Södertörns University|Department of Social Sciences|
Economics

Health and Long Run Economic Growth in Selected Low Income Countries of Africa South of the Sahara

Cross country panel data analysis

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Acknowledgment

I am grateful to God who made all the things possible.

I would like to thank the people who have helped and supported me not only throughout my project but also for making my stay in Stockholm more pleasant.

I am grateful to my Advisor Mr. Leo Foderus for his continuous support & encouragement. I would also like to thank the institute of Södertörns Högskola for providing such an opportunity. Coming to Stockholm for my Msc has been an interesting journey of my life. I have been able to experience different aspect of life, which have helped me become a much stronger person.

My deepest gratitude goes to my friends Ahmed Hashim, Fikirte Tegaye, Michael Tedla, Million Kibret and everyone who has contributed in one way or the other in the course of the project.

Finally, my dues are to my Parents Frew Tekabe and Abebu Debebe and the rest of my beloved family for the love, support and encouragement. I can't imagine any of this without your unconditional support.

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Abstract

Health is one of the most important components of human capital. It can affect production level of a country through various channels. In this study the causal relationship of health and real GDP per capita income in 5 low income countries of Africa south of the Sahara is analyzed using granger causality test. Unbalanced panel data set during the year 1970 to 2009 is used. Life expectancy and mortality rate are used as a proxy for health.

The result revealed that mortality rate has a significant and negative impact on real per capita income. The Granger causality test showed, real GDP per capita and mortality rate have causal or bidirectional relationship. On the other hand, real GDP per capita does not granger cause life expectancy, but life expectancy granger cause real GDP per capita.

The comparative descriptive analysis of the health indicators in different income groups of the world also showed that, higher income countries are better off in their health status.

Key words: human capital, economic growth, per capita GDP, Africa south of the Sahara

Chapter One

1.1 Introduction

Health is recognized to be an essential element of human welfare and sustained economic and social development. Alma-Ata Declaration signatories noted that Health would contribute both to a better quality of life and also to global peace and security (World Health Organization, 2010).

People rate health as one of their highest priorities. Health has become as important as any other economic and social concerns, such as unemployment, low wages and a high cost of living. As Bloom, Canning, & Sevilla, (2004) noted the "the most basic human capabilities that is leading a long life, being knowledgeable, and enjoying a decent standard of living" (UNDP, 1990) can be represented by health, education, and income. These are considered as the three pillars of human development. Furthermore, health is consistently ranked number one in the things people desire in life.

Poor health has stand out among other likely candidate for the disappointing growth performance of poor countries. Even though life expectancy increased in developing countries for the past 60 years, many people in low income countries encounter bad health conditions (Howitt, 2005). More than billions of people lack access to safe water in low and middle income countries. Moreover, diseases such as AIDS, malaria and tuberculosis have highly damaged the continent of Africa (The Economist Intelligent unit, 2011).

In the early days, attention was solely given to physical capital accumulation as an engine for economic growth. During 1960s human capital started getting recognition for its contribution to economic growth. Among others, (Mankiw, Romer, & Weil, 1992) showed the central role of human capital for economic growth by providing theoretical and empirical evidences.

Many studies have shown that better health has a positive impact on GDP per capita as an index for economic growth and development by increasing output. Thus, it is prudent to work upon the improvement of health policies in developing countries.

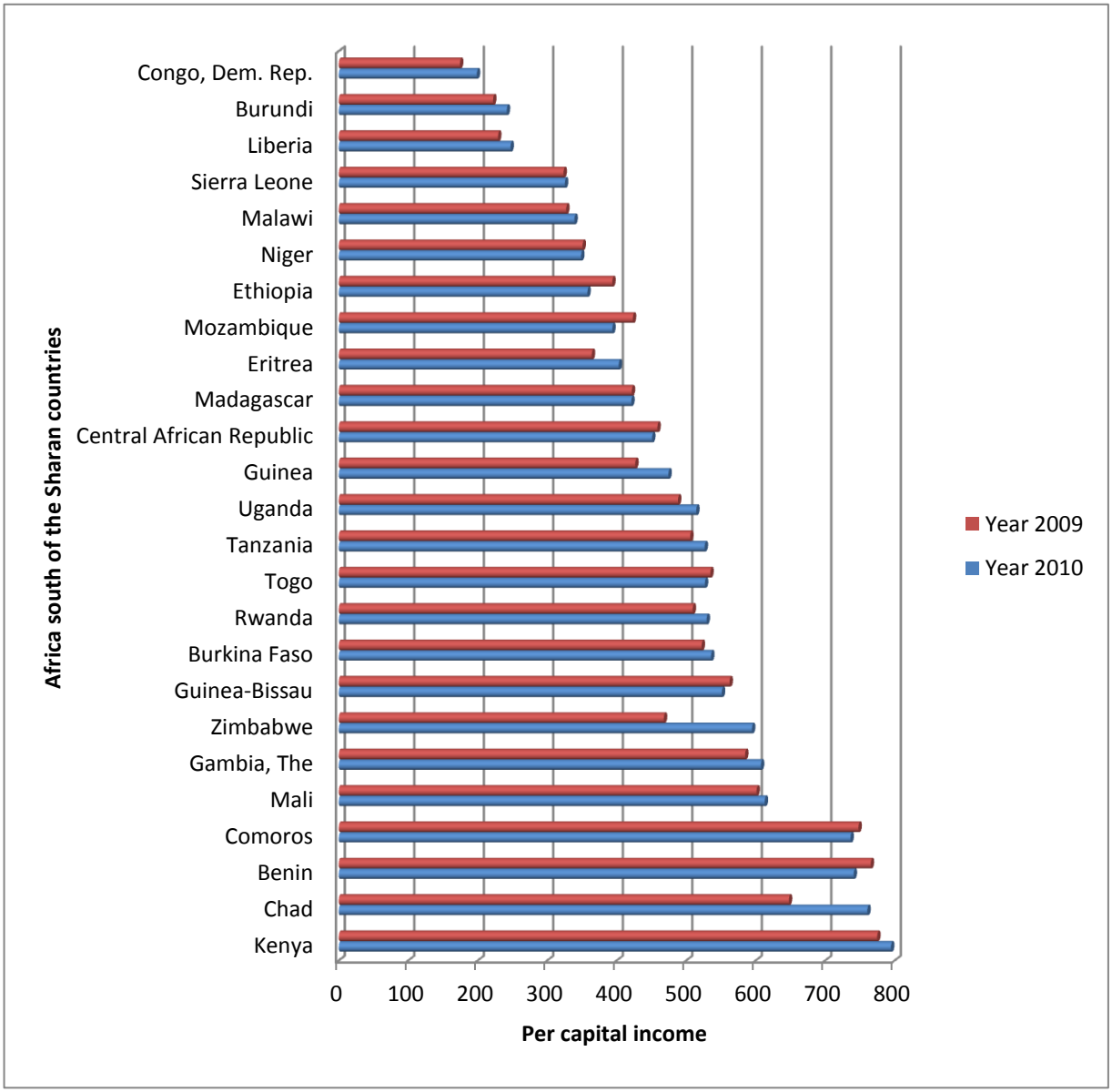
Many African countries are grouped either in lower income group or in lower middle income group category where poor health is very common trend. The prevalence of poor health in developing country and its impact on the development process of the countries call for research needs. According to (World Development Indicators, 2009), life expectancy at birth in Africa south of the Sahara is 54 which is the lowest from the world. Prevalence of HIV total (percent of population ages 15-49), is also the highest in this region which is about 5.5percent. Thus, this thesis tries to analyze cross country evidences of selected 5 African south of the Saharan[1] countries.

Seychelles have the highest per capita income of USD 26317, Gabon (USD 11363), Mauritius (USD 10029), Botswana (USD 9703) and South Africa (USD 8647) are among the middle income countries in African region. Libya, Egypt and Tunisia are also among the North African countries that exhibit better real per capita income in the continent of Africa. On the other hand, in regards to global competitiveness, Tunisia, South Africa, Mauritius and Egypt are in better position. (Heston, Summers, & Aten, 2011).

In the following figure, Africa south of the Saharan countries which have less than 1000 USD per capita income are ranked from the lowest to the highest. Out of 46 Africa south of the Saharan countries, 25 of them have less than 1000$ per capital income. These regions are among the least developed regions of the world.

[1] Africa south of the Sahara countries are the countries that were previously known as sub Saharan countries.

Figure 1: Africa south of the Saharan countries with per capital income < 1000 dollar



Data source: Penn World Index 7.0

Although good health may be considered as form of human capital that has a positive impact on productivity, income is also expected to influence health in a positive way.

Thus, this study tries to see the causality of health variables with per capita income using granger causality test, and see whether the relationship of health and per capita income is two way or not for the sample groups. It also analyzes the impact of health on real per capita income by taking life

expectancy and mortality rate as proxies for health. The model has also included other variables that are expected to be determinants of economic growth such as; inflation, education, fertility rate etc. based upon the model of Barro's study on the determinant of Economic Growth (Barro, 1996)

1.2 Objective of the Study

The main objective of the study is to analyze the causal relationship of health and real per capita income or long run economic growth in Ethiopia, Kenya, Rwanda, Uganda and Tanzania. At the end of this study, the following questions are answered; is there a causal relationship between health and real per capital GDP in Ethiopia, Kenya, Rwanda, Tanzania and Uganda?

The specific objectives are to see whether health affect real per capita GDP in the selected countries. In the meantime, short and brief comparative analysis of health and economic growth indicators in different income groups of the world is presented, in order to help us observe the relationship of income and health, by using descriptive method.

1.3 Significance of the Study

Africa being among the developing nations with lots of economic potential, it needs to pinpoint areas of improvement to achieve its economic and development goals. Among the African nations, most Africa south of the Sahara countries are among least developed countries. They need to optimally allocate their resources and since human resource is abundant in these regions, it would be productive to have healthier and productive human capital resource. In order to make this a reality, there is a need to study the relationship of health and economic growth. Hence, this topic is selected to point out the causal relationship of health and per capita GDP of selected low income countries of Africa south of the Sahara, so that the countries would be able to work on the factors that should be built up so as to enhance their economic performance.

1.4 Limitation

This thesis will be limited to five low income countries of Africa South of the Saharan. The countries that will be included in this study are only Ethiopia, Kenya, Rwanda, Tanzania and Uganda because of missing data problem. Variables that are expected to be determinants of economic growth such as rule of law index, democracy and corruption index are not also included in this study because it's difficult to find the data for the countries.

1.5 Organization of the Paper

The rest of the study continues as follows. Chapter two contains review of literature in which some theoretical and empirical studies, the theories on human capital and Solow growth model are discussed. Chapter three consists of the method and data analysis followed by chapter four which include conclusion of the study. The comparative analysis of health indicators is found on annex section.

Chapter Two: Literature Review

2.1 Theoretical Literature Review

2.1.1 Health and Economic Growth

From early 1990s, various studies have attempted to identify the determinants of economic growth. Among the few variables that were statistically significant for explaining economic growth, health is found to be one of them. Sustained growth depends on levels of human capital whose stocks increase as a result of better education, higher level of health, and new learning and training procedure. The effect of human capital variables imply that the investment rate tends to increase as levels of education and health rise (Lopez, Rivera, & Currais, 2005).

Until the second half of 1990s, the role of human capital was mainly related only to education. Few authors recognized the importance of other factors such as health and nutrition to have an impact on real per capita income. (Fogel, 1994), (Barro & Sala, 2003) were among some economists that examined relationship between economic growth and health, and this lead to other works focusing on the link between Health, Wealth and Growth.

Lopez, Rivera, & Currais (2005) stated that good health to be a crucial part of overall wellbeing. Based on economic grounds, good health raises levels of human capital, and this has a positive effect on individual productivity and economic growth rates. Better health increases labor force productivity by reducing incapacity, weakness, and the number of days lost to sick leave. Moreover, healthier workers are physically and mentally more energetic and thus effective on the labor market. The effect of having a less productive labor is stronger in developing countries, because higher proportion of the work force is engaged in manual labor than industrial countries (Scheffler, 2004). There is also positive spillover effect in tackling poverty. Enhancement of health and health indexes in the society will encourage individuals to have more saving through reduction of mortality and increase of life expectancy. Following increased saving in the society, physical capital is expected to improve and will indirectly enhance labor force productivity and economic growth (Weil, 2005).

Understanding the causal relationship between health and wealth is important to clearly see how the two works. The existence of possible endogeneity between health and wealth makes it difficult to analyze it. Although good health may be considered as form of human capital that has a positive impact on productivity, income also influences health in a positive way. Earning higher income will increase the consumption of health related good such as adequate food and medicine (Lopez, Rivera, & Currais, 2005). There will also be improvement on the living standard and this will indirectly bring efficiency in the work place. The causal relationship of health and per capita income will bring biasedness and inconsistency when analyzing the estimates of the impact of health on economic growth. The positive effect of health on economic growth is identified either in exogenous growth models during the transition to the steady state or in endogenous growth models, each within the context of inter-context of inter-temporal optimization. Thus it is useful to carefully investigate their relation.

2.1.2 Need for a better health Care

A world report published in 2003 emphasized the gap in the life expectancies between rich and poor countries is widening. A child born in Japan has a life expectancy of 82 years, on the contrary, in Sierra Leone; average life expectancy at birth is around 34 years, more than 16 percent of which is spent in ill health (World Development Indicators, 2010). The same holds true in Angola and Afghanistan. While AIDS is the main killer in Africa, heart disease and other non-communicable diseases are taking many lives elsewhere (Lopez, Rivera, & Currais, 2005). “For LDCs investing in health usually provides a means of escaping from the poverty trap. Public health and epidemiological programs help to short-circuit the vicious circle characteristic of poverty and ill health creating complementarities within other forms of human capital, such as education or sustainable fertility rates for families. Indeed, it is well documented how increases in life expectancy after parental decisions to invest in their children’s education by lowering the expected losses from infant mortality. As a result, women may reduce birth rates since the rate at which the family labor needs to be replaced declines. This, in itself, increases per-capital income. In addition, a more highly educated, healthier population is more productive, and contributes a national income that is shared among a less impoverished populace.”

According to (World Health Organization, 2002), treatable disease such as tuberculosis and malaria are still a major problem in poor countries. The impacts of these diseases are tremendous in poor countries with very low health expenditure.

(Scheffler, 2004), noted an increase in health care cost is due to technology. In many industrialized countries the enormous growth of health care spending is indirectly linked to technology. In the past, health spending was not considered to be necessary for development. It was thought to be something that would come after a country was developed. But recent studies show that, in order to develop a country economically, there should be a well-managed and planned health care system for the successful achievement of the development of a country. This thinking is centered on the development of human capital which includes; education, training and health.

In undeveloped countries, people have large families but because of high child and infant mortality rates, few of the children survive. For these and other reasons such as low contraceptive usage of rural populations of less developed countries, family planning is not well practiced (Scheffler, 2004). Keeping other factors constant, the development of health care system of a country would help in bringing a healthier family. Thus families will have a higher quality rather than larger quantities of children. This is important for economic growth model.

Moreover, bad health is a major cause of poverty. Serious illness causes people to become poor because they drop out of the labor market. So in order to develop a country, health of the population must get better. One way of achieving this is by educating women. As women are the primary home caretakers of a household especially in the case of less developed countries (Scheffler, 2004). Having a well-developed health care system will thus help to improve the labor productivity, which leads to higher wage and GDP.

When countries get wealthier, their spending on health care increases. Thus, the elasticity for health care is greater than one, which can be categorized as luxury good. This is common for every country because health care contributes to a greater quantity and quality of life.

In general, the wealthier a country, the higher the elasticity of health care (which is about 1.25). But for poorer countries, the elasticity is very close to one. That is in countries such as US, Britain,

and France for every 10 percent increase in income, there is a 12.5 percent increase in health care spending (Scheffler, 2004).

2.1.3 Health and poverty

International organizations such as IMF (international monetary fund), OECD (organization for economic cooperation and development), UN (united nation) and WB (World Bank) have made the reduction of poverty one of their major priorities (World Health Organization 2002). Among their seven international development goals; three of them are directly related to health. The first is to "reduce the proportion of people living in extreme poverty by half" between 1990 and 2015.

By taking different macroeconomic indicators of health such as life expectancy, infant mortality and prevalence of tropical and infectious diseases such as Malaria and HIV AIDS, industrialized countries with higher per capita income have lower mortality rates, and the prevalence of HIV in high income countries are as low as 0.3 percent (world bank data, 2009). As per capita GDP is an index for economic growth and wellbeing, we can say that wealth and health is positively related.

According to World Health Organization (2002) report, Income (financial wealth) together with education is said to be key determinant of health. Nutrition and child feeding practices improve with higher level of income. Moreover, sanitary hygiene such as hand washing and disposal of feces are also positively correlated to income per capita of a country.

The poor usually would delay their medical needs because of money problems. An increase in users' fee in public clinics will highly affect the poor than the better off because they cannot afford to cover their medical expenses. Higher income promotes accessibility to improved health facilities, better nutrition, clean water and sanitation, education and medical care (The Economist Intelligent unit, 2011).

Developing countries with low per capita income straggle with the prevalence of tropical diseases and HIV AIDS. As stated by (Bloom, Canning, & Sevilla, 2004), some disease such as malaria that may not have high mortality effect might have more negative impact on the economy because of their high morbidity burden. Moreover, mortality due to HIV AIDS is said to have negative and

significant indirect effect on long term economic growth because deaths due to this disease are highly concentrated among youth adult men and women leading to higher dependency ratio. In Africa south of the Saharan countries, about 5.45 percent (percentage of people ages 15-49 who are infected with HIV) of the total population is affected by HIV (World Bank, 2009).

With all the positive benefits of growth in per capita income, (Bloom, Canning, & Sevilla, 2004) states, improvement in health will prevail even if income remains fixed. Especially in developing countries, low cost tropical disease interventions bring large scale returns in saving people lives.

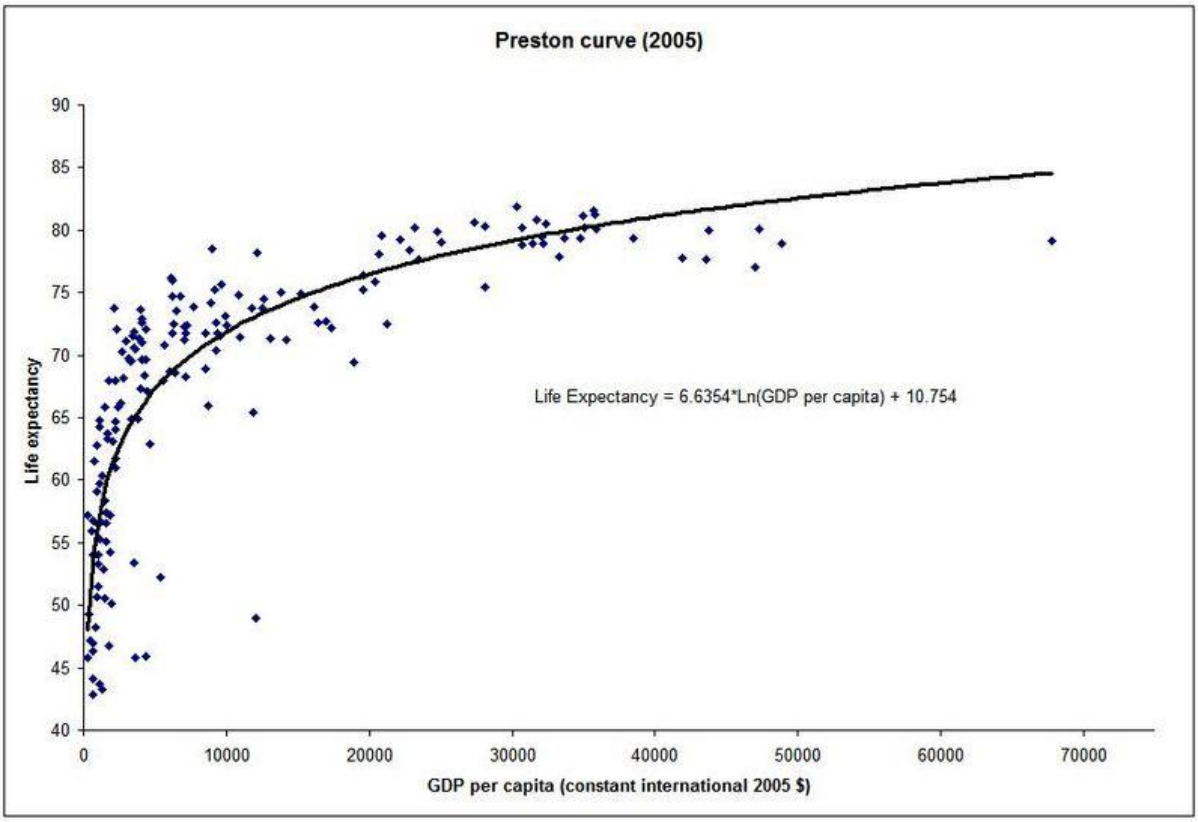
2.1.4 Human capital indicators

Mortality rate has been considered as a measure of health because of its accuracy in most previous studies. There are also other indicators such as, morbidity (illness) rates and disability days or sick leaves that can be useful for the purpose of measuring health.

Life expectancy is usually used in many cross country growth regressions and is generally found to be positive and significant on the rate of economic growth (Bloom, Canning, & Sevilla, 2004). Even though Life expectancy or adult survival rate is a measure of population health, it does not directly reflect the productivity of the labor force (Bhargava, Jamison, Lau, & Murray, -). The authors explain on how human capital such as skilled labor force, is important for capital formation. For this, experience and technical innovations that takes years of investment in research and development is important.

(Preston, 1975), have shown an empirical cross-section relationship between life expectancy and real per capita income in his well know “Preston Curve”. Preston studied the relationship for the 1900s, 1930s and the 1960s and found the correlation coefficient between the logarithm of national income per head and life expectancy was 0.885 in the 1930s and 0.880 in the 1960s. The following 2005 Preston curve will depict the Preston curve, using cross-country data for 2005. The curve clearly shows the relationship between GDP per capita and life expectancy is positive.

Figure 2: Preston Curve for GDP per capita and Life Expectancy



Source: Wikipedia

The betterment of health such as the decrease of infant and maternal mortality will increase population number. These are believed to decrease fertility, stabilize population growth and generate demographic dividend through lower level of youth dependency in the long term. On the contrary, another argument for this can be the increase of population, especially in Africa south of the Saharan countries, where the large number of population is a problem. The gain from better health might be offset by the decrease of per capita income if the economy doesn't have the ability to absorb the increasing population.

On the other hand, diseases that don't lead to death but which highly affects the health and performance of an individual will negatively affect productivity. If proper attention and care is not taken, HIV AIDS is an example for the previous statement because the disease can make a patient dependent on others. But if People with HIV AIDS get proper medical treatment and ample nutrition, they can work, perform and produce. As sited by (Bloom, Canning, & Sevilla, 2004).

``even though the causal effect of health on individual productivity and economic growth is accepted, the argument for using health as an input depends on it being low-cost health intervention that can increase population health without first having a high income level. There is however, a larger number of such interventions that can be implemented`` (Commission on Macroeconomics and Health, 2001). Thus African countries can start with having such kind of low cost intervention to tackle health related problems.

In most cases, higher education indicates better health. “The model of Grossman indicates that education raises marginal product of the direct inputs for producing health so it reduces the quantity required to produce a given amount of gross investment.” Thus, it suggests that health can be generated at a lesser cost for educated people. Because educated people are more likely to choose higher level of health stock than people with lesser education (Folland, Goodman, & Stano, 2010).

Better health is said to affect education in different mechanism and education is agreed to positively affect economic growth of the country. According to (Bloom, Canning, & Sevilla, 2004), a healthy child has better school attendance and a good learning capacity. Secondly, lower mortality and the expectation of longer life span will encourage people to invest in human capital.

Lower level of school participation in developing countries is usually related to illness, poor nutrition and other family poverty and problems (these includes situations that usually occur in rural areas, for example rather than sending a child to school, parents prefer their child to help out the mother in the household or at a farming filed). Even though increasing number of rural families are starting to be aware of the advantages of education, their lower standard of living usually forces them not to send their children to school. These factors are not only related to education but also income levels and the poverty of Africa south if the Saharan countries.

2.2 Empirical Literature Review

After recognizing the importance of human capital to economic growth, several researchers have done empirical analysis on the subject of the health and economic growth.

Barro (1997) stated that higher initial schooling and life expectancy, lower fertility, lower government consumption, better maintenance of rule of law, lower inflation and improvement of terms of trade enhance economic growth. He used panel of 100 countries from 1960 to 1990, and he also included dummies for Africa south of the Saharan countries.

Bloom, Canning, & Sevilla (2004), aimed at including health in a well-specified aggregate production function in an attempt to test for the existence of an effect of health on labor productivity, and to measure its strength. They estimated a production function model of aggregate economic growth including work experience and health. They have used a panel of countries observed every 10 years over 1960–90.Their main result is that good health has a positive, sizable, and statistically significant effect on aggregate output even when controlled for experience of the workforce. They concluded that that the life expectancy effect in growth regressions appears to be a real labor productivity effect, and are not the result of life expectancy acting as a proxy for worker experience. They suggested that a one-year improvement in a population's life expectancy contributes to a 4 percent increase in output. Thus improvements in health may increase output not only through labor productivity, but also through the accumulation of capital.

Kambiz, Roghieh, Hadi, & Rafat (2011), analyzed the relationship between health and economic growth in Organization Islamic Conference (OIC) member states (i.e. Indonesia, Iran, Pakistan, Bangladesh, Burkina Faso, Saudi Arabia, Kirgizstan, Kuwait, Mali, Malaysia, Egypt, Somalia, Uzbekistan, Tajikistan and Turkey). They used panel data for the years of 2001-2009 using the framework of a Semi log regression model. They followed (Bhargava, Jamison, Lau, & Murray, -) model where; Where economic growth is a factor of real gross domestic product, ratio of investment to GDP, openness degree of economy, life expectancy (in adults) and fertility rate. They omitted ratio of investment to GDP and openness degree of economy because it is not

effective in OIC member states. The result reveals that increased life expectancy has enhanced economic growth in these countries. They also found fertility to negatively affect economic growth.

(Hashmati, 2001), studied conditional convergence of OECD countries in gross domestic product (GDP) and health care expenditure (HCE) per capita the paper is an extension of the augmented Solow model suggested by (Mankiw, Romer and Weil, 1992) by using health expenditures as a proxy of health status in the growth function. He also considered the existence of causality relationship between GDP and Health care Expenditure (HCE) and found that the relationship is one way from HCE to GDP. The results indicate that OECD countries converge at 3.7 percent per year to their steady state level of income per capita, suggesting that health care expenditure has positive effect on the economic growth and the speed of convergence, but unlike (Mankiw, Romer, & Weil, 1992) the inclusion of human capital is found to be insignificant in the growth model. Temple (1999), also found the effects of human capital to be data specific and sensitive to the model specification and estimation methods used.

Rivera & Currais (1999) estimated the relationship between health and growth of OECD member countries for the period of 1960-1990. Health care expenditure per capita was used as a proxy for health. They showed that countries having more health expenditures have higher economic growth. They also considered investment in health as an important component for output. They have concluded that education is not the only effective factor in labor force performance and its productivity but also health.

Weil (2005), used microeconomic estimates to construct macroeconomic estimates to examine the effect of health on economic growth. His objective was to quantitatively assess the role of health in explaining income differences between rich and poor countries then to calculate the income gains that would result from an improvement in the health of people living in poor countries. He used data on three indicators of health: average height of adult men, the adult survival rate (ASR) for men, and age of menarche (onset of menstruation) for women. The analysis showed, eliminating health differences among countries would reduce the variance of log GDP per worker by 9.9 percent, and reduce the ratio of GDP per worker at the 90th percentile to GDP per

worker at the 10th percentile from 20.5 to 17.9. This effect is economically significant, but substantially smaller than estimates of the effect of health on economic growth that are derived from cross-country regressions.

Barro (1996) has found that 10 percent of the increase in life expectancy will lead to almost 1/2 percent increase in economic growth. His empirical finding for a panel of 100 countries states, growth is positively related and enhanced by higher initial schooling and life expectancy, lower fertility, lower government consumption and better maintenance of the rule of law, lower inflation and improvement of terms of trade.

From the literatures reviewed, it can be seen that most of the researcher proxy health with life expectancy, mortality rate or health expenditure per capita. Most of the studies found good health to raise human capital. Health also has a positive and significant impact on economic growth. Moreover, researchers have agreed that the causal relationship of health and per capita income have to be investigated to clearly see their relation. Some studies show that the relationship of per capita income and health variable has a bidirectional but others found it to be just one way. Therefore, it is important to study the not only the impact of health on economic growth but also the causal relationship of health and per capital GDP for low income countries such as; Ethiopia, Kenya Rwanda, Tanzania and Uganda. These countries are among the low income countries of the continent of Africa and it would be useful to work on the improvement of the health sector of the countries and there by facilitate their economic growth.

2.3 Theoretical Presentation

2.3.1 Theory

The Solow-Swan exogenous growth model has been a benchmark for subsequent growth models. This model was published based on the Cobb-Douglas production function and equation of capital accumulation. The main assumptions behind the model are; the existence of diminishing returns in the factor of production (capital and labor) and accepts the constant returned to scale and there is constant proportion of saving from household income. Thus, production side determine output when firms maximize profit taking as given the constant proportion of output that is saved by households and used for capital accumulation (Andreas & Thanasis, 2009).

By recognizing human capital (which is accumulated through knowledge and new skills and ideas that are used in production) as an important tool for sustained (endogenous) growth, the Solow model was also further extended to include human capital as a factor for economic growth. Mankiw, Romer and Weil (1992) added human capital to the Solow model and came up with human-capital extended slow-swan model. Human capital is believed to directly contribute to production in the extended model.

For Endogenous growth theorist's economic growth is primarily the result of endogenous variables such as human capital, innovation and knowledge. These variables are significant contributors to economic growth. This model was developed by Romer (1986) and Lucas (1988). The Schumpeterian perspectives states that the basic idea of endogenous growth theory is that technological progress is the driving force behind long run growth.

Endogenous growth models are useful to understand why advanced economies and the world as a whole can continue to grow in the long run despite the workings of diminishing returns in the accumulation of physical and human capital (Barro, 1996).

The simplest form of endogenous growth model is that output per capita is a function of capital and technology (AK model), where;

- K - includes both physical and human capital and it represents the volume of capital

- A - is level of technology which is positive and constant

Thus the model assumes positive constant level of technology k and capital which includes human capital. This model didn't make an explicit distinction between capital accumulation and technological progress.

To estimate the effect of health on economic growth, health is considered as a component of human capital in aggregate production function. This is in line with the augmented Solow model, used by (Mankiw, Romer, & Weil, 1992).

Endogenous growth theory differs from neo-classical theory in emphasizing that technological progress is itself an economic process, with economic determinants much like the process of capital accumulation.

Lucas model also stated, "health status of a population as a determinant of the supply of healthy labor force" so health will influence the accumulation of knowledge by improving learning capacity. Therefore; there will be effective labor force, resources spent on health will not be available for other uses and good health influences utility in a direct way through the net growth rate of population and the endogenously determined level of health activities

Health problems can reflect the existence of reduction and obstacles of economic growth. Barro, who was a Neo-classical economist, considered health as a human capital because health is a capital productive asset and an input for economic growth. Most of his works are influenced by David Ricardo, Robert Lucas, JR and Zvi Grillches. Among his contributions, Economic Growth model was one of them. Barro focus on human capital as a determinant of economic growth. i.e. Education, Health and social capital are considered to be Human Capital.

(Grossman, 1972), also developed a model showing that illness prevents work so that the cost of ill health is lost labor time. Human capital theory of Grossman states "individuals invest in them-selves through education, training and health to increase earnings." Thus health can be analyzed as a capital good similar to consumption and investment good. He also pointed out that a higher

wage yields higher optimal level of health stock. The return of being healthy is greater for higher wage workers, so increased wage will increase health capital (Folland, Goodman, & Stano, 2010).

2.3.2 Theoretical framework

Within the stream of Neo-classical growth model or exogenous growth model, Solow studied economic growth by assuming a neo-classical production function with decreasing returns to capital, the rate of saving and population growth considered as exogenous. In Solow's model, the rate of saving and population growth determine the level of per capita income across countries (Hashmati, 2001).

According to the Solow growth model, countries with higher saving will have higher per capita income holding other things constant and long term economic growth is taken to be constant. The model concludes that there is no long term growth but the introduction of exogenous technological progress can bring long term growth.

The model in its simplest form is - $Q = AK^{\alpha}L^{\beta}$ Where

Where: Q = total production

A = total factor productivity

K = capital input

L = labor input

α and β are the output elasticity's of labor and capital.

Solow also noted that, an increase in capital input would increase both output and labor productivity, an increase in total factor productivity could increase labor productivity. However, an increase in labor input (corrected by the rate of technological progress and the rate of depreciation) would decrease labor productivity because of diminishing returns to scale.

Even though the Solow growth model is a good starting point for explaining growth, but it do not take into account of other determinant of growth such as human capital.

(Mankiw, Romer, & Weil, 1992), presented the human capital augmented Solow growth model by including variables such as educational attainment. The addition of human capital in to the model

is said to help to explain the differences in output levels across countries. That is, countries that invest more in education are anticipated to be in a better position in regards to their income level than countries that does not invest in education.

Basic augmented version of Solow model with the inclusion of human capital is

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

Q = Output

K(t) = capital at time t

H(t) = health at time t

A(t)L(t) = productivity augmented labor

Where $\alpha,\beta \in (0,1)$ and $\alpha+\beta \in (0,1)$ and t denotes time, This implies that the production function exhibits constant returns to scale in its three factors: physical capital (K), human capital (H), and productivity-augmented labor (AL).

The above function is the motivation for the model of this study. The model is further extended by including variables that are expected to affect long run economic growth in the selected Africa south of the Saharan countries.

Health is expected to affect long run economic growth of a country because health is found to be among the important components for the development and wealth of a country in different previous studies. Economic theories and previous researchers such as Lucas (1988), Barro (1996), and Folland, Goodman and Stano (2010), suggested that factor accumulation: physical capital, labor and human capital; technological progress; institutions are the components potential source of f economic growth. Better health is found to be a crucial part of overall wellbeing. Based on economic grounds, good health raises levels of human capital, and this has a positive effect on individual productivity and economic growth rates (Lopez, Rivera, & Currais, 2005). Better health increases labor force productivity by reducing incapacity, weakness, and the number of days lost to sick leave. Moreover, healthier workers are physically and mentally more energetic and thus effective on the labor market. The effect of having a less productive labor is stronger in developing

countries, because higher proportion of the work force is engaged in manual labor than industrial countries (Scheffler, 2004).

Furthermore, when countries get wealthier, their spending on health care increases. This is common for every country because health care contributes to a greater quantity and quality of life. Thus when income increases, health care and health expenditure increases. In most cases, life expectancy and per capita income is directly related and inversely related with mortality rate. On the other hand, there is also an agreement that per capita income and health have two way relationships. Most industrialized countries with high per capita income have a better health care condition. On the contrary, low income countries have a very low life expectancy and high mortality rate.

There is also an argument that betterment of health such as the decrease of infant and maternal mortality will increase population number. These are believed to decrease fertility, stabilize population growth and generate demographic dividend through lower level of youth dependency in the long term. On the contrary, another argument for this can be the increase of population, especially in Africa south of the Saharan countries, where the large number of population is a problem. The gain from better health might be offset by the decrease of per capita income if the economy doesn't have the ability to absorb the increasing population.

Therefore, this paper uses the following model to analyze the impact of health on long run economic growth in selected African south of the Saharan countries. And it will also analyze the causal relationship between health and long run economic growth.

Chapter Three

3.1 Data

Out of 47 Africa south of the Saharan countries, five countries are considered for the undertaken research. The sample countries have similar economic situation based on real GDP per capita, moreover, availability of data has also influenced the choice of the countries because there is missing data problem. The countries included in this study are Ethiopia, Kenya, Rwanda, Tanzania and Uganda. The panel is unbalanced over the period of 1970 to 2009. For Ethiopia 36 year data is taken for the year 1974 to 2009, for Kenya and Tanzania 40 years data, from 1970 to 2009, for Rwanda 34 years data from 1976 to 2009, and for Uganda, 29 years data from 1981 to 2009. In total, 179 years of data is taken.

According to the World Bank classification (as shown in the following table), the sample countries are all low income countries and geographically located in Easter and southern Africa. The data is compiled primarily from the World Bank database, National bank of the respective countries and the Penn and world database.

Table 1: Classification of low- -income countries by income level, epidemic level, and geographical UNAIDS, UNICEF and WHO regions

Country	Classification of economy	Geographical region	UNAIDS region	UNICEF region	WHO region
Ethiopia	Low income	Africa south of the Sahara	Africa south of the Sahara	Eastern and Southern Africa	African Region
Kenya	Low income	Africa south of the Sahara	Africa south of the Sahara	Eastern and Southern Africa	African Region
Rwanda	Low income	Africa south of the Sahara	Africa south of the Sahara	Eastern and Southern Africa	African Region
Tanzania	Low income	Africa south of the Sahara	Africa south of the Sahara	Eastern and Southern Africa	African Region
Uganda	Low income	Africa south of the Sahara	Africa south of the Sahara	Eastern and Southern Africa	African Region

Source: World Bank

It is possible to analyze the impact of health on real GDP per capita by including health indicators and other socio economic variables that are expected to affect economic growth. The data is compiled for the long run real per capita income, mortality rate, life expectancy, fertility rate, education, initial real GDP, inflation (in consumer price), investment, government expenditure, aid, year and country dummies. The study variables included these variables by following previous empirical literatures.

Real per capita GDP, investment and government expenditure are taken from Heston, Summers, & Aten (2011). Inflation, education, mortality, fertility, life expectancy and aid data are from world development indicators (2010). Missing values were filled using data from national banks of the respective countries. Some of the variables of interest for the study are briefly discussed in the following section.

Long run economic growth

Long run economic growth is the dependent variable of the study and it is measured by the real GDP per capita. The data is taken from Penn world index, 2011.

Mortality rate and Life Expectancy are taken as indicators for health status. Barro's paper and other studies interchangeably use either life expectancy child mortality rate as an indicator for health. In this paper, life expectancy and mortality is taken as proxies for health because the data are more comprehensive.

Mortality rate under-five is the probability per 1,000 that a newborn baby will die before reaching age five (World development indicators, 2010).

Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life (World development indicators, 2010).

Fertility rate, (total births per woman): many studies suggest fertility rate as an important variable for economic growth especially for African countries.

Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates (World development indicators, 2010).

Secondary school enrollment, (gross percentage) – is taken as a proxy for education. Education is considered as one component of human capital in several studies.

Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Secondary education completes the provision of basic education that began at the primary level, and aims at laying the foundations for lifelong learning and human development, by offering more subject- or skill-oriented instruction using more specialized teachers (World development indicators, 2010).

3.2 Method

To undertake the empirical analysis and to answer the main objective of the thesis, secondary data and STATA statistical package is used. Baltagi, (2008), stated that panel data will be useful to utilize both time series and cross sectional information and it gives large number of observations, increasing the degree of freedom and reducing the co-linearity among explanatory variables**.** (Gujarati, 2004)**,** and (Green, 2003) also stated that panel data improves empirical analysis and it gives more flexibility for modeling the behavior of cross sectional units than convectional time series analysis.

The regression analysis of (Mankiw, Romer, & Weil, 1992), (Barro & Sala, 2003) was based on panel regression framework. They used long year data (about 25-39 years data) to increase the number of observation and to improve their empirical analysis. This study will also take panel of five of the low income Africa south of the Saharan countries. It also takes long year data that is 18 to 40 years similar to the above mentioned researchers.

For the purpose of this particular thesis, the data is constructed out of real per capita GDP, initial GDP, inflation, investment, education, mortality rate, life expectancy, fertility rate, government expenditure and aid.

Model:

$$lnRGDP_{it} = \alpha_{it} + \sum_{c}^{5} \alpha_{ic} D_{ic} + \beta_1 lnIntRGDP_{i0} + \beta_2 lnInflat_{it} + \beta_3 lnInvest_{it} + \beta_4 lnEdu_{it} + \beta_5 lnMort_{it} + \beta_6 lnFert_{it} + \beta_7 lnLE_{it} + \beta_8 lnGovexp_{it} + \beta_9 lnaid_{it} + year + \varepsilon_{it} \quad \text{..... (1)}$$

Where;

- *lnRGDP is log of real GDP per capita income is the dependant variable and it will indicate long run economic growth*
- *lnMort is log of mortality and lnLE is log of life expectancy which are considered as health indicators*
- *lnFert is log of Fertility, Developing countries especially low income Africa south of the Saharan countries have high fertility rate and this variable is expected to have an impact on long run economic growth*
- *lnEdu is log of education, this variable is one of the component of human capital thus it is considered for this study*
- *lnIntRGDP is log of initial real GDP per capita income, and will show the conditional rate of convergence*
- *lnInflat is log of inflation (in consumer price), inflation is getting higher and higher in low income countries of African and it is expected to have an impact on long run economic growth*
- *lnInvest is log of investment of Real GDP per capita is expected to have a positive impact on economic growth*
- *lnGovexp is log of government expenditure, government spending is also expected to have an impact on economic growth*
- *lnaid is log of Aid, there is large amount of net official assistance to low income countries of Africa and this is expected to have an impact on long run economic growth*
- *Year to control for time effects*
- *Dummy variable for country effects*

The following table depicts the sum of all variables in the analysis. It is calculated by using STATA software. It shows the overall information about the variables.

Table 2: Data description

Variable	No. of Observation	Mean	Standard Deviation	Minimum	Maximum
Year	179	1991	10.74	1970	2009
Real GDP per capita at current prices (in dollar)	179	590.25	296.65	146.69	1403
Initial Real GDP[2] at current prices (in dollar)	179	193.86	58.63	115.34	272.38
Investment Share of real GDP per capita at current prices (in percentage)	179	16.056	5.37	4.32	35.98
Education School enrollment, secondary (Percentage gross)	179	17.26	12.96	2.65	60.17
Mortality rate under-5 (per 1,000)	179	152.87	41.05	80.4	289.1
Fertility rate, total (births per woman)	179	6.48	0.921	4.35	8.29
Life expectancy at birth, total (years)	179	49.75	6.03	26.81	59.67
Inflation consumer prices (annual percentage)	179	16.81	28.001	-9.8	200.02
Government expenditure (share of real GDP per capita at current prices in percentage)	179	11.88	7.601	3.45	32.77
Aid in current dollar	179	7.25e+08	6.27e+08	5.10e+07	3.82e+09

The variables are taken in logarithmic form. Transformation of variables in logarithmic form helps to show influential points in very sharp manner and also corrects skewed variables in to the right distribution toward normality (Green, 2003). This is relevant in the context of regression analysis.

Using single cross-country regression and reducing the time series to single digit may lead to omitted variable bias (Baltagi, 2008). Thus it is an advantage to use panel data and long year data because it increases the number of observation and also improve the empirical analysis. There is

[2] Initial Real GDP is the Real GDP of the first year observation for each country. It is denoted by $IntRGDP_{i0}$. For Ethiopia the real GDP on 1974, for Kenya and Tanzania the real on 1970, for Rwanda, the real GDP on 1976 and for Uganda, the real GDP on 1981 is taken as initial Real GDP for this study. The data on initial per capita GDP are from World Bank ś database.

also causality issue that needs accounting for. When we deal with analyzing health and growth, we need to take the above stated issues into account. Previous papers such as (Islam, 1998) and Caselli, Esquival and Lefort (1996) used dynamic panel data approach to solve the omitted variable and endogeneity issues.

Bloom, Canning, & Sevilla (2004), also stated the causality or endogenity issue could be encountered when one tries to analyze human capital and growth. The causality relation of the two variables will be a problem in analysis because it creates a correlation between independent variable and the error term. This could lead to an inconsistent estimate, and might overstate the contribution of the independent variables to growth.

Thus (Bloom, Canning, & Sevilla, 2004) used Instrumental Variables (IVs) to reflect on the existence of endogeneity between health indicator and economic growth.

Ordinary least square (OLS), or Standard linear regression model will be used to analyze the model. Granger causality test will also be undertaken to see the causal relation of health variables with real per capita GDP.

3.3 Pre-estimation Tests

Before moving on to the estimation of the econometric models, it is important to explore the statistical characteristics of the data set. The following tests will be carried out in order to see the characteristics of the data sets.

3.3.1 Unit root test

In this paper, statistical tests of the hypothesis of stationary against the alternative of a unit root in panel data are done. It is an important step to test for stationary of the data in order to avoid a spurious regression that would lead to erroneous conclusion.

Among the available panel unit root test, Im–Pesaran–Shin (2003), and Fisher-type (Choi 2001) tests are undertaken because these tests allow for unbalanced panels. Both the Im-Pesaran-Shin and Fisher-type test relax the restrictive assumption of Levin-Lin-Chu.

The null hypothesis for Im–Pesaran–Shin is that all individuals follow a unit root process:

$$H_o: \rho_i = 0 \; for \; all \; i$$

The alternative hypothesis allows some (but not all) of the individuals to have unit roots:

$$H_1: \begin{cases} \rho_i < 0 \; for \; i = 1,2, \ldots . N_1 \\ \rho_i = 0 \quad for \; i = N_1 + 1, \ldots . N \end{cases}$$

The Fisher-type test, which is based on Augmented Dickey fuller tests, uses p-values from unit root tests for each cross-section. The formula of the test looks as follows:

$$P = -2 \sum_{i=1}^{N} \ln p_i$$

The test is asymptotically chi-square distributed with 2N degrees of freedom, ($T_i \rightarrow \infty$ for finite N).

The following table depicts the statistics result from fisher type test of the variables of interest. This has also been check with Im–Pesaran–Shin test.

Table 3: Stationary Test

Test	Test statistics
Log of real per capita GDP	1.5945*
Log of Inflation	8.3736***
Log of Education	2.2768**
Log of Mortality	2.0466**
Log of Life-expectancy	1.5719*
Log of Investment	6.1312***
Log of Government expenditure	1.2834*
Log of Aid	4.0356***

Note: + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001

The above variables have turned out to be stationary with different significance level. A stationary process has the property that the mean, variance and autocorrelation structure do not change over time (Wooldridge, 2002).

3.3.2 Heteroskedasticity

A simple test for heteroskedasticity disturbances in a linear regression model is developed using the framework of LM test (Breusch & Pegan, 1979). When the usual assumption of homoskedastic disturbances and fixed coefficient are not met, the loss of efficiency in using OLS may occur. More importantly, the biases in estimated standard errors may lead to invalid inferences. (Wooldridge, 2002) also classified this test as a means to justify the use of usual OLS or 2SLS.

The test show, the calculated value of this test statistics is greater than the tabulated value forcing at 1 percent forcing us to reject the null hypothesis of homoskedasticity. This is also backed up by the p-value calculated to be 0.0000 which is less than 0.01. Therefore, we can conclude that there is heteroskedasticity. In order to correct the heteroskedasticity problem, robust estimators are used. These standardized errors are asymptotically valid in the presence of any kind of heteroskedasticity including homoskedasticity (Wooldridge, 2002).

3.3.3 Serial autocorrelation

Autocorrelation exists when one or more explanatory variables are not exogenous and are correlated with the error term. The existence of autocorrelation will result in consistent but inefficient estimated of the regression coefficients and biased standard errors (Baltagi, 2008).

(Wooldridge, 2002), test for autocorrelation in panel data, shows that tabulated value of the F statistics at 1 percent and thep-value i.e. 0.0226is greater than 0.01. Therefore, we accept the null hypothesis that says there is no first-order autocorrelation.

To conclude, as the above tests indicate, the main variables of the study such as life expectancy, mortality rate and fertility rate are found to be stationary and there is no first order autocorrelation. Nevertheless, there exist heteroskedasticity problem. Therefore to account for the heteroskedasticity of the variables, robust estimates are used instead. These standardized

errors are asymptotically valid in the presence of any kind of heteroskedasticity including homoskedasticity. These tastes reassure that linear regression model in their level form (without taking their difference) can be applicable for the study. Moreover, stationarity of the variables allows us to undertake granger causality test.

3.4 Regression Result

As the following table shows, four regressions are carried out based on model (1) to see the significance of the variables of interest (human capital proxies).

- regression 1: real per capita GDP= f(initial GDP, inflation, investment, education, mortality rate, life expectancy, fertility rate, government expenditure and aid),
- regression 2: real per capita GDP= f(initial GDP, inflation, investment, education, mortality rate, life expectancy, fertility rate, government expenditure, aid and year),
- regression 3: real per capita GDP= f(initial GDP, inflation, investment, education, mortality rate, life expectancy, fertility rate, government expenditure, aid and country dummies), and
- regression 4: real per capita GDP= f(initial GDP, inflation, investment, education, mortality rate, life expectancy, fertility rate, government expenditure, aid, year and country dummies).

In this study, mortality rate and fertility are expected to negatively affect per capita income. On the other hand, life expectancy, and education are expected to positively affect real per capita income in Ethiopia, Kenya, Rwanda, Tanzania and Uganda. Investment, aid and government expenditure and inflation are also expected to affect real per capita income in the sample countries.

Table 4: Regression result (dependant variable= Log of real per capita GDP)

Independent variable	Regression 1		Regression 2		Regression 3		Regression 4	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Log of Mortality	-0.99***	(0.16)	-0.89***	(0.14)	-0.71***	(0.17)	-0.32+	(0.16)
Log of Life Expectancy	-0.41*	(0.18)	-0.38*	(0.16)	-0.008	(0.18)	0.11	(0.16)
Log of Fertility	-0.40**	(0.13)	-0.28+	(0.15)	-0.44***	(0.12)	-0.59**	(0.19)
Log of Education	-0.025	(0.03)	-0.059*	(0.03)	0.28***	(0.06)	0.24***	(0.06)
Log of initial GDP	0.65***	(0.09)	0.66***	(0.08)	-	-	-	-
Log of Inflation	-0.042**	(0.01)	-0.013	(0.01)	-0.039**	(0.01)	-0.0076+	(0.01)
Log of Investment	-0.21**	(0.07)	-0.17**	(0.06)	-0.23***	(0.06)	-0.20***	(0.05)
Log of Gov't Exp.	0.19***	(0.03)	0.056+	(0.03)	-0.077	(0.05)	-0.046	(0.04)
Log of Aid	0.23***	(0.03)	0.089**	(0.03)	0.16***	(0.03)	0.049+	(0.03)
Constant	5.74**	(2.01)	-41.4***	(7.10)	7.82***	(1.81)	-51.8***	(9.04)
Year	-	-	0.024***	(0.00)	-	-	0.029***	(0.00)
Ethiopia	-	-	-	-	-0.53***	(0.06)	-0.35***	(0.06)
Kenya	-	-	-	-	-0.37***	(0.09)	0.064	(0.10)
Rwanda	-	-	-	-	0.29***	(0.06)	0.29***	(0.05)
Tanzania	-	-	-	-	-0.048	(0.08)	0.21*	(0.08)
N	171		171		171		171	
R-sq	0.892		0.917		0.921		0.938	
Adjusted R-sq	0.886		0.911		0.914		0.933	

Note: + p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Discussion of Results

The R^2 and adjusted R^2 values is about 89 percent to 94 percent in all the regressions. This implies that the explanatory variables, namely inflation, fertility, investment, life expectancy, government expenditure, mortality, education, aid, initial GDP explains about on average 90 percent systematic variation on Real GDP per capita income over the observed years (1970-2009)while the remaining variation is explained by other determinant variables outside the model.

Mortality rate and Life Expectancy

Mortality negatively affects economic growth in all the regressions. Mortality is significant with 0.1 percent significance level in the first three regressions and with 10 percent significance level in the fourth regression. As regression four depicts, holding other variables constant, after controlling for time effect and also including dummies for country, coefficient for mortality is equal to -0.32. It

means that one percent increase (decrease) in mortality result in 0.32 percent decrease (increase) in real per capita GDP. Similarly, (Weil, 2005), (Lopez, Rivera, & Currais, 2005) and (Barro, Health and Economic Growth, 1996) found that mortality negatively affect economic growth.

In the first three estimations, life expectancy is found to negatively affect real per capita GDP with 5 percent significance level. Contrary to the first three estimation results, the variable life expectancy turns out to be insignificant in the fourth regression. (Hashmati, 2001), also found health indicator to be insignificant for economic growth for OECD countries. Contradictory to the above result, researcher such as (Barro, Health and Economic Growth, 1996), (Kambiz, Roghieh, Hadi, & Rafat, 2011) and (Weil, 2005) found life expectancy to positively affect real per capita GDP and economic growth.

The reason of negative effect life expectancy on real per capita GDP might be because, Africa south of the Saharan countries have the lowest life expectancy in the world. This countries where highly affected by epidemics such as; HIV-AIDS and malaria. For example, southern Africa has been reduced by 15–20 years in comparison with life expectancy because of HIV. Other African countries have lost 5–10 years of life expectancy because of HIV (World Health Report, 2000). This situation is expected to have an impact on the above unexpected result.

Fertility rate, negatively affects per capita GDP and the result is significant with different significance level for the above regressions. (Kambiz, Roghieh, Hadi, & Rafat, 2011) and (Barro, Health and Economic Growth, 1996) also found fertility to negatively affect per capita GDP.

Secondary school enrollment, (percent gross) – is taken as a proxy for education. The result of the second regression that didn't include country dummies shows education has a negative coefficient and is significant with 5 percent significance level. The third regression includes country dummies with the other determinant variable, the fourth regression includes both year and country dummies and the coefficients variable were highly significant with 0.1 percent significance level. The coefficient is 0.28 and 0.24 respectively, meaning a one percent increase in education will increase per capital income with 0.28 and 0.24 percent respectively. This is in line with the studies of (Barro, Health and Economic Growth, 1996), (Barro, Cross-Country Empirical Study of

Determinants of Economic Growth, 1997) and (Bloom, Canning, & Sevilla, 2004). The discrepancy of the regression result might be due to the unique features of the countries. As (Levin and Renelt, 1992) and (Sala-i-Martin, 1997) argued, despite the availability of different sets of explanatory variables that can be used for explaining growth, only few of them would turn out to be significant. Furthermore, variables that were significant in one set of model or regressors might be insignificant with another one.

Initial real GDP: This study has taken initial GDP as an explanatory variable. Initial Real GDP is the Real GDP of the first year observation for each country. It is denoted by $IntRGDP_{i0}$.

The estimation coefficient is positive and statistically significant for regression one and two at 0.1 percent significance level. Initial real GDP is omitted from the regression when country dummies are included in the model because of collinearity. Unlike (Barro & Sala, Economic Growth, Second edition, 2003), (Casseli, Gerardo, & Fernando, 1996) also showed a positive relationship between initial GDP per capita and economic growth which indicates non convergence of initial real GDP in the sample countries.

Government Expenditure and Inflation in consumer prices (annual percent): government expenditure and inflation has been recognized as an explanatory variable for economic growth in several studies including Barro's paper. Unlike (Barro, Health and Economic Growth, 1996), government expenditure is significant in regression one and two. It positively affects economic growth with 0.1.and 10 percent significance level. Inflation has a negative in all the regression and it is significant in regression 1, 3 and 4. (Barro, Cross-Country Empirical Study of Determinants of Economic Growth, 1997), and (Barro, Health and Economic Growth, 1996) also found inflation to negatively affect economic growth.

Investment Share of RGDP (percent): the coefficient of investment variable in the model has a negative sign and it is statistically significant in all the regressions. Contrary to (Barro, Cross-Country Empirical Study of Determinants of Economic Growth, 1997) and (Mankiw, Romer, & Weil, 1992), investment is negatively affecting per capital income in the sample countries. In most

low income countries, corruption is a major issue (Ugur & Dasgupta, 2011). Thus, bad investment decisions that have an adverse effect on economic growth are made in these countries.

Aid/ Net official development assistance and official aid received (current US$): as expected, the coefficient of aid is positive and significant in all the regressions. Regression four which controls for time effect and country dummies, a one percent increase in aid increase per capital income by 0.049 percent in the sample countries.

Year and country dummies: In regression model no. 2, time was included as a variable. But there has not been any major change in the regression result. The years have turned out to be significant. This is also supported by time fixed effect test. The calculated p-value turned out to be 0.000 being less than 0.01 (1percent) we reject the null hypothesis that says the years coefficients are jointly zero. Therefore; time fixed-effects are needed.

The third model includes the country dummies and the fourth model includes all variables with the year and country dummies all together. The country dummy variables have turned out to be significant. Meaning, the countries the regression results for dummy variables indicated the individuality of each country in the relationship between health and economic growth. Uganda is the base country and its coefficient and except Kenya the rest of the countries are statistically significant.

3.4.1 Granger causality test

The relationship of Health and per capita GDP is expected to be bidirectional. This may cause simultaneity problem. Some literature use instrumental variables for health in order to deal with the problem, other carry out causality analysis to determine the direction of the relationship between the Health proxies and GDP per capita. Granger test is a common test to show causal relationship as proposed by Granger (1969). The null hypothesis is that x does not Granger causal y and this is evaluated by estimating an equation in which y is regressed on lagged values of y and the lagged values of an additional variable x.

As shown by the following equation (2), it is present when $f(x_t / x_{t-1}, y_{t-1})$ is not equal to $f(x_t / x_{t-1})$. That is where lagged value of y_t add additional information to explanation of movement of x_t itself. If x_t is weakly exogenous and if y_{t-1} does not cause x_t, then x_t is strongly exogenous (Green, 2003).

Granger test will be carried out to determine whether there exists causal relationship between the health indicator variables and real GDP per capita. Granger causality test require stationary of the variable or else, there will be misspecification. As shown above, the real per capita income and health variables have turned out to be stationary, so we can carry out granger test. This test will be carried out by running two regressions and by recording the restricted and unrestricted residual sum of squares.

The following pair of regression is carried out for k appropriate lags:

$$y_t = \sigma_1 + \sum_{j=1}^{p} \alpha_j x_{t-k} + \sum_{j=1}^{p} B_j y_{t-k} + u \quad \text{..... (2)}$$

Where $H_{0:} B_j = 0 \; for \; all \; j$ and $H_{1:} B_j \neq 0 \; for \; some \; j$

$$x_t = \partial_1 + \sum_{j=1}^{q} \alpha_j y_{t-k} + \sum_{j=1}^{q} B_j x_{t-k} + u \quad \text{..... (3)}$$

Where $H_{0:} \alpha_j = 0 \; for \; all \; j$ and $H_{1:} \alpha_j \neq 0 \; for \; some \; j$

Then F test will be applied in order to test for the hypothesis. We have to run restricted and unrestricted regressions by recording residual sum of squares. We then use the calculated residual sum of squares to calculate the F test using the following formula.

$$\text{F Test} = \frac{(RSS_R - RSS_U)/r}{RSS_U/df_u}$$

Where; RSS_R restricted sum of residual .
RSS_U unrestricted some of residual
r is no. of restriction imposed
df_u is n-k where n is no. of sample size and k is parameters in unrestricted model.

We will test Real GDP per capita with mortality and Life Expectancy.

$lnRGDP_{it} = \alpha_1 + \beta_1 lagRGDP_{it} + \beta_2 lagMort_{it} + u_{it}$ ..... (4)

- In the first stage we restrict $lagMort$ to be zero.

$lnMort_{it} = \alpha_1 + \beta_1 lagMort_{it} + \beta_2 lagRGDP_{it} + u_{it}$..... (5)

- In the first stage we restrict $lagRGDP$ to be zero.

$lnRGDP_{it} = \alpha_1 + \beta_1 lag\ RGDP_{it} + \beta_2 lagLE_{it} + u_{it}$ ..... (6)

- In the first stage we restrict $lagLE$ to be zero.

$lnLE_{it} = \alpha_1 + \beta_1 lagLE_{it} + \beta_2 lagRGDP_{it} + u_{it}$ ..... (7)

- In the first stage we restrict $lagRGDP$ to be zero.

The results for the second and the third lags are found to be insignificant thus result for the first lag is only presented. The F test can be calculated by using the restricted and unrestricted models.

The regression and calculation result shows that, real GDP per capita granger cause mortality rate because the calculated F test at 1 percent critical level. Mortality rate, also granger cause real GDP per capita at 1 percent critical level. Thus, relationship is bidirectional. On the other hand, Real GDP per capita does not granger cause life expectancy. But, life expectancy granger cause Real GDP per capita at 5 percent critical level.

Granger causality or block exogeneity wald tests indicate bidirectional relationship from mortality rate to real per capita GDP. There is also unidirectional relation from life expectancy to real per capita income. This indicates that the health variables are helping per capita income and vice versa of selected low income counties of Africa south of the Sahara. This result is similar to (Mostafizur, 2010). He took health expenditure as a proxy for health and found that health have a causal relation with GDP.

Chapter Four

4.1 Conclusion

This study has focused on the causality issue of health and per capita GDP or long run economic growth in low income countries of Africa south of the Sahara. Linear regression model is used to see the impact of health variables on long run economic growth and granger causality test is done to see the direction of their relation.

Health and economic growth has been studied by different researchers but the scope of the study is usually focused on developed countries. There are also some studies that are done for African countries and Africa south of the Sahara regions as a whole but not for the particular sample countries of this particular study. This study provides analysis of health and real per capita income specifically in low income countries with in the Africa south of the Saharan region. Furthermore, the study deals with the existence of simultaneity between health and real per capita GDP in the sample countries.

The study has been conducted using unbalanced data during the years from 1970 to 2009. According to the analysis result, there is a causal relationship between per capita income and health in Ethiopia, Kenya, Rwanda, Tanzania and Uganda. The Granger causality test showed that real per capita GDP and mortality rate have bidirectional relationship. On the other hand, real per capita GDP have unidirectional relationship with life expectancy. The causality relation of health and per capita GDP means that health has a positive impact on productivity, and income also influences health in a positive way. Earning higher income will increase the consumption of health related good such as adequate food and medicine (Lopez, Rivera, & Currais, 2005). There will also be improvement on the living standard and indirectly will bring efficiency in the work place and these promote higher levels of health levels through increased income. But, with all the positive benefits of growth in per capita income, (Bloom, Canning, & Sevilla, 2004) states, improvement in health will prevail even if income remains fixed. Especially in developing countries, low cost tropical disease interventions bring large scale returns in saving people lives.

Thus investment in health, even in the low income countries of Africa south of the Sahara should be a priority. On the other hand, better health is caused by higher per capita income; therefore economic growth of the countries will consecutively result in better health for the countries. This statement is supported by the above granger causality test for the sample countries.

In conclusion, Mortality rate negatively affect real per capita GDP in low income countries of Africa south of the Sahara. This result is also supported by other studies such as, (Barro, Health and Economic Growth, 1996), (Bloom, Canning, & Sevilla, 2004) and (Weil, 2005). The other explanatory variables such life expectancy, fertility, initial GDP, inflation, investment, government expenditure and aid are also statistically significant. (Bloom, Canning, & Sevilla, 2004) and (Howitt, 2005) are among many researchers who also stated that financial wellbeing will positively affect health status, similarly the descriptive analysis (refer to annex) has also illustrated that higher income countries are better off in their health status.

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Appendix

1.1. Comparative Descriptive Analysis of health indicators in Different income groups of the world

By taking selected health indicators the following descriptive analysis is undertaken in different income groups of the world.

The following figures and tables will illustrate the existence of a very wide gap between different developed worlds or rich countries and the developing countries. Not only low income and sub Saharan countries but also the middle income economies are far behind from high income countries in regards to health status.

The following indicators are selected as indicators for the purpose of the comparison,

- GDP per capita (current US$) - GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars.

- Health expenditure per capita (current US$) - Total health expenditure is the sum of public and private health expenditures as a ratio of total population. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation. Data are in current U.S. dollars.

- Life expectancy at birth, total (years) - Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.

- Mortality rate, under-5 (per 1,000 live births) - Under-five mortality rate is the probability per 1,000 that a newborn baby will die before reaching age five, if subject to current age-specific mortality rates.

- Incidence of tuberculosis (per 100,000 people) - Incidence of tuberculosis is the estimated number of new pulmonary, smear positive, and extra-pulmonary tuberculosis cases.

- Prevalence of HIV, total (percent of population ages 15-49) - Prevalence of HIV refers to the percentage of people ages 15-49 who are infected with HIV. Middle income countries data were not available so lower middle income countries data were considered.

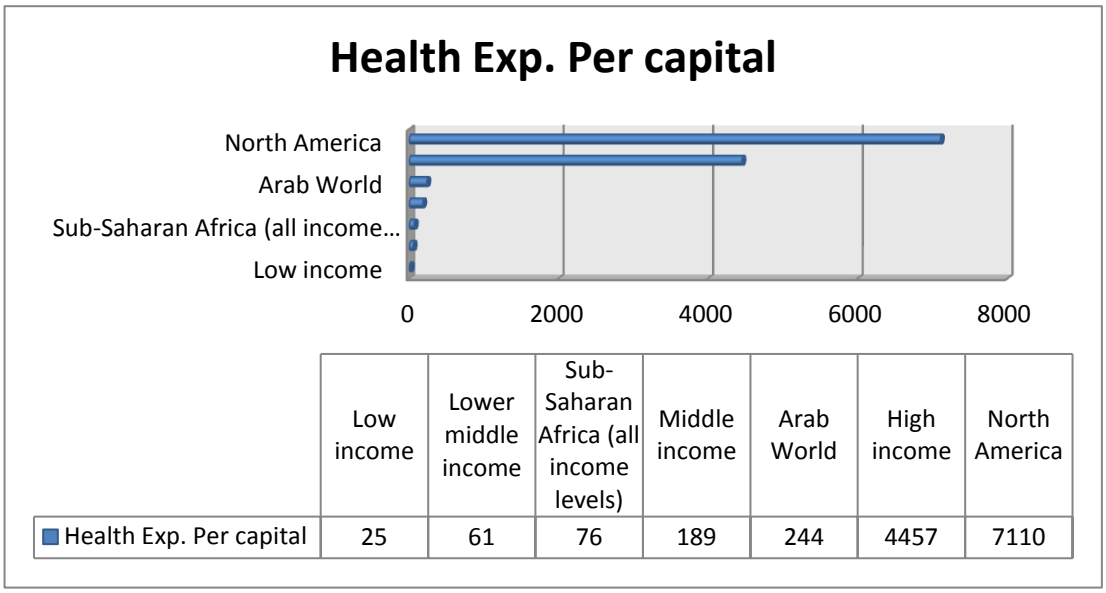
The data used for the analysis are primarily from the World Bank/ world development indicator (WB, WDI 2012).The data are from 2000 to 2009.

Income per capita and Health expenditure

Countries with higher income per capita are much better in every health indicators. The gap between the high income countries with the other lower income groups including middle income countries is very wide.

The following figure illustrates health care expenditure per capita among the world categorized by income levels. When we compare the health care expenditure, it can be seen that there is a major disparity: North America alone spends 58percent more on health expenditure; high income countries spend 37percent more. On the contrary, low income countries, spends almost 0percent for health care purpose when compared with the rest of the income groups.

Figure 3: Health Expenditure per capita of different regions of the world



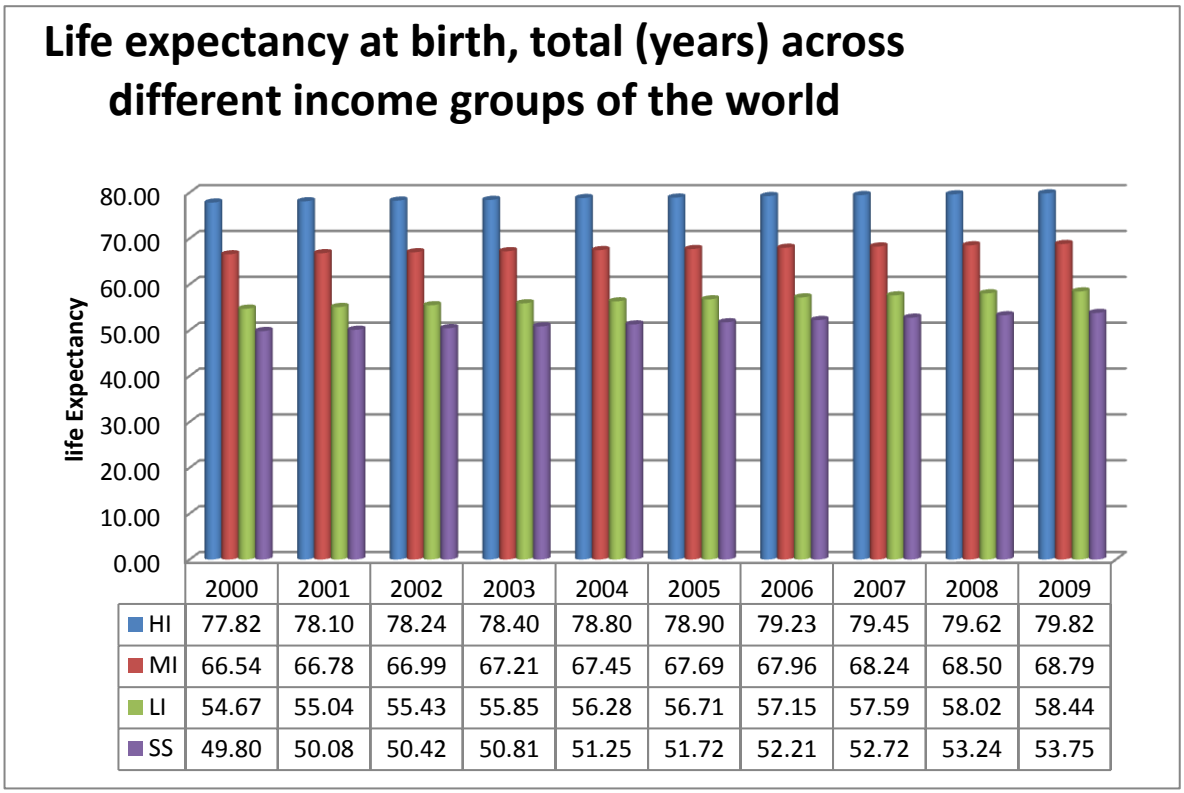
	Low income	Lower middle income	Sub-Saharan Africa (all income levels)	Middle income	Arab World	High income	North America
Health Exp. Per capital	25	61	76	189	244	4457	7110

Data Source: world Bank webpage 2012

In general, larger proportion of health care spending is going to a small amount of the population. The spending for Africa and South Asia are very low for medical care, particularly in Africa, where diseases such as malaria, tuberculosis (TB), and AIDS prevails. The spread of these diseases is epidemic, requiring much more health care spending.

As we can see, the gap among the different income groups is very wide and even its incomparable. From the above table and figure, the average health expenditure per capita for high income countries (OECD member countries) is on average 32848, for middle income countries its 2115, for sub-Saharan countries its 825 and for low income countries its 342.

Figure 4: Life Expectancy of Different income Groups of the world

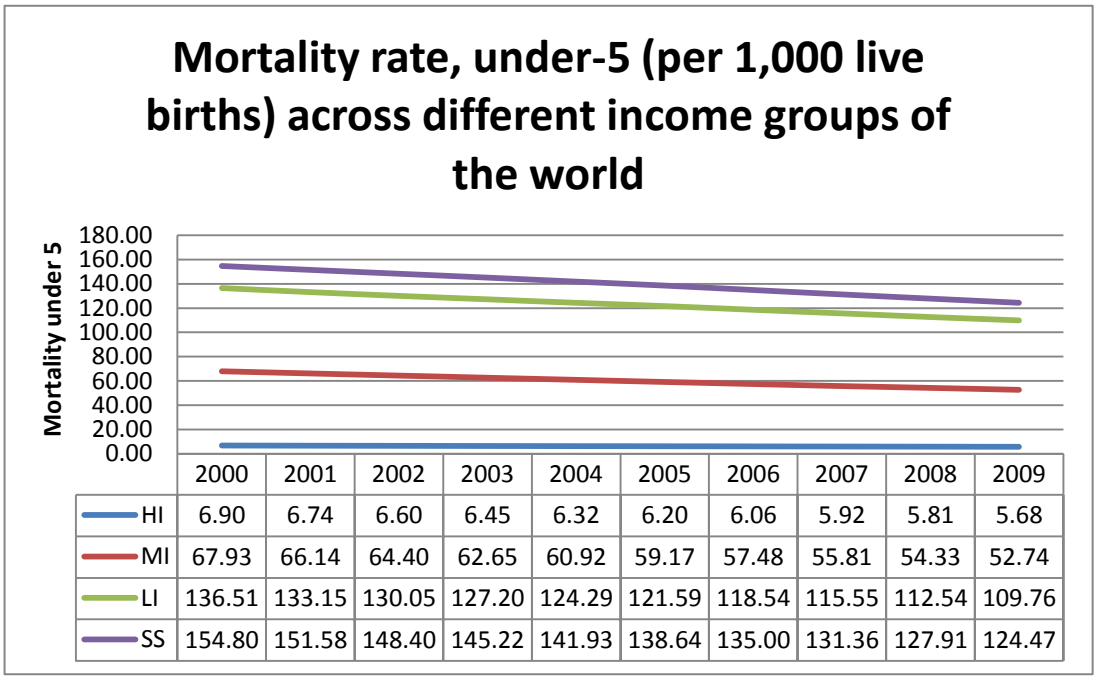


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
HI	77.82	78.10	78.24	78.40	78.80	78.90	79.23	79.45	79.62	79.82
MI	66.54	66.78	66.99	67.21	67.45	67.69	67.96	68.24	68.50	68.79
LI	54.67	55.04	55.43	55.85	56.28	56.71	57.15	57.59	58.02	58.44
SS	49.80	50.08	50.42	50.81	51.25	51.72	52.21	52.72	53.24	53.75

Similar to the analysis of Health expenditure, life expectancy is much greater in richer countries. The average life expectancy for sub Saharan countries is 51 years, where in low income countries it is 56, 67 for middle income countries and 78 for high income countries.

In Africa South of the Sahara, low income and lower middle income countries, as shown in the following table, the infant mortality rate is very high. There is major discrepancy between the different regions of the world regarding the rate of infant mortality rate. This indicates that as countries become wealthier there would be better health services.

Figure 5: Mortality rate, infant (per 1,000 live births) of different income groups of the world



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
HI	6.90	6.74	6.60	6.45	6.32	6.20	6.06	5.92	5.81	5.68
MI	67.93	66.14	64.40	62.65	60.92	59.17	57.48	55.81	54.33	52.74
LI	136.51	133.15	130.05	127.20	124.29	121.59	118.54	115.55	112.54	109.76
SS	154.80	151.58	148.40	145.22	141.93	138.64	135.00	131.36	127.91	124.47

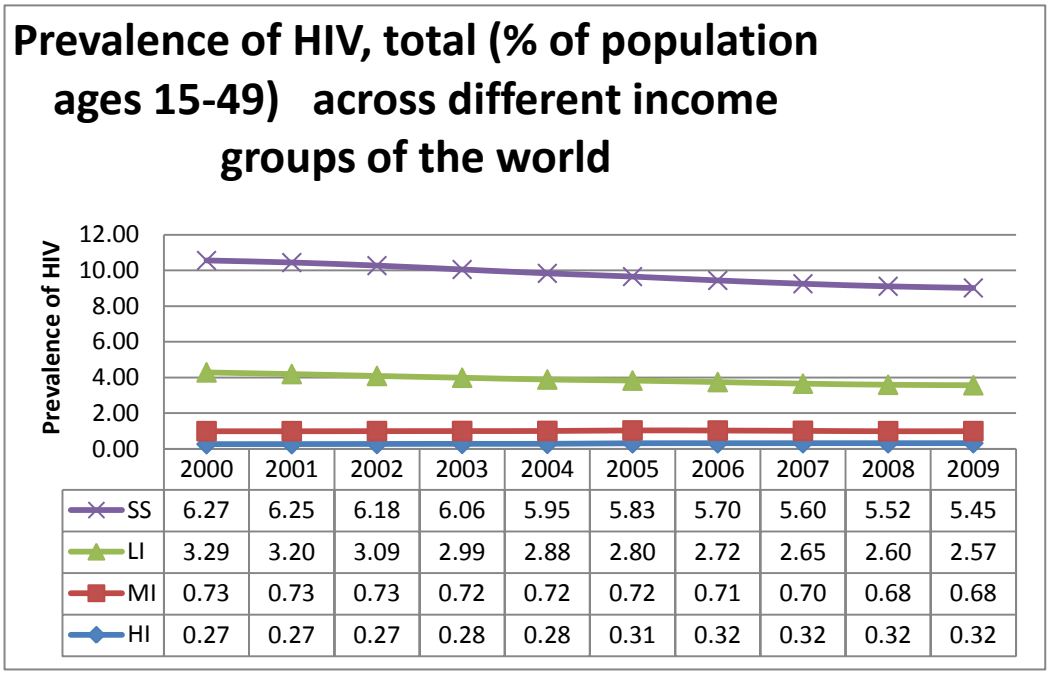
Source: World Bank (2012) (WDI???)

There is a high infant mortality rate in low income countries. The difference is more than 10 folds compared to high income countries. “Closing inter-country or intra-country gaps between the poor and the better off by securing greater proportional improvements amongst poorer groups, is not simply a poverty issue but also a question of social justices and equity” (WHO 2002).

In Africa, South of the Sahara, on Average 139 Infants die per 1000 live birth, 122 for low income countries, 60 for middle income whereas 6 for high income countries.

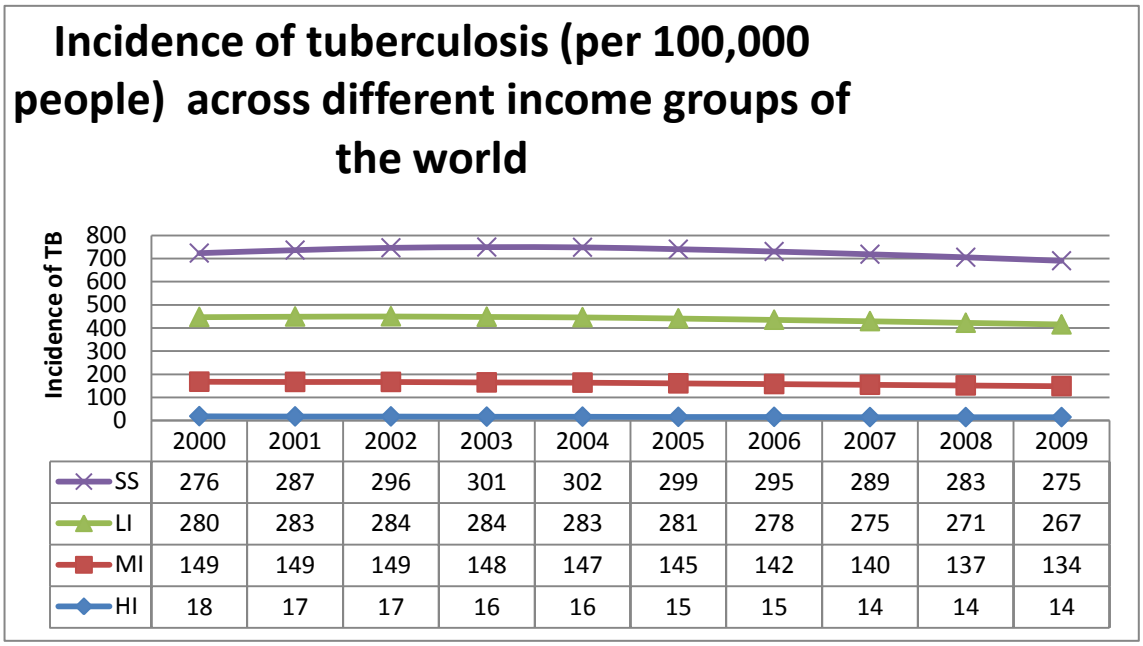
The following figures will show the prevalence of HIV and occurrence of Tuberculosis.

Figure 6: Prevalence of HIV across different income groups of the world



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
SS	6.27	6.25	6.18	6.06	5.95	5.83	5.70	5.60	5.52	5.45
LI	3.29	3.20	3.09	2.99	2.88	2.80	2.72	2.65	2.60	2.57
MI	0.73	0.73	0.73	0.72	0.72	0.72	0.71	0.70	0.68	0.68
HI	0.27	0.27	0.27	0.28	0.28	0.31	0.32	0.32	0.32	0.32

Figure 7: Incidence of Tuberculosis across different income groups of the world



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
SS	276	287	296	301	302	299	295	289	283	275
LI	280	283	284	284	283	281	278	275	271	267
MI	149	149	149	148	147	145	142	140	137	134
HI	18	17	17	16	16	15	15	14	14	14

As the above figures and tables illustrates, the richer a country the better their health status. the prevalence of HIV (percent of population ages 15-49) in Sub Saharan countries is on average, 5.88percent while it is 0.29percent on average for high income countries, 2.87percent and 0.71percent for low income and middle income countries respectively. Incidence of tuberculosis (per 100,000 people) is 290, 278, 144, and 15 on average for sub Saharan, low income, middle income and high income countries respectively.

Another tool that can be used to see the different health indicators with per capita income is the Lorenz Curve.

A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of recipients, starting with the poorest individual or household. A Gini coefficient is a summary numerical measure of how unequally one variable is related to another (Lorenzo G. and Paolo L. 2005). The Gini index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Let's say that the area between the line of perfect equality and Lorenz curve is A, and the area under the Lorenz curve is B, then Gini Coefficient is calculated as A/(A+B).

If the Lorenz curve is represented by Y=F(X) then

$$Gini = 1 - 2\int_0^1 F(X)dX$$

Thus a Gini index of 0 represents perfect equality, while an index of 1 implies perfect inequality.

The following concentration indexes are used to calculate the Lorenz curve and Gini coefficients.

Table 5: Income groups, GDP per capita, Health Expenditure (HE) as a percent of GDP, Infant Mortality under 5 and their proportions respectively

Income Groups	GDP per capita 2010	proportion GDP per-capital	HE percent GDP	proportion of HE percent GDP	Infant Mortality<5	Proportion of Infant Mortality<5
Low income	523.05	0.004	5.13	0.07	107.87	0.26
Africa south of the Sahara	1301.71	0.009	6.56	0.09	121.23	0.29
Lower middle income	1749.61	0.012	4.34	0.06	69.44	0.16
Middle income	3992.30	0.028	5.60	0.08	51.28	0.12
Upper middle income	6245.69	0.045	5.96	0.08	19.64	0.05
Middle East & North Africa	6448.27	0.046	4.92	0.07	31.30	0.07
OECD members	34630.64	0.247	11.86	0.16	8.20	0.02
High income	38208.22	0.273	11.84	0.16	6.44	0.02
North America	47111.43	0.336	15.75	0.22	7.37	0.02
Total	140210.93	1.000	71.97	1.00	422.76	1.00

Table 6: Cumulative proportions of GDP per capita and Health Expenditure (HE) as a percent of GDP

Income Groups	cumulative Proportion of GDP/capital (X)	cumulative proportion of HE percent GDP (Y)	y_i +1+ y_i (A)	x_i +1- x_i (B)	A*B
Low income	0.004	0.07	0.07	0.004	0.000266
Africa south if the Sahara	0.013	0.16	0.23	0.009	0.00217
Lower middle income	0.025	0.22	0.39	0.012	0.004806
Middle income	0.054	0.30	0.52	0.028	0.014899
Upper middle income	0.099	0.38	0.68	0.045	0.030463
Middle East & North Africa	0.145	0.45	0.84	0.046	0.038405
OECD members	0.391	0.62	1.07	0.247	0.263875
High income	0.664	0.78	1.40	0.273	0.380901
North America	1.000	1.00	1.78	0.336	0.598478
Total					1.334262

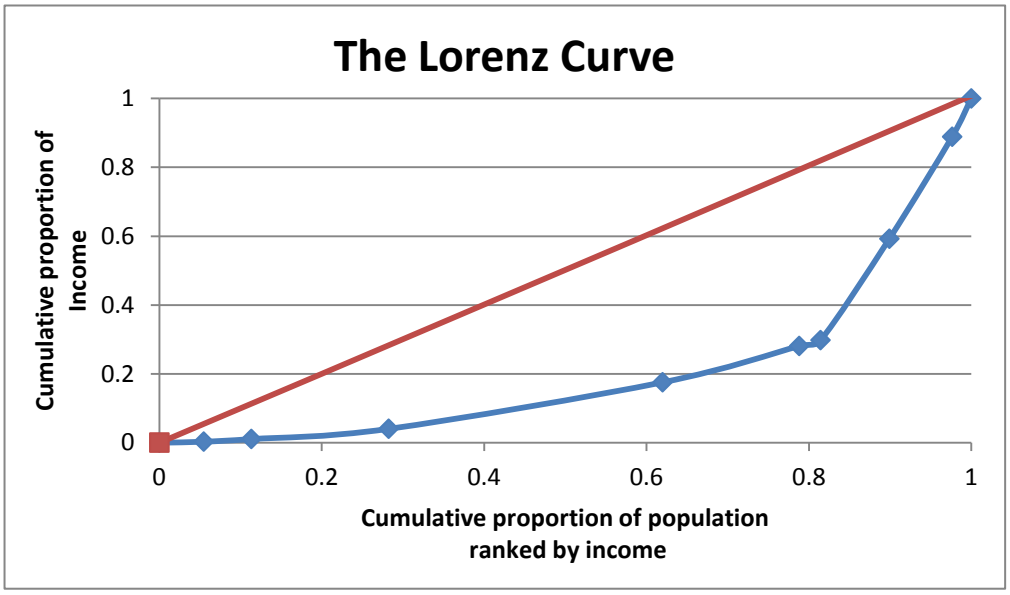
Table 7: Cumulative proportions of GDP per capita and Infant Mortality under 5

Income Groups	cumulative Proportion of GDP/capital (X)	Cumulative proportion of Infant Moratlity <5 (Y)	y_i +1+ y_i (A)	x_i +1- x_i (B)	A*B
Low income	0.004	0.26	0.26	0.004	0.000952
Africa south of the Sahara	0.013	0.54	0.80	0.017	0.013347
Lower middle income	0.025	0.71	1.25	0.039	0.048059
Middle income	0.054	0.83	1.53	0.079	0.121859
Upper middle income	0.099	0.87	1.70	0.152	0.259421
Middle East & North Africa	0.145	0.95	1.82	0.243	0.442735
OECD members	0.391	0.97	1.92	0.536	1.026584
High income	0.664	0.98	1.95	1.055	2.05811
North America	1.000	1.00	1.98	1.664	3.298987
Total					7.270053

The data are from World bank website for, 2009

The following Lorenz curve will depict the distribution of health indicators with ranked per capita income distribution of different income groups of the world. Population and per capita income of different income groups (from low income countries to high income countries) are taken in to consideration.

Figure 8 Income Distribution among different income groups of the world



The above figure illustrates a typical Lorenz Curve. As can be seen, the curve starts from coordinates (0,0), as a zero fraction of the population owns a zero fraction of income. Since the Lorenz Curve records cumulative proportions, it must be that total population owns total income. Hence, the Lorenz Curve has coordinates (1,1) at the end point.

If income was equally distributed across a population (i.e. everybody had the same income), a given proportion of the population (say 10 per cent) would have the same proportion of income (10 per cent). But, an income distribution is made of poor and rich people. It means that poor individuals own less than an equally distributed share of total income because richer individuals own more than the same equally distributed share. Therefore, for a typical income distribution, the Lorenz Curve is the convex curve (Lorenzo & Paolo, 2005).

In the above figure, the x-axis records the cumulative proportion of population ranked by income level. Its range is (0,1). The y-axis is the cumulative proportion of income for a given proportion of population, i.e. the income share calculated by taking the cumulated income of a given share of the population, divided by the total income Y, as follows:

$$L(k/p)=\frac{\sum_{i=1}^{k} yi}{Y}$$

Where: k=1….n is the position of each individual in the income distribution;

i=1….k is the position of each individual in the income distribution;

P is the total number of individuals in the distribution;

y_i is the income of the i_{th} individual in the distribution

$\sum_{i=1}^{k} yi$ is the cumulated income up to the k_{th} individual.

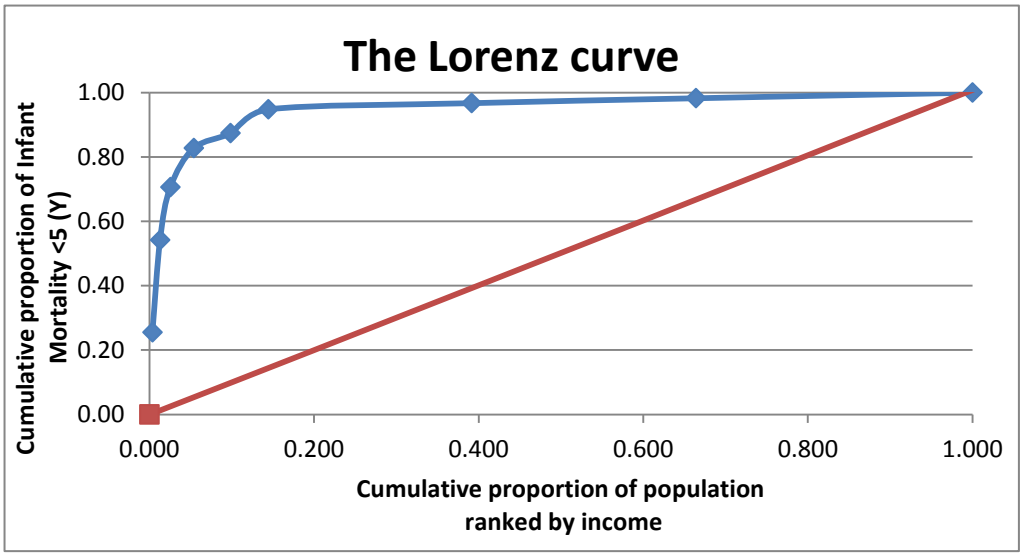
It is apparent that $\sum_{i=1}^{k} yi$ ranges between 0, for k=0, and Y, for k=n, therefore $L(k/p)=\frac{\sum_{i=1}^{k} yi}{Y}$ ranges between 0 and 1.

The above Lorenz curve depicts the distribution of income among different income groups of the world. The gini coefficient is calculated to be 0.58 which is far from 0, shows there is unequal income distribution.

When applying this index to health variables, the cumulative proportion of the population is generally shown on the X axis, and the cumulative proportion of the health variable on the Y axis. The greater the distance from the diagonal line, the greater the inequality.

Lorenz curve for health indicator is depicted by taking infant mortality as a proxy for Health. As can be seen in the following figure, the curve is above the equality line, showing that more infants die in countries with lower per capita income than in wealthier countries. The Gini coefficient is 0.48 in this case.

Figure 9 Cumulative proportion of Infant Mortality <5 ranked by per capita income for different income groups of the world



Concluding Remarks

The analysis has illustrated that higher income countries are better off in their health status. (Bloom, Canning, & Sevilla, 2004) and (Howitt, 2005) are among many researchers who stated that financial wellbeing will positively affect health status.

Financial wellbeing is a generally accepted factor for health but it does not necessarily guarantee health of an individual. Even though, earlier studies suggested being rich does bring better health, later studies showed that the relationship of income and health is rather more complex and contradictory (Sherman F. et al 2010). Even though, their relationship is directly proportional, they also have causal relation. This is also supported by the above granger causal test.