Health And Economic Growth Across Sub Saharan Africa: The Unobserved Role of Demography

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Copyright statement

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Abstract

This thesis revisits the debate on the impact health has on economic growth. The majority of previous work on the subject have focused on how health affects growth in developed countries and developing countries outside Africa. However, Sub Saharan Africa (SSA) is where insights into this relationship are most of value as the continent of Africa bears one quarter of the overall global disease burden, with 69% of deaths in SSA resulting from infectious diseases like HIV/AIDS and malaria. Of the 37.4 million people living with HIV globally, 25 million live in Africa (World Economic Forum, 2019). Waage et al. (2015) suggests that achieving health and wellbeing for all can only be accomplished if poverty is reduced. These two objectives poverty reduction and good health and wellbeing for all are in line with Sustainable Development Goals (SDGs) 1 and 3. The critical nature of health and its resulting effect on growth makes it essential to find ways of improving the state of health in developing countries.

This thesis provides insights into the direct and indirect role played by health in conjunction with other factors, through the process of economic development in Sub Saharan Africa. This is vital because the realisation of strategies that are intended to improve health depends not only on understanding the economic context but also on the understanding of the epidemiological and the sociological environment. Chapters in this thesis therefore considers some of the factors that have been highlighted as important influences on the health-growth relationship, but not fully explored in the Sub Saharan African context. These include diseases load, the demographic transition, geographical variation, and causal channels through which population health affects economic development. Policy makers as well as researchers undertaking further empirical investigation into health and growth in developing countries will benefit from the contribution of knowledge this thesis provides.

CHAPTER 1

1.1 Introduction

Researchers have tested many variables in exploring the determinants of economic growth, but few have statistical significance in explaining economic development. The role of human capital is generally deemed indispensable in this regard (Boucekkine et al., 2003). Sustained economic development is contingent on human capital levels, which rises because of better education and higher levels of population health. As educational and health standards improve, investment rates within a country also increase, evolving systematically according to the level of economic development (Bleakley, 2010a). Therefore, low levels of human capital represent a barrier to economic development and understanding the mechanisms that underlie human capital formation is vital for growth. Historically, the significant role played by human capital in the economic development process was linked to education, although the literature had recognised the important role played by health (Becker, 1962). From the late 1990s, academics began to consider not only education but also the role of health and nutrition in human capital analysis (Mankiw et al., 1992). Nonetheless, the nexus between economic growth and population health only became widely accepted as a significant issue in economic enquiry after the notable works of Barro and Lee (1994) and Fogel (1997).

It is, therefore, essential to acknowledge that human capital emerges in two main forms, education, or health (Becker, 1962; Grossman, 1972, 2000). Educational capital is normally proxied by enrolment ratios, skills, educational expenditure, or average years of schooling, whereas in most cases, health capital is proxied by life expectancy or factors that affect health like malnutrition and various diseases like malaria and HIV. This thesis uses human capital when referring to both health and educational capital, health capital when referring to the health aspect of human capital, and educational capital when referring to the educational part of human capital as outlined in table 1.1 below.

Table 1.1
Distinction between human, health, and educational capitals

Variable	**Definition**
Human capital (education and health)	Health capital + educational capital
Health capital	Health aspect of human capital
Educational capital	Education/schooling aspect human capital

Improving population health is critical to economic growth. As human capital increases, the productivity of individuals also rises, this affects economic growth positively by reducing mortality and morbidity within the workforce. Moreover, good health improves education and increases the turnover of educational investment.
Spillover effects such as increased savings, capital formation and technological innovation, all factors that attract investment into a country, cannot be undervalued. To broaden our understanding of the health growth nexus, it is crucial to determine causal mechanisms through which improvement in population health influences economic development.

Researchers have used micro and macro-level data to examine various health indicators and how they influence economic growth. The former uses anthropometric measures like height, body mass index, weight, and self-assessed health status data to examine how health affects wages at the individual level (Schultz, 2002; Black et al., 2006). Macro studies use within and cross-country data in analysing how health indicators, such as life expectancy, affect economic output at the aggregate level (Shastry and Weil, 2003; Frimpong and Adu, 2014). In addition, international organisations like the World Health Organisation (WHO), the National Bureau of Economic Research (NBER), the Pan American Health Organisation (PAHO) and the United Nations (UN) are continuously analysing the extent to which improvements in health can influence economic growth (NBER, 2005; WHO, 2015). For instance, the Commission on Macroeconomics and Health (CME) analysed the channels through which health-related investments could positively influence economic development and equity in developing nations. The PAHO conducted similar studies in Latin America and the Caribbean, focusing on the nexus between health, productivity and sustained economic development. These initiatives have generated a large body of research and filled many voids in the existing literature.

While the literature on the nexus between population health and economic growth is large, the variables used for population health do not adequately capture the nuances of longevity. This is notable, especially for developing countries with a high burden of disease, where population health is simultaneously determined along with many other factors. Therefore, the main difficulty in any approach to this task lies in the possible existence of endogeneity and in finding indicators that adequately represent population health. The majority of studies that have examined this relationship are based on developed rather than developing countries. Although the level of diseases in developed countries also affects economic growth, this is considerably less than developing countries, which are especially challenged by infectious diseases, poor health infrastructure, high mortality, and morbidity. This thesis addresses some of these difficulties and contributes to the literature by focusing on countries in Africa with a high burden of disease and limited literature on the contribution of improvements in population health to economic development. I use improved measures of population health, the Disability Adjusted Life Years (DALYs) and Health Adjusted Life Expectancy (HALE). DALYs accounts for the overall burden of disease within populations whilst the HALE measure simultaneously accounts for morbidity and mortality, providing an overarching view of health within a population. I use econometric techniques that address endogeneity issues and establish both the long- and short-term impact of health on economic development, these approaches have not been used in this context for countries in Sub Saharan Africa. I also examine two causal channels through which improvements in population health influence economic development for countries in Sub Saharan Africa.

1.2 Outline of Thesis

The rest of this thesis is organised as follows: Chapter 2 presents an overview of the theoretical and empirical literature on the relationship between health and economic development, concentrating on three main areas deemed most important to developing countries in Sub Saharan Africa.

Chapter 3, the first empirical analysis, explores the relationship between improvements in life expectancy, the high burden of disease and how this influences economic growth across Sub Saharan Africa. Life expectancy is used to represent population health and the Disability Adjusted Life Years (DALYs) is the proxy used for the burden of disease. DALYs was developed in 1993 by the World Bank and the World Health Organisation as they sought to create an accurate measure of the universal burden of untimely death, disease, and injury as an aid in making appropriate recommendations geared towards improving health specifically for developing countries (World Bank, 1993). This measure has been used in many empirical studies to represent the overall burden of diseases but, to the author's knowledge, has not been used in the Sub Saharan Africa context (Gold et al., 2002; Krishnamoorthy et al., 2009; Nurchis et al., 2020). The findings indicate that although increases in longevity for the last 59 years show a positive and significant influence on economic growth, the overall burden of disease for countries in Sub Saharan Africa, is having a detrimental and negative effect on growth. The prominent causes of mortality in the region include respiratory infections, HIV/AIDS, and malaria. These contribute to this negative and significant effect on economic development. This proposition that the level of health in any country is a critical factor to economic development echoes the findings from both the theoretical and empirical literature (Becker, 1962; Weil, 2007; Bloom et al., 2018).

With the role of health and diseases established for countries in Sub Saharan Africa, Chapters 4 and 5 examine two main channels through which health influences economic development, using life expectancy and Health Adjusted Life Expectancy (HALE) as the measures for population health. HALE is a summary health measure that builds on the notion of life expectancy. Life expectancy estimates are indifferent to population health as its focus is on the quantity and not the quality of life. HALE takes this shortcoming in the life expectancy measure into account and calculates the average number of years a person of a certain age may anticipate to live in good health. The differences between these two measures (life expectancy and healthy life expectancy) are substantial for countries in Sub Saharan Africa, making it essential to use an appropriate measure if the true effect of health on causal channels are to be established (Salomon et al., 2012).

Chapter 4 examines the association between health and labour productivity for Sub Saharan African countries. Choosing productivity as the main direct channel of focus is underpinned by this reasoning: Productivity explains more than 60 percent of the differences in the levels and up to 90 percent of the differences in growth rates between countries (Helpman, 2009). Gains in productivity reduce the physical limitations imposed on economic growth by factors like demography, the availability of natural resources, and lower rates of savings within a country.

Moreover, gains in productivity to a large degree are driven by improvements in the standard of living and economic growth in the long term. In the short term, productivity also affects factors such as inflation, the business cycle, exchange rate, consumption, and employment rates (Tompa, 2002).

In other words, productivity is a fundamental source of economic growth, and a country's ability to innovate and remain productive depends on the quality of its human capital, that is, health and education. Traditionally, education has been used as the proxy for human capital, with many studies looking at how it affects productivity, whilst the impact health has on productivity, especially for developing countries, has received less attention. Therefore, understanding how population health influences growth through productivity is an essential consideration for developing countries. Chapter 4 examines this relationship, factoring in the demographic transition theory. The findings indicate that for Sub Saharan Africa, improvements in life expectancy from 1984 to 2018 has had a positive and significant impact on labour productivity.

Population health also affects economic growth through many indirect channels. These include technological advancement, geography, foreign direct investment, institutions, and culture. Chapter 5 focuses on how population health influences Foreign Direct Investment (FDI). FDI is essential for all countries, both developed and developing, but for countries in Sub Saharan Africa, this source of funding is significant as the benefits are much greater. There is a clear link between FDI and economic development as this source of finance acts as a catalyst for economic development (Chowdhury and Mavrotas, 2006; Yean et al., 2018). FDI provides access to international networks, enables the transmission of skills, technology, and innovative capacity, and expands the resources and capital available to countries that receive FDI.

In Sub Saharan African countries, the recurrence of infectious diseases coupled with the low levels of domestic investment and savings means that without external funding, these attributes of FDI that enhance productivity and competitiveness is lost. Even though there is a large body of literature on the factors that influence FDI, only a few studies include population health in their analysis. A majority of these studies use econometric approaches that do not separate the short- and long-term impact and the measures of health used do not fully capture the effects of morbidity and mortality. How health affects FDI also varies for countries in different income classifications, and the overall level of human capital is vital in attracting FDI. These considerations, which are vital for Sub Saharan African countries but are not included in the literature that focuses on the region, are addressed in Chapter 5. I find that from 1990 to 2019, life expectancy and HALE has had a negative and significant impact on FDI inflows for countries in Sub Saharan Africa. Similarly, the level of human capital has not influenced FDI. Chapter 6 concludes this thesis with further research opportunities and policy implications.

CHAPTER 2

2.1 Literature Review

There is an extensive literature that examines the health growth relationship. This chapter first discusses the complexities of the association between health and economic growth, showing how the variations in health measures, causal mechanisms and the different dimensions of health can have different implications for different countries. I then present a general overview of the literature before proceeding to the significant issues for developing countries. This begins by looking at the role of the demographic transition in the health growth nexus, followed by the role of women's health and fertility and finally, the role of infectious diseases. In general, empirical studies on this relationship find a significant association between population health and economic development, especially in developing countries; however, the direction and strength of this relationship is dependent on the factors mentioned above.

2.1.1 Health and Economic Growth

At the start of the 20th century, people rarely lived past the age of 40 and GDP per capita was only one- sixth of its current value globally. From the 20th century to date, forces such as education, physical capital accumulation and technological progress has driven economic growth. This is well documented in the economic literature (Becker, 1962; Ashraf et al., 2008). Similarly, forces that influence health like the environment, individual behaviour and the availability of medical care has been thoroughly described and is well understood (Bhargava et al., 2001; Bazzi and Clemens, 2013). However, there is still no simple explanation of the interrelations between health and economic growth. Health influences economic development through various social and economic pathways, and this is true of the reverse, where growth also fosters better health. Furthermore, improving institutional quality and the environment improves population health and economic growth. These confounding factors complicate the relationship and make it difficult to develop and identify a theoretical and empirical model. Moreover, although the positive influence of health on economic growth has been recognised in the empirical and theoretical literature, the fundamentals of this relationship are complex. To better understand the health growth nexus, these issues that are of central concern need to be addressed. This includes addressing measurement issues, dimensions of health and identifying the causal mechanisms through which health affects economic growth, given that they are varied and differ for developing and developed countries. I first discuss these complexities before exploring the extended literature.

2.1.2 Population Health Measures

Health is measured differently across studies, with variations in measures used for micro and macro studies. Studies that analyse the health growth nexus mostly use two health proxies, inputs, and outcomes (Weil, 2007). Factors that have a physical impact on an individual's health are referred to as health inputs; these include nutrition, access to medical care, and exposure to different pathogens. These inputs determine an individual's health outcomes. A person's genetic capabilities can also determine their health outcomes. Life expectancy, cognitive functioning and height are examples of health outcomes.

These inputs, or outcomes of health, are used in the extensive literature that evaluates the impact of population health on economic development, with inputs mostly used in micro studies and output in macro studies. Studies that use health inputs include Behrman and Rosenzweig (2004), Miguel and Kremer (2004), Cutler et al. (2010) and Hoynes et al. (2016). Behrman and Rosenzweig (2004) identify how foetal nutrition affects wages and education in adulthood by using variations in birthweight among identical twins. They do this by regressing the gaps in education, stature, and wages on the gap in foetal development and find that minor differences in foetal development (1 unit) results in a 0.657 difference in years of schooling, 0.190 gap in wages and 3.76 difference in their height in adulthood. Treating school-aged children with deworming medications in Kenyan schools increased attendance rates (Miguel and Kremer, 2004). More recently, Hoynes et al. (2016) shows that access to food stamps and cash safety net programmes during childhood lead to an improvement in adult health, reductions in conditions like obesity, heart disease, diabetes and, for women, an increase in economic self-sufficiency (higher educational attainment, higher earnings) in adulthood. In contrast to the micro-studies that use health inputs, macro-economic studies analyse the differences in health and how it relates to differences in economic growth, using data on health outcomes at the aggregate rather than the individual level. Bhargava et al. (2001) find that Adult Survival Rate (ASR) positively impacts the growth rate of GDP per capita. Gupta and Mitra (2004) point out that better health status and low rates of poverty coincide with higher economic growth, while Cooray (2013) highlight the different influence of health outcomes on economic growth based on the level of income (low income / high and upper income) of the countries under analysis. Although difficult to compare findings from studies using health inputs and health outcomes given the differences in inputs and outcomes for individuals and different countries, a recent study combines these two strands of literature and shows that when the findings in micro studies are aggregated, the point estimates are close to those found in macro studies, justifying both approaches in estimating the developmental benefits of improvements in population health (Bloom and Canning, 2018).

2.1.3 Causal Mechanisms

It is well established that improved health is positively correlated with high-income levels, yet the question remains, does better population health cause, or result from higher income? Most notable in this regard is the Preston Curve, which shows the correlation between life expectancy and national income and birth, with the perceived explanation being that higher incomes enable countries to provide better medical care, better food, cleaner environment, and shelters which results in longer life expectancies (Preston, 1975). Moreover, better health enhances productivity, increases savings, and attracts Foreign Direct Investment (FDI), factors that contribute to growth in income (Cole and Neumayer, 2006; Li et al., 2007; Bhattacharjee, 2020). This bidirectional association between population health and economic development makes the nature of their relationship unclear. The literature that analyses these relationships attempts to identify partial channels of causality. Cutler et al. (2006), Gupta and Mitra (2004), and Hall and Jones (2007) focus on the relationship that starts from economic development to improved population health whilst Bhargava et al. (2001), Bloom and Canning (2000), Frimpong and Adu (2014) focus on the reverse channel.

Additionally, the correlation between health and education further obscures this (Becker et al., 2005). Education shows the same two-way causality with income; an observation recently shown by Lutz and Kebede (2018).

They extend Preston's data from 1970 – 2015 and show that the typical shape identified by Preston's curve can also be explained by education, even suggesting that human capital in the form of education may be an enhanced determinant of longevity as its effect remains the same even at higher levels of life expectancy. Similarly, Weil (2015) stipulates that factors that raise income like improved institutional quality and technological progress can also improve population health, eventually influencing the health growth relationship. These considerations make it difficult in identifying the causal channels and quantitatively analyse their relative importance (Bloom et al., 2018).

2.1.4 Dimensions of Health

Another important consideration in the health growth nexus is the dimension of health under analysis: morbidity versus mortality and the gender, age, and socioeconomic status of the group under analysis. The labour force participation rate in countries with low levels of morbidity is high (Garthwaite, 2012). This reflects low levels of diseases within a population, increasing the productivity of investments in education (Bleakley, 2010a). Similarly, reductions in mortality also increase the supply of labour, especially in developing countries, boost higher savings, increase physical capital investment, and increase the returns to education (Boucekkine et al., 2002; Bloom et al., 2003). In considering the population under analysis, Miguel and Kremer (2004) and Bloom et al. (2015) show variations in the returns on investment in children’s and women's health and in the health of men, with the former showing higher returns than the latter. Health interventions in childhood have strong positive effects on the learning ability of children and on their income in adulthood. Moreover, spillovers from intergenerational investments in women's health positively influence their children's health by encouraging reductions in birth rate, which spurs economic development in countries with high rates of fertility (Field et al., 2009; Bhalotra and Rawlings, 2011).

2.1.5 Developed and Developing countries

Finally, improvements in population health have different impacts on countries, based on their level of development. In developing countries where the health status is low, minimal health initiatives can have a significant positive impact on the workforce (Luca et al., 2018). In contrast, advanced economies deal with issues around "flat of the curve medicine" where intensive health interventions have a negligible impact on the health status of the population as these improvements mostly accumulate to those in the population who are not active in the workforce (Fuchs, 2004). Lastly, the role of the demographic transition is important, that is how increases in longevity encourage investment in education and economic growth, but only if a country has transitioned, so that fertility and mortality rates have fallen below a specified threshold (Cervellati and Sunde, 2011, 2015). With the implications of the distinctions above in mind, the following section focuses on the empirical and theoretical literature on the association between population health and economic development.

2.2 Theoretical and Empirical Literature on Health and Economic Growth

Before the 1990s, few studies used econometric methods to analyse health's influence on economic development (Barro and Lee, 1994; Chen, 1997). Several studies followed in this vein, recognising the positive impact of improvements in life expectancy on different measures of economic development (Bloom et al., 2004; Lorentzen et al., 2008). Growth in GDP per capita is positively and significantly associated with investment in health human capital (Gyimah and Wilson, 2004). Bloom et al. (2004) points out that a one-year increase in life expectancy increases output by 4 percent. Similarly, high death rates within a population reduce economic growth by shortening time horizons, referencing Africa's growth tragedy (Lorentzen et al., 2008). Zhang and Zhang (2005), in exploring the connections between life expectancy, economic growth, schooling, and savings, argue that increases in education along with reductions in fertility are associated with the positive impact that life expectancy exerts on economic growth. While most of the previous research does not explicitly deal with identification issues, Bhargava et al. (2001) use a method they advanced in an earlier study (Bhargava, 1991), identifying restrictions over time. Following this, Bloom et al. (2004) use lagged levels and differences in their study, while Lorentzen et al. (2008) use climatic factors, environmental features, and disease ecology (malaria) as instruments for death. Their study reveals that a decrease in the death rate discourages risky behaviour and encourages investment in education and physical capital, ultimately increasing economic growth.

Using a development accounting technique, other studies identify how certain health conditions affect productivity at the aggregate level and suggest that health has a positive effect on overall level of labour productivity and, therefore, on national income (Shastry and Weil, 2003; Weil, 2007). Using microeconomic estimates (e.g., the effect of HIV on workers productivity) to infer the macro effects of health on economic growth is advantageous, as these micro estimates are less likely to have issues with reverse causality that other techniques must deal with (Shastry and Weil, 2003; Bloom et al., 2018). However, as discussed in section 2.2.1 above, estimates from both micro and macro studies are similar once micro estimates are aggregated.

In contrast to much of the literature on the causal channel from health to economic development, Acemoglu and Johnson (2007) suggest that improving health negatively influence economic development. They contend that mortality rates fell globally for all countries (developed and developing) with the introduction of various health interventions and new drugs after the 1940s, which led to a fall in mortality rates as populations continued to grow. Using this global epidemiology as an instrument, and holding the fertility rate constant, they highlight that economic growth fell as the increasing population diluted any capital gains achieved and reduced income at the constant state, a fact from Solow (1956). Nonetheless, Aghion et al. (2010), among others, have challenged these findings, stating that Acemoglu and Johnson (2007) excluded initial health in their model and only regressed economic growth on health improvements. They indicate that countries that grew faster started with better population health, which explains why they may have experienced smaller health improvements during the analysis period, in comparison to countries whose population health was low to begin with. Aghion et al. (2010) and Bloom et al. (2014) address this point, using the dataset used by Acemoglu and Johnson (2007) but include initial health in their examination. They find that, with this inclusion, the negative causal effect vanishes. The theory supporting this work infers that at the macro level, any investments in health will experience decreasing returns over time (Aghion et al., 2010; Bloom et al., 2014).

This echoes the works of Bhargava et al. (2001) and Hansen and Lonstrup (2015). These studies show that the initial positive correlation between GDP growth and adult survival rate is reversed as longevity increases.

Other researchers have distinguished the impact of specific aspects of health (e.g., HIV) and not aggregate health (e.g., life expectancy) on income. Suhrcke and Urban (2010) and Hyclak et al.'s (2016) studies show evidence that in developed countries (OECD), improving specific sources of morbidity and mortality significantly promotes economic growth only when countries have low levels of income and population health. Using GMM and lagged differences of the dependent variable as instruments for death associated with cardiovascular diseases among the working-age population, their results show that heart diseases negatively impact on economic growth in Eastern European countries in their sample, both for an earlier study from 1960-2000 and a subsequent study from 2000-2012. In Western European countries, where individuals have access to healthcare systems that function properly and are well equipped, further improvements in longevity can be accomplished only at a significant resource cost that repress economic development. This is because the gains from the cardia revolution have been exhausted, with all the benefits accruing to countries that still have low levels of health and income (Bloom et al., 2018). This supports the theory of diminishing returns to health improvement.

For developing countries, specifically Sub-Saharan Africa, the rate of diseases like HIV/AIDS is of major concern. Young's (2005) research on "the tragedy of AIDS and the welfare of future African generations" claims that HIV/AIDS will encourage development in the long term by limiting the supply of labour in the short run. He states that this will eventually lead to increased wages, a decline in fertility and a simultaneous increase in child investments. Yet, recent studies suggest that this fall in fertility has not happened (Fortson, 2009; Juhn et al., 2013). Azomahou et al. (2016) propose a different explanation, indicating that the HIV epidemic will lead to an initial small drag in economic growth due to the reduction in labour supply. This is followed by a severe drag in economic growth, resulting from decreased human capital investment associated with decreased longevity. Moreover, other studies point out that fertility reduction among uninfected women is not related to community-level HIV prevalence (Juhn et al., 2013; Kalemli-Ozcan, 2012). Using microdata that provides estimates on HIV prevalence, they emphasis the behavioural response to higher risks of HIV infection and mortality in Sub Saharan Africa by examining the fertility histories of infected and uninfected women before the onset and during the disease. They find that the birth outcomes of these two groups of women remain relatively unchanged.

Although most of these studies show the positive micro and macroeconomic effects of health improvements and imply that benefits can be reaped from improving the treatment of specific diseases, they also indicate that huge spending on healthcare will not necessarily lead to economic growth (Cutler et al., 2010). This may result from ineffective treatment of chronic diseases, ineffectual management in the healthcare system or misdirected spending in healthcare that focuses on groups who have no prospect for productivity gains (Chandra and Skinner, 2012).

Two main observations are drawn from the studies above. Firstly, many of the variables used as proxies for health in macro-economic studies do not fully capture all the aspects of health (Bazzi and Clemens, 2013). Secondly, it is difficult to compare the estimated impact of health on growth between studies.

This reflects the differences in context, econometric techniques, and health measures used. This makes it difficult to summarise the overall findings. However, the correlation between population health and economic development has been assessed for many years, and while both growth proponents and sceptics continue to debate the nature of this link, there is a consensus that health has a positive although sometimes weak causal influence on economic development. However, many of these analyses focused on advanced countries, and those that consider less developed countries note some important contextual factors which needs to be taken into account. The following sections describe how population health influences economic development in emerging countries. Section 2.3 starts with a more detailed examination of the demographic transition. Although this thesis does not directly explore women's health and its impact on growth, its important role in determining the overall patterns observed, make it important to consider the literature covering this. This thesis considers two main channels, the role of infectious diseases and the demographic transition.

2.3 The Demographic Transition

Galor and Weil (2000) were the first to give the take-off from Malthusian stagnation towards sustained economic growth an endogenous explanation. This initiated the supposed unified growth theory, which explains how economies have grown over centuries, explaining how the industrial revolution occurred (Galor, 2005). The theory stipulates that the differences between developed and developing countries is because of the differences in the timing of their take off from Malthusian stagnation towards sustained long-run growth. Malthus (1878) explains the association between GDP per capita and increases in population, suggesting that the existence of a fixed factor of production like land implies diminishing returns to scale for all other aspects of production, indicating that the expansion of resources like land or technology would not change the level of income per capita as any increases will be diluted by the growing population. This framework, proposed by Malthus, accurately describes the historical evolution of economies and populations around the world.

Living standards remained constant and had little variation among countries for thousands of years. For example, Maddison and Maddison (1995) shows that GDP per capita grew by 0.2 percent per year from 1500-1820 in Latin America and Western Europe and 0.1 percent in Asia and Africa. Casting this further back to the pre-1500 would suggest that GDP per capita was constant, as indicated by Malthus. Likewise, world population growth was sluggish, increasing at 0.064 percent per year from 1 to 1750 (Bacci, 1855), reflecting the slow pace at which technology progressed, bearing out Malthus predictions. Nonetheless, advancement in technological progress above the rate of population growth allowed income to keep rising, explaining why population growth did not dilute the gains in income per capita in today's developed economies (Galor and Weil, 2000). In addition to technological progress, negative shocks to the populations of earlier centuries, such as the Black Death, decreased the population of Europe by almost one-third (Pamuk, 2007). As a result of this epidemic, the labour force decreased, income went up, attracting more people, including women who substituted having children and an early marriage to joining the workforce (Greif, 2001). Eventually, all these led to output exceeding population size and the transition from the post-Malthusian regime through the initiation of the demographic transition.

In examining the role that demography plays in the process of economic development, Cervellati and Sunde (2011) use the same methodology and measures used by Acemoglu and Johnson (2007) in their analysis and find that in the pre-transition stage, any improvements in life expectancy negatively but insignificantly affect economic development, but a positive and significant effect after a country has transitioned from pre-industrialised to an industrialised economic system. They reiterate this point in a subsequent paper where they show that these arise from the different effects that longevity has on the behaviour and decisions about education and fertility at various phases in the demographic transition (Cervellati and Sunde, 2015). The works of Hansen and Lonstrup (2015) supports this notion. In combination with the analyses of Bhargava et al. (2001), these results indicate that improving population health in pre-demographic transition countries is detrimental to economic growth. Although this will be beneficial to countries that have transitioned, attaining high levels of life expectancy reduces this effect, making it negative.

The association between income and population health has altered dramatically in recent years. In the past, higher income might have encouraged technological progress, which allowed Europe and its subsidiaries to improve the health of its population by enhancing their standards of living and improving human capital accumulation, thereby pushing them from stagnation to growth. Comparing this to present-day conditions, a higher income is no longer a prerequisite for better health. Health interventions and technologies are accessible and can be imported even by very poor countries (Bloom et al., 2018). For example, the GDP of Somalia in 1997 was 182 USD. This did not impact activities initiated by WHO to eradicate polio in the country, allowing Somalia to be free from polio for 6 years from 2007 to 2013. These health interventions undoubtedly contributed to increases in life expectancy from 48 in 1997 to 55 in 2013. Similarly, middle-income countries in Sub Saharan Africa import 70 percent of their pharmaceutical products and up to 80 percent of antiretroviral drugs used to treat HIV AIDS (Galor and Weil, 2000). This reliance on foreign medications implies that although health, as expressed through life expectancy, has improved in developing countries, the over reliance on foreign intervention in addressing recurring epidemics like HIV AIDS, malaria, and tuberculosis, has not incentivised local investment in human capital, which can progress technological advancements within the region (Whiteside, 2010). This is seen through the rate of adjustment in human capital, measured by combining average years of schooling and returns to education, which has remained relatively unchanged over the last 30 years in most Sub Saharan African countries. In 1970, this was 1.02, 1.04 and 1.19 in Angola, Cote Devoir and Botswana, respectively, rising moderately to 1.47, 1.66 and 2.88 in 2017. These changes are small compared to advanced economies like the UK and Norway, whose human capital has increased by almost 10 percentage points, starting at 2.74 and 2.77 in 1970 and rising to 3.75 and 3.64 in 2017.

Comparably, an alternative index on human capital that considers how productive the next generation of workers will be, compares it to a benchmark of complete standard education and full health indicates, that Sub Saharan Africa is the lowest-ranked region on the human capital index. Countries like Rwanda, Ghana and Cameroon have developed over 60 percent of their human capital, yet fall in the bottom half of the index, ranking at 71, 72 and 73 out of the 130 countries in the study. Nigeria and Ethiopia are among the lowest performers, ranking 114th and 127th (World Economic Forum, 2017).

Hazan and Zoabi (2006) find that when life expectancy is improved, economic development does not contribute significantly to the accumulation of human capital when countries are transitioning from stagnation to sustained growth. This is because improved longevity at this stage has a positive influence on the returns to quality and the quantity of offspring that parents decide to have. The works of Galor and Weil (2000) echoes this. Hazan and Zoabi's analysis highlights the importance of including fertility or population growth when investigating the health growth relationship. Moreover, the relationship between longevity and income per capita is nonlinear because income per capita is subject to the previous level of life expectancy (Desbordes, 2011). His study argues that in the presence of the epidemiological transition, countries that started with life expectancy at 43 years saw negative effects on their per capita income, while those that started with life expectancy at 53 saw significant positive effects.

2.4 The Role of Women's Health and Fertility in the Demographic Transition Process

Bloom et al. (2015) considers the role of women's health in the process of economic development and the demographic transition. A woman's health indicates her chances of joining the labour market. Therefore, investing in the health of women increases the possibility of them having fewer, better educated children given the higher opportunity cost of having more children as opposed to participating in the labour market (Langer et al., 2015). These outcomes are consistent with the observations of Canning and Schultz (2012) as enhancement of economic growth results from reductions in fertility, which leads to low youth dependency and an increase in the number of women participating in paid employment. The health of women affects economic growth through four main channels. 1) Healthy women are more productive when participating in the labour market (Bloom et al., 2015).
2) Healthy women are less likely to miss out on education due to morbidity. Education enhances their cognitive abilities and enhances the likelihood of participating in the labour market, which increases the returns on investment they make in their education (Albanesi and Olivetti, 2014). 3) Children's health is a direct reflection of the mother's health. This occurs via in utero effects and the ability of mothers to nourish their children (Field et al., 2009). 4) Improved women's reproductive health can reduce fertility rates through the availability of contraceptives, with long term effects of reducing the dependency ratio as more women participate in education and contribute to the labour market (Bailey, 2006).

Jayachandran and Lleras-Muney (2009) estimate how human capital investments impacts girls when maternal death declines. Using data from 1946 – 1953 for Sri Lanka and geographical variations to estimate the corresponding change in human capital, they find that the fall in maternal mortality increases the life expectancy of girls, with each additional year of life expectancy increasing literacy and years spent in education. Recent studies by Alimohamadi et al. (2019) and Minamimura and Yasui (2019) have found similar results. Using data from 1980-2010 for South Asian countries, the former finds that in developing countries, the fall in maternal mortality rates (MMR) and under 5 mortality rate is partly determined by improvements in the human development index. The latter uses an overlapping generational model and the same data set as Acemoglu and Johnson (2007) and finds that decreases in MMR increases income per capita, especially when educational levels are high. However, the positive effect observed depends on the demographic stage of the country under analysis.

This is because a fall in MMR suggests that childbearing becomes less risky, ultimately increasing fertility, and population size and slowing down economic growth in a country that has not transitioned demographically (Cervellati and Sunde, 2015).

In Sub Saharan Africa, MMR per one hundred thousand live births is the highest in the world, averaging around 546 deaths in 2015 (see table below). Although an improvement from 987 deaths per one hundred thousand live births in 1990, this high rate of death is cause for concern, given that most maternal deaths are caused by preventable risk factors (poor nutrition, poverty, low weight, illiteracy etc.), as evidenced by the vast differences between rich and poor countries. In high income countries, women face a 1 in 3300 chance of dying from complications from pregnancy, compared to Sub Saharan Africa, where the risk of maternal death is 1 in every 36 women (UNICEF, 2017).

Figure 2.1 Trends in Maternal Mortality: 1990 to 2015 (per 100,000 live births)

https://www.afro.who.int/sites/default/files/2017-05/trends-in-maternal-mortality-1990-to-2015.pdf

Source: World Health Organisation, UNICEF, United Nations Population Fund and The World Bank, Trends in Maternal Mortality: 1990 to 2015, WHO, Geneva, 2015.

Despite these poor statistics, very few studies have considered the impact of female health on economic development for Sub Saharan African countries. These include studies by Kirigia et al. (2006) who use a production function estimation for a cross-section of 45 countries in Africa to analyse maternal mortality's effect on economic growth. Echoing studies done for other regions in the world, they indicate that maternal mortality negatively and significantly affects GDP. Compared to other parts of the world, Sub Saharan Africa has the highest female labour participation rate (International Labour Organisation, 2019). However, women mostly work in the informal sector, which is characterised by low wages and less secure jobs than their male counterparts. These negative implications make improving males' health a priority in such societies as this guarantees an increase in household income.

Bloom et al. (2015) highlights the conflict between the short-term interests of households which prioritise investment in male children, and long-term development goals which focuses on the health of women.

The preference for male children, partly for economic reasons, have been widely documented in Asia. For example, in deprived areas in New Delhi, females are more likely to die from diseases such as diarrhoea, as parents are less likely to spend money on girls' illnesses than boys (Khanna, 2003). Duflo (2012) highlights the perception held in India that women who do not work outside the home do not need to be as strong and healthy as their male counterparts.

For Sub Saharan Africa, a recent study using individual-level data from the 2008 Nigerian demographic health survey shows how parental gender preference affects fertility behaviour, influences both the traditional and social institutions within the country and negatively affects the health and wellbeing of girls and women (Milazzo, 2014). Milazzo's analysis shows that MMR and morbidity are highest among women who have girls as their first-born child, especially if they are also from a lower socioeconomic background. This preference for sons shortens the spacing between having children, increases fertility and increases maternal mortality. Milazzo (2014) only consider data for a year, focusing on one country in Africa. Her results are a starting point. Further analysis using an extended dataset for many countries in Sub Saharan Africa on how gender preference has historically affected females and its subsequent effect on health and growth will add to current knowledge on the subject.

Although an improvement in women's health may depress wages in the short run through an aggregation in the supply of labour, especially in low-income countries, the health of women speeds up the transition to sustained economic growth, thereby offsetting this temporary negative effect (Bloom et al., 2015). A person's productivity depends on how healthy they are, as health is an essential element of human capital (Bloom et al., 2004). On average, women face greater morbidity issues which results in productivity losses during their industrious years, although their life span is longer in comparison to that of men (Vos et al., 2012). A study on sex differences in morbidity and mortality attributes the differences in female and male health to how certain conditions affect both sexes in their early years (Case and Paxson's, 2005). They find that chronic conditions associated with high morbidity affect women to a greater extent. However, these conditions affect men more severely, leading to higher mortality rates among men. Improving the health of both sexes' foster growth, although not to the same extent as investment in female health alone does. This applies especially to developing countries, as improving men's health increases the fertility rate, thereby slowing down the demographic and economic transition to sustained growth (Bloom et al., 2015). Field et al. (2009), Jayachandran and Lleras-Muney (2009) and Albanesi and Olivetti (2014) all show that a fall in mortality enhances investments in the education of females which in the long run results in lower fertility and greater participation in the labour market.

This section and section 2.3 have highlighted how the demographic transition affects the health-growth relationship. The next section focuses on the role of infectious diseases, given their high prevalence in Sub Saharan Africa.

2.5 The Role of Infectious Diseases

In addition to the role of the demographic transition, women's health and fertility discussed in sections 2.3 and 2.4, stressing the impact of infectious diseases that continues to affect many developing nations is essential. Recurring diseases can trap countries in a Malthusian state where mortality, morbidity and fertility are extreme, making longevity and survival volatile (Lagerlof, 2003; Chakraborty et al., 2016). In such an instance, growth in income alone cannot push countries out of the development trap. Lagerlof (2003) references countries with a high burden of disease and indicates that for these countries to escape this development trap, a long transition period where major epidemics are suppressed is required, as this allows countries to build protective human capital within the population.

Liu and Goenka (2017) analyse the loss to human capital accumulation when faced with reoccurring diseases. Soares (2005) and Kalemli-Ozcan (2012) develop models in which a constant probability of death is taken into account when individuals make investment decisions about their education and show a significant economic increase when mortality is reduced. Bleakley (2010b), shows in his work on disease and development and the eradication of malaria the impact that diseases with long term morbidity, but low mortality can have on the growth of an economy. Chakraborty et al. (2010) shows how developing countries exposed to infectious diseases like HIV and malaria have low productivity while facing high premature deaths. These countries also have lower saving-investment propensity and take much longer to experience robust growth due to complementarities of such diseases; that is, being infected with one disease makes one more susceptible to other diseases.

For developing countries, eradicating diseases to improve health has an economic advantage over medical interventions (Chakraborty et al., 2016). However, the advancements in longevity and decreases in the death of children in Africa have happened mainly through medical treatment rather than the eradication and prevention of infectious diseases. In such cases, physical limitations associated with infection-related morbidity reduces productivity and stifles the incentive to invest in human capital (Bloom et al., 2018). For Sub Saharan African countries, healthy life expectancy is less than overall life expectancy, suggesting that although individual lifespan has extended, people in the region spend most of these additional years in poor health. Even when people remain in the labour force, their productivity declines simultaneously with their health. The average life expectancy for Sub Saharan African countries stood at 63.9 years in 2017, yet healthy life expectancy was almost nine years lower at 55.2 years. This indicates that people in the region who survive to this age spend 13.6 percent on average of their life in poor health. This varies across different countries in the region and between men and women, with variations ranging between 13.8 and 14.4 percent (James et al., 2018). Much of the work on infectious diseases and growth do not fully endogenies disease dynamics when using either cross country regressions or simulating macro effects from micro estimates; as such, no quantitative consensus has been reached on the significant impact of infectious diseases in the process of economic growth (Liu and Goenka, 2017).

Researchers like Gallup and Sachs (2001) and Bloom et al. (2014) find a significant effect, while others like Ashraf et al. (2008) find modest effects. Other studies such as Acemoglu and Johnson (2007) and Young (2005) study shows the opposite influence, which they suggest is caused by dilution in the labour market and an increased dependency ratio caused by a large population.

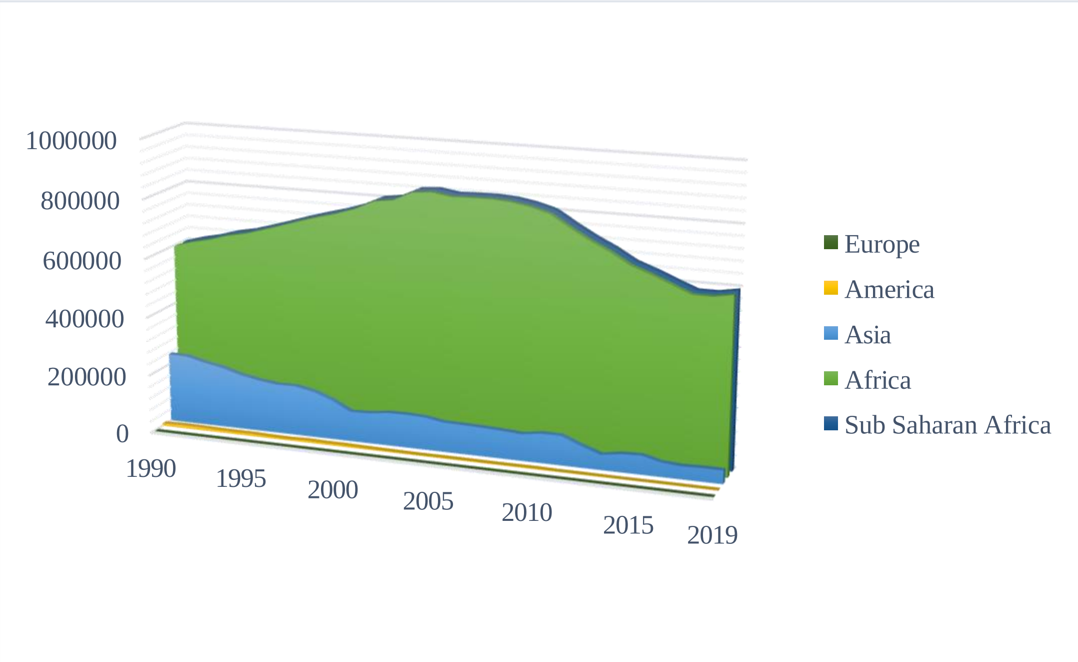
Young's (2005) study simulates how the current AIDS epidemic will affect the living standards of future generations in Africa. He focuses on two main components, the effect the disease will have on the accumulation of human capital of orphans and the fertility rate within the community. Based on his simulations, Young suggests that this epidemic will lead to a fall in human capital, reduce fertility rates, and cause a drag in population growth, resulting in labour scarcity and increasing the value of women's time, thereby enhancing per capita income over the long run. His two focal points, fertility, and human capital effects are based on assumptions that the AIDS epidemic will have similar effects for Africa as the black death that struck Britain. The black death halved the population of Britain in the late 14th century, increased real wages as the labour force declined, stagnated the population throughout the 15th century which increased female participation in the labour market and contributed to lowering fertility rates (Safley, 1994). These proposed effects are an overestimation, and Young's underlying assumptions do not accurately reflect the case for HIV and all countries in the region. In Sub Saharan Africa, 25.7 million people now live with the HIV/AIDS. Although a substantial number of people, this makes up only 2.15 percent of the entire population of 1.2 billion. Infection rates are declining, aided by medical breakthroughs and behavioural change. In 2017, 10.3 million, 59 percent of people living with the virus, were receiving Antiretroviral Therapy (ART), an increase from 3.6 percent in 2005. Due to these advancements in medical technology, people with the virus live longer, slowing down the proposed declines in population growth, while the deterioration in their health means they are unable to contribute productively to the active workforce (World Economic Forum, 2017).

As discussed above, Young's suggestion that a fall in fertility rates will result from the AIDS epidemic has also been challenged by Fortson (2009) and Juhn et al. (2013). Even when the grim view presented by Young is considered, it takes a very narrow outlook of the effect an epidemic can have on the economy of the affected population. His paper does not consider the differences in institutions, although his assumptions are based on the example presented by the black death. Institutional change, triggered in part by the black death, encouraged advancement in technological progress, which helped maintain the high-income levels in the northern parts of Europe in comparison to the south, where the black death did not significantly alter women's involvement in market activities, fertility, and marriage behaviour. Inclusive as opposed to extractive economic institutions encouraged this change (Acemoglu and Robinson, 2013).

Another infectious disease that plagues countries in Sub Saharan Africa is malaria. Malaria is prevalent in more than ninety countries, with 300 to 500 million clinical cases reported each year, resulting in a death toll of between one and three million (Field et al., 2007). The disease has a devastating effect, especially on the young, killing 2000 children each day worldwide (Sachs and Malaney, 2002). The most affected region globally is Sub Saharan Africa, where malaria claims the life of one out of every twenty children under the age of five.

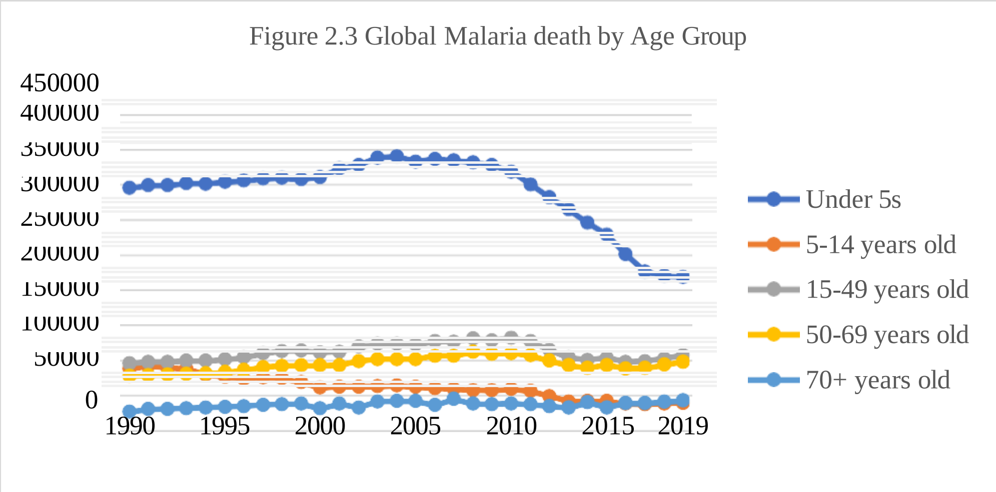
It is one of the top killers among communicable diseases in Africa, a major health problem contributing to poor health in the region. Although mortality rates are lower in adults, the frequency of attacks reduces the quality of life as the disease leaves behind some physiological limitations from infection related morbidity (McCarthy et al., 2000). Figures 2.2 and 2.3 show the global death caused by malaria by region and age group.

Figure 2.2 Global Malaria Death by Region



Data for graph sourced from Global Burden of Disease (2021)

Figure 2.3 Global Malaria Death by Age Group



Data for graph sourced from Global Burden of Disease (2021)

The human and financial burden of malaria is well documented, and many authors have found the disease to have an adverse and significant influence on the long-term development of many nations (Malaney et al., 2004). Although many country-level programmes successfully eliminated the malaria parasite over the last century, the disease burden of malaria has risen again sharply over the last few decades (Sachs and Malaney, 2002). Globally, 50 million cases of malaria were reported in 1980. This rose sharply to 250 million cases a decade later, although the number of reporting countries went down as some countries, especially in the west, eliminated the disease. By 1997, this number had fallen to 180 million, only to increase to 239 million cases in 2010. In 2016, 217 million incidences of malaria were reported, and in 2017 this number was 219 million cases (WHO, 2021). These figures show the volatility of this infectious disease.

In Sub Saharan Africa, malaria mortality rates have remained persistent; 553,444 deaths in 1990 and 543,289 deaths in 2017 (Global Burden of Disease, 2019). 92 percent (200 million) of the reported incidents in 2017 were in African countries, with fifteen nations in India and Sub Saharan Africa accounting for nearly 80 percent of the worldwide burden of malaria. 93 percent of all death caused by malaria in 2017 occurred in the WHO African Region (World Health Organisation, 2021). Nigeria (25%), Mozambique (5%), the Democratic Republic of Congo (11%) and Uganda (4%), all countries in the region, account for 44 percent of all malaria cases globally. All these countries reported increases in the incidence of malaria, reporting an additional 500 thousand new cases in 2017 compared to the previous year. In Tanzania, illness and death from malaria are particularly high despite their participation in malaria research and developing tools to control the disease. For one district in the region, the burden of malaria has remained the same since the 1960s, notwithstanding interventions by the government and from WHO (Makundi et al., 2007; World Health Organisation, 2021). Breman et al. (2004) estimates that the number of malaria cases will double in the next two decades if effective solutions that can reduce and potentially eliminate the negative long-run effects of malaria are not found.

The association between malaria and poor development was highlighted by Gallup and Sachs (2001) in their work on the economic and social burden of malaria, in which they showed that the average GDP in 1995 in malaria-endemic countries was $1,526 in comparison to $8,268 in countries where incidences of malaria were mild. The reverse interconnectedness from malaria to growth and vice versa is acknowledged by many authors (Gallup, Sachs 2001; Kiszewski et al., 2004; McCord et al., 2017). Sachs and Malaney (2002) highlight the powerful links from health (in this case, malaria) to underdevelopment which is generally underappreciated. Their work echoes the studies of others who show that intense malaria incidences are mostly in regions with low economic growth and high poverty rates (Shepard et al., 1991; McCarthy et al., 2000; Datta and Reimer, 2013). This suggests that urbanisation, increased prevention methods such as bed nets or insecticides, and government sanitation programmes can reduce malaria transmission.

Countries in low temperate zones like Italy and the United States partly enjoy their current economic status because they eliminated malaria in the 1930s to 1950s through socioeconomic development programmes, environmental management and intensive antimalaria interventions (Kitron and Spielman, 1989). However, economic development alone cannot eliminate malaria from countries located in the tropics and high temperate zones, as is the case in countries like Oman and the United Arab Emirates. Filmer (2002) points out how the incidence of malaria can eliminate any differences between income classes in regions with a high incidence of malaria as people from wealthy households fall ill just as frequently as the very poor. Estimating the economic burden imposed by malaria is critical, especially for Sub Saharan Africa, as targeting interventions efficiently and guiding the allocation of resources is paramount to controlling the disease's negative long-term economic and social effects.

Several macroeconomic studies have analysed how malaria affects the growth of output per capita by using it as an explanatory variable in growth regressions. These studies address the problem of indigeneity that may arise when analysing the influence of disease on economic development by incorporating controls, using an exogenous variable like malaria ecology[1] that impacts a country's disease levels but does not influence income except through the disease channel (Gallup and Sachs, 2001; Sachs, 2003; Weil, 2010). Gallup and Sachs (2001) use the malaria exposure index to measure malaria, the average level of growth in income as the dependent variable and geography, schooling, institutional quality, and life expectancy at birth as controls, and find that eliminating malaria in areas with malaria ecology index of 1.0 increases economic growth by 1.3 percent. Weil (2010) compares the findings of Bloom et al. (2004), which looks broadly at the overall influences of population health on economic development, to the studies of Gallup and Sachs (2001), which looks at the effect's malaria has on development.

[1] Malaria ecology index is used in many studies as an instrument to solve the problem of indigeneity and omitted variable bias (Kiszewski et al., 2004). This index is constructed in such a way that any human activity does not influence prevalence of a disease. Yet studies that incorporate malaria ecology in their analysis of the relationship between health and growth also face several limitations. The coefficients from malaria ecology variable cannot be compared readily in regression analysis as they are not scaled to allow easy economic interpretations. Furthermore, the process of economic development might correlate with independent variables like other tropical diseases or climate aside malaria ecology which may not be controlled for in the analysis (Weil, 2010; Depetris-Chauvin and Weil, 2018).

He finds that although both studies show that health has large positive effects on economic growth, their quantitative implications are different. When malaria is included as a variable in the estimates used by Bloom et al. (2004), its effect on growth is relatively small compared to the findings of Gallup and Sachs. This suggests that correlation with the error term is likely, especially in studies that focus on Africa and regress income on health, by using life expectancy or the prevalence of a disease. This is because low income in itself, or factors that lower income, like low-quality institutions, can also lead to the presence of disease (Acemoglu et al., 2001).

Instrumental variable approach is another methodology that researchers use to analyse how diseases, in general, affect economic development. Acemoglu and Johnson (2007) examine how changes in health affects income, factoring in the epidemiological transition that occurred between 1940-1980 and using predicted mortality as an instrument. They find a correlation between declines in mortality increases in life expectancy, which speeds up the rise in population growth, diluting the labour market, which eventually leads to declines in income. Ashraf et al. (2008) demonstrates that growth in life expectancy found in Acemoglu and Johnson (2007) study is an overestimation when compared to projections made using simple demographic models. They show that although the instrumental variable approach theoretically addresses the problem of endogeneity and omitted variables, it does not identify the spurious correlations between elements that influence economic growth and increases in life expectancy. Using malaria ecology, controlling for institutional quality, and using GDP per capita as the dependent variable, Sachs (2003) contrasts his previous paper with Gallup (Gallup and Sachs 2001) and does not control for other channels like education through which malaria might affect income. Findings from Sachs (2003) echo those of Gallup and Sachs (2001), but the estimates are much larger. This finding may be because malaria ecology could be substituting for other variables not included in the analysis but have a negative effect on income (Weil, 2010).

Another approach used to analyse how diseases affect economic growth is using direct productivity measures to analyse how morbidity affects labour input. Many studies that follow this approach use the overall prevalence rate and do not account for the varying effect on productivity that various diseases have on the different groups within the population (Arora 2001; Alemu et al. 2006; Cole and Neumayer, 2006). Malaria, on which most of the disease to growth studies in Africa focus, has a significant toll on children and the very young, whilst prevalence among adults is very low (see Figures 2.2 and 2.3 above). One-quarter of all adults suffer from malaria at any time, which lasts a short duration, usually less than a week (Weil, 2010). However, these approaches are valid as malarial episodes in children can affect income in adulthood, especially in the case of cerebral malaria. Cerebral malaria significantly affects children under the age of 5 in Sub Saharan Africa, affecting 575,000 each year. Of these, 110,000 die, and the remainder sustain neurological complications, developmental and behavioural issues (Murphy and Breman, 2001).

This shows how diseases in childhood (not limited to malaria) can affect future income by reducing the productivity of labour. HIV and tuberculosis, on the other hand, have a severe impact in adulthood as opposed to childhood, which makes them highly essential considerations when analysing the direct effect of diseases on labour input (Weil, 2010).

Additionally, other studies have analysed how early-life exposure to malaria influences health, educational attainment, and future income. Analysis of this type use two main empirical approaches. The first uses instrumental variables and historical data to identify the causal effect of malaria (see Hong, 2007; Barreca, 2010; Depetris-Chauvin and Weil, 2018). These studies find negative effects of malaria on both health and education. The second uses the difference-in-difference approach by considering the effect malaria eradication that occurred in the early to mid-twentieth century had on the accumulation of human capital in childhood and its subsequent economic effect in adulthood. This method is used by Bleakley (2010b), Cutler et al. (2010), Lucas (2010), Venkataramani (2012), Chang et al. (2011) and Cogneau and Rossi (2019). Lucas's (2010) sample focuses on women in Paraguay and Sri Lanka who were born before and after the eradication of malaria from these countries. Cutler, Fung, Kremer, Singhal and Vogel (2010) concentrate on a sample from India. These two studies use data on spleen inflammation as proxies for the rate of malaria infection, which is a precise measure and has an advantage over the endemicity variable (malaria ecology) used by Bleakley (2010b). His sample only considers men in Columbia, Mexico, Brazil, and the United States, limiting his results' application as they exclude women and children from their analysis.

Lucas's (2010) and Cutler et al.'s (2010) studies present two issues. Firstly, they use an individual's current local residence instead of their place of birth, as determinants for their probable infection rate before the launch of malaria campaigns. This limits their studies as selective migration might be a confounding factor. Secondly, the period is crucial as malaria in childhood affects cognition and education and might take decades to see its economic effects on individuals. They consider a limited period and, as such, restrict their analysis's emphasis to the first few years rather than the first few decades, which Bleakley considers (2010b). These papers also do not discuss the potential reductions in mortality that resulted from these campaigns. The approach used in these studies is understandable, given that their focus is on parts of the world where the strain of malaria is not as dangerous and does not lead to many fatalities as the strain found in Sub Saharan African countries.

For countries in Sub Saharan Africa, Clarke et al. (2008) used randomised control trials in 30 schools in Kenya over 12 months to examine the effect of preventative treatment of malaria on health and education. Their findings align with previous work, which finds an improvement in cognition and health. However, the methodology used here is limited as it does not address general equilibrium effects. Kuecken, Thuilliez and Valfort (2014) address this issue by combining all the approaches used above, employing the difference-in-difference approach with instrumental variable analysis. They also use climate, geographic, and genetic factors for 14 Sub Saharan African countries to estimate the impact of malaria eradication programmes on children's educational outcomes from 2000 to 2012. Their findings indicate that malaria reduction positively affects years of schooling completed by primary school children.

Malaria mortality is highest in Africa. Yet, Clarke et al. (2008) and Kuecken et al. (2014), although use data on Africa, do not account for the effect these eradication programmes had on mortality rates. The short time span of their data also means they do not account for the possible economic implications in adulthood for those children whose cognition and health improved because of these eradication programmes.

Recent studies using advanced identification techniques have addressed the issues with mortality mentioned above (Langhorne et al., 2008; Ferreira et al., 2011; Stanisic et al., 2015; Cervellati et al., 2017; Depetris-Chauvin and Weil, 2018). However, they also find no sizable effect of the disease on economic growth. Depetris-Chauvin and Weil (2018) address the mortality issue in their study by constructing a historical measure of the burden of malaria. This measure has an advantage over the malaria ecology measure as it provides actual rather than predicted data. Using Ordinary Least Squares (OLS) and instrumental variable approach, they examine the historical impact of malaria on mortality in Africa by using data on the frequency of the mutation that causes sickle cell disease. With these estimates, they analyse how the disease has affected economic development in the region, measuring at the ethnic level[2] as opposed to the country level analysis used in many studies. They find that in high prevalent areas, the chances of surviving into adulthood are reduced by about 10 percentage points, which is twice the current burden of the disease, and there is no evidence to support a disruption in economic growth. This is because the highest mortality rates occur in very young children in whom society has invested limited resources. In other words, malaria imposes a heavy mortality burden but not an economic one, both in the past and presently.

Cervellati et al. (2017) conduct a similar study in Africa by using the light density at night as an indicator for development. They first identify the channel of causality in a linear specification by using disaggregated cell data that exploits within-country variation of projected clinical incidence of Plasmodium falciparum malaria[3]. This data avoids omitted variable and reverse causality issues. They also challenge the traditional empirical specification, which explores the relationship between malaria and growth in a linear fashion, suggesting that the epidemiological features of the disease make it nonlinear. This is demonstrated by Langhorne et al. (2008), Ferreira et al. (2011), and Stanisic et al. (2015), who show that children who survive long term exposure and repeated attacks to the malaria pathogen develop resistance or immunity and become less susceptible to the attacks from the disease as adults, although they may carry the pathogen asymptomatically. In high prevalence areas, child mortality caused by malaria remains monotonic because of this. However, the risk for adults, especially in areas where transmission of the disease is less frequent or unstable, remains high. Cervellati et al. (2017) points out that these factors make the effect of malaria on growth nonlinear. Using a nonlinear specification to identify the causal influence that malaria has on development (as defined by the density of night light), using data on malaria ecology[4] and malaria endemicity[5] in a further analysis, controlling for climate, geography, natural resources, cell area and ethnic diversity. Their findings show that in areas with high latent malaria, the disease is detrimental only to adults who have had low to intermittent levels of exposure to the pathogen, confirming the U-shaped pattern of how exposure to malaria influences economic development.

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[2] Ethnic level analysis provides more data (sourced from Alsan, 2015) based on realities and is less heterogeneous in terms of early development when compared with data from political units (Depetris-Chauvin and Weil, 2018).

[3] This data is from Bhatt et al. (2015) and is measured as number of cases per 1,000 people per year.

[4] Malaria's ecology index provides projections and not actual malaria exposure. This index uses data on the local malaria vectors and the climatic conditions which are less likely to be reversed in comparison to prevalence of malaria data.

[5] Historical data on malaria in 1900 was developed and digitalized by Lysenko and Semashko (1968) and Hay et al. (2004).

Resistance to malaria is high in endemic areas due to how sickle cell spreads within such populations (Langhorne et al., 2008; Stanisic et al., 2015). This finding justifies studies that also find a small effect of malaria on economic growth, given that high prevalence in a population (particularly among adults) could just be asymptomatic, with no effects on their productivity.

Despite the advanced instruments used by Cervellati et al. (2017) and Depetris-Chauvin and Weil (2018), they do not control for channels like education through which malaria can limit economic growth. Secondly, the historical data on malaria endemicity used does not stratify incidence by age or account for consequential mortality or morbidity. Furthermore, their use of night light density per capita instead of GDP per capita or GDP growth used in most studies is questionable. Bickenbach et al. (2016) study on night light and regional GDP shows that this relationship is unstable in both areas with high quality data (e.g., the United States and Brazil) and low-quality data (e.g., India). The instability between these two suggests that night light is a poor proxy for economic activity in developing countries. There is ample literature with reasonable estimates on how malaria directly affects workers' education, demography, and productivity. Yet the results from adding these micro estimates are relatively small compared with cross country growth regressions. The possibility of these estimates being wrong is just as likely as the possibility that important pieces of information are not being captured in simulation exercises (Weil, 2010).

Therefore, a systematic approach to geographical variation in studies that analyse the economic costs of diseases in developing countries is essential. Although there is great variation epidemiologically and economically across Africa, most studies on the subject lump countries in the region together without taking these factors into account. HIV prevalence varies for countries across Africa. Similarly, in Sub Saharan Africa, 60 percent of the population live in areas of stable transmission, where individuals develop protective immunity against malaria from 5 years of age. 10 percent live in areas where transmission is unstable, and epidemics have severe consequences for adult morbidity and mortality. The remaining 30 percent live in areas where the transmission of malaria happens seasonally, and protective immunity is only gained around the age of ten (Brinkmann and Brinkmann, 1991). Yet, no empirical work analyses how the burden of disease affects the economic growth of different groups within Sub Saharan Africa. Furthermore, most studies use microdata, focusing on agricultural farming communities, the majority of rural Africa, neglecting the impact malaria or HIV has on modern sectors like manufacturing, commercial services, and the construction industry.

Several gaps have been indicated in the literature from the discussion above. Many of the variables used as proxies for health in macro-economic studies do not fully capture all the aspects of health (Bazzi and Clemens, 2013). Secondly, most studies use the overall prevalence rate of a disease (mainly HIV or malaria) when analysing the health growth nexus for countries in Sub Saharan Africa. Thirdly most studies do not consider the structure of different populations and the demographic stages of countries they analyse. The next section starts the empirical analyses and addresses some of these gaps by examining the association between health and economic growth across Sub Saharan Africa.

CHAPTER 3

3 Examining the Relationship Between Health and Economic Growth in Sub Saharan Africa

3.1 Introduction

Chapter 2 discussed the literature on the relationship between health and economic growth, considering factors like demography, infectious diseases, and women's health that significantly influence this relationship for developing countries. As a next step, this empirical chapter re-examines the debate on the influence health has on economic development for Sub Saharan African countries. Most of the previous work on the subject has focused on how health affects growth in developed and developing countries outside Africa. However, Sub Saharan Africa is where insights into this relationship is of most value as the continent of Africa bears one-quarter of the overall global disease burden, with 69 percent of deaths in the region resulting from infectious diseases like malaria and HIV/AIDS. Of the 37.4 million people living with HIV globally, 25.7 million live in Africa (World Economic Forum, 2019). Waage et al. (2015) suggest that achieving health and wellbeing for all can only be accomplished if poverty is reduced. These two objectives, poverty reduction and good health and wellbeing for all, align with Sustainable Development Goals (SDGs) 1 and 3. The critical nature of health and its effect on growth makes it essential to find ways of improving the state of health in developing countries. The following passage is worth quoting in full:

'*Improving the health and longevity of the poor is an end in itself, a fundamental goal of economic development. But it is also a means to achieving the other development goals relating to poverty reduction. The linkages of health to poverty reduction and long-term economic growth are powerful, much stronger than generally understood. The burden of disease in some low-income regions, especially Sub-Saharan Africa, stands as a stark barrier to economic growth and therefore must be addressed frontally and centrally in any comprehensive development strategy*.' (Husni and Hussain, 2007, p.1249)

One area where Sub Saharan Africa faces a development challenge is healthcare. A majority of the population lack access to primary healthcare as these systems are poorly funded, leading to many deaths in the region and a continually increasing burden of disease (Muthuri- Kirigia and Barry, 2008; Oleribe et al., 2019). The entire African continent spends less than 1 percent on health, yet the continent bears 25 percent of the disease burden globally (WHO, 2015). For most of the population, their only access to healthcare is through the provision made by these underfunded public health facilities. The Abuja declaration made in 2001 saw countries in the WHO Africa region pledge to allocate 15 percent of their GDP annually on improving healthcare within their countries. Yet 19 countries in the region had reduced their healthcare spending by 2016, and only two countries, South Africa, and Rwanda, had met the 15 percent annual healthcare spending target (WHO, 2015). This is reflected in the limited number of healthcare workers, medical facilities, and drugs in many countries in the region. Death associated with pregnancy remains high, and although life expectancy has been increasing steadily, healthy life expectancy is very low compared to other parts of the world (Salomon et al., 2012; UNICEF, 2017). The prevalence of HIV and malaria further aggravates these conditions (Bryan et al., 2010; WHO, 2015).

Being severely ill represents a significant loss to individuals as they may be unable to work or provide for their dependents. Countries with a high burden of disease may see this reflected in their output at the aggregate level (WHO, 2015). The stifling of productivity resulting from this high burden of disease ultimately affects economic development as aggregate output is depressed. The cross-country variations in economic growth have been attributed to variables such as education, initial level of income and trade openness, among others (Mankiw et al., 1992). The literature on the vital role that health plays in the process of economic development as discussed in detail in chapter 2, although section 2.5 shows that only a few studies have focused on countries in Sub Saharan Africa (Bloom and Canning, 2000; Arora, 2001; Frimpong and Adu, 2014).

This chapter has three main objectives. First, to reassess the nature of the relationship between health, proxied with life expectancy, and economic development for a comprehensive panel of countries in Sub Saharan Africa. Second, previous studies have used measures like HIV, malaria, or the prevailing rates of various diseases to represent poor health in Sub Saharan Africa; this has a drawback as it omits the impact of other diseases. This limitation is addressed in this chapter by using an improved measure that takes the overall burden of disease into account, a measure obtained by merging 359 diseases and injuries, the Disability Adjusted Life Years (DALYs). This proxy quantifies ailment and incapacity within a given country by assessing the gap between a population's current health and projected ideal health attainment. In addition to this, I determine how the prevalence rates of HIV, malaria, and respiratory infections, which are the prominent sources of poor health in Sub Saharan Africa, affect economic growth. Thirdly, I interact health and education, and consider the combined influence of these human capital variables and corruption on economic growth. This reflects the insights from studies covered in sections 2.3 and 2.5, that note how improved health human capital boosts investments in education human capital, but that education also has benefits for health, mainly through its impact on growth. The preliminary result from this empirical analysis indicates that health, as expressed through life expectancy, has positively and significantly influenced economic development. The results also show that the impact of improvements in life expectancy to growth is comparatively more significant, in relation to the influence of the overall burden of disease (DALYs). This finding highlights the significance of improving population health and supports the notion that population health is just as important as education when it comes to economic development. The significant influence of the interaction between health and education suggests that including both variables in an analysis of this type is essential as it addresses omitted variable issues. The negative and significant impact of population growth and corruption on income is also seen. As the aim of this thesis is to improve our understanding of the nexus between population health and economic growth, for countries in Sub Saharan Africa, it is vital first to ascertain the impact that population health as expressed through life expectancy and the overall burden of diseases as expressed through DALYs, have on economic development, before examining specific channels through which this influence occurs. The first part, identifying the role of health and the burden of diseases, has been fulfilled in this chapter. The chapters that follow look at the next steps and identify two causal channels through which morbidity and mortality influence economic growth. Chapters four and five consider these aspects.

The rest of the chapter is organised as follows. Section 3.2 provides a brief literature review on the relationship between health and economic growth. This section focuses on analyses conducted in African countries and the current difficulties on the health to economic development nexus for the region. Section 3.3 describes the variables, the datasets, and the econometric techniques used in the analysis. Section 3.4 shows the findings from this study and discussion. Section 3.5 concludes this chapter with policy recommendations and further research avenues.

3.2 Literature Review

For Sub Saharan Africa, there has been limited attempt to measure the impact population health has on economic development, as most of the cross-country analysis on this relationship focuses mainly on the impact education has on growth (Hakeem, 2010; Zelleke et al., 2013; Glewwe et al., 2014). A few studies have included the role of health in their analysis. Sarpong et al. (2018) use health expenditure as the measure of population health for 35 countries in Sub Saharan Africa from 1997-2016 and find that health human capital (health expenditure) is only productive when combined with the requisite level of institutional quality. Similarly, Gebrehiwot's (2014) study analyse the long and short-run effects of health on growth by using health expenditure as a measure of health for Ethiopia. Using Autoregressive Distributed Lag (ARDL) as the estimation technique, they find that health expenditure positively influenced economic growth in Ethiopia from 1974 to 2011. Piabuo and Tieguhong (2017) employ data from 1995 to 2015 and conduct a comparative study on CEMAC countries[6] in Sub Saharan Africa and 5 other African countries[7] that had accomplished the recommendations set out in the Abuja Health Declaration. Results from their dynamic least square estimates stipulate that an increase of 1 percent in health expenditure increases GDP per capita by 0.30 and 0.38 percent. Colantonio et al. (2010) uses health expenditure and life expectancy at birth as measures of overall health for 15 African countries and reach similar conclusions.

Lawanson (2015) uses life expectancy at birth, mortality among infants and those under 5 as measures for longevity, data for 16 West African countries from 1980 to 2015 and the Generalised Method of Moments (GMM) as the estimation method. Gyimah-Brempong and Wilson (2004) use data on health expenditure, the inverse of child mortality, and life expectancy for 21countries in Sub Saharan Africa, whilst Frimpong and Adu (2014) use data for 30 countries from 1970 to 2010, life expectancy for population health and ARDL as the estimation method. Eggoh et al. (2015) and Ogundari and Awokuse (2018) all use life expectancy at birth to represent population health in their studies on Sub Saharan Africa. Conclusions from these studies echo those conducted in other regions globally, finding that population health positively impacts economic development for countries in Sub Saharan Africa. These studies improve our understanding of this nexus in Sub Saharan Africa; however, several limitations prevent findings from these studies being representative of the region. Firstly, most of these analyses employ health expenditure as the proxy for health. However, health care expenditure does not automatically translate into stocks of health human capital and therefore does not accurately represent population health.

[6] Equatorial Guinea, Cameroon, Democratic republic of Congo, Gabon, Chad, Central African Republic

[7] Botswana, Rwanda, Zambia, Madagascar, Togo.

Secondly, studies for the region that use life expectancy include a limited number of countries in their analysis. Sarpong et al. (2020) use the most extensive dataset for 35 out of the 48 countries in the region, yet the period they consider is short (1997 to 2016), and they use health expenditure as the measure of health.

To the author's knowledge, the closest study to this chapter in terms of methodology and sample composition is the study by Ogundari and Awokuse (2018). However, this study was limited to 35 countries in Sub Saharan Africa from 1980 to 2010 and uses only life expectancy at birth as the measure of population health. The analysis in this chapter adds to the literature in several ways. Firstly, in contrast to previous studies, this study uses the largest dataset and the most extended period for 41 countries in Sub Saharan Africa, from 1962 to 2019, using life expectancy as the measure for health. Secondly, other studies consider how the high burden of disease influences economic growth in the region by using disaggregated measures like HIV or malaria to represent health (Manuelli, 2011; Waziri et al., 2016). In addition to using life expectancy, HIV, malaria, and respiratory infections, this chapter also uses an enhanced measure for the burden of disease and disability within a population, the Disability Adjusted Life Years (DALY). Audibert et al. (2011) first used this measure to analyse the global disease burden for 159 countries. Other researchers have followed, using DALYs to examine the economic burden of diseases for other countries (Lee et al., 2013; Chaker et al. 2015; Nurchis et al. 2020). Nonetheless, this measure has not been used to analyse the health growth nexus for countries in Sub Saharan Africa. Thirdly, this study includes a measure for democracy that unveils additional growth effects. Finally, I interact health and education to see how the two components of human capital influences development for Sub Saharan African countries. The next section sets out the data and methods used to achieve the chapter's aims.

3.3 Empirical Methodology

Section 3.3 outlines the econometric methodology used to test the empirical association between population health and economic development across Sub Saharan African countries. Previous studies using cross country data have presented varying effects on the health growth nexus. This study considers how health might impede economic growth by drawing upon methodologies used in the existing literature. This chapter reconciles estimates in previous studies to clarify the effect that the improvements in health and burden of disease have on economic development in Sub Saharan Africa. This is achieved by using a large sample of countries in Sub Saharan Africa, with recent data, life expectancy at birth as the measure for population health and the DALYs as the proxy of the overall disease burden. The strengths and limitations of the estimates given in previous studies are considered in relation to the present study. This analysis starts by using pooled Ordinary Least Squares OLS and fixed effects. This is followed by using G.M.M., a more robust empirical estimator that resolves correlation issues seen in OLS estimates. I use Dynamic Ordinary Least Squares (DOLS) for robustness checks, a methodology used by most studies that focus on Sub Saharan African countries.

Two main theoretical approaches have been used in the macroeconomic literature that tries to address the health growth relationship. The first is based on the studies by Lucas (1988) and Mankiw et al. (1992). Studies that follow this approach, such as Acemoglu and Johnson (2007), indicate that the growth rate of GDP should correlate with the rate at which health is improved as health is regarded as a regular factor of production. The second is inspired by studies conducted by Nelson and Phelps (1966). Studies that follow this approach state that GDP growth should correlate with the initial level of health, suggesting that technological innovation which stimulates economic growth is facilitated only if the stock of health in a given country is high enough (Lorentzen et al., 2008). Aghion et al. (2010), Bloom et al. (2014) and Hansen and Lonstrup (2015), among others, embed the two approaches. Their combined framework implies that growth in GDP should depend on initial levels of GDP per capita and improvements in health. I follow this approach by analysing how improvement in health influences the rate of growth in GDP per capita.

3.3.1 The econometric model

This chapter examines the influence of population health on economic development for countries in Sub Saharan Africa. The model underlying the empirical study builds on Barro-type growth specifications, an approach used by much of the empirical growth literature (see technical details in appendix). In this study, population health represented by life expectancy and DALYs are the key variables of interest. To investigate this relationship, several panel data econometric techniques are used to estimate variants of the following equation:

$$Y_{i,t} = \beta_1 lifeexp_{i,t} + \beta_2 laggdppc_{i,t} + \beta_3 edu_{i,t} + \beta_4 Z_{i,t} + \eta_s + c_i + \varepsilon_{i,t} \quad (3.1)$$

Where i=1,2,……, N, and t=1,2,….,T. Y_{it} is the growth rate of GDP per capita, $lifeexp_{it}$ is life expectancy at birth, $Laggdppc_{it}$ is the lag of GDP per capita, edu_{it} is primary school enrolment, Z_{it} represents other control variables like trade, FDI and population. η_s is the time-specific effect, c_i is the country-specific effect, and ε_{it} is the error term. The outcome variable that this study focuses on is the influence that health, as expressed through life expectancy at birth and DALYs, has on the growth rate of GDP per capita. The level of economic growth is denoted by GDP per capita growth as commonly used in the literature. The explanatory variables are the growth rate of life expectancy and DALY. As mentioned in section 3.3 above, different estimators are applied to the dataset to deal with different econometric issues and ensure the robustness of the results produced. I start with fixed effects followed by pooled OLS. I then use one and two-step system GMM with orthogonal deviations, which corrects for endogeneity and eliminates dynamic panel bias. The long-time span used also ensures that any bias, if present, will be marginal (Judson and Owen, 1999).

Interaction

Equation 3.2 below shows the model with interaction terms. Here, the log of life expectancy at birth is interacted with primary school enrolment, which is shown in the equation as $lifeexpEdu_{i,t}$

$$Y_{i,t} = \beta_1 lifeexp_{i,t} + \beta_2 laggdppc_{i,t} + \beta_3 edu_{i,t} + \beta_4 lifeexpEdu_{i,t} + \beta_5 Z_{i,t} + \eta_s + c_i + \varepsilon_{i,t} \quad (3.2)$$

$Y_{i,t}$ is the growth rate of GDP per capita, $lifeexp_{it}$ is life expectancy at birth, and $Laggdppc_{it}$ is the lag of GDP per capita, edu_{it} is primary school enrolment, Z_{it} represents the same control variables used in model 3.1 above.

3.3.2 Data and Variables

This section outlines the variables selected for analysis in this chapter, their sources, studies that have included them in their research and the expected impact for each variable. The present study begins by examining an unbalanced panel of 41 out of the 48 countries in Sub Saharan Africa[8] from 1962 to 2019. The selection of countries is solely based on the availability of data. Although some countries in the region have been excluded from this analysis, the results are still robust. This is because the 7 countries excluded from this study are mostly smaller countries and economies in the region, which accounted for $99,871,006, making 5.4 percent of the aggregate economic output in Sub Saharan Africa in 2019. The remaining 41 countries used accounted for $1,752,168,996.13, which is 94.6 percent of the total economic output in the region. The countries excluded also has a population total of 194,050,745, which makes up 17.1 percent of the entire population in the region. Table 3.1 shows the data used and their sources.

[8] Angola, Benin, Botswana, Burkina Faso, Burundi, Carbo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo Dem. Rep, Congo Republic, Cote d'Ivoire, Eswatini, Gabon, Gambia The, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

Table 3.1
Variable description and source of data.

Variable	Variable Description	Data Source
GDP. Growth	Annual percentage growth rate.	World Bank national accounts
Life Expectancy	Life expectancy at birth total (years).	World Bank national accounts
Population Growth	The annual population growth rate includes all residents regardless of legal status or citizenship.	World Bank National Accounts
Education	Primary school enrolment (gross) is the ratio of total enrolment irrespective of age to the age group of the population that officially corresponds to the level of education shown.	UNDP Human Development Reports
Foreign Direct Investment (FDI)	Net inflows (% of GDP) of investments to purchase a management interest in a firm located in a country/economy other than the investor.	IMF, International Financial Statistics, and Data Files.
Democracy index: Corruption	This measure taps into several notable forms of corruption, "petty and grand, bribery and theft", and briberies intended at persuading law-making and its application.	V-Dem (10)
Trade	Trade (% of GDP). Trade is the sum of imports and exports of goods and services measured as a share of GDP.	World Bank National Accounts
DALYs	Measures disease burden by combining years of life lost due to premature mortality and years lived with disability due to the prevalence of diseases.	Global Burden of Disease Database
HIV/AIDS	Prevalence rates of human immunodeficiency virus.	Global Burden of Disease Database
Malaria	Prevalence rates of remittent and intermittent fever caused by a parasite that invades the red blood cells.	Global Burden of Disease Database
Respiratory Infections	Prevalence rates of infectious diseases that affect the upper and lower respiratory tract.	Global Burden of Disease Database

3.3.3 Life Expectancy

Life expectancy at birth is the traditional measure used for measuring the health of a population. It is broader than the limited measure of child mortality centred exclusively on the death of young children. Life expectancy considers mortality over an individual's life, showing the typical age of mortality with a given population. Life expectancy at birth represents health in this study. Although life expectancy is the most popular indicator used to describe the health of a population, it has several limitations (Bloom et al., 2004; Cervellati and Sunde, 2011; Ngangue and Manfred, 2015). For example, in Sub Saharan Africa, people might be living longer, but the additional years are spent in illness (Salomon et al., 2012). An alternative proxy is "Health Adjusted Life Expectancy (HALE)". This measure estimates the total number of years a child is expected to live a healthy life from diseases and disability. Adult mortality rate (ASR) and under 5 death rates (U5MR) are alternative population health indicators; however, data on these measures are limited for Sub Saharan Africa. Life expectancy, although not perfect, has a strong relationship with the other measures of population health and is, therefore, the measure of health used in this chapter as a starting point (Roser et al., 2013). Data on HALE is only available from 1990 – 2019 and is used in subsequent chapters in addition to life expectancy, which assesses the effect of overall health on channels like productivity in chapter 4 and FDI in chapter 5 through which it affects economic growth.

3.3.4 Disability-adjusted life-years (DALYs)

Disability-Adjusted Life-Years (DALYs) is a multifactorial proxy of the burden of disease; it captures prevalence, premature mortality, and severity of ill health. This measure uses the conceptualisation of health outcomes which does not lead to death, details which are obtained from the "International Classification of Impairments, Disability, and Handicaps (CIPH)" and focuses on how a disease affects an individual's ability to perform their daily tasks (Gold et al., 2002). The data for DALYs have been obtained by merging 345 illnesses and injuries for 195 nations and is available from 1990 to 2019 for all the countries in Sub Saharan Africa (James et al., 2018). This indicator was first proposed by WHO and the World Bank in 1993. To the best of my knowledge, the first macroeconomic study to use this measure was Audibert et al. (2011) for 159 countries from 1999-2004. Organisations and governments are increasingly using the DALYs measure to determine funding for infectious diseases like malaria in Africa (Longfield et al., 2013; Gunda et al., 2016). To accurately inform policies and get a clearer picture of the state of health in a region, it is vital to understand the overall trends in the health of a given population and changes in the leading causes of disease burden over time, not just the gains in longevity. DALYs is the proxy used to represent disease burden in this chapter.

3.3.5 Control Variables

It is well documented in the literature that Trade and FDI are variables that have a positive effect on economic growth as they encourage efficient resource allocation, and greater utilisation of available capacity due to competition from foreign markets (Ehrlich and Lui, 1991; Keho, 2017). Given this, FDI and trade are included as control variables. Following Gyimah-Brempong and Wilson (2004), Bloom et al. (2014) and Ogundari and

Awokuse (2018), population growth is included as a control variable as it factors in the input of the working population.

It also shows the impact of capital as the available capital becomes smaller with increases in population growth and expands as population growth falls (Weil, 2015). The lag of GDP per capita is included to examine the "convergence hypothesis", which suggests that GDP per capita in poorer countries tends to grow faster than richer countries. The other component of human capital, education, is proxied with primary school enrolment in this chapter. Primary school enrolment has been used in studies by some researchers and found to influence growth positively (Glewwe et al., 2014; Akinola and Bokana, 2017). Primary school enrolment is included to evaluate how it influences growth separately and jointly with life expectancy. Following Bloom et al. (2004), this study includes an indicator for democracy that captures the influence that political institutions have on economic development by measuring the presence of corruption. The following section presents descriptive statistics, correlation and deliberates on the preliminary findings from the fixed effects and OLS estimates.

3.4 The Effect of Life Expectancy on Economic Growth

3.4.1 Descriptive Statistics and Correlation

The descriptive statistics in table 3.2 indicate that from 1962 to 2019, the mean growth rate of GDP per capita in Sub Saharan African countries has been 0.002 percent. GDP growth in most African countries is volatile, rising sharply and falling to 1 percent or lower within a few years. This is partly due to oil, and natural resource found in the region that attracts investment which raises the growth rates, but this falls sharply due to political, food, high disease load or inflationary crises in the region (WHO, 2020). The mean for life expectancy at birth in Sub Saharan Africa is 52 years. This mean is the lowest in the world. The correlation matrix provides evidence on the association between the variables under analysis, presented in table 3.3. The results show that the correlation between the majority of the explanatory variables is below 0.50, with the relationship between life expectancy and primary school enrolment being the highest at 0.571. This suggests that multicollinearity should not be an issue in the predicted model. There is a positive and significant correlation between GDP per capita growth and life expectancy (0.132). Also notable is the strong and significant positive relationships between primary school enrolment and GDP growth (0.101), trade and GDP growth (0.121) and FDI and GDP growth (0.116). The negative and significant correlation between population growth, corruption and GDP growth can also be seen. The highest variance inflation factor (VIF) for one variable is 1.85, with a mean for all variables of 1.60, indicating no evidence of multicollinearity. See table 3.18 in the appendix for the full VIF results.

3.4.2 OLS Results

The analysis starts by using pooled OLS and fixed effects as benchmark methods of estimation for equation 3.3. This approach shows the sensitivity of coefficients as the lag of GDP per capita, and the control variables are added to the model before proceeding to use system GMM. Table 3.4a, and 3.4b shows the pooled OLS and fixed effect estimates of the influence of life expectancy at birth on economic development when GDP per capita growth is used as the dependent variable.

Life expectancy shows a positive and significant impact on economic development across all four models in table 3.4. Specifically, the results suggest that a one percent change in life expectancy will result in a 0.42 percent rise in GDP per capita, as shown in the results from the fixed-effects model and a 0.27 percent increase in the OLS results. This is consistent with development principles proposed by Romer (1986), Lucas (1988), and Mankiw et al. (1992), which also confirms the empirical results of the 12 studies on health and growth assessed in Bloom et al. (2004). Although the coefficients in this study are larger than those found in Bloom et al.'s (2004) study, and other studies conducted in developed countries, they are in line with coefficients found in studies that focus on Sub Saharan Africa (Frimpong and Adu, 2014; Ogundari and Awokuse, 2018). Education shows a significantly positive effect on economic growth, echoing results from previous studies. Bloom et al. (2014) show that primary school enrolment has a positive and significant impact on economic growth. Cutler and Lleras-Muney (2006) and Ogundari and Awokuse (2018) also find similar positive and significant effects when using primary school enrolment in their studies.

For the other determinants of economic growth, the signs and significance are similar for both the fixed effects and OLS results. Trade shows positive and significant effects on growth. Studies by Hossain and Mitra (2013), Adams and Opoku (2015), and Ogundari and Awokuse (2018) for Sub Saharan African countries found similar results, in line with the idea that programmes that liberate the market and boost global trade also enhance economic development. The coefficient on the lag of GDP per capita shows a negative and significant impact in all models in tables 3.4. Findings from this study support the convergence hypothesis, which suggests that poorer economies grow at a faster rate in comparison to richer countries. Population growth also shows a negative and significant impact. Increasing population supports the dilution of capital hypothesis (Weil, 2015), which indicates a reduction in the amount of capital available to each worker when the size of a population increases. FDI is critical to the economic growth of developing nations, and the positive and significant influence it has on countries in Sub Saharan Africa can be seen in table 3.4, echoing findings of Alsan et al. (2006) and Asamoah-Adu et al. (2019).

Table 3.2
Descriptive Statistics

Variable	Obs.	Mean	Std.Dev.	Min	Max
GDP per Capita Growth	2238	0.002	0.165	-3.642	1.305
Education	1762	4.352	0.480	2.063	5.052
Lag GDP pc	2254	6.969	0.936	5.103	9.882
Trade	2097	4.028	0.519	1.844	5.741
FDI	1951	3.432	0.136	2.414	4.883
Population	2485	1.538	1.493	-3.211	5.303
Corruption	2579	0.589	0.239	0.049	0.967
Life expectancy	2560	3.931	0.170	3.265	4.311
DALY	1290	11.138	0.405	10.161	13.525
HIV	1290	10.043	0.260	9.289	10.656
Malaria	1290	10.748	0.499	8.761	11.330
Respiratory Infections	1290	10.372	0.209	9.680	10.845

Notes: Yearly data from 1962 – 2019. Growth: growth rate of GDP per capita; Life Expectancy: life expectancy at birth; Education: primary school enrolment; GDP: GDP per capita (constant 2010 US$); Trade: Trade (% of GDP); FDI: foreign direct investment, net inflows (% of GDP); Population Growth: Annual population growth rate; DALY: disability adjusted life years; HIV, Malaria and Respiratory Infections: Prevalence rates.

Table 3.3
Correlation matrix of the association between life expectancy and the control variables (1962-2019)

	1	2	3	4	5	6	7	8
(1) GDP per capita growth	1							
(2) Life Expectancy	0.132*	1						
	(0.00)							
(3) Primary enrolment	0.101*	0.571*	1					
	(0.00)	(0.00)						
(4) Lag GDP per capita	0.092*	0.479*	0.387*	1				
	(0.00)	(0.00)	(0.00)					
(5) Trade	0.121*	0.403*	0.331*	0.483*	1			
	(0.00)	(0.00)	(0.00)	(0.00)				
(6) FDI	0.116*	0.236*	0.246*	0.126*	0.349*	1		
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)			
(7) Population	-0.014	-0.073*	-0.037	-0.296*	-0.434*	-0.107*	1	
	(0.517)	(0.00)	(0.122)	(0.00)	(0.00)	(0.00)		
(8) Corruption	0.003	0.014	0.060*	-0.138*	-0.148*	-0.007	0.327*	1
	(0.882)	(0.467)	(0.011)	(0.00)	(0.00)	(0.754)	(0.00)	

Notes: correlations for the full sample, based on N= 41 countries and T = 57 years. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 3.4a
GDP Per Capita Growth and Life Expectancy with control variables 1962-2019
(Fixed Effect Estimates)

VARIABLES	(1)	(2)	(3)	(4)
Life expectancy	0.302***	0.294***	0.330***	0.422***
	(0.108)	(0.108)	(0.107)	(0.109)
Primary enrolment		0.013***	0.019***	0.023***
		(0.004)	(0.004)	(0.004)
Lag GDP per capita			-0.026***	-0.045***
			(0.005)	(0.005)
Trade				0.026***
				(0.005)
FDI				0.047***
				(0.013)
Population				-1.066***
				(0.210)
Corruption				-0.052***
				(0.015)
Constant	0.009***	-0.0502***	0.111***	0.016
	(0.001)	(0.018)	(0.037)	(0.053)
Observations	1,368	1,368	1,368	1,368
R-squared	0.006	0.014	0.031	0.097
N	41	41	41	41
Time (1962-2019) 57yrs.				

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 3.4b
GDP Per Capita Growth and Life Expectancy with control variables 1962-2019
(Pooled OLS. Estimates)

VARIABLES	(1)	(2)	(3)	(4)
Life expectancy	0.284*** (0.106)	0.261** (0.106)	0.263** (0.106)	0.276*** (0.107)
Primary enrolment		0.091*** (0.024)	0.093*** (0.024)	0.095*** (0.023)
Lag GDP per capita			0.001 (0.002)	-0.007*** (0.002)
Trade				0.017*** (0.003)
FDI				0.054*** (0.012)
Population				-0.594*** (0.183)
Corruption				-0.015* (0.008)
Constant	0.010*** (0.002)	0.009*** (0.002)	-0.003 (0.015)	-0.176*** (0.042)
Observations	1,368	1,368	1,368	1,368
N	41	41	41	41
Time (1962-2019) 57yrs.				

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 3.5a
Interaction
GDP Per Capita Growth and Life Expectancy with control variables and interaction between health and education 1962-2019
(Fixed Effect Estimates)

Variables	(1)	(2)	(3)	(4)
Life expectancy	0.302*** (0.108)	0.278*** (0.108)	0.308*** (0.108)	0.383*** (0.108)
Primary enrolment		0.102*** (0.024)	0.095*** (0.024)	0.090*** (0.023)
Health * Education				0.005*** (0.001)
Lag GDP per capita			-0.018*** (0.005)	-0.045*** (0.005)
Trade				0.026*** (0.005)
FDI				0.045*** (0.013)
Population				-1.149*** (0.212)
Corruption				-0.049*** (0.015)
Constant	0.009*** (0.001)	0.008*** (0.001)	0.140*** (0.036)	0.034 (0.054)
Observations	1,368	1,368	1,368	1,368
R-squared	0.006	0.019	0.028	0.109
N	41	41	41	41
Time (1962-2019) 57yrs.				

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 3.5b
Interaction
GDP Per Capita Growth and Life Expectancy with control variables and interaction between health and education 1962-2019
(Pooled OLS. Estimates)

Variables	(1)	(2)	(3)	(4)
Life expectancy	0.284***	0.261**	0.263**	0.290***
	(0.106)	(0.106)	(0.106)	(0.106)
Primary enrolment		0.091***	0.093***	0.100***
		(0.024)	(0.024)	(0.023)
Health * Education			0.001	0.011***
			(0.002)	(0.002)
Lag GDP per capita				0.016***
				(0.003)
Trade				0.043***
				(0.012)
FDI				-0.699***
				(0.184)
Population				-0.023***
				(0.008)
Corruption				0.003***
				(0.000)
Constant	0.010***	0.009***	-0.003	-0.151***
	(0.002)	(0.002)	(0.015)	(0.042)
Observations	1,368	1,368	1,368	1,368
N	41	41	41	41
Time (1962-2019) 57yrs.				

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 3.5a and 3.5b above shows the interaction between life expectancy and education and the effect this interaction has on economic development. Coefficients for the other variables remain the same, and the interaction shows positive effects on the rate at which GDP per capita increases. This echoes the findings of Cutler and Lleras-Muney (2006), who find that better health and educational attainment positively affect labour market participation within a population. Eggoh et al. (2015), using a sample of 49 African countries, also find similar positive effects of the interaction between population health, education, and economic growth. As discussed in 3.3.1 above, GMM is the next method used to address endogeneity and reverse causality issues that may be present in the fixed effects and pooled OLS estimates.

3.4.3 Panel GMM Results.

I estimate equation 3.6 using system GMM, treating all the variables as endogenous. Given the p-values of AR (2) statistics, there is no evidence of second-order serial correlation in the model's goodness of fit[9]. The p-values from the Hansen test indicates that the instruments used are valid.

Table 3.6 shows that life expectancy exerts a positive and statistically significant influence on the growth rate of GDP per capita both in one step and two-step system GMM estimates. These results echo findings from the fixed effects results in tables 3.4 and 3.5, although the coefficient here is smaller. A 1 percent change in GDP per capita growth is linked to a 0.180 percent and 0.181percent increase in life expectancy in the short run at the 5 percent significance level, all things being equal. Here, too, primary school enrolment significantly influences economic development, while population growth and corruption remain negative and significant. FDI and trade's positive and significant effects found in the fixed effects estimations are also seen here. These results echo findings of studies in Sub Saharan Africa that use the GMM approach (Ogundari and Awokuse, 2018).

With the role of health as expressed through life expectancy established, 3.5 below examines the influence of the high burden of diseases (DALYs) on economic growth, and 3.6 compares the effect of life expectancy, DALYs and leading causes of poor health (HIV, malaria, respiratory infections) on growth.

[9] The first lag of each variable is used to reduce the number of instruments while these are collapsed as suggested by Roodman (2009).

Table 3.6
GMM Estimations
The Effect of Life Expectancy on GDP. Growth 1962-2019

	(1) 1 Step System GMM.	(2) 2 Step System GMM.
Dependent Variable: GDP Per Capita Growth		
Lag GDP per capita growth	0.183*** (0.042)	0.183*** (0.042)
Life expectancy	0.180** (0.070)	0.181** (0.070)
Primary enrolment	0.076** (0.026)	0.076** (0.026)
FDI	0.049*** (0.014)	0.049*** (0.013)
Trade	0.007*** (0.003)	0.007*** (0.003)
Population	-0.370** (0.221)	-0.372** (0.208)
Corruption	-0.011* (0.006)	-0.011** (0.005)
Constant	-0.176*** (0.050)	-0.177*** (0.049)
Observations	1,364	1,364
N	41	41
Instruments	10	10
AR (2)	0.967	0.967
Hansen Statistic Time (1962-2019) 57yrs.	0.858	0.858

Notes: *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.
Standard errors in parentheses, p-values reported for AR (2) and Hansen statistic. Yearly data used (1962-2019).

3.5 The Effect of Disability Adjusted Life Years (DALYs) on Economic Growth

Table 3.7 shows the association between GDP per capita growth, DALYs and the control variables. As expected, there is a negative and significant relationship between growth and the high burden of disease proxied with DALYs. The fixed effects estimate in table 3.8 also shows this negative association. The positive effect of education, trade and FDI, and the negative effect of population and the lag of GDP on growth does not change from the previous models above. However, the democracy variable, corruption, loses its significant influence. The GMM findings of the impact of DALYs on economic growth, as shown in tables 3.9 and 3.10, also confirm the findings from the fixed effects estimates. Specifically, a percentage increase in DALYs leads to a 0.155 percent fall in GDP per capita growth.

This negative effect shows the significant influence various diseases has on economic growth for countries in Sub Saharan Africa. These results align with previous work that uses the DALYs measure in an analysis on the "global burden of disease and economic growth" for 159 countries (Audibert et al., 2011). They are also in conformity with research that stresses the importance of identification strategy when assessing the influence of population health on economic development (Bloom et al., 2004).

Table 3.7
Correlation matrix of the association between Growth, DALYs and the control variables (1990-2019)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) GDP per capita growth	1.000							
(2) DALY	-0.390* (0.000)	1.000						
(3) Primary enrolment	0.160* (0.000)	-0.051 (0.108)	1.000					
(4) Lag GDP pc	0.085* (0.003)	0.066* (0.021)	0.325* (0.000)	1.000				
(5) Trade	0.072* (0.013)	0.082* (0.005)	0.384* (0.000)	0.513* (0.000)	1.000			
(6) FDI	0.086* (0.002)	-0.031 (0.285)	0.179* (0.000)	0.081* (0.004)	0.375* (0.000)	1.000		
(7) Population	0.038 (0.175)	-0.168* (0.000)	-0.211* (0.000)	-0.305* (0.000)	-0.257* (0.000)	0.009 (0.740)	1.000	
(8) Corruption	-0.149* (0.000)	-0.091* (0.001)	-0.127* (0.000)	-0.388* (0.000)	-0.253* (0.000)	-0.035 (0.211)	0.316* (0.000)	1.000

Notes: correlations from 1990- 2019 sample, based on N= 41 countries and T = 29 years. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 3.8
GDP Per Capita Growth and DALY with control variables 1990-2019
(Fixed Effect Estimates)

VARIABLES	(1)	(2)	(3)	(4)
DALY	-0.164***	-0.162***	-0.181***	-0.200***
	(0.048)	(0.048)	(0.049)	(0.049)
Primary enrolment		0.127***	0.120***	0.120***
		(0.025)	(0.025)	(0.025)
Lag GDP pc			-0.011	-0.027***
			(0.007)	(0.007)
Trade				0.019***
				(0.006)
FDI				0.037***
				(0.012)
Population				-0.734***
				(0.233)
Corruption				-0.029
				(0.019)
Constant	0.0116***	0.009***	0.087*	0.028
	(0.001)	(0.001)	(0.052)	(0.064)
Observations	855	855	855	855
R-squared	0.014	0.043	0.045	0.090
N	41	41	41	41
Time (1990-2019) 29yrs.				

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 3.9
The effect of DALY on GDP Per Capita Growth with control variables 1990-2019
(GMM estimates)

VARIABLES	(1) 1 Step System GMM.	(2) 2 Step System GMM.
Lag GDP per capita growth	0.154***	0.161***
	(0.042)	(0.051)
DALYs	-0.155***	-0.155***
	(0.050)	(0.052)
Primary enrolment	0.108***	0.106***
	(0.028)	(0.029)
FDI	0.037***	0.029**
	(0.013)	(0.013)
Trade	0.000	-0.000
	(0.004)	(0.005)
Population	-0.451*	-0.417*
	(0.227)	(0.225)
Corruption	-0.016**	-0.020***
	(0.007)	(0.007)
Constant	-0.103*	-0.0708
	(0.053)	(0.054)
Observations	855	855
N	41	41
Groups/Instruments	10	10
AR (2)	0.661	0.665
Hansen Statistic	0.257	0.257
Time (1990-2019) 29yrs.		

Notes: *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.
Standard errors in parentheses, p-values reported for AR (2) and Hansen statistic. Yearly data used (1990-2019).

3.6 Comparing the Effect of Life Expectancy and the Burden of Disease (DALYs)

Table 3.10 provides fixed effect estimates of the influence poor population health has on economic development, applying commonly used measures in the literature for Sub Saharan African countries. The fixed effect estimates suggest that from 1990 to 2019, HIV has had the highest negative influence on the growth rate of GDP per capita. This is followed by respiratory infections then malaria. However, the effect of the overall burden of diseases (DALYs) on growth is slightly less than that of HIV. Specifically, a one percent increase in HIV results in a decrease of 0.48 percent in GDP growth, while a percentage increase in the overall disease burden leads to a decrease of 0.164 percent in GDP growth. Table 3.11 includes the control variables, yet the negative and significant influence of HIV, malaria, and respiratory infections and DALYs persists. The GMM results for the effects of HIV, malaria, and respiratory infections shown in table 3.12 differ from their corresponding fixed effects results. Here, HIV is the only measure of health that remains consistently negative and significant in both the 1 and 2 step GMM models. This finding reiterates the role of infectious diseases, and the detrimental effect HIV has on growth in Sub Saharan African countries, which is discussed extensively in chapter 2, section 2.5. The results in this analysis echo findings from studies that use HIV as proxies for the burden of disease (Young 2005; Waziri et al., 2016; Azomahou et al., 2016). Tables 3.13 and 3.14 presents fixed effects and GMM estimates comparing the influence of enhanced life expectancy to the impact of DALYs on economic development for the same period, 1990-2019. The findings here are consistent with previous results, both for fixed effect estimates and GMM estimates in Tables 3.4, 3.6, 3.8 and 3.9.

Life expectancy shows positive and significant effects, while DALYs shows a negative and significant impact on economic growth. Tables 3.16 and 3.17 in the appendix present correlation coefficient results for life expectancy from 1990 – 2019.

Table 3.10
Comparing the effect of measures for the burden of disease on Growth of GDPPC
(Fixed Effect Estimates) 1990-2019

	(1)	(2)	(3)	(4)
DALYs	-0.164***			
	(0.048)			
Respiratory Infections		-0.032***		
		(0.010)		
HIV.			-0.468***	
			(0.137)	
Malaria				-0.012*
				(0.006)
Constant	0.011***	0.346***	0.0170***	0.145**
	(0.001)	(0.106)	(0.001)	(0.073)
Observations	855	855	855	855
R-squared	0.014	0.012	0.014	0.004
N	41	41	41	41
Time (1990-2019) 29yrs.				

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 3.11
Comparing the effect of leading causes of poor health with control variables on the growth rate of GDPPC
(Fixed Effect Estimates) 1990-2019

	(1)	(2)	(3)	(4)
HIV.	-0.321**			
	(0.136)			
Malaria		-0.024***		
		(0.008)		
Respiratory Infections			-0.064***	
			(0.012)	
DALYs				-0.200***
				(0.049)
Primary enrolment	0.120***	0.126***	0.130***	0.120***
	(0.025)	(0.025)	(0.025)	(0.025)
Lag GDP pc	-0.019***	-0.0349***	-0.045***	-0.027***
	(0.007)	(0.009)	(0.009)	(0.007)
Trade	0.017***	0.016**	0.012**	0.019***
	(0.006)	(0.006)	(0.006)	(0.006)
FDI	0.038***	0.039***	0.037***	0.037***
	(0.012)	(0.012)	(0.012)	(0.012)
Population	-0.623***	-0.639***	-0.816***	-0.734***
	(0.236)	(0.234)	(0.232)	(0.233)
Corruption	-0.020	-0.0197	-0.025	-0.029
	(0.019)	(0.019)	(0.018)	(0.019)
Constant	-0.023	0.353**	0.853***	0.028
	(0.063)	(0.152)	(0.188)	(0.064)
Observations	855	855	855	855
R-squared	0.078	0.081	0.100	0.090
N	41	41	41	41
Time (1990-2019) 29yrs.				

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 3.12
Comparing the effect of leading causes of poor health with control variables on growth rate of GDPPC (GMM estimates) 1990-2019

VARIABLES	(1 Step) HIV	(2 Step) HIV	(1 Step) RES	(2 Step) RES	(1 Step) MALARIA	(2 Step) MALARIA
Lag GDP per capita Growth	0.161***	0.154***	0.183***	0.180***	0.156***	0.159***
	(0.046)	(0.055)	(0.044)	(0.055)	(0.045)	(0.0530)
Burden of Disease	-0.362***	-0.402***	-0.010	-0.013	0.003	0.003
	(0.105)	(0.110)	(0.011)	(0.010)	(0.004)	(0.004)
Primary enrolment	0.103***	0.093***	0.103***	0.099***	0.098***	0.098***
	(0.029)	(0.027)	(0.028)	(0.027)	(0.027)	(0.028)
FDI	0.039***	0.028**	0.042***	0.030**	0.046***	0.038***
	(0.014)	(0.013)	(0.015)	(0.014)	(0.013)	(0.013)
Trade	0.000	-0.000	-0.000	-0.001	0.000	0.000
	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)
Population	-0.396	-0.449**	-0.360	-0.346*	-0.430*	-0.331
	(0.237)	(0.203)	(0.228)	(0.186)	(0.223)	(0.210)
Corruption	-0.016**	-0.018***	-0.010	-0.013*	-0.015**	-0.019**
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)
Constant	-0.106*	-0.059	-0.009	0.063	-0.175**	-0.143*
	(0.055)	(0.053)	(0.148)	(0.130)	(0.070)	(0.075)
Observations	855	855	855	855	855	855
N	41	41	41	41	41	41
Instruments	10	10	10	10	10	10
AR (2)	0.826	0.782	0.862	0.885	0.703	0.715
Hansen Statistic	0.217	0.289	0.211	0.211	0.219	0.219
Time (1990-2019) 29yrs.						

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 3.13
Comparing the effect of Life Expectancy and DALYs with control variables on Growth of GDPPC
(Fixed Effect and Pooled OLS. Estimates) 1990-2019

VARIABLES	(1) Life Expectancy	(2) Life Expectancy	(1) DALY	(2) DALY
Health	0.398***	0.325***	-0.200***	-0.186***
	(0.125)	(0.112)	(0.049)	(0.045)
Primary enrolment	0.118***	0.115***	0.120***	0.117***
	(0.025)	(0.025)	(0.025)	(0.025)
Lag GDP pc	-0.027***	-0.000	-0.027***	0.000
	(0.007)	(0.002)	(0.007)	(0.002)
Trade	0.020***	0.000	0.01***	0.00
	(0.006)	(0.003)	(0.006)	(0.00)
FDI	0.036***	0.044***	0.037***	0.043***
	(0.012)	(0.011)	(0.012)	(0.011)
Population	-1.040***	-0.583***	-0.734***	-0.504***
	(0.257)	(0.181)	(0.233)	(0.173)
Corruption	-0.024	-0.016**	-0.029	-0.019***
	(0.019)	(0.006)	(0.019)	(0.006)
Constant	0.034	-0.115***	0.028	-0.120***
	(0.066)	(0.038)	(0.064)	(0.038)
Observations	855	855	855	855
R-squared	0.083	0.081	0.090	0.090
N	41	41	41	41
F.E./Pooled O.L.S	FE.	OLS.	FE.	OLS.
Time (1990-2019) 29yrs.				

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Tables 3.13 and 3.14 presents the fixed effects, pooled OLS and GMM estimates comparing the influence of enhanced life expectancy to the impact of DALYs on economic development for the same period, 1990-2019. The findings are consistent with previous results, both with the fixed effect estimates and the GMM estimates in tables 3.4, 3.6, 3.8 and 3.9. They show that population health, represented by life expectancy, has a positive and statistically significant influence on economic growth. DALYs also show the opposite negative and significant influence on growth. This also supports the theory and empirical studies that find that better population health contributes to improved human capital, which eventually leads to economic growth (Bloom and Canning, 2000; Lawson, 2015).

Table 3.14
System GMM estimation of economic effects of DALYS and Life Expectancy in Sub Saharan African Countries
(GMM Estimates) 1990-2019

VARIABLES	(1 Step) LE	(2 Step) LE	(1 Step) DALYs	(2 Step) DALYs
Lag GDP per capita Growth	0.158***	0.160***	0.159***	0.160***
	(0.042)	(0.053)	(0.042)	(0.047)
Health	0.223**	0.222**	-0.155***	-0.152***
	(0.089)	(0.10)	(0.050)	(0.050)
Primary enrolment	0.108***	0.096***	0.107***	0.109***
	(0.028)	(0.026)	(0.028)	(0.028)
FDI	0.040***	0.030**	0.037***	0.032**
	(0.013)	(0.013)	(0.013)	(0.012)
Trade	-0.000	-0.002	0.000	0.000
	(0.005)	(0.005)	(0.004)	(0.004)
Population	-0.470*	-0.594**	-0.451*	-0.412*
	(0.271)	(0.271)	(0.227)	(0.219)
Corruption	-0.013*	-0.014**	-0.016**	-0.018**
	(0.006)	(0.006)	(0.007)	(0.007)
Constant	-0.108*	-0.061	-0.103*	-0.082
	(0.055)	(0.054)	(0.053)	(0.052)
Observations	855	855	855	855
N	41	41	41	41
Groups/Instruments	10	10	9	9
AR (2)	0.774	0.796	0.661	0.668
Hansen Statistic	0.202	0.202	0.255	0.255
Time (1990-2019) 29yrs.				

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

3.7 Robustness Checks

To assess the association between life expectancy and economic growth in Sub Saharan Africa over an extended period, I employ Fully Modified OLS (FMOLS), which can accommodate heterogeneity across individual panel members as discussed by Pedroni (2001). I also use the technique recommended by Stock and Watson (1993), the Dynamic Ordinary Least Square (DOLS). Monte–Carlo models suggest that panel FMOLS does not improve the biases present in OLS estimates, and as such, DOLS is a better approach than OLS and FMOLS estimators (Kao and Chiang, 2001). In other words, DOLS includes leads and lags in the differences in the regressions, thereby addressing any endogeneity that may be present in the explanatory variables (Stock and Watson, 1993; Masih and Masih, 2000).

Ketenci (2014) suggests that DOLS shows the long-term association between variables and improves serial correlation, an advantage over the GMM estimator. The model specified below is used to estimate FMOLS and DOLS.

$$Y_{i,t} = \beta_0 + \beta X'_{i,t} + \sum_{j=-n}^{m} d_{ij}\, \Delta X'_{i,t-j} + u_{i,t} \qquad (3.7)$$

Where Y is GDP per capita growth, X is a vector of explanatory variables (life expectancy, primary school enrolment, trade, FDI, population and corruption), β is the co-integrating vector showing the influence of a change in X and Y over the long term, m signifies the length of lags used; and n denotes lead length.

The DOLS results (table 3.15, 3.16) confirm the fixed effects, pooled OLS and GMM results for the effect of improvements in health, that is, life expectancy and the effect of the high disease burden on economic development. Life expectancy, trade and FDI all show positive and significant associations with economic growth in GDP per capita, whilst population and the lag of GDP shows a negative and significant association with economic growth. DALYs also indicates a negative and significant influence on economic growth.

Table 3.15
GDP Per Capita Growth and Life Expectancy with control variables 1962-2019
(Dynamic and Fully Modified Ordinary Least Square Estimates)

	(1)	(2)
VARIABLES	DOLS	FMOLS
Life expectancy	0.912**	0.351**
	(0.296)	(0.119)
Primary enrolment	0.011	0.017***
	(0.011)	(0.005)
Lag GDP pc	-0.053***	-0.031***
	(0.011)	(0.006)
Trade	0.035**	0.019***
	(0.011)	(0.005)
FDI	0.100***	0.052***
	(0.033)	(0.014)
Population	-1.578**	-0.679**
	(0.560)	(0.235)
Corruption	-0.010	-0.047**
	(0.032)	(0.016)
R-squared	0.689	0.173
Adjusted R-squared	0.160	0.142
Long-run variance	0.000	0.002
Observations	1,058	1316
N	41	41
Time (1962-2019) 57yrs.		

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 3.16
GDP Per Capita Growth, Life Expectancy with and DALYs control variables 1990-2019
(Dynamic Ordinary Least Squares)

VARIABLES	(1) DOLS Life Expectancy	(2) DOLS DALYS
Population Health	0.362*	-0.039***
	(0.150)	(0.008)
Primary enrolment	0.110***	0.120***
	(0.029)	(0.028)
Lag GDP pc	-0.034***	-0.031***
	(0.009)	(0.006)
Trade	0.020**	0.012
	(0.007)	(0.007)
FDI	0.035*	0.034
	(0.014)	(0.013)
Population	-1.105***	-1.151***
	(0.303)	(0.290)
Corruption	-0.025	-0.028
	(0.022)	(0.021)
R-squared	0.208	0.228
Adjusted R-squared	0.160	0.182
Long-run variance	0.001	0.001
Observations	823	823
N	41	41
Time (1990-2019) 29yrs.		

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

3.8 Conclusion

A majority of the existing studies use mortality measures, like life expectancy, as measures of population health and the level of individual diseases in analysis of this type (see Aghion et al., 2010; Cervellati and Sunde, 2011,2015; Bloom et al., 2014; Bloom et al., 2018, to name a few). This may give a clearer indication of the effect health has on growth in developed countries where there is a low burden of disease. Using life expectancy in developing regions where the burden of disease is high to determine the health effect on economic growth does not give an accurate impact and provides a biased view. This is because the gap between healthy life expectancy and actual life expectancy in Sub Saharan Africa is much greater as individuals in the region spend a smaller proportion of their lives in good health in contrast to other countries (Salomon et al., 2012).

An accurate indicator of the burden of disease must account for non-fatal outcomes of diseases, and disability, and how these impact the productivity of individuals. This is addressed by the disability-adjusted life year (DALYs) measure initiated by the World Bank and WHO. This chapter shows that the overall burden of disease in Sub Saharan Africa is having a significantly negative impact on the growth rate of GDP per capita. This negative effect dampens the positive gains in life expectancy through reoccurring infections and diseases that affect individual productivity, prolonging the time it takes countries in the region to sustain economic growth. This chapter also shows that a less aggregated health measure like HIV prevalence rates remains a significant predictor of economic development. The results in this chapter are like those found in the broad literature on health and economic development. Although the coefficients of population health and the burden of disease are large, they conform to studies conducted on countries in the region and countries where the burden of disease is high.

These findings back the proposition, which suggests that improvement in population health is a prerequisite for development and contributes to poverty reduction (Dodd and Cassels, 2006).
To account for the structural differences across countries, relevant macroeconomic determinants like education, FDI, population and trade were included in this analysis. In addition to these variables, a democracy index was included to measure corruption's effect on economic growth.

This chapter adds to the discussion on the association between population health and economic development by focusing on how health is measured. It is argued that conventional health measures like rates of mortality, life expectancy, or the prevalence of certain diseases do not fully capture the overall impact of the burden of disease in each country as they are focused on specific health issues (e.g., higher rates of malaria are representative of countries in the tropics). Many studies in the health sciences use the burden of disease in their analysis; however, they do not quantitatively assess this in economic terms. El-Bcheraoui et al. (2020) use Global Burden of Disease (GBD) data to perform a systematic analysis that provides crucial information on the burden of disease in Francophone Africa. Their findings suggest that although poverty and other structural barriers are the leading causes of death in the region, most countries fared better than expected in terms of mortality in comparison to morbidity. They indicate that persistent weakness in managing diseases results in a higher-than-expected disease burden regarding years lived with disability (YLD). Nonetheless, their measures do not account for the varying effects that the burden of disease has on the economic development of African countries. This is addressed in this chapter, where DALYs is used as a proxy for the high burden of diseases in Sub Saharan Africa.

3.9 Appendix

Table 3.17
Correlation matrix of the association between Growth, Life Expectancy, and the control variables (1990-2019)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Growth	1.000							
(2) Life expectancy	0.099* (0.000)	1.000						
(3) Primary enrol	0.160* (0.000)	0.058 (0.063)	1.000					
(4) Lag GDP pc	0.085* (0.003)	-0.126* (0.000)	0.325* (0.000)	1.000				
(5) Trade	0.072* (0.013)	-0.056 (0.053)	0.384* (0.000)	0.513* (0.000)	1.000			
(6) FDI	0.086* (0.002)	0.086* (0.002)	0.179* (0.000)	0.081* (0.004)	0.375* (0.000)	1.000		
(7) Population	0.038 (0.175)	0.247* (0.000)	-0.211* (0.000)	-0.305* (0.000)	-0.257* (0.000)	0.009 (0.740)	1.000	
(8) Corruption	-0.149* (0.000)	0.097* (0.000)	-0.127* (0.000)	-0.388* (0.000)	-0.253* (0.000)	-0.035 (0.211)	0.316* (0.000)	1.000

Notes: correlations from 1990- 2019 sample, based on N= 41 countries and T = 29 years. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Tables 3.17 above presents correlation coefficient results for life expectancy from 1990 – 2019. Like the correlation results found in table 3.3 on page 44, the correlation between most of the explanatory variables is below 0.50. The highest correlation in this table is between the lag of GDP per capita and trade at 0.513. This suggests that multicollinearity is not an issue between the variables.

Table 3.18
Variance Inflation Factor results for variables used in main analysis

	VIF.	1/VIF
Trade	1.850	0.541
Life expectancy	1.850	0.542
Primary enrolment	1.790	0.559
Lag GDP per capita	1.770	0.565
Population growth	1.520	0.659
Corruption	1.250	0.798
FDI	1.190	0.843
Mean VIF	**1.600**	

Technical Details on fixed effects and GMM specification

The basic framework used in this chapter builds on growth regression models as stated:

$$Y_{i,t} = \mu_i + \gamma \mathrm{X}_{i,t} + \varepsilon_{i,t} \qquad (3.3)$$

where i=1,2,3……..N represents country, t=1,2,3…...represents time; μ represents country fixed effects that represent heterogeneity across countries. Income in the preceding year is an important factor as it influences income in the following year (Caselli et al., 1996); therefore, a dynamic panel framework is more appropriate as specified below:

$$Y_{i,t} = \mu_i + \beta Y_{i,t-1} + \gamma X_{i,t} + \varepsilon_{i,t} \qquad (3.4)$$

Using fixed effects for equation 3.4 will lead to wrong coefficient estimates, which will result from the association between the lags of the dependent variable and the fixed effects. This is partly solved by taking the first differences of each variable as it removes the fixed effects (Nickell, 1981; Sharma, 2018).

$$Y_{i,t} - Y_{i,t-1} = \beta(Y_{i,t-1} - Y_{i,t-2}) + \gamma(X_{i,t} - X_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \qquad (3.5)$$

Estimating equation 3.5 above still produces biased results due to the correlation between $(Y_{i,t-1} - Y_{i,t-2})$ and $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$ and endogeneity due to reverse causation from income to determinates of growth like health, education, or trade. These issues are addressed by using $Y_{i,t-2}$ as an instrument for $(Y_{i,t-1} - Y_{i,t-2})$. $E(Y_{i,t-1} - Y_{i,t-2})$ is not correlated with $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$ by construction, if there is no correlation with the new error term (Arellano and Bond, 1991).

Equation 3.5 is the first step in difference estimation and is used for OLS and fixed effect estimations in this chapter. Moment conditions in equation 3.6 are used to arrive at the estimates of β and γ.

$$\mathrm{E}[Y_{i,t-s}(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \; for \; s \geq 2, t = 3,4 \ldots \ldots \ldots T \qquad (3.6)$$

Equation 3.6 above will also result in overidentification as the moment conditions exceed the parameters that will be assessed. This is resolved by using GMM to arrive at the coefficients of β and γ. GMM provides valid estimates if the differenced variables are not correlated with the error term[10]. With all these factors considered, variations of equation 3.1 in section 3.3.1 above are the estimated models used in this study.

10 The Hansen test of overidentifying restrictions is used to validate the results as it is robust to heteroscedasticity and auto correlation (Arellano, 2002).

CHAPTER 4

4 Health, Productivity and Economic Development

4.1 Introduction

Chapter 3 established the positive influence of health, as expressed through life expectancy, on Sub Saharan Africa's economic development. The negative and significant influence of the overall burden of disease on growth was also seen. These results suggest that countries in the region can increase growth in income by enhancing population health through the reduction of morbidity and premature death. This holds especially for countries in the region where the level of diseases exceeds that of life expectancy and longevity levels. The Millennium Development Goals (MDG) encourages developing countries to increase investment in health and education to achieve sustainable development by 2030 (Sachs, 2012). Therefore, to better understand the health growth relationship, the causal channels through which it influences economic growth must be explored. This chapter investigates this relationship further by analysing how health influences labour productivity and affects economic growth.

In 1992, Mankiw, Romer and Weil showed that including educational and physical capital, savings, and population dynamics in an augmented Solow (1956) model, explained the variations in income across different countries. This framework excluded the role of health, although previous studies had highlighted health as a vital part of human capital (Becker, 1962; Behrman, 1987). Studies that followed on from Mankiw et al.'s (1992) work focused exclusively on using education as a representation for human capital in analysing the role of human capital in economic development, neglecting the role of health (Benhabib and Spiegel, 1994; Gennaioli et al., 2013; Manuelli and Seshadri, 2014). This leaves an open question, particularly for developing countries where the literature is limited; what role does health play, in explaining the variations in economic development across countries? This question highlights the importance of recognising that human capital can take the form of either health or education (Becker, 1962; Grossman, 1972, 2000). Building on Becker's (1962) analysis of household production, Grossman (1972, 2000) provides the framework that models the two main parts of human capital, education, and health, showing how these relates to productivity. This model stipulates that health is just as important as education and an integral determinant of productivity.

Health is an important form of human capital that improves the output of workers by raising their capacities, both mentally and physically. These include their strength and cognitive functioning (Becker, 1962; Grossman, 1972, 2000). There is substantial empirical evidence on the positive influence of the educational aspect of human capital on productivity, less so for the health aspect of human capital (Chevalier et al., 2004; Annabi, 2017). Although some studies examine how health capital impacts economic development through the direct channel of productivity, these analyses are mainly based on developed countries (Arora, 2001; Tompa, 2002; Alexa et al., 2016).

A small number of researchers have included some developing countries for comparative purposes (Kumar and Chen, 2013; Alvi and Ahmed, 2014; Cole, 2019), while very few researchers focus exclusively on countries in Sub Saharan Africa (Azomahou et al., 2016; Ssozi and Asongu, 2016). The findings from these studies are mixed, given the variations in methods and sample compositions.

An important consideration for the health to productivity nexus for developing countries is the influence of morbidity, mortality, fertility, and population dynamics, that is, the function of the demographic stage of the countries in each sample under analysis as discussed earlier in chapter 2, section 2.3 (Cervellati and Sunde, 2015).

No empirical analyses separate and identify the predominant channels through which improvements in health affect economic growth for developing countries like those in Sub Saharan Africa, where income growth alone cannot push countries out of the Malthusian trap, given the repeated cycles and high burden of diseases. This chapter contributes to current knowledge by analysing the association between population health and economic development through the channel of labour productivity for a large sample of Sub Saharan African countries, using an Auto-Regressive Distributed Lags (ARDL) approach. An advantage of using this approach is that it shows how population health affects economic growth through labour productivity in the long and short run. This approach also deals with endogeneity, is more stable and performs better on data with small sample sizes, which is appropriate for this study. I consider the case for 36 countries in Sub Saharan Africa from 1984 to 2018, with subsamples based on life expectancy within the region. The results indicate that HALE and life expectancy has had a positive and significant impact on labour productivity, especially for countries in the region whose current life expectancies exceeds 52 years of age. Similarly, education shows a positive and significant association with labour productivity.

The rest of this chapter is structured as follows. Section 4.1 explores the literature and theoretical underpinnings for the relationship between health and productivity. Section 4.2 considers how poor health affects growth and productivity for developing countries like those in Sub Saharan Africa. Section 4.3 shows the data and econometrics that will be used in the empirical analysis. The results and discussion of the ARDL estimates are presented in section 4.4, and section 4.5 concludes this chapter.

4.2 Literature and Theoretical Underpinnings

The existing literature indicates that health is important when examining the variations in growth across countries, with productivity being a direct channel through which health affects economic growth (Hall and Jones, 1999; Islam, 2003; Bloom et al., 2014; Alemu et al., 2006; Cole and Neumayer, 2006; Azomahou et al., 2016). This sub-section firstly outlines the theoretical underpinnings for how improvements in health influence economic growth through the direct channel of productivity, including how the demographic transition affects this relationship. The second part considers the empirical literature on the health productivity nexus. These studies use various measures for health and productivity with variations in samples and methods. The final sub-section looks at studies that have examined how poor health affects growth through productivity in Sub Saharan Africa. Some of the limitations found in these studies are discussed and addressed in the next sub-section.

Grossman's (1972, 2000) work on the demand for human capital model offers insights into the relationship between the two vital parts of human capital (education and health) and how they relate to the supply of labour, productivity, and income. The theory of human capital is based on the idea that as individuals increase their stock of education (knowledge) and health, their productivity increases simultaneously.

In the model formulated by Grossman, the influence that health capital has on an individual's income and, eventually, economic growth is different from the impact of their educational capital. This is because health affects all activities that an individual participates in (both market and non-market related). Although educational capital determines how productive an individual will be at their work, it is dependent on the total amount of healthy time they have, which is defined by an individual's overall health (Tompa, 2002).

Health affects economic growth through various channels, and they differ for developing and developed countries (Ben-Porath, 1967; Aghion et al., 2010; Lutz and Kebede, 2018). Researchers have used both empirical and theoretical studies to analyse this relationship. The empirical literature emphasises the direct labour productivity effects of improving population health on growth (Shastry and Weil, 2003; Weil, 2007), whereas the theoretical models focus on the indirect impact that health has on economic growth (Finlay, 2007; Bleakley, 2010a). For the direct channel, health affects economic growth predominantly through its role in enhancing productivity (Acemoglu and Johnson, 2007; Aghion et al., 2010; Cervellati and Sunde, 2013; Bloom et al., 2018;; Sharma, 2018). At the aggregate level, health can affect an individual's productivity through four main pathways. Healthy individuals are unlikely to miss work because of their stock of physical and mental energy; they invest more in their education in anticipation of greater returns; they also save more for retirement, which increases physical capital accumulation. Finally, there is a reduction in fertility which increases labour market participation and an eventual reduction in the dependency ratio (Bloom and Canning, 2000).

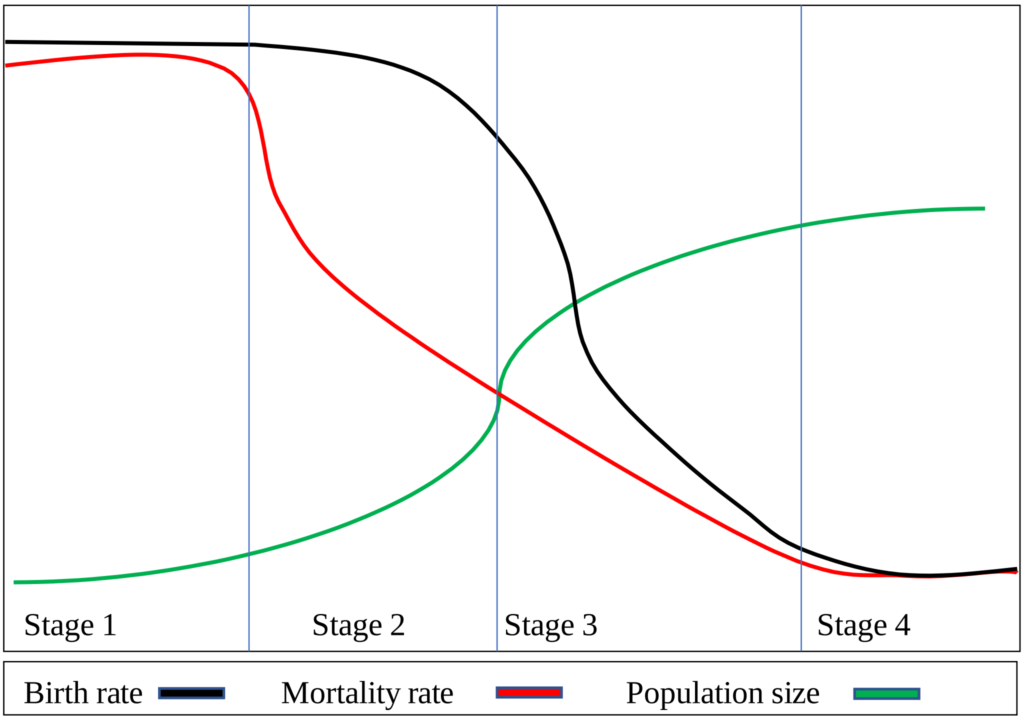
Indirectly, improvements in health affect growth through a variety of channels. Declines in mortality triggers greater investments in human capital, as improvements in life expectancy creates incentives to invest (De la Croix and Licandro, 1999; Galor and Weil, 2000; Boucekkine et al., 2003). This includes investments in education, technology, and physical capital. When life expectancy is extended, investments in health and education are more beneficial as the time spent in the labour force is longer (Ben-Porath, 1967; Cervellati and Sunde, 2013). Investments in education over time improves cognitive development, enhances technology through the application of new scientific knowledge, innovations are generated from within the domestic economy and diffusion of technology from abroad (Aghion et al., 2010; Bleakley, 2010a). Longevity also encourages individuals to save more, increasing capital formation within an economy (Ogundari and Awokuse, 2018; Tompsett, 2020).

Theoretically, the influence of improvements in population health on economic growth depends on several factors. Although a fall in mortality may increase the productivity of workers, which in turn will increase wages, lower mortality may also accelerate the growth of a population, diluting any gains in income over the long term, especially in the presence of Malthusian effects (Galor, 2005). A majority of studies have shown how health affects growth in developing countries, can also be explained by the demographic transition, that is, how changing mortality, fertility and population dynamics affects economic development (Bloom et al., 1998, 2018; Cervellati and Sunde, 2011; Defo, 2014). This consideration is important when looking at the channels through which health influences economic growth in developing countries.

The demographic transition model suggests that countries with high births and death rates, transition to low births and death rates over time, changing the size and distribution of the population.

Galor and Weil (2000) break this process down into four phases as shown in figure 4.1: in the first phase, death and birth rates are high, in the second phase, adult mortality and infant mortality starts to fall as health starts to improve with developments in medications that become available to the general population. This is followed by a fall in the birth rate in response to behavioural and social changes (low infant mortality), and in the final phase, population growth becomes stationary. In other words, a country has started the demographic transition process if their lifespan exceeds 50 years, there is a fall in fertility rates, and birth rate has dropped below 30/1000 live births (Cervellati and Sunde, 2015).

Figure 4.1 Demographic Transition Model



With continuous improvements in life expectancy and a fall in fertility, recent studies on population projections suggest that the final stage could see a collapse in populations as fertility rates become very low. Many developing countries, including China, will be extremely affected, potentially losing 31.4 million, or around 2.2 per cent, between 2019 and 2050 (UNDP, 2019). This implies that care needs to be taken to ensure that all countries in a sample under analysis are in the same phase, and development level, to avoid underestimating the results. Figure 4.2 shows the current life expectancy at birth, total population, birth, and death rates, for all Sub Saharan African countries from 1960 to 2019. Countries in the region are following the stages outlined in the demographic model; however, major differences in all these predictors exist among countries. For example, life expectancy in Seychelles in 2019 was 74 whereas that of Central African Republic was 53 years at birth. The crude birth rate was 16 births per 1,000 people for Seychelles whilst it was 35 for Central African Republic.

Figure 4.2

Figure 4.2a Population Total

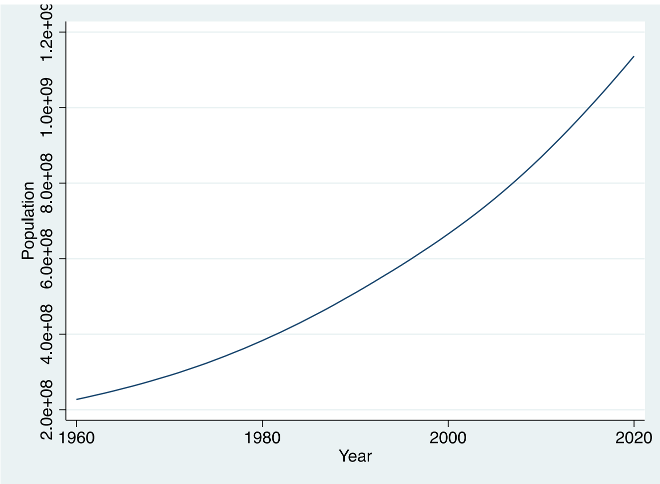


Figure 4.2b Crude Death Rate (per 1,000 people)

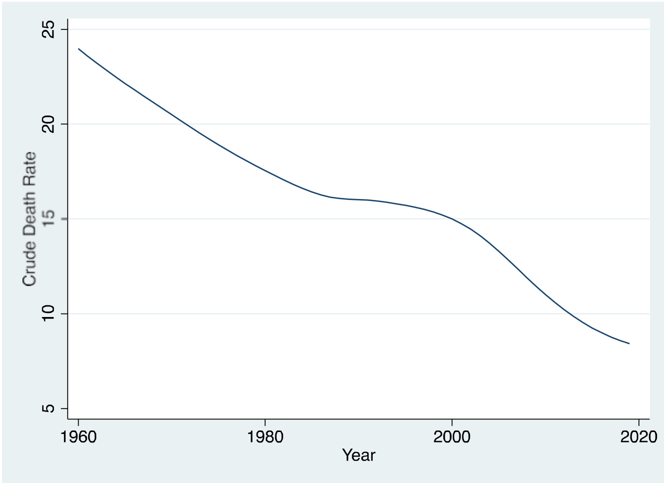


Figure 4.2c Crude birth Rate (per 1,000 people)

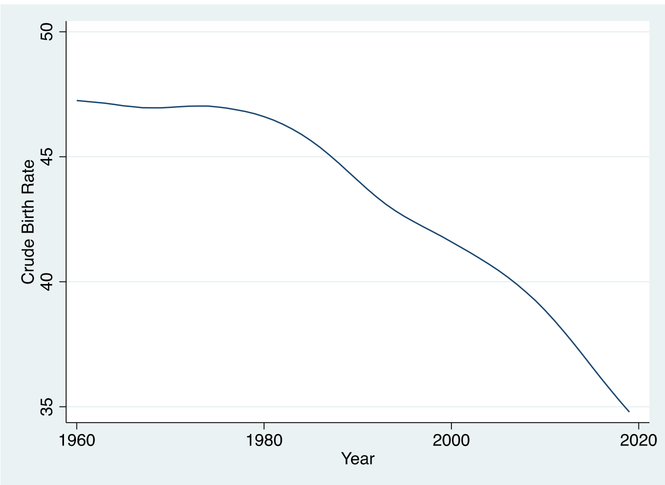
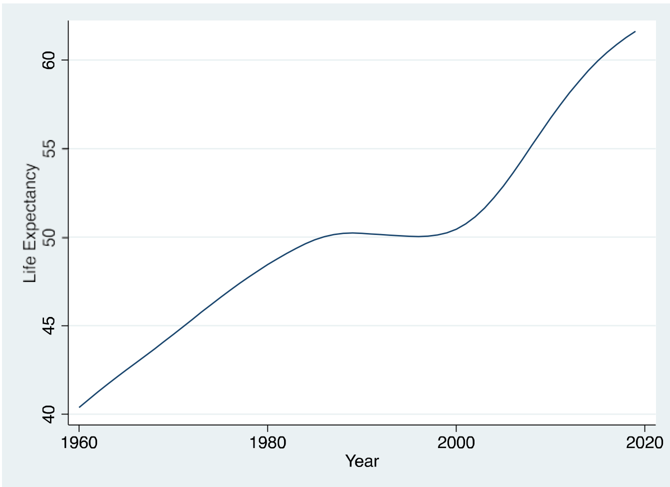


Figure 4.2d Life Expectancy at Birth (total years)

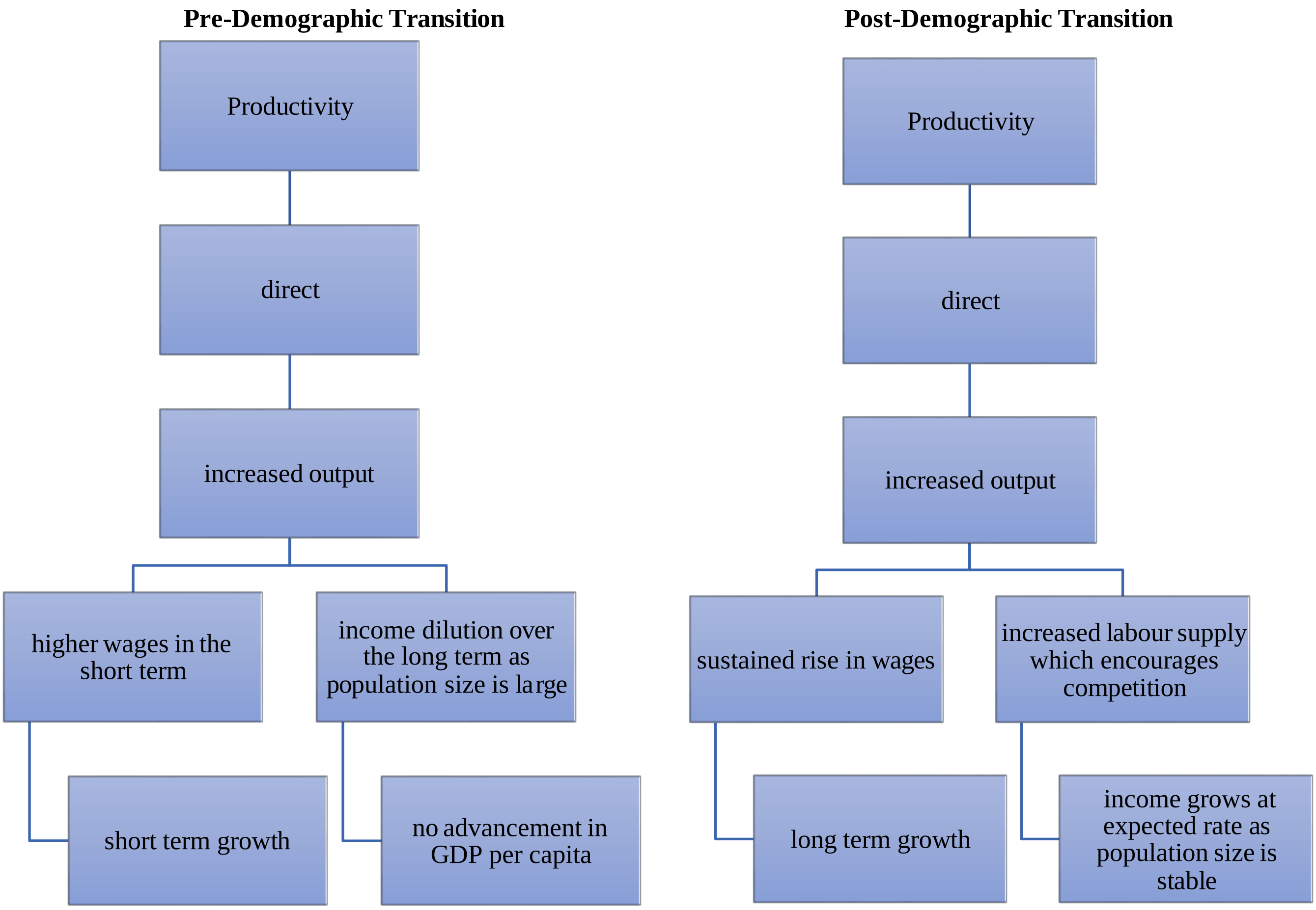


Cervellati and Sunde (2015) state that once a country starts the demographic transition, the negative impact of population expansion which is detrimental to those who have not started the process, disappears. Once the demographic transition starts, a rise in life expectancy hastens economic development by altering the age distribution of a given population. This is achieved through improvements in the indirect channels of causality like educational attainment and more females participating in the labour market, which in turn reduces fertility. Cervellati and Sunde (2005) modelled the demographic transition, by looking at instances in which as mortality falls, parents invest in their children's education, and reduce the number of children they have. Given how the changes above will lead to growth, Chakraborty (2004) goes further in his study, allowing life expectancy to be endogenously modified by public health investments.

In summary, the contradictory findings from studies examining the health to growth nexus are not due to variations in identification; rather, the relationships found are due to different sample compositions (Cervellati and Sunde, 2015). These are used when merged with different models that presuppose that life expectancy should have the same effect across all countries under analysis.

The discussion above shows, that the demographic transition is an important determinant of how population health influences economic development, through the direct and indirect channels (summarised in figure 4.3). This shifts the emphasis away from focusing entirely on the econometric approach to finding an appropriate model for such an analysis. (Cervellati and Sunde, 2011).

Figure 4.3 How Health Affects Economic Growth through the Direct Channel of Productivity in the Pre and Post Demographic Transition Stages



4.2.1 Empirical studies on the relationship between population health and productivity

With the role of the demographic transition process and how it can affect developing countries recognised, this section reviews the empirical studies on the health to productivity nexus, focussing on poor health, and studies conducted on countries in Sub Saharan Africa.

Empirically, there is substantial evidence showing how increased human capital, mostly proxied by education, affects productivity and, subsequently, economic growth. How human capital in the form of health affects productivity has received less attention. Yet, the few studies that have included health, proxied by death in children or life expectancy, shows that health is positively and significantly associated with economic development (Bloom and Canning, 2000; Arora, 2001; Alsan et al., 2006; Frimpong and Adu, 2014).

Cole and Neumayer (2006) extend the literature by examining the direct impact that poor health has on productivity by using data from 52 developed and developing countries from 1965-1996. Using several health indicators such as life expectancy, the incidence of malaria, waterborne diseases, and the percentage of malnourished within a country, they find that poor health has a detrimental impact on the productivity of labour. Alemu (2006) estimates the impact of health on productivity for 100 countries, using the HIV prevalence rate from 1994 to 2002 as the indicator for health. He finds that productivity falls by 23 percent in Lesotho, and up to 15 percent in South Africa, as HIV progresses. Assessing how health affects labour productivity in Nigeria, Umoru and Yaqub (2013) use data from 1975 to 2010, and a GMM approach finds that enhanced productivity makes the association between population health and economic development positive and significant. Similarly, Bloom et al. (2004) use cross country macroeconomic data to assess the influence of population health on worker productivity and find a positive and significant effect.

Kumar and Chen (2013), using data from 1960 – 2005, study the dynamics of productivity and the impact it has on health education and the rate at which total factor productivity (TFP) grows. They find that although health and education have a substantial effect on the rate of growth in TFP, the burden of disease proxied by infant mortality has a significantly negative effect on the growth rate of TFP. Using an economic-epidemiological Solow model, Azomahou et al. (2016) examine the mortality and morbidity effects of disease (HIV) on the productivity of labour. They use prevalence data for the active working population by age and sex in South Africa and make future projections based on the effects of the disease. As expected, they find that HIV/AIDS will have a negative and significant effect over the medium to long term on economic growth in the region, caused primarily by the delayed negative productivity effects, which is enhanced by slow demographic dynamics.

These studies suffer from some limitations. Cole and Neumayer (2006) and Alemu et al. (2006) do not examine the influence of the other aspect of human capital, i.e., how education influences labour productivity. The positive relationship between health and education is recognised in the literature, and the productivity of the labour force depends on these two aspects of human capital (Arora, 2001; Kalemli-Ozcan et al., 2000; Cutler and Lleras-Muney, 2006; Davies et al., 2018;). Therefore, excluding education in such an analysis leads to omitted variable bias and an overestimation of the effect of health on productivity.

Cole and Neumayer's (2006) sample contain nine Sub Saharan African countries. Alemu et al.'s (2006) sample have data on 30 countries in the region, but they omit education and use HIV as the only proxy for health. They also use a short period (1994-2002), and the long-run effect of health proxied by HIV is not assessed. Total factor productivity is the ideal measure for such a study, as is a multifactorial measure that captures the effectiveness and intensity with which inputs are used in the production process. Other measures only focus on one input, typically labour, a limitation that other measures like output per worker or labour productivity face.

Kumar and Chen's (2013) analysis is the only study on the health productivity nexus that uses the growth rate of TFP; however, their analysis also covers a short period (1960-1985 and 1985-2005) and includes only thirteen countries in Sub Saharan Africa. The large significant impact of population health on the productivity of labour, in the analyses above supports the case for examining the impact of both morbidity and mortality for developing countries, whilst considering the demographic makeup of countries in the sample. However, none of the studies outlined above considers all these factors. Umoru and Yaqub (2013) highlight the negative influence of the high burden of disease, and examine how infant mortality and conditions like malaria, diarrhoea, and acute respiratory diseases affect productivity. However, their study is limited to just one country in Sub Saharan Africa, Nigeria.

Life expectancy is the measure used to represent health capital in most studies. Mortality is reflected in the longevity and infant mortality measures. Although there is a connection between the two measures (mortality and morbidity), economic growth is greatly influenced by the effect of morbidity and poor health, especially in developing countries, not just mortality (Aksan and Chakraborty, 2014). For developing countries, the overall burden of disease is a vital determinant of how productive the population will be, given that poor health most often has nonfatal consequences but leaves behind some physiological impairments, and for those in the labour force, this decreases their productivity (Azomahou et al., 2016; Cuddington and Hancock, 1994; Dixon et al., 2001). Besides the direct effects, recurrent epidemics such as malaria and HIV/AIDS indirectly affects economic development by reducing worker productivity and factor accumulation (Cuddington and Hancock, 1994; Dixon et al., 2001; Cole and Neumayer, 2006; Umoru and Yaqub, 2013; Azomahou et al., 2016).

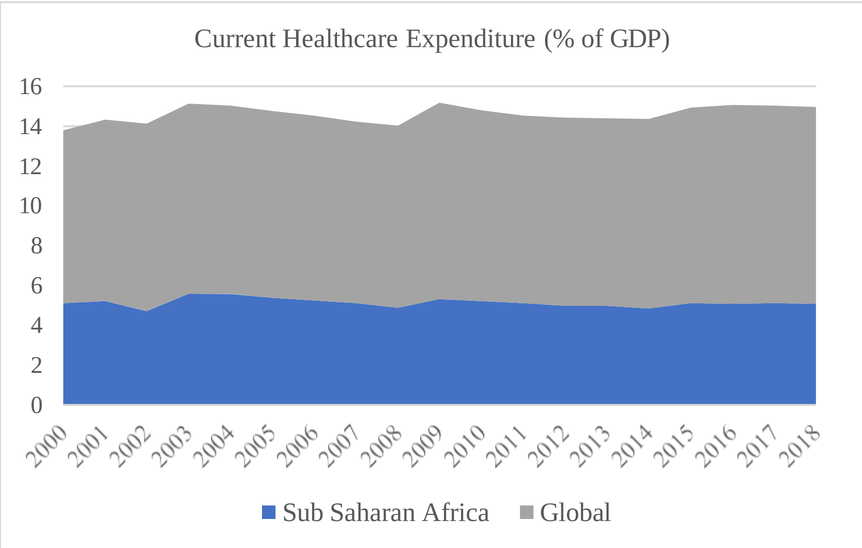
Developing countries exposed to infectious diseases like HIV and malaria have low productivity whilst facing high premature death rates (Chakraborty et al., 2010). Cuddington and Hancock (1994) assess the influence of AIDS on economic development in Malawi by examining how it influences labour, investments, and savings within the region. They find that growth rates of GDP per capita is lower in projections where the disease persists. Similarly, Dixon et al. (2001) analyse how HIV influences economic growth in Africa and find that the high prevalence of HIV/AIDS in the region reduces labour supply and productivity. The discussion above shows how poor health directly influences productivity. The following section explores these further, with a focus on countries in Sub Saharan Africa.

4.3 Poor Health, Growth and Productivity in Sub Saharan Africa

One area where Sub Saharan Africa faces a development challenge is healthcare. A majority of the population lack access to basic healthcare as these systems are poorly funded, leading to many deaths in the region and a continual increase in the burden of disease (Muthuri Kirigia and Pathe Barry, 2008; Oleribe et al., 2019). Although Africa accounts for 17 percent of the global population, the continent bears 25 percent of the disease burden globally, and Sub Saharan African countries command below 1 percent of health expenditure globally (WHO, 2021).

As stated in chapter 3, section 3.1, for most of the population, their only access to healthcare is through the provision made by these underfunded public health facilities. The Abuja declaration made in 2001 saw countries in the WHO Africa region pledge to allocate 15 percent of their GDP annually to improving healthcare within their countries. However, 19 countries in the region had reduced their healthcare spending by 2016, and only two countries, South Africa, and Rwanda, had met the 15 percent annual healthcare spending target (WHO, 2015).

Figure 4.4 Current Health Expenditure (% of GDP) Sub Saharan Africa and Global



Data for graph sourced from World Bank (2021)

Being severely ill represents a significant loss to individuals as they may not work or provide for their dependents. Countries with a high burden of disease may see this reflected in their productivity at the aggregate level (WHO, 2015). The stifling of productivity resulting from this high burden of disease ultimately affects economic development as aggregate output is constrained. The cross-country variation in productivity rates and economic growth has been attributed to variables like education, the initial level of income and trade openness, among others (Mankiw et al., 1992). The literature on the important role that health plays in the process of economic development is growing (Bloom and Canning, 2000; Arora, 2001; Frimpong and Adu, 2014), but few studies have focused on the causal channels, especially for countries in Sub Saharan Africa. Poor health affects economic development largely through productivity, not only as a vital aspect of the production process but by influencing how productive the other factors of production also are (Arora, 2001; Cole and Neumayer, 2006; Azomahou et al., 2016). This assertion suggests that health potentially influences the growth in output, through channels like productivity.

For Sub Saharan Africa, there is limited research on the direct and indirect effects of health on economic growth. Although many studies that focus on the region indicate, they investigate one of these channels, a closer examination of them reveals that they analyse the total effect of population health on economic development, not the direct or indirect impact that health has on economic development as they suggest (Gyimah-Brempong and

Wilson, 2004; Frimpong and Adu, 2014; Gebrehiwot, 2014; Piabuo and Tieguhong, 2017; Ogundari and Awokuse, 2018; Sarpong et al., 2018). These studies are discussed in detail in chapter 3, section 3.2. The techniques used by these studies show the total impact of health on economic development, not just the direct or indirect effects they suggest. This is because spillovers from either the direct or indirect effects of improved health are not excluded in their analysis.

Of the studies that focus on Sub Saharan Africa, the majority examined the association between population health and growth through the indirect channel of investment, either through investments in education or health expenditure. None of these studies takes the demographic aspect of the countries in their sample into consideration. Studies that account for the burden of disease in the region, using different forms of diseases (mostly HIV and malaria), find that the burden of disease impacts growth negatively. No study has combined the burden of disease with life expectancy in their analysis. Although fertility rates are generally high in Sub Saharan Africa, there are minor distinctions in fertility, life expectancy, and the rate of population growth, which can explain why health displays the varied effects seen in the above studies.

The relationship between health and growth is non-monotonic, an observation that has emerged from the economic and demographic literature that suggests that population dynamics are closely related to the demographic transition, which is also associated with long-run economic growth (Cervellati and Sunde, 2011; Kalemli-Ozcan, 2012; Cervellati and Sunde, 2015; Bloom et al., 2017; Forman-Peck and Zhou, 2021). This view is also supported by the unified growth theory (Galor, 2005). The importance of longevity has been acknowledged in the literature, given its rising influence on economic development through the direct and indirect channels. However, no published study empirically assesses, separates, and identifies the predominant channels through which improvements in health affects economic development for developing countries like those in Sub Saharan Africa. In this region, income growth alone cannot push countries out of the Malthusian trap given the repeated cycles and high burden of diseases.

This chapter seeks to fill these gaps in knowledge by exploring the morbidity and mortality effects of health on the productivity of labour. Much of the literature use education as the measure for human capital when analysing how it influences productivity, excluding the role of health. Understanding how all aspects of human capital (education and health) influences productivity, which leads to economic growth, is an important consideration for developing countries. This knowledge will enhance our understanding of the health productivity nexus and assist policymakers in addressing issues that slow down the transition to economic growth. I examine the relationship between health, proxied with life expectancy and health adjusted life expectancy (HALE), and productivity, factoring in the demographic transition theory. I find that improvement in life expectancy (mortality) and HALE (morbidity and mortality) from 1984 to 2018 in Sub Saharan African countries, have had a positive and significant impact on the productivity of labour. Countries in Sub Saharan Africa with an average life expectancy above 52 years are more likely to benefit from improvements in morbidity and mortality over the long run. The data and methods used to examine these are explored in the next section.

Threshold /Scale effect

If health influences economic growth, then improving health should be the aim of policymakers – but at what level does the relationship between health and economic development become positive? Recent studies have examined the nonlinearity of the nexus between health and economic growth. This non-linear relationship suggests the presence of an inflexion point or threshold at which the association between the two changes. This preposition also applies to the direct and indirect channels through which health influences growth. The demographic transition theory proposed by Chesnais (1992) shows the different points at which the association between health and growth changes, i.e., life expectancy above 50 years of age, a birth rate below 30 per 1000 live births and a sustained fall in fertility rate. Cervallati and Sunde (2011) explore this association using a sample of 47 countries outside Africa, 25 pre-transitional and 22 post-transitional. Their findings indicate a non-monotonic relationship, which is negative before the onset of the demographic transition but statistically significant and positive after the transition.

This thesis re-examines the health to productivity relationship, addressing threshold effects using quantile regressions. Quantile regression is an approach that is flexible to error distribution, an alternative to the least squares regression and robust to outliers (Koenker, 1978). This approach explores the whole conditional distribution of the response and not just its mean. Results from the quantile regression emphasise the results from Chesnais (1992) and Cerverlatti and Sunde (2011). These results, as discussed in section 4.9.2 and shown in table 4.15, suggest the existence of a threshold beyond which health exerts a positive and significant influence on labour productivity. Countries in the region whose current life expectancy exceeds 52 years of age see the positive and significant effect of improvements in life expectancy on labour productivity. Countries at the lower end of the quartile (0.05, 0.25, 0.50) see the opposite negative and significant effect of life expectancy on labour productivity.

Economic history literature and the contribution of women to human capital

A predominant question in economics is understanding the variations between rich and poor countries, the factors that caused these variations in economic growth and how they can be remedied. The earliest modern economic growth in western Europe was precipitated by disasters in the demographic distribution like the black death and immense mortality shocks (Malamina, 2012). These factors encouraged fundamental changes in institutions and labour market participation, delaying the age at which women got married, reducing family size as survival chances improved and boosting human capital over time (Foreman-Peck and Zhou, 2018). Human capital accumulation increased, and population growth began to slow down after the first industrial revolution. Many European countries started their demographic transition process during the 19th century (Lee, 2003).

Foreman-Peck and Zhou (2018) show how late marriage contributed to the industrial revolution in England. They postulate that volatility in mortality in the 14th and 15th centuries depressed life expectations and subsequent increases in life expectancy reduced the number of births per household.

Recent studies have shown that many developing countries share a similar modern experience, China being the most cited example. Their imposition of the one-child policy and late marriage in the 80s is credited for the growth miracle seen in the country (Liao, 2013). In contrast, India has experienced a much slower growth pace as such policies were not imposed (Bosworth and Collins, 2008). The policies imposed by China and the institutional change that initiated the demographic transition in many European countries sustained income rises and improved living standards. Later marriage constrained population growth and enhanced female learning opportunities through 'service'. Females could join the labour market due to scarcity (Foreman-Peck and Zhou, 2018). These provided opportunities for them to learn informally and broaden their horizons. These women passed on the skills and work discipline they learned to their children as schooling was informal and not compulsory until the 1880s in England (Black et al., 2005). Over the centuries, this raised human capital and productivity, eventually leading to the industrial revolution. Without this factor, wages in England would have stayed the same as in eastern Europe, where marriage and labour market participation remained relatively unchanged. Nonetheless, these improved employment prospects did not change women's wages compared to their male counterparts.

There is a fundamental link between gender equality and economic growth, which makes the two mutually reinforcing (Dollar and Gatti, 1999). Giving women equal access to education and employment expands a country's economy, as evidenced in most developed countries (Klasen, 1999; 2003). On the contrary, countries where women's capacities to make productive means are limited witness low standards of living and hampered economic growth. The importance of human capital as a fundamental source of economic growth has been highlighted in most economic literature. Among the first growth models with various approaches offered for economic analysis were the theoretical works of Romer (1986) and Lucas (1988). However, earlier studies recognised human beings and their skills as capital and acknowledged the importance of investing in humans to increase productivity (Kiker, 1996).

Alfred Marshall used the impact of human capital in his analysis to estimate the revenue derived from investment in education. Theodore Schultz emphasized the importance of human capital in economic analysis, without which he noted that the explanation for economic growth would be incomplete. His works postulate that education capital, the quality of human resources, available technology and economies of scale contribute significantly to economic growth. More recently, Larson and Morros (2008) analysed how an individual's gender influenced the laws in a country. Their findings showed that gender significantly influenced wages, and the salaries of men were considerably higher than those of their female colleagues.

Furthermore, channels like FDI through which knowledge, ideas and technology are transmitted rely heavily on the level of human capital in the recipient country (Psacharopoulos, 1972; Mohanty and Sethi, 2019).

Becker (1971) highlighted the decreased wage gap between men and women in countries with increased competition in product markets. Development should empower both men and women to develop their full capacities. However, the benefits of females participating in the labour market significantly and positively impact society.

Examples from around the world have reemphasized the invaluable contribution of women to human capital. A study conducted in 2018 by the World Bank on building human capital indicates that ‘‘women who are empowered to stay in education longer and choose the number of children they have gain economic opportunities for their families and the country as a whole’’ (World Bank, 2018, p.2). Empowering women whilst investing in human capital simultaneously quickens the transition from Malthusian stagnation through the process of the demographic transition. As mentioned above, evidence from studies conducted in east Asia shows how their transition to sustained economic growth was triggered by low fertility rates with less than four births per woman. Taking the case of Botswana, a country in Sub Saharan Africa, targeted policies that advanced women's health, education, and economic opportunities resulted in fertility rates declining from 6.5 in 1975 to 2.7 in 2018. These steps also influenced economic growth, raising GDP per capita from $479 in 1975 to $8200 in 2018.

Africa has the largest number of young people and young women and empowering them by implementing changes that enhance human capital accumulation, especially for women in developing countries, will have a cumulative impact over the next few decades.

4.4 Data and Methodology

This section outlines the data and methodology used to test the empirical relationship between labour productivity and population health for countries in Sub Saharan Africa.

4.4.1 Labour Productivity

This study employs annual data for 36 countries in Sub Saharan Africa over a 34-year period from 1984 to 2018. Country selection is based solely on the availability of data. Table 4.1 shows the countries used in this study. The dependent variable is productivity, proxied by labour productivity (output per worker). One advantage of using labour productivity is that among all the measures of productivity available for Sub Saharan Africa, this variable has the largest number of observations for each country. A disadvantage of using this variable is that it fails to capture the intensity or quality of labour input. However, it has been proven to be a robust measure of productivity and has been used in studies by Bernard and Jones (1996), Arora (2001), Fox et al. (2004), Bakas et al. (2019), and Dua and Garg (2019).

Table 4.1

Sample of Countries in Sub Saharan Africa (36)

Benin	Cote d'Ivoire	Madagascar
Burkina Faso	Eritrea	Malawi
Burundi	Eswatini	Mali
Cabo Verde	Ethiopia	Mauritania
Cameroon	The Gambia	Mauritius
Comoros	Ghana	Mozambique
Congo Democratic Republic	Guinea	Namibia
Congo Rep	Kenya	Niger
Tanzania	Lesotho	Nigeria
Togo	Sao Tome and Principe	South Africa
Uganda	Seychelles	Zambia
Sudan	Senegal	Zimbabwe

Definition of Variables

Data on labour productivity, life expectancy at birth, GDP per capita, primary school enrolment, and financial development are sourced from World Bank, World Development Indicators. Data on education (average years of schooling and returns to education) is sourced from Penn World Tables 10.0. Data on Health Adjusted Life Expectancy is sourced from the Global Burden of Disease Database.

4.4.2 Determinants of Labour Productivity

I. Measures of Population Health

Researchers typically use measures centred around mortality like life expectancy, infant mortality, or mortality related to certain diseases to evaluate population health. These mortality-based indicators provide useful information in a cursory way, as this information is not sufficient to judge the impact that an intervention will have on a population's health (Gold et al., 2002). It is recognised in the broader literature that population health is multi-dimensional, and longevity alone cannot contain all the complexities surrounding the health of a population (Blundell and Bond, 1998).

There has been an improvement in the measures used to assess population health and the resulting medical outcomes in recent years. This has resulted in the development of enhanced alternatives like Health Adjusted Life Expectancy (HALE) which combines the impact of morbidity and mortality and allows these to be considered simultaneously across different populations, with varying diseases and medical interventions. The umbrella term Health Adjusted Life Years (HALYs) incorporates a set of metrics like the "Quality Adjusted Life Years (QALYs), Disability Adjusted Life Years (DALYs) and Health Adjusted Life Expectancy (HALE)", measures that have been used by many studies to represent population health (Kominski et al., 2002; Manuel et al., 2002; Audibert et al., 2011; Chaker et al., 2015; Dalal and Svanstrom, 2015; Ranabhat et al., 2018). This study uses two measures for population health: Health Adjusted Life Expectancy (HALE) and life expectancy.

In the economics literature, life expectancy is the most common and traditionally used health metric. Therefore, I start the analysis by using life expectancy at birth. This measure signifies how many years an individual will live, if mortality patterns at the time the person is born, were to remain constant throughout their lifetime. I then use one summary measure, HALE. I use this measure rather than the QALYs or the DALYs. DALYs measure quantifies the disease burden and disability within a country whilst QALYs shows the quantity and quality of life. DALYs quantify the burden of disease and has an expected negative influence on economic growth, as indicated in the analysis for chapter 3, section 3.5 and 3.6 and, in studies such as Audibert et al. (2011) and Nurchis et al. (2020). QALYs contrarily measures the quality-of-life component and therefore exerts a positive effect on growth. Unlike DALYs and QALYs, which only shows the effects of either mortality or morbidity or the quality and duration of life, HALE combines QALY and DALY, providing an overview for the number of years a person can anticipate living a healthy life, not impeded by morbidity or disability. This measure can also be used to capture the effectiveness of the health systems in the region. Better performing health services prevent a disease from having a large effect even if the prevalence of disease is high. Therefore, it can be argued that HALE provides the most comprehensive measure of health in capturing those facets that are likely to affect productivity.

4.4.3 Control variables

The literature suggests several other variables that affect labour productivity. I elaborate on the four variables selected for this analysis as they are deemed to have the strongest influence on labour productivity for developing countries.

II. Education

Theoretical and empirical studies have identified education as a positive determinant of productivity. Education stimulates the growth in productivity by accelerating the adoption and implementation of new technologies and encouraging the use of technological innovations for domestic production (Nelson and Phelps, 1966; Romer, 1986). Therefore, countries with more education are most likely to see this influence their productivity positively as they take advantage of technological diffusion. Two measures of educational capital are used in this study. Primary school enrolment is used in the main analysis, and average years spent in school and the returns to education (one variable) is applied in the robustness checks. The data on average years of schooling is mostly used in the literature as it is supposedly an improved measure of educational capital compared to enrolment ratios (Anand and Ravallion, 1993). For comparative purposes, this study uses the data on enrolment ratios (primary school enrolment) for the main analysis as the variable is available over a longer period for more Sub-Saharan African countries. Considering this is vital, as this analysis is trying to capture the long-run effect for a large sample reflective of countries in the region. Using this variable is also essential for the methodology used, as data must cover a longer period to estimate the long-run effects accurately. Data on primary school enrolment is sourced from the World Bank, World Development Indicators. Data on the second proxy of educational capital combines the average years of schooling and returns to education into a single measure. This is sourced from Penn World Tables 10.0.

III. Economic activity

GDP per capita represents economic activity. This variable exposes the total effect of economic wellbeing on productivity as improvements in GDP encourage the acquisition of physical capital and competition in the market, which also incentivises improvements in productivity (Akinola and Bokana, 2017). Improvements in economic status also affect savings positively, increasing physical capital accumulation (WDI, 2012). Data on GDP per capita is sourced from the World Bank, World Development Indicators.

IV. Financial development

It is well established in the literature that financial development is a potential determinant of productivity (Chang and Luh, 1999; Amissah, 2018). It is argued that more financially developed economies are better able to allocate savings which enhances capital accumulation, and technological progress and is, therefore, productivity-enhancing (Hassan et al., 2011; Dua and Garg, 2019). Therefore, I consider financial development as a determinant of productivity in this study. As commonly used in the literature, the amount of domestic credit given by banks to the private sector is used to measure financial development. This data is sourced from the World Bank, World Development Indicator.

Table 4.2

Description of Variables

Variables	Definition	Source
Labour Productivity	Labour productivity levels are measured as real GDP in US dollars split by employment, based on 2010 prices and exchange rates.	World Bank, World Development Indicators
Life Expectancy	Life expectancy at birth indicates how many years a new-born would survive if current mortality patterns at the moment of its birth remained constant throughout its life.	World Bank, World Development Indicators
Health Adjusted Life Expectancy (HALE)	Years lived in less-than-ideal health (YLDs) and years lost owing to early mortality (YLLs) are combined in a single measure of average population health to incorporate mortality and nonfatal outcomes.	Global Burden of Disease Database
Primary School Enrolment	The proportion of total enrolment, irrespective of age, to the population of the age group that officially relates to the level of education.	World Bank, World Development Indicators
Human capital	Human capital index, based on Barro and Lee (2013) 's average years of schooling and an expected rate of return to education, based on Mincer equation estimates from around the world (Psacharopoulos, 1994).	Penn World Tables
Financial development (Domestic credit by banks)	refers to funds provided to the private sector in the form of loans, non-equity securities purchases, trade credits, and other accounts receivable that establish a claim for repayment.	World Bank, World Development Indicators
GDP per capita	GDP is divided by the population during the midpoint of the year. The figures are in 2010 US dollars.	World Bank, World Development Indicators

Table 4.3
Summary Statistics

Variable	Obs.	Mean	SD.	Min	Max
Labour productivity	1353	7.969	1.012	5.770	10.255
Life expectancy	2140	3.952	0.166	3.339	4.311
Health adjusted life expectancy	1079	3.937	0.121	3.626	4.18
GDP per capita	1862	6.938	0.874	5.102	9.619
Primary school enrolment	1557	4.354	0.483	2.461	5.052
Human capital	1780	1.488	0.390	1.007	2.908
Financial development	1737	2.503	0.832	-0.800	4.666

Notes: All variables in logarithms except human capital.

Stationarity tests

The study in chapter 4 employs annual data for 36 countries in Sub Saharan Africa over 34 years from 1984 to 2018. Data on HALE is from 1990 to 2018. Country selection is based solely on the availability of data. Table 4.1 shows the countries used in this study. The dependent variable is productivity, proxied by labour productivity (output per worker). The independent variables include life expectancy at birth, HALE, GDP per capita, primary school enrolment, and financial development. Data on all variables are sourced from the World Bank and World Development Indicators except HALE, which is sourced from the Global Burden of Disease Database.

The issue of non-stationarity is a problem that many panel datasets face. To resolve this, this study conducts stationarity tests using unit root to check the stochastic properties of the variables in this study. Theoretical and empirical studies have highlighted the importance of this test (Breitung and Meyer, 1994; Hadri, 2000; Pesaran and Shin, 2003). The Fisher test based on the Augmented Dickey-Fuller (ADF) is used. The fisher ADF type test results show all the variables are integrated of order 1, I(1), except life expectancy, financial development and HALE, which are stationary at level. See the table 4.3a below.

Table 4.3a
Unit Root Test

Variables	Levels		1st difference	
	Statistic Fisher Chi-square	p-value	Statistic Fisher Chi-square	p-value
Labour productivity	79.2034	0.2113	502.082	0.0000
GDP per capita	71.875	0.4820	457.330	0.0000
Primary sch. enrolment	87.6914	0.1007	343.862	0.0000
Financial development	120.169	0.0003		
Life expectancy	222.119	0.0000		
HALE	178.080	0.0000		

Note: based on the SIC criterion.

The ARDL approach shows the consistency and asymptotic distributions in cases where the regressors are either I(0) or I(1) (see Pesaran et al., 1999). Therefore, the results of the unit root test provide further justification for the adoption of the ARDL dynamic approach used for the main analysis in this chapter, as all variables are of mixed level of integration - I(1) or I(0). The ARDL results show both the long and short-run effects of the influence of population health, as expressed through the Health Adjusted Life Expectancy (HALE) and life expectancy measures, on labour productivity for Sub Saharan African countries.

4.5 Methodology

In examining the relationship between health and productivity, many studies apply static models such as fixed effects and pooled Ordinary Least Squares (OLS) before proceeding to use other methods such as Generalised Method of Moments (GMM) and Error Correction Models (ECM) (Miller and Upadhyay, 2000; Arora, 2001; Cole and Neumayer, 2006; Kumar and Chen, 2013; Saha, 2013; Alvi and Ahmed, 2014).

One limitation of previous studies that concentrate on countries in Sub Saharan Africa, is that the methods used do not differentiate between the short- and long-term effects of health on productivity. This is an important consideration in analysis of this type for developing countries. This is because, with extended life expectancy, individuals' productivity rises, resulting in increased output. Similarly, the negative effects of disease manifest over a period and, in the long run, have detrimental effects on productivity, especially through the indirect route. As discussed in the literature in section 2.5 of chapter 2, one-quarter of all adults suffer from malaria at any given time, which lasts a short duration, usually less than a week (Weil, 2010). However, malarial episodes in children can affect income in adulthood, especially in the case of cerebral malaria. Every year, 575,000 children under five in Sub-Saharan Africa contract cerebral malaria. 110,000 people die because of this. The remaining sustain neurological complications and developmental and behavioural issues (Murphy and Breman, 2001). This shows how diseases in childhood (not limited to malaria) can affect future productivity. This limitation is addressed in this chapter. The preliminary analysis starts with static models (fixed effects, random effects, OLS). The equation given below is used to estimate the determinants of labour productivity.

$$\ln lp_{i,t} = \gamma_i + \delta_t + \theta_1 \ln X_{i,t} + \theta_2 \ln GDPpc_{i,t} + \ln Edu_{i,t} + \ln Fd_{i,t} + \varepsilon_{i,t} \quad (4.1)$$

The logs of all variables are taken. *lp* is labour productivity, *X* is HALE and life expectancy at birth, *GDPpc* denotes economic activity, *Edu* is primary school enrolment and *Fd* is financial development, *i* and *t* signify country and year and ε is the error term.

I proceed to use the Auto Regressive Distributed Lag (ARDL) modelling. Mean group (MG), pooled mean group (PMG), and dynamic fixed effects (DFE) are three complementary estimators used in the ARDL framework. Studies employing this approach use panel regressions that are heterogeneous. (Pesaran and Smith, 1995; Makhlouf et al., 2020). The model is specified as follows:

$$\Delta lnlp_{i,t} = \theta_i[lnlp_{i,t-1} - \{\beta_{i,0} + \beta_{i,1}\mathrm{K}_{i,t-1}\}] + \sum_{j=1}^{p-1}\xi_{ij}\Delta lnlp_{i,t-j} + \sum_{j=0}^{q-1}\eta_{ij}\Delta\mathrm{K}_{i,t-j} + e_{it} \quad (4.2)$$

Lags of all variables are indicated with p and q in the equation above. The logs of all variables are taken, where lp is labour productivity for country i at year t. K represents the determinants of productivity and the control variables in logs. ξ and η denote short-run coefficients, β denotes coefficients over the long term, and θ is the adjustment coefficient, which should be negative and significant if the model used is valid.

Three different criteria, Akaike's (AIC), Schwarz (SIC) and Final Prediction Error (FPS), are used for ARDL models. In comparing these criteria for selecting the model order, studies show that AIC will overfit the data and SIC is a better criterion for application when the sample size is large (Koehler and Murphree, 1988; Gayawan and Ipinyomi, 2009). This is confirmed by Liew (2004), whose study shows that AIC and FPE are better when dealing with smaller samples, that is, 60 observations and below. This is crucial because they diminish the risk of bias in results produced while improving the likelihood of retrieving the actual lag length. Since this study uses more than 500 observations, SIC is the best criterion to use. The model specified above captures the long and short-run relationship between health (proxied by HALE and life expectancy) and labour productivity. The theoretical literature points to a positive long-run relationship between health and productivity, bearing in mind the demographic transition effect. In this instance, the association between health and productivity is expected to be negative for countries still experiencing low life expectancy, high fertility, and high death rates.

4.5.1 Robustness Checks – Quantile Regression

To complement the fixed effects, OLS and ARDL results, this study uses quantile regressions, which reduces the weight of differences in estimations (Koenker and Bassett, 1978; Koenker and Hallock, 2001). Symmetric and asymmetric weights are normally employed for quantile regressions, depending on the level being analysed. On the contrary, classical OLS regressions examine provisional mean functions. An advantage of quantile regression over OLS is that it goes beyond explaining just the mean of the dependent variable, as it can be used to examine any point of the distribution in the dependent variable. In other words, quantile regression analyses show how similar or different coefficients are. This chapter uses this approach to examine if the variations in health (differences in average life expectancy) influences labour productivity for different groups of countries.

One assumption in OLS estimation is that there is a normal distribution between the error term, and the dependent variable, resulting in unreliable estimates if the distribution is not normal. On the other hand, quantile regression does not require a normally distributed error term. This approach is used for the full sample to look at different parts of the distribution. I look at different quantiles 0.5, 0.25, 0.50, 0.75 and 0.95. An advantage of using quantile regressions is that it is robust to outliers, giving critical insights, especially in the sample used in this study where valuable information may lie in the tails of the distribution, given the small differences between countries. The estimation follows a linear approach and uses the model specified in equation 4.1 above. Table 4.15 shows results and discussions based on quantile regressions.

4.5.2 Divided Sample

Chapter 2, section 2.4, discussed the role of the demographic transition and how it influences economic growth. To test the demographic transition theory, the sample in this study is divided up. According to the theory, this transition represents a critical moment in population dynamics, as it facilitates the change from stagnation to growth (Cervellati and Sunde, 2011; Bloom et al., 2017, Foreman-Peck and Zhou, 2021). In the 1950s, the average life expectancy globally was 47 years, gradually increasing to 69 years between 2005-2010. By the end of the decade, 77 years was the expected life expectancy for the majority of developed countries, 73 years for countries in Latin America and the Caribbean (4 years shorter), 70 years for Asian countries, (7 years shorter), 56 years for all of Africa (21 years shorter), and 53 years for countries in Sub Saharan Africa (24 years shorter). The variations in the increases in longevity have been sustained by shifts in fertility, mortality and population growth, leading researchers to develop theoretical frameworks like the demographic and epidemiological transitions that explain these patterns (McCracken and Philips, 2016). The two main components of the demographic transition are centred around the decreases in mortality and fertility. These two factors determine population dynamics and how this subsequently influences economic growth. Since the second world war, developing countries have been going through the demographic transition at varying paces, with most countries in Sub Saharan Africa at the early stages. Sub-Saharan Africa has witnessed and will continue to experience tremendous population increases. Population growth was 183 million for the region in 1950, rising to 863 million by 2010. Current rates (2020) stand at 1.34 billion, with projected rises reaching 2.5 billion by 2050 (Roser et al., 2013). Estimated declines in crude birth and death rate in the period from 1985 to 2025 surpass, by almost a fourth, the previous increases from 1950 (Eastwood and Lipton, 2011). This follows a similar pattern as seen in Asia, where population growth peaked 20 years before the projected peak in Sub Saharan Africa. For Asia, the subsequent decreases in the dependency ratio have been associated with many advantages, especially rapid economic development (Bloom et al., 1998; Bloom et al., 2000).

I split the sample to analyse, if a similar pattern can be expected in Sub Saharan African countries, that have started the demographic transition. One aspect of this, is that population health in countries that have higher life expectancies see a positive and significant influence on their labour productivity. To determine whether a country has reached the transitional stage, the literature proposes 3 main criteria: 1) life expectancy exceeds 50 years, 2) there is a constant fall in rates of fertility and 3) birth-rate has dropped below the threshold of 30/1000 (Chesnais, 1992; Cervellati and Sunde, 2011). This is discussed extensively in chapter 2, section 2.3. Fertility and death rates are similar across all countries in Sub Saharan Africa; however, there are minor differences in life expectancy. The mean for life expectancy in the region is 52; therefore, this is used to divide up the countries, those below and those above the mean. Countries with life expectancy from 28 to 52 in one group and those with life expectancy from 52.1 to 74 in another group.

Alternative variable for education

As shown in 4.4.3 above, education is a positive determinant of economic growth. I use an alternative variable of education for robustness. Primary school enrolment is used in the main analysis, and the average years of schooling and returns to education (one variable), which is available for a limited number of countries in Sub Saharan Africa, is used for robustness checks. Studies that have used alternative variables for education in their analyses to show its varying effects on economic growth includes Artidi and Sala-i-Martin (2003) and Lawanson (2015).

4.6 Empirical Results and Discussion

The discussion of the empirical analysis starts by presenting fixed effects and pooled Ordinary Least Squares (OLS) results. This is followed with ARDL results, which shows both the long and short-run effects of the influence of population health as expressed through Health Adjusted Life Expectancy (HALE) and life expectancy, on labour productivity for Sub Saharan African countries.

To control for heteroskedasticity, this analysis firstly uses fixed effects and random effects and compares them with pooled OLS. Tables 4.4 and 4.5 presents the results from these estimations based on equation (4.1), using life expectancy as the indicator for population health. It shows the fixed effects results (column 1) are supported by the Hausman test. Bell and Jones (2015) suggest that, in most analyses, the random-effects model cannot be estimated consistently because the country effects are associated with the independent variables. However, the results from random effect and pooled OLS are shown for comparative purposes in columns 2 and 3.

The fixed effect estimator indicates that life expectancy has a positive and significant impact on labour productivity. This supports the finding of other studies that have used fixed effects (Cole, 2019; Alvi and Ahmed, 2014). The signs for the control variables; primary school enrolment, GDP per capita and financial development are as expected. The results from these static models do not differentiate between long and short-run effects, an important consideration given that any improvements in life expectancy is not realised over the short run. This is addressed in Table 4.6, where the ARDL results from PMG, MG and DFE are presented.

Table 4.4
Labour Productivity and Life Expectancy
(Static Models)

VARIABLES	(1) FE	(2) RE	(3) POOLED OLS
Life expectancy	0.866***	0.879***	3.785***
	(0.067)	(0.068)	(0.184)
Constant	4.496***	4.458***	-7.209***
	(0.272)	(0.305)	(0.739)
Observations	1,353	1,353	1,353
R-squared	0.110		0.238
N	36	36	36
Time (1984 – 2018) 34yrs			

Notes: Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$ are statistically significance at the 1%, 5% and 10% levels respectively.

Table 4.5
Labour Productivity and Life Expectancy with control variables
(Static Models)

	(1)	(2)	(3)
VARIABLES	FE	RE	POOLED OLS
Life expectancy	0.212***	0.005	-0.065
	(0.035)	(0.032)	(0.079)
GDP per capita	0.912***	0.865***	1.112***
	(0.012)	(0.0126)	(0.011)
Primary s. enrolment	0.078***	0.033***	0.075***
	(0.012)	(0.01)	(0.024)
Financial development	0.000***	0.000	-0.001***
	(0.000)	(0.000)	(0.000)
Constant	0.459***	1.794***	0.657***
	(0.164)	(0.137)	(0.260)
Observations	1,047	1,047	1,047
R-squared	0.908		0.944
N	36	36	36
Time (1984 – 2018) 34yrs.			

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

4.6.1 The Influence of Life Expectancy on Labour Productivity

The discussion of the ARDL results focuses on the PMG estimator as it is viewed as the most efficient estimator compared to MG and DFE (Shin et al., 2014; Nkoro and Uko, 2016; Shrestha and Bhatta, 2018). The Hausman test performed confirms this assertion, and the error correction term for PMG, MG, and DFE are all negative and significant. Table 4.6 shows the PMG results, which indicate that life expectancy has a positive but insignificant influence on labour productivity in the short run. However, the long-run impact is positive and significant on the productivity of labour with a coefficient value of 0.61. This implies that a 1 percent increase in life expectancy increases labour productivity by 0.61 percent. This supports the literature on the health productivity relationship, particularly for developing countries. A growing number of empirical literature supports the positive and significant association between education and productivity, including the findings of Kumar and Chen (2013), who, when examining the dynamics of cross-country productivity differences, find that education, measured by average years of schooling has a positive effect on productivity. Other studies that have used government expenditure on education, secondary and tertiary enrolment, and completion rates as proxies for education, have all shown a positive effect of education on productivity, with developed countries experiencing higher rates of return (Kim and Loayza, 2017; Israel et al., 2019; Dua and Garg, 2019).

For economic activity and financial growth measures, GDP per capita shows a positive and significant influence on productivity, in the long run, echoing the findings of Cole and Neumayer (2006), Alvi and Ahmed (2014) and

Isreal et al. (2019). The financial development measure summarises the depth, accessibility, and efficiency of developed financial institutions and markets. The results show that from 1984 - 2018, financial development has had no positive or significant influence on labour productivity for the 36 countries in Sub Saharan Africa in this analysis. Financial development influences economic growth positively for developing countries by increasing the productivity of investments (Ghirmay, 2011; Hassan et al., 2011). Law and Azman-Saini (2012) suggest that variations in financial development across countries can be explained by the quality of their institutions.

TABLE 4.6
Productivity and Population Health (Life Expectancy)
(ARDL Models)

	(1)	(2)	(3)
VARIABLES	**PMG**	**MG**	**DFE**
Long-run coefficients			
Life expectancy	0.610***	-0.139	-0.937
	(0.058)	(0.503)	(0.697)
GDP per capita	0.915***	0.913***	0.375
	(0.009)	(0.141)	(0.296)
Primary sch. enrolment	0.090***	-0.006	0.279
	(0.020)	(0.109)	(0.210)
Financial development	-0.002***	0.036	0.073
	(0.000)	(0.034)	(0.081)
Short run coefficients			
Error-correction coefficients	-0.089**	-0.259***	-0.018**
	(0.042)	(0.069)	(0.009)
Life expectancy	2.337	2.263	-0.139**
	(1.597)	(2.151)	(0.065)
GDP per capita	0.853***	0.754***	0.923***
	(0.048)	(0.069)	(0.017)
Primary sch. enrolment	0.003	-0.010	-0.013
	(0.022)	(0.030)	(0.012)
Financial development	0.000	0.008	0.001
	(0.000)	(0.012)	(0.003)
Constant	-0.113**	0.0151	0.141***
	(0.052)	(0.477)	(0.041)
Observations	1,047	1,047	1,047
Hausman test		1.19	1.01
P-value		0.87	0.90
N	36	36	36
Time (1984 – 2018) 34 yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. PMG is a more efficient estimator than MG and DFE under the null hypothesis.*

4.7 The Effect of Health Adjusted Life Expectancy (HALE) on Productivity

As noted in the discussion of measures of population health (see subsection 4.4.2 above), life expectancy does not adequately account for the influence of health capital regarding morbidity, just mortality. To account for this, I switch to HALE as the measure of health capital. Table 4.7a and 4.7b presents results from the static models, which displays a positive and significant association between HALE and labour productivity in all the estimations. The association between the independent variables and labour productivity are also positive and significant, as expected. Table 4.8 presents the PMG, MG and DFE results of the effect of HALE on labour productivity. Data on HALE is from 1990-2018. The effect of HALE on labour productivity over the 28-year period confirms the positive and significant association seen when population health is proxied with life expectancy. However, the effect seen here is slightly larger than the impact life expectancy has on productivity for the same period (see table 4.9 below). This new measure reaffirms findings from the theoretical and empirical works, that confirm the important role population health plays in the process of economic development.

TABLE 4.7 (a)
Labour Productivity and Health Adjusted Life Expectancy (HALE)
(Static Models)

	(1)	(2)	(3)
VARIABLES	FE	RE	Pooled OLS
HALE	1.136***	1.145***	3.576***
	(0.075)	(0.075)	(0.241)
Constant	3.537***	3.506***	-6.064***
	(0.296)	(0.334)	(0.949)
Observations	1,013	1,013	1,013
R-squared	0.189		0.179
N	36	36	36
Time (1990– 2018) 28yrs.			

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

TABLE 4.7 (b)
Labour Productivity and HALE with other independent variables
(Static Models)

	(1)	(2)	(3)
VARIABLES	FE	RE	Pooled OLS
HALE	0.153***	0.168***	-0.225**
	(0.047)	(0.047)	(0.088)
GDP per capita	0.916***	0.943***	1.100***
	(0.017)	(0.016)	(0.011)
Primary sch. enrolment	0.072***	0.073***	0.051*
	(0.015)	(0.015)	(0.030)
Financial development	0.019***	0.017**	-0.015
	(0.006)	(0.006)	(0.013)
Constant	0.668***	0.435**	1.045***
	(0.221)	(0.216)	(0.336)
Observations	772	772	772
R-squared	0.870		0.946
N	36	36	36
Time (1990-2018) 28 yrs.			

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

TABLE 4.8
Labour productivity and Health Adjusted Life Expectancy (HALE)
(ARDL Models) 1990 – 2018

	(1)	(2)	(3)
VARIABLES	**PMG**	**MG**	**DFE**
Long-run coefficients			
HALE	0.503***	-0.077	-0.443
	(0.036)	(0.606)	(0.324)
GDP per capita	0.808***	0.972***	0.700***
	(0.012)	(0.223)	(0.122)
Primary sch. enrolment	0.192***	-0.093	0.170
	(0.029)	(0.163)	(0.106)
Financial development	-0.001***	0.003	-0.0565
	(0.000)	(0.034)	(0.0540)
Short-run coefficients			
Error-correction coefficients	-0.106**	-0.428***	-0.047***
	(0.046)	(0.083)	(0.012)
HALE	-0.459	0.552	-0.088
	(0.304)	(0.465)	(0.071)
GDP per capita	0.795***	0.566***	0.885***
	(0.051)	(0.083)	(0.025)
Primary sch. enrolment	0.016	0.033	-0.009
	(0.029)	(0.028)	(0.015)
Financial development	5.610	0.004	0.003
	(0.000)	(0.007)	(0.004)
Constant			
	-0.038***	1.366*	0.198***
	(0.014)	(0.743)	(0.0610)
Observations	772	772	772
Hausman test		0.54	0.43
P-value		0.96	0.99
N	36	36	36
Time (1990-2018) 28yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. PMG is a more efficient estimation than MG and DFE under the null hypothesis.*

Table 4.9
Labour productivity and Life expectancy for the same period
(ARDL Models) 1990 - 2018

VARIABLES	(1) **PMG**	(2) **MG**	(3) **DFE**
Long-run coefficients			
Life expectancy	0.434*** (0.046)	6.887 (6.665)	-0.805** (0.343)
GDP per capita	0.887*** (0.011)	-0.630 (1.352)	0.787*** (0.129)
Primary sch. enrolment	0.068*** (0.015)	0.188 (0.271)	0.213** (0.107)
Financial development	-0.001*** (0.000)	-0.005 (0.004)	-0.002 (0.002)
Short-run coefficients			
Error-correction coefficient	-0.167*** (0.055)	-0.515*** (0.085)	-0.048*** (0.012)
Life expectancy	3.900 (2.837)	4.779 (3.334)	-0.151* (0.081)
GDP per capita	0.757*** (0.059)	0.534*** (0.085)	0.882*** (0.025)
Primary sch. enrolment	0.026 (0.024)	0.037 (0.037)	-0.011 (0.015)
Financial development	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Constant	-0.043*** (0.016)	0.157 (0.753)	0.230*** (0.058)
Hausman test		1.73	0.06
P-value		0.78	0.99
Observations	772	772	772
N	36	36	36
Time (1990-2018) 28 yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. PMG is more efficient estimation than MG and DFE under the null hypothesis.*

Table 4.10
Countries in Sub Saharan Africa are divided based on the mean of life expectancy at birth (1960-2019)

Life expectancy above 52 years		Life expectancy below 52 years at birth	
Country	Life expectancy (mean)	Country	Life expectancy (mean)
Benin	51	Burkina Faso	48
Cabo Verde	63	Burundi	49
Cameroon	51	Congo Democratic Republic	49
Comoros	54	Cote d'Ivoire	49
Congo Republic	54	Ethiopia	49
Eritrea	51	The Gambia	49
Eswatini	51	Guinea	47
Ghana	55	Malawi	46
Kenya	55	Mali	43
Lesotho	51	Mozambique	46
Madagascar	53	Niger	45
Mauritania	57	Nigeria	45
Mauritius	68		
Namibia	55		
Sao Tome and Principe	60		
Senegal	53		
South Africa	57		
Seychelles	71		
Sudan	56		
Tanzania	51		
Togo	52		
Uganda	50		
Zambia	51		
Zimbabwe	54		

4.8 Testing the Demographic Transition Theory

The following results test the demographic transition theory (introduced in section 2.3) for countries in Sub Saharan Africa based on the divided sample mentioned in section 4.5 above. The demographic transition theory stipulates that the effect of improving longevity for economic development depends on the demographic stage of the countries under analysis (Cervellati and Sunde, 2011, 2015). Enhancements in life expectancy do not significantly change accumulation of human capital when countries are transitioning from stagnation to sustained growth. Once transitioned, improvements in population health have a positive and substantial influence on economic development (refer to chapter 2, section 2.5 for detailed discussion).

The PMG results for the sample with a life expectancy over 52 years of age (table 4.11) are consistent with results from the full sample. Here, life expectancy shows a positive and significant impact on labour productivity in the long run. This is in line with the theory for countries in the post demographic transition stage (see figure 4.3, discussion in chapter 4, section 4.2 and chapter 2, section 2.3). For this group of countries, the positive impact of improvement in life expectancy on productivity and increases in output is sustained over a longer time. This translates into a sustained rise in wages, increases in labour supply and eventually long-term economic growth. The signs and significance of all the independent variables are consistent with the fixed effects and random effects results in table 4.3 and echoes the findings in the extensive literature discussed above, where investments in education begin to take over.

The PMG results for the sample with life expectancy below 52 years of age (table 4.12) show that life expectancy has a negative and significant impact on labour productivity in the long run. This is again in line with the literature on the demographic transition where improvements in the low levels of life expectancy do not positively influence economic growth as it dilutes the capital available per worker. GDP per capita is the only variable that displays a consistently positive and significant influence on labour productivity for both the long and short term for this sample. Primary school enrolment shows (no impact in the short run) a negative association in the short run, but this turns positive and significant over the long-term.

Table 4.11
Countries with life expectancy above the mean
Labour productivity and Life Expectancy

(ARDL Models)

	(1)	(2)	(3)
VARIABLES	**PMG**	**MG**	**DFE**
Long run coefficients			
Life expectancy	0.227**	-0.336	0.182
	(0.091)	(0.317)	(0.166)
GDP per capita	-1.571*	1.900**	0.144
	(0.920)	(0.886)	(0.476)
Primary sch. enrolment	0.983***	2.732	0.274
	(0.362)	(2.903)	(0.244)
Financial development	0.012**	-0.006	0.006
	(0.005)	(0.018)	(0.006)
Short run coefficients			
Error correction coefficient	-0.009**	-0.182***	-0.016*
	(0.004)	(0.051)	(0.009)
Life expectancy	-0.001	-0.002	-0.000
	(0.001)	(0.001)	(0.003)
GDP per capita	0.925***	0.795***	0.923***
	(0.037)	(0.050)	(0.017)
Primary sch. enrolment	0.014	0.014	-0.011
	(0.021)	(0.021)	(0.011)
Financial development	0.000	0.000	8.260
	(0.000)	(0.000)	(0.000)
Constant	0.146**	0.441***	0.086***
	(0.061)	(0.142)	(0.029)
Observations	1,039	1,039	1,039
Hausman test		1.10	0.04
P-value		0.77	0.99
Time (1984-2018) 34 yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. PMG is a more efficient estimation than MG and DFE under the null hypothesis.*

Table 4.12
Countries with life expectancy below the mean.
Labour productivity and Health Adjusted Life Expectancy

(ARDL Models)

	(1)	(3)	(5)
VARIABLES	**PMG**	**MG**	**DGE**
Long run coefficients			
Life expectancy	-0.012***	0.336	-0.182
	(0.004)	(0.317)	(0.166)
GDP per capita	1.068***	1.900**	0.144
	(0.031)	(0.886)	(0.476)
Primary sch. Enrolment	0.035***	2.732	0.274
	(0.009)	(2.903)	(0.244)
Financial development	0.002***	-0.006	0.006
	(0.000)	(0.018)	(0.006)
Short run coefficients			
Error correction coefficients	-0.028**	-0.182***	-0.0160*
	(0.025)	(0.051)	(0.009)
Life expectancy	0.000	0.002	0.000
	(0.001)	(0.001)	(0.003)
GDP per capita	0.882***	0.795***	0.923***
	(0.041)	(0.050)	(0.017)
Primary sch. Enrolment	0.032	0.014	-0.011
	(0.023)	(0.021)	(0.011)
Financial development	0.000	0.000	8.260
	(0.000)	(0.000)	(0.000)
Constant	0.006	0.440***	0.089***
	(0.011)	(0.141)	(0.029)
Observations	1,039	1,039	1,039
Hausman test		3.99	0.03
P-value		0.79	1.00
Time (1984-2018) 34 yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. PMG is a more efficient estimation than MG and DFE under the null hypothesis.*

4.9 Robustness Checks

4.9.1 Using an alternative variable for education

In the regressions below, I use an alternative variable in place of primary school enrolment. This variable is defined as average years of schooling and returns to education. This is used in place of primary school enrolment. This variable exposes the differences in the level of education and educational capital within countries. The data is available for 30 out of the 36 countries initially used in the above analysis. Table 4.13 below shows static models when average years of schooling and returns to education is used in place of primary school enrolment. The association between life expectancy and labour productivity remains positive and significant. However, average years of schooling and the returns to education, shows a negative and significant impact on labour productivity, in the PMG results in table 4.14. This indicates that the overall level of education in Sub Saharan Africa needs to improve if the positive benefits of primary school enrolment (observed in tables above) are to be sustained.

TABLE 4.13
Labour productivity and Life Expectancy (using average years of schooling and returns to education in place of primary school enrolment)
(Static Models)

	(1)	(2)	(3)
VARIABLES	FE	RE	Pooled OLS
Life expectancy	0.303***	0.309***	0.291***
	(0.032)	(0.032)	(0.078)
GDP per capita	0.931***	0.939***	1.192***
	(0.012)	(0.012)	(0.012)
Average yrs. of sch.	-0.125***	-0.117***	-0.081***
	(0.022)	(0.022)	(0.026)
Financial development	0.001***	0.001***	-0.003***
	(0.000)	(0.000)	(0.000)
Constant	0.466***	0.377**	-1.234***
	(0.165)	(0.172)	(0.303)
Observations	1,068	1,068	1,068
R-squared	0.897		0.944
Number of countries	30	30	30
Time (1984 – 2018) 34 yrs.			

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 4.14
Labour productivity and Life expectancy (using average years of schooling and returns to education in place of primary school enrolment)

	(1)	(2)	(3)
VARIABLES	PMG	MG	DFE
Long-run coefficients			
Life expectancy	0.321***	-1.475	0.188
	(0.046)	(1.134)	(0.341)
GDP per capita	1.038***	1.070***	0.581***
	(0.025)	(0.281)	(0.189)
Average yrs. of sch.	-0.357***	0.170	-0.156
	(0.044)	(0.290)	(0.165)
Financial development	-0.004***	0.000	0.002
	(0.000)	(0.001)	(0.003)
Short-run coefficients			
Error correction coefficient	-0.083**	-0.307***	-0.0242***
	(0.032)	(0.046)	(0.009)
Life expectancy	0.806	-0.211	-0.090
	(1.159)	(1.276)	(0.063)
GDP per capita	0.858***	0.661***	0.898***
	(0.037)	(0.047)	(0.017)
Average yrs. Of sch.	0.114	-1.302	-0.042
	(0.649)	(0.854)	(0.052)
Financial development	0.001	0.000	0.000
	(0.000)	(0.000)	(0.000)
Constant	0.178***	1.330**	0.081**
	(0.044)	(0.539)	(0.037)
Observations	1,068	1,068	1,068
Hausman test		1.42	1.61
P-value		0.51	0.99
N	30	30	30
Time (1984-2018) 34 yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. PMG is a more efficient estimation than MG and DFE under the null hypothesis.*

4.9.2 Quantile regression results

The regression results using five different quantiles (0.05, 0.25, 0.50, 0.75, 0.95) are presented in table 4.15 for the relationship between health and labour productivity. The results here show that the coefficients between and among the different quantile estimates are different for most of the independent variables analysed. It confirms the initial results in this chapter, which suggests that life expectancy has had a positive and significant impact on labour productivity, especially for countries in the region whose current life expectancies exceeds 52 years of age. It is also in line with the general literature on the relationship between poor health, represented here with low life expectancy, productivity, and economic growth (refer to section 4.3 above). Countries at the lower end of the quantile (0.05, 0.25, 0.50) see that their life expectancy exerts a negative and significant impact on the productivity of labour, whereas for those at the upper end of the quantile (0.75 and 0.95), see the opposite positive and significant effect, suggesting that as life expectancy improves, it's effect on productivity also improves. These results are echoed in the empirical literature. For example, Weil (2004) points out that income level within a country is determined by health capital, which determines how productive and efficient the available labour can be. Health capital partly explains the differences in production levels between developed and developing countries. Taking life expectancy as an example, Europe, North America, and Asia had the fastest growing economies (GDP per capita), with Latin America experiencing the smallest growth (Azomahou et al., 2009). These results also confirm how the health to economic growth relationship changes as life expectancy rises, as suggested by the demographic transition literature (see chapter 2, section 2.3). That is, the positive impact of improvements in life expectancy is only seen when life expectancy reaches a certain level.

Bloom et al. (2001) study showed that each additional year of life expectancy correlates with a 4% boost in productivity growth. Similarly, Chirikos and Nestel (1985) stipulate that the average declines in productivity caused by early mortality, accounts for 20 percent of losses in productivity. GDP per capita is important at all levels of life expectancy. Education expressed through primary school enrolment shows more of an impact on countries with low life expectancies. As life expectancy improves, the positive and significant effect on primary school enrolment is lost, becoming negative and significant at very high levels of life expectancy. At this stage, higher levels of education are needed to sustain and improve the gains in productivity (Annabi, 2017).

Table 4.15
Quantile regression coefficients at different quantiles full sample (1984-2018)

VARIABLES	(1) Quantile regression at 0.05 quantile	(2) Quantile regression at 0.25 quantile	(3) Quantile regression at 0.50 quantile	(4) Quantile regression at 0.75 quantile	(5) Quantile regression at 0.95 quantile
Life expectancy	-0.355*** (0.129)	-0.394*** (0.101)	-0.355*** (0.129)	0.246*** (0.073)	0.550*** (0.174)
GDP per capita	1.151*** (0.020)	1.049*** (0.016)	1.151*** (0.020)	1.228*** (0.011)	1.261*** (0.027)
Primary enrolment	0.0650* (0.0393)	0.110*** (0.030)	0.065* (0.039)	-0.034 (0.022)	-0.111** (0.052)
Financial dev.	-0.000 (0.001)	0.001** (0.000)	-0.000 (0.001)	-0.006*** (0.000)	-0.008*** (0.001)
Constant	1.072** (0.453)	1.541*** (0.355)	1.072** (0.453)	-1.097*** (0.258)	-1.997*** (0.609)
Observations	1,124	1,124	1,124	1,124	1,124

Notes: Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$ are statistically significance at the 1%, 5% and 10% levels respectively.

4.10 Conclusion

In this chapter, I explore the morbidity and mortality aspects of population health and address the potential long-term and short-term effects of population health on labour productivity and how this influence economic development for developing countries in Sub Saharan Africa, an important consideration that has not been addressed in the literature. I find that increases in life expectancy in Sub Saharan Africa from 1984 to 2018 has had a positive and significant impact on the productivity of labour. Countries in the region whose life expectancy is above 52 years of age are more likely to see the benefits of improvements in morbidity and mortality in the long run, as well as the positive effects of investments in education. These results suggest that policies aimed at improving economic growth through the direct channel of productivity should firstly include population health in the classification of human capital. Secondly, they should not only focus on mortality-based indicators like life expectancy but also look at how morbidity might influence productivity for individual countries based on their current fertility, mortality, and morbidity rates. It is important to acknowledge that this empirical study has used only one measure of productivity. The effect of population health could be different if other measures of productivity are used. Therefore, the long-run influence of population health on economic development through other measures of productivity is still an open issue, awaiting further work as more data becomes available.

CHAPTER 5

5 Health, FDI and Economic Development

5.1 Introduction

Chapter 4 examined one of the main (direct) channels through which health affects economic growth: labour productivity. The overall results showed that improving health is a prerequisite for improvements in productivity which increases output within an economy. The effect of health expressed through life expectancy and health adjusted life expectancy (HALE) on productivity was positive and significantly higher for countries with life expectancy over 52 years compared to countries whose average life expectancy was below 52 years. For developing countries like those in Sub Saharan Africa, where there is a high burden of disease, improvements in productivity alone, a direct channel from health to growth has not been sufficient in most countries to sustain economic growth rates. Similarly, this has not made any significant reductions in poverty or lowered the high rates of unemployment. To accelerate development and structural transformation in the region, an external source of financing, therefore, becomes essential. The next step in this chapter considers how improvements in population health influence Foreign Direct Investment (FDI), an indirect channel.

One source of finance that has become increasingly important for countries worldwide is FDI. It has been argued that drawing in FDI is vital for all countries, irrespective of their developmental stage; however, for developing countries, this is vital, as they have lower income levels and savings rates (Loayza et al., 2000; Alsan et al., 2006). FDI plays a crucial role in reducing poverty and encouraging economic growth in these countries (Klein et al., 2001; see the results in chapter 3). For these countries, FDI is not only a source of capital, but also increases tax revenue in the host economy; creates jobs; provides access to global markets for local firms, which facilitates the transfer of technology, all benefits that are well established in the literature (Loungani and Assaf, 2001; Demirhan and Masa, 2008; Turkson et al., 2015; Alam et al., 2016).

The Commission on Macroeconomics and Health (CMH) asserts that to attract FDI, the population in the host country must have a healthy workforce (WHO, 2001). This statement has been made by many other international organisations, such as the National Bureau of Economic Research (NBER, 2005) and the World Bank (World Bank, 2006), with such claims reinforcing the importance of population health for global development. Furthermore, creating the desirable conditions domestically and internationally that can facilitate net FDI inflows to developing countries, was the agreement made at the United Nations International Conference for Financing and Development (ICFD) in 2002 (Shaw, 2007). This objective has not been fully achieved to date, partly because there are limited empirical works on the link between population health and FDI, as only a few studies on developed and developing countries have examined this nexus, and as such, FDI is still not distributed evenly (Lipsey, 2001; Kokko, 2006; Buckley et al., 2010; Sabir et al., 2019).

Developing countries are continuously looking for new approaches to boost technology transfer and enhance economic development through FDI; however, only a few studies examine how health influences this relationship for countries in Sub Saharan Africa.

Although some studies include a limited number of countries from the region in their analysis, this is done mainly for comparison as Sub Saharan African countries are not the focus of these studies. For example, Alsan et al.'s (2006) sample of 74 countries includes only 18 countries from Africa. Azemar and Desbordes (2009) study of 70 developing countries consists of 28 countries from Sub Saharan Africa. Ghosh and Renna (2015) include 22 countries in the region to their sample of 114. Despite the crucial role of health and FDI for developing countries, only one recent study focusses exclusively on countries in Sub Saharan Africa, using HIV prevalence as the measure for population health and a dataset from 1990 to 2008 (Asiedu et al., 2015).

This chapter adds to the empirical literature in several ways. Firstly, it extends previous work that explores the influence of population health, proxied with life expectancy, on attracting FDI for 36 Sub Saharan African countries over an extended period (1960-2019), after controlling for other relevant variables. While the advantages of using HALE have been discussed in chapter 4, this measure is particularly important for FDI because health affects the productivity of labour directly and indirectly, with implications for attracting FDI. Workers in good health are more productive and less prone to miss work. On the other hand, poor health affects workers physically and mentally, affecting their nutritional levels, their wages and, at the aggregate level, their productivity (Alsan et al., 2006; Bhattacharjee, 2020). One indirect benefit of better population health is a longer lifespan for the working population (Woolf, 2015). While this is reflected in the current literature on how improved health impacts FDI for developed countries, no research has been undertaken on the long-term impact of health gains on FDI for countries in Sub Saharan Africa, as reflected by morbidity and mortality simultaneously. To address this gap, this chapter use the Health Adjusted Life Expectancy (HALE) in addition to the traditional proxy of health, life expectancy used in studies conducted in developed countries (see chapter 4, section 4.4.2 for advantages of using HALE).

Secondly, the two measures of health used (life expectancy and HALE) are interacted with education. This combination shows the joint effect of human capital on FDI inflows in countries in Sub Saharan Africa, contrasting the majority of studies that use only education as the proxy for human capital when analysing its influence on FDI inflows (Noorbakhsh et al., 2001; Wang, 2011). In addition, the econometric approach used in this chapter examines the long- and short-term effects of health on FDI, something that has not been explored for a large sample of countries in Sub Saharan Africa.

Thirdly, although countries in Sub Saharan Africa have minor differences in terms of economic growth and longevity status, which may have different implications for FDI inflows, they are typically clustered together and analysed as one with no distinctions. This chapter divides the sample of countries under analysis into two groups. One is based on income classification and the other on the level of FDI inflows as a percentage of GDP received from 1970 – 2018. Although these divisions could potentially lead to selection bias, they are vital as they will aid in a better understanding of the health effects of FDI inflows into countries within these groups, clarifying why some countries in Sub Saharan Africa have received higher levels of FDI inflows than others. These classifications have been used in similar studies which analysed the nexus between FDI and economic development for different regions in China (Clegg et al., 2004).

Their groupings included the level of economic development and inward FDI concentration, which they proxied with GDP per capita for the former and FDI divided by total domestic investment for the latter. Similarly, Blomstrom et al. (1994) classified countries by income level in their analysis on the growth of developing countries. Kasibhatla et al. (2008) grouped countries into high, medium, and low income in their study on the role of FDI in these countries.

This study finds that health, proxied by life expectancy and HALE, has had a negative and significant influence on FDI inflows for Sub Saharan African countries from 1990-2019. This significant effect disappears when considering the impact life expectancy has on FDI over a more extended period, from 1960-2019. The findings in this study validate the hypothesis that population health is vital in attracting FDI for developing countries, and are consistent with the results from studies that use individual diseases as proxies for overall population health (Asiedu et al., 2015; Immurana, 2020). More importantly, they indicate that Sub Saharan African countries are different, as shown in the divided sample. For countries classified as low income and those who have received FDI inflows below 100 billion from 1970-2018, HALE shows a negative and significant impact on FDI inflows. In contrast, for upper-income countries and those whose FDI inflows exceed 100 billion over the same period, HALE shows no effect on FDI inflows. According to the literature, a positive and significant effect should be seen here. This suggests that policies that have been successful in other regions may not yield the same results for Sub Saharan African countries.

This study indicates that the current level of human capital (health and education), GDP per capita and the high burden of disease explain the negative long-term impact of health on FDI for countries in Sub Saharan Africa. These results are consistent with findings from chapters 3 and 4. All three chapters (3, 4 and 5) show that the benefits from the demographic transition are only realised after health has reached a high enough level. Improvements in health prior to the demographic transition has a detrimental effect on GDP per capita and labour productivity as the gains in growth are diluted with the increasing population and high rates of unemployment. Similarly, this negative effect persists with foreign investment that could be a potential source of capital, but is drawn away from countries with poor health, given the low levels of productivity in these countries and potential loss to their investment.

The remainder of this chapter is structured as follows. Section 5.2 presents stylised facts on FDI inflows to developed and developing countries, 5.3 explains the theory of FDI inflows and reviews the empirical literature that has considered the impact that population health has on FDI in developing countries. Section 5.4 outlines the methodology and data used in this study. Section 5.5 presents the empirical results with discussion and robustness checks. Section 5.6 concludes this chapter.

5.2 Stylised Facts

In 1982, FDI inflows globally were $64.8 billion, rising sharply to $755 billion in 2002 and reaching $1.744 trillion in 2019 (UNCTAD, 2020). The most likely destinations for FDI are developed economies, although certain emerging countries receive more inflows than others. (Alesina and Weder, 2002). FDI to the least developed countries was on the rise from 2002 ($5.9 billion) to 2015 ($38.5 billion) but has been on a steep decline and is currently around 2008 values, a decrease to $18.4 billion (World Bank, 2020). Africa's share of global FDI is only 2.9 percent. In addition, the continent as a whole registered a decrease in FDI in 2019 (Narula, 2002; Blomstrom and Kokko, 2003; Yean et al., 2018). Countries in the north of Africa, like Egypt, received an increase in their FDI, but for most of those in Sub Saharan Africa, there was a fall in FDI. FDI to the region increased substantially from 1990 to 2001, starting at 0.28 percent of GDP in 1990 and rising to 4.094 percent of GDP in 2001. A sharp decline follows from 2001 with recent figures in 2019 equating to 1.682 percent of GDP for all countries in the region (see figures 5.1 and 5.2).

Figures 5.1: FDI Inflows, Top Host Economies in Africa

https://unctad.org/news/covid-19-slashes-foreign-direct-investment-africa-16

Image source: UNTCAD (2019)

Figure 5.2: FDI Net Inflows (% of GDP) – Sub Saharan Africa

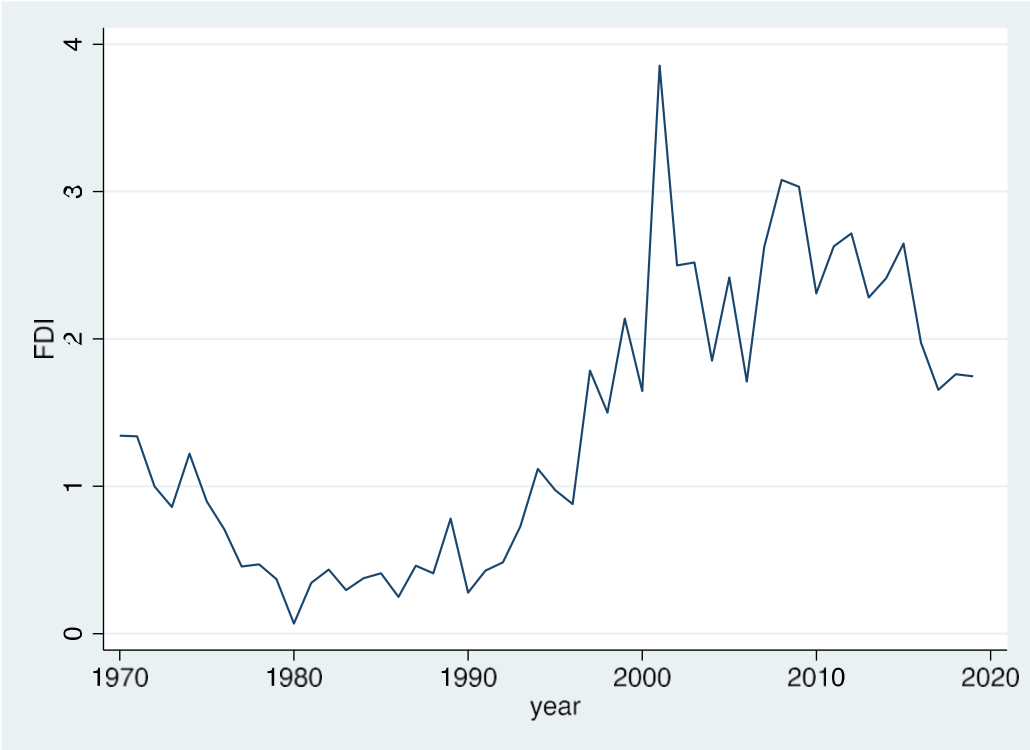


Figure 5.3: Life Expectancy and FDI in Sub Saharan Africa

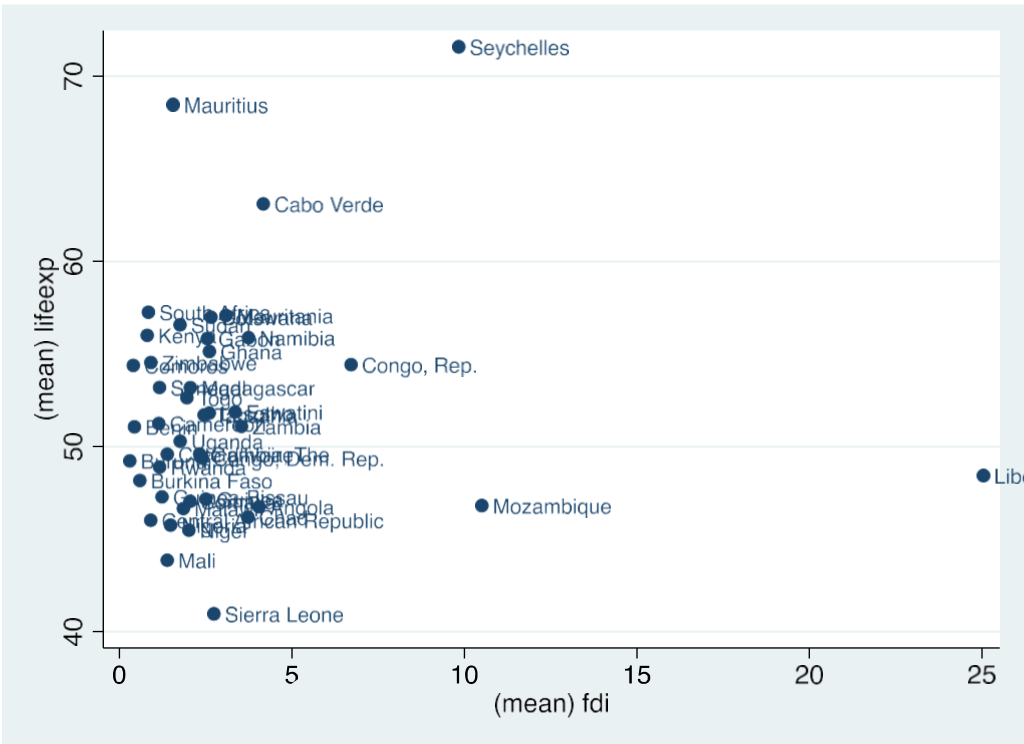
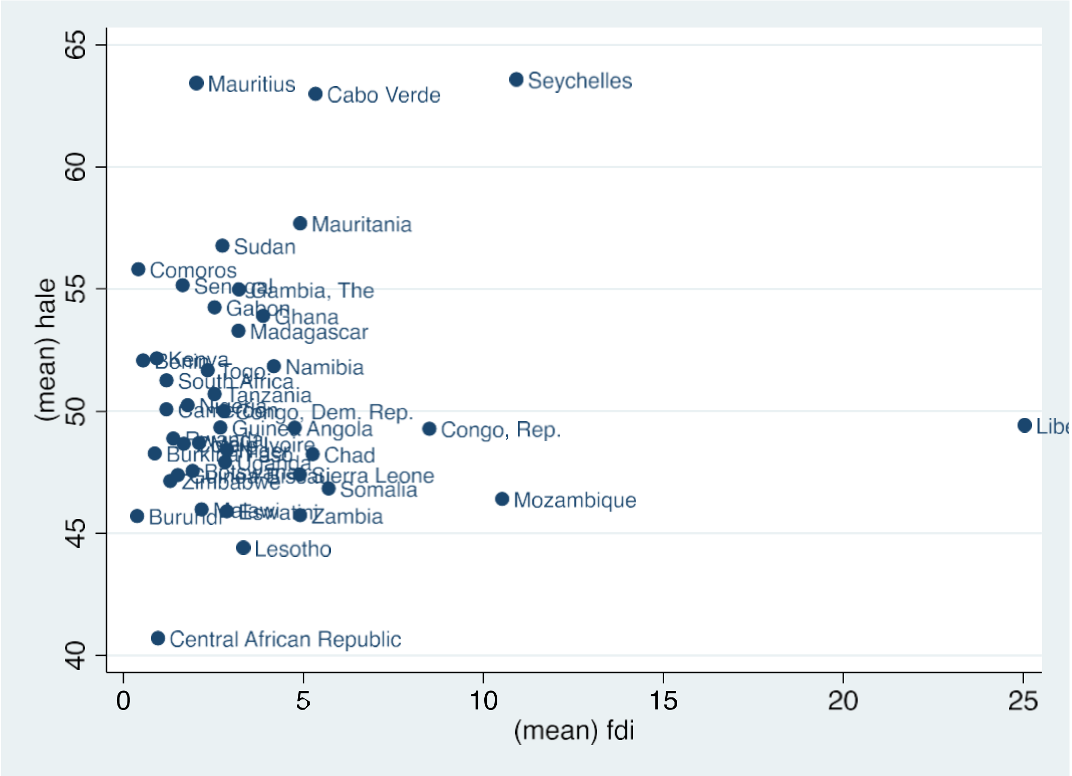


Figure 5.4: HALE and FDI in Sub Saharan Africa



5.3 Literature and Theoretical Underpinnings

Dunning's (1977) theoretical structure, the "eclectic theory", provides a framework for determining the extent and patterns of FDI, categorising them into three groups: ownership, a source of internalisation for the host country and location. The theoretical literature has evolved to include an abundance of resources such as infrastructure, raw materials, market size (Dunning, 1982), and the skills and educational level of the labour force (Lucas, 1990). The idea that investing firms will be interested in the human capital (health and education) of the population in a host country is not implausible, as this has also been embedded in the theoretical literature (Becker, 1962; Eicher and Kalaitzidakis, 1997). Differences in human capital in less developed countries discourage FDI inflows whereas the composition of the labour force, and availability of infrastructure has an impact on the amount of FDI inflows and the activities that international enterprises undertake in a country (Dunning, 1973; Lucas, 1990; Zhang and Markusen, 1999). The product life cycle theory of FDI and the eclectic paradigm suggests that the key driver of FDI inflows is investment returns. (Vernon,1992; Dunning 1973, 1977, 2000). Population health is an important component of human capital (Becker, 1962). A country with better population health not only improves their productivity as shown in the preceding empirical chapter (chapter 4), and by studies including the works of Arora (2001), Alvi and Ahmed (2014), but better health also improves the profitability of firms. The indication is that good population health can have an impact on the amount of FDI a country receives.

The level of educational capital is essential, especially in the case of international organisations operating in skill-intensive industries (Miyamoto, 2008; Liesbeth et al., 2009; Kheng et al., 2017). Hanson (1996) examines how educational capital impacts FDI for 75 least developed countries and finds a positive and significant impact. Likewise, Noorbakhsh et al. (2001) and Kheng et al. (2017), focusing on developing countries in their studies, find that secondary education, tertiary education, and government expenditure on education all statistically and positively influence FDI inflows. Health capital can also affect FDI through several mechanisms. Poor population health affects the profitability and manufacturing costs of a company. This is because the turnover of workers is high as new workers must be recruited and trained constantly. In developing countries where public health provision is limited, firms also incur higher medical coverage costs, increased life insurance benefits and commitments to pension funds that must be paid out earlier due to shorter life spans (Ghosh and Renna, 2015). Again, foreign investors may abstain from countries with high disease rates for fear of endangering the lives of expatriate staff, given their lack of resistance to certain diseases in the host country. For example, the sickle cell trait is prevalent in a small number of the African population, while a significant proportion has developed resistance to malaria due to recurring infections (Grosse et al., 2011). A study on how multinational corporations invest in Africa found that for 33 percent of firms in 43 African countries, HIV/AIDS has negatively affected their access to FDI over the past five years (Asiedu and Gyimah-Brempong, 2015). In addition to affecting the cost involved in the production process, healthy populations are more productive, earn higher wages, and create larger market for goods and services, which has a direct impact on the level of demand.

Although there are many empirical works on the factors that influence FDI in developing countries, many of these analyses use education for human capital and do not take the role that population health plays into account. This limitation of excluding health as part of human capital also applies to studies conducted on countries in Sub Saharan Africa. For instance, Agbloyor et al. (2016) study examined the factors that influence FDI from 1975 to 1999 for 29 countries in Africa, found that factors like the growth rate of GDP per capita and openness of the economy positively influence FDI inflows. Demirhan and Masca (2008) used 38 developing countries from 2000 to 2004 in their analyses and reached similar conclusions. Boga (2019) considered 23 countries in Sub Saharan Africa from 1975 to 2017 and found that GDP per capita, trade openness and natural resources are among the determinants of FDI into the region. Research that considers the determinants of FDI inflows into individual countries in Africa has also found that factors like GDP per capita, trade, and infrastructure positively and significantly influence FDI inflows (Asiamah et al., 2019; Maboa and Ncanywa, 2020). These studies used various measures of education but did not account for the role of health. Including the role of health in this analysis is an important consideration for Sub Saharan African countries given the high burden of disease.

A few recent papers that consider developed and developing countries have included health as an influencing factor in attracting FDI into their analysis (Alsan et al., 2006; Azemar and Desbordes, 2009; Asiedu et al., 2015; Ghosh and Renna, 2015; Hasan-Talukdar and Parvez, 2017; Olayiwola, 2019; Bhattacharjee, 2020).

The following section identifies the gaps in the literature by focusing on empirical studies that look at the influence population health has on FDI inflows in African countries, bringing in studies conducted on other developing countries where they offer insight relevant to this research question.

5.4 A Review of the Literature for Cross Country Analysis

The literature that looks at cross country analysis combines developed and developing countries in their examination of this relationship. These authors utilise different measures of FDI (net inflows and gross outflows) in their models and represent population health with either life expectancy, mortality rates, communicable diseases, or survival probabilities. These papers form an important part of the FDI and health debate as they show the different impacts health can have on FDI for different groups of countries.

Finding’s notable in the context of this study is from Alsan et al. (2006), who studied how population health influences FDI inflows in 74 industrialised and developing nations. Using data from 1980-2000, pooled Ordinary Least Squares (OLS) as the estimation technique, their findings indicate that if life expectancy increases by 1 year, FDI also increases by 9 percent in countries with low income. Of their low- and middle-income country sample, only 18 are located in Sub Saharan Africa. They control for other variables like education, income, governance, and infrastructure. As an extension to this work, Ghosh and Renna (2015) expand the measures of health and analyse how communicable diseases, age-standardised mortality rates and life expectancy influence FDI inflows for 114 countries. They use the instrumental variable approach and distance from the equator to address endogeneity. They assert that the lack of cold seasons in tropical and subtropical regions means that the insect population is not controlled (Diamond, 1999); thus, the distance from the equator has a significant influence on population health with an expected positive effect the further you are from the equator. Their results indicate that FDI decreases by 3.7 percent when mortality caused by communicable diseases increases by 1 percent. Similar to Alsan et al.’s (2006) work, their sample includes only a limited number of countries (22) from Sub Saharan Africa. 53 countries from their sample are either low/middle income, and the remaining are from middle/ high-income countries. Nonetheless, they do not divide up the sample of 114 countries. It is well known that the fundamental factors that determine whether FDI activities will occur in a country vary across least developed and developed countries (Blonigen and Wang, 2004). This suggests that the findings of Ghosh and Renna (2015) could be biased. This also makes it challenging to draw similar conclusions for Sub Saharan Africa as the overall effect of communicable diseases may have been reduced by their inclusion of developed countries where the burden of disease is low.

More recently, Bhattacharjee (2020) explores how longevity can attract FDI into middle-income countries from 1994-2014. Using life expectancy and the probabilities of surviving to old age as the indicators for health and a novel instrumental variable. They develop this instrumental variable as an exogenous determinant of how long an individual will live that is not linked to FDI flows. This they construct by using the convergence of longevity compared to average life expectancy globally. In line with previous studies, they find that FDI inflows increase by 5 percent with each additional year’s increment in lifespan.

5.4.1 The next set of studies consists of papers that focus on Africa.

In examining the determinants of FDI to developing countries, Asiedu (2002) makes an important observation that US companies that invest in Sub Saharan Africa have higher rates of return in comparison to investing in other countries. However, countries in Sub Saharan Africa have a lower likelihood of attracting US investors than non-Sub Saharan African countries. Furthermore, factors like capital investment and infrastructure that are known to promote FDI to non-Sub-Saharan African countries did not show any impact on countries in the region. These findings are confirmed and reinforced by studies conducted in the region that use other proxies for life expectancy in their analysis. For example, Azemar and Desbordes (2009) examine the relationship between population health, public governance and FDI for 28 countries in the region and find that if HIV and malaria were non-existent, FDI inflows into Sub Saharan Africa between 2000-2004 could have been one-third higher. Azemar and Desbordes (2009) assume a linear relationship between HIV and FDI and suggest that the deficit in FDI for countries in the region can be explained by the insufficient provision of public goods that cater to health and education in the region. To the best of my knowledge, the only study that focus exclusively on many countries in Sub Saharan Africa is by Asiedu et al. (2015), who question the assumption made by Azemar and Desbordes (2009). They examine the influence that HIV has on FDI for 41 Sub Saharan African countries from 1990-2008, with a two-step estimator in their empirical model. Their results indicate that HIV deters FDI to Sub Saharan Africa, and countries within the region that manage to reduce their infection rates are more likely to attract FDI. However, this applies only to countries that start with lower HIV infection rates as they also find that HIV has a non-linear and negative influence on FDI. A more recent study by Immurana's (2020) focus on one country in Sub Saharan Africa (Ghana) and examines the relationship between FDI and population health. He considers mortality rates, the incidence of malaria, and measles in addition to life expectancy, and finds that FDI inflows are significantly influenced by population health, regardless of the health metric used. Life expectancy showed positive and significant effects, whereas the various diseases showed the opposite effect. These studies show that poor population health negatively impacts FDI inflows into countries in Sub Saharan Africa.

As shown in the studies above, Alsan et al. (2006) and Bhattacharjee (2020) use the traditional measure of population health for middle income and industrialised countries in their studies. Ghosh and Renna (2015) use communicable diseases (HIV, malaria, and tuberculosis) as the measure of health but include only 22 countries in Sub Saharan Africa in their sample. Asiedu et al.'s (2015) sample is the only study that focuses exclusively on Sub Saharan Africa, but they use a narrow measure of health (HIV/AIDS) and do not control for geographical or institutional variations within the region. Their data is also limited to 2008. Although Azemar and Desbordes (2009) control for governance in their study on the region, they also limit their measures of health to only look at the impact of HIV/AIDS and malaria. Immurana (2020) uses the death rate and measles vaccine utilisation as additional health outcome indicators, in addition to life expectancy, but for only one country in Sub Saharan Africa. Furthermore, only fixed, and random effect estimators are used in his study, techniques that in most instances produce unreliable results and cannot differentiate the long and short-run effects of health on FDI.

Building on this limited literature, this study focuses on Sub Saharan Africa in exploring the association between population health and FDI inflows for 34 countries in the region using an extended dataset. I conduct a panel data analysis from 1960 to 2019.

I include an improved proxy of population health, the Health Adjusted Life Expectancy (HALE) that factors in morbidity and mortality, and includes notable diseases like malaria, HIV/AIDS, lower respiratory infections, and other communicable and non-communicable diseases. I also include variables known to influence FDI for countries in Sub Saharan Africa. This dataset is advantageous as it includes many countries in the region over an extended period, improving the degrees of freedom and thus enhancing the credibility of the results. Furthermore, using the HALE allows me to test the extent to which the overall burden of disease in combination with improvements in life expectancy explain the variation in FDI for the countries in Sub Saharan Africa. Countries in the region are also grouped by income level, and the amount of FDI received (below or above 100 billion) to analyse if health influences FDI to countries in these groups. Finally, Health and education are interacted to establish the influence of human capital (health and education) on FDI inflows for the region. The following section outlines the economic methodology used to examine the nexus between population health as expressed through Health Adjusted Life Expectancy (HALE), life expectancy, and FDI.

5.5 Methodology and Data

Empirical studies that examine the FDI and health relationship start with econometric approaches like pooled OLS, fixed effects, and random effects (Alsan et al., 2006; Immurana, 2020). Following this approach, I estimate equation 5.1 below using the suggested methods (OLS, fixed effects, and random effects) as a starting point. Population health is not an exogenous variable, and therefore it is subject to bias as it can influence FDI through its impact on economic growth. It is established in the theoretical and empirical literature that the growth rate of GDP per capita influences population health, and higher levels of health also affect economic growth positively. These associations suggest that OLS, fixed effects, and random effects estimates may be biased because of potential endogeneity. To overcome this limitation, I employ two dynamic approaches. Autoregressive Distributed Lags (ARDL) and Generalised Method of Moments (GMM). Dynamic models address endogeneity issues and can produce reliable estimates. ARDL is used in the main analysis, where HALE and life expectancy are used as the measures for health, while Generalised Method of Moments (GMM) is used for robustness checks. GMM addresses correlation and endogeneity when heteroskedasticity exists between the explanatory variables and the error term (Roodman, 2009).

As discussed in chapter 4, ARDL has the advantage of determining the long- and short-term outcomes. It also deals with endogeneity by incorporating the lags of the dependent and independent variables as additional explanatory variables and is, therefore, able to produce consistent coefficients (Nkoro and Uko, 2016; Shrestha and Bhatta, 2018). This approach has been used in similar studies on the relationship between FDI and population health; however, none of these studies focus on countries in Sub Saharan Africa (Alam et al., 2016; Shahbaz et al., 2016; Magombeyi and Odhiambo, 2017). More closely related to the present study in terms of approach used is the work by Jaiblai and Shenai (2019).

They use ARDL to examine the factors that attract FDI into Sub Saharan African countries, although they do not account for the role of health. Their analysis includes only ten countries in the region over a short period (1990-2017).

The preliminary analysis starts with static models (Fixed Effects (FE), Random Effects (RE) and pooled Ordinary Least Squares (OLS)). The equation to estimate the impact that population health has on FDI is specified as follows:

$$\ln fdi_{i,t} = \beta_1 ln\mathrm{X}_{i,t} + \beta_2 GDPpcgrowth_{i,t} + \beta_3 \ln Edu_{i,t} + \beta_4 \ln insti_{i,t} + \beta_5 \ln Open_{i,t} + \eta_s + c_i + \varepsilon_{i,t} \quad (5.1)$$

fdi represents net FDI inflows, *X* represents HALE or life expectancy at birth, *GDPpcgrowth* is the growth rate of GDP per capita, *Edu* is average years of schooling and returns to education, *insti* represents institutional quality, *Open* represents trade, η_s is the time-specific effect, and c_i is the country-specific effect.

The ARDL model is specified as follows:

$$\Delta lnfdi_{i,t} = \theta_i\left[lnfdi_{i,t-1} - \{\beta_{i,0} + \beta_{i,1}\mathrm{K}_{i,t-1}\}\right] + \sum_{j=1}^{p-1}\xi_{ij}\Delta lnfdi_{i,t-j} + \sum_{j=0}^{q-1}\eta_{ij}\Delta\mathrm{X}_{i,t-j} + e_{i,t} \quad (5.2)$$

The logs of all variables are taken except for the growth rate of GDP per capita. Where$\Delta lnfdi_{i,t}$ is foreign direct investment for country i at year t. K represents the determinants of FDI and the control variables which are life expectancy, GDP per capita growth, average years of schooling and returns to education, trade, and corruption. ξ and η denote short-run coefficients of the lags of all the regressors and dependent variable. β signifies long-run coefficients and θ indicates the adjustment coefficient. The data on HALE is limited and only available from 1990. This limits the period 1990-2019 (29 years) and with a sample of 34 countries, ARDL results may be biased as the number of countries (*N*) is greater than the period (*T*). I, therefore, use GMM here for robustness checks. I use the GMM approach recommended by Blundell and Bond (1998), an approach that is asymptotically efficient and resistant to heteroskedasticity of all kinds. GMM is also suited to this study as it deals well with endogeneity and can produce efficient results with a limited time dimension. By specification, the lag of the dependent variable is included in the GMM model; this also reduces potential autocorrelation that may result from a wrongly specified model.

The GMM model uses the same variables in equation 5.1 and is specified as follows:

$$lnfdi_{i,t} = lnfdi_{i,t-1} + \beta_1 lnX_{i,t} + \beta_2 GDPpcgrowth_{i,t} + \beta_3 lnEdu_{i,t} + \beta_4 \ln insti_{i,t} + \beta_5 \ln Open_{i,t} + \varepsilon_{i,t} \quad (5.3)$$

Data on HALE is from 1990 to 2019. Data on life expectancy for the same period (1990-2019) is used for comparative purposes. As life expectancy is available for a longer period, I also run regressions using data on life expectancy from 1960 to 2019.

Interaction between health and education

Equation 5.4 shows the interaction model between life expectancy at birth and average years of schooling, shown in the equation as $\beta_4 XEdu_{i,t}$

$$\ln fdi_{i,t} = \beta_1 ln X_{i,t} + \beta_2 \ln Edu_{i,t} + \beta_3 XEdu_{i,t} + \beta_4 GDPpcgrowth_{i,t} + + \beta_5 \ln insti_{i,t} + \beta_6 \ln Open_{i,t} + \eta_s + c_i + \varepsilon_{i,t} \quad (5.4)$$

5.5.1 Data

This empirical analysis employs panel data for 34 countries in Sub Saharan Africa from 1990 to 2019, where HALE and life expectancy are used to represent health. The list of countries included is shown in the appendix to this chapter (Section 5.9[11]). The choice of countries is solely dependent on the availability of data. A summary of data and sources is shown below. Net FDI inflow is the dependent variable, and population health, proxied with HALE and life expectancy at birth, are the predictor variables. For the control variables, average years of schooling and returns to education is used as the measure for education; market size is proxied by the growth rate of GDP per capita, trade is used as the measure of openness and the level of political corruption as the proxy for institutional quality. The literature guides the choice of these control variables (see, for example, Asiedu, 2002; Alsan et al., 2006; Acheampong and Osei, 2014; Asiedu et al., 2015; Immurana, 2020).

Data on FDI, life expectancy, GDP per capita growth and trade are sourced from World Bank, World Development Indicators. Data on average years of schooling and returns to education is sourced from Penn World Tables 10.0. Data on institutional quality is sourced from V-Dem, and data on HALE is sourced from Global Burden of Disease (GBD). Table 5.3 shows the correlation coefficients for the samples used. HALE shows a positive and significant association with FDI in table 5.3a. This positive and significant association can also be seen between life expectancy and FDI in tables 5.3b and 5.3c. In tables 5.3c, which uses the longest data from 1960 to 2019, life expectancy is second only to trade in correlation to FDI inflows.

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[11]Data from 1960 to 2019 is also used with the life expectancy measure. In this chapter, average years of schooling is used as the proxy for education, not primary school enrolment as used in chapters 3 and 4. The reason for changing the education variable for this chapter is that for investing firms, the overall rate of education and efficiency of the education system is what matters, playing a significant role in attracting FDI (Miningou and Tapsoba, 2020). Nonetheless, primary school enrolment is used for robustness checks.

Table 5.1
Data and their sources

Variable	Definition	Source
FDI	net inflows of capital into a company that operates in a country other than the investors.	World Bank, World Development indicators (2021)
Health Adjusted Life Expectancy (HALE)	Years lived in less-than-ideal health (YLDs) and years lost owing to early mortality (YLLs) are combined in a single measure of average population health to incorporate mortality and nonfatal outcomes.	Global Burden of Disease (2021)
Life expectancy	Life expectancy at birth indicates how many years a newborn would survive if current mortality patterns at the moment of its birth remained constant throughout its life.	World Bank, World Development indicators (2021)
GDP per capita growth	GDP is divided by the population during the midpoint of the year. The figures are in 2010 U.S. dollars.	World Bank, World Development indicators (2021)
Trade	The sum of commodities and services exported and imported, measured as a percentage of GDP.	World Bank, World Development indicators (2021)
Average years of schooling	based on the number of years spent in school and the returns to education	Penn World Tables 10.0
Institutional quality (political corruption)	This measure taps into several distinguished types of corruption, petty and grand, bribery and theft, and corruptions aimed at influencing law making that affects its implementation.	V-Dem (V-10)

Table 5.2 (a)
Summary Statistics of Variables Used in Analysis (1990 – 2019)

Variable	Obs.	Mean	Std.Dev.	Min	Max
FDI	1006	3.451	0.153	2.833	4.883
Life expectancy	1020	4.004	0.136	3.265	4.311
HALE	1020	3.913	0.125	2.216	4.177
GDP growth	1009	1.118	4.994	-47.503	37.535
Corruption	1020	0.613	1.132	-2.609	0.335
Trade	973	4.062	0.465	2.406	5.741
Av. Years of schooling	1020	1.699	0.427	1.03	2.939

Notes: All variables in logarithms except GDP growth. Data on all variables from 1990 – 2019.

Table 5.2 (b)
Summary Statistics of Variables Used in Analysis (1960 – 2019)

Variable	Obs.	Mean	Std.Dev.	Min	Max
FDI	1570	3.426	0.134	2.414	4.883
Life expectancy	2040	3.93	0.165	3.265	4.311
HALE	1020	3.913	0.125	2.216	4.177
GDP growth	1826	1.294	5.252	25.785	36.889
Corruption	2039	0.598	0.231	0.049	0.967
Trade	1731	3.987	0.507	1.844	5.741
Av. Years. schooling	2015	1.483	0.408	1.007	2.939

Notes: All variables in logarithms except GDP growth. Data on all variables from 1960 – 2019, except HALE, which is from 1990-2019.

Table 5.3 (a)
Correlation Matrix HALE and FDI (1990-2019)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) FDI	1.000					
(2) HALE	0.168*	1.000				
	(0.000)					
(3) GDP Growth	0.093*	0.201*	1.000			
	(0.001)	(0.000)				
(4) Trade	0.375*	0.203*	0.074*	1.000		
	(0.000)	(0.000)	(0.011)			
(5) Av. yrs. sch	0.066*	0.274*	0.074*	0.458*	1.000	
	(0.033)	(0.000)	(0.016)	(0.000)		
(6) Corruption	0.009	0.198*	0.177*	0.154*	0.189*	1.000
	(0.759)	(0.000)	(0.000)	(0.000)	(0.000)	

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 5.3 (b)
Correlation Matrix Life Expectancy and FDI (1990-2019)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) FDI	1.000					
(2) Life expectancy	0.187*	1.000				
	(0.000)					
(3) GDP Growth	0.093*	0.117*	1.000			
	(0.001)	(0.000)				
(4) Trade	0.375*	0.305*	0.074*	1.000		
	(0.000)	(0.000)	(0.011)			
(5) Av. yrs. sch	0.066*	0.410*	0.074*	0.458*	1.000	
	(0.033)	(0.000)	(0.016)	(0.000)		
(6) Corruption	0.009	0.257*	0.177*	0.154*	0.189*	1.000
	(0.759)	(0.000)	(0.000)	(0.000)	(0.000)	

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 5.3 (c)
Correlation Matrix Life Expectancy and FDI (1960 – 2019)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) FDI	1.000					
(2) Life expectancy	0.276*	1.000				
	(0.000)					
(3) GDP growth	0.158*	0.077*	1.000			
	(0.000)	(0.001)				
(4) Corruption	-0.050*	0.044*	-0.106*	1.000		
	(0.041)	(0.043)	(0.000)			
(5) Trade	0.348*	0.419*	0.150*	-0.207*	1.000	
	(0.000)	(0.000)	(0.000)	(0.000)		
(6) Av. yrs. sch	0.201*	0.627*	0.045	-0.013	0.414*	1.000
	(0.000)	(0.000)	(0.073)	(0.578)	(0.000)	

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

5.6 Empirical Results and Discussion

The analysis in this section presents OLS and fixed effect results, proceeding to the results from ARDL models (MG, PMG, DFE). PMG is the intermediate estimator between MG and DFE and assumes homogeneous coefficients in the long run, allowing for variations in the error term and the coefficients (Nkoro and Uko, 2016). This also enhances the identification of short-run differences across groups, recognising the number of observations presented for each group. MG estimator is the least restrictive but not as efficient as PMG as it averages the data and does not recognise that some parameters can be consistent for all groups (Ghouse et al., 2018). Although endogeneity exists in the data, MG produces consistent estimates of the mean of the long-run coefficients, but this becomes inefficient. The DFE approach allows intercepts to vary across the groups and allows for a dynamic specification. This study focuses on the findings from the PMG model given the results of the Hausman test, which suggests that PMG is the best approach, given that it is more robust and efficient.

5.6.1 Health and Foreign Direct Investment

Results from estimating equation 5.1 are presented in tables 5.4 when health is regressed on FDI. The results indicate that health, measured by HALE and life expectancy at birth, have a positive and significant association with FDI. This echoes the findings of (Asiedu, 2002) in their preliminary analysis where they use an OLS specification. The signs from the control variables (GDP per capita growth, average years of schooling, trade, institutional quality) are as expected.

When the control variables are included, the fixed effects results indicates that life expectancy, which only considers mortality, becomes insignificant (Table 5.5 b). Similarly, fixed effects results for HALE also shows no significant impact on FDI (Table 5.5a), suggesting that the low life expectancy and high morbidity rates in Sub Saharan Africa have not influenced FDI into the region. These findings re-emphasise the empirical results in chapter 3, where for 41 Sub Saharan African countries, the disease burden (DALYs) and individual illnesses including HIV, respiratory infections, and malaria negatively and significantly influence economic growth. In the full period (1960-2019), a positive relationship is found for life expectancy and FDI (Table 5.5c). However, the results from these static models do not differentiate between long and short-run effects, an important factor, given that the benefits of any improvements in health are not realised over the short run. This is addressed in table 5.6, where the ARDL results from PMG, MG and DFE are presented.

Table 5.4
Foreign direct investment and population health (HALE and Life expectancy)
(Static Models)

	HALE (1990 – 2019) **a**			Life expectancy (1990 – 2019) **b**			Life expectancy (1960 – 2019) **c**		
VARIABLES	FE	RE	OLS	FE	RE	OLS	FE	RE	OLS
Population health	0.201*	0.194***	0.130***	0.252**	0.240***	0.144***	0.263***	0.240***	0.144**
	(0.100)	(0.0438)	(0.0385)	(0.110)	(0.040)	(0.035)	(0.059)	(0.024)	(0.020)
Constant	2.662***	2.697***	2.940***	2.441***	2.494***	2.874***	2.387***	2.403***	2.574***
	(0.392)	(0.172)	(0.151)	(0.441)	(0.163)	(0.141)	(0.238)	(0.099)	(0.080)
Observations	1,006	1,006	1,006	1,006	1,006	1,006	1898	1898	1898
R-squared	0.020		0.011	0.036		0.016	0.054		0.056
N	34	34	34	34	34	34	34	34	34
Hausman test	0.006			0.021			0.002		

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 5.5
Foreign direct investment and population health with control variables
(Static Models)

	HALE (1990 – 2019) **a**			Life expectancy (1990 – 2019) **b**			Life expectancy (1960 – 2019) **c**		
VARIABLES	FE	RE	OLS	FE	RE	OLS	FE	RE	OLS
Population Health	0.085	0.134**	0.098**	0.137	0.171***	0.113***	0.149***	0.147***	0.087***
	(0.123)	(0.054)	(0.042)	(0.127)	(0.047)	(0.038)	(0.031)	(0.030)	(0.028)
GDP Growth	0.005	-0.003	0.016	0.116**	0.112***	0.117***	0.001***	0.001***	0.001***
	(0.047)	(0.030)	(0.032)	(0.042)	(0.016)	(0.011)	(0.000)	(0.000)	(0.000)
Trade	0.121***	0.117***	0.119***	0.082	0.030	-0.040***	0.073***	0.073***	0.070***
	(0.043)	(0.016)	(0.011)	(0.054)	(0.024)	(0.012)	(0.011)	(0.010)	(0.007)
Education	0.106**	0.048**	-0.035***	0.057	0.077*	0.060***	0.049***	0.044***	0.007
	(0.045)	(0.023)	(0.012)	(0.071)	(0.043)	(0.021)	(0.013)	(0.013)	(0.009)
Corruption	0.052	0.071	0.052**	0.016	0.017	0.032	0.048	0.058**	0.067***
	(0.073)	(0.043)	(0.022)	(0.026)	(0.027)	(0.030)	(0.031)	(0.028)	(0.015)
Constant	2.387***	2.338***	2.542***	2.189***	2.141***	2.423***	2.428***	2.445***	2.738***
	(0.352)	(0.185)	(0.164)	(0.461)	(0.194)	(0.176)	(0.118)	(0.117)	(0.104)
Observations	972	972	972	972	972	972	1471	1471	1471
R-squared	0.093		0.122	0.098		0.125	0.102		0.109
N	34	34	34	34	34	34	34	34	34
Hausman test	0.008			0.039			0.004		

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 5.6 (a)
HALE and FDI 1990 – 2019 (ARDL Models)

	(1)	(2)	(3)
VARIABLES	**PMG**	**MG**	**DFE**
Long run coefficients			
HALE	-0.101***	1.233	0.034
	(0.036)	(1.713)	(0.131)
Trade	0.025**	0.084**	0.049
	(0.010)	(0.040)	(0.039)
Growth	0.079***	0.130	0.075
	(0.022)	(0.131)	(0.086)
Av. Years of sch.	0.059***	-1.440	0.122**
	(0.022)	(1.881)	(0.062)
Corruption	-0.075**	0.003	0.032
	(0.037)	(0.544)	(0.118)
Short run coefficients			
Error correction model	-0.660***	-0.942***	-0.426***
	(0.058)	(0.070)	(0.028)
HALE	0.918*	-1.540	0.206**
	(0.478)	(1.771)	(0.086)
Trade	0.100***	0.060**	0.045*
	(0.028)	(0.027)	(0.024)
Growth	-0.042	0.015	-0.089***
	(0.043)	(0.045)	(0.030)
Av. Years of schooling	-9.679	-9.986	-0.631
	(9.985)	(11.820)	(0.480)
Corruption	0.0373	0.430	0.127
	(0.270)	(0.286)	(0.103)
Constant	2.356***	-1.405	1.116***
	(0.246)	(4.767)	(0.201)
Observations	938	938	938
Hausman		0.91	0.13
P-value		0.96	0.99
N	34	34	34
Time (1990 – 2019) 29 yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time (1990-2019). PMG is a more efficient estimator than MG and DFE under the null hypothesis.*

Table 5.6 (b)
Life Expectancy and FDI 1990 – 2019 (ARDL Models)

	(1)	(2)	(3)
VARIABLES	**PMG**	**MG**	**DFE**
Long run coefficients			
Life expectancy	-0.092***	-11.50	0.156
	(0.035)	(12.30)	(0.110)
Trade	0.030***	0.253	0.039
	(0.009)	(0.189)	(0.038)
Growth	0.103***	-0.273	0.093
	(0.028)	(0.308)	(0.078)
Av. Year. schooling	0.072***	7.334	0.075
	(0.023)	(8.715)	(0.066)
Corruption	-0.058	-3.179	0.034
	(0.039)	(3.156)	(0.118)
Short run coefficients			
Error correction coefficient	-0.686***	-0.959***	-0.432***
	(0.052)	(0.069)	(0.029)
Life expectancy	2.156	-3.223	0.281
	(2.279)	(0.440)	(0.288)
Trade	0.107***	-0.005	0.036
	(0.027)	(0.091)	(0.024)
Growth	-0.059	0.110	-0.041*
	(0.040)	(0.082)	(0.023)
Av. Years of schooling	-0.400	-5.520	-0.694
	(2.440)	(5.170)	(0.484)
Corruption	0.350	1.238	0.136
	(0.276)	(0.923)	(0.103)
Constant	2.338***	5.280	1.320
	(0.233)	(1.710)	(0.196)
Observations	938	938	938
Hausman		1.61	0.17
P-value		0.89	0.99
N	34	34	34
Time (1990-2019) 29yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time (1990-2019). PMG is a more efficient estimator than MG and DFE under the null hypothesis.*

Table 5.6 (c)
Life Expectancy and FDI – Extended period 1960 – 2019 (ARDL Models)

	(1)	(2)	(3)
VARIABLES	**PMG**	**MG**	**DFE**
Long-run coefficients			
Life expectancy	0.001	-11.140	0.189***
	(0.018)	(12.34)	(0.061)
Trade	0.035***	0.209	0.041*
	(0.007)	(0.186)	(0.021)
Growth	0.059***	6.687	0.064**
	(0.007)	(8.692)	(0.025)
Av. Year. schooling	-0.013	-2.975	0.055
	(0.016)	(3.126)	(0.059)
Corruption	0.053***	-0.246	0.085
	(0.015)	(0.303)	(0.053)
Short-run coefficients			
Error correction coefficient	-0.637***	-0.462***	-0.859***
	(0.046)	(0.0233)	(0.0525)
Life expectancy	2.729	-5.391	0.189
	(2.166)	(10.17)	(0.197)
Trade	0.070***	-0.033	0.030*
	(0.020)	(0.088)	(0.017)
Growth	-0.810	-3.330	-0.930***
	(2.420)	(5.140)	(0.284)
Av. Year. schooling	0.293	1.050	0.0458
	(0.191)	(0.876)	(0.065)
Corruption	-0.032	0.075	-0.028
	(0.029)	(0.079)	(0.017)
Constant	2.097***	8.491	1.156***
	(0.196)	(7.388)	(0.129)
Observations	1,433	1,433	1433
Hausman		1.50	0.40
P-value		0.91	0.99
N	34	34	34
Time (1960-2019)59 years			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time (1960-2019). PMG is a more efficient estimator than MG and DFE under the null hypothesis.*

5.6.2 The short and long-run effects of HALE and Life expectancy on FDI

Here, I present the ARDL results for the full sample. The PMG results in tables 5.6 (a) indicates that although the number of years a person can anticipate living in good health without being impeded by disease or injury (HALE) shows a positive and significant influence on FDI inflows over the short term, this effect becomes significantly negative over the long run. A one percent increase in HALE decreases FDI by 0.10 percent. Similarly, life expectancy for the same period (1990-2019) shows a negative and significant influence on FDI in the long run, where a one percent decrease in life expectancy decreases FDI inflows by 0.092 percent, as shown in table 5.6(b). HALE has a slightly stronger effect than life expectancy. This is as expected as HALE combines both morbidity and mortality, whereas life expectancy shows the effect of only mortality. The results here are for 29 years. This may not be a long enough period to realise the benefits of improvements in life expectancy. Since data on life expectancy is available from 1960, I use this longer dataset in table 5.6 (c). Here, life expectancy shows no influence on FDI both in the short and long-run periods. The literature points to some plausible reasons for the mixed results seen here.

The high burden of disease, the current level of GDP per capita and the level of human capital development. Primarily, the high burden of disease, unpredictability in mortality and morbidity resulting from recurring infectious diseases makes investing in Sub Saharan Africa risky. This view echoes empirical studies which find that agencies often classify African countries, especially those in the Sahara, as riskier than warrantied by the fundamentals when grouping countries based on their creditworthiness (Haque et al., 2000; Busse and Hefeker, 2007; Barassi and Zhou, 2012). The implication is not limited to individual countries in the region, but it informs the FDI choices of potential investor countries, dampening FDI inflows into Sub Saharan Africa as a whole (Ghosh and Rena, 2015; Immurana, 2020). Secondly, the current levels of human capital (health and education) in the region are not high enough to have a long-term impact on FDI inflows. To attract foreign investment, a healthy, educated, and skilled labour force and the necessary technological infrastructure must be in place in a host country. Findings from the interaction of health and education in this chapter show that overall human capital in Sub Saharan African countries does not influence FDI inflows (Table 5.17). Education in PMG results for the longest dataset (1960-2019) also shows no impact on FDI inflows. Although GDP per capita shows a long-run positive impact on FDI, current levels may not be high enough to sustain FDI. These findings are in line with other studies that have assessed the influence of life expectancy on FDI inflows in Africa. These studies, using measures like malaria, HIV, measles, and mortality rates, have found that they have a significant detrimental influence on FDI inflows (Asiedu, 2002; Azemar and Desbordes, 2009; Asiedu et al., 2015).

The other component of human capital, education, has a positive and significant influence on FDI only in the long run for all PMG models from 1990 - 2019, whilst for the longest period (1960-2019), education shows no influence on FDI inflows. The literature shows contradictory evidence on the significance of education in attracting FDI. Alsan et al. (2004) and Miningou et al. (2017) use secondary school enrolment and years of schooling and find that they have an insignificant effect on FDI, whilst Azam et al. (2015), Alarcon Osuna (2016) and Immurana

(2020) find positive and significant effects when using secondary enrolment, tertiary, and postgraduate enrolment. Miningou and Tapsoba (2020) suggest that any effect of education on FDI is largely dependent on the efficiency of the educational system in the countries under analysis. This implies that in attracting FDI, the ability of the labour force to appropriately convert its education into income is more significant than the level of education itself.

The positive effect of GDP per capita growth on FDI inflows is seen only in the long run for all tables (5.6 a, b, c). An economy whose growth rate is increasing signals the possibility of larger returns on investment. The influence of GDP growth on FDI in this study are similar to the findings of Asongu et al. (2018) and Asiamah et al. (2019), although they contradict Jaiblai and Shenai's (2019) work on the determinants of FDI into Sub Saharan African countries. It can be that the period used in their analysis (14 years) in addition to the limited sample, ten countries in Sub Saharan Africa is not long enough to capture the significant effects of GDP growth rate on FDI. Trade is the only variable that shows a positive and significant impact on FDI in the short and long run in all models. Due to the use of net FDI inflows in this study, excessive economic liberalisation may result in the repatriation of FDI returns to investors' home countries or the relocation of investments to other countries with greater expected returns, explaining how trade influences FDI (Asamoah Adu et al., 2019). Similarly, access to global markets and the presence of commodity production and resources that can be extracted and exported in vast amounts explain this positive impact.

To test for robustness, I add an institutional variable, political corruption, postulated to be a determinant of FDI inflows into Africa (Alesina and Weder, 2002). The PMG results suggest that political corruption shows a positive and significant influence on FDI in the short run when the extended data on life expectancy is used in table 5.6 (c). However, this effect is statistically negative and significant when HALE is used as the measure for population health (see table 5.6 (a)). Although corruption shows no significant detrimental effect in the long run when using life expectancy, there is also no positive effect in all tables. This implies that higher levels of corruption are associated with higher levels of FDI inflows in Sub Saharan Africa, at least in the short run. This finding validates the helping hand hypothesis, which states that corruption "greases" the wheels of commerce in the presence of weak regulatory frameworks and facilitates FDI (Huntington, 1968; Bendix, 1971). Quazi et al. (2014) reached similar conclusions when analysing the impact of corruption on FDI for 53 African countries from 1995 to 2012. Houston (2007) also found that corruption reduced economic growth in countries with strong legal and regulatory institutions, but the opposite was found in countries with weak institutions.

5.6.3 Divided Sample based on FDI received and income classifications

One important consideration for this study is understanding if there are any variations in FDI inflows within the countries in Sub Saharan Africa, and if the differences in population health can explain these variations. I, therefore, analyse this using a variety of restricted samples. The first is based on countries that have received high net FDI inflows between 1970 – 2018 and those who have received low net FDI inflows for the same period (see tables 5.7 and 5.8). In table 5.9, I present the FE, RE, OLS and ARDL results for the sample that received over 100billion in FDI inflows using HALE as the measure for health.

I present similar results in table 5.10 for the sample that received above 100 billion in FDI inflows, representing overall population health with life expectancy. Tables 5.11 and 5.12 present results from the income classification samples and use HALE as the measure of population health. Table 5.11 shows the results from the static models (FE, RE, OLS) and ARDL for the high- and middle-income sample. Table 5.12 presents similar results using the low-income sample. Table 5.15 shows countries in Sub Saharan Africa, their total FDI as a percentage of GDP from 1970 – 2019, their life expectancies at the start of the period and their life expectancies in 2019.

The fixed effects, random effects and pooled OLS results for the sample which has received low FDI inflows since 1970 shows that HALE has not influenced FDI (table 5.7 (a)), while life expectancy show a slightly positive and significant influence (table 5.8 (a)). The PMG results are like the results for the full sample; here, HALE shows a negative and significant impact on FDI inflows for countries in this group. Specifically, a 1 percent increase in HALE decreases FDI by 0.25 percent in the long run. In this sample, the current levels of political corruption and trade show a negative and significant influence on FDI in the long run. Table 5.8 (b) shows that life expectancy has no influence on FDI in both the short and long run for this sample. However, control variables like education and the growth rate of GDP positively and significantly impact FDI inflows. The fixed effects, random effects, and pooled OLS results for the sample, which has received above 100 billion, in FDI net inflows since 1970, shows that HALE and life expectancy has not had any influence on FDI (tables 5.9 (a), 5.10(a)). However, variables like GDP per capita growth, average years of schooling and trade all have positive and significant associations with FDI. In the PMG results, HALE, and life expectancy (tables 5.9 (b), 5.10 (b)) shows no effect in the long run. For this group of countries, life expectancy shows a positive and significant effect on FDI only in the short run.

The size of an economy can influence the amount of FDI received, suggesting that results from the second group of countries may be skewed, favouring large economies. I, therefore, use income classification: low income and middle to high income next, to divide the countries in the region, and use HALE which accounts for both mortality and morbidity. The results for the samples can be seen in tables 5.11 and 5.12. Here, HALE in countries classified as upper middle income shows no influence on FDI, whereas, for those within the low-income group, HALE shows a negative and significant influence on FDI in the long run. FDI is positively influenced by corruption for both groups. Within the low-income group, education is the only other variable that shows significant and positive long-run effects on FDI, whilst trade shows this effect for the middle- and high-income groups. These results show that even within Sub Saharan Africa, the impact of health expressed through HALE and life expectancy has on FDI, varies depending on the differences in income and the size of different economies.

Table 5.7 (a)
Sample that has received below 100 billion in FDI from 1970-2018
Foreign Direct Investment and HALE with control variables
(Static Models)

VARIABLES	(1) FE	(2) RE	(3) Pooled OLS
HALE	0.225	0.352**	0.190*
	(0.396)	(0.142)	(0.108)
Trade	0.170*	0.166***	0.185***
	(0.096)	(0.036)	(0.027)
Average yrs. Of schooling	0.349*	0.085	-0.150***
	(0.191)	(0.098)	(0.048)
Corruption	0.210	0.137	0.031
	(0.135)	(0.098)	(0.047)
GDP growth	0.000	0.001	0.001
	(0.001)	(0.002)	(0.002)
Constant	1.573	1.278**	2.022***
	(1.396)	(0.543)	(0.427)
Observations	407	407	407
R-squared	0.113		0.116
N	15	15	15
Time (1970-2018) 48yrs.			

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 5.7 (b)
Sample that has received below 100 billion in FDI from 1970-2018
Foreign Direct investment and HALE with control variables
(ARDL Models) – 15 countries

	(1)	(2)	(3)
VARIABLES	**PMG**	**MG**	**DFE**
Long-run coefficient			
HALE	-0.256**	3.062	0.226
	(0.099)	(3.849)	(0.375)
Trade	-0.104*	0.129	0.003
	(0.058)	(0.089)	(0.096)
Average years of schooling	0.091	-3.803	0.112
	(0.061)	(4.294)	(0.168)
Corruption	-0.324**	0.299	0.221
	(0.140)	(1.242)	(0.339)
GDP growth	0.002	0.003	0.005
	(0.002)	(0.005)	(0.005)
Short-run coefficient			
Error-correction coefficient	-0.535***	-0.877***	-0.402***
	(0.101)	(0.139)	(0.045)
HALE	1.496	-3.654	0.334
	(1.058)	(3.955)	(0.745)
Trade	0.206***	0.125**	0.047
	(0.042)	(0.050)	(0.052)
Average years of schooling	-1.320	-3.500	-1.754
	(0.690)	(4.570)	(2.151)
Corruption	0.010	0.703	0.164
	(0.684)	(0.589)	(0.206)
GDP growth	-0.002	-0.000	-0.004**
	(0.002)	(0.002)	(0.001)
Constant	2.852***	-2.269	-0.922***
	(0.542)	(1.740)	(0.525)
Observations	392	392	392
Hausman		1.72	0.43
P-value		0.88	0.99
N	15	15	15
Time (1970-2018) 48yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time (1970-2018). PMG is a more efficient estimator than MG and DFE under the null hypothesis*

Table 5.8(a)
Sample that has received below 100 billion in FDI from 1970-2018
Foreign Direct Investment and Life expectancy with control variables
(Static Models)

VARIABLES	(1) FE	(2) RE	(3) Pooled OLS
Life expectancy			
	0.299*	0.297***	0.191***
	(0.163)	(0.080)	(0.066)
Trade			
	0.101*	0.100***	0.092***
	(0.050)	(0.022)	(0.017)
Average yrs. Of schooling			
	0.073	0.062	-0.019
	(0.053)	(0.050)	(0.036)
Corruption			
	0.086	0.091	0.065**
	(0.129)	(0.073)	(0.032)
GDP growth			
	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Constant			
	1.762***	1.783***	2.283***
	(0.576)	(0.302)	(0.251)
Observations	594	594	594
R-squared	0.108		0.095
N			
Time (1970-2018) 48 yrs.			

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 5.8 (b)
Sample that has received below 100 billion in FDI from 1990-2019
Foreign Direct investment and HALE with control variables
(ARDL Models) – 15 countries

VARIABLES	(1) **PMG**	(2) **MG**	(3) **DFE**
Long-run coefficient			
Life expectancy	-0.136	-5.554	0.407**
	(0.110)	(8.752)	(0.165)
Trade	0.164***	0.133	0.0236
	(0.039)	(0.155)	(0.047)
Average years of schooling	0.117***	1.309	0.0301
	(0.035)	(7.187)	(0.055)
Corruption	-0.203	-1.750	0.077
	(0.134)	(2.255)	(0.169)
GDP growth	0.003**	-0.00471	0.001
	(0.001)	(0.006)	(0.003)
Short-run coefficient			
Error-correction coefficient	-0.529***	-0.752***	-0.456***
	(0.076)	(0.082)	(0.037)
Life expectancy	3.643	0.851	1.180
	(4.835)	(8.008)	(0.762)
Trade	0.111***	0.067	0.034
	(0.038)	(0.077)	(0.038)
Average years of schooling	-2.300	-4.981	-1.401**
	(2.521)	(0.500)	(0.580)
Corruption	0.663	1.236	0.086
	(0.427)	(1.012)	(0.143)
GDP growth	-0.002*	0.000	-0.001
	(0.001)	(0.001)	(0.001)
Constant	2.052***	3.141	0.764***
	(0.486)	(0.910)	(0.264)
Observations	392	392	392
Hausman		1.52	0.33
P-value		0.91	0.99
N	15	15	15
Time (1990-2019) 29yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time (1970-2018). PMG is a more efficient estimator than MG and DFE under the null hypothesis.*

Table 5.9 (a)

Sample that has received above 100 billion in FDI from 1970-2018

Foreign Direct Investment and HALE with control variables

(Static Models) - 19 countries

VARIABLES	(1) FE	(2) RE	(3) Pooled OLS
HALE	0.008	0.039*	0.075***
	(0.025)	(0.023)	(0.019)
Trade	0.065***	0.050***	0.020***
	(0.020)	(0.008)	(0.006)
Average yrs. Of schooling	0.143***	0.071***	0.009
	(0.048)	(0.020)	(0.012)
Corruption	-0.004	0.026	0.049***
	(0.040)	(0.020)	(0.012)
GDP growth	0.001**	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
Constant	3.056***	3.006***	2.994***
	(0.124)	(0.094)	(0.079)
Observations	565	565	565
R-squared	0.222		0.127
N	19	19	19
Time (1970-2018) 48yrs.			

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 5.9 (b)

Sample that has received above 100 billion in FDI from 1970-2018

Foreign Direct investment and HALE with control variables

(ARDL Models) – 19 countries

	(1)	(2)	(3)
VARIABLES	**PMG**	**MG**	**DFE**
Long-run coefficient			
HALE	-0.019	-0.191	0.034
	(0.031)	(0.331)	(0.037)
Trade	0.019*	0.0467**	0.059***
	(0.010)	(0.021)	(0.013)
Average years of schooling	0.048**	0.296*	0.077***
	(0.022)	(0.155)	(0.021)
Corruption	-0.003	-0.210	-0.011
	(0.039)	(0.232)	(0.037)
GDP growth	0.002***	0.001	0.002***
	(0.000)	(0.001)	(0.000)
Short-run coefficient			
Error-correction coefficient	-0.738***	-0.989***	-0.712***
	(0.062)	(0.067)	(0.042)
HALE	0.046	0.278	-0.010
	(0.409)	(0.511)	(0.032)
Trade			
	0.039	0.012	0.030**
	(0.033)	(0.029)	(0.014)
Average years of schooling	-0.454	0.926	-0.551*
	(0.974)	(1.347)	(0.312)
Corruption			
	0.016	0.175	-0.008
	(0.067)	(0.207)	(0.068)
GDP growth	-0.000	-0.000	-0.000
	(0.001)	(0.000)	(0.000)
Constant	2.462***	3.104***	2.092***
	(0.212)	(1.165)	(0.156)
Observations	546	546	546
Hausman		2.71	0.01
P-value		0.74	1.00
N	19	19	19
Time (1970-2018) 48yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time (1970-2018). PMG is a more efficient estimator than MG and DFE under the null hypothesis.*

Table 5.10 (a)

Sample that has received above 100 billion in FDI from 1970-2018

Foreign Direct investment and Life Expectancy with control variables

(Static Models)

VARIABLES	(1) FE	(2) RE	(3) Pooled OLS
Life expectancy	0.032 (0.022)	0.047** (0.023)	0.095*** (0.021)
Trade	0.057*** (0.019)	0.045*** (0.008)	0.004 (0.006)
Average yrs. Of schooling	0.073*** (0.014)	0.0591*** (0.010)	0.016** (0.007)
Corruption	0.030 (0.033)	0.0521** (0.020)	0.080*** (0.012)
GDP growth	0.0044** (0.001)	0.004** (0.002)	0.005** (0.002)
Constant	2.915*** (0.093)	2.912*** (0.084)	2.924*** (0.079)
Observations	584	584	584
R-squared	0.227		0.145
N	19	19	19
Time (1970-2018) 48yrs.			

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 5.10 (b)

Sample that has received above 100 billion in FDI from 1970-2018

Foreign Direct investment and Life Expectancy with control variables

(ARDL Models) – 19 countries

	(1)	(2)	(3)
VARIABLES	**PMG**	**MG**	**DFE**
Long-run coefficient			
Life expectancy	0.0264	-0.048	0.057**
	(0.016)	(0.154)	(0.023)
Trade	0.035***	0.041**	0.044***
	(0.007)	(0.017)	(0.009)
Average years of schooling	0.054***	0.103	0.069***
	(0.007)	(0.084)	(0.012)
Corruption	-0.007	-0.048	0.022
	(0.016)	(0.195)	(0.023)
GDP growth	0.001***	0.001**	0.002***
	(0.000)	(0.000)	(0.000)
Short-run coefficient			
Error-correction coefficient			
	-0.730***	-0.950***	-0.678***
	(0.058)	(0.061)	(0.032)
Life expectancy			
	0.917*	2.412**	-0.078
	(0.545)	(1.170)	(0.097)
Trade			
	0.015	-0.007	0.024**
	(0.011)	(0.011)	(0.010)
Average years of schooling			
	-0.643	1.335	-0.415**
	(0.727)	(1.108)	(0.208)
Corruption			
	0.045	0.099	-0.020
	(0.060)	(0.176)	(0.039)
GDP growth			
	0.000	9.760	-0.000**
	(0.000)	(0.000)	(0.000)
Constant			
	2.251***	3.240***	1.957***
	(0.180)	(0.507)	(0.112)
Observations	856	856	856
Hausman		0.44	0.02
P-value		0.99	1.00
N	19	19	19
Time (1970-2018) 48yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time (1970-2018). PMG is a more efficient estimator than MG and DFE under the null hypothesis.*

Table 5.11 (a)
High- and Middle-Income Sample
Foreign Direct investment and HALE with control variables
(Static Models Models) – 15 countries

	(1)	(2)	(3)
VARIABLES	FE	RE	OLS
HALE	0.062	0.0806	0.131**
	(0.083)	(0.077)	(0.061)
GDP Growth	0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)
Trade	0.148***	0.160***	0.182***
	(0.027)	(0.024)	(0.017)
Av. Years of schooling	0.106	0.078	0.021
	(0.073)	(0.063)	(0.036)
Corruption	-0.007	-0.003	0.000
	(0.013)	(0.012)	(0.007)
Constant	2.499***	2.426***	2.220***
	(0.281)	(0.268)	(0.227)
Observations	434	434	434
R-squared	0.121		0.255
N	15	15	15
Time (1990-2019) 29yrs.			

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 5.11 (b)
High- and Middle-Income Sample
Foreign Direct investment and HALE with control variables
(ARDL Models) – 15 countries

	(1)	(2)	(3)
VARIABLES	**PMG**	**MG**	**DFE**
Long run coefficients			
HALE	0.016	-1.724	0.036
	(0.032)	(1.181)	(0.212)
Trade	0.063***	0.086	0.0361
	(0.018)	(0.090)	(0.062)
Corruption	0.017**	0.068	0.006
	(0.008)	(0.062)	(0.030)
Av. Years schooling	0.023	1.587	0.216
	(0.054)	(2.35)	(0.175)
GDP Growth	0.000	0.008	0.003
	(0.000)	(0.008)	(0.004)
Short run coefficients			
Error correction coefficient	-0.551***	-0.801***	-0.399***
	(0.085)	(0.0891)	(0.041)
HALE	0.631	-0.0543	0.105
	(0.583)	(0.768)	(0.081)
Trade	0.083*	0.082	0.062*
	(0.045)	(0.073)	(0.033)
Corruption	-0.002	-0.0573	-0.044**
	(0.015)	(0.0364)	(0.019)
Av. Years. schooling	-0.850	-3.750	-1.072
	(1.810)	(0.280)	(1.095)
GDP Growth	-0.000	-0.001	-0.002*
	(0.001)	(0.001)	(0.001)
Constant	1.840***	6.104***	1.161***
	(0.304)	(2.022)	(0.290)
Observations	419	419	419
Hausman test		0.97	0.13
P-value		0.99	0.99
N	15	15	15
Time (1990-2019) 29 yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time (1970-2018). PMG is a more efficient estimator than MG and DFE under the null hypothesis.*

Table 5.12 (a)
Low Income Sample
Foreign Direct investment and HALE with control variables
(Static Models) – 19 countries

VARIABLES	(1) FE	(2) RE	(3) OLS
HALE	0.060	0.090	0.057
	(0.084)	(0.068)	(0.050)
GDP Growth	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Trade	0.081***	0.071***	0.071***
	(0.025)	(0.020)	(0.013)
Av. Years of schooling	0.114***	0.068***	0.024*
	(0.030)	(0.022)	(0.013)
Corruption	-0.012	-0.013*	-0.015***
	(0.009)	(0.007)	(0.005)
Constant	2.646***	2.656***	2.875***
	(0.339)	(0.284)	(0.205)
Observations	538	538	538
R-squared	0.067		0.083
N	19	19	19
Time (1990-2019) 29yrs.			

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 5.12 (b)
Low Income Sample
Foreign Direct investment and HALE with control variables
(ARDL Models) – 19 countries

VARIABLES	(1) **PMG**	(2) **MG**	(3) **DFE**
Long run coefficients			
HALE			
	-0.218***	3.952	-0.031
	(0.044)	(2.930)	(0.163)
Trade	-0.003	0.036	0.036
	(0.013)	(0.062)	(0.051)
Corruption	0.027***	0.008	-0.022
	(0.007)	(0.042)	(0.019)
Av. Years schooling	0.140***	-3.089	0.153**
	(0.023)	(2.464)	(0.071)
GDP Growth	0.001	0.000	0.002
	(0.000)	(0.002)	(0.003)
Short run coefficients			
Error correction coefficient	-0.806***	-1.053***	-0.481***
	(0.101)	(0.085)	(0.042)
HALE	0.091	-5.719	0.019
	(1.253)	(4.934)	(0.474)
Trade	0.093**	0.056	0.039
	(0.042)	(0.039)	(0.037)
Corruption	-0.012	-0.019	0.044***
	(0.022)	(0.036)	(0.016)
Av. Years of schooling	0.993	-0.062	-0.716
	(2.03)	(2.066)	(0.487)
GDP Growth	-0.000	0.000	-0.001
	(0.001)	(0.001)	(0.001)
Constant	3.277***	-6.011	1.520***
	(0.434)	(7.709)	(0.328)
Observations	519	519	519
Hausman test		1.79	0.34
P-value		0.87	0.99
N	19	19	19
Time (1990-2019) 29yrs.			

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time (1990-2019).PMG is a more efficient estimator than MG and DFE under the null hypothesis.*

5.6.4 Interaction between health and education

Horizontal and vertical FDI are the two main reasons firms decide to invest abroad, increasing market size for their products or minimising the costs involved in production (Markusen, 1995; Beugelsdijk et al., 2008). In horizontal FDI models, firms produce their goods or services in their home country and export to consumers abroad in their initial stages when cost-effective. However, the presence of high trading costs (tariffs and transportation) creates an incentive for firms to shift production closer to their consumers abroad (Yokota and Tomohara, 2009).

Hence, higher trading costs and a bigger host market are expected to increase horizontal FDI. With vertical FDI, on the other hand, firms seek to improve production costs by locating different aspects of the production process in host countries where inputs of production are cheaper (Yokota and Tomohara, 2009). Vertical FDI is projected to increase in the presence of cheap labour. These theories suggest that investing firms choose their host location based on factor endowment differences among countries. Sub Saharan African countries have some of the highest unemployment rates globally, e.g., unemployment in South Africa in 2020 was 28.5%, and for Lesotho, this was 22.8% in comparison to developed countries where unemployment is very low, 4.34% for the UK and 4.94% for Switzerland in the same period (IMF, 2021). These high unemployment rates indicate a ready labour market, yet FDI inflows into the region continue to fall (UNCTAD, 2020). Factor endowment, therefore, does not fully explain why countries with abundant labour receive a small portion of FDI inflows. Markusen (2002) and Osuna (2016) propose that a minimum level of health and education is required for firms to invest in a country that has an abundant labour supply. To attract foreign investment, a healthy, educated, and skilled labour force and the necessary technological infrastructure must be in place in a host country. To establish the influence of human capital on FDI inflows into Sub Saharan Africa, tables 5.17 and 5.18 shows the findings from the specifications with the interaction of health (HALE and life expectancy) with education (average years of schooling). Findings from this interaction of health and education indicate that the current level of overall human capital in Sub Saharan Africa does not influence FDI inflows in all models.

5.7 Robustness Checks: Health Adjusted Life Expectancy (HALE), Life Expectancy and Foreign Direct Investment

ARDL used in the main analysis above has many advantages, as discussed in sections 5.5 and 5.6. ARDL is the best approach for determining cointegration relationships in small samples; it addresses potential endogeneity issues and identifies the long and short-run association between the variables (Pesaran, 1995; Ghouse et al., 2018; Maklouf et al., 2020). Nonetheless, this approach is most suitable when the period considered is higher than the number of countries under analysis. In this study, especially in instances where HALE is used as the measure for population health, the dataset starts from 1990, limiting the time considered in relation to the number of countries (34) used in this analysis. To address this limitation, GMM is used for robustness checks. Roodman (2009) shows that GMM deals well in instances where heteroskedasticity is present by addressing the correlation between the predictor variables and the error term (Roodman, 2009). It is also more suited to datasets where the number of countries is greater than the time span.

Table 5.13 shows the results from GMM for HALE, life expectancy and FDI for the same period. The GMM results confirm that from 1990 to 2019, overall health (HALE) and life expectancy have not influenced FDI in the one and two-step GMM estimates. This finding implies that the efforts made to improve the burden of disease in combination with increasing life expectancy in Sub Saharan Africa have not yet had any impact in attracting foreign investment, reinforcing findings from the analysis in section 5.6, where ARDL is used. These results support the findings of Immurana (2020). His study shows that for one country in Sub Saharan Africa (Ghana), population health indicators negatively and significantly influence FDI inflows. Asiedu et al. (2015), who theoretically and empirically examine the HIV/AIDS and FDI nexus, reach similar conclusions in their study of 41 countries in Sub Saharan Africa.

The results for the effect of life expectancy for the extended period also shows no impact on FDI (Table 5.14). This reaffirms the demographic transition theory where improvements in population health can only have a significant influence on growth and factors that enhance growth like FDI, only after reaching a high enough level. Trade is the only other variable that shows a positive and significant influence on FDI in all GMM models for HALE and life expectancy.

Table 5.13
The effect of HALE and Life Expectancy on FDI with other control variables 1990-2019
GMM Estimations

Dependent variable: log of FDI	1 (Sys GMM)	2 (Sys GMM)	3 (Sys GMM)	4 (Sys GMM)
	One step.	Two step.	One step.	Two step.
	Health Adjusted Life	**Expectancy**	**Life Expectancy**	
Lag of FDI	0.642*** (0.042)	0.643*** (0.077)	0.640*** (0.042)	0.641*** (0.075)
HALE	0.028 (0.032)	-0.017 (0.031)		
Life Expectancy			0.080* (0.048)	0.079 (0.050)
Trade	0.060*** (0.015)	0.055*** (0.016)	0.059*** (0.015)	0.055*** (0.016)
GDP Growth	-0.000 (0.001)	0.002 (0.001)	-0.000 (0.001)	0.001 (0.001)
Average yrs. schooling	-0.008 (0.011)	-0.012 (0.014)	-0.011 (0.012)	-0.015 (0.015)
Corruption	0.0159 (0.016)	0.011 (0.017)	0.018 (0.017)	0.010 (0.018)
Constant	0.986*** (0.162)	1.129*** (0.232)	0.948*** (0.145)	1.055*** (0.238)
Observations	943	943	943	943
N	34	34	34	34
Groups/ Instruments	11	11	11	11
AR (2)	0.121	0.140	0.121	0.140
Hansen Statistic	0.105	0.105	0.111	0.111
N	34	34	34	34
Time (1990-2019) 29yrs.				

*Notes: *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively; p values in parentheses. p-values reported for AR (2) and Hansen statistic. Yearly data used (1990-2019). Regarding the model's goodness of fit, there is no evidence of second-order serial correlation given the p-values of AR (2) statistics. The null hypothesis of instruments validity cannot be rejected at the 5% significance level given the p-value of the Hansen statistics.*

Table 5.14
The effect of Life Expectancy on FDI with other control variables 1960-2019
GMM Estimations

Dependent variable: log of FDI	(Sys GMM) One step.	(Sys GMM) Two step.
Lag of FDI	0.616***	0.610***
	(0.0518)	(0.108)
Life Expectancy	0.032	0.0132
	(0.021)	(0.023)
Trade	0.024***	0.025***
	(0.007)	(0.009)
GDP Growth	0.000	0.001
	(0.000)	(0.001)
Average years of schooling	0.004	0.003
	(0.009)	(0.013)
Corruption	0.023	0.013
	(0.014)	(0.015)
Constant	1.066***	1.163***
	(0.193)	(0.384)
Observations	1,442	1,442
N	34	34
Groups/ Instruments	10	10
AR (2)	0.189	0.951
Hansen Statistic	0.390	0.390
N	34	34
Time (1960-2019) 59yrs.		

*Notes: *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively; p values in parentheses. p-values reported for AR (2) and Hansen statistic. Yearly data used (1960-2019). Regarding the model's goodness of fit, there is no evidence of second-order serial correlation given the p-values of AR (2) statistics. The null hypothesis of instruments validity cannot be rejected at the 5% significance level given the p-value of the Hansen statistics.*

Table 5.15
Foreign Direct Investment net inflows (% of GDP) for Countries in Sub-Saharan Africa used in the Analysis. (1970–2018 US$, billions)
Source: WDI (2021) and authors' calculations.

Countries	FDI (1970-2018)	Life expectancy in 1970	Life expectancy in 2018
Liberia	$ 500,874,975	39.3	64.1
Congo, rep.	$ 335,220,704	50.7	64.5
Mozambique	$ 304,870,244	41.3	60.8
Zambia	$ 176,751,191	50.1	63.8
Mauritania	$ 154,285,559	50.4	64.9
Angola	$ 149,569,477	40.9	61.4
Sierra leone	$ 137,357,007	36	54
Namibia	$ 130,924,107	52.6	63.7
Ghana	$ 130,419,612	49.3	64
Gabon	$ 127,405,648	47.1	66.4
Botswana	$ 122.121753	53.8	69.5
Lesotho	$ 117,180,378	50.5	54.3
Gambia, the	$ 116,223,323	37.8	62
Madagascar	$ 102,868,661	44.7	67
Niger	$ 100,785,286	35.8	62.4
Togo	$ 97,867,868	46.5	61
Uganda	$ 88,100,672	49.2	63.3
Congo, dem. Rep.	$ 86,561,609	43.9	60.6
Sudan	$ 86,236,022	52.2	65.3
Tanzania	$ 78,517,493	46.7	65.4
Nigeria	$ 74,160,001	40.9	54.6
Cote d'ivoire	$ 69,433,276	44.1	57.7
Mauritius	$ 68,439,627	63.1	74.2
Mali	$ 68,052,421	32.3	59.3
Rwanda	$ 58,323,261	44.6	69
Senegal	$ 58,189,839	39.2	67.9
Cameroon	$ 57,209,330	46.5	59.2
Zimbabwe	$ 45,746,022	56.9	61.4
Central African Republic	$ 45,579,749	42.2	53.2
South Africa	$ 42,105,543	52.6	64.1
Kenya	$ 40,387,363	52.5	66.6
Burkina Faso	$ 29,764,981	39	61.5
Benin	$ 21,938,915	42.1	61.7
Burundi	$ 14,962,923	43.8	61.5

5.8 Conclusion

Even though there is a large body of literature on the factors that influence FDI, only a few studies include population health in their analysis. Most of these studies use econometric approaches that do not differentiate between short- and long-term effects, and the measures of health used do not fully capture the overall effects of morbidity and mortality. These considerations are essential for developing countries where the disease burden is extreme, as policies aimed at improving longevity takes time to take effect and knowing the long-run outcomes will encourage policymakers to hold off withdrawing such policies if their effects are not seen in the short run. This chapter extends the limited work for countries in Sub Saharan Africa by empirically examining the relationship between population health and FDI from 1960 to 2019, distinguishing between the long and short-run effects, and is the first to use HALE as an improved measure of population health in such an analysis. While other studies conducted on African countries typically use life expectancy, which accounts for only mortality, or disease-specific measures, to study the impact on FDI inflows, this study uses a measure that accounts for both mortality and morbidity simultaneously to capture this impact. I also consider the overall impact of human capital (health and education) on FDI inflows into the region. No study looks at variations between countries in Sub Saharan Africa and how these influence the health FDI relationship. This study addressed this gap by grouping countries in the region, firstly based on the amount of FDI received and secondly based on their income classification.

The empirical findings from this study indicate that while population health, measured by life expectancy, show an initial positive and significant association with FDI over a shorter period, in the long run, this relationship becomes statistically significant and negative. For countries in Sub Saharan Africa, life expectancy either shows a long-term unfavourable and severe impact on FDI inflows (1990-2019) or no impact when extended data is used (1960-2019). Similarly, in the long run, the overall level of health (HALE) shows a significantly negative association with FDI from 1990 to 2019 for the full sample, for countries who have received less FDI, and those classified as low income. For countries classified as high income and those with high FDI inflows, population health shows no influence on FDI. Studies that focus on developing countries typically find that life expectancy positively impacts FDI; however, the approaches used only show the short-term impact; this echoes findings in the analysis above (Fixed effects results and short-run results from PMG). Findings from the long-run influence of health on FDI in this study contradict the common assumption that better population health spontaneously promotes FDI inflows, as seen in studies conducted on richer countries with different characteristics. Nevertheless, they echo studies that find that poor health has a negative impact on FDI inflows. There are three plausible explanations for the mixed results for Sub Saharan African countries. The level of human capital development (health and education), the high burden of disease and the current level of GDP per capita.

Firstly, due to the high burden of disease, volatility in mortality and morbidity and recurring infectious diseases, investing in Sub Saharan Africa is considered to be inherently risky. This view is echoed by empirical studies which find that agencies often classify African countries, especially those in the Sahara, as riskier than warrantied by the fundamentals when grouping countries based on their creditworthiness (Haque et al., 2000; Busse and Hefeker, 2007; Barassi and Zhou, 2012).

The implication is not limited to individual countries in the region, but it also affects the FDI choices of potential investor countries at the aggregate level, dampening FDI inflows into Sub Saharan Africa (Ghosh and Rena, 2015; Immurana, 2020). This effect is indicated in the findings from this chapter, where health has no influence on FDI inflows for countries classified as high income, where arguably, population health is better.

Secondly, current levels of human capital in the region are not high enough to have a long-term impact on FDI inflows, as shown in the results from interacting health and education. This study aimed to examine if overall health, an essential component of human capital, has influenced FDI inflows to countries in Sub Saharan Africa. The findings suggest that the current state of health separately and in combination with education in Sub Saharan African countries have not reached a level where they can positively influence FDI inflows in the long run.

Thirdly, there is substantial empirical support for the positive association between FDI inflows and GDP per capita. Countries with higher GDP attract significant investments (Chakrabarti, 2001; Ang, 2008; Jaiblai and Shenai, 2019). This is in line with the eclectic paradigm theory proposed by Dunning (1973, 2000). According to this theory, a significant amount of market-seeking investment flows towards countries with huge markets. Countries with greater purchasing power indicate to foreign firms the potential of receiving higher returns on their investments (Jordan, 2004). Other studies echo this assertion and find a positive association between FDI and GDP (Asiedu, 2002, 2008; Kurecic, 2016). The results in this chapter indicate that GDP is not high enough to attract and sustain FDI for most countries in Sub Saharan Africa. For countries in the region that have received higher FDI inflows (over 100 billion), GDP shows a positive and significant impact on FDI in the long run. For the other group of countries who have received less than 100 billion FDI, GDP shows no impact on FDI in all models except in one instance when the indicator for population health is life expectancy (table 5.7). The impact of GDP on FDI seen in this chapter is in line with results in chapter 4, where improvements in population health showed a negative impact on labour productivity for countries that had not transitioned demographically. Improvements in health increase the available labour without complementary capital (i.e., growth in GDP), and although FDI is the capital needed to sustain growth, it is drawn away because of the low levels of productivity.

These findings fit into the broader literature that links the role of population health to economic behaviour and is especially important in the current context of diseases like COVID 19. Studies that disaggregate the burden of disease find that illnesses like HIV, malaria and respiratory infections deter FDI in African countries, given the adverse effects these have on the productivity of workers. These studies find that as these conditions improve, FDI also improves, and policy recommendations from these studies focus on improving specific health conditions as a way of attracting FDI. However, the aggregate measure of health used in this chapter and the econometric approach, which exposes the long-run effect, gives more insight in addition to the short-run positive effect, which other studies also find.

The empirical findings reported in this chapter support policy recommendations that focus on overall human capital development.

5.9 Appendix

Appendix 5.1

Table 5.16

Countries in Sub Saharan Africa used in the Analysis

Liberia	Togo
Congo, rep.	Uganda
Mozambique	Congo, dem. Rep.
Zambia	Sudan
Mauritania	Tanzania
Angola	Nigeria
Sierra Leone	Cote d'Ivoire
Namibia	Mauritius
Ghana	Mali
Gabon	Rwanda
Botswana	Senegal
Lesotho	Cameroon
The Gambia, the	Zimbabwe
Madagascar	The Central African Republic
Niger	South Africa
	Kenya
	Burkina Faso
	Benin
	Burundi

Table 5.17 Interaction
Health Adjusted Life Expectancy (HALE), Life Expectancy and FDI with control variables and interaction between health and education 1960 – 2019 and 1990-2019
(Fixed, Random and OLS Estimates)

	HALE (1990 – 2019)			Life expectancy (1990 – 2019)			Life expectancy (1960 – 2019)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
VARIABLES	FE	RE	OLS	FE	RE	OLS	FE	RE	OLS
Health	0.082	0.038	0.196	0.197	0.171	0.228*	0.142	0.137	0.189**
	(0.369)	(0.187)	(0.155)	(0.352)	(0.151)	(0.134)	(0.193)	(0.089)	(0.083)
Education	0.096	-0.184	0.188	0.247	0.032	0.241	0.035	0.022	0.294
	(0.988)	(0.438)	(0.342)	(0.900)	(0.377)	(0.313)	(0.536)	(0.246)	(0.217)
Health*Education	0.002	0.058	-0.056	-0.039	-0.000	-0.069	0.003	0.005	-0.071
	(0.246)	(0.110)	(0.086)	(0.217)	(0.0917)	(0.077)	(0.133)	(0.060)	(0.053)
Trade	0.121**	0.118***	0.118***	0.114**	0.112***	0.116***	0.076***	0.076***	0.071***
	(0.044)	(0.016)	(0.011)	(0.042)	(0.016)	(0.011)	(0.023)	(0.010)	(0.007)
Corruption	0.052	0.075*	0.051**	0.051	0.077*	0.058***	0.049	0.058**	0.061***
	(0.086)	(0.044)	(0.022)	(0.086)	(0.044)	(0.022)	(0.053)	(0.029)	(0.016)
GDP growth	0.005	0.002	0.010	0.015	0.017	0.030	0.035	0.035*	0.041*
	(0.046)	(0.032)	(0.034)	(0.025)	(0.027)	(0.030)	(0.022)	(0.020)	(0.023)
Constant	2.401*	2.686***	2.187***	1.955	2.139***	1.971***	2.307***	2.336***	2.170***
	(1.366)	(0.677)	(0.567)	(1.383)	(0.589)	(0.532)	(0.815)	(0.358)	(0.337)
Observations	972	972	972	972	972	972	1,471	1,471	1,471
R-squared	0.093		0.122	0.098		0.126	0.099		0.108
N	34	34	34	34	34	34	34	34	34

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are statistically significance at the 1%, 5% and 10% levels respectively.

Table 5.18 Interaction

Health Adjusted Life Expectancy (HALE), Life Expectancy and FDI with control variables and interaction between health and education (GMM estimates)

	HALE (1990 – 2019)		Life expectancy (1990 – 2019)		Life expectancy (1960 –2019)	
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	1 Step System GMM	2 Step System GMM	1 Step System GMM	2 Step System GMM	1 Step System GMM	2 Step System GMM
Lag of FDI	0.642***	0.656***	0.640***	0.646***	0.617***	0.613***
	(0.041)	(0.075)	(0.041)	(0.078)	(0.051)	(0.114)
HALE	0.045	-0.036				
	(0.060)	(0.053)				
Life expectancy			0.049	-0.013	0.0363	0.0130
			(0.040)	(0.037)	(0.0239)	(0.0255)
Health*Education	-0.000	0.010	-0.004	0.007	-0.004	-0.004
	(0.014)	(0.014)	(0.013)	(0.015)	(0.009)	(0.009)
Average years of schooling	-0.014	-0.091	0.010	-0.082	0.036	0.035
	(0.117)	(0.119)	(0.112)	(0.124)	(0.066)	(0.069)
Trade	0.034***	0.038***	0.034**	0.046**	0.025***	0.026**
	(0.013)	(0.014)	(0.014)	(0.018)	(0.008)	(0.011)
Corruption	0.015	0.013	0.017	0.014	0.020	0.011
	(0.015)	(0.014)	(0.015)	(0.016)	(0.013)	(0.015)
GDP Growth	-0.027	0.047	-0.014	0.062*	0.004	0.047
	(0.057)	(0.029)	(0.050)	(0.036)	(0.038)	(0.041)
Constant	1.024***	0.954***	0.972***	0.822***	1.051***	0.986***
	(0.149)	(0.256)	(0.164)	(0.260)	(0.173)	(0.344)
Observations	943	943	943	943	1,442	1,442
N	34	34	34	34	34	34
Group/Instruments	12	12	11	11	11	11
AR (2)	0.120	0.130	0.121	0.134	0.083	0.108
Hansen Statistic	0.080	0.080	0.056	0.056	0.014	0.014

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.1$ are statistically significance at the 1%, 5% and 10% levels respectively.
Standard errors in parentheses, p-values reported for AR (2) and Hansen statistic. Yearly data used.

CHAPTER 6

6 Conclusion

This thesis ends with this chapter. Its objectives are fourfold: (1) to restate the thesis' basic structure; (2) to emphasise the contributions of the work completed; (3) to emphasise the limitations in this work; and (4) to propose potential avenues for further research.

6.1 Thesis summary

Chapter 2 presented a summary of the theoretical and empirical literature on the association between population health and economic growth. The findings from chapter 3 suggested that although increases in longevity in Sub Saharan Africa showed a positive and significant influence on economic growth, the overall burden of disease for countries in the region, is having a detrimental and negative effect on economic growth. Notably, disease such as malaria, HIV/AIDS, and respiratory infections in the region, contribute significantly to this negative effect on economic development. The findings from chapter 4 showed that improvements in life expectancy from 1984 to 2018 has had a positive and significant impact on labour productivity for countries in the region. The analysis from chapter 5 also indicates that from 1990 to 2019, life expectancy and HALE has had a negative and significant impact on FDI inflows for countries in Sub Saharan Africa. Similarly, the level of human capital has not influenced FDI.

Chapter 2 re-examined the body of evidence on the health growth nexus. This focused on areas deemed most important to developing countries like the role of the demographic transition in economic growth, the significant role played by women's health and fertility, and the effect of infectious diseases on growth. This review highlighted several research avenues in the economic assessment of how improvements in population health contribute to economic growth for developing countries. Three of the highlighted gaps were chosen and analysed in the empirical chapters of this thesis. These included using enhanced population health measures such as (the Disability Adjusted Life Years (DALYs), for the burden of diseases and Health Adjusted Life Expectancy (HALE) for overall population health). The demographic transition stage of countries under analysis was also considered in subsequent chapters that examined the impact of one direct, and one indirect causal channel, (productivity and foreign direct investment) through which population health influences economic growth.

Chapter 3 revisited the debate on the effect of improvements in population health and the impact of the high burden of diseases, for a large sample of Sub Saharan African countries, over an extended period. I showed that proxies used to indicate the burden of disease in the population health to economic growth assessment for developing countries have many drawbacks, as they provide either an underestimation or overestimation of the effect of diseases, especially in the case of populations where diseases like HIV and malaria are prevalent. This chapter used the Disability Adjusted Life Years (DALYs) as the proxy for disease burden. A measure that encompasses 359 diseases and injuries and reflects the overall influence of poor population health on economic development for countries in Sub Saharan Africa.

Chapter 4 demonstrated that one of the leading direct channels through which health affects economic development in Sub Saharan Africa is through the productivity of labour. I used an enhanced proxy of population health, the Health Adjusted Life Expectancy (HALE). This measure incorporates both morbidity and mortality, providing reliable estimates of the influence of overall health on productivity, in addition to the traditional measure, i.e., life expectancy typically used in the literature.

Chapter 5 empirically examined one indirect channel, foreign direct investments (FDI), through which health, as expressed through life expectancy and HALE, influences economic growth by encouraging greater investment. Its aim was to establish how external funding can assist in economic development for countries with a high burden of disease.

6.2 Contributions

This dissertation contributes to the empirical literature on the economic assessment of the influence of population health on economic development in several ways

Contribution 1: Demonstrated that the current approach used in analysing the influence of poor health on economic development for countries with a high burden of disease results in biased estimates.

The analysis in chapter 3, sections 3.5 and 3.6 demonstrated that the current methods used in assessing the disease burden for developing countries provide biased estimates. Focusing on individual diseases, primarily the prevalence of HIV and malaria for Sub Saharan African countries, ignores the interaction and spillover effects from other diseases. Tables 3.10 and 3.11 in chapter 3 compare the impact of the overall burden of disease as measured with DALYs and the leading causes of poor health (HIV, malaria, and respiratory infections) on GDP per capita growth rates for 41 Sub Saharan African countries. Many studies have shown that diseases like malaria are most severe during childhood and within groups who are not economically active (e.g., the old, those suffering from other medical conditions, etc.). Therefore, using prevalence data from the entire population in economic analysis overestimates the adverse effects of this disease. Similarly, those affected with HIV have a severe decrement in their health at the onset, but once they start and maintain Anti-Retroviral Treatment (ART), a majority of the affected live a healthier and longer life, as the damage caused by the infection is suppressed, preventing it from progressing into advanced AIDS (Byrareddy et al., 2016). For example, in 1996, a 20-year-old HIV-positive person might expect to live for 39 years. In 2011, such an individual lived to be 70 years old.

Although analysis using individual diseases like HIV, malaria, and respiratory infections in this thesis showed significantly negative effects on GDP growth with large coefficients, the combined impact of 359 diseases and injuries showed far less significance on growth, although this was still negative. Individually, these diseases may have significant effects on specific groups within the population or sectors within a country, but their overall effect on economic growth is marginal. Chapter 3 introduced the Disability Adjusted Life Years (DALYs) measure, which has not been applied in assessing the burden of diseases for Sub Saharan African countries, although the region carries the greatest burden of disease globally.

The advantage of using this single measure to signify the overall burden of disease is that health interventions can be assessed to see their effectiveness on population health over time. The overall burden of disease (DALYs) should begin to fall as these interventions take effect. Life expectancy remains an important measure for population health; however, more focus should be placed on improving overall morbidity given its current negative and significant influence on economic development for developing countries. In addition, the number of countries considered in the empirical analysis in chapter 3 is, to the author's knowledge, the largest of any study conducted on Sub Saharan Africa to analyse this relationship. The time considered is also the longest (when life expectancy is used to measure population health).

Contribution 2: Used an improved measure of population health, the Health Adjusted Life Expectancy (HALE).

In addition to showing that DALYs is an improved measure for the burden of disease, this thesis provides the first assessments of the long- and short-term effect of overall health (HALE) on the main causal channel (productivity) through which health influences economic development for countries in Sub Saharan Africa. The analysis also divides countries into groups that account for the demographic transition, considering variations in life expectancy. More specifically, this is presented in chapter four, sections 4.6, 4.7 and 4.8, where I used Auto Regressive Distributed Lags (ARDL), an approach that considers the short and long-run relationship between variables. Highlighting this aspect is important because techniques used in analysing this relationship for countries in Sub Saharan Africa primarily consider only the short run effects. Considering only the short-term effects limit policy implications and, in some cases, cause a reversal or withdrawal of programmes intended to improve health, as their anticipated benefits are not seen straightaway. Given the high burden of disease, limited resources, poverty, lack of workers in the health service, and inadequate health facilities, the questionable sustainability of health interventions implemented in Sub Saharan Africa is inevitable and as such, drawing attention to the continuance of interventions by presenting policymakers with both the short- and long-term effects of improvement in overall health is needed.

Contribution 3: Highlighted the importance of demographic variations for countries in Sub Saharan Africa.

The literature review in chapters 2, section 2.3 and 2.5 emphasised the importance of considering variations such as demographic and economic differences when exploring the association between longevity and economic growth. The analysis in chapters 4, section 4.8 and chapter 5, section 5.6 draws attention to these variations within Sub Saharan Africa and the importance of acknowledging these differences in economic analysis. Countries whose health-adjusted life expectancy (HALE) and life expectancy exceeds 52 years saw a positive and significant impact on their productivity compared to those whose current life expectancy is below 52 years. Similarly, HALE shows a large and detrimental impact on foreign direct investment in countries classed as low income in Sub Saharan Africa.

Countries in the North of Africa initiated their demographic transition in the early 70s whereas, for some countries in Sub Saharan Africa, this started in the late 90s. The high fertility rates in Sub Saharan Africa have contributed to this slow decline in population growth, contributing about 2.5 percent to the overall population in Africa. In contrast, the North contributes less than 2 percent annually (Bloom et al., 2017). Mortality and infant mortality rates have declined in both regions; however, this has also been slow for countries in Sub Saharan Africa. Sub Saharan Africa as a whole hasn't gone through the typical demographic shift. As discussed, although death rates have fallen, fertility has not for the greater part of the region, resulting in unprecedented population growth and high dependency ratios, unlike other regions in the world. Analysis in this thesis shows the importance of acknowledging the different stages of a countries' development, even minor differences, when pursuing health policies. For example, in various regions within Sub Saharan Africa, children are still viewed as insurance against old age and a source of labour. In addition to this, there is limited financial infrastructure, especially in rural areas. Access to quality healthcare is limited, the distribution of land is made according to family size, etc., factors that encourage fertility and delay the transition to sustained growth.

With these in mind, countries that can overcome some of these limitations should focus on policies aimed at reducing infant and child mortality, encouraging the education of girls, and participation in the labour force for both sexes. All these combined with rises in life expectancy will eventually lead to a fall in fertility, ultimately changing the age distribution and size of the population.

Contribution 4: Demonstrated that the current level of population health in Sub Saharan Africa is having a negative impact on Foreign Direct Investment (FDI) inflows, an essential source of financing for emerging nations.

This thesis estimated the impact of population health as expressed through HALE and life expectancy for countries in Sub Saharan Africa. It assessed the variations in life expectancy, how it corresponds to net FDI inflows received, and whether countries that receive high levels of FDI fall in either low income or middle to high income groups within the region. This thesis is the first empirical analysis to use HALE as a proxy for population health in health to FDI study, for a large group of countries in Sub Saharan Africa. The findings suggest that life expectancy and HALE, have a negative and significant impact on FDI inflows for countries in Sub Saharan Africa.

Many studies in the region do not include health as a determinant of FDI, but the analysis in this thesis has shown health's significant role in attracting foreign investment, a vital source of economic development and global integration. However, the dilution of capital and strain placed on societal infrastructure (such as the education system) seem to have the opposite effect in Sub Saharan Africa, where the demographic transition is yet to be completed (Canning et al., 2015; Ross, 2019). Global FDI reduced substantially in 2020 for both developed and developing countries due to COVID-19, with countries in Africa seeing a 16 percent reduction in their FDI with the uncertain nature of this pandemic clouding the outlook of FDI into Africa (William and Bevir, 2021). Countries in the region can enhance the business climate by making aggressive long-term policies aimed at improving the health of the population. This way, the negative effects of COVID -19 does not add to the already high burden of diseases within the region.

Variables that could have been included and their benefits, but data availability prevented this.

Many empirical studies have examined the direct and indirect factors influencing economic growth. These studies offer insights into the sources of growth by using various methodologies that emphasise different sets of explanatory variables. The selection process of the variables used in the thesis among a long list of variables proposed by previous studies was driven by those that were most commonly recognised by multiple studies in the literature, but the final decision was also affected by data availability for the group of countries in Sub Saharan Africa. Other variables deemed important in the literature but could not be included in this thesis due to the data availability are discussed below.

Innovation, research, and development: The rate at which a country progresses its productivity and growth largely depends on the increasing use of technology that introduces new and superior processes and products. This has been explored in the theoretical and empirical literature (Fagerberg 1987; Lichtenberg 1992; Ulku 2004; Broughel and Thierer, 2019).

Theories on economic growth emphasise endogenous technological change as the determining factor for the variations in growth across the world. Romer (1986) indicates that human capital and knowledge within an economy create technological innovation in the research and development sectors. This facilitates the production of goods and services, increasing output growth. Empirical studies test the effectiveness of research and development variables on productivity. Aghion and Howitt's (1988) study argues that the GDP share of research and development is a better indicator as it factors into the size of an economy. For developed countries, many studies have shown a strong and positive relationship between productivity growth and research and development investments (Scherer, 1982; Griliches and Lichtenberg, 1984; Aghion and Howitt, 1998; Frantzen, 2000; Ugur et al., 2020). For developing countries, spillovers from research and development from industrialised countries positively impact total factor productivity (Griffith et al., 2003).

Although an in-depth analysis of data on research and development has enabled economists to shed light on endogenous growth theories, especially in developed countries, for developing countries, data limitations restrain this. For such an analysis, data on inputs into research and development and output of innovative activity will be needed. The number of patent applications and gross research and development expenditure are the common indicators used for studies conducted in developed countries (Ulku, 2004; Zachariadis, 2003; Akcali and Sismanoglu, 2015). For developing countries, studies that use data on research and development are heavily concentrated on investments in the agricultural sector, where it is easier to capture inputs and outputs (Adenle, 2018). Yet the distribution of the internal rates of return (IRR) in the agricultural sector in developing countries, although positively skewed, is well below the mean compared to studies conducted in other parts of the world (Pardey et al., 2016). Other studies have also shown that in Africa's agricultural sector, evidence obtained from commodity-specific sectors is not consistent with the composition of agricultural production in the region, making it difficult to discern meaningful patterns in the evidence (Hurley et al., 2016; Pardey et al., 2016).

Macroeconomic conditions, institutions, and economic policies are essential factors that set the framework within which economic growth occurs. Policies on human capital investment, legal/political institutions, and infrastructure can hamper or sustain growth. Moreover, stability within the macroeconomic environment can enhance economic growth by reducing uncertainty in the market, as instability can negatively influence growth through its impact on productivity and investment (Barro 1991, 1997; Easterly and Rebelo 1993; Fischer 1993; Barro and Sala-i-Martin 1995). In addition, transaction costs and property rights regulated by institutions influence economic growth (North and Thomas, 1973; Spruk and Kovac, 2019). Non-market institutions play a significant role in creating comprehensive and reliant markets, making it less risky for businesses to operate and use available innovation resources (Rodrik, 2004). Institutions like governance, law enforcement, justice, and regulations impact growth through monetary and fiscal policies (Hall and Sobel, 2008). These institutional factors also impact productivity, and many studies have shown that countries with better institutions exhibit higher productivity levels (March and Olsen, 1998; Acemoglu et al., 2001; Rodrik et al., 2004). Moers (1999) highlights the statistical limitations associated with using different proxies for institutions in a single regression, given the high risk of multicollinearity. Most studies use various indicators for different equations (Acemoglu et al., 2001; Meon and Sekkat, 2004). Most studies use the World Governance Indicators (WGI) institutional indicators to measure institutional quality. These measures embed six governance indicators which broadly cover a range of institutions. However, these indicators have been criticised both in the theoretical and empirical literature as lacking an accurate theoretical basis, being complicated, and the various indicators being poorly identified with inter-correlation between most of the variables (Oman and Arndt, 2006; Langbein and Knack, 2010). These measures are also limited and are only available for a handful of countries in Sub Saharan Africa for a few years.

Socio-cultural factors like trust, religion, language and ethnic composition have also been emphasised in the empirical literature. Knack and Keefer (1997) and Zack and Knack (2001) initiated the trust to growth association in modern literature. Zak and Knack (2001) examined 29 market economies to ascertain if any economic benefits can be obtained from social capital. Using data from the World Values Survey (WVS), they analyse the nexus between norms, interpersonal trust, civic corporation, and economic performance. Their findings indicate that trust has a significant influence on economic growth. Recent studies have suggested that although there is no correlation between norms and economic growth, countries with high trust levels have grown faster in recent decades (Whiteley, 2000; Beugelsdijk et al., 2004; Roth, 2022). Other researchers show that socio-cultural factors influence economic growth through several transmission channels like schooling (Coleman, 1988; Putnam, 2001; Bjornskov, 2005, 2012), governance (Putnam, 1993, 2001; Uslaner, 2002; Rothstein, 2003) and investments (Levine and Renelt, 1992; Bjornskov, 2012). Studies conducted on Sub Saharan African countries are usually limited to a few countries due to data limitation issues. Lavellee et al. (2008) studied 18 Sub Saharan African countries, examining the nexus between trust in political institutions and corruption. Their findings confirm the previous studies – corruption negatively influences citizens' trust in political institutions.

Physical geography is another factor deemed to influence economic growth. Studies have used geographical variables like disease ecology, average rainfall, and proximity to a coast. Findings from studies that focus on geographical aspects have found that climate, being landlocked and the availability of natural resources directly influence productivity, competitiveness and economic structure, factors that all impact growth (Sachs and Warner 1997; Bloom and Sachs 1998; Masters and McMillan 2001; Armstrong and Read 2004). However, findings are not conclusive as a few studies have found no effect (Easterly and Levine 2003; Rodrik et al.2004). Although there is data available on many geographical variables, these are spread out, with some countries in Sub Saharan Africa having a lot of data whilst others have none.

Acknowledgement of different approaches that could have been adopted to be resolved as alternatives to those that were adopted.

Many econometric approaches, including the Auto Regressive Distributed Lags (ARDL) approach, used in this study, have been used in the empirical literature, given their dynamic nature. Among these include using lags for the other variables in the model. Lagging variables eliminates autocorrelation in the residuals. This approach is used to model dynamic relationships, given that the technique mimics other dynamic regression models where the current values of the dependent variables are the function of their previous values (Beck and Katz, 2011). In spite of these benefits, lagging variables do not expose the long- and short-term impact of the variables under analysis, an advantage that ARDL, the approach used in this study has.

Tong (1983) developed a threshold regression model; an effective approach applied extensively in econometrics. This approach divides a sample into groups based on the value of an observed variable and whether it exceeds a specified threshold. This approach has been enhanced and extended by Hansen (1999), Cancer and Hansen (2004) and Hsiao et al. (2002). Empirical studies that follow this approach account for the dynamics that all macroeconomic models exhibit; that is, the growth rate in any year relies on the previous growth rate. Ramirez-Rondan (2015) indicates that the Maximum Likelihood Estimator (MLE) and Transformed Maximum Likelihood Estimator are more efficient than the Generalised Method of Moments (GMM) estimators as the linear transformation used eliminates individual effects, especially when the time series used is short. Analysis in this chapter used the mean of life expectancy as the turning point for the change in the relationship between health and productivity. Given the existence of a threshold level between improvements in life expectancy and productivity, employing this approach would have given further insight into this relationship, however, MLE can be heavily biased for small samples and populations that are not regular (Pan and Fang, 2002). That is where a parameter value is constrained by a single observed value. Therefore, using this approach for the sample in this thesis would have produced unreliable results.

Arellano and Bond's (1991) GMM method is also widely used to test the influence of health on productivity in the empirical literature (Kuma and Chen, 2012). This approach enables the use of instrumental variables, which is made possible by first differencing, eliminating fixed country effects. GMM performs well in panel data analysis and addresses correlation and endogeneity in the presence of heteroskedasticity (Roodman, 2009). This approach is used in chapters 3 and 5 of this thesis. Again, Least Square Dummy Variables (LSDV) is another approach widely used in the literature. Ulrich and Frauke (2009) indicate that fixed effect panel models that employ LSDV are not biased and enhance the understanding of fixed effects as they control for time-invariant differences between the individual coefficients. With this approach, the effect of all the independent variables is mediated by the differences across countries. The actual effect is seen with each estimation as unobserved heterogeneity is controlled (Baltagi, 2008; Baum, 2006). Nonetheless, LSDV has been found to be inconsistent for dynamic panel data models with individual effects (Kiviet, 1995; Bruno, 2015).

6.3 Limitations

In this thesis, I used improved measures for the burden of diseases (DALYs) and population health (HALE) to analyse the relationship between health and economic development for a large sample of countries in Sub Saharan Africa. I examined one direct channel, i.e., productivity and one indirect causal channel, i.e., FDI, through which improvements in population health influence economic growth. I also accounted for the variations in life expectancy, demographic transition stage, different income groups and the leading causes of death (HIV, malaria, respiratory infections) in the region. I demonstrated through the empirical analysis that from 1960 to 2019, health improvements in Sub Saharan Africa have not been a mere consequence of economic growth; instead, it has also been growth-enhancing and growth limiting based on the health status of the sample of countries analysed. I established that countries in the region with better population health are more likely to see these positive effects reflected in their productivity, output, ability to attract foreign investment, and eventually economic development. Whilst this study has achieved all these aims, like all research, some limitations need to be considered.

Firstly, the Disability Adjusted Life Years (DALYs) and Health Adjusted Life Expectancy (HALE) used to represent health in this thesis presents two main limitations. Although this data is available for all 48 countries in Sub Saharan Africa, it is only available from 1990, restricting the number of years and methodological approaches that can be used in analysing its effect on economic growth. The DALYs measure has also been criticised for not capturing the broader social impact of diseases, especially for subtle diseases that take hold in childhood, with potential effects on education and income in adulthood (Hotez et al., 2014). Nonetheless, the 29-year period (1990 – 2019) used in this thesis for both DALYs and HALEs provides valuable insights into the relationships between health, economic growth and the two causal channels analysed: labour productivity and FDI. Secondly, chapter 4 used labour productivity as the measure of productivity, given that it is the dataset available for most countries in Sub Saharan Africa and has been available since 1960. A measure such as total factor productivity was preferable as results from using total factor productivity would have exposed the proficiency and intensity of inputs employed in Sub Saharan Africa. Data on total factor productivity is available for only a handful of countries in the region for a limited time, and as such, it was not appropriate for this research question, given the aims of understanding the long-term effects of population health.

6.4 Further Research and Policy Implications

There are several ways to extend this thesis. Firstly, it will be interesting to develop a model where values of HALE in the past (from 1960) can be generated. This consideration will extend data on the HALE measure, making it possible to compare with the life expectancy measure over more extended periods. Capturing this will reduce the uncertainty associated with implementing costly long-term health interventions in developing countries where resources are scarce.

For example, the Abuja declaration discussed earlier might have had more of an impact, and many countries in Sub Saharan Africa would have implemented the pledged healthcare spending if they had confidence in the returns on investments in health.

Another development to this thesis will be examining the effects of improvements in health on productivity for the different groups within the population, especially the active working population. Many studies, including the analysis in this thesis have shown that investing in health before the start of the demographic shift has a negative but insignificant influence on economic growth, as it enhances fertility, increases the dependency ratio, and drags the transition from stagnation to growth (Boucekkine et al., 2002; Croix and Licandro, 2013; Cervellati and Sunde, 2015). It will be interesting to see if this holds for investing in the active working population in pre-demographic transition countries, with targeted interventions that encourage women's education.

Thirdly, encouraging girls' education is vital as it speeds up the transition from stagnation to sustained economic growth (refer to chapter 2, section 2.4). The gender gap in countries with high rates of female education is much closer in comparison to countries where the education of females is low. Developed countries also have a larger pool of skills and expertise within their economies as female education is high. Further research can explore how developing countries can effectively prioritise and enhance female education, especially in those countries where discriminatory policies and practices limits opportunities for girls. A model incorporating gender-specific educational investment resulting from a fall in morbidity and mortality will provide further insights. Some of the gaps identified in the studies above can be addressed by using a dynamic model which accounts for the intergenerational effects of maternal mortality, gender preference (including investment in male and female children) and its impact on fertility. The effect that female morbidity has on productivity and the overall socio-economic cost incurred because of poor female health in the region will add to current knowledge on the health growth nexus.

Finally, behavioural/cultural elements influence a population's health, which subsequently influences economic growth. This is another area that can be explored. Very little work is available on this area for countries in Africa; this is understandable as data is limited. With more data on behavioural factors for countries in Sub Saharan Africa becoming available, another area for further work will be to examine the relationships between cultural values, population health and economic development. Finally, this thesis focused on two causal channels through which improvements in health influence economic development for Sub Saharan African countries. Other channels, such as, boosting technological development or improving the quality of institutions via agency (Huggins and Thompson, 2021), may be having more of an impact on growth. Alternatively, these may moderate the relationship between health and growth, productivity or FDI (Johnson and Lenartowicz, 1998; Forson et al., 2013).

Furthermore, microdata can also be used to evaluate the gaps mentioned above, allowing for an in-depth understanding of the economic and social issues surrounding the nexus between health and growth. These are avenues for further research. As discussed earlier (refer to chapter 4, subsection 4.4.2), HALE is a summary measure used to monitor population health trends and analyse inequalities between populations (Mathers, 2002; Robine et al., 2003).

Over the last two decades, HALE has been a benchmark proxy in enhancing living standards, advancing medical technology, promoting education, and implementing public health interventions (Kyu et al., 2018). As an indicator of population health, HALE has many advantages over a health gap indicator like life expectancy. Firstly, the Sullivan method used in calculating HALE ensures that it is not influenced by population size or structure (Sullivan, 1971; Rogers and Crimmins, 2011). Secondly, the disability weight scheme used in its calculation enables the inclusion of a wide range of health conditions that determine how severe a disease is. This makes HALE is superior compared to disability-free life expectancy, which uses dichotomous weights (zero and one). Additionally, unlike the life expectancy measure, HALE does not set a goal for health, avoiding the associated bias of setting such goals (El Bcheraoui et al., 2020). Considering the advantages mentioned above, HALE can aid policymakers and researchers in better understanding the changes in population health and identifying areas of priority in health policy. Governments and policymakers should broaden the scope of variables used for population health to include HALE. This will ensure that decisions about health made at local and national levels encompasses both aspects of health, i.e., morbidity and mortality.

One clear policy implication from the findings of this thesis is that to decrease the high disease burden whilst improving population health across Sub Saharan African countries; policymakers need to prioritise policies and investment in health and health systems that are focused on reducing the high burden of disease. This is because overall population health cannot be improved if the level of diseases and premature death remain high. Governments in the region should aim to spend more and ensure that it is spent cost-effectively across the healthcare system to improve health outcomes in the region, eventually leading to economic growth. They should also recognise this longer-term aspect of any intervention. For countries yet to experience the demographic transition, health improvements will first reduce growth, productivity gains and FDI, but without this short-term disadvantage, the longer-term gain will be potentially forever out of reach.

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