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Health and Economic Growth

Unraveling the Dynamic Relationship for Policy Purposes

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1. Introduction

1.1 Background and relevance

For many years researchers are working on the question how the differences in economic growth and prosperity across countries can be explained. In the beginning of the nineteenth century all countries had about similar income levels, but ever since the income gap between rich and poor countries have risen sharply (Sachs, 2005). Some countries were able to develop, whereas other countries don't earn much more today than they did 200 years ago. In 2010, the GDP (PPP) per capita of the high income countries was roughly 17 times higher than the average income in developing countries in Sub-Saharan Africa (World Bank, 2011). In the ongoing debate on the causes of poverty and the reasons for divergence in income levels still no consensus is reached, and – because of the complexity of the topic – probably there never will be. In the wide range of possible explanations for differences in growth rates, researchers point to factors such as: geography, wars, historical factors, corruption, bad governance, poor institutions, health and diseases, cultural differences, and natural resources.

This article focuses specifically on the role of health and diseases in economic growth. It is said that diseases are an enormous burden on economic growth in Sub-Saharan Africa. The African continent is, more than any other continent, tackled excessively by diseases, of which malaria, tuberculosis (TB) and HIV/AIDS form the three worst epidemics of the present. From the 1950s onwards donors have spent large amounts of money on the health sector in Sub-Saharan Africa, but in spite of all these efforts, the life expectancy of African people has only decreased, and the number of people infected with diseases rose sharply. There are measures, drugs and other interventions available to fight these diseases, but many Africans do not have effective access to prevention and treatment (Mills and Shillcutt, 2004). The relevance of health and diseases and the huge attention that international community gives to this topic becomes clear in the UN Millennium Development Goals (MDGs), which were set out to bring more prosperity to developing countries. In three of the eight goals health plays a role: the fourth goal is to reduce child mortality; the fifth goal is to improve maternal health; and the sixth goal is to combat HIV/AIDS, malaria and other diseases (UN, 2008).The idea is that to reach these goals both developing countries and donor countries should extend their current efforts.

The aim of this study is to analyze the relationship between health and economic growth. For policymaking to be effective it is very important to know how health and economic growth are interrelated. By reviewing and analyzing literature, this study is not only of importance to the academic world, but also to policymakers.

1.2 Scope of Research and Methodology

The research question will be answered by means of a literature study. Since for analyzing the relationship between health and economic growth all countries are at stake, there is no geographical delimitation in this study. However, the recommendations for policymakers specifically focus on developing countries as they receive most developmental aid for health purposes. Health is broadly defined as "*a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*" (WHO, 1946). This study looks at the health status of a country (the national level) and does not distinguish between for example different diseases. As we will see however, the latter distinction might be useful for policymaking.

1.3 A First Impression of the Correlation

Intuitively one feels that changes in health and changes in income interact with each other. A high disease burden will have (among others) consequences for productivity, and lack of income makes it difficult to invest in health. A quick look at the maps of appendices 1.1 – 1.5 already shows the great similarities between geographic data on health and income: no matter how income is measured and no matter which health indicator you look at, areas with the lowest income per capita tend to experience a relatively 'bad' health status. Higher income countries tend to have a much better health status. The most striking feature in this macroeconomic correlation is the position of Sub-Saharan Africa. More than any other part of the world, the health indicators show an extremely negative health status and income is exceptionally low in comparison with other regions. The question is what this picture tells us. Is the low income caused by the bad health status or is the bad health status caused by low income? Or maybe there is another external explanatory variable that causes the correlation between health and the economy.

Worldwide there are huge variations in both GDP per capita growth and life expectancy at birth. Nevertheless, as shown in figure 1.1 we can observe a correlation between countries with a longer life expectancy and that have higher average growth percentages between 1980 and 2009. The map of appendix 1.3 shows a similar correlation.

Figure 1.1. **Growth and Life Expectancy**
Based on data from 127 countries of all income levels around the world.
Source: dataset from *World dataBank*

On the next page, figure 1.2 links life expectancy to poverty, suggesting that countries with a higher life expectancy have significantly lower poverty rates than countries with lower life expectancies. This figure is derived from a Worldbank dataset of 110 countries. In the group of countries with a life expectancy lower than 45 years, almost 80 percent of the population lives from less than $2 a day. In countries with a life expectancy higher than 70, the percentage of people that lives below the poverty line is substantially lower: an average of only 14.4 percent of the population. The two graphs and the scientific literature on the relationship between life expectancy and the economy all seem to agree on the existence of a strong relationship between health and economic growth. Once again the question remains, what is causing what?

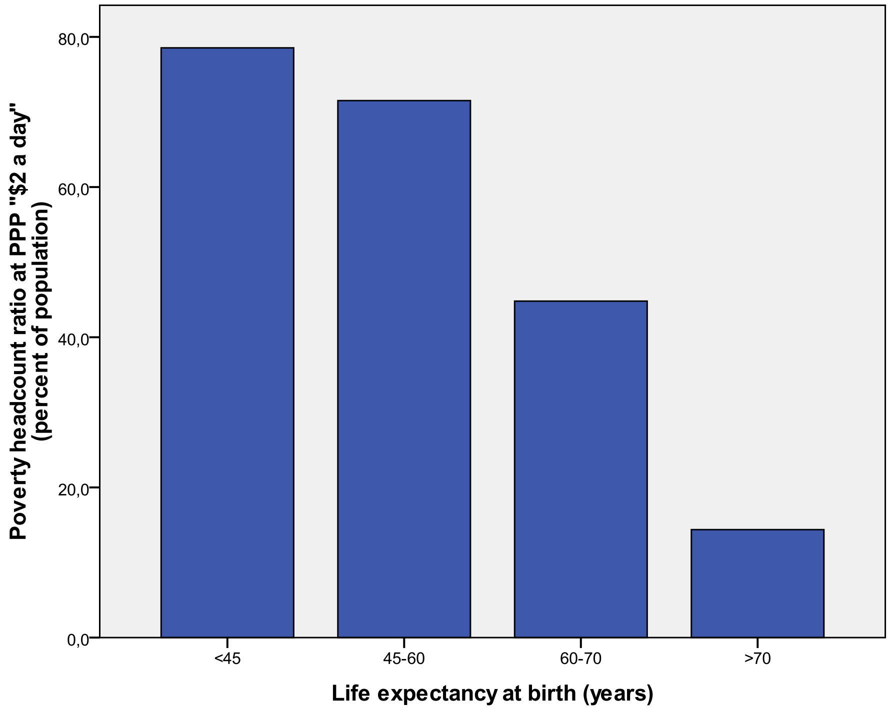


Figure 1.2. **Poverty and Life Expectancy (2000-2010 average)**
Source: *World dataBank*

Figure 1.3 shows the relationship between the under-five mortality rate and GDP per capita. It is a powerful picture showing the strong correlation between both variables. In the countries with lowest GDP per capita, mortality rates are significantly higher than in richer countries. In the 177 countries analyzed, in low-income economies (US$1,005 or less, PPP), an average of 120 out of 1,000 children does not live to their fifth birthday. In lower-middle-income economies (US$1,006 to $3,975, PPP), 81 out of 1,000 children die early in life. The under-five mortality rate in upper-middle-income economies (US$3,976 to $12,275, PPP) is even lower: 31 out of 1,000 children in these countries die before their fifth birthday. In high-income economies (US$12,276 or more, PPP) only 13 out of 1,000 children do not survive to their fifth birthday. The under-five mortality rate in low-income countries is more than 9 times higher than the under-five mortality rate in high-income countries. These incredibly big differences again indicate the correlation between health and income levels, but cannot prove what exactly the causal relationship is.

The pictures in this section mainly describe the link between health and *income*. The possible link leading from improvements in health to changes in income presumes dynamic variables, and therefore this study not only looks at health and income, but focuses on the link between health and economic *growth.*

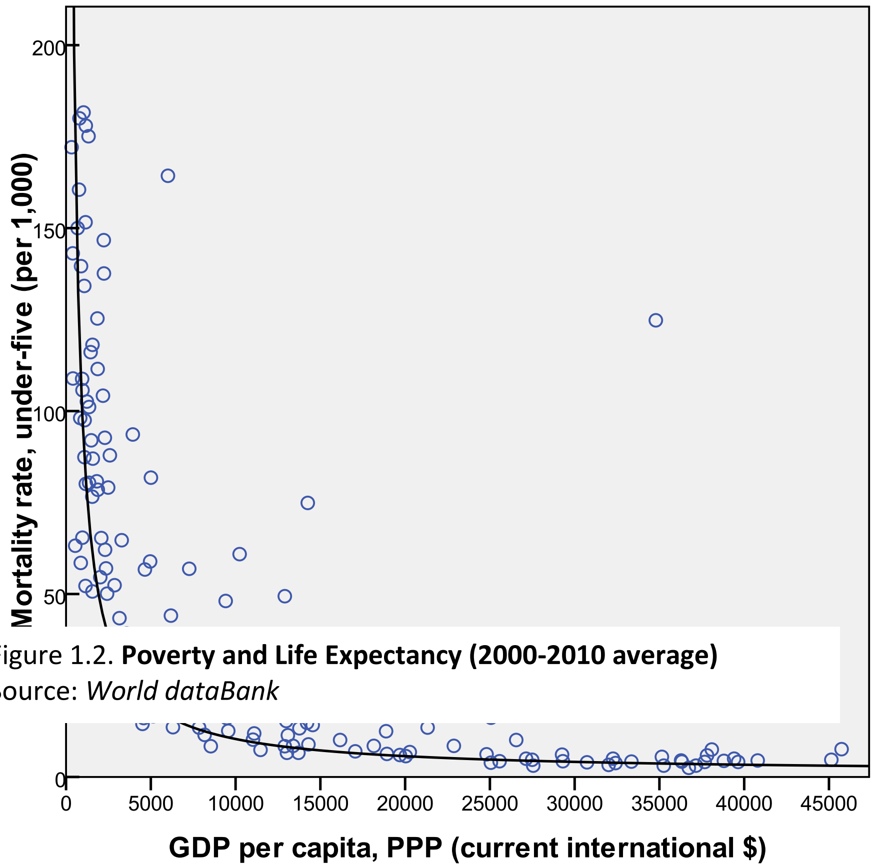


Figure 1.2. **Poverty and Life Expectancy (2000-2010 average)**
Source: *World dataBank*

Figure 1.3. **Child Mortality and Income (2009)**
Source: *World dataBank*

The figures of the health indicators represented above do not give a complete picture of the correlation between health and economic growth. In the WHO Global Burden of Disease (GBD) study from 2004, the World Health Organization recognizes that years lived with a disability are different from healthy years. The WHO uses DALYs to calculate the Burden of Disease of various diseases in different countries around the world[1]. These data show that, especially with respect to communicable diseases, the position of Sub-Saharan Africa is remarkable. Almost 25 percent of the total DALYs can be found in Sub-Saharan Africa, which means that Sub-Saharan Africa bears a quarter of the total Global Burden of Disease. This big share is mainly caused by DALYs resulting from communicable diseases, maternal and perinatal conditions and nutritional deficiencies. Examples of diseases that cause high mortality/morbidity rates in Sub-Saharan Africa are: HIV/AIDS, diarrhoeal diseases, malaria, childhood diseases and tuberculosis. The amount of DALYs caused by infectious and parasitic diseases is almost 70 times higher in Sub-Saharan Africa than in the Developed World.

Table 1.1 shows some of the most important morbidity statistics. The malnutrition prevalence 'height-for-age' refers to the percentage of children under-five years that are stunted. The 'weight-

[1] Data from WHO Global Burden of Disease 2004 Summary Tables, countries grouped by MDG regions.

for-age ratio' refers to the percentage of children that are underweight. Once again, low income countries tend to score worse than countries with higher incomes.

Table 1.1. Selected Morbidity Statistics (Source: *World dataBank)*

	Low income	**Lower middle income**	**Upper middle income**	**High income: OECD**
Prevalence of HIV, total (% of population ages 15-49)	2,6	0,7	0,7	0,3
Incidence of tuberculosis (per 100,000 people)	296	179	99	13
Malnutrition prevalence, height for age (% of children under 5)	44	42	13	-
Malnutrition prevalence, weight for age (% of children under 5)	28	32	4	-

1.4 Outline of Study

The abovementioned correlation between health and the economy is only the beginning of the story. Many economists have tried to give a more nuanced view on the (causal) relationship between health and economic growth. To answer the research question, this study attempts to analyze some of the most important contributions in the literature of the last decade. To unravel the dynamic relationship, in Chapter 2 first an overview of economic growth theory will be given. Subsequently, the methods and results of three of the most important economic studies on this topic in the last decade will be set out, analyzed and discussed. This will show how economists see the relationship between health and economic growth. Chapter 2 ends with a comparison between the articles, followed by a short discussion in which several shortcomings of the research paper are stated. Chapter 3 continues with a discussion on the main results found in Chapter 2 and elaborates on topics such as 'causality', 'channels through which health and income are linked', and 'measurement of health'. To underline additional considerations for policymaking, Chapter 4 shows an alternative approach in which the utility of health is empathized. Here the controversial Copenhagen Consensus Project will be discussed, as it is in line with the utility approach and offers a possibility to differentiate between different kinds of policy measures. The study ends in Chapter 4 with conclusions and recommendations.

2. Economic Models in Articles

This chapter explores how economists see the relationship between health and economic growth by unraveling the models of three of the most influential articles on this topic of the last decade. Since the articles make use of economic growth theory, in section 2.1 first the basics of growth models will be explained. The rest of the chapter discusses the three articles and compares them. The articles chosen are: Bloom, Canning and Sevilla (2004) *The Effect of Health on Economic Growth: A Production Function Approach* (section 2.2); Acemoglu and Johnson (2007) *Disease and Development: the Effect of Life Expectancy on Economic Growth* (section 2.3); and Weil (2007) *Accounting for the Effect of Health on Economic Growth* (section 2.4). The article of Weil differs from the two other articles by also taking into account indirect effects such as effects on education and savings. In addition, it uses microeconomic estimates to construct macroeconomic estimates, whereas the other articles make use of aggregate data. The articles will be analyzed by first setting out the methodology used in the studies, which provides insights in what, according to the authors, drives growth. Secondly the results and conclusions drawn from the articles will be set out. Finally for every article we analyze how the authors see the relationship between health and economic growth. Section 2.5 compares the three articles by looking at similarities and differences between them. The critical reflection and discussion of the articles will be given in the next chapter (chapter 3).

2.1 Theories of Economic Growth

Economists usually use growth models to understand which dimensions of development are causing economic growth. These models explore the contributions to economic growth of both factor accumulation and productivity gains. Growth models have various equations, but an aggregate production function is at the core of every standard macroeconomic growth model. Aggregate production functions describe "*the relationship of the size of a country's total labor force and the value of its capital stock with the level of that country's gross domestic product (its total output)*" (Perkins, Radelet and Lindauer, 2006: 105). Since a production function is at the heart of a growth model, growth models focus on the production side of the economy rather than the consumption side. An aggregate production function can take many forms and can be extended by more or less variables. One can choose for example to in- or exclude education and health (both human capital) or other factors such as governance, institutions and geographical location. From the process of accumulating additional capital and labor and increasing their productivity, the rate of change of output can be measured – which is economic growth. Some examples of growth models are the Harrod-Domar model, the Solow (neoclassical) model and two-sector models (Perkins, Radelet and Lindauer, 2006).

The Solow (neoclassical) growth model has become the most influential growth model in economics. The first basic equation in the Solow model ($y = f(k)$) states that the output per worker (y) depends on the capital per worker (k). The second equation shows that changes in capital per worker (Δk) depend on saving (s), the population growth rate (n), and depreciation (d), and the equation can be written as $\Delta k = sy - (n + d)k$. Saving thus plays an important role in the Solow model, but because of diminishing marginal returns to capital, the relationship between savings and growth is not linear.

The assumption of a diminishing marginal product of capital has the following implications: (1) *ceteris paribus,* poor countries have the potential to grow faster than rich countries; (2) as countries become richer, growth rates tend to slow; and (3) since poor countries potentially grow faster, they can catch up with richer countries and therefore income levels between countries would converge over time. There is much debate about these implications, especially because there is not much evidence for income levels converging over time. Once controlled for differences across countries in key characteristics that might influence growth (such as macroeconomic and political stability, investment in health and education, effective governance and institutions, favorable environment for private enterprises and favorable geography), some evidence is found for *conditional* convergence.

Unlike the Harrod-Domar model, in the Solow model the population growth rate plays a role, and allows for substitution between capital and labor in the growth process. The inverse correlation between population growth and economic growth (more rapid population growth reduces capital deepening and, therefore, reduces growth in output per worker) is an appealing factor in the model, but the reality is more complex. Population growth influences more aspects of economic growth than only those described by the Solow model. In Chapter 3 the effect of population growth will be explained more in depth.

It is important to mention that although the Solow growth model provides some important insights in the contributions to economic growth, the model does not provide a full explanation for growth since it does not explain the more fundamental causes of factor accumulation and productivity growth, and it does not address the issue of resource allocation across sectors (Perkins, Radelet and Lindauer, 2006).

2.2 Bloom, Canning and Sevilla (2004)

The first article that will be analyzed in this chapter is *The Effect of Health on Economic Growth: A Production Function Approach* by Bloom, Canning and Sevilla (2004). In a production function model of aggregate economic growth the authors estimate the effect of health (as being part of human capital) on economic growth. The result of their cross-country regression analysis is that "*health has a positive, sizable, and statistically significant effect on aggregate output even when we control for experience of the workforce.*" (Bloom, Canning and Sevilla, 2004: 1).

2.2.1 Methodology Bloom, Canning and Sevilla

Generally, human capital is seen as an important contributor to economic growth. Labor not only differs in its quantity, but also in its quality (depending for example on education and skills). In addition to education, Bloom, Canning and Sevilla (2004) see health as a crucial aspect of human capital, since healthier workers are more physically and mentally energetic and productive, less absent from work because of illness, and earn higher hourly wages. Therefore they think that not only education should be assessed to decide upon the amount of human capital, but also health. In their study the authors try to incorporate health in an aggregate production function to test for the existence of an effect of health on labor productivity, and to measure its strength. Human capital is multidimensional and by taking as a measure of human capital only education and health into account, the health component might be biased. Empirical evidence has found that countries with a higher life expectancy tend to have older work forces with more experience. To control for this effect Bloom, Canning and Sevilla include working experience directly in the model. Human capital then consists of the components education, health (measured by life expectancy) and working experience. The aggregate production function specified by Bloom, Canning and Sevilla expresses a country's output as a function of two sources: its inputs and the efficiency with which it uses these inputs.

At time Bloom, Canning and Sevilla assume that a country will converge to its steady state level. They include a country specific variable to control for structural differences between countries caused by a country's geographical and political characteristics. This suggests that the authors believe in conditional convergence.

Turning the production function in a growth equation for country *i* at time *t*, the equation looks like:

$$\Delta y_{it} = \Delta a_t + \alpha \Delta k_{it} + \beta \Delta l_{it} + \emptyset_1 \Delta s_{it} + \emptyset_2 \Delta exp_{it} + \emptyset_3 \Delta exp_{it}^2 + \emptyset_4 \Delta h_{it} + \Delta v_{it} \qquad [1]$$

This makes clear that according to Bloom, Canning and Sevilla economic growth is be driven by four main components: the growth of world TFP (Δa_t), the growth of different inputs ($\alpha \Delta k_{it} + \beta \Delta l_{it} + \emptyset_1 \Delta s_{it} + \emptyset_2 \Delta exp_{it} + \emptyset_3 \Delta exp_{it}^2 + \emptyset_4 \Delta h_{it}$), a catch-up term between a country's current and its steady-state level of TFP, and an error term (the latter two components are both part of Δv_{it}, which also includes the country specific term and which is derived from the level of TFP).

The data for all variables comes from a panel of countries observed every 10 years over 1960-90. Total output is obtained by multiplying real per capita GDP (PPP) measured in 1985 by national population.

The authors themselves warn for a potential problem of reverse causality in their growth equation, since the growth rate of output may affect the growth of inputs as well. They use lagged levels and growth rates of inputs and output as instruments for current input growth rates to overcome this problem. The validity of using these lagged levels as instrumental variable depends on whether they are uncorrelated with current shocks to TFP (represented by the error term in the growth equation). Bloom, Canning and Sevilla test this validity using overidentifying restrictions. The reverse causality problem will be further discussed in chapter 3.

2.2.2 Conclusions from Article

The macroeconomic results found in this study are close to the results earlier found in microeconomic studies. Health has positive and statistically significant effect on economic growth. One-year improvement in life expectancy raises the productivity of workers and contributes to 4% increase in output. This is not the result of correlation with an omitted variable (worker experience), but it represents a real productivity effect. An important implication of the relatively large effect found in this study is that it suggests that health expenditures might be justified just on the ground of their impact on economic growth.

As expected, countries in the tropics tend to have lower steady-state levels of TFP, while countries with better governance tend to have a higher TFP. These results are significant, and therefore the assumption that the steady-state level TFP is constant across countries should be rejected.

The used model cannot differentiate for the effects of different kind of health investments and different groups within the population. Improvements in health may increase output through more channels than only through labor productivity, and therefore a fully specified model of economic growth would be multidimensional.

2.2.3 Discussion Relationship Health and Economic Growth

As explained in the methodology of the article, Bloom, Canning and Sevilla see health as an input to growth and as being part of the production factor human capital. Health influences economic growth via the productivity channel. Growth is driven by a number of inputs (physical capital, quantity of labor, human capital) and these inputs and the efficiency with which it uses these inputs will determine the final level of output. By controlling in the TFP for governance, institutions and geographical location, the model takes into account some of the structural differences between countries. This is important since some key characteristics may influence growth significantly, and excluding these characteristics may lead to biased results. One factor that is not included in the model, however, is the amount of land. Since developing countries often are agricultural economies this exclusion might be problematic. In the article 'health' is set equal to 'life expectancy'. This assumption might have some implications for the conclusions drawn as well. As will be seen in Chapter 3, health is a broad concept which can be defined and assessed upon in many ways.

By measuring health as a production factor, the authors only measure the direct effect of health. There are also a number of indirect effects of health in which they influence growth positively. At the same time, due to for example population growth, there are indirect effects that might negatively influence economic growth. Furthermore, in addition to health as an investment good (capital), health might also be seen as consumption good, in which health yields direct utility and satisfaction (Grossman, 1972). These effects will be further discussed in Chapter 4.

Apart from what is included and what is excluded in the model, also the empirical strategy used will influence the results. This will not be discussed extensively in this report, but it is important to acknowledge that the collection of data and the strategy used may influence the end results. Furthermore, as the authors warn for themselves, causality is an important issue. Is it really the case that an improvement in health leads to economic growth, or does the causality run in both ways? In the Bloom, Canning and Sevilla model it is not possible to control for omitted variable bias. They try to validate their results by using overidentifying restrictions, but still their approach is questioned in the academic world. The abovementioned methodological considerations are of importance to the conclusions drawn, and since these conclusions are being used as justifications for certain policies, it is important to mention these considerations.

2.3 Acemoglu and Johnson (2007)

In the article *Disease and Development: the Effect of Life Expectancy on Economic Growth* Acemoglu and Johnson (2007) investigate the effect of health on economic growth using both microeconomic and macroeconomic estimates. As cross-country regression studies show a strong correlation between measures of health and economic growth, but are not able to explain the causal relationship, Acemoglu and Johnson developed a new model and empirical strategy that, according to them, overcomes these problems. In this study life expectancy at birth is used as a proxy of general health conditions.

2.3.1 Methodology Acemoglu and Johnson

In the empirical analysis, first medium-run and long-run implications of increased life expectancy are derived from a closed-economy neoclassical (Solow) growth model. Acemoglu and Johnson use for the economy (*i*) at time (*t*) the following constant returns to scale production function:

$$Y_{it} = (A_{it}H_{it})^{\alpha}K_{it}^{\beta}L_{it}^{1-\alpha-\beta} \,, \qquad [2]$$

where *A* denotes total factor productivity (TFP), (*H*) is the effective units of labor depending on human capital per person (*h*) and total population (*N*), (*K*) is the amount of capital, and (*L*) denotes the supply of land. In this model the supply of land is assumed fixed (L_i=1) for all *i* and *t*. Health (life expectancy, *X*) affects output through various channels: if life expectancy (*X*) changes, as a result, population, productivity and human capital per worker change. The model shows that income per capita will rise if, and only if, the positive effects of better health exceed the potential negative effects arising from the increase in population. If (in the long run) capital adjusts to life expectancy, the effect of life expectancy on income is greater.

To overcome endogeneity problems, Acemoglu and Johnson analyze data from the epidemiological transition as an empirical strategy. The epidemiological transition resulted in large improvements in life expectancy. From the 1940s onwards a range of new chemicals and drugs were introduced and the international community applied more effective public health measures. According to Acemoglu and Johnson (2007: 975) the period of the epidemiological transition *"provides us the possibility to isolate potentially exogenous changes in health conditions"*. This episode makes it possible to draw a sharp distinction between countries that at that time were affected by diseases such as tuberculosis, pneumonia and malaria and whose mortality rates from these diseases declined sharply, and other countries that were unaffected by these diseases. The latter group of countries did not experience the same improvements in health and mortality. Acemoglu and Johnson exploited these differential changes and use 'predicted mortality' as an instrument for determining life expectancy at birth from mortality rates of 15 of the most important infectious diseases. They estimate long-difference regressions (1940 and 1980; and 1940 and 2000) from a sample of 47 countries with different levels of income. African countries are not included in the base sample, because there is no relevant data for predicted mortality for these countries. The focus will be on the period 1940 – 1980 because from the 1980s onwards AIDS had a major impact on life expectancy. Besides income per capita, other outcome variables that are analyzed with the model are: log population, log births and the age composition of the population, total GDP, and GDP per working age population (Acemoglu and Johnson, 2007).

2.3.2 Conclusions from article

The results that Acemoglu and Johnson have found are that a 1 percent increase in life expectancy leads to 1.7-2 percent population growth. This direct effect may even be larger, taking into account that total births will increase when more women survive to childbearing age. Acemoglu and Johnson, find a small positive effect of life expectancy on total GDP, but they do not find a statistically significant effect of health on GDP per capita nor on GDP per working age population. These data show relative declines in GDP for the countries experiencing large increases in life expectancy. The reason for this might be that population growth depresses income per capita. In a longer horizon this initial decline sometimes is compensated by a higher output, as more people work and more capital is accumulated - but this is not always the case. Especially not if some factors of production, for example land, are supplied inelastically. Acemoglu and Johnson conclude their article with remarking that although improvements in life expectancy have a negative effect on GDP per capita, these findings do not imply that improvements in health have *"not been a great benefit to less developed nations during the postwar era."* (Acemoglu and Johnson, 2007: 930). The health interventions have considerably improved 'overall welfare', but did not - as many other scientists have claimed - increase output per capita.

2.3.3 Discussion Relationship Health and Economic Growth

As in the Bloom, Canning and Sevilla model, Acemoglu and Johnson use the Solow growth model to describe the relationship between health and economic growth. Health is seen as a production factor, affecting output through various channels: if life expectancy changes, as a result, population, productivity and human capital per worker change. In this way, the model differs from the Bloom, Canning and Sevilla approach, since changes in population growth explicitly are included in the model as endogenous. This is the main reason why the results of both articles differ so widely. As in the Bloom, Canning and Sevilla model, no other indirect effects are included and health is not seen as consumption good. Another similarity with the Bloom, Canning and Sevilla model is that life expectancy is taken as a proxy for health – a choice which may influence the results. Furthermore, a difference with the first article is that land is included in the model – although it is assumed constant over time. In developing countries (with a large agricultural sector) this assumption probably is ambiguous. In the collection of data no African countries are included (this might bias the results), and since the main dataset is until 1980, the impact of AIDS has not been captured.

2.3.4 Response to the article by Bloom, Canning and Fink

In their empirical strategy Acemoglu and Johnson try to deal with the causality problem and they take the epidemiological transition as empirical strategy to overcome endogeneity problems. As a response to the Acemoglu and Johnson article, Bloom, Canning and Fink (2009) wrote an article criticizing this approach and they redid the Acemoglu and Johnson research by allowing for conditional convergence. They refute the claim that the 20th century's large improvements in health did not improve income levels by applying a model of conditional convergence. Instead of the assumption that initial health and income do not affect subsequent economic growth, this model of conditional convergence (with income adjusting to its steady state over time) controls for initial conditions. Bloom, Canning and Fink base their critique on empirical evidence which suggests that health has a positive effect on income in the long term. There is, for example, a link between health in childhood and further economic success. According to the findings of Bloom, Canning and Fink, the exogenous improvements in health derived from the epidemiological transition, *did* increase income levels. They think that the reason that Acemoglu and Johnson found a negative correlation is that there is a strong convergence in health, and the countries with relatively good initial health have relatively smaller subsequent improvements of health. Therefore the results of comparing countries with initial low life expectancy with countries with initial high life expectancy are biased.

Bloom, Canning and Fink expand the Acemoglu and Johnson model by controlling for initial health and income. Their model finds relatively large and highly significant positive effects of health on income. Allowing for initial income as explanatory variable undermines the validity of the predicted mortality instrument; therefore more research is needed on the endogeneity of health and causality issues. Bloom, Canning and Fink also included labor productivity, savings and population effects in the model, but the results they have found all reverse the Acemoglu and Johnson results. They agree with the population mechanism resulting in a lower per capita income in the short run, but in the long run fertility tends to be reduced. In the long run therefore this effect disappears. Since every story has two sides, it is important to take the critique by Bloom, Canning and Fink into account and to respect their alternative analysis. The different results between the two studies suggest that the empirical strategy chosen is of a key importance to the end results found, and therefore as well to the 'evidence' where policymakers base their decisions on. More than just being rational and objective, policymakers need to choose a side and a story to believe.

2.4 Weil (2007)

Being critical of the approach used in cross-country regressions, Weil (2007) uses in his article *Accounting for the Effect of Health on Economic Growth* microeconomic estimates of the effect of health on individual outcomes to construct macroeconomic estimates of the proximate effect of health on GDP per capita. Although in the economic model only proximate effects are included, Weil also mentions the importance of indirect effects of health on economic growth. The effects of health on economic growth he found in his analysis are substantially smaller than the estimates derived from cross-country regressions, such as in the study by Bloom, Canning and Sevilla (2004).

2.4.1 Methodology Weil

Weil (2007) first does a literature study to get a broader understanding of the relationship between health and economic growth. By doing this, he not only pays attention to the proximate effect of health (the productivity channel in which healthier people are better workers), but also to a number of indirect channels through which health affects output. Subsequently, in his economic model and analysis Weil only looks at the proximate effect and he thus examines the effect of better health in enabling workers to work harder and more intelligently - holding constant other factors such as the level of physical capital, education and the quality of institutions. The endogeneity of health itself makes economic modeling difficult. People who are richer and countries that are richer can afford higher expenditures on health and health related fields such as hygiene, shelter and food. Because of the endogeneity it is almost impossible to use aggregate data (by saying this he thus criticizes the article by Bloom, Canning and Sevilla and other cross-country regression analyses), and therefore Weil constructs his dataset out of a combination of structural microeconomic estimates along with aggregate data on health differences among countries.

Health generally can be measured by looking at health inputs and health outcomes. Examples of inputs to health (physical factors that influence an individual's health) include for example nutrition, the availability of medical care and exposure to pathogens. Health outcomes (e.g. life expectancy, height, ability to work hard, cognitive functioning) are characteristics that are determined both by an individual's health inputs and by his genetic endowment. It is difficult to use the microeconomic estimates of health inputs directly to construct macroeconomic data which can be compared between countries, since comparable datasets and valid theoretical approaches do not exist. Therefore Weil constructed "*a framework in which estimates of the effect of variation in health inputs on individual wages can be used to generate estimates of how differences in health, as measured by observable outcomes, contribute to differences in national income.*" (Weil, 2007: 1272).

In the economic model, the main difference with the other articles is the construction of his dataset out of microeconomic estimates. Subsequently, in the analysis Weil also starts using a macroeconomic approach and he uses the following Cobb-Douglas aggregate production function:

$$Y_i = AK_i^{\alpha}(H_i)^{1-\alpha} \quad , \qquad [3]$$

in which output (Y), physical capital (K), a country specific productivity term (A) and the labor composite (H) are included, and where (i) indexes countries. The labor composite is determined by education, health and the number of workers. In the health variable are included only these aspects of health that are relevant for the production of output. The return to a health indicator is equal to "*the change in wages resulting from a specific change in health inputs divided by the change in the health indicator resulting from the same change in health inputs*." (Weil, 2007: 1282).

Weil (2007) uses data on three indicators of health: the age of menarche for women (onset of menstruation), the adult survival rate for men (ASR), and the average height of adult men. All indicators have their own advantages and disadvantages, but together they are assumed to give a good picture of the multidimensionality of health and they provide information about malnutrition in infancy and childhood, the survival rate during working years and the health environment in which a person grew up. A concern by Weil of the used indicators is that there may exist genetic differences across populations explaining the different returns to indicators.

In estimating the return to health characteristics Weil takes three approaches: using instrumental variables from variation in childhood inputs, using variation in birth weight between monozygotic twins (this is the baseline estimate), and using long-term historical data.

2.4.2 Conclusions from article

From the literature Weil found that besides the proximate or direct effect of health, there are a number of indirect effects. Health improvements might raise the level of education that individuals attain, since the education investment can be spread out over a longer working life, healthier students are less absent and function better cognitively. Furthermore, if mortality rates fall, people will have a higher incentive to save money (for example for retirement) and more savings will result in higher levels of investment and physical capital per worker. Another channel through which capital per worker might rise is by an increase in the marginal product of capital because healthier workers increase their labor input. The effect of health on population growth (also mentioned in the Acemoglu and Johnson paper) is ambiguous and a distinction should be made between the effects in the short run and the effects in a longer horizon. In the short run a longer life expectancy and a decrease in child mortality will result in more rapid population growth. Population growth may depress the income per capita. In the long run lower infant mortality may lead to a decline in the fertility rate, resulting in a positive effect from health to income per capita.

Looking at the proximate effect of health on GDP per worker, Weil (2007) has found that health is an important determinant of income variation, but the effect of health on income is much smaller than the existing estimates derived from cross-country regressions would suggest. Both human capital from education and physical capital are more important as explanator of income differences among countries than health. The effect of health on GDP is strongest among the poorest countries. By taking into account the indirect effects of health on the one hand (e.g. via the effect of better health in physical human capital accumulation) the estimations would be bigger, but on the other hand negative indirect effects such as population growth would lower the estimates.

2.4.3 Discussion Relationship Health and Economic Growth

In the economic model Weil assesses “only these aspects of health that are relevant for the production of output”, so by doing this he also looks at the production side of the economy. In addition, Weil shows the implications of including some indirect effects of health and he calculates how results would change if some of these effects would have been included. Agreeing with Acemoglu and Johnson, he emphasizes that apart from the positive indirect effects, population growth might negatively influence economic growth. He refers to the inclusion of all indirect effects into an economic model as an area of future research.

In the aggregate production function, land again is not included. By including factors such as for example the quality of institutions, for some other structural differences across countries is controlled.

Different from the other two articles, health is assumed as being multidimensional. Since the measurement of health differs strongly from the other two articles, the collection of data is different as well. To derive unbiased estimates of the return to health, Weil uses instrumental variables, variation in birth weights between monozygotic twins and historical data. Weil worries about the presence of a bias due to AIDS. By adjusting for the role of AIDS in affecting mortality in the 1990s, the conclusion that health is an important determinant of income variation, but that the effect is smaller than estimated from cross-country regressions, does not change.

2.5 Comparing the Articles

Now all three articles have been analyzed, it is interesting to compare the findings. This comparison is the basis for the next chapter, which discusses the different outcomes from the comparison. The table below shows the main similarities and differences between the articles and which evidence they give for the relationship between health and economic growth.

Table 2.1 Comparing the Articles

	Bloom *et al.*	Acemoglu and Johnson	Weil
Inputs to growth	Physical capital, quantity of labor, human capital.	Physical capital, Effective units of labor (depending on human capital per person and total population), supply of land.	Physical capital, Labor composite (which is determined by education, health and the number of workers).
Health as investment good vs. health as consumption good	Investment good: health is part of human capital and influences economic growth via productivity channel.	Investment good: if life expectancy changes, as a result, population, productivity and human capital per worker change.	Investment good: in model direct effect of health via the productivity channel in which healthier people are better workers.
Direct vs. indirect effects of health	Direct effects.	Direct and population growth.	Direct and indirect effects.
Measurement health	Life expectancy.	Life expectancy.	Age of menarche, Adult survival rate, Average height.
Allowing for conditional convergence across countries?	Yes, and therefore controlling for institutions and geographical location.	No – initial conditions are not controlled for.	Yes, controlled for institutions.
Causality	It is not possible to control for omitted variable bias. What is causing what?	Analyzing historical data from the epidemiological transition as an empirical strategy to overcome endogeneity problems.	Because of endogeneity health, Weil constructs dataset out of combination structural microeconomic estimates along with aggregate data.

Conclusion	A one-year improvement in life expectancy results to a 4% increase in output.	No statistically significant effect of health on GDP per capita nor on GDP per working age population. Relative declines in GDP for the countries experiencing large increases in life expectancy.	Health is an important determinant of income variation, but the effect of health on income is much smaller than the existing estimates derived from cross-country regressions would suggest.

Table 2.1 shows that the different conclusions the researchers come up with has much to do with the differences in empirical strategy and data collection, the different models and the different factors which are included in the model. An important similarity between the articles is that they all (mainly) see health as a factor which directly influences growth via the productivity channel. People with better health are better workers. Acemoglu takes also the effect on population growth into account and in addition Weil looks at some indirect effects. However, in none of the articles individuals are seen as consumers of health. Obviously, this has implications for the way economists think about the relationship between health and economic growth. Furthermore, the measurement of health may have great implications for the conclusions that will be drawn.

All abovementioned factors and aspects are of importance to the determination of the relationship between health and economic growth, which as a consequence is of importance to policy makers: how should they value and prioritize their expenditures on the health sector? Since all the models and approaches described above have their own limitations and do not give a complete picture of the complex relationship between health and growth, the next chapter – by discussing and complementing the results found in the articles – suggests possible pathways for future research.

3. Further Discussion of Articles

In Chapter 2 the articles by Bloom, Acemoglu and Weil were analyzed and discussed and a framework was given to further discuss the relationship between health and economic growth. In this chapter this relationship will be critically reflected, separated into two sections: analyzing health and economic growth (Section 3.1) and measuring health (Section 3.2).

3.1 Analyzing Health and Economic Growth

In the preceding chapter provided some important insights about how economists think about the relationship between health and economic growth. The models tell how different factors are interrelated and how they influence each other. Moreover, not only does it matter what is included in the model, but at least as important can be what is excluded. The variables in economic modeling are discussed in Section 3.1.1. In Section 3.1.2 causality will be discussed. Section 3.1 ends with an overview of the channels through which health and economic growth are related. This overview helps to analyze to what extent the methodologies and conclusions from the articles in Chapter 2 are comprehensive.

3.1.1 Variables in the Model

In Section 2.5 it became clear that there are differences as to which variables are included in the models, and that these differences are of importance in determining the relationship between health and economic growth. Economic models are always simplifications of the complex reality and including all variables imaginable would not be feasible. A great danger could be that leaving out critical variables leads to omitted variable bias. Hence it is important to include the relevant variables. The last chapter shows the disagreement on what these variables are. All articles analyzed incorporate some of the standard variables in economic growth models such as physical capital, a productivity variable (TFP) and labor. In addition, human capital is included, although not in all models exactly in the same way. The authors agree that human capital depends on more than education and they include health in the model to measure its strength. How the authors model health tells something about how they think health is related to GDP. Does health only directly influences productivity? Which indirect channels are of importance? Section 3.1.3 discusses the channels through which health influences economic growth, as found in literature. This picture is far more complex than the relationship described in the economic models from the last chapter.

Besides the 'standard' variables, there are some other similarities and differences between the economic variables in the three articles. The supply of land is not controlled for in the models or has been held constant – in developing countries (often agricultural economies) this assumption might be problematic. In addition, we saw that sometimes there is controlled for factors that are said to cause structural differences (geographical location, disease burden, institutions, governance) and sometimes it is not. Whether or not to control for these variables depends also on the assumptions of the authors, and (unrealistic) assumptions are always a pitfall in economic modeling. Whether or not allowing for (conditional) convergence could be one of these important assumptions.

3.1.2 Causality in Macro- and Microeconomic Analyses

A central consideration in the last chapter was the question whether the articles were able to determine a causal relationship. In the article by Bloom, Canning and Sevilla this causal relationship was very much doubted, but the other articles determination was questioned as well. According to the World Health Report (WHR) 1999 conclusions drawn from the literature rarely permit determination of cause and effect and therefore are suggestive rather than definitive. Hence this study does not search for definitive answers but only attempts to reflect the current academic debate in the best way possible.

The problems that cross-country macroeconomic analyses face are often related to the endogeneity of health. Health depends positively on income since wealthier people can spend more money on purchasing food and medical treatments and on adequate shelter, sanitation, and education. In addition, higher income gives incentives for fertility limitations. In richer countries, the public health sector is often more advanced (Ruger *et al.,* 2006). In figure 3.1 the links from income to health are indicated by the green arrows. When using aggregate data, it is not possible to make a distinction between the effects of health itself and the effects caused by higher income (Perkins, Radelet and Lindauer, 2006). Macro studies thus may be capturing the negative effects of other (omitted) disadvantages. This leads to the causality problem. Weil (2010: 7) states that the strategy of cross-country regression analyses would only work if one finds an "*empirically usable source of variation in health, either in cross section or time series that is not correlated with the error term in the equation determining income*." According to Weil (2010) the article by Bloom, Canning and Sevilla cannot meet this criterion and therefore the paper suffers from a severe problem of endogeneity. In the empirical strategy by Acemoglu and Johnson is attempted to overcome these endogeneity problems, but as indicated in Section 2.3.3, according to Bloom, Canning and Fink (2009) it is problematic that this study does not allow for initial conditions and conditional convergence.

Many microeconomic studies have attempted to describe the relationship between health and economic growth as well. This type of studies generally concludes that health has a significant effect on individual productivity and therefore on economic growth. However, general equilibrium effects are not incorporated in these studies and therefore they cannot resolve the question whether income differences between countries are caused by health differences (Acemoglu and Johnson, 2007).

Now the causality problem is clarified, the next question would be: does causality matter? Should policy makers be worried or change their minds if there is academic uncertainty about the exact effect and relationship between health and economic growth. It is very plausible that causality runs in both ways and that there exist a circular relationship between health and economic growth. If that is the case, uncertainty about the strength of the effect of health on economic growth would not be a strong argument against investments in health. If investments in health are able to create a virtuous cycle, it potentially helps countries to break free from a poverty trap. On the other hand, often health related development policies are explicitly justified with the 'health effect' on economic growth, and if that is not scientifically proven, such arguments might be misleading.

3.1.3 Channels through which Health influences Economic Growth

In economic thinking about the relationship between health and economic growth, economists primarily have identified the productivity channel in which better health improves productivity and therefore results in higher income. However, there are direct and indirect effects in the dynamic relationship between health and economic growth. In the analysis of the article by Weil (2007) some of the indirect effects of health on economic growth have been revealed already. In the article by Acemoglu and Johnson population effects form a key aspect of their study. The figure below summarizes the most important channels through which health and economic growth are related. The effects from income to health are already explained in Section 3.1.2. This section respectively discusses demographic effects, the direct effect of health on income and the indirect effects.

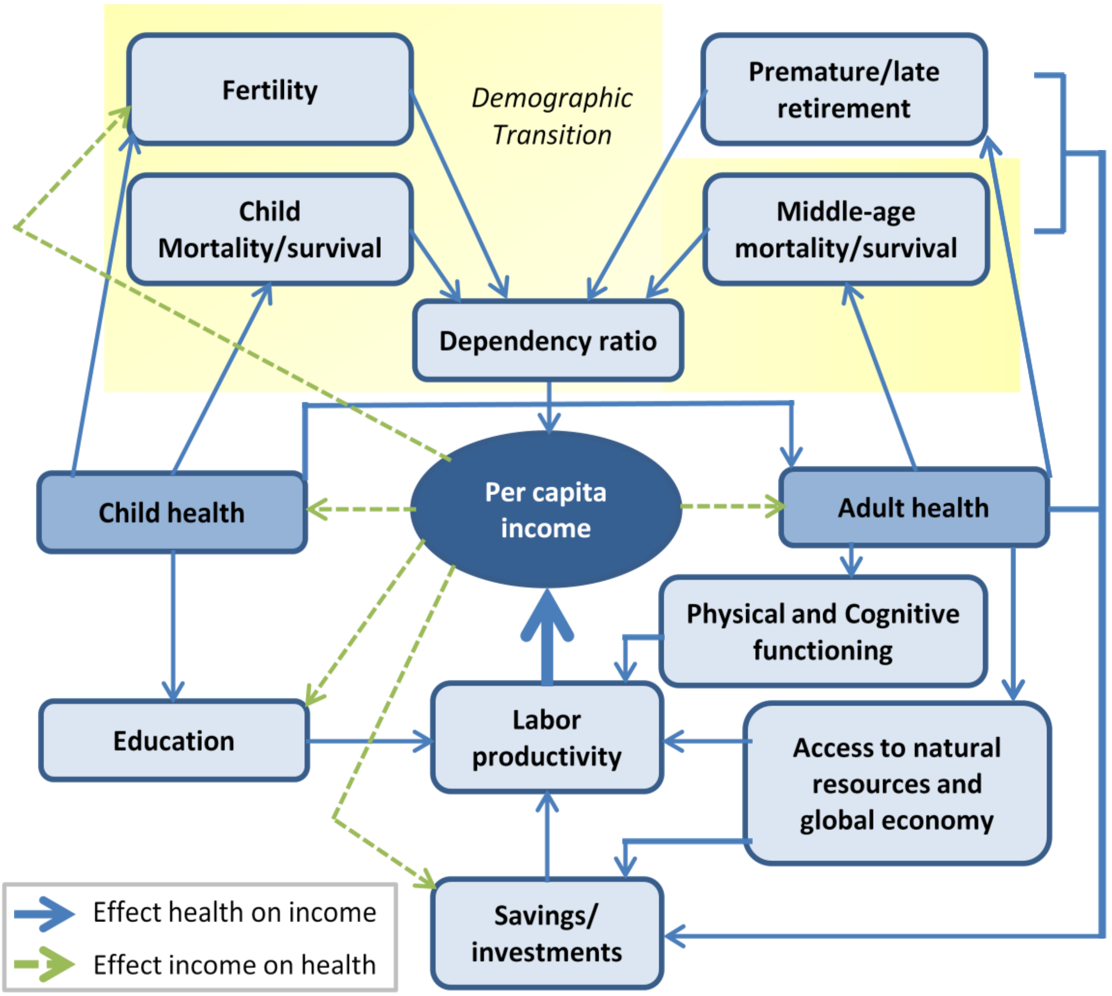


Figure 3.1 Channels through which health and income are linked. *Own revision, based on figure 1.5 World Health Report 1999: Making a Difference, WHR (1999), p.11.*

Improvements in health can influence economic growth through their impact on demography. The top half of figure 3.1 shows these age-structure effects. Improvements in health will lead to asynchronous changes in mortality and fertility, which set the first phase of a demographic transition (WHR, 1999). Whether or not health influences income positively via the demographic channel remains a point of discussion. On the one hand Acemoglu and Johnson underlined the negative aspects, in which, because of population growth, income per capita is depressed. From most diseases, the majority of the disease burden falls on infants and young children. A decline in the disease burden then leads to population growth and the age structure shifts towards more (dependent) children. Moreover, a fall in premature mortality rates leads to more elderly people – positively influencing the dependency ratio. Consequently, in the beginning there will be more consumers, but not more 'producers'. On the other hand, in the long run a decrease in mortality rates might lower fertility. In addition, the initial increase in the number of children results in more productive workers when they become adults, changing the dependency rate positively. This positive effect is sometimes referred to as a *demographic gift* (Perkins, Radelet and Lindauer, 2006). These facts above show that it is important whether the effects from health on income are analyzed in the short run or in a longer horizon.

Weil (2010) shows that different diseases might affect population (and therefore economic outcomes) in different ways. As mentioned before, the impact of HIV/aids seems to strongly differ from other diseases. HIV/aids exceptionally strong hits the working age population and the disease is much more present and problematic in Sub-Saharan Africa than in other parts of the world. Improvements in the HIV/aids epidemic directly will lead to higher productivity and a bigger workforce (since less people die premature and/or are disabled). For these reasons it is recommendable to analyze the relationship between HIV/aids and economic growth separate from 'health' and economic growth, and to distinguish between policymaking in the area of 'health' (in general) and 'HIV/aids'.

Besides the demographic effects, there are a number of other channels in which health and income are linked with each other. First of all, microeconomic studies have found that child health can influence adult health. Children that are ill or undernourished may face the consequences of this when they become adults. Furthermore, the lower half of figure 3.1 shows how health influences productivity, and therefore income. The effect most present in the economic analyses of the last chapter is the direct effect, leading from adult health to productivity. Disease, malnutrition and other health factors affect physical and cognitive functioning and result in absenteeism from work – reducing human capital, and therefore the labor productivity (Ruger *et al.*, 2006). Another channel runs through education. Scientists have found that *"Improvements in health raise the incentive to acquire schooling since investments in schooling can be amortized over a longer working life. Healthier students also have lower absenteeism and higher cognitive functioning and, thus, receive a better education for a given level of schooling" (Weil, 2007: 1266).* On the right side of figure 3.1 an arrow goes from premature/late retirement, middle-age mortality/survival and adult health, to savings and investments. If people expect to live longer, they have a higher incentive to save for the future. Weil (2007) describes this relation as: *"Improvements in mortality may also lead people to save for retirement, thus raising the levels of investment and physical capital per worker. Physical capital per worker may also rise because the increase in labor input from healthier workers will increase capital's marginal product."* (Weil, 2007: 1266). A less obvious link between health and economic growth is according to the World Health Report 1999 caused by geographically specific diseases. According to the report (WHO, 1999: 11) *"geographically specific diseases (…) deny communities access to valuable land or productive resources. And high levels of illness in a community may weaken links to the global economy – links that through the movement of ideas, goods and capital help create the conditions for more rapid growth".*

None of the models in chapter 2 capture all of the effects described in figure 3.1. This means that the articles by definition under- or overestimate the effect from health on economic growth. This is an important conclusion that policymakers should take into account.

3.2 Measuring Health

In order to describe the relationship between health and economic growth one needs to assess the health status of a country. However, measuring 'health' is not that easy. It is almost impossible to quantify such a concept in one country and it is even more complex to compare health statuses between different cultures and over time. General indicators such as the mortality rate, the morbidity rate and life expectancy offer a first impression of the health status of a country, but are not always suitable for drawing overall conclusions. Another important point of discussion in measuring health is the severity of a disease. Some diseases are likely to have a greater impact on the economy than others. How to account for that?

First of all, it is worth mentioning again that the health status of a country depends both on health inputs and health outcomes. This difference between the two is already explained in Section 2.3.1. Since health outcomes are (among others) determined by an individual's health inputs, and rich countries have more of almost all health inputs than poor countries, comparisons of health indicators (outcomes) show the same tendency: health outcomes are better in rich countries than in poor countries (Weil, 2007). As stated before, the endogeneity of health itself in examining the effect of health on economic growth makes using aggregate data on health almost impossible. This understanding and the fact that health is multidimensional made Weil construct aggregate data from microeconomic data and he uses three indicators of health: the age of menarche for women, the adult survival rate (ASR), and the average height of adult men. However, as we will see in the following paragraphs, these indicators do not control for severity of diseases and the burden of disease. Moreover, in the indicators of Weil there might be a positive correlation between a person's health and wage: "*People with high wages are able to take better care of themselves. And even in the case of aspects of health that are determined early in life (for example, height and age of menarche), people from high-income families are well nourished and cared for as children, and they also carry into the labor market advantages, such as better schooling and family connections, that are not observed by the econometricians. The omission of these factors biases upward the coefficient on a health indicator in a wage regression.* (Weil 2010: 19/20)"

The articles by Bloom, Canning and Sevilla and by Acemoglu and Johnson use life expectancy at birth as a proxy for health. Life expectancy is a health output indicator, depending on several health inputs such as labor productivity, education, health care facilities and the investment climate. Life expectancy (e_x) is the average number of subsequent years a person now aged *x* can expect to live, if in the future they experience the current age-specific mortality rates in the population (WHO, 2011). Life expectancy can affect growth by influencing productivity and by boosting savings and capital accumulation. People with a longer life expectancy might have a higher motivation to invest in education since they expect to have higher lifetime earnings (Perkins, Radelet and Lindauer, 2006). Often, in statistical data the life expectancy at birth (e_0) is given, which reflects the overall mortality level of a population. However, sometimes this life expectancy at birth can give a distorted picture of reality, since in countries with high infant mortality rates, e_0 can be very low but in reality there might be a lot of elderly people. To exclude the effect of high infant mortality rates one might use for example the life expectancy at age 5 (e_5). Acemoglu and Johnson chose to check the validity of their results by making calculations for both life expectancy at birth, and life expectancy at age 20. Another solution to such misinterpretations would be to use a life table, which presents a set of tabulations that describe the probability of dying, the death rate and the number of survivors for each age or age group.

As criticism of the three analyzed articles is that one could argue that not only it matters how many years one lives, but also how many years in good health. Morbidity statistics measure rates of diseases and illnesses. This type of data is important because diseases or disabilities may limit participation and performance in labor or family life (Perkins, Radelet and Lindauer, 2006).

Furthermore, morbidity is negatively correlated with school attendance and performance. Bloom, Canning and Sevilla (2004: 1) found that: *'Illness and disability reduce hourly wages substantially, with the effect especially strong in developing countries, where a higher proportion of the work force is engaged in manual labor than in industrial countries.'* Morbidity thus has a negative effect on productivity, and developing countries experience the worst consequences. Although Boom, Canning and Sevilla are aware of that data on life expectancy measure mortality rather than morbidity, they still choose to use life expectancy as a proxy for the health of the workforce, since life expectancy is generally associated with better health status and lower morbidity.

A drawback of (using) general indicators such as mortality, morbidity and life expectancy is that comparing the results of different countries is difficult. High income countries typically have other kinds of diseases than low income countries; geography is of importance (tropical diseases); gender plays a role and the age distribution between different populations might differ. In the economic models of Bloom, Canning and Sevilla (2004) and Weil (2010) is a correction made for this kind of characteristics. Weil (2010) and Acemoglu and Johnson (2007) correct for population effects.

An often used attempt, which combines both mortality and morbidity statistics into a single unit and distinguishes between different diseases (with different severity rates), are the earlier mentioned Disability Adjusted Life Years (DALYs) statistics. The sum of Disability Adjusted Life Years (DALYs) is the standard measure to decide upon the burden of disease in a society and is used in for example cost-effectiveness analyses to prioritize health interventions and to evaluate progress in reaching the MDGs (Anand and Hanson, 1998). One DALY is one lost year of a "healthy" life. The burden of disease measures the gap between the current health situation and an "ideal" or "reference" health situation where the entire population lives to an advance age, free of disease and disability. This means that the burden of disease not only measures the death rate, but also takes into account the impact of premature death (Years of Life Lost (YLL)) and disability (Years Lost due to Disability (YLD)) (WHO, 2011). As we will see in the next chapter, this type of measurement is already used in policymaking.

The different possibilities in measuring health show that health is a multidimensional and ambiguous concept. To keep modeling feasible, often life expectancy is used as a proxy for health, but although it might give a reasonable estimate, it does not provide a complete picture of the health status of a country, neither it includes a country's disease burden.

4. Policymaking and the Utility of Health

So far, only the effects of health on GDP and vice versa have been discussed – which is of course the research question of this article. However, it may be important to mention as well (especially for policy purposes) that people care about more than just the products and services they consume and its total value. Suppose there is no (positive) economic effect of improvements in health, would that mean that the donor world should stop sending money to developing countries for improving health and fighting diseases? Should humanitarian arguments be taken into account in the debate as well? And what exactly is known about how health is valued?

4.1 Utility of Health

Ideally one would compare GDP with other things that we care about. Economists make this kind of comparisons using the concept of 'utility'. 'Utility' combines both GDP and other aspects of life (Weil, 2010). The basis for this kind of ideas and comparisons lies in Michael Grossman's (1972) model of health production. Apart from health being an investment good (better health increases productivity, leads to fewer sick days and higher wages), health is seen as a consumption good that yields direct satisfaction and utility. Sick days, on the contrary, are a source of disutility (Grossmann, 1972). Factors that could be included in a health utility function are for example people's health status (e.g. no pain and suffering associated with illness), utility loss from the death of loved ones, and how long a person lives (loss of one's own life). Economists use the 'value of a statistical life' to value health in terms of an income equivalent (Weil, 2010). Although putting a value on one's life may seem heartless or unethical, in practice constantly human lives are being valued both directly and indirectly, and trade-offs are being made to prioritize investments. Weil (2010: 86) states that: "*policy decisions regarding the allocation of scarce resources between different uses (for example, more health clinics versus improvements to infrastructure) could be based on the goal of achieving a utility-maximizing combination of increases in health and income*".

4.2 The Copenhagen Consensus Project

A well-known example of a study and project that explicitly prioritizes investments based on a cost-benefit analysis and in which health investments are also valued based on utility functions is The Copenhagen Consensus project directed by Bjørn Lomborg. This study is very different from the other articles analyzed in Chapter 2, but it is worth mentioning because it enables policymakers to go beyond the effects of health 'in general' and to differentiate between different measures. The study does not look at the relationship between health and economic growth, but purely looks at the efficiency of spending donor money. The economists of Chapter 2 are for or against using 'the effect of health on economic growth' as justification for certain policies, but maybe it is better to look at the effects and efficiency of fighting *specific* diseases and health related issues on economic growth.

The Copenhagen Consensus project held conferences in which possible solutions to a wide range of problems and challenges regarding health, poverty, hunger and the environment were presented by experts in each field and subsequently were analyzed en prioritized by prominent (welfare) economists, including three Nobel laureates. This resulted in Copenhagen Consensus reports in 2004 and 2008 in which the interventions were rated and classified into very good, good, fair and bad solutions. To measure the burden of disease 'disability-adjusted life years' (DALYs) are used to value both mortality changes and changes in health status. In terms of cost effectiveness the seven key interventions for disease control that the Copenhagen Consensus 2008 found are (Jamison, Jha and Bloom, 2008: 51):

1. Tuberculosis: appropriate case finding and treatment
2. Heart attacks (AMI): acute management with low-cost drugs
3. Malaria: prevention and ACT treatment package
4. Childhood diseases: expanded immunization coverage
5. Cancer, heart disease, other: tobacco taxation
6. HIV: "combination prevention"
7. Injury, difficult childbirth, other: surgical capacity at the district hospital

The benefit-cost ratios of these investments and the deaths that these interventions could advert (calculated in DALY's) can be found in Appendix 4.1. Besides disease control, Copenhagen Consensus ranked many other health related interventions such as solutions lying in the challenges 'malnutrition', 'water', and 'air pollution'. Examples of these cost-effective interventions are 'micronutrient supplements for children' (allover solution nr. 1); 'micronutrient fortification' (nr. 3); 'biofortification' (nr. 5); 'deworming and other nutrition programs at school' (nr. 6); 'community-based nutrition promotion' (nr. 9); 'bio-sand filters for household water treatment' (nr. 15); 'rural water supply' (nr. 16); and a 'total sanitation campaign' (nr.20).

As stated before, the valuation of human lives in the Copenhagen Consensus project is criticized for being controversial and unethical. In addition, Jeffrey Sachs (2004: 726) argues that the project "*failed to mobilize an expert group that could credibly identify and communicate a true consensus of expert knowledge on the range of issues under consideration*." Almost all panel members are economists and there was only little input of natural scientists, engineers and public-health specialists.

Nevertheless, the Copenhagen Consensus project is an interesting viewpoint in thinking about prioritizing investments. In contrast to the three articles analyzed in Chapter 2, this study makes it possible to explicitly distinguish between different aspects of health and different types of diseases and interventions. Further discussion and research on the topic is needed, but in essence it could be a powerful tool for policy making.

5. Conclusions and Recommendations

As resources are scarce, the international community has to make choices where to spend donor money on. Health is, and always has been, one of the areas in which a lot of efforts have been made. Sometimes aid on the health sector is justified based on the alleged effect of improvements of health on economic growth. Simple figures show the correlation between the two variables. Economists, however, are having many disagreements about the causality in the strength of the effects. Therefore this literature study has attempted to unravel the dynamic relationship between health and economic growth.

By means of analyzing three economic articles on this topic, it has turned out that economists use different approaches, strategies and variables in their models. The direct channel leading from improvements in health, via better productivity, to economic growth, is most present in economic thinking about the relationship. Sometimes indirect effects and population effects are included. Moreover, the way health is measured differs strongly. The abovementioned differences result in different conclusions about the alleged relationship between health and economic growth. The validity of the results depends on the choices, strategies and assumptions that the researchers make, but so far it is not clear which is the best approach. All of the articles seem to have their own advantages and disadvantages.

Current policies often are based on the conclusions of this type of studies, but the uncertainty and discussion about the strategies and results show that policymakers rather choose to take a side in the debate, than that policies are based on scientifically grounded evidence. This is not to say that nothing is known about the relationship, nor that it is ‘wrong’ to invest in the health sector – but the way policymakers use existing evidence seems not so convincing as justification for certain policies.

This all suggests there is room for improvement with respect to economic modeling. Therefore the results found from the articles have been further discussed and complemented. Because of the endogeneity of health, determining causality is difficult. The articles analyzed have attempted to deal with this, but were not able to give definitive answers. The effects from higher income to better health – richer people and countries can spend more money on improving their health and the health sector – is very likely to be present. Therefore it is plausible that causality runs in both ways and that health and income are related in a circular relationship. Assuming this way of thinking is right, it still seems to be an argument for investing in health. Investments in health then might create a virtuous cycle, potentially helping countries to break free from a poverty trap.

To complement the articles by Bloom, Acemoglu and Weil, all channels should be identified through which health and income are related. The direct channel enables workers to be more productive, positively influencing economic growth. The effect of health on income via population growth is more ambiguous. In the short run, population growth seems to depress per capita income, but in a longer horizon demographic effects may give a boost to the economy. A number of indirect effects from health to income run through education, savings and access to natural resources and the global economy. Putting all these effects together into an inclusive and multidimensional model, which is able to measure the strength of the effects, seems yet not feasible. In addition, for various reasons it is recommendable to do research and make policy on the area of HIV/aids apart from ‘health’ in general.

The measurement of health is another relevant aspect which leads economists to come up with different conclusions. Often life expectancy (at birth) is used, but sometimes this gives a distorted picture. A major consideration in measuring health would be whether or not to account for morbidity and severity of diseases.

In addition to the economic relationship and effects, decisions about investments on health could also be based on humanitarian considerations. People seem to care about more than economic value and therefore measuring 'utility' of health provides a solution. Economists have done this by calculating the 'value of a statistical life'. Although sometimes the approach is criticized for being unethical, at least it provides a helpful way of thinking. An example of such a project is the Copenhagen Consensus Project. Copenhagen Consensus prioritizes investments based on cost-benefit analyses and value health with DALYs. Contrary to the articles by Bloom, Acemoglu and Weil, this project provides an opportunity to differentiate between investments on different kinds of diseases and health problems and therefore it is a promising method.

This thesis has showed that the relationship between health and economic growth is complex. So far, in economic literature no consensus is reached about how health and economic growth are related and what the strength is of the effects.

References

Acemoglu, D. and Johnson, S. (2007) Disease and Development: The Effect of Life Expectancy on Economic Growth, *Journal of Political Economy*, 115 (6): 925-85.

Anand, S. and Hanson, K. (1998) DALYs: efficiency versus equity, *World Development*, vol. 26(2), pages 307-310

Bloom, D.E., Canning, D. and Fink, G. (2009) Disease and development revisited. *NBER Working Paper No w15137*.

Bloom, D.E., Canning, C. and Sevilla, J. (2004). The Effect of Health on Economic Growth: A Production Function Approach. *World Development,* 32 (1): 1-13.

Grossman, M. (1972). On the Concept of Health Capital and the Demand for Health. *Journal of Political Economy,* 80 (2): 223-255

Jamison, D.T., Jha, P. and Bloom, D. (2008) The Challenge of Diseases. *Copenhagen Consensus 2008*

Mills, A. and Shillcutt, S. (2004) *The Challenge of Communicable Diseases.* Copenhagen Consensus 2004

Perkins, D.H., Radelet, S. and Lindauer D.L. (2006). *Economics of Development,* 6th edition. New York: W.W. Norton & Company.

Ruger J.P., Jamison D.T., Bloom D.E. and Canning D. (2006) Chapter 13. Health and the economy. In: Merson M.H., Black R.E., Mills A., eds. *International Public Health: Diseases, Programs, Systems, and Policies. Second Edition.* Sudbury, Massachusetts: Jones and Bartlett Publisher, 2006: 601–647.

Sachs, J.D. (2004). Commentary. Seeking a global solution. *Nature* 430, 725-726 (12 August 2004).

Sachs, J. D. (2005). *The End of Poverty: How We Can Make It Happen in Our Lifetime*. London: Penguin.

United Nations (UN). (2008). *The Millennium Development Goals Report 2008.* United Nations.

Weil, D. N. (2007). Accounting for the effect of health on economic growth. *Quarterly Journal of Economics,* 122 (3): 1265-1306.

Weil, D.N. (2010) Endemic Diseases and African Economic Growth: Challenges and Policy Responses. *Journal of African Economies*, volume 19, pp. 81–109

World Bank (2011) World Development Indicators. Online at: http://databank.worldbank.org

World Health Organization (WHO). (1946). *Preamble to the Constitution of the World Health Organization.* World Health Organization.

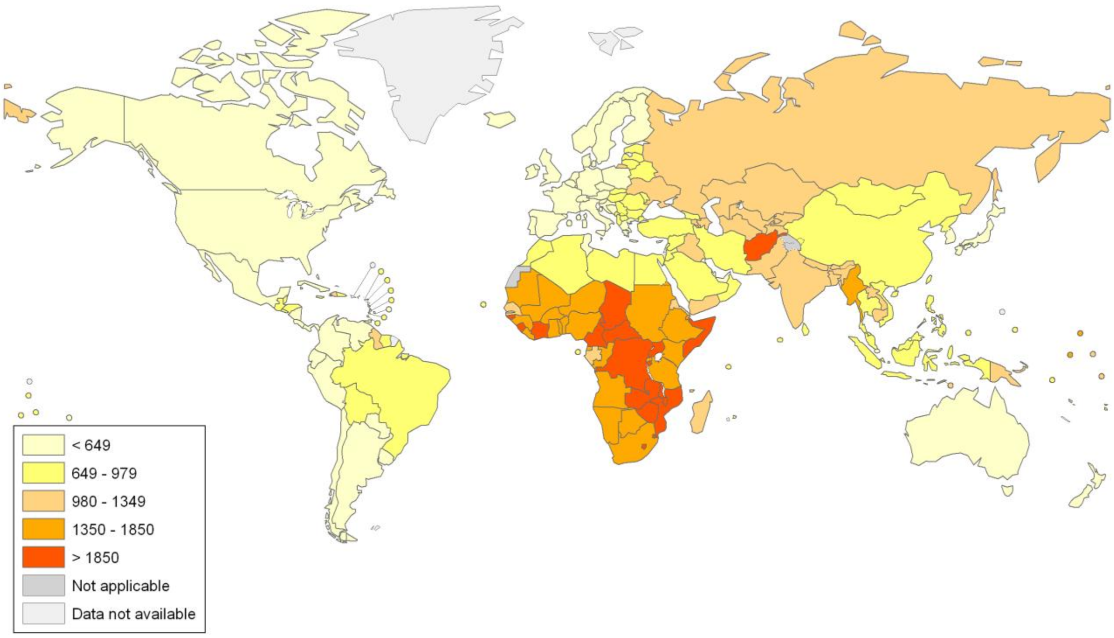
World Health Organization (WHO). (1999). *World Health Report 1999: Making a Difference.* World Health Organization.

World Health Organization (WHO). (2008). *The global burden of disease: 2004 update*. Geneva, World Health Organization, 2008. Online at: http://www.who.int/evidence/bod

World Health Organization (WHO). (2011). *Data and Statistics.* Online at: http://www.who.int/en/

Appendix 1.1: World Death Rate Map

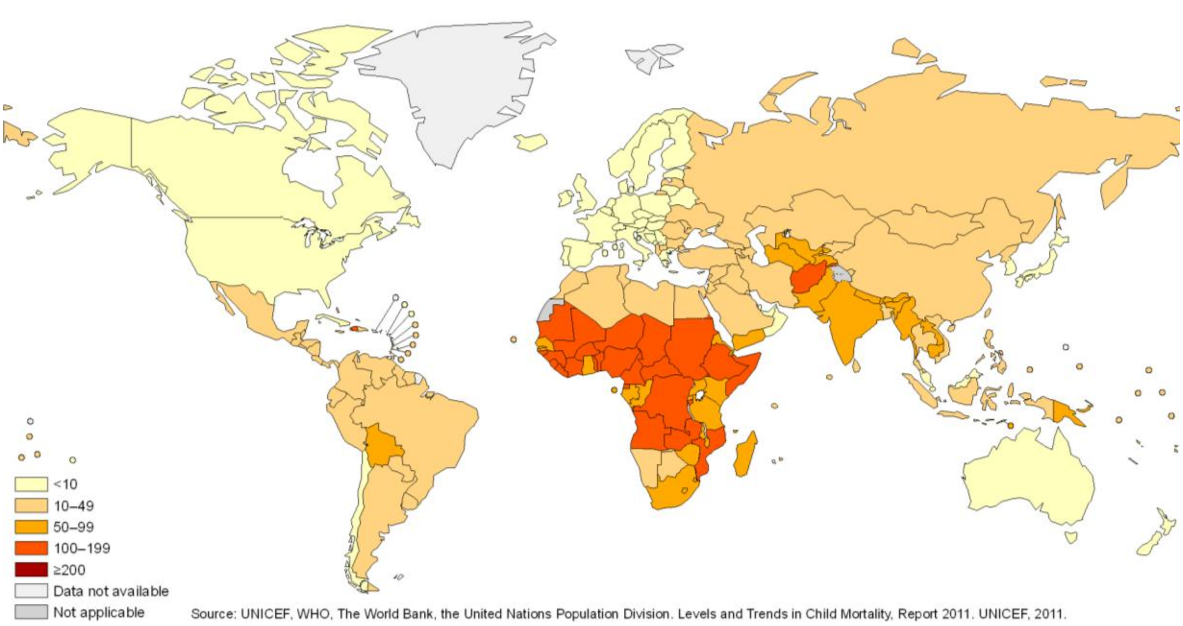
Map age standardized death rates (per 100 000 population), 2008



Source: World Health Statistics 2011, WHO

Appendix 1.2: World Under-Five Mortality Rate Map

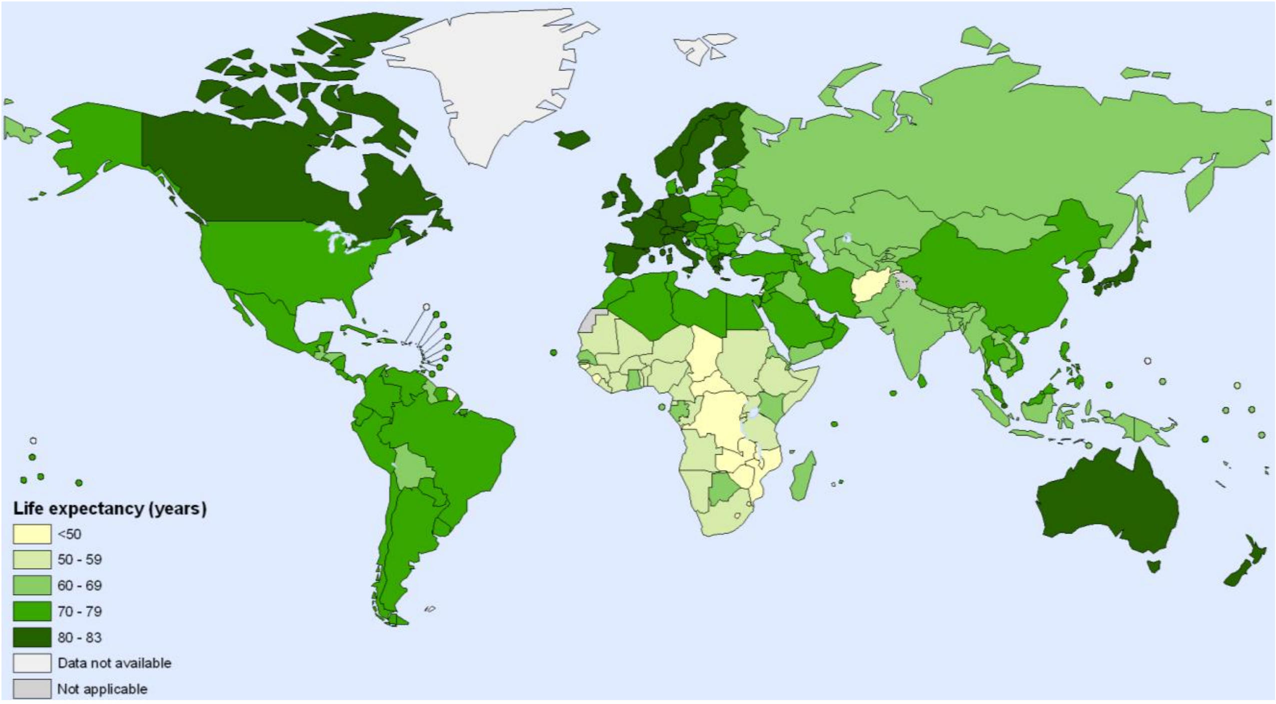
Map under-five mortality rate (probability of dying by age 5 per 1000 live births), 2010



Source: World Health Statistics 2011, WHO

Appendix 1.3: World Life Expectancy at Birth Map

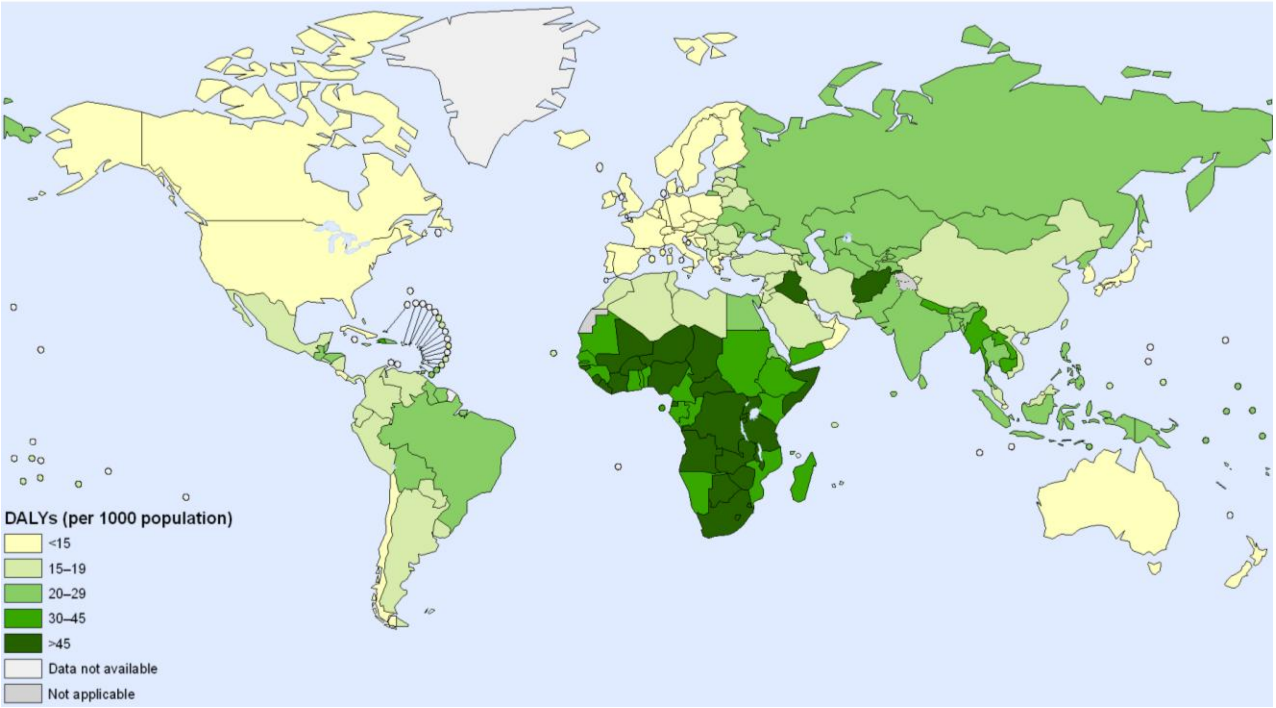
Map life expectancy at birth. Both sexes, 2009



Source: World Health Statistics 2011, WHO

Appendix 1.4: World Age Standardized DALY Rates Map

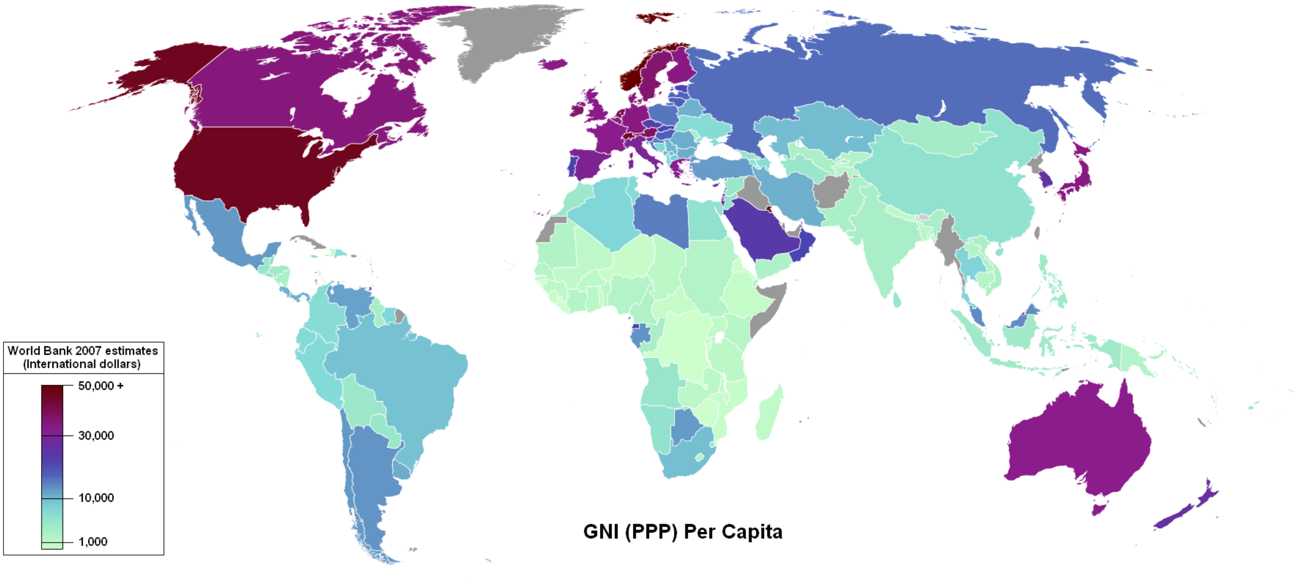
Map age standardized disability-adjusted life year (DALY) rates, 2004.



Source: World Health Statistics 2011, WHO

Appendix 1.5: World GNI Per Capita Map

Map GNI per capita, PPP (current international $)



Source: WorldBank

Appendix 4.1: Disease Control: Key Investment Priorities

Priority Area	Indicative Benefit-Cost Ratio	Level of Capacity Required[a]	Financial Risk Protection Provided[a]	Relevance for Development Assistance[a]	Annual Costs ($ billions)	Annual Benefits[b]
1. Tuberculosis: appropriate case finding and treatment	30:1	M	H	M	1	1 million adult deaths averted or 30 million DALYs
2. Heart attacks (AMI): acute management with low-cost drugs	25:1	M	H	H	.2	300,000 heart attack deaths averted each year or 4.5 million DALYs
3. Malaria: prevention and ACT treatment package	20:1	M	L	M	.5	500,000 (mostly child) deaths averted or 7.5 million DALYs
4. Childhood diseases: expanded immunization coverage	20:1	L	L	L	1	1 million child deaths averted or 20 million DALYs
5. Cancer, heart disease, other: tobacco taxation	20:1	H	H	H	1	1 million adult deaths averted or 20 million DALYs
6. HIV: "combination prevention"	12:1	M	H	H	2.5	2 million HIV infections averted or 22 million DALYs
7. Injury, difficult childbirth, other: surgical capacity at the district hospital	10:1	H	H	H	3	30 million 'surgical' DALYs averted or about 20% of DALYs

[a] Level of capacity required, extent of financial risk protection provided and relevance for development assistance, are judged by the authors to be high (H), medium (M) or low (L).
[b] In the formulation of DALYs the benefits of averting a death in a given year all accrue in that year and are calculated as the present value (at a 3% discount rate) of the future stream of life years that would have occurred if the death had been prevented.

Source: Jamison, D.T., Jha, P. and Bloom, D. (2008) The Challenge of Diseases. *Copenhagen Consensus 2008*. p. 51