are diverse, so too are the benefits derived from education. Education makes a perceived contribution to improvements in health and nutrition (Sweetland, 1996). In addition, education tends to affect a control on population growth and to increase overall quality of life (Becker, 1993). Education also provides the means to an enlightened citizenry able to participate in democratic and legal due process and to pursue values such as equality, fraternity, and liberty at both private and social levels (Swason & King, 1991).

More education has been found to be associated with better public health and parenting, lower crime, better environment, wider political and community participation and greater social cohesion, all of which are in turn likely to feed back into economic growth. While these qualitative benefits may represent the most important contributions made by education, each is difficult to measure quantitatively. Perhaps this explains why economic growth has become the benefit of choice for empirical analysis. (OECD, 1998)

Human capital theory suggests that individuals and society derive economic benefits from investment in people. The investment feature of this suggestion significantly differentiates human capital expenditures from consumption expenditures. The concept that investment in human capital promotes economic growth dates back to the time of Adam Smith (1776) and the early classical economists, who emphasized the importance of investing in human skills. Even if human capital theory formally evolved in this century, its bona fide conceptualization was articulated centuries ago (Kiker, 1968 quoted in Sweetland, 1996).

Smith (1776) recognized that lack of education prevented a significant and valuable proportion of the population from working with the efficiency they would be capable of showing if they had been trained. Smith's two principal components which served as the foundation of all productive human capital frameworks were the following:

1. Labor inputs are not merely quantitative. They qualitatively include "the acquired and useful abilities of all inhabitants or members of the society" as well as "the state of the skill, dexterity, and judgment with which labor is applied".
2. Ability acquired through "education, study, or apprenticeship, always costs a real expense, which is a capital fixed and realized, as it were, in person". Ricardo, Malthus, and Mill, all supported the extension of education. However, Smith's successors did not get deep into the problem as their school founding predecessor.

It was Alfred Marshall (1890) who took up Smith's theory and in fact went further by saying that ". . . the most valuable of all capital is that invested in human beings". Acknowledging the views of Smith, Marshall (1890) centered his economic discussions of human capabilities on the premise that they are agents of productive wealth. But, Marshall empirically dismissed the inclusion of human capital in the market mechanism because it lacked a market exchange for determining value.

Fisher (1906) expressly stated, "Wealth in its broadest sense includes human beings". Besides, he implied that, participation in production processes constituted a form of capital: "in a complete view of production processes, the human machine is no more to be left out of consideration than machines which handle the wheat in its prior stages".

The incorporation of human capital into the mainstream of economic analysis and research is a new and lively development of the past five decades. The need for this development became apparent in the 1950's and the 1960's, when the application of empirical economic research to the concerns about economic growth and about income distribution revealed major defects not only in our understanding of each but also in our way of thinking about these matters. Two types of findings were especially significant

1. The observed growth of conventionally measured inputs of labor and capital was by far smaller than the growth of output in the U.S. and in other countries for which long time series were available.

2. Data on personal income distribution which began to appear with greater frequency and detail showed that the variance of labor incomes rather than functional differences between returns to labor and to capital, represented major components of personal income inequality.

The development of human capital theory was a response to these twin challenges. According to Mincer (1981), this led to the abolition of two simplifying but unduly inhibiting assumptions:

1. The restriction of the concept of capital to physical capital, and
2. The assumption of homogenous labor.

So the contribution of human capital theory to economics does not lie in a reformulation of economic theory, but in pushing back the boundaries of Economics beyond the sphere of market transactions.

The application of human capital concept to economic growth and to labor economics was initially pioneered independently by Jacob Mincer (1958), Theodore W. Schultz (1961) and Gary S. Becker (1961). At the microeconomic level, Mincer (1958) has shown that differences in individual human capital stocks and in their growth can explain much of the observed variation in the wage structure and in the personal distribution of income. Jacob Mincer developed a model for examining the nature and causes of inequality in personal incomes. To measure two major types of human capital formation, the model incorporated education and years of work experience.

While a significant role is accorded for education in economic growth, it is not clear whether the externalities at the lower or higher schooling levels are more important for economic development. Psacharopoulos (1994) asks whether one can weigh two very elusive items: (a) the positive externalities associated with a

university graduate discovering a new vaccine; and (b) the negative externalities associated with 30 percent of the population being illiterate for their entire lifetimes. New growth theory, however, is preoccupied with a different question than is development theory: how to explain the persistence of growth rather than how to get it started. Critics ask whether there is anything new about new growth theory. What is the value added of the literature, at least as far as policy implications are concerned? It is argued that no guidance is offered towards the identification of appropriate interventions (Selowsky (1993), d'Autumne and Michel (1993)).

## **2.2. Empirical literature Review**

Despite their conclusions are controversial, different scholars has tried to analyze the relationship between human capital and economic growth. Mankiw, Romer, and Weil (1992), on their cross-country regression analysis, have showed that human capital as one of the reasons for income variation across countries. That means they found a positive and significant correlation between human capital and per capita income growth.

Although earlier studies (Lucas 1988; Romer 1990) analysed the importance of education and human capital development in the growth process, it was Barro (1991) that brought to the limelight the link between educational expenditures and economic growth. The study found a positive relationship between the growth rate of real per capital output and the level of school enrolment. The study argued that an increasing rate of investment in human capital development would help to close the development gap between the developing and developed countries.

Again, Barro (1996; 2013) have measured human capital using average years of schooling in primary and secondary school .He found positive and significant relationship between per capita income growth and human capital from 1960 to 1990. Based on his simple panel regression analysis, Barro reported that the process of catching up was firmly linked to human capital formation: only those poor countries with high levels of human capital formation relative to their real GDP tended to catch up with the richer countries.

It is commonly believed that economic growth leads populations to live better, have longer lives and good health. Firstly, economic growth means rising per capita income and part of this increased income is translated into the consumption of higher quantity and better quality nutrients. Through

nutrition, health as measured by life expectancy responds to increases in income (Fogel, 1997).

Ramirez et al (1997) employing cross country data investigated the channels through which human capital development affects economic growth and vice versa. The study argues that economic growth may lead to human capital development and human capital development could also lead to economic growth. This bi-directional relationship could lead to virtuous or vicious cycles of economic growth. The study finds that countries which promoted economic growth tend to achieve the vicious category while countries which favored human capital development encounter the virtuous growth.

Benhabib and Spiegel (2002) also find an indirect positive and significant correlation between the two macroeconomic variables. According to their finding, countries with a larger human capital stock show faster technological catch-up. Similarly, Bassanini and Scarpetta (2001) investigate the relationship between human capital accumulation and economic growth for OECD countries between 1971 and 1998. They said that one extra year of schooling increases the long-run average per capita output level by about 6%.

One of the first attempts to measure the contribution of education to growth was made by Denison (1964), who argued that about 23 percent of the increase in U.S national income between 1929 and 1960 was due to the increased education of the labor force. He also performed a similar accounting in 1974, and found out that the measured contribution of education to economic growth remained substantially what it was before. Critics have however denied the possibility of quantifying the contribution of education to growth, but is fairly generally agreed that education is vital element in economic development. Denison however did not deny that there are lots of uncertainties in his theorizing.

Barro and Sala-i-Martin (1995; 2004) also tried to prove the effect of primary, secondary, and tertiary school attainment (by sex) on economic growth. They got an insignificant effect of primary education of males and females on economic growth. But they found significant relationship for males' secondary and tertiary education. They also analyzed the role of educational attainment on the convergence theory. Their result proves that countries with relatively low initial GDP grow faster when they have higher levels of human capital in the form of educational attainment

Bils and Klenow (2000) first shed light on the casual relationship between economic growth and educational attainment. They find that the channel from

education to economic growth does not explain a significant proportion of the relationship between education and growth documented in the previous studies. They interpret these results to indicate that the impact of schooling on economic growth may be modest across countries.

It was Shultz (1963) who first connected his work with the puzzle of the “residual”. He made an estimate of the growth in total human capital in the U.S, created by the educational system and considered how much of the growth in output it could account for (about one fifth was his estimate). He also asserted the economic function of education as human capital forming and in this way contributing to economic growth.

Baldwin and Borrelli (2008) also wrote an article that show relationship between higher education and economic growth in US and conclude that expenditure on higher education has a positive relation with per capita income growth.

Jacob Mincer (1958) developed a model for examining the nature and causes of the inequality in personal incomes. To measure two types of education; formal and informal, Mincer’s model incorporated years of education and years of work experience. He then found out that as more skill and experience are acquired with the passage of time, earnings rise.

Some scholars like, Barro (1966; 2013) has formulated a model that includes physical capital inputs, level of education, health capital, and the quantity of hours worked. The model assumes that “people are born with initial endowments of health which depreciate with age and grow with investment in health”. Based on his analysis, he concluded that an increase in health indicators raises the incentives to invest in education and a raise in health capital lowers the rate of depreciation of health. Taking life expectancy as an indicator of health, Bloom Canning, and Sevilla (2004) also found a strong positive and statistically significant effect on output. They suggest that each extra year of life expectancy raises the productivity of workers and leads to an increase of 4% in output.

Gyimah- Brempong and Wilson (2005) and Odior (2011) also argued that education captures just one aspect of human capital. It could not account the differences in school quality and health aspect of human capital. For instance, based on microeconomic evidences, Strauss and Thomas (1998) argue that health explains the variations in wages at least as much as education. Gyimah-Brempong and Wilson (2005) find that health capital indicators positively influence aggregate output. They find that about 22 to 30 percent of the growth



rate is attributed to health capital, and improvements in health conditions equivalent to one more year of life expectancy are associated with higher GDP growth of up to 4 percentage points per year. Barro and Sala-i-Martin (1995; 2004), have also included life expectancy and infant mortality in their growth regressions as a proxy of tangible human capital and concluded that life expectancy has a strong positive relation with growth.

The state of health in a country affects its economic growth through various channels. When health improves, the country can produce more. Good health and nutrition enhance workers' productivity. Healthier people who live longer have stronger incentives to invest in developing their skills, because they expect to reap the benefits of such investments over longer periods. Better health increases workforce productivity by reducing incapacity, debility and number of days lost due to sick leave. Moreover, good health helps to forge output with any given combination of skills, physical capital and technological knowledge. (Rosen, 1993; Morand, 2005).

Dorian (1997) employing a neoclassical framework estimated a structural growth model in which he included education and health as explanatory variables. The study found a positive relationship between economic growth and health. The relationship between education and economic growth was found to be insignificant.

According to Nazneen and Joseph (2011) the majority of recent studies on the relationship between human capital (education) and economic growth have used a cross-section of heterogeneous countries, generally focusing on developed nations. The causal relationship between human capital and economic growth in the context of developing countries has not received adequate attention in current literature. Issues surrounding accumulation of human capital stock have significant policy implications for developing countries.

Using other indicators of human capital, some researchers have analyzed the relationship between the two macroeconomic variables. For instance, using the dynamic panel estimator method, Gyimah- Brempong and Wilson (2005) showed a positive and robust link between investment in health & education and economic growth in Africa and the rest of the world for the period 1960-2000.

Several empirical cross- country studies document that education is important for economic growth in the early stages of development. Most notably, Krueger and Lindahl (2001) illustrate that the strong impact of education on economic

growth may not hold in the latter stages of development due to decreasing returns to education. Their research suggests that it is crucial for developing nations to invest significant resources in education in their early developmental stages when returns to education are greatest.

While the implications of Krueger and Lindahl's work are important, developing countries face the realities of limited resources. Investment in education is expensive and may not yield observably high returns in the short run. Countries with limited resources may not have the luxury of long horizons to realize the returns from investment in human capital and therefore may delay investment in human capital until they reach a sustainable level of prosperity. The dilemma developing nations face is an example of the classic „horizon problem“. While the long term benefit of investing in education is enormous, in the short run the opportunity cost of investing in education is significant as scarce resources could be channeled to other types of productive investments that offer rapid growth opportunities and relatively quicker payoffs

Arora (1999) examined The provision of public resources for better health in a developing country can assist the poor to release resources for other investments, such as in education, as a means to escape poverty. The long-term relationship between income and health is examined by considering the developed countries in the world and has observed the hypotheses that health of the population has influenced economic growth and that it should be an integral component of the productivity of economies and supporting the endogenous growth models. A similar study made by Arora (2001) provides that in the co integrated relation between health and income, innovations in health lead to economic growth and not vice versa.

Another study by Simon Appleton and Francis Teal (1998) suggests that the role of human capital in Africa's economic development is complex. Inadequate investment in education and health are clearly not the only cause of Africa's economic difficulties. However, the poor health and education of Africa's workers is one factor explaining her low income.

Another study by Teshome (1981) systematically surveys the literature related to the problem of “educated unemployment” in Africa and puts out three lines of arguments to explain this phenomena. 1 st - Education is considered ill suited to the needs of the continent and the world of work. 2 nd - Most African nations exhibit unsatisfactory growth rates in employment determining factors such as output, investment, aggregate saving, etc. 3 rd - The malfunctioning

behavior of the labor market contributes to this adverse phenomenon of educated unemployment.

Odior (2011), also made a research in Nigeria to provide an empirical evidence on whether government expenditure on health can lead to economic growth or not. He used an integrated sequential dynamic computable general equilibrium (CGE) model and found a significant relationship between economic growth and government expenditure on health sector. In addition, taking government recurrent and capital expenditures on education and health, Oluwatobi & Ogunrinola (2011) and Umaru (2011) have made an econometric analysis in Nigeria, over the period 1970-2008 and 1977- 2007 respectively, to analyze the relationship between government spending on education and health and economic growth. They followed the Johnson cointegration technique and got a positive relationship between government recurrent expenditure on human capital development and real output, while capital expenditure is negatively related to the level of real output.

In contrast to the macroeconomic studies, microeconomic studies in the African continent with respect to the returns of education are immense. The private returns to education are substantial and even more important in sub-Saharan Africa than in other regions of the world. Across different levels of education, returns to primary education generally appear to be the highest, because foregone earnings for smaller children are lower than for older ones. (Psacharopoulos, 1994)

Kefela and Rena (2007) who made their study on North East African States also showed that 40 percent to 60 percent of growth rates in per capita GDP were resulted from investment in human capital.

When we come to the Ethiopian case, Woubet (2006) has made co-integration analysis to investigate the impact of human capital on total level of output using the Barro and lee method of human capital measurement over the period 1971-2005. He got an insignificant relationship between the two macroeconomic variables. But this finding ignores health which is one component of human capital development.

Using school enrollment as a proxy for human capital, Netsanet (1997) found out that human capital has a significant impact on the level of output while Seid (2000) found out that the human capital variable has an insignificant impact in the dynamic model using a similar proxy.

For instance, the returns to health in rural Ethiopian agriculture are more than double of the returns to inputs like fertilizer (Kefela and Rena, 2007). On the other hand, using public spending on education and health sector as a proxy for investment in human capital development, Teshome (2006) found a positive impact of human capital development on economic growth in Ethiopia over the period 1960/61- 2003/04.

This finding is reinforced by Tofik (2012) who found a positive and significant relationship between capital spending on human capital and economic growth from year 1975 to year 2010. But both of them didn't show the separate impact of the health and education sector's spending on economic growth. In addition Tofik fails to incorporate the recurrent expenditure account of the government.

A study which accorded due role to education and economic growth through the school labor market linkage is by Teshome (1995). Teshome (1995) finds out that high levels and rates of unemployment growth and the continued rise in labor supply in the wake of stagnation or relative low growth of the demand for labor force wage levels down even to the minimum value of the reservation wage.

Abosetegna (2000) shows that the main causes of unemployment for tertiary level graduates are the absence of relationship between higher education and the labor market, the non-existence of national policy of employment for graduates, stagnation of the economy and language barrier.

There was also a serious mismatch between what the educational institutions are producing and what the employers need (Abosetegna, 2000). In this respect Alemu (2000) finds out that the major factors that determine the employability of the graduates from vocational schools were linkages between schools and companies, working facilities and curriculum, which were found to be poorly developed especially in the government schools.

Generally, the empirical analyses related to human capital and economic growth mostly rely on measures of formal education as a proxy for human capital formation by ignoring the contribution of health on human capital development, while both education and health are important for human capital development (Gundlach, 1996; Karagiannis & Benos (2009)).

To avoid such limitations, many researchers have used both of the education and health measures as a proxy for human capital. For instance, Karagiannis & Benos (2009) have used enrolment rates, student/teacher ratios for the educational indicators and number of medical doctors and hospital beds for

the health indicators. On the other hand, Qadri and Waheed 2011) have used education indicator (enrolment rates) and health indicator (share of total government expenditure on health to GDP). Barro (2003) has also measured human capital using education (educational attainment) and health (life expectancy). Including both the education and health indicators are relatively better measure of human capital than using education or health indicators alone. Because it expresses the notion that both education and health are an important elements of human capital.

With regard to this paper, education index is used as a proxy for human capital in the education area. On the other hand, the health index is used as a proxy for health human capital in the health area is used so as to empirically analyze the effects of human capital development on economic growth.

## **2.3. Education and health Policy in Ethiopia**

### **2.3.1. The Ethiopian economy.**

Ethiopia is the oldest independent country in Africa. It is the tenth largest country in Africa, covering 1,104,300 square kilometers (with 1 million sq km land area and 104,300 sq km water) and is the major constituent of the landmass known as the Horn of Africa. Ethiopia is a country with great geographical diversity ranging from peaks up to 4,550m above sea level down to a depression of 110m below sea level. More than half of the country lies above 1,500 meters. The predominant climate type is tropical monsoon, with three broad climatic variations: the “Kolla”, or hot lowlands, below approximately 1,500 meters, the “Wayna Degas” at 1,500- 2,400 meters and the “Dega” or cool temperate highlands above 2,400 meters. (HSDP, 2010)

According to Projections from the 2007 population and housing census estimate a total population in 2010 is 79.8 million. It is one of the least urbanized countries in the world with about 5/6th of the population living in rural areas (83.6% rural vs only 16.4% urban) and nationally, the average household size is 4.7 persons. The population age pyramid has remained predominately young: 44% are under 15 years, over half (52%) are between 15 to 65 years, and only 3% of all persons are over the age of 65 years. The sex ratio between male and female is almost equal, and women in the reproductive ages constitute 24% of the population. While the average lifetime fertility has declined in the past 15 years from a 1990 level of 6.4 births per woman down

to 5.4 births , rural women still have an average of three more births per woman compared to women in urban areas. Overall, even with the fertility decline, the population is still growing at an annual rate of 2.6%. (DHS ,2005)

The economic performance of the country varies with the regimes that ruled the country. In the last four decades, the Ethiopian economy has changed from a liberalized economy (till 1974) to a controlled one (1974-1989/90) and again back to a liberalized one (after 1991).

During the 1960/61 to 1973/74 period the economy achieved sustained economic growth. Between 1960 and 1970, for example, Ethiopia enjoyed an annual 4.4 percent average growth rate in per capita gross domestic product. The manufacturing sector's growth rate more than doubled from 1.9 percent in 1960/61 to 4.4 percent in 1973/74, and the growth rate for the wholesale, retail trade, transportation, and communications sectors increased from 9.3 percent to 15.6 percent. Ethiopia's 4.4 percent average per capita GDP growth rate was higher than Sudan's 1.3 percent rate or Somalia's 1 percent rate but lower than Kenya's estimated 6 percent annual rate, and Uganda's 5.6 percent growth rate during the same 1960/61 to 1972/73 period. By the early 1970s, Ethiopia's economy not only had started to grow but also had begun to diversify into areas such as manufacturing and services. However, these changes failed to improve the lives of most Ethiopians. The structure and objective of the economy was changed alongside the objective of the socialist government during the period 1974-1991. The performance of the economy was the worst during the planned economic era in which real GDP registered an average growth rate of 2.3% per annum (per capita income growth being - 0.4%) between 1974/75 and 1989/90. (Woubet ,2006)

The period, 1992-2005, was characterized by a more liberal regime. The performance of the economy has shown improvement in the 1990s: real GDP grew on average by about 4.22 percent. During 1990/91-1999/00, GDP and per capita GDP on average grew by 3.7% and 0.7% respectively. Ethiopia's economy which heavily depend on the agricultural sector which accounts for 83.4% of the labor force, about 43.2% of the Gross Domestic Product (GDP) and 80% of exports; perform very poor which recorded an average growth rate of 1.77 percent. While the manufacturing sector and the services sector grew by 4.86% and 6.76% respectively. This is Due to the drought that hit Ethiopian agriculture in 2002/03 the real GDP growth fell from 7.7 percent in 2000/01 to estimated 1.2 per cent in 2001/02 and an estimated negative growth of 3.8 percent in 2002/ 03. The value added in agriculture fell by 12 per cent (MOFED, 2003).

The fact that Regular droughts combined with poor cultivation practices, make Ethiopia's economy vulnerable to climatic changes. Ethiopia has shown an impressive economic growth over the last seven years. According to HSDP (2010) The Poverty Head Count Index has declined from the 1996 level of 45.5% to 32.7% in 2007/08. The reduction in poverty has been more pronounced in rural than urban areas. Even with this growth, the annual per capita earnings of 235 USD remain below the Sub-Saharan average. The overall economic dependency ratio for the country is estimated at 93 dependents per 100 persons in the working age group of 15-64 years.

Sustained economic growth will be achieved by high human capital such as education and health, sufficient infrastructures leading to high marginal productivity of capital, high saving rates, and a stable population.

Alemayehu and Befekadu(2002) had made some key conclusions on Ethiopian economy which include the following: Over quite a long period of time and despite very different policy regimes, the structure of the economy has changed relatively little. And Growth performance is still dependent on a fragile economic sector and on exogenous conditions. Not only this but also, over a long period of time the economy has performed below expectations, given initial conditions.

### **2.3.2. Education policy in Ethiopia**

Education is a process by which man transmits his experiences, new findings, and values accumulated over the years, in his struggle for survival and development, through generations. Education enables individuals and society to make all-rounded participation in the development process by acquiring knowledge, ability, skills and attitudes. And aims at strengthen the individual's and society's problem-solving capacity, ability and culture starting from basic education and at all levels. Education enables man to identify harmful traditions and replace them by useful ones. It helps man to improve, change, as well as develop and conserve his environment for the purpose of an all-rounded development by diffusing science and technology into the society. Education also plays a role in the promotion of respect for human rights and democratic values, creating the condition for equality, mutual Understanding and cooperation among people Education does not operate in isolation, rather it has to be integrated with research, practice and development to contribute towards an all- rounded development of society.( TGE, 1994)

In Ethiopia, education dates back to the Sixth Century when the Sabeen alphabet was introduced along with Christianity. Beginning in the early years of the Christian era, the churches of Ethiopia developed school system which over the centuries served not only as focal points for learning but also prepared the nation's religious and governmental leaders. Church educations remained the predominant form of education until the commencement of modern secular education in Ethiopia. The indigenous system of church education had its parallel in the schools of Falashas, and the Quranic schools of the Muslims. (Woubet, 2006)

Because, any investigation in-to the workings of the environment and the universe in general is regarded as anti Christian and sinful, studies of the sciences, and domestic handicrafts were very limited and often discouraged. The primary urge was religious rather than scientific and developmental. "The primary purpose of church education was - - - to lead men to accepting the existing order of things as it is, to preserve whatever has been down through the years, and in turn to pass it unchanged to the next generation." (Girma Amare, 1964 quoted in Teshome, 1979). It tended to stifle healthy curiosity and independent thinking. The Pedagogy was based on repetition and memorization, with strict adherence to the convention preferred by the teacher.

According to Teshome (1979), church education has not been impartial in the provision of education to the public and didn't serve the whole nation. But no other church in Africa has had such a great impact on the development of education as the Ethiopian Orthodox Church. In the long history of church education, Ethiopia evolved a particularly Ethiopian education system. The full curriculum consisted of religious teachings, prose, poetry and poems as well as documentation in Geez and Amharic. It is emphasized that education has, meaning only when in its cultural context. But the pattern of education changed very little in contrast to the emerging socio economic transformations. And, an opportunity was lost to combine the educational effort of an ancient church with that of a government system. So, any account of education in Ethiopia must recognize the contributions made by church education.

The Ethiopian education system has been to a large extent foreign and alien to the nation's needs and requirements. It was emphasized that Ethiopian education should neither be French, American, British or Italian. It must be Ethiopian. Church education has laid the groundwork in this respect. But it was not possible to have a sensible extension of education to the existing socio economic conditions in the country, afterwards. Developments in the field of modern education can be discussed in the three phases as follows.



### **2.3.2.1. Education during the imperial period.**

At the beginning of the twentieth century, the education system's failure to meet the needs of people involved in statecraft, diplomacy, commerce, and industry led to the introduction of government-sponsored secular education. Hence the more planned and coordinated expansion of education has been done after 1941, the primary objective of education had been to produce trained manpower that could run the emergent state bureaucracy. Particularly after 1941, the government's main concern was to replace expatriates that worked at various levels in the state machineries by Ethiopian nationals. In this respect the perspective of education was very limited. This leads to the establishment of the first public school in Addis Ababa in 1907, and a year later a primary school opened in Harer. Foreign languages, elementary mathematics, and rudimentary science were taught in French to a limited number of students, along with Amharic and religious subjects. (Teshome ,2006)

The Italian occupation (1936-1941) and the Second World War seriously disrupted the development of modern secular education started during the Menelik era. It was after 1941 that a series of concrete educational policies were introduced for the promotion of education in the country. The Ethiopian Government continued to believe that education held the key to Ethiopia's development. To meet this need, reconstruction began with the re-establishment of the Ministry of Education in 1942. To enhance expansion, a Board of Education was established in each region and an educational tax was also introduced to partly finance education. To supplement government efforts, private and voluntary organizations were encouraged to open schools. The missionaries were also, for the first time, officially invited to participate in providing educational services. From 1942 until 1955, the Ethiopian Government was engaged in the expansion of the education system. The high expenditure on education in relation to total expenditure, as well as the rapid growth of student enrolment showed the commitment of the Ethiopian government to the expansion of education. Non formal education in the form of adult education and literacy programs were coordinated and sponsored by the adult Education and Literacy Department of the Ministry of Education. Work oriented or functional literacy programs directed to workers in specific fields

such as agriculture, textile and other activities were provided. Ayalew Shibeshi (1989)

According to Woubet (2006) these efforts are reinforced by the measures taken during the course of the three consecutive five-year development plans which have provided a strong role for education to play in the economy; among its objectives:

1. To provide education for the majority, particularly for the rural population, in line with more adequate networks of modest rural roads and bus services.
2. To provide an educational system which create a modern scientific outlook in life ,which will be in harmony with Ethiopia's cultural tradition.
3. To provide an education which develop positive attitude towards manual work and practical skills.
4. To place appropriate emphasis on the quality of education and promoting efficiency.
5. To provide a system with in which a more effective national medium of communication through the Amharic language can be realized.

In addition there were two institutions of higher education: Haile Selassie I University in Addis Ababa, formed by imperial charter in 1961, and the private University of Asmera, founded by a Roman Catholic religious order based in Italy.

As a result, from 1942 to 1972, the education sector was allowed to expand with confidence and optimism. Gross Primary enrollment increased by 60% between 1968 and 1972. Between 1961 and 1971, the government expanded the public school system more than fourfold, and it declared universal primary education a long-range objective. In 1971 there were 1,300 primary and secondary schools and 13,000 teachers, and enrollment had reached 600,000. (MOE, 1975)

However, the optimism was not sustainable. The schools were found to be highly inefficient especially in terms of dropouts. 50% of the Grade one students had dropped out by the end of the second year of schooling. Grade five had less than 10 percent of the students of grade 1. 17 The issue of equity was not properly addressed. Education in the beginning was an urban male dominated phenomenon. Under the pressure of growing public dissatisfaction and mounting student activism in the university and secondary

schools, the imperial government initiated a comprehensive study of the education system. Completed in July 1972, the Education Sector Review (ESR) recommended attaining universal primary education as quickly and inexpensively as possible, realizing the curriculum through the inclusion of informal training, equalizing educational opportunities, and relating the entire system to the national development process. (Lipsby ,1962)

The ESR criticized the education system's focus on preparing students for the next level of academic study and on the completion of rigid qualifying examinations. Also criticized was the government's lack of concern for the young people who dropped out before learning marketable skills, a situation that contributed to unemployment.

### **2.3.2.2. Education during the Derg.**

After the overthrow of imperial rule, the provisional military government dismantled the feudal socioeconomic structure through a series of reforms that also affected educational development. The structure and organization of educational activities were changed alongside the objectives of the socialist government. In the National Democratic Revolution Program of the Ethiopian Government (April, 1976), Educational Guideline was issued, which states, "There will be an educational program that will provide free education, step by step, to the broad masses". The Government's goals for education are (1) education for production, (2) education for scientific consciousness, and (3) education for political consciousness. (MOE, 1976).The new regime nationalized all private schools, except church-affiliated ones, and made them part of the public school system. Additionally, the government reorganized Haile Selassie I University and renamed it Addis Ababa University. Soon after the military government initiated reforms of the education system based partly on ESR recommendations and partly on the military regime's socialist ideology.

According to TGE (1994)The general policy program did not provide an elaborate policy of education up until 1984/85 when A Ten Year Perspective Plan (1974/75-1984/85) was adopted with the following major goals of the education sector.

1. To provide education which will meet the basic needs of the people as well as serve as an instrument in the struggle against feudalism, imperialism and bureaucratic capitalism.

2. To give priority to providing polytechnic education to all those children with in appropriate age bracket.
3. To provide skilled manpower in such numbers proportions and quality as needed.
4. To promote continued education
5. To eradicate illiteracy and expand preschool education.

The military regime worked toward a more even distribution of schools by concentrating its efforts on small towns and rural areas that had been neglected during the Imperial regime. With technical assistance from the Ministry of Education, individual communities performed all primary school construction. In large part because of such community involvement, the number of primary schools grew from 3,196 in 1974/75 to 7,900 in 1985/86, an average increase of 428 schools annually. The number of primary schools increased significantly in all regions except Eritrea and Tigray, where there was a decline. (Tekeste Negash ,1996)

A major move towards expansion of non-formal education was made by the Socialist regime. Two main programs were launched, the National Work Campaign for Development through Cooperation, and The Ethiopian National Literacy Campaign. One of the success stories in the socialist regime has been the achievement in terms of reduction of illiteracy rate in the country. The national literacy campaign began in early 1975 when the government mobilized more than 60,000 students and teachers, sending them all over the country for two-year terms of service. This experience was crucial to the creation in 1979 of the National Literacy Campaign Coordinating Committee (NLCCC) and a nationwide effort to raise literacy levels. The literacy rate, fewer than 10 percent during the Imperial regime, increased to about 63 percent by 1984, according to government figures. The literacy campaign received international acclaim when the United Nations Educational, Scientific, and Cultural Organization (UNESCO) awarded Ethiopia the International Reading Association Literacy Prize in 1980.(Teshome ,1988)

However the Derg failed to build on what was already achieved in the past. Recommendations of the ESR were barely followed as claimed. Private sector development and the development of the market incentive structure both in the education sector and in the labor market were highly discouraged. The Education system has been centralized in both the Imperial and the Derg

regimes. And the red tape in a highly decentralized system of education might incur wastes and stifle growth. (Teshome , 1988)

### **2.3.2.3. Education during EPRDF**

According to the Transitional Government of Ethiopia (1994), it was necessary to replace the educational system that served the “old discarded order by the new one”. The development of the education sector in Ethiopia has been at an early stage. On the eve of the ongoing educational reform process, which began in 1994 following the endorsement of the New Education and Training Policy, enrollment in primary education stood at about 2.81 million. This includes over-age pupils that amount 34 % of the school-age population. Likewise, enrolment ratio in secondary level stood at about 15% and in the third level at 1 %. 29 Compared to African countries, Ethiopia’s enrolment ratios fared among the lowest in primary education and somewhat better though below average in secondary education. Similarly, enrollment in all levels of education is male biased, the tertiary level being worse. (TGE, 1994)

The new strategy presupposes the overall lack of coordination between education, training, research and development efforts in the country. The objectives of Ethiopian education as stated in the various documents of The Transitional Government of Ethiopia, The Education and Training Strategy (1994) are summarized as follows.

1. To provide a good quality primary education with an ultimate aim of achieving Universal Primary Education.
2. To make education relevant by providing problem solving skills and an all rounded education catering to the needs of the individual and the society.
3. To provide vocational education and training at different levels attuned to the manpower requirements of the economy.
4. To provide a secondary education of appropriate quality in an equitable way.
5. To promote higher education of good quality, relevance and focusing on Research & Development.
6. To make available special and non formal education in line with the needs and capability of the country.

7. To improve the quality of training, professional competence and career structure of teachers and other professionals.
8. To strengthen the management and organization of the educational system so as to make it decentralized, coordinated, professional and efficient.
9. Increase the financing of education by encouraging community participation, introducing cost-sharing mechanisms, involving the private sector in the provision of education.
10. To improve the collaboration and coordination of the education sector with other relevant sectors.
11. Production of lower, middle, and higher level skilled manpower than can participate in the country's economic growth and social development.

The structure of the Ethiopian education system encompasses formal and non-formal education. But it is not clear how the non-formal education will be implemented. For this reason, it is viewed as open-ended in terms of training program and in terms of institutional arrangement. The emphasis has shifted to the formal education; addressing the problems of low enrolment in the formal schools, rectifying gender imbalance and the like. (TGE ,1994)

The New Education and Training Policy also addressed the issues of technical Vocational training. Thus, it is stipulated in the document that Parallel to general education, diversified technical and vocational training will be provided for those who leave school from any level of education for the development of middle level manpower. (MOE ,1994)

It was also stipulated that every "nation" and nationality has the right to learn in its own language at least at the basic education and general primary level. But this has put into question the speed at which the adaptation would take place in terms of preparation and provision of teaching materials and training of the appropriate pedagogical and managerial staff. This change has been revolutionary rather than a cautionary transformation. In this respect, a study by Workalemahu (2004) shows that the necessary preconditions were not fulfilled to select the language as a medium of instruction: there were no available curriculum materials; teachers did not get adequate training; there was imposition on those who don't speak the local language.

High repetition rates intensify the stress on already overburdened schools and increase the numbers of children and youth who eventually drop out of school completely. Too often, investment is thought to be simply more schools, and

places for more kids in school. These are necessary conditions but insufficient alone to bring about needed development gains. More is needed, including increasing curriculum relevancy, training teachers to use the most effective pedagogy, improving the way schools are organized and managed, and involving parents and the larger community in supporting schools and ensuring quality education. (Woubet ,2006)

### **2.3.3. Health policy in Ethiopia.**

The main cause of many of Ethiopia's health problems is the relative isolation of large segments of the population from the modern sector. Additionally, widespread illiteracy prevents the dissemination of information on modern health practices. A shortage of trained personnel and insufficient funding also hampers the equitable distribution of health services. Moreover, most health institutions were concentrated in urban centers prior to 1974 and were concerned with curative rather than preventive medicine. (HSDP ,2010)

The current Government therefore accords health a prominent place in its order of priorities and is committed to the attainment of these goals utilizing all accessible internal and external resources. In particular the Government fully appreciates the decisive role of popular participation and the development of self-reliance in these endeavors and is therefore determined to create the requisite social and political conditions conducive to their realization.(TGE ,1994)

According to TGE (1994)The Government believes that health policy cannot be considered in isolation from policies addressing population dynamics, food availability, acceptable living conditions and other requisites essential for health improvement and shall therefore develop effective inter sectorality for a comprehensive betterment of life. So health development shall be seen not only in humanitarian terms but as an essential component of the package of social and economic development as well as being an instrument of social justice and equity. Pursuant to the above the health policy of the Transitional Government shall incorporate the following basic components.

According to HSDP (2010) The National Health Policy is an overarching policy document that gives strong emphasis to the fulfillment of the needs of the less privileged rural population that constitutes about 83% of the total population in Ethiopia. The Health Policy outlines:

1. Democratization and decentralization of the health system;

2. Development of the preventive components of the health service;
3. Ensuring accessibility of health care by all population;
4. Promoting inter-sectoral collaboration, involvement of the NGOs and the private sector;
5. Promoting and enhancing national self- reliance in health development by mobilizing and efficiently utilizing internal and external resources.

Having the national health policy as an umbrella for the development of HSDP IV, other health and health related policies and strategies have been considered. These include:

1. Policy and Strategy for Prevention and Control of HIV/AIDS
2. The National Drug Policy
3. The National Population Policy
4. The National Policy on Women
5. Child Survival Strategy
6. National Nutrition Program
7. National Strategy for the prevention, control and elimination of malaria
8. National TB prevention and control strategy
9. Development and Transformation Plan (DTP)

Hence by applying those policies the government of Ethiopia has a success story in the world.



## Chapter three

### Methods and procedures

#### 3.1. Data type and sources

The study will use annual data from 1971 to 2011, log of per capita income (in US\$) as a proxy for economic growth. Education index reflects composite measure of knowledge and it has been taken as an important ingredient of human capital along with health index. Both self-constructed indices are based on UNDP methodology given in 1999-2000. All are drawn from CSA (Central Statistics Agency), MoE, (Ministry of Education), MoH (Ministry of health) MoFED, and NBE (National bank Ethiopia). The following formula has been used for constructing both education and health indices:

$$\text{Education Index} = \left[ \frac{2}{3} * ALI \right] + \left[ \frac{1}{3} * GEI \right]$$

$$\text{Where } ALI = \frac{ALR - 0}{100 - 0} \text{ and } GEI = \frac{CGER - 0}{100 - 0}$$

ALI = Adult literacy index, ALR = Adult literacy rate, GEI = Gross enrollment index, CGER = Combined gross enrolment rates.

Education index is constructed by adding together adult literacy index (ALI) with two-third weight age and combined primary, secondary and tertiary gross enrollment index (GEI) with one-third weight age.

$$\text{Health Index} = \left[ \frac{LE - 25}{85 - 25} \right] \quad \text{where LE = Life expectancy.}$$

Since values of these indices lie between 0 and 1 and they are unit free, we are unable to take log of these indices. So we have used semi-log model in our study.

### 3.2. Model specification

Endogenous growth theory as developed by Lucas (1988) basically represents an extension of the Solow (1956) neoclassical growth model incorporating positive externalities related to the accumulation of human capital viz. knowledge. Following Schultz (1997), it can be argued that the production of human capital is possible through education and health sector. They formulate model in equation form as follow.

$Y_i = A.F(\mu h L_i, K_i).H_a^\gamma$  Where, A is the total factor productivity,  $Y_i$  is the output of the  $i^{th}$  firm,  $L_i$  is the number of workers used by firm i,  $\mu$  is the proportion of time that each worker devotes to production, h is the human capital of worker employed by the firm i,  $K_i$  is the physical capital used by firm i.  $H_a$  is the average human capital in the economy and  $\gamma$  is a positive coefficient. Here, effective labor input  $\mu h L_i$  replaces the simple labor input L, specified in the standard Solow (1956) growth model.  $H_a^\gamma$  term is the externality effect of human capital, which raises economy-wide labor productivity. Mankiw et al. (1992) explain the relationship as follow in a Cobb-Douglas production function with constant returns to scale:

$Y = K_t^\alpha H K_t^\beta (A_t L_t)^{1-\alpha-\beta}$  Where Y represents output, A is the level of technology. K, H and L are physical capital, human capital and labor respectively. In order to investigate empirical association between human capital and economic growth the study follows model specified by Asghar (2011) as follow.

$$IPCY_t = \beta_0 + \beta_1 EI_{1t} + \beta_2 HI_{2t} + \mu_{1t} \text{ Where,}$$

$PCY_t$  = log of per capita income (in US\$) as a proxy for economic growth.

$EI_{1t}$  = Education Index (first proxy for human capital).

HI<sub>2t</sub> = Health Index (second proxy for human capital).

### 3.3 Econometrics testing

Hence, in the methodological approach of this paper includes the following steps: **first** it needs to check for a unit root test of all variables in levels. **Second**, it needs to test them for co integration. If the variables are co integrated, i.e. C (1, 1), a vector error correction (VEC) model will be used to discover the long run relationship. So, the last step is to test for causality by employing the granger causality tests.

#### 3.3.1 Unit Root Tests

Most of the economic time series variables are non-stationary and the use of non-stationary time series leads to spurious regression which cannot be used for precise decision. A variable is said to be stationary if its mean, variance and auto-covariance remains the same no matter at what point we measure them. The null hypothesis of non-stationary is tested against alternative hypothesis of stationary. A number of tests are available in the literature to check the existence of the unit root problem both in the level of the variables as well as in their first difference, i.e. to determine the order of integration. The Dickey Fuller (DF) test is applicable if error terms (Ut) are uncorrelated. In case the error terms (Ut) are correlated, DF test is useless. The study follows Augmented Dickey Fuller (ADF) test which takes care of this problem by “augmenting” the equation(s) of DF test by adding the lagged values of the dependent variables (Pantula, 1989).

$$\Delta y_t = \alpha + \beta t + \delta y_{t-1} + \sum_{i=1}^p \gamma_i \Delta y_{t-i} + \varepsilon_t$$

$$\Delta y_t = \alpha + \delta y_{t-1} + \sum_{i=1}^p \gamma_i \Delta y_{t-i} + \varepsilon_t$$

$$\Delta y_t = \delta y_{t-1} + \sum_{i=1}^p \gamma_i \Delta y_{t-i} + \varepsilon_t$$

If the plot of the series does not start from the origin and if there is some kind of visible trend then probably model should include constant and trend but if e.g the trend is not apparent (e.g differenced series) then it should not be included in the model. Where as in order to determine the lag length the correlogram will be inspected followed by a testing down procedure removing the lags that are Statistically in significant (Ibid).

### 3.3.2 Co- integration

Co integration is a statistical property that describes long-run relationship of economic time series. Johansen (1988) proposed an approach to investigate long-run relationship among non-stationary variables. This study uses Johansen and Juselius (1990) co integration approach for exploring long-run relationship between economic growth and human capital. To analyze the relationship between GDP and human capital, the study uses vector auto regression (VAR) and vector error correction models (VEC). The reasoning for these methodologies is as follows: first, this allows the possibility for both GDP and human capital to be endogenous, as suggested by endogenous growth models. Second VAR and VEC models are useful for forecasting systems of interrelated time-series variables and testing causality. The basic VAR model in the absence of co integration is expressed as:

$$Z_t = \mu + \Gamma_1 Z_{t-1} + \dots + \Gamma_p Z_{t-p} + \varepsilon_t$$

Where:  $Z_t$  are variables which will be used in the study i.e GDP and human capital.  $\mu$  is a vector of constants,  $\Gamma$ ' s are matrices of parameters estimated, and  $\varepsilon_t$  is the residual vector. Block exogeneity or Granger causality tests are conducted to examine whether or not the lagged values of one endogenous

variable in the system have forecasting power for other variables in the system. If GDP and human capital are found to be co integrated, it is appropriate to estimate a vector error correction model to examine the dynamic relationship between GDP and human capital. A VEC model has co integration relations built into the model; it restricts the long-run behavior of the endogenous variables that converge to their co integrating relationships while allowing for short-run adjustment dynamics. According to Engle and Granger (1987) equilibrium relationships found with simple VAR may be causal behavior, or simply a reduced form relationship among similarly trending variables. To test for co integration we use standard Johansen (1991) rank tests. If co integration is detected from the rank tests, then using a VEC is appropriate for examining the causal relationships between GDP and human capital.

Johansen's full information maximum likelihood (FIML) approach is used for testing the co-integration (Johansen, 1988). The likelihood ratio test constructed for detecting the presence of a single co-integrating vector is trace test statistic. The equation for this trace test is as follows;

$$\lambda_{trace} = -2 \ln Q = -T \sum_{i=r+1}^p \ln(1 - \lambda_i)$$

If co-integration is established then error correction specification is used to test for Granger causality (Engle & Granger, 1987).

### 3.3.3 VECM Based Causality

According to Granger Representation Theorem, if two variables are co-integrated and first difference stationary then there is an existence of causality in either direction. The present study uses multivariate causality test to explore all channels of causal relationship. Causality in systems (co-integrated systems) can be established if and only if lagged error correction term ( $ECT_{t-1}$ )

that takes into account long-run dynamics and sum of the coefficients of the lagged variables that takes into account short run dynamics both are significant.

### **3.3.4 Diagnostic Tests**

In this study for confirming the validity of the fitted model three diagnostic tests are employed, i.e. LM test to check serial correlation problem, Jarque-Bera test to check normality and White hetero-skedasticity test for observing the variance constancy of the residuals.

### **3.3.5 Stability Tests**

The stability of the model is confirmed through CUSUM and CUSUMSQ proposed by Brown et al. (1975). These tests depend on cumulative sum of recursive residuals that provides analysis of parameter variations. If CUSUM cumulative sum of recursive residuals remains within the boundaries of 5 % critical lines in order to ensure stability.

## Chapter Four

### 4. Empirical Results of Data Analysis

The aim of this paper is to analyze the relationship between human capital and economic growth in Ethiopia using recent econometric technique of Johnson co integration and causality analysis. Human capital variables represented by health index and education index data are found by author calculations and Real GDP per Capita represented by  $ry$ , from 1971 up to 2011 were collected from MoFED (2013). Since values of the indices lie between 0 and 1 and they are unit free, the study does not take log of these indices in case of real GDP per capita it uses log transformation.

#### 4.1. Unit root test

Most economic variables that exhibit strong trends (variables that moves up ward and down ward direction persistently with time), such as GDP, consumption, or price level, are not stationary. Unit root test is a common method to accommodate non-stationarity of the data. If non-stationarity of macro variables is not corrected, it would lead to the problem of spurious regression (false relationships among the variables). When a series contains unit root, it is common to transform the variables so as to make it stationary. Such a transformation process can be carried out through differencing. The number of times in which the series is differenced to attain stationarity is referred to as the order of integration. A stationary series is a series that is integrated of order zero, known as  $I(0)$ . If the data requires differencing once to make it stationary then it said to be integrated of order one,  $I(1)$  (Green, 2003).

A formal test for stationarity and the order of integration of each variable are undertaken using different methods (mostly ADF). Here, the test for ADF is

performed for the model with intercept and trend component and also for the model without intercept term and trend component.

**Table 4.1 unit root test result**

Results of a unit root tests based on ADF at level						
variables	intercept and time trend item		intercept and no time trend item		no intercept and no time trend items	
	Test Statistic	5% Critical Value	Test Statistic	5% Critical Value	Test Statistic	5% Critical Value
hi	-1.092	-2.961	-2.324	-3.544	-1.038	-1.950
eduin	0.847	-2.961	-0.869	-3.544	0.177	-1.950
lry	-0.151	-3.544	0.141	-2.961	0.927	-1.950
Results of a unit root tests based on ADF at first difference						
dhi	-3.614	-2.964	-9.152	-3.548	-2.118	-1.950
deduin	-4.201	-2.964	-4.453	-3.548	-3.548	-1.950
dry	-3.476	-2.964	-4.739	-3.548	-3.283	-1.950

The results of unit root tests reveal that all the variables are non stationary at level,  $I(0)$ , while after taking the first difference,  $I(1)$ , all the variables were confirmed to be stationary as shown in table 4.1 all the variables in this study are integrated of order one.



## **4.2 Lag Order Selection for Endogenous Variables**

Since stationarity of the results confirmed that all variables were integrated of order 1, before identifying the number of co-integrating vectors, we first applied VAR test in order to determine optimal lag length. The optimal lag order is determined with the sequential modified Likelihood Ratio test statistics (LR), the Final Prediction Error (FPE), the Akaike Information Criterion (AIC), the Schwarz Information Criterion (SIC), and the Hannan-Quinn Information Criterion (HQ).

## **4.3 Co integration test result**

As justified by unit root test all the variables of the study are integrated of order one so co –integration tests are possible. Both the trace and maximal eigen value tests reveal that there are only one co-integrating vectors in the system at 5% level of significance. This suggests the existence of long-run relationship between the variables. . It may also be possible to use the Engle-Granger two-step procedure to test for cointegration. But, the Engle-Granger method tests the presence of only one co-integrating relationship and does not reveal whether there may be other such relationships.

## 4.2 Table of co integration test

. vecrank hi eduin lry, trend(constant) lags(1) max

Johansen tests for cointegration						Number of obs =	40
Trend: constant						Lags =	1
Sample: 1972 - 2011							
maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value		
0	3	267.89426	.	89.8207	29.68		
1	8	308.33601	0.86762	8.9372*	15.41		
2	11	312.76266	0.19855	0.0839	3.76		
3	12	312.80459	0.00209				

maximum rank	parms	LL	eigenvalue	max statistic	5% critical value		
0	3	267.89426	.	80.8835	20.97		
1	8	308.33601	0.86762	8.8533	14.07		
2	11	312.76266	0.19855	0.0839	3.76		
3	12	312.80459	0.00209				

According to Johnson co integration procedure when the variables are co integrated we run vector error correction model in the long run. As shown on the appendix from the normalized VEC long run relationship is present as follow.

## 4.4. VECM estimated result

The major purpose of VECM is to indicate the speed of adjustment from short-run equilibrium to long-run equilibrium state. When the variables are co-integrated and their first difference stationary then there is an existence of causality in either direction. The present study uses multivariate causality test to explore all channels of causal relationship. Causality in co-integrated systems can be established if and only if lagged error correction term (ECTt-1) that takes into account long-run dynamics and sum of the coefficients of the lagged variables that takes into account short run dynamics both are significant.

## Long run Relationship.

### Normalized long run coefficient

**Table 4.3**

Long run coefficients ( $\beta_s$ )			
Lry	Eduin	Hi	constant
1	-0.90 (-2.98)	-2.62 (-3.76)	-5.85

## Model

$$lrcy_t = \beta_0 + \beta_1 EI_{1t} + \beta_2 HI_{2t} + \mu_{1t}$$

$$lry = 5.85 + 0.90eduin + 2.62hi$$

(0.003)      (0.000)

The long-run coefficients of both education and health indices are aligned with theory and are also statistically significant indicating that both measures of human capital contribute in economic growth during 1971 - 2011. The results of the study strongly support the view that in the long-run educated and well-nourished healthy labor force significantly contributes to economic growth. The coefficients of education and health reveal the existence of a positive and significant long-run relationship between human capital and economic growth. It may be because of an increase in workers' productivity due to the proper provision of health and educational facilities to the workers. The possible factors that can be cited in this regard are increase in labor force participation

especially female participation in economic activity, imparting knowledge and skills related to production process, increase in labor efficiency due to increased health facilities and improved technology, building of professional ethics and attitudes. The long-run relationship between the variables is evident from the negative and significant coefficient of the lagged error correction term -0.082 (.001). The fairly low coefficient of (ECT-1) shows very low speed of adjustment 8% per year towards long-run equilibrium.

### Short run Relationship.

The paper tries to see the short run relationship that education and health had with that of economic growth. As the above table shows in the short run only health has a significant effect on economic growth. Whereas education does not affect economic growth in the short run.

Table: short run Coefficient dynamics.

variables	coefficient	Std. error	p-value	decision
constant	-.0048829	.0102019	0.632	-
D_lry	-.0822963	.0246384	0.001	significant
D_hi	-.0148932	.0009944	0.000	significant
D_eduin	-.0236965	.0253737	0.350	-
EMC_1	-.0822963	.0246384	0.001	0.001
R <sup>2</sup> = 11.6213 (0.23551)				
Vec diagnostic test1				
AR test Chi <sup>2</sup> (25) = 19.58049(0.76848)				
Normality test chi <sup>(^)</sup> =1.046 (0.59283)				
Hetro test chi <sup>(^)</sup> = 72.76 (.4546)				

## **4.5. Vector diagnostic test**

### **Residual Vector Serial Correlation LM Test**

As shown in the appendix, there is no evidence that reveals the presence of autocorrelation at the first and second lags. The large P-value implies that the chi-squared statistics at all lags are not large enough to help reject the null of no autocorrelation at any of the given critical values. Thus, the study could not find any evidence of autocorrelation problem in the residuals.

### **Residual Vector Normality Test**

Jarque-Bera test is a common and frequently used method to test normality. The finding shown in the appendix reveals that the residual vector of the model is found to be jointly normal only at 10 percent level. But, as normality is an asymptotic or large sample property, it may be expected that the residual normality could asymptotically improve if the sample size could be increased.

Vector AR test;  $\chi^2 = 11.6213$  (0.23551)

## **4.6. Short run causality result**

Short run causality result can be seen from the result on joint significance of lagged variables after estimating unrestricted VAR. As shown below from granger causality result there is unidirectional causality runs from economic growth to health provision and feedback causality between education and health provision.

. vargranger

Granger causality wald tests

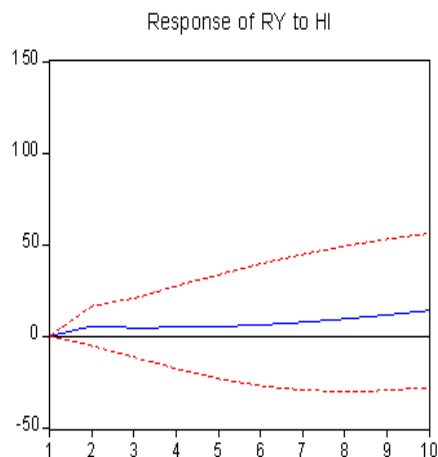
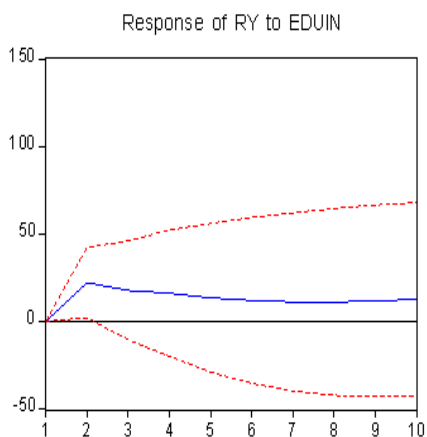
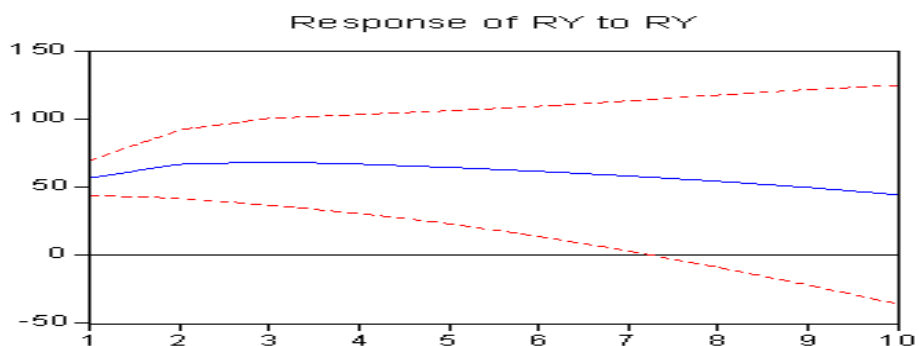
Equation	Excluded	chi2	df	Prob > chi2
try	eduin	1.108	1	0.293
try	hi	.06976	1	0.792
try	ALL	10.877	2	0.004
eduin	try	1.2588	1	0.262
eduin	hi	10.292	1	0.001
eduin	ALL	10.32	2	0.006
hi	try	23.94	1	0.000
hi	eduin	4.1887	1	0.041
hi	ALL	24.282	2	0.000

All the analysis result strongly supports existence of long run relationship between human capital and economic growth in Ethiopia which shows further investment on education and economic growth would leads further economic progress. The some finding result in Pakistan by Asghar Nabila (2012), for Greece by Solaki Melina (2013) , Zivengwa Tichana (2012) in Zimbabwe and Kefle Wubet (2006) through different methodology and proxy variable are used their finding supports the view of new growth theory quality of human capital was a significant factor for economic advancement.

### Impulse Response Functions

In addition to Granger causality test the paper present the impulse response function graphs that could provide us some insights about the interaction between the variables. In general IRF analysis in time series analysis is important in determining the effects of external shocks on the variables of the system. In general IRFs show us how an unexpected change in one variable at the beginning affects another variable through time.

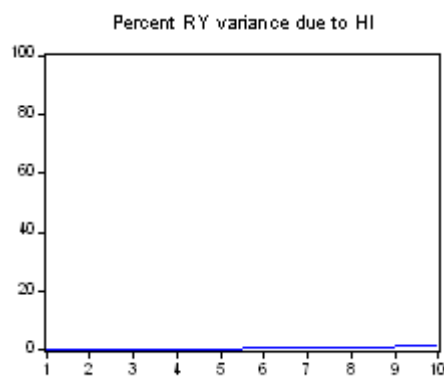
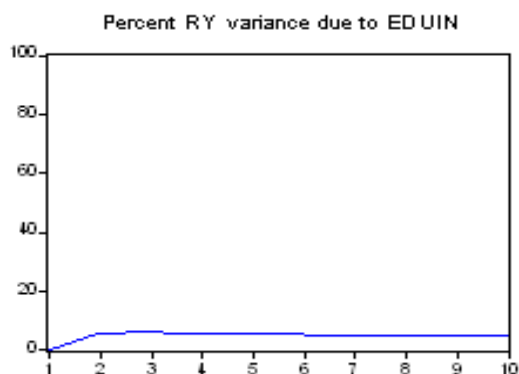
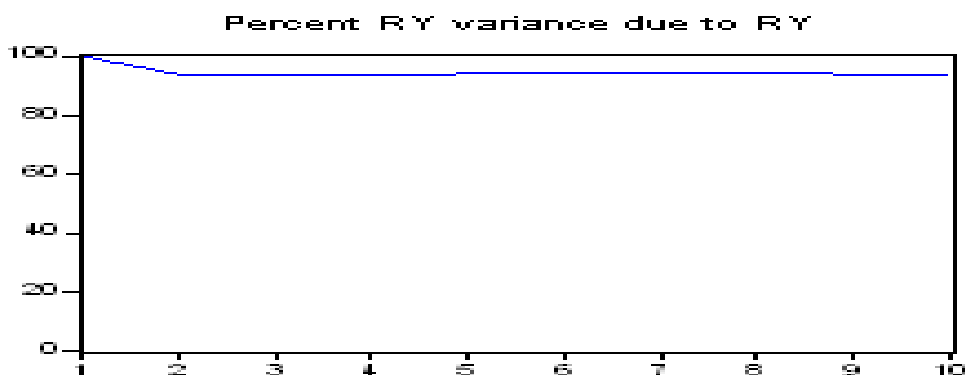
**Response to Cholesky One S.D. Innovations ± :**



The first part of our graph shows economic growth responses to a shock in itself is positive and somehow constant and the second part shows Economic growth response to a shock in education is first it raises then its positive and persistent meaning education has positive effect in the economy. The last part shows economic growth response for a shock in health has small and positive initially and increasing later.

## Variance decomposition

Variance decomposition permits inferences to be drawn regarding the proportion of the movement in a particular time-series due to its own earlier “shocks” vis- à-vis “shocks” arising from other variables in the VAR. After estimating the VAR, the impact of a “shock” in a particular variable is traced through the system of equations to determine the effect on all of the variables, including future values of the “shocked” variable. The technique breaks down the variance of the forecast errors for each variable following a “shock” to a particular variable and in this way it is possible to identify which variables are strongly affected and those that are not (Granger, 1969).

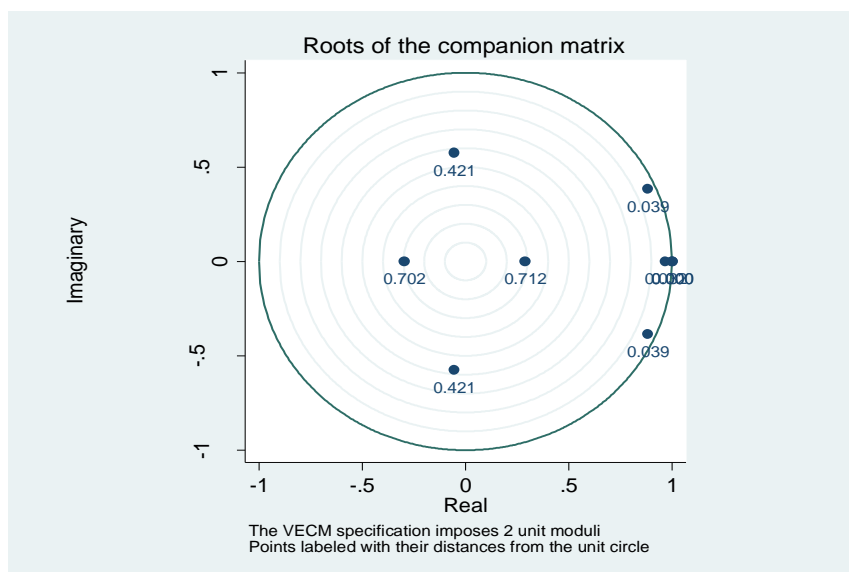




## 4.7. Stability test

The stability of the model and the results of the post-estimation diagnostics could affect the validity and robustness of the results of impulse response function and other diagnostics; therefore, it should be tested before going further. The companion matrix showing the roots of the characteristic polynomial and the corresponding modulus is presented in the figure below.

Figure 4.1. The Inverse Roots of AR



The figure shows that all of the moduli lie inside and on the unit circle. Consequently, the report suggests that the model satisfies the stability condition.

## **Chapter five**

### **Conclusions and policy Implication**

#### **5.1 Conclusions**

Human capital occupies a central role in modern thinking about growth. Despite a large literature on the matter, there is a lot to be learned: there is no consensus of its role in growth and development, presumably because this role varies across different institutional settings and national environments. This study was undertaken in the hope of uncovering the situation for Ethiopia.

This study aimed to examine the relationships between human capital and economic growth in Ethiopia (using real GDP per capita, as a proxy for economic growth and health index and education index as proxy of human capital) from 1971 - 2011. The results of this study are found consistent with the theory as well as with the past empirical research conducted on subject matter. All the variables are non stationary at level while they are stationary after taking their first difference. The finding supports significant positive impact of human capital on economic growth by confirming direct positive relationship between economic growth and measures of human capital education and health. The existence of stable long-run relationship between economic growth and both measures of human capital is confirmed through Johansen co integration test. Short run causality reveals existence of unidirectional causality runs from economic growth to health provision and feedback causality between education and health provision.

The findings of this research concerning the long run positive impact of the education and health human capital are consistent with the endogenous growth theories (mainly advocated and/or developed by Lucas (1988) , Romer (1990), Mankiw, Romer and Weil (1992) which argue that improvement in human capital (skilled and healthy workers) leads to productivity improvement and thereby output growth. With respect to the researches made in Ethiopia,

the finding of this research is also similar to Teshome (2006), Woubet (2006) and Tofik (2012).

## **5.2 possible policy Implication**

The results of this study have important policy implications. In order to improve economic growth, public expenditure needs to be better prioritized towards basic health service provision. In addition, to achieve economic growth, more resources should be devoted to educate the citizens of the country. Such measures have a large impact on human productivity which leads to improved national output per capita. In other words, as more people become educated and healthy, they will increase their productivity in the long run. Although not investigated in this paper, one of the ways through which education and health affects economic wellbeing is its externalities effect. That means, education and health may have indirect benefits (positive spillovers) that enhance productivity in the long run.

Hence policy makers and / or the government should strive to create institutional capacity that increase school enrolment and improve basic health service. That means, the policy makers and the government should center on securing more resources and structures that are essential and appropriate for better school enrolment and improved basic health service provision. Such measures should focus not only on creating new institutional capacity, but also on strengthening and changing the existing institutional setups of the education and health sectors of Ethiopia that produce quality manpower. In addition, the government should also continue its leadership role in creating enabling environment that encourage better investment in education and health by the private sector. Because, healthier participation of the private sector in the education and health sectors can speed up the creation of human capital in Ethiopia.

### **5.3 Limitations and directions for further study**

The major limitation of the study is that it does not include any other determinant of economic growth as a repressor in the model. It is left on the interested readers to analyze the causal relationship between human capital and economic growth by including the determinants of economic growth along with human capital index. The other limitations are related with inconsistency of the data and shortcoming related with indices. Further consideration of all shortcomings will advance the study in the subject areas.

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## Appendix

. varsoc hi eduin ry

Selection-order criteria  
Sample: 1975 - 2011

Number of obs = 37

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-286.612				1262.86	15.6547	15.7008	15.7853
1	-183.148	206.93	9	0.000	7.6709*	10.5485*	10.7327*	11.071*
2	-180.941	4.4142	9	0.882	11.2	10.9157	11.238	11.83
3	-174.957	11.968	9	0.215	13.5503	11.0787	11.5392	12.3849
4	-162.778	24.357*	9	0.004	12.0263	10.9069	11.5055	12.6049

Endogenous: hi eduin ry  
Exogenous: \_cons

2 unit root result at level hi

. dfuller hi, lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 39

z(t)	Test Statistic	Interpolated Dickey-Fuller		
		1% Critical Value	5% Critical Value	10% Critical Value
	-1.092	-3.655	-2.961	-2.613

Mackinnon approximate p-value for z(t) = 0.7181

. dfuller hi, trend lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 39

z(t)	Test Statistic	Interpolated Dickey-Fuller		
		1% Critical Value	5% Critical Value	10% Critical Value
	-2.324	-4.251	-3.544	-3.206

Mackinnon approximate p-value for z(t) = 0.4208

. dfuller hi, noconstant lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 39

z(t)	Test Statistic	Interpolated Dickey-Fuller		
		1% Critical Value	5% Critical Value	10% Critical Value
	-1.038	-2.638	-1.950	-1.606

At first difference hi

. dfuller dhi, lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            38

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
Z(t)	-3.614	-3.662	-2.964	-2.614

Mackinnon approximate p-value for Z(t) = 0.0055

. dfuller dhi, trend lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            38

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
Z(t)	-9.152	-4.260	-3.548	-3.209

Mackinnon approximate p-value for Z(t) = 0.0000

. dfuller dhi, noconstant lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            38

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
Z(t)	-2.118	-2.639	-1.950	-1.605

At level edu

. dfuller eduin, lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            39

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
Z(t)	0.847	-3.655	-2.961	-2.613

Mackinnon approximate p-value for Z(t) = 0.9924

. dfuller eduin, trend lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            39

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
Z(t)	-0.869	-4.251	-3.544	-3.206

Mackinnon approximate p-value for Z(t) = 0.9594

. dfuller eduin, noconstant lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            39

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
z(t)	0.177	-2.638	-1.950	-1.606

At first difference edui

. dfuller deduin, lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            38

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
z(t)	-4.201	-3.662	-2.964	-2.614

Mackinnon approximate p-value for z(t) = 0.0007

. dfuller deduin, trend lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            38

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
z(t)	-4.453	-4.260	-3.548	-3.209

Mackinnon approximate p-value for z(t) = 0.0018

. dfuller deduin, noconstant lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            38

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
z(t)	-3.548	-2.639	-1.950	-1.605

At level lry

. dfuller lry, trend lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            39

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
Z(t)	-0.151	-4.251	-3.544	-3.206

Mackinnon approximate p-value for Z(t) = 0.9923

. dfuller lry, noconstant lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            39

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
Z(t)	0.927	-2.638	-1.950	-1.606

At first difference, lry

. dfuller dry, lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            38

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
Z(t)	-3.476	-3.662	-2.964	-2.614

Mackinnon approximate p-value for Z(t) = 0.0086

. dfuller dry, trend lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            38

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
Z(t)	-4.739	-4.260	-3.548	-3.209

Mackinnon approximate p-value for Z(t) = 0.0006

. dfuller dry, noconstant lags(1)

Augmented Dickey-Fuller test for unit root                      Number of obs    =            38

	Test Statistic	1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	10% Critical Value
Z(t)	-3.283	-2.639	-1.950	-1.605

. vec lry eduin hi, trend(constant) lags(1)

Vector error-correction model

Sample: 1972 - 2011  
 No. of obs = 40  
 AIC = -15.0168  
 Log likelihood = 308.336  
 HQIC = -14.89467  
 Det(Sigma\_ml) = 4.05e-11  
 SBIC = -14.67902

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_lry	2	.055196	0.2592	13.2957	0.0013
D_eduin	2	.056844	0.1238	5.369365	0.0682
D_hi	2	.002228	0.9506	731.7227	0.0000

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
D_lry						
_ce1						
L1.	-.0822963	.0246384	-3.34	0.001	-.1305867	-.0340058
_cons	-.0048829	.0102019	-0.48	0.632	-.0248784	.0151125
D_eduin						
_ce1						
L1.	-.0236965	.0253737	-0.93	0.350	-.0734281	.026035
_cons	.0139787	.0105064	1.33	0.183	-.0066135	.0345708
D_hi						
_ce1						
L1.	-.0148932	.0009944	-14.98	0.000	-.0168421	-.0129442
_cons	.0047405	.0004117	11.51	0.000	.0039335	.0055475

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	2	357.351	0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
_ce1						
lry	1					
eduin	-.9008103	.3024313	-2.98	0.003	-1.493565	-.3080558
hi	-2.62378	.6976578	-3.76	0.000	-3.991164	-1.256396
_cons	-5.851679	.	.	.	.	.

.



## Diagnostic result of VECM

. vec1mar

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	11.6213	9	0.23551
2	5.4825	9	0.79038

H0: no autocorrelation at lag order

. vecnorm, jbera

Jarque-Bera test

Equation	chi2	df	Prob > chi2
D_lry	1.046	2	0.59283
D_eduin	59.978	2	0.00000
D_hi	9.132	2	0.01040
ALL	70.156	6	0.00000

## Stability result

Eigenvalue stability condition

Eigenvalue	Modulus
1	1
1	1
.9682566	.968257
.8810078 + .3850784 <i>i</i>	.961489
.8810078 - .3850784 <i>i</i>	.961489
-.05473494 + .5762611 <i>i</i>	.578855
-.05473494 - .5762611 <i>i</i>	.578855
-.2976982	.297698
.2876178	.287618

The VECM specification imposes 2 unit moduli.