CHAPTER 1
Health Investments and Economic Growth: Macroeconomic Evidence and Microeconomic Foundations

William Jack and Maureen Lewis

Improvements in health status over the last 50–100 years, as measured by a number of indicators, have been nothing short of spectacular. Vaccines, antibiotics, and other pharmaceutical developments have drastically reduced the incidence of illness and death. Economic growth has also helped: richer people are better nourished and educated, and richer countries are more able to afford the public goods (such as supply of water and sanitation and control of disease vectors such as mosquitoes) that reduce the transmission of disease.

Do improvements in health themselves help to boost economic growth? This proposition is at the heart of the report of the World Health Organization's Commission on Macroeconomics and Health (WHO 2001: i), which states, "Extending the coverage of crucial health services . . . to the

This chapter was drafted for the Commission on Growth and Development, and an earlier version was presented at the commission's workshop on health and growth, October 16, 2007. The authors thank Jeffrey Hammer, Magnus Lindelow, Mattias Lundberg, Andre Medici, Paul Schultz, Duncan Thomas, and participants at the workshop for useful comments. Ann Merchant and Erika Mae Lorenzana provided expert research assistance. The authors alone are responsible for the content of this chapter.

world's poor could save millions of lives each year, reduce poverty, spur economic development, and promote global security." According to this view, better health care may be able to accomplish what development practitioners, nongovernmental organizations (NGOs), economists, foreign aid, and diplomacy have failed to achieve. Some researchers who have found a significant link from health to growth (for example, Bloom and Canning 2003a, 2003b) have used this finding to argue for large increases in government spending on health.

Both directions of causality between health and income are likely operative, although they are difficult to measure and estimate, and a vigorous ongoing debate about which direction dominates reflects these empirical challenges. A resolution of this debate could boost the urgency of the quest for growth, inform that quest, or both. For example, a finding that economic growth reduces infant mortality could hasten the adoption of potentially growth-enhancing policy reforms. Alternatively, if better population health were found to stimulate economic growth, the full social returns to policies that directly improve health status would be higher than is now recognized, and interventions designed to improve health might be added to the armory of growth-friendly policies to be used in the quest for growth.

To help inform decision making on public policy, this review examines the routes by which improvements in health might indeed increase incomes and growth and the related evidence. Recent advances in the literature suggest that a link from health to growth may be operational, but difficult to measure, and that its effect is likely to be relatively small.

Better health may lead to income growth, but this does not necessarily mean that governments of developing countries should spend more of their budgets on health care. As Bloom and Canning (2003a: 313) point out, "The key issue is not that spending on health would be good [although some authors question even this assumption], it is whether spending on health is better than other uses of the limited funds available in developing countries." Public spending on health care might not be the best way to achieve health, let alone growth.

Thus a second goal of our review is to investigate the determinants of health itself, particularly the evidence on the impact of public expenditure policies on health. Some specific public interventions seem to be very good for health outcomes, while some broader measures seem to have little measurable effect. But overall there appears to be growing evidence that public policies only improve health when institutions are of sufficiently high quality, and that good institutions themselves are likely to have a more important *direct* effect on growth than on growth-through-health.

We caution the reader against expecting to find consensus in the empirical literature on the links from health to growth or even from health policies to health. A number of papers present unambiguous results but contradict one another. From our reading, the literature is a mix of rigorous scientific

investigation and well-motivated advocacy on both sides.[1] Further, when attempting to untangle the link from health to growth, or vice versa, econometric issues of endogeneity and measurement error are particularly problematic, and the validity of even the most innovative approaches continues to be debated.

Health status is affected by food and nutrition, public health investments, lifestyle and individual medical services. In addition, other factors, notably cognitive and noncognitive educational attainment, deeply affect the predisposition to illness and the ability to ward off and manage illness in adulthood. We review the evidence surrounding all of these influences to gain some appreciation of the link between a country's investments in "health" and economic growth.

The first section of this chapter examines the links between health outcomes and economic growth at the macroeconomic level, encompassing discussion of the econometric and policy issues. Then, because the health-income literature provides little policy guidance on how to improve health, the second section reviews the microeconomic linkages between health and income and considers the crucial role that public investments outside the "health" sector have played in improving health status. The third section summarizes the weak links between investments in medical care and health status and addresses the institutional challenges within the health sector if investments in health care are to improve health. A final section concludes.

Population Health and Income: Potential Links and Evidence

This section provides an overview of the historical patterns of health improvements as background to a review of the mechanisms by which improvements in a population's health might lead to increases in income. We then present some basic evidence on the associations between trends in health and trends in national income across countries and within two large developing countries (China and India) over time, and discuss the challenges faced in interpreting these associations.

How Did We Get So Healthy?

This historical overview details the main causes of improvements in population health, many of which, such as improvements in food supply, sanitation, and control of disease vectors, lie outside the health care field.

The dramatic improvements in health status of the past 50 years—most obvious from the declines in mortality and increases in life expectancy—stem

1 As Dixit (2006: 23) notes in a thought-provoking discussion, conflicting research findings in the growth and development literature "can leave a user who is not an expert in a particular area in a thorough state of confusion and indecision."

mainly from improvements in nutrition, advances in public health, and education; for populations at large, higher spending on health care has had minimal impacts on mortality.

Historically, inadequate food production and the resulting malnutrition compromised adult productivity. For example, data from the United Kingdom show that, until the late eighteenth century, U.K. agricultural production could only feed 80 percent of the population. Greater output raised nutritional status, leading to longer working hours, while parallel investments in public health improved the use of the calories consumed (Fogel 2002). Fogel (1986) concludes that nutritional improvements have contributed about 40 percent to the decline in mortality since 1700, with sharp rises in nutritional status occurring in periods of abundant food, mostly in the twentieth century.

Along with better nutrition, advances in hygiene and education have played a more important role in reducing mortality than advances in medicine. McKeown, Record, and Turner (1962, 1975) examine the reasons for mortality declines in England and Wales during the nineteenth and twentieth centuries. Mortality was affected by medical measures such as immunizations, but lower exposure to infection, expanded access to piped water and sanitation, and better nutrition were the major factors explaining the rising survival rate. Reduction in death from airborne infections occurred before the introduction of effective medical treatment, and better nutrition had a large effect on the ability to ward off infection and on the probability of death. Declines in mortality from water- and food-borne diseases could be traced to improved hygiene and better nutrition, with treatment emerging as largely irrelevant.

Similarly, Fuchs (1974), in his study of infant mortality reductions in New York City between 1900 and 1930, attributed these shifts mainly to rising standards of living, education, and lower fertility, rather than to medical advances. Fogel (2002) compares morbidity levels in the post–Civil War period in the United States with those in the latter part of the twentieth century and finds that morbidity levels have fallen significantly, partly because of changes in lifestyle and partly because of other factors including medical interventions. Lleras-Muney (2005) examines the determinants of life expectancy in the United States using a synthetic cohort beginning in 1900. Her estimates indicate that each year of education increases life expectancy at age 35 by as much as 1.7 years, a very significant increase that suggests the central importance of education. Similar findings are reported in multiple studies in developing countries (Schultz 2002).

Exceptions are breakthroughs in pharmaceutical therapies after the 1940s—notably vaccines, penicillin, and other antibiotics that penicillin spawned—that changed the health landscape. Acemoglu and Johnson (chapter 4 in this volume) also point to the development of the pesticide DDT, which effectively controlled disease vectors like mosquitoes, and to the establishment of the World Health Organization, which helped to spread knowledge about, and methods for, the adoption of technologies that helped to reduce mortality. The contribution of medical advances to either morbidity or mortality is more difficult to trace and to attribute directly. This is because it is difficult

to isolate the effect of individual procedures, as successful application depends on many factors.[2]

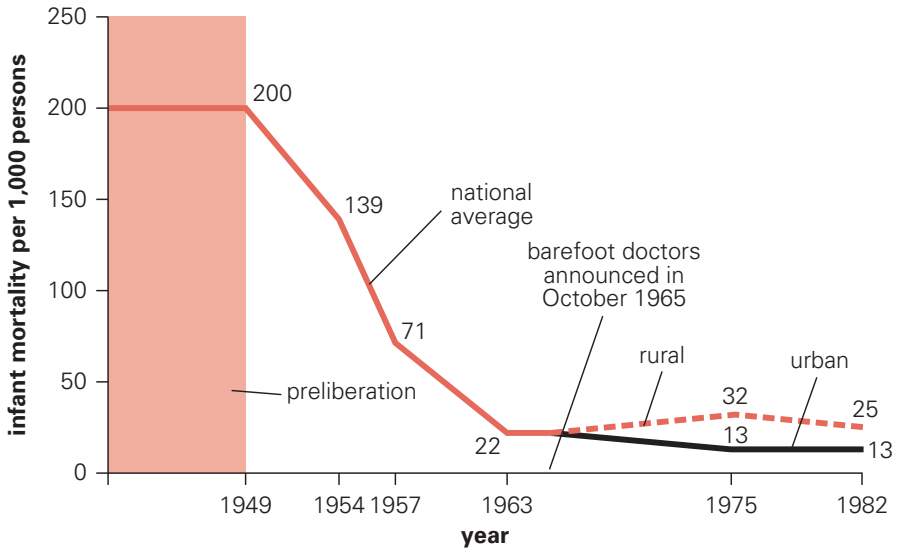
More recent evidence from Organisation for Economic Co-operation and Development (OECD) countries suggests that changes in lifestyle and nonmedical advances have had a bigger impact than medical advances and health care on longevity and well-being. Lifestyle changes such as reduced cigarette smoking and more moderate alcohol consumption have made the U.S. population healthier (Wolfe 1986).

Both in OECD countries and in China, many of the most effective therapies for infectious diseases only emerged after the improvements in public health were well established. In their examination of the declines in infectious diseases in the United States over the period 1900–73, McKinley and McKinley (1997), like other researchers, find that effective treatments emerged only after the incidence of these diseases had fallen; nonmedical factors had played important roles in reducing morbidity and mortality from those diseases. China has historically shown much better health indicators than its income might predict. Although much of this achievement was popularly attributed to the country's barefoot doctors—minimally trained medical personnel who were tasked with providing primary health services—most of the improvements in infant and child mortality occurred *before* the barefoot doctors began to be deployed in 1965; after the barefoot doctor system was abandoned, China's health status did not decline. The early health improvements can be credited to, among other things, Chairman Mao's "five pests" campaign, his exhortation to drink tea instead of (unboiled) water, and China's generally safe latrines. Figure 1.1 illustrates the lack of evidence linking barefoot doctors to health improvements.

Underlying the health improvements that countries achieved were investments informed by advances in public health science. Periodic epidemics of cholera, malaria, and other infectious diseases plagued Europe and the Americas during the nineteenth century until the science of disease transmission developed and viable interventions were discovered. Major investments in public health in the nineteenth century—in response to the work of Snow (1849) linking contaminated water with cholera—resulted in dramatic declines in mortality. Simply eliminating people's contact with sewage-contaminated water contained the cholera epidemic in London in 1854 (Crossier 2007). Similarly, the Thames embankment, which helped

2 Limited data for specific interventions, differences in patients' health when treated, and high variability in the medical treatment across medical facilities that complement and influence successful application of new medical technologies, among other things, make it difficult to determine the contribution of new medical procedures. Cost-effectiveness studies have shed light on some procedures, but controversy persists about the value of medical advances in terms of additional years of life. For example, Cutler (2007) examines the cost-effectiveness of therapeutic surgical care after a heart attack and concludes that it is not clear whether the benefits of revascularization are due to the procedure itself or to the other services that are associated with care at hospitals with the capacity to offer these services. Unlike the pharmaceutical and vector control innovations, the contribution of medical advances remains controversial.

Figure 1.1 Health Improvements and the Advent of Barefoot Doctors in China



Source: Hsiao 1984.

Note: The curved arrow and associated text have been added to the original.

the river to move effluent out of London, and the draining of swamps elsewhere led to the disappearance of malaria in the United Kingdom (Kuhn and others 2003). More recently, Cutler and Miller (2005) have studied the impact of clean water on health, looking at the results of the adoption of filtration and chlorination by U.S. cities in the first quarter of the twentieth century. They attribute nearly half of the total reduction in mortality in major cities, three-quarters of the reduction in infant mortality, and two-thirds of the reduction in child mortality to improved water supply.

An important factor that facilitated the introduction of public health measures was centralized decision making with little involvement of citizens, driven by economic imperatives. Eminent domain effectively ensured that public health measures in Europe and parts of the Americas were implemented before the twentieth century. Beginning in the mid-nineteenth century in the Americas, concerns about contagious tropical illnesses such as yellow fever, cholera, and malaria prompted the region's governments to adopt the Pan American Sanitary Code, which entailed the adoption of intense disease surveillance and reporting, control of disease vectors, sanitary improvements, and significant investments in parasitology research centers across Latin America to limit quarantine and other delays to regional trade (PAHO 1999). A recent example of collective action to enhance human and economic well-being is the multicountry- and multidonor-funded Onchocerciasis (river blindness) Control Program in the Niger delta in West Africa. The program of spraying infected areas with pesticide has effectively controlled the black flies responsible for this debilitating and lethal human infection. It has enabled the recultivation of 25 million hectares of fertile agricultural land, which had been abandoned because of the prevalence of the disease (Benton 2001).

Other such public health interventions are needed across the developing world to deal with some of the same challenges that confronted European cities in earlier times. The World Bank estimates that a billion people lack access to clean water and 2.6 billion (or roughly 40 percent of the world's population) lack access to basic sanitation. Some 94 percent of diarrheal cases worldwide can be attributed to unsafe drinking water, poor sanitation, and inadequate hygiene, with 1.5 million cases resulting in death, mostly among children (World Bank 2008). The importance of these basic public health measures to promoting good health and reducing mortality remains fundamental to investments that have demonstrated links to expanding economic activity.

How Might Health Make You Rich?

The most obvious reason why healthier people might be richer is that they can work harder, longer, and more consistently than others. In turn, those who are disabled or ill can work less, placing an economic burden on the household. But can better health increase the *rate* at which income grows?

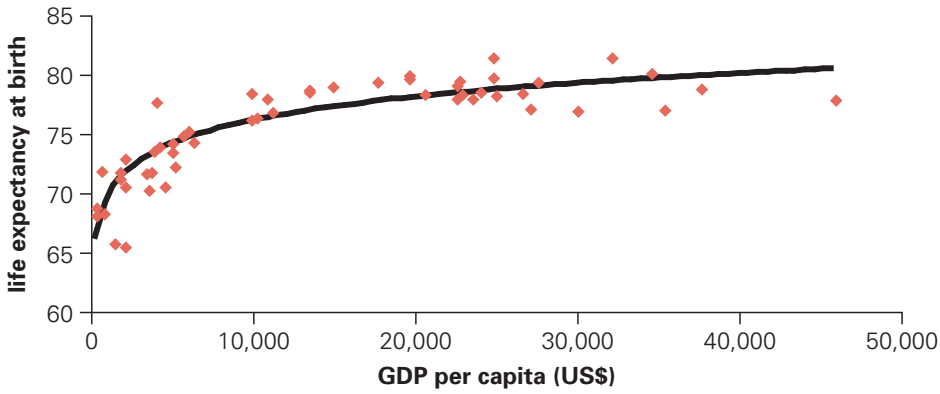
Human Capital Accumulation. A recurring theme in the literature is that health leads to income growth through its effect on human capital accumulation—and particularly through education—provided that people have sufficient food and satisfactory educational opportunities.

First, children who are healthy and adequately nourished may spend more time at school and be better learners while there, preparing themselves to earn higher incomes. Along these lines, Sachs and Malaney (2002) describe a number of channels through which malaria can compromise educational attainment, including by hampering fetal development, reducing cognitive ability, and lowering school attendance.

Second, the health status of adults affects human capital accumulation by their children. A large proportion of human capital investment decisions are made by parents on their children's behalf. But if parents die, they cannot invest in their children. Orphans do not necessarily suffer a complete withdrawal of adult support, given the social networks in many societies, but they are likely to receive less than when their parents were alive, an issue that is discussed below in the context of the economic impact of illness. Lorentzen, McMillan, and Wacziarg (2005), using an instrumental variables approach, find that the adult mortality rate affects growth less through its influence on investments in education than through its influence on fertility and physical capital investments.

Physical Capital Accumulation. A population in better health may accumulate physical capital more quickly. The most obvious route is through savings, as higher life expectancy (for example) increases the expected length of retirement. Indeed, Bloom, Canning, and Graham (2002) attribute the rapid growth of East Asia to precisely this mechanism. Alsan, Bloom, and Canning (2006) and Sachs and Malaney (2002) highlight the impact that better population health has on inflows of foreign capital, as

Figure 1.2 The Preston Curve, 2001



Source: World Bank, World Development Indicators.

opposed to increases in domestic savings; this effect is usually thought to operate in situations in which foreign (direct) investment and expatriates (either in the role of staff or consumers) are highly complementary. Tourism is the most commonly cited example, as the threat of communicable diseases such as SARS (severe acute respiratory syndrome) deters visitors and investment, at least in the short term, because it suggests high-risk environments (Bell and Lewis 2004).

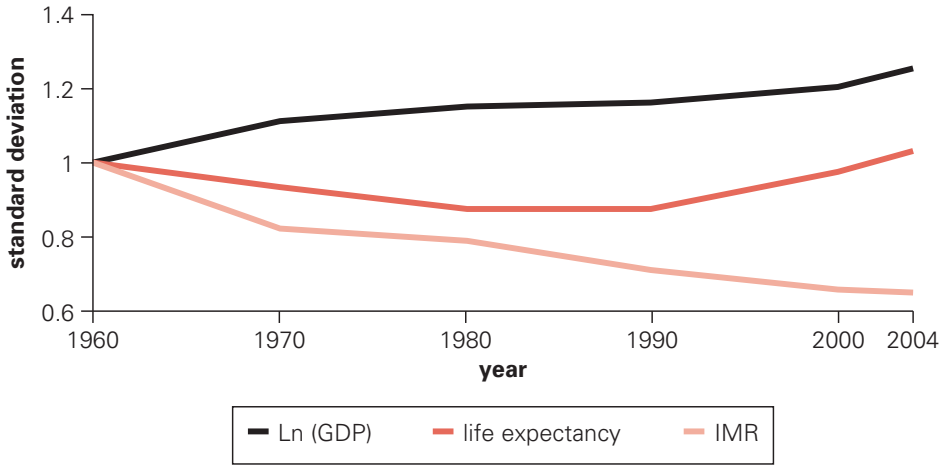
Trends in Health and National Income

The economics and population-health professions were brought together empirically only in the last 30 years. Preston (1975) presents data on per capita income and on population health status as measured by life expectancy for a cross section of countries. More recent data confirm his finding of a concave relationship between health status and income (see figure 1.2) and show that this relationship is becoming stronger over time.

This latter fact shows that income, as measured by GDP, cannot be the sole determinant of health; if it were, countries that grew richer over time would simply have moved along the curve defined by a given year's cross-sectional data. On average, countries whose incomes have grown have achieved better health improvements than would have been predicted from the 1975 data.

The concave relationship between income and health suggests the importance of income distribution for a country's health status: in a country with highly unequal income distribution, the population at large is likely to be less healthy than would be predicted for countries with the same average income. It is commonly argued that this relationship provides a rationale for redistributing a country's income from rich to poor citizens, so as to raise average health status while keeping average income constant (ignoring the efficiency costs of redistribution). This sounds reasonable if indeed increasing the incomes of the poor will improve their health. However, if one believes that changes in health drive income growth, the same concavity properties imply that redistributing *health* from the unhealthy to the

Figure 1.3 Normalized Cross-Country Standard Deviations of Health and Income, 1960–2004



Source: Deaton 2006.

Note: The infant mortality rate (IMR) measures the number of children born who die before their first birthday per 1,000 births. The standard deviation of the under-five mortality rate shows a similar evolution and is not presented in this figure. The IMR is a significant factor in life expectancy calculations, because, particularly in countries with high death rates, a significant portion of a country's deaths occur in the first year of life.

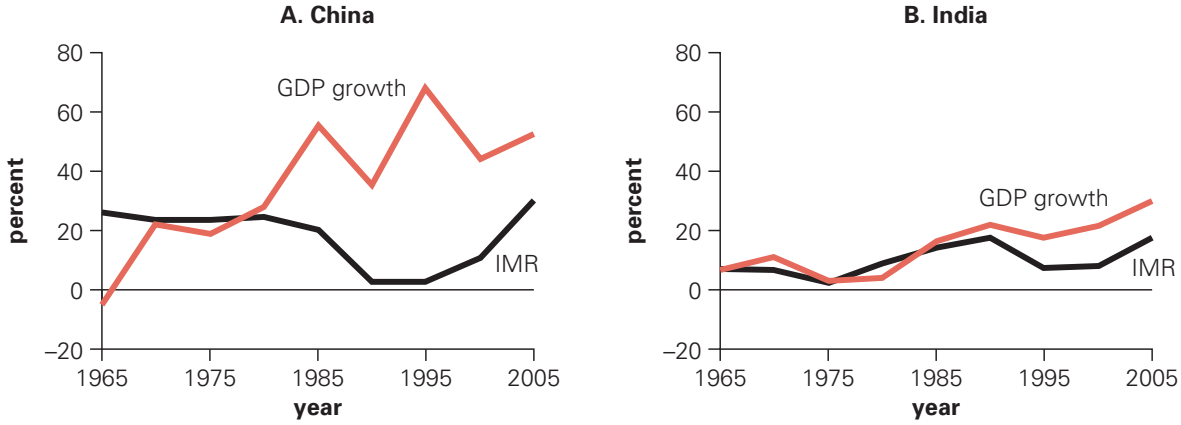
healthy (that is, in the "wrong" direction) would increase aggregate income, with no effect on average health status. The validity, if not the desirability, of each of these interventions thus depends crucially on the direction of causality between income and health.

Although the Preston curve shows a close relationship between income and health in the cross-sectional data, longitudinal data suggest that this relationship may not hold within individual countries over time. Figure 1.3 draws on data presented by Deaton (2006) on the evolution of the cross-country distribution of national incomes and health status between 1960 and 2004. Each curve represents the standard deviation of a variable relative to its value in 1960. The figure shows that per capita incomes have steadily diverged, in keeping with the well-established evidence that incomes in poor countries have not grown fast enough to catch up with incomes in richer countries (Commission on Growth and Development 2008; Pritchett 1997). By contrast, country-level health indicators have converged—until 1990 for life expectancy and through 2004 for the infant mortality rate.[3]

Thus figure 1.3 suggests that, over time, changes in income seem to be unrelated, or even negatively related, to changes in health status: incomes have continued to diverge, while health status has converged. That is, health

3 The reversal of the converging trend in life expectancy in the last 15 years is likely due to the collapse of the former Soviet Union, which exhibits high adult mortality, and to the explosion of HIV/AIDS in Sub-Saharan Africa in the 1990s. HIV/AIDS, while it has implications for children and potentially for their incomes later in life—through its impact on schooling—has a more pronounced impact on adult life expectancy than on infant and child mortality.

Figure 1.4 Income Growth and Infant Mortality Rate Reductions in China and India, 1960–2000



Source: World Bank data, as used by Deaton 2006; see his figure 8.

Note: Each line shows the annualized proportional change for a variable over the preceding five years. IMR is infant mortality rate.

status has improved in poor countries at a faster rate than in rich countries (albeit from a lower base), despite the fact that incomes have grown more slowly in poor countries than in rich ones.

In view of the difficulties and limitations of cross-country comparisons, we summarize the evolution of incomes and health status in two countries—China and India—since 1960. (This exercise follows Deaton 2006; Drèze and Sen 2002). Figure 1.4 suggests that both of these countries have improved their health status and per capita incomes over the last 40 years but that their experiences have differed.

In China the annualized growth rate of GDP is negatively correlated with the annualized rate of reduction of the infant mortality rate (correlation coefficient –0.45, *t* statistic), while in India the correlation is positive (correlation coefficient 0.77, *t* statistic). As Deaton (2006) notes, in China the largest gains in health *preceded* the takeoff in economic growth.

The data from India are perhaps more ambiguous: during that country's period of relatively slow economic growth from 1965 to 1985, the correlation between changes in income and health was tight, but in more recent years, as economic growth has taken off, the rate of improvement in the infant mortality rate has fallen off.

Interpreting Correlations between Health and Income: Data and Estimation Issues

Research on the links between health and growth are fraught with measurement problems, from the selection of variables and the validity of those measures to the econometric problems that emerge where there is reverse causality. Creative solutions to these challenges have met with mixed results, but from a policy perspective the bottom line is that there is a tenuous link between health and growth at the macroeconomic level. This section reviews the measurement issues, the analytic constraints, and alternative options for capturing the correlations between health and income.

Limitations of Aggregate Measures of Health and Income. Although relationships between aggregate measures of health and income can be informative, they have some limitations because both indicators are summary statistics of complex, multidimensional assessments of human activity and well-being.

Measuring "health" is tricky, and no measure aptly captures morbidity and mortality (Schultz 2005). In particular, the use of life expectancy or infant and child mortality rates as measures of health status is not without ambiguity, for both conceptual and practical reasons. First, these indicators attempt to measure aspects of health that might be related to productivity, including the extent to which individuals experience, or are at risk of, bad health, encompassing both morbidity (illness) and premature death. For example, in using life expectancy in cross-country analysis, we place too much weight on infant mortality, while that measure itself is an *imputed* variable in most contexts. Mortality is also a one-time event and remains rare even in high mortality settings. Despite the heavy reliance on mortality statistics to measure health, for all these reasons mortality is a suboptimal measure of "health."

Second, at a practical level, accurate measures of life expectancy require good vital registration data, particularly on deaths. In some developing countries, these data simply do not exist, and estimates of life expectancy are based on child mortality rates, using standard life tables to impute infant mortality levels (adjusting for guesses about mortality risks in the population where necessary). While the cross-country pattern of life expectancy *levels* is likely to be reasonably accurate, data on *changes* in life expectancy may well embody large errors, due to the variety of (unmeasured) causes of such changes.

Third, interventions that affect morbidity but not mortality may well have important effects on productivity that will not be attributed to changes in health status if the latter are measured by life expectancy or infant and child mortality rates. A primary example of such an intervention is the control of the *vivax* strain of malaria, which causes relatively few deaths but high morbidity rates, compared with the more lethal *falciparum* strain. Controlling *vivax* malaria could significantly boost productivity, both directly as adults suffer fewer and less severe attacks and indirectly through increases in the return to, and hence the level of, schooling for children (Bleakley 2006b). Alternative measures of morbidity such as self-reported health status or activities of daily living are not only rarely available but tend to be less reliable than objectively collected data, and they are hard to compare across countries.

Econometric Approaches. Interpreting the observed correlations between country-level health status and income is challenging. First, it is very likely that higher incomes help to improve health status. Second, there may be other factors that affect *both* income and health in a country (Deaton 2006); for example, these might include the country's climate and its disease environment. For both of these reasons, a correlation between income and health might be observed even if there is no direct causal relationship from health to income.

These identification problems are at the root of the lively debate among economists and public health researchers and are well recognized. For example, Bleakley (2007: 73, 74) notes, "Simple correlations of public health and economic outcomes are unlikely to measure the causal effect [of health on income] since public health is endogenous. Indeed, it is likely a normal good." Similarly, in a paper focusing on the impact of malaria, Malaney, Spielman, and Sachs (2004: 143) acknowledge concerns over endogeneity and omitted variables: "The causal effect of malaria on poverty cannot readily be isolated from the effect of poverty on malaria. A second econometric problem lies in the effect of such confounding factors as climate that may drive both poverty and malaria."

Researchers have used various procedures to try to overcome these and other estimation problems. Some studies focus on the relationships between measures of population health (such as life expectancy) and national income (such as GDP) and use econometric techniques to correct for endogeneity and omitted-variable biases; we refer to these as macro approaches in the discussion that follows. At the other extreme, micro approaches examine the link for individuals between health improvements and incomes, with the goal of minimizing identification problems by careful choice of setting. A third strand of the literature combines the macro and micro approaches within a growth-accounting framework, scaling up micro-level measures of the effects of individual health improvements on incomes to yield macro-level estimates of the impact of changes in population health on national income. The following subsections briefly review the findings of studies using the macro and growth-accounting techniques. Subsequently, we explore the more micro approaches.

Findings of Macroeconomic Studies

If we look at a wide enough range of countries, we find that people in richer countries are on average healthier: they live longer and fall ill less often. A cross-country regression quantifies this correlation. One of the first contributions to this literature is the work of Pritchett and Summers (1996), who conclude that "wealthier was healthier"—that is, the causality ran from income to health.

Subsequent work focused on the link between health and *changes* in income: healthier countries might be richer, but do they grow more quickly? Gallup and Sachs (2001) address this question and find a strong correlation between the level of population health and income growth. Of course, there are obvious endogeneity and omitted-variable concerns with this kind of exercise, but it offers the tantalizing prospect that a country can raise its income by improving its health.

A range of papers subsequently refined and extended the Gallup and Sachs methodology. Bloom, Canning, and Sevilla (2004) report the results of 13 studies that all employ cross-country regressions and all show large effects of health on growth. To try to correct for possible third factors that affect both the level of health and the growth of income, Bloom, Canning,

and Sevilla (2004) assess the correlation between changes in health status and changes in income across countries; they find similar results.

The problem of endogeneity affects virtually all of the cross-country studies in this genre, because differences in the levels and growth rates of income can plausibly affect the levels and changes in health status. The methodological response is to use a proxy indicator for health status (or for changes therein), which the researcher believes does not *directly* affect the level or growth of income. Any observed correlation between such an "instrumental variable" and income is then evidence of a causal link from health to income.[4]

Gallup and Sachs (2001) use geography as an instrumental variable for health status. The basic epidemiology and biology of infectious diseases mean that at any given level of income these diseases are likely to be more prevalent in tropical regions. An impact of geography (distance from the equator) on incomes might then constitute evidence of an impact of health on incomes. This approach has been questioned in a series of papers (Acemoglu, Johnson, and Robinson 2002; Easterly and Levine 2003; Rodrik, Subramanian, and Trebbi 2002) that challenge the assumption made by Gallup and Sachs that geography does not affect growth either directly or through its impact on a third factor that is itself important for growth. In particular, these critics illustrate that, once the effect of geography on a country's *choice of institutions* is accounted for, geography has little independent impact on incomes. Broadly speaking, tropical equatorial countries have tended to adopt institutions that are less conducive to economic growth than have other countries, and it is the choice of institutions that induces a correlation between health and income. The stark implication of their findings is that improving health status (by, say, expanding the use of bed nets to reduce the incidence of malaria) would have little impact on overall growth and that institutional reform is what is needed to increase income.

Sachs (2003) admits the possibility that geography affects institutional quality, but takes issue with the finding that this is the *only* effect that geography has. To this end, he conducts a series of cross-country regressions aimed at distinguishing the effect of malaria prevalence—which is highly correlated with geography—from that of institutional quality. Instead of using a simple measure of geography (distance from the equator) as a proxy for health outcomes, which are arguably correlated with income, he constructs two instruments: one for malaria risk, which he calls "malaria

4 Bloom, Canning, and Sevilla (2004) use lagged values of health-related inputs and economic output (and their lagged growth rates) as instruments. However, Weil (2005) questions the validity of this strategy and claims that "the identifying assumption required . . . is not explicitly stated or defended." Mankiw (1995: 303–04) goes as far as to suggest that "cross-country data can never establish, for instance, the direction of causality between investment [or health] and growth." He notes the implausibility of lagged variables being good instruments, highlights the issue of multicollinearity—"those countries that do things right do most things right, and those countries that do things wrong do most things wrong"—and illustrates how lack of independence and measurement errors (both of which are acute in cross-country regressions) can bias results.

ecology" and which is based on climatological conditions and vector prevalence, and one for institutional quality, which is based on settler mortality and the share of a country's population living in temperate zones. In all his specifications he finds that both institutional quality *and* malaria risk are statistically significant determinants of income. But even this approach does not escape methodological criticism. In particular, the measured impact of malaria ecology on growth is unbiased only if we believe that malaria ecology does not affect institutional quality.

Aside from the econometric issues that arise when conducting cross-country regressions, one should not rely too heavily on results that selectively exclude some countries. Bloom and Canning (2003b) illustrate this point. They analyze how the demographic changes in East Asia that were brought about by health improvements led to increased savings and growth. They then reflect on the experience of Latin America, which had "broadly similar demographic and health conditions," and note, "East Asia's economy grew explosively, while economic growth in Latin America was stagnant. Latin America's policy environment—with poor labor market policies, a lack of openness to world markets, and an inadequate education system—was quite different from East Asia's and did not offer the same favorable conditions." While it may be that the interaction of good policies with good health is what matters, the comparison between East Asia and Latin America suggests that it is, to first order, simply good *policy* that matters.

Several recent papers have attempted to identify the impact of health on income and growth by modeling innovations in the health environment that can plausibly be taken as exogenous. For example, Acemoglu and Robinson (2008) investigate whether advances in the health sciences have affected national income. They analyze the considerable technical progress in drug therapies, vaccines, insecticides, and the dissemination of scientific knowledge through international organizations that occurred in the twentieth century and find that these advances did not cause a rise in per capita income. For their study, the authors construct a measure of how much a country could expect to gain from these technological and institutional innovations—countries with a high incidence of now curable or avoidable diseases would be predicted to have greater gains in terms of reduced mortality—and use this measure as an instrumental variable for actual changes in population health. The idea is that the instrument is correlated with actual improvements in health, but not directly with changes in income. They find that the advances in medicine significantly raised the growth rate of population and that income (as measured by GDP) also increased. Since the increase in income did not match the increase in population, real per capita income fell, despite the health improvements. This effect is essentially a general equilibrium phenomenon: labor supply rose, while other factors (land, capital) did not adjust, thereby reducing per capita output.

Their result mirrors that obtained by Young (2005), who uses micro data to calibrate a neoclassical growth model with fertility effects, in order to estimate the impact of the HIV/AIDS epidemic in South Africa. Young finds that, because of the negative effect of the epidemic on population,

capital-labor ratios increase enough to offset any plausible reduction in the rate of intergenerational human capital transmission associated with parental deaths.

Commenting on a paper by Acemoglu and Johnson (see chapter 4 of this volume), Bleakley (2006a) notes that these authors find no impact of health changes on aggregate GDP. He emphasizes that labor market conditions, in particular the extent of unemployment and underemployment, are crucial in determining the impact of health improvements on measured GDP. Suggesting that a model assuming that capital is fixed is inappropriate, Bleakley notes that in reality the capital stock should have responded over the 40 years covered by these authors' analysis and that land productivity too is likely to have improved over the period (due to increased urbanization and the green revolution in agriculture).

Using Growth Accounting to Assess the Impact of Health on Economic Returns

Another group of studies attempts to overcome the shortcomings of the macroeconomic evidence by adding microeconomic elements. Their use of more refined techniques and reliance on measures that better capture the economic effects of health and nutrition investments arguably provide a firmer foundation than the macro studies for drawing conclusions about the link between health and growth.

Shastry and Weil (2003) and Weil (2005) use a different methodology to estimate the share of cross-country variation in income that can be associated with differences in health status. Combining microeconomic estimates of the impact of health on productivity with a macroeconomic accounting model, they decompose aggregate country output into a (residual) productivity term plus the return to certain factors, including physical capital, educational human capital, and health human capital. Measures of output, physical capital, and educational capital (proxied by years of schooling) are readily available for some countries, although admittedly a subset, particularly for education; the challenge is to construct a measure of health that is relevant to productivity.

Weil's (2005) approach to accounting for the effect of health on economic performance is to estimate the returns (in terms of higher wages) to a number of health indicators, including adult height, adult survival rate, and age of menarche, using instruments for differences in health inputs, birth weight differences between twins (see, for example, Behrman and Rosenzweig 2004), and historical data on caloric intake (see Fogel 1997). He finds that a 10 percent increase in the adult survival rate would lead to an increase in labor input per worker of 6.7 percent and in GDP per worker of about 4.4 percent. Notably, this estimate of the increase in GDP per worker is much smaller than other such estimates in the literature.[5] Weil

5 Indeed it lies *below* the lower bound of the 95 percent confidence interval for the same measure as estimated by Bloom and Canning (2005) using a cross-country regression with lagged variables as instruments.

calculates that about 9.9 percent of the variance of log GDP per worker is attributable to health and nutrition gaps between countries. He concludes, "My estimates do not match the characterization of ill health as a major stumbling block to economic development, as described in the WHO [World Health Organization] report on macroeconomics and health."

When general equilibrium effects associated with fertility and population changes are incorporated into Weil's analysis—which, as Acemoglu and Robinson (chapter 4 of this volume) point out, implicitly assumes a fixed population size—the estimated impact of health on per capita income may be somewhat smaller. However, the aggregation methodology does not allow for certain behavioral responses to improved health, such as changes in savings rates or educational choices, which could possibly increase incomes in the long term. In a more recent paper, Ashraf, Lester, and Weil (2007) incorporate these additional channels by which health changes might affect growth, but they still find only modest income gains.

The conclusions from these combined micro-macro studies suggest some limitations. As discussed below regarding microeconomic studies (for example, Bleakley in chapter 5 of this volume), health improvements can improve economic performance but are unlikely to explain why some countries lag far behind others in material well-being. Moreover, because the most significant health improvements occur early in a person's life, the associated income effects take a long time to come to fruition.

The Links between Individual Health and Productivity: Microeconomic Evidence on Health and Growth

An alternative approach to studying links between health and income is to examine individual and household investments and their effects on household income. The advantage of this approach, given data of sufficient quality, is that we might have more confidence in attributing certain impacts to particular health or other variables.

The disadvantages of a microeconomic approach are that the results may not be easily applicable to other circumstances and that what may be true at the micro level may not apply for the population at large because of external or general equilibrium effects. For example, if the labor market rewards individuals solely according to their health rank (healthier people get more job offers), then improvements in one person's health will translate into increases in his or her income, matched by reductions in the income of others, and there will be no impact on aggregate income. More generally, as in Acemoglu and Robinson (2008), if workers use other factors of production that are in relatively fixed supply, such as land and capital, then health improvements that increase the supply of labor could conceivably reduce average output per worker. Micro-level studies cannot pick up such effects.

Despite these shortcomings, micro approaches provide important insights into the potential impact of health on economic well-being. Below we focus

on two broad sources of health-related variation across individuals and see how these translate into differences in economic productivity. The first source of differences among individuals is in the basic inputs to a healthy and productive life; we report on the economic implications of these differences and on the results of interventions to improve nutrition and caloric intake, on the one hand, and to enhance early childhood development, on the other. The second source of differences is in the incidence of illnesses and the access to and use of medical treatments; we report the findings of select studies on the negative impacts of HIV and malaria on productivity and the economic impacts of treatments such as deworming tablets and antiretroviral therapy.

Impact of Interventions Affecting Early Childhood Development

Mounting evidence from economics, psychology, and neuroscience indicates that early investments in young children profoundly affect their long-term physical and mental health, earnings, and well-being. Early experience shapes brain architecture (Knudsen and others 2006), and early childhood development has a long reach that affects physical and mental health and well-being later in life (Drukker and Tassenaar 1997; Fogel 1994; Mustard 2006). Knudsen (2004) has shown that there are sensitive periods for neurological development early in life that influence long-term memory. Thus the critical period for intervention is in the preschool years. Recent work has produced considerable evidence on the issue.

Victora and others (2008) summarize the results and long-term implications of maternal undernutrition from five developing-country cohort studies and review the literature on the same topic. They find that undernutrition can cause structural damage to the brain and that maternal and child undernutrition result in shorter adults, less schooling, lower productivity, and lower birth weights among their offspring. There is also a link with adult cancer, lung disease, and mental illness, all of which compromise productivity and earnings.

Thomas and Frankenberg (2002) provide a useful review of microeconomic studies of the impact of nutrition on economic outcomes at the individual level. They summarize their findings as indicating that "while the establishment of this link [from health to income] is not straightforward, the weight of evidence points to nutrition, and possibly other dimensions of health, as significant determinants of economic productivity." Walker and others (2007), in a meta-study of risk factors for young children, note that stunted children consistently show cognitive and educational deficits, although the size of the deficit varies across settings. They argue for intervention to prevent stunting, inadequate cognitive stimulation, iodine deficiency, and iron deficiency anemia.

Heckman (2007) emphasizes the importance of noncognitive skills in preparing children for school, adulthood, and the workplace, and his research suggests that both the cognitive and social-emotional abilities of individuals as children explain many features of their later economic and social behavior. Gaps in cognitive ability are established early, and in the United

States they explain much of the differential in individuals' educational performance across income levels (Cunha and others 2006).

Grantham-McGregor and others (2007) summarize the scientific and behavioral evidence from developing countries and point to poverty, malnutrition, poor health, and unstimulating home environments as compromising the cognitive, motor, and social-emotional development of children. Their meta-study finds that both poverty and childhood stunting (due to persistent undernutrition) correlate with poor school performance, lower income in adulthood, higher fertility, and inadequate care of their own offspring.

Longitudinal studies show the relationship between early childhood development and language, intelligence, and criminality. Black and others (2008) illustrate how low birth weights significantly affect longer-run outcomes such as adult height, intelligence quotient, earnings, and education. Verbal exposure by reading and talking has significant effects on children's verbal skills and language at later stages of development (Mustard 2006: 33). Many studies (cited in Mustard 2006: 37) have shown that children with poor verbal skill development during their first three years of life do poorly in language and literacy in school.

Both stunting and poverty are associated with declines in years of schooling. In Brazil, low-income, stunted children receive more than four fewer years of schooling on average and, once they become adults, earn an estimated 30 percent less income than the average worker (Grantham-McGregor and others 2007).[6] Thomas and Strauss (1997) show almost a 20 percent reduction in returns to schooling among self-employed males in Brazil when height is added to the wage function.

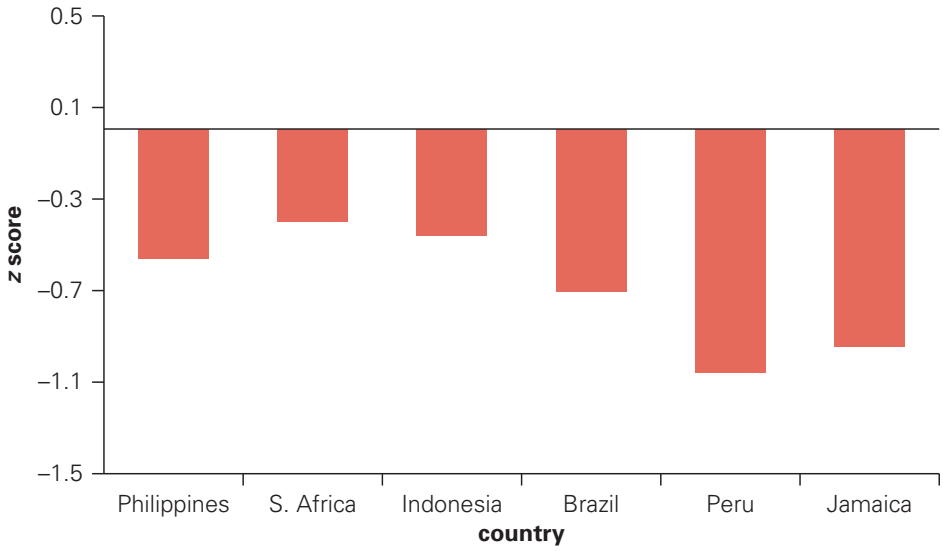
Studies of adult literacy in the United States under the U.S. Department of Education National Education Assessment Program have shown that children with the lowest physical and mental health also perform at the bottom of the distribution in standardized tests. Figure 1.5, from Grantham-McGregor and others (2007), shows the cognitive deficits resulting from being in the lowest wealth quintile in the first three years of life. On the basis of income, the standard deviations in cognitive and schooling deficits of children (*z* scores) in the poorest 20 percent of households are significant. The five countries featured represent three continents and both low- and middle-income groups, suggesting that culture and location are less important than biology in determining these deficits.

What of the impact of interventions? Cuba, with its extensive programs for pregnant women and young children, has achieved significantly better performance on literacy assessments, scoring two standard deviations higher than any other Latin American country (Carnoy and Marshall 2005, as cited in Mustard 2006: 39).

Fogel (2002) and Alderman, Behrman, and Hoddinott (2003) show the importance of specific nutrition interventions in bolstering cognitive

6 Stunted children with limited cognitive skills are more likely to drop out and to learn less when they do stay in school (Grantham-McGregor and others 2007).

Figure 1.5 Cognitive or Schooling Deficits Associated with Moderate Stunting in Children Less Than Three Years Old from Six Longitudinal Studies



Source: Grantham-McGregor and others 2007.

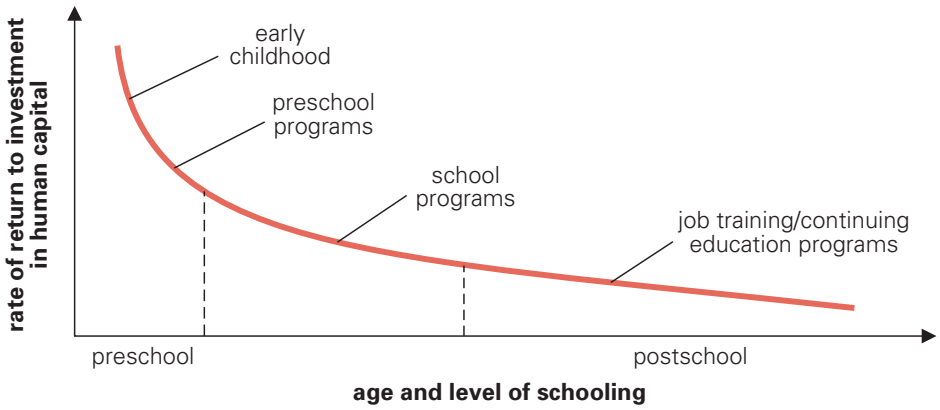
development, physical stature and strength, earlier school enrollment and more regular school attendance, greater schooling and learning, increased adult productivity, and healthier offspring.

A recent 35-year longitudinal study of the long-term impacts of nutrition intervention during early childhood provides striking results (Behrman in chapter 6 of this volume; Melgar and others 2008). Two nutrition supplements were randomly assigned to low-income children in rural Guatemala; children who consumed the protein-rich supplement achieved dramatically better educational performance and labor force earnings. Women who received the protein-rich supplement during their first three years of life attained 1.17 more years of schooling, their infants' birth weight was 179 grams heavier, and their children were a third taller than those of women who consumed the calorie-based supplement as children. Men who consumed the high-protein supplement in the first two years of their childhood earned an average wage 46 percent above that of men who consumed the calorie-based supplement.

Thus the evidence on the value of interventions in the preschool years is striking. Indeed, recent evidence (see figures 1.6 and 1.7) suggests that the economic rate of return to preschool attendance dwarfs the returns to university or job training (Carneiro and Heckman 2003) and that the lack of attention to early childhood development has high long-run costs (Heckman 2007).

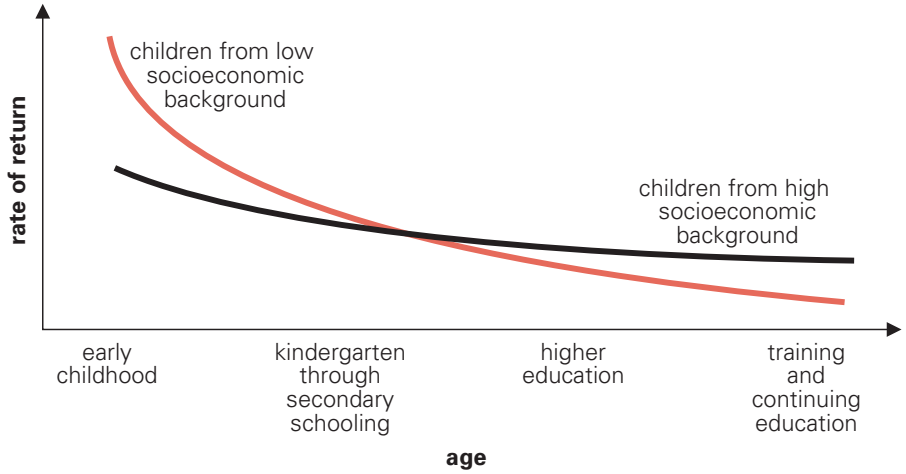
Investments in individual children before the age of three produce more significant impacts than any other social or health investments and at a lower marginal cost (Carneiro and Heckman 2003). Only investments in public health improvements may be more important, but these tend to be complements to, rather than substitutes for, interventions targeted to young children.

Figure 1.6 Returns to Different Levels of Education Based on Family Background



Source: Adapted from Cunha and others 2006.

Figure 1.7 Returns to Different Levels of Education and Family Background



Source: Wößmann and Schütz 2006.

To sum up, interventions affecting early childhood development produce long-term benefits for human capital and productivity. The microeconomic studies reviewed above suggest that prenatal care, food supplements for malnourished children, micronutrients, and preschool for disadvantaged children, among other such investments, help to raise the potential for long-term academic and workplace success and lifelong well-being. These results are among the most robust in terms of the direct impacts on individuals and long-term implications for enhanced health status, productivity, and income. Perhaps even more important is the potential impact on the next generation. Indeed, these findings suggest that the cycle of poverty, morbidity, and early mortality can be broken by interventions in early childhood.

Unfortunately, early childhood investments have not received enough attention or resources. Developed and developing countries alike now have a major opportunity to enhance human capital by turning their attention to such investments.

Impact of Illness on Income

Investments in young children and better nutrition for malnourished children are likely to make people healthier and less likely to fall ill. But what happens to productivity when people do fall ill? A broad literature addresses this issue, using the so-called cost-of-illness approach to measure the impact of health on income. Some studies focus on the immediate impacts of illness, including reduced labor supply and the lower productivity of sick people while on the job, and others include possibly long-term effects due to protracted separations from the labor force and disengagement from economic activities.

Two studies by Bleakley (chapter 5 of this volume) examine the effects of disease-eradication campaigns on health and economic outcomes; his results suggest that improving health could be important for growth on the margin but is unlikely to be a panacea. In his 2007 study of the impact of hookworm eradication efforts under the Rockefeller Sanitary Commission in the American South in the early twentieth century, Bleakley measures the infection rates that prevailed before the intervention; on average, 40 percent of school-age children were infected. Like Acemoglu and Johnson (chapter 4 of this volume), he uses data on infection rates by location, which reflect the geographic variation in potential benefits from hookworm eradication, to identify the impact of changes in the health environment on economic outcomes.

Bleakley finds that areas with higher preexisting infection rates saw greater increases in school enrollment, attendance, and literacy after the intervention. For example, he finds that school attendance before 1910 was negatively correlated with 1913 infection rates, but that by 1920 the 1913 infection rates did not predict attendance. That is, those areas that had more to gain from hookworm eradication saw their school enrollment rates increase more. Bleakley finds similar results for literacy. Other changes in the economic environment could have led to similar trends over this period, but he argues that, if so, these influences would have affected adults in different areas in similar ways. However, he finds no similar pattern among adults across the affected areas who, by the nature of the disease, had virtually no preexisting infection.

Bleakley (2006b) undertakes a similar exercise, focusing on the malaria eradication campaigns in the United States circa 1920 and in Brazil, Colombia, and Mexico circa 1955. Preexisting prevalence rates across regions, combined with a paced eradication campaign across the U.S. South, which provide exogenous variation, permit him to identify the impact of childhood exposure to malaria on future adult literacy and incomes. He finds that, among individuals born well before the relevant eradication campaign, those born in more malarial regions had lower wages and lower literacy rates later in life, while among individuals born well after the campaigns, malaria prevalence before the eradication campaign had little effect on future wages and literacy. He concludes, "Persistent childhood malaria infection reduces adult income by 40 to 60 percent."

Bleakley is able to differentiate the impact of morbidity from that of mortality on future income. He finds that eradication of *vivax* malaria (which causes high morbidity, but relatively few deaths) leads to significant increases in human capital formation and future income, but that eradication of *falciparum* malaria (which is often fatal) produces no such gains. To explain this result, he argues that, although reductions in mortality rates increase the marginal benefit of human capital acquisition (because people who survive have more years in which to earn a return on human capital investments), this might have little impact on the level of investment if marginal costs are rising steeply. By contrast, a reduction in morbidity makes it easier to attend school and to learn while there, thereby flattening the marginal cost curve and leading to significant increases in human capital acquisition.

Bleakley uses his results to extrapolate across countries and estimates that malaria may account for about 10–16 percent of the income gap between the United States and Latin America. This suggests that eradicating malaria could modestly narrow the income gap by inducing higher growth in Latin America. He concludes, "While reducing malaria could bring substantial income gains to some countries, the estimated effect is approximately an order of magnitude too small to be useful in explaining the global income distribution" (Bleakley 2006b: 26).

Several other studies of the effects of malaria eradication programs find that the control of disease vector environments (for example, swamps) has a profound effect on health status and on education and productivity. Cutler and others (2007) examine the impact of a malaria eradication program across Indian states during the 1950s and find that the program increased literacy and primary school completion rates by 10 percentage points, accounting for about half the observed gains in these measures over the period spanning the intervention in malarial regions. Barecca (2007), Hong (2007), and Lucas (2005) all find significant effects of either exposure to malaria or its eradication on a variety of economic outcomes such as schooling, literacy, labor force participation, and wealth. These findings call to mind the broad-ranging positive results of the West African Onchocerciasis Control Program, discussed above.

The recent expansion in the availability of antiretroviral drugs in Sub-Saharan Africa has enabled researchers to examine the impact of HIV/AIDS treatment on labor market outcomes. The effects on labor supply and income seem to be considerable. In a study in western Kenya, Thirumurthy, Graff Zivin, and Goldstein (2005) find that, within six months of starting treatment, a patient is 20 percent more likely to participate in the labor force and has a 35 percent increase in weekly hours worked. Larson and others (2008) study a similar expansion of antiretroviral treatment (ART) in Kericho, a tea-growing region of western Kenya. They find that in the nine months before starting ART, HIV-positive individuals worked significantly fewer days plucking tea each month than their comparators without HIV, but that, after starting ART, the individuals undergoing treatment quickly increased the number of days they spent on this work (to 6.8, 11.8, and

14.3 days a month at one, six, and 12 full months on ART, respectively), while the labor supply of their comparators remained constant at 17–18 days a month. Also, during the first six months on ART, the individuals on treatment earned on average 25 percent less than their comparators, but during the next six months of therapy they raised their earnings to 89 percent of those of their comparators.

Health care can work to improve children's school attendance as well as adults' labor supply. Miguel and Kremer (2004) provide something of a benchmark analysis of the link between health care and schooling by examining the impact of randomly assigned deworming treatment across schools in western Kenya. They find that the intervention reduced student absenteeism by a quarter, with the larger gains among the youngest students and among girls compared with boys. Despite the impressive gains in school attendance, however, their study found no effect on educational outcomes as measured by test scores. This may be because school attendance was not enough to ensure good academic performance: complementary inputs such as teachers and facilities may have been sufficiently poor, or sufficiently overstretched, that children's additional days at school had little impact on learning.[7]

Another route by which health affects schooling is orphanhood. This has received a great deal of attention in the literature on the economic effects of AIDS. If orphans receive less education, then the intergenerational transmission of human capital can be interrupted, with important, and potentially disastrous, long-term effects (Bell, Devarajan, and Gersbach 2003). Case, Paxson, and Ableidinger (2002) use demographic and health surveys across 10 Sub-Saharan countries to examine the impact of orphanhood and find that orphans are significantly less likely than other children to be enrolled in school. In this study, however, the repeated cross-sectional nature of the data means that the interpretation of the results is not without ambiguity. Gertler, Levine, and Ames (2004) use panel data from Indonesia and find that a parental death doubles the probability that a child will drop out of school the same year. Neither of these two studies finds a gender effect, either at the parent or child level. Other studies find little impact of parental death on schooling, possibly because members of extended families take on the parenting function (Ainsworth, Beegle, and Koda 2002; Kamali and others 1996; Lloyd and Blanc 1996).[8]

Consistent with this view, Fortson (2006: 26) reports that children in areas in southern Africa with high HIV prevalence are "less likely to attend school, [are] less likely to complete primary school, and progress more slowly through school." Fortson shows that more than half of this

7 Miguel and Kremer (2004) suggest that the classroom overcrowding that resulted from lower infection rates could have offset any positive effect from lower absenteeism.

8 Evans and Miguel (2003), as discussed in Miguel (2005), use data from the randomized deworming project in western Kenya to address some of the identification issues that trouble cross-sectional and panel data studies. Their results on the impact of parental death on schooling mirror those of Case, Paxson, and Ableidinger (2002) and Gertler, Levine, and Ames (2004): parental death seems to reduce schooling, and there is little difference by gender.

impact on schooling can be attributed to the expectation of a shorter life of the parent and not to orphanhood itself; all children do badly when adults expect to die sooner. Reductions in adult mortality might lead to greater investment in children's education, because of higher demand either by parents or by children themselves, who expect to reap the future returns for longer.

Another important dimension of poor health is the economic impact it has on other people. Thirumurthy, Graff Zivin, and Goldstein (2005), studying the impact of HIV/AIDS treatment in Kenya, find that the labor supply of other household members changes: young boys and women in the household work considerably less after the patient in their family starts treatment, although girls and men in the household do not change their labor supply. The authors highlight the important potential implications for schooling outcomes. Beegle, De Weerdt, and Dercon (2006) study the impact of mortality from AIDS on the economic well-being of surviving household members, in both the short and long term, in a 13-year cohort of individuals in Tanzania. The authors find that households who have experienced an adult death due to AIDS see a reduction in their consumption of 7 percent after five years, while households not so affected see an increase in their consumption of 12 percent over the same period. Thus, vis-à-vis the average household, households who experience an adult death due to AIDS suffer a 19 percent fall in consumption after five years. There is some evidence that such losses are persistent, although they are estimated imprecisely, and the possibility that they are reversed in the long term cannot be rejected. An interesting finding is that losing a *female* adult to AIDS leads to a particularly severe fall in consumption.

Health-Related Interventions and Health: Evidence and Policy Implications

The above review of the literature suggests that the macro link from health to growth is still not beyond dispute, although our interpretation is that the link, if it exists, is relatively small. However, individuals and households can improve productivity and boost their incomes with specific health-related investments.

What this means for policy choices is not immediately clear. Improving life expectancy by a year might increase a country's income by some amount, but *how* such a health improvement is to be achieved is the subject of a whole separate literature. However, we need to examine whether we care about health only for its own sake or also for its potential role in improving incomes.

Experience shows that it will not be that easy to spend our way to better health and thence, if there is a causal link, to higher growth: just as growth-inducing policy interventions are elusive, so too can health-improving

strategies be difficult to identify and politically unpopular.[9] All too often the link from spending on health care to health outcomes is weak (Filmer, Hammer, and Pritchett 2000). The question is why that is the case and what interventions and policies can remedy the situation.

Market Failures and the Financing and Delivery of Health Care

As well as investing in public goods that improve health and hygiene, all governments take an active role in financing and providing health care, which has the attributes of a private good, given the significant failures in private markets for both health care and insurance. Economists have long understood the limitations of unfettered private markets in delivering health care. First, an agency problem can exist between the provider and the patient: the patient, being at an informational disadvantage, might not know the cause of illness or what health intervention, if any, is appropriate, and she is at the mercy of the provider. Of course, similar problems exist in many service markets, from auto repair to accounting services, many of which appear to operate reasonably well.

The second feature of medical care markets that can restrict their efficiency is individuals' need for insurance against the possibility of random catastrophic events. Such events can expose individuals to significant risks, but adverse selection might limit the extent to which private markets can spread those risks. Governments sometimes respond by financing or delivering medical care themselves (as in the U.K. National Health Service), in order to maintain coverage of a broad pool of individuals. This desire to provide a safety net explains the significant presence of public spending on health in most developing countries and, especially, in countries in transition from communism, where governments continue to dominate health care delivery.

Some countries couple more or less universal public insurance with private provision of medical care. Examples include the U.S. insurance programs for the elderly (Medicare) and the poor (Medicaid) and the Australian, French, and German health care systems. In much of the developing world, universal health care translates into government financing and provision from mandatory wage taxes or general revenue that underwrite health care costs. Parallel out-of-pocket costs and private insurance finance private health care. Transition countries, with their history of generous government financing and provision, now combine public provision and finance with some private sector activity and informal, under-the-table payments to public providers.

9 Indeed, while the technical and scientific knowledge exists to solve many health problems, the fact that these solutions are often not widely adopted suggests that they are not simple to implement (World Bank 2005). For example, oral rehydration therapy (ORT) is a simple and cheap way to reduce diarrhea, which kills more than 4 million children a year. But ORT fails to reach needy families in some developing and transition countries for the same reasons that most redistributive policies are not fully effective: political tradeoffs, vested interests, corruption, and a general lack of resources.

Relatively open-ended public insurance coverage, in conjunction with strong profit motives in the private sector, can often lead to inefficient levels of care, such as overprescription of drugs and unnecessary procedures. Not facing the (marginal) cost of their decisions regarding the use of services, physicians order and patients opt for excess testing, treatment, and other benefits. Even if there is no agency problem between provider and patient, insurance leads to overconsumption. To control costs, these moral hazard effects have led to the introduction of provider payment arrangements that reward performance and discourage overspending (for example, prospective payments systems), rationing of care, and other cost-control measures.

Physician agency, adverse selection, and moral hazard together suggest that health care services will be provided excessively to people with insurance and deficiently to people without. In practice, however, the failures of the medical care market are more nuanced. While spending might be excessive in some countries, the actual delivery of useful services does not always follow suit: far from spending and getting too much, society spends too much and gets too little. Similarly, the theory of adverse selection implies that the bad (risks) will drive out the good (risks), but policy makers usually express exactly the opposite concern: that people with high risks will not be able to afford insurance. Publicly financed insurance is then likely to appear expensive, precisely because it covers relatively expensive, high risk individuals.

Cross-Country Evidence on Health Care Spending and Health in Developing and Transition Countries

Cross-country evidence on the link between health care spending and health status is not encouraging. Both market *and* government failures combine to complicate the design of health policy, in general, and the financing and delivery of health care, in particular. Indeed, considerable debate continues over what effect, if any, public spending on health care has on health in developing and transition countries. At first, this ambiguity seems surprising: surely spending on widgets should produce widgets?

The reasons why public spending on health care might not improve health, as set out by Filmer, Hammer, and Pritchett (2000), are economically straightforward. First, if there is a functioning private market for health care, public spending may simply replace private activities, rather than adding to the aggregate supply of health care. Second, public purchase of health care services does not necessarily assure their delivery to patients: doctors who are paid but do not show up to work, drugs that are procured but are siphoned off, and diagnostic equipment that lies idle for lack of maintenance or complementary inputs, such as electricity or skilled labor, all contribute to health spending, but not to health. Third, the technical efficacy of some health care spending (on garlic as a cure for AIDS, for example) is very low or even zero, so that even if some publicly financed services are delivered to patients, they might have little effect.

One way to examine the impact of public spending on health is to employ cross-country regression techniques, as in the health-income literature reviewed above. In this case, though, we can be somewhat more

confident about the use of cross-country comparisons, because problems of endogeneity seem to be less severe: it is unlikely that better population health would, in itself, lead to greater public spending on health.

Filmer and Pritchett (1999) regress under-five mortality on a variety of variables, including public health spending, and find that virtually all the cross-country variation is attributable to average per capita income, its distribution, female education, ethnolinguistic diversity, and religious and regional dummy variables. That is, health spending is more or less uncorrelated with health outcomes: independent variation in public health spending explains a paltry one-seventh of 1 percent of the variation in child mortality.

Wagstaff and Claeson (2004) examine how these results are affected by good governance. They find that health spending does reduce under-five mortality as long as the quality of governance, as measured by the CPIA (country program and institutional analysis) index, is high.[10] Flawed institutions would be expected to produce limited and poor-quality health services. But Lewis (2006) finds no association between the effectiveness of health spending and proxy measures for the effectiveness of institutions in the health sector—either the government effectiveness or the corruption measures of Kaufmann, Kraay, and Mastruzzi (2005).

One channel through which public spending may affect health—and one that, implicitly or otherwise, motivates some calls for greater spending—is its impact on the poor. Bidani and Ravallion (1997) find that public health spending significantly affects the health of the poor, but (consistent with Filmer and Pritchett 1999) not aggregate health.

In more recent work, Boone and Zhan (2006) investigate the determinants of child mortality using survey data on 278,000 children in 45 low-income countries. Their results provide some nuances to those of Filmer, Hammer, and Pritchett (2000). Somewhat controversially, they find that the prevalence of common diseases and the supply of infrastructure such as water and sanitation are *not* good predictors of child mortality, but that parents' education and a mother's propensity to seek out modern medical care are. Here the simulated effects they report appear large: for example, they find that if all mothers and fathers in the 45 countries had years of schooling equal to those of parents in Egypt, child mortality in these countries would fall by 19 percent. They also report that halving the prevalence of diarrhea, fever, and cough would reduce child mortality by only 3 percent.[11]

In keeping with the results of country-level studies, Boone and Zhan (2006) conclude that educated parents demand health services and that these services will be forthcoming from the private market. Educated parents

10 This is good news as much for health spending as for the CPIA index as a measure of governance. "Good" public spending should lead to improved health outcomes (unless it simply crowds out private spending), so the fact that countries with high CPIA scores show a positive link from spending to health is consistent with the CPIA measuring something relevant.

11 These numbers are, however, difficult to apply to decision making, as the costs of the two hypothetical interventions are not reported.

may well be better able to obtain a supply of quality medical care from the private market. They might even be better able, or better motivated, to ensure good governance procedures within the public sector, thereby improving both the quality of publicly delivered medical care and the reliability and adequacy of public infrastructure.

In the OECD countries the evidence on the impact of health spending on health status is tenuous. Bunker, Frazier, and Mosteller (1994) suggest that the main effect of health care is on the quality of life and well-being, as measured by increases in activity and mobility. This indirect evidence suggests that health care plays a key role by providing information (about lifestyle and prevention) and reducing morbidity.

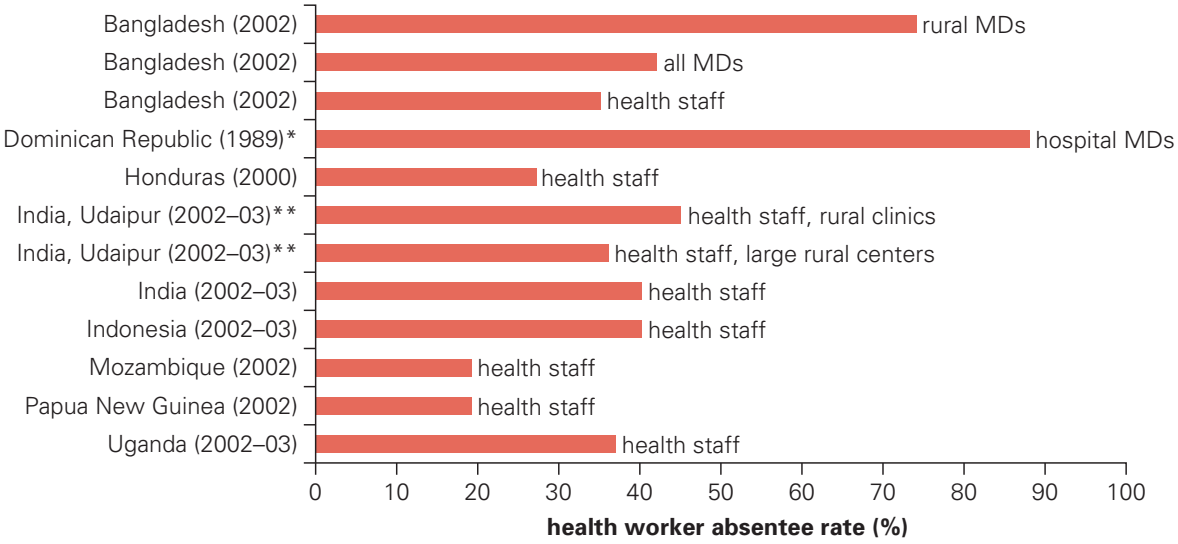
Country-Level Evidence on the Effectiveness of Health Care Spending: The Importance of Institutions

Examining why the link between health spending and health status is so tenuous is easiest at the country and health facility level, where institutional issues can be fully explored. Limited data and research on the subject complicate the design of effective policies, but evidence is beginning to emerge on the nature of health institutions in developing and transition countries and the kinds of services that they support. Our reading of the literature suggests that the most severe constraints in improving health through the delivery of health care in developing countries are institutional in nature and include the establishment and enforcement of basic performance incentives and cost containment. This section discusses some recent evidence on these topics and their relevance for institutional strengthening to improve health care service delivery.

Access to health care has improved markedly in the last two decades, but the quality of public health care services has been examined only recently. For the most part it has been found wanting. Recent evidence suggests that ineffective incentives and lack of accountability undermine the public provision of health services, leading to underperformance and substandard care (Lewis 2006). This may help to explain why public spending shows minimal effects on health status. Jack and Lewis (2004) attribute the shortcomings to government failure, effectively "government interventions that have gone wrong."

Institutions in health care are important but understudied. The lack of sound institutions undermines health investments and leads to ambiguous evidence on the relationship between health care services and health status. Accepted indicators of health care performance such as hospital infection rates, utilization statistics, or surgery survival rates are rarely collected even where required, for lack of some combination of oversight, regulation, and enforcement. This applies in middle-income countries as well as poorer ones. Indirect indicators of poor performance that are increasingly relied on in the absence of more direct measures include provider absenteeism, lack of basic medical supplies and drugs, poor management of purchases, corruption in selling public positions, leakage of funds, and under-the-table payments by patients, all of which highlight the nature of the performance lapses that undermine effective service delivery (Lewis 2006).

Figure 1.8 Absentee Rates among Health Workers in Select Countries, 1989–2003



Sources: Banerjee, Deaton, and Duflo 2005; Chaudhury and Hammer 2004; Chaudhury and others 2005; Lewis 2006; Lewis, La Forgia, and Sulvetta 1996; Lindelow, Kushnarova, and Kaiser 2006.

*Santo Domingo Hospital, Dominican Republic.
**Udaipur District, Rajasthan, India.

An extraordinarily important factor in public health care is simply whether workers show up for work. Chaudhury and Hammer (2004) report shockingly high rates of absenteeism among doctors in rural Bangladesh: 40 percent of doctors in large clinics and fully 74 percent of doctors in small (single-doctor) clinics. Chaudhury and others (2005) report figures on the absenteeism of health workers and teachers across six developing countries (Bangladesh, Ecuador, India, Indonesia, Peru, and Uganda). Figure 1.8 summarizes evidence from these studies and others that show similarly high rates of absence using different methods including surprise visits, time-in-motion studies, and clinical observations. Absenteeism has been captured in qualitative work as well (DiTella and Savedoff 2001).

Results from a range of countries—India, Tanzania, and Brazil—are instructive. A study in India finds that the public sector provides medical practitioners with attenuated incentives for good performance: Das and Hammer (2007) report the results of observing more than 4,000 doctor-patient interactions in Delhi and comparing clinical practices with what the doctor knew to be appropriate behavior.[12] They find that "public doctors exert much less effort than their private counterparts" (Das and Hammer 2007: 8). In addition, better-trained doctors do not necessarily provide better service: Das and Hammer find that, although providers without medical degrees are less competent (that is, they know less about what *should* be done in clinical situations), providers with medical degrees exert significantly less effort. Indeed, "clearly incentives are strong for MBBS [that is,

12 Vignettes are case studies that assess adherence to clinical protocols.

degree-holding] doctors to do less than they know, and [the incentives are] stronger still in the public sector."

In Tanzania, using vignettes and direct clinical observation, Leonard and Masatu (2006) show that NGO physicians consistently provide more accurate diagnoses and better treatment than their public sector colleagues. The main differences are that NGOs charge more and exhibit better management, incentives, and accountability. These authors' results suggest that performance is better where facility directors have greater authority, particularly the ability to hire and fire staff and adjust compensation. Leonard and Masatu (2007) indicate that in rural Tanzania a physician's training has little effect on performance once the ownership of the provider is taken into account: what counts is not what you know but what you do, and the two are unrelated where incentives are not in place to encourage the application of medical knowledge.

In Brazil, a recent experiment in hospital autonomy in 12 general public hospitals in the state of São Paulo led to significantly higher productivity of staff, more care, lower infection rates, reduced mortality, and lower costs when compared to a set of 12 traditionally managed general public hospitals of the same size in other similar locations. The ability to contract and terminate staff and to initiate efficiency measures provided powerful incentives for better hospital performance. Hospital directors who did not improve under the pilot project had their appointments terminated. Monthly tracking of performance led to impressive improvements in both quality and efficiency in hospitals where the ability to terminate both staff and management appointments provided accountability to the state funding agency (La Forgia and Couttolenc 2008).

The evidence from India, Tanzania, and Brazil highlights the critical roles of incentives, supervision, and accountability in raising performance and ensuring that expenditures will have positive returns in enhancing the health status of patients. Lewis (2006) summarizes a wealth of complementary evidence on issues of financing and delivery of care, identifying shortcomings and their measurement and emphasizing the importance of incentives and accountability if health institutions are to contribute effectively to improving health status and individual well-being.

One response to poor performance in public facilities is to shift the focus to private actors, but as Das and Hammer (2007) illustrate, this is by no means a panacea in service delivery, for the reasons discussed above. At the same time, adverse selection problems in the insurance market can lead to a breakdown in private insurance coverage as the unhealthy and the poor are excluded. In this case, some form of mandatory insurance coverage, even if privately provided and financed, may be necessary to avert an adverse selection spiral. This is the approach taken in Chile, Colombia, Switzerland, and, more recently, the U.S. state of Massachusetts. In all of these cases, and others, the government requires the private purchase of insurance by people earning middle and upper incomes, while subsidizing coverage for the poor, who would otherwise be unable to comply with the insurance mandate.

To sum up, if health care spending is to improve health status, institutions matter. The systemic problems are increasingly well understood, but without shifts in the institutions and the incentives for performance embedded in them, the link between spending and outcomes is likely to remain weak.

Conclusions

The impacts of a population's health on national income are hotly debated, and they probably vary depending on the health indicator used and the countries included in the analysis. Some cross-country regressions using instrumental variables find quite large impacts of health on income, but few other analytical approaches yield similar results. Part of the problem in resolving the debate lies in the fact that comparisons of health and nonhealth interventions in nonexperimental environments are besieged by identification problems, while (quasi) experimental settings that would allow such comparisons are especially rare. It is difficult enough to estimate the impact of a health *or* growth intervention compared with the status quo, but comparing health *and* growth interventions has proven especially intractable, particularly in light of the vast array of interventions that are feasible in both areas.

The two empirical approaches to this dilemma have been, first, to estimate the effects of arguably exogenous innovations in population health status on incomes at the macro level and, second, to focus at the micro level on the impact of specific health interventions on economic outcomes.

At the macroeconomic level, our tentative conclusion is that the effect of health on income is small if it exists at all and that the results are ambiguous, largely because of the methodological challenges discussed above. National public health investments such as environmental cleanup or vaccinations show an impact on overall health status and are associated with improved investment opportunities that contribute to growth. At the microeconomic level, clear causal relationships have been documented from health to earning potential and income.

Although the macroeconomic analyses seek to provide information on the impacts of improved health on aggregate incomes, they cannot really tell us whether an extra dollar of public funding should be allocated to the health sector or to an alternative or which interventions provide the biggest bang to health *and* income for the buck. Our understanding is that some health policies and investments, particularly those with pure public-good attributes, can plausibly have important impacts on incomes, but that at the macroeconomic level health and incomes are at least as likely to be jointly determined by such intangible features as institutional quality, corruption, and public sector accountability.

Nevertheless, microeconomic studies provide solid guidance on marginal benefits and on some of the tradeoffs across investments at the individual and household levels. Factors that foster greater productivity

and higher wages are nutrition, early childhood education (both cognitive and noncognitive), education more generally, and mother's education in particular. Public health investments that eliminate pathogens raise health status and expand access to agricultural land, which translate into enhanced learning and rising agricultural yields, respectively, and serve to raise productivity, labor supply, and earnings. Much remains to be done, however, on ensuring the benefits of medical interventions and investing to improve their effectiveness and impact.

The lack of clarity about the macroeconomic link from health to economic growth is not a reason to refocus public investment away from the health sector. The link from growth to health itself takes many forms, and it would seem to be a mistake to put all our eggs in the growth basket if we care about health for its own sake. The more pressing problem is to improve the link from health spending to health outcomes: scarce resources allocated to the health sector that have little impact on health are very unlikely to have the knock-on effect on incomes that some scholars and advocates seek. Institutions matter and need to be considered and invested in if health care spending is to pay off. Even if it turns out that there is little effect on growth, the improvements in health status will be worth the effort.

References

Acemoglu, Daron, and Simon H. Johnson. 2006. "Disease and Development: The Effect of Life Expectancy on Economic Growth." NBER Working Paper W12269, National Bureau of Economic Research, Cambridge, MA. http://ssrn.com/abstract=906747.

Acemoglu, Daron, Simon H. Johnson, and James Robinson. 2002. "Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution." *Quarterly Journal of Economics* 117 (4): 1231–94.

Acemoglu, Daron, and James Robinson. 2008. "Persistence of Power, Elites, and Institutions," *American Economic Review* 98 (1): 267–93.

Ainsworth, Martha, Kathleen Beegle, and Godike Koda. 2002. "The Impact of Adult Mortality on Primary School Enrollment in Northwestern Tanzania." UNAIDS Africa Development Forum Paper, World Bank, Washington, DC.

Alderman, Harold, Jere R. Behrman, and John Hoddinott. 2003. "Nutrition, Malnutrition, and Economic Growth." In *Health and Economic Growth,* ed. Guillem López-Casasnovas, Berta Rivera, and Luis Currais, ch. 7. Cambridge, MA: MIT Press.

Alsan, Marcella, David Bloom, and David Canning. 2006. "The Effect of Population Health on Foreign Direct Investment Inflows to Low- and Middle-Income Countries." *World Development* 34 (4): 613–30.

Ashraf, Quamrul, Ashley Lester, and David Weil. 2007. "When Does Improving Health Raise GDP?" Working Paper 2008-7, Brown University, Department of Economics, Providence, RI.

Banerjee, Abhijit, Angus Deaton, and Esther Duflo. 2004. "Wealth, Health, and Health Services in Rural Rajasthan." *American Economic Review* 94 (2): 326–30.

Barecca, Alan. 2007. "The Long-Term Economic Impact of *in utero* and Postnatal Exposure to Malaria." University of California, Davis. http://economics.missouri.edu/seminars/files/2008/021208.pdf.

Beegle, Kathleen, Joachim De Weerdt, and Stefan Dercon. 2006. "Adult Mortality and Consumption Growth in the Age of HIV/AIDS." Policy Research Working Paper 4082, World Bank, Washington DC.

Behrman, Jere R., and Mark Rosenzweig. 2004. "Parental Allocations to Children: New Evidence on Bequest Differences among Siblings." *Review of Economics and Statistics* 86 (2): 447–64.

Bell, Clive, and Maureen Lewis. 2004. "The Economic Implications of Epidemics Old and New." *World Economics* 5 (4): 137–74.

Bell, Clive, Shanta Devarajan, and Hans Gersbach. 2003. "The Long-Run Economic Costs of AIDS: Theory and an Application to South Africa." Policy Research Working Paper 3152, World Bank, Washington, DC.

Benton, Bruce. 2001. "The Onchocerciasis (River Blindness) Program's Visionary Partnerships." Africa Region Findings 174, World Bank, Washington, DC. http://www.worldbank.org/afr/findings/english/find174.htm.

Bidani, Benu, and Martin Ravallion. 1997. "Decomposing Social Indicators Using Distributional Data." *Journal of Econometrics* 77 (1): 125–39.

Black, Robert, Lindsay Allen, Zulfiqar Bhutta, Laura Caulfield, Mercedes de Onis, Majid Ezzati, Colin Mathers, and Juan Rivera. 2008. "Maternal and Child Undernutrition: Global and Regional Exposures and Health Consequences." *Lancet* 371 (9608): 5–22.

Bleakley, Hoyt. 2006a. "Disease and Development: Comments on Acemoglu and Johnson (2006)." Remarks delivered at the NBER Summer Institute on Economic Fluctuations and Growth, July 16. http://home.uchicago.edu/~bleakley/Bleakley_Comments_Acemoglu_Johnson.pdf.

_____. 2006b. "Malaria in the Americas: A Retrospective Analysis of Childhood Exposure." Documentos CEDE 003185, Universidad de los Andes, Centro de Estudios sobre Desarrollo Económico, Bogotá.

_____. 2007. "Disease and Development: Evidence from Hookworm Eradication in the American South." *Quarterly Journal of Economics* 122 (1): 73–117.

Bloom, David, and David Canning. 2003a. "Health as Human Capital and Its Impact on Economic Performance." *Geneva Papers on Risk and Insurance* 28 (2): 304–15.

_____. 2003b. "The Health and Poverty of Nations: From Theory to Practice." *Journal of Human Development* 4 (1): 47–71.

_____. 2005. "Health and Economic Growth: Reconciling the Micro and Macro Evidence." Unpublished document, Harvard School of Public Health, Cambridge, MA.

Bloom, David, David Canning, and Bryan Graham. 2002. "Longevity and Life Cycle Savings." NBER Working Paper 8808, National Bureau of Economic Research, Cambridge, MA. http://www.nber.org/papers/w8808.

Bloom, David, David Canning, and Jaypee Sevilla. 2004. "The Effect of Health on Economic Growth: A Production Function Approach." *World Development* 32 (1): 1–13.

Boone, Peter, and Zhaoguo Zhan. 2006. "Lowering Child Mortality in Poor Countries: The Power of Knowledgeable Parents." CEP Discussion Paper 751, London School of Economics, Centre for Economic Policy Research, London.

Bunker, John P., Howard S. Frazier, and Frederick Mosteller. 1994. "Improving Health: Measuring Effects of Medical Care." *The Milbank Quarterly* 72 (2): 225–58.

Carneiro, Pedro Manuel, and James J. Heckman. 2003. "Human Capital Policy." NBER Working Paper W9495, National Bureau of Economic Research, Boston, MA.

Carnoy, Martin, and Jeffrey Marshall. 2004. "Comparing Cuba Students' Academic Performance with the Rest of Latin America." Unpublished manuscript.

Case, Anne C., Christina H. Paxson, and Joseph D. Ableidinger. 2002. "Orphans in Africa." NBER Working Paper W9213, National Bureau of Economic Research, Cambridge, MA. http://ssrn.com/abstract=332257.

Chaudhury, Nazmul, and Jeffrey Hammer. 2004. "Ghost Doctors: Absenteeism in Bangladeshi Health Facilities." *World Bank Economic Review* 12 (3): 423–41.

Chaudhury, Nazmul, Jeffrey Hammer, Karthik Muralidharan, and F. Halsey Rogers. 2005. "Missing in Action: Teacher and Health Worker Absence in Developing Countries." *Journal of Economic Perspectives* 20 (1): 91–116.

Commission on Growth and Development. 2008. *The Growth Report: Strategies for Sustained Growth and Inclusive Development.* Washington, DC: Commission on Growth and Development, World Bank. http://www.growthcommission.org/index.php?option=com_content&task=view&id=96&Itemid=169.

Crossier, Scott. 2007. "John Snow: The London Cholera Epidemic of 1854." Center for Spatially Integrated Science, University of California, Santa Barbara.

Cunha, Flavio, James J. Heckman, Lance J. Lochner, and Dimitriy V. Masterov. 2006. "Interpreting the Evidence on Life Cycle Skill Formation." In *Handbook of the Economics of Education,* ed. Eric A. Hanushek and Finis Welch, 697–812. Amsterdam, the Netherlands: North-Holland.

Cutler, David. 2007. "The Lifetime Costs and Benefits of Medical Technology." NBER Working Paper 13478, National Bureau of Economic Research, Boston, MA.

Cutler, David, Winnie Fung, Michael Kremer, and Monica Singhal. 2007. "Mosquitoes: The Long-Term Effects of Malaria Eradication in India." Unpublished working paper, Harvard University, Cambridge, MA.

Cutler, David, and Grant Miller. 2005. "The Role of Public Health Improvements in Health Advances: The Twentieth Century United States." *Demography* 42 (1): 1–22.

Das, Jishnu, and Jeffrey Hammer. 2007. "Money for Nothing: The Dire Straits of Medical Practice in Delhi, India." *Journal of Development Economics* 83 (1): 1–36.

Deaton, Angus. 2006. "Global Patterns of Income and Health: Facts, Interpretations, and Policies." NBER Working Paper W12735, National Bureau of Economic Research, Cambridge, MA. http://ssrn.com/abstract=948648.

DiTella, Rafael, and William Savedoff, eds. 2001. *Diagnosis Corruption: Fraud in Latin America's Public Hospitals.* Washington, DC: Inter-American Development Bank.

Dixit, Avinash. 2006. "Evaluating Recipes for Development Success." Policy Research Working Paper 3859, World Bank, Washington, DC.

Drèze, Jean, and Amartya Sen. 2002. *India: Development and Participation*. Oxford: Oxford University Press.

Drukker, Jan W., and Vincent Tassenaar. 1997. "Paradoxes of Modernization and Material Well-Being in the Netherlands during the 19th Century." In *Health and Welfare during Industrialization,* ed. Richard H. Steckel and Roderick Floud, 331–79. Chicago: Chicago University Press.

Easterly, William, and Ross Levine. 2003. "Tropics, Germs, and Crops: How Endowments Influence Economic Development." *Journal of Monetary Economics* 50 (1): 3–39.

Evans, David, and Edward Miguel. 2003. "Will the Sun Come out Tomorrow? Orphans and Schooling." Unpublished working paper, University of California, Berkeley.

Filmer, Deon, Jeffrey Hammer, and Lant Pritchett. 2000. "Weak Links in the Chain: A Diagnosis of Health Policy in Poor Countries." *World Bank Research Observer* 15 (2): 199–224.

Filmer, Deon, and Lant Pritchett. 1999. "The Impact of Public Spending on Health: Does Money Matter?" *Social Science and Medicine* 49 (1): 1309–23.

Fogel, Robert W. 1986. "Nutrition and the Decline in Mortality since 1700: Some Additional Preliminary Findings." NBER Working Paper 1802, National Bureau of Economic Research, Boston, MA.

_____. 1994. "Economic Growth, Population Theory, and Physiology: The Bearing of Long-Term Processes on the Making of Economic Policy." *American Economic Review* 84 (June): 369–95.

_____. 1997. "New Findings on Secular Trends in Nutrition and Mortality: Some Implications for Population Theory." In *Handbook of Population and Family Economics*. Vol. 1A, ed. Mark Rosenzweig and Oded Stark. Amsterdam: Elsevier.

_____. 2002. "Nutrition, Physiological Capital, and Economic Growth. Lecture." Pan American Health Organization and the Inter-American Development Bank, Washington, DC.

Fortson, Jane. 2006. "Mortality, Risk, and Human Capital Investment: The Impact of HIV/AIDS in Sub-Saharan Africa." Unpublished paper, University of Chicago.

Fuchs, Victor R. 1974. *Who Shall Live? Health, Economics, and Social Choice*. New York: Basic Books.

Gallup, John Luke, and Jeffrey Sachs. 2001. "The Economic Burden of Malaria." *American Journal of Tropical Medical Hygiene* 64 (1-2): S1–S11.

Gertler, Paul, David Levine, and Minnie Ames. 2004. "Schooling and Parental Death." *Review of Economics and Statistics* 86 (1): 211–25.

Grantham-McGregor, Margaret, Yin Bun Cheung, Santiago Cueto, Paul Glewwe, Linda Richter, and Barbara Strupp. 2007. "Development Potential in the First Five Years for Children in Developing Countries." *Lancet* 369 (9555): 60–70.

Heckman, James. 2007. "Investing in Disadvantaged Young Children Is Good Economics and Good Public Policy." Testimony before the Joint Economic Committee, Washington, DC, June 27.

Hong, Sok Chul. 2007. "A Longitudinal Analysis of the Burden of Malaria on Health and Economic Productivity: The American Case." Unpublished paper, University of Chicago.

Hsiao, William C. 1984. "Transformation of Health Care in China." *New England Journal of Medicine* 310 (14): 932–36.

Jack, William, and Maureen Lewis. 2004. "Falling Short of Expectations: Public Health Interventions in Developing and Transition Economies." *Social Science and Medicine* 58 (2): 223–25.

Kamali, A., J. A. Seeley, A. J. Nunn, J. F. Kengeya-Kayondo, A. Ruberantwari, and D. W. Mulder. 1996. "The Orphan Problem: Experience of a Sub-Saharan Africa Rural Population in the AIDS Epidemic." *AIDS Care* 8 (5): 509–15.

Kaufmann, Daniel, Art Kraay, and Massimo Mastruzzi. 2005. "Governance Matters IV: Governance Indicators for 1996–2004." Policy Research Working Paper 3630, World Bank, Washington, DC. http://ssrn.com/abstract=718081 or DOI: 10.2139/ssrn.718081.

Knudsen, Eric I. 2004. "Sensitive Periods in the Development of the Brain and Behavior." *Journal of Cognitive Neuroscience* 16 (8): 1412–25.

Knudsen, Eric I., James J. Heckman, Judy L. Cameron, and Jack P. Shonkoff. 2006. "Economic, Neurobiological, and Behavioral Perspectives on Building America's Future Workforce." *PNAS (Proceedings of the National Academy of Sciences)* 103 (27): 10155–62.

Kuhn, Katrin Gaardbo, Diarmid H. Campbell-Lendrum, Ben Armstrong, and Clive R. Davies. 2003. "Malaria in Britain: Past, Present, and Future." *PNAS (Proceedings of the National Academy of Sciences)* 100 (17): 9997–10001. http://www.pnas.org/content/100/17/9997.full.

La Forgia, Gerard M., and Bernard F. Couttolenc. 2008. *Hospital Performance in Brazil: The Search for Excellence*. Washington, DC: World Bank.

Larson, Bruce A., Matthew P. Fox, Sydney Rosen, Margaret Bii, Carolyne Sigei, Douglas Shaffer, Fredrick Sawe, Monique Wasunna, and Jonathan L. Simon. 2008. "Early Effects of Antiretroviral Therapy on Work Performance: Preliminary Results from a Cohort Study of Kenyan Agricultural Workers." *AIDS* 22 (3): 421–25.

Leonard, Kenneth, and Melkiory Masatu. 2006. "The Use of Direct Clinician Observation and Vignettes for Health Services Quality Evaluation in Developing Countries." *Social Science and Medicine* 61 (9): 1944–51.

———. 2007. "Variation in the Quality of Care Accessible to Rural Communities in Tanzania." *Health Affairs* 26 (3): w380–w392.

Lewis, Maureen. 2006. *Governance and Corruption in Public Health Care Systems*. Center for Global Development Working Paper 78, Center for Global Development. http://ssrn.com/abstract=984046.

Lewis, Maureen, Gerald La Forgia, and Margaret Sulvetta. 1996. "Measuring Public Hospital Costs: Empirical Evidence from the Dominican Republic." *Social Science and Medicine* 43 (2): 221–34.

Lindelow, Magnus, Inna Kushnarova, and Kai Kaiser. 2006. "Measuring Corruption in the Health Sector: What Can We Learn from Public Expenditure Tracking and Service Delivery Surveys in Developing Countries?" In *Global Corruption Report 2006: Special Focus on Corruption and Health*. Transparency International. London: Pluto Press.

Lleras-Muney, Adriana. 2005. "The Relationship between Education and Adult Mortality in the United States." *Review of Economic Studies* 72 (1): 189–221.

Lloyd, Cynthia B., and Ann K. Blanc. 1996. "Children's Schooling in Sub-Saharan Africa: The Role of Fathers, Mothers, and Others." *Population and Development Review* 22 (2): 265–98.

Lorentzen, Peter, John McMillan, and Romain Wacziarg. 2005. "Death and Development." NBER Working Paper 11620, National Bureau of Economic Research, Boston, MA.

Lucas, Adrienne. 2005. "Economic Effects of Malaria Eradication: Evidence from the Malarial Periphery." Unpublished paper, Brown University, Providence, RI.

Malaney, Pia, Andrew Spielman, and Jeffrey Sachs. 2004. "The Malaria Gap." *American Journal of Tropical Medicine and Hygiene* 71 (suppl 2): 141–46.

Mankiw, N. Gregory. 1995. "The Growth of Nations." *Brookings Papers on Economic Activity* 1: 275–326.

McKeown, Thomas, R. G. Record, and R. D. Turner. 1962. "Reasons for the Decline of Mortality in England and Wales during the Nineteenth Century." *Population Studies* 16 (2): 94–122.

_____. 1975. "An Interpretation of the Decline of Mortality in England and Wales during the Twentieth Century." *Population Studies* 29 (3): 391–421.

McKinley, John, and Sonja J. McKinley. 1997. "The Questionable Contribution of Medical Measures to the Decline of Mortality in the United States in the Twentieth Century." *Millbank Memorial Fund Quarterly/Health and Society* 55 (3): 404–28.

Melgar, Paúl, Luis Fernando Ramírez, Scott McNiven, Rosa Mery Mejía, Ann DiGirolamo, John Hoddinott, and John A. Maluccio. 2008. "Resource Flows among Three Generations in Guatemala Study (2007–08): Definitions, Tracking, Data Collection, Coverage, and Attrition." Working Paper Series 0803, Middlebury College, Department of Economics, Middlebury, VT.

Miguel, Edward. 2005. "Health, Education, and Economic Development." In *Health and Economic Growth: Findings and Policy Implications*, ed. Guillem López-Casasnovas, Berta Rivera, and Luis Currais, pp. 143–68. Cambridge, MA: MIT Press.

Miguel, Edward, and Michael Kremer. 2004. "Worms: Identifying Impacts on Education and Health in the Presence of Treatment Externalities." *Econometrica* 72 (1): 159–217.

Mustard, J. Fraser. 2006. *Early Child Development and Experience-Based Brain Development: The Scientific Underpinnings of the Importance of Early Child Development in a Globalized World*. Washington, DC: Brookings Institution. http://www.brookings.edu/views/papers/200602mustard.htm.

PAHO (Pan American Health Organization). 1999. *The Pan American Sanitary Code: Toward a Hemispheric Health Policy*. Washington, DC: World Health Organization, Pan American Health Organization.

Preston, Samuel H. 1975. "The Changing Relation between Mortality and Level of Economic Development." *Population Studies* 29 (2): 231–48.

Pritchett, Lant. 1997. "Divergence, Big Time." *Journal of Economic Perspectives* 11 (3): 3–17.

Pritchett, Lant, and Lawrence H. Summers. 1996. "Wealthier Is Healthier." *Journal of Human Resources* 31 (4): 841–68.

Rodrik, Dani, Arvind Subramanian, and Francesco Trebbi. 2002. "Institutions Rule: The Primacy of Institutions over Geography and Integration in Economic Development." NBER Working Paper 9305, National Bureau of Economic Research, Boston, MA.

Sachs, Jeffrey D. 2003. "Institutions Don't Rule: Direct Effect of Geography on Per Capita Income." NBER Working Paper 9490, National Bureau of Economic Research, Boston, MA.

Sachs, Jeffrey D., and Pia Malaney. 2002. "The Economic and Social Burden of Malaria." *Nature* 415 (February 7): 680–85.

Schultz, Paul. 2002. "Why Governments Should Invest More to Educate Girls." *World Development* 30 (2): 207–25.

_____. 2005. "Productivity Benefits of Health: Evidence from Low-Income Countries." In *Health and Economic Growth*, ed. Guillem López-Casasnovas, Berta Rivera, and Luis Currais. Cambridge, MA: MIT Press.

Shastry, Gauri Kartini, and David Weil. 2003. "How Much of Cross-Country Income Variation Is Explained by Health?" *Journal of the European Economic Association* 1 (2-3): 387–96.

Snow, John. 1849. *On the Mode of Communication of Cholera*. London: John Churchill.

Thirumurthy, Harsha, Joshua Graff Zivin, and Markus Goldstein. 2005. "The Economic Impact of AIDS Treatment: Labor Supply in Western Kenya." NBER Working Paper 11871, National Bureau of Economic Research, Cambridge, MA.

Thomas, Duncan, and Elizabeth Frankenberg. 2002. "Health, Nutrition, and Prosperity: A Microeconomic Perspective." *Bulletin of the World Health Organization* 80 (2): 106–13.

Thomas, Duncan, and John Strauss. 1997. "Health and Wages: Evidence on Men and Women in Urban Brazil." *Journal of Econometrics* 77 (1): 159–86.

Victora, Cesar, Linda Adair, Caroline Fall, Pedro Hallal, Reynaldo Martorell, Linda Richter, and Harshpal Singh Sachdev. 2008. "Maternal and Child Undernutrition: Consequences for Adult Health and Human Capital." *Lancet* 371 (9609): 340–57.

Wagstaff, Adam, and Mariam Claeson. 2004. *Rising to the Challenge: The Millennium Development Goals for Health*. Washington, DC: World Bank.

Walker, Susan P., Theodore Wachs, Julie Meeks Gardner, Betsy Lozoff, Gail Wasserman, Ernesto Pollitt, and Julie Carter. 2007. "Child Development: Risk Factors for Adverse Outcomes in Developing Countries." *Lancet* 369 (9556): 145–57.

Weil, David N. 2005. "Accounting for the Effect of Health on Economic Growth." NBER Working Paper 11455, National Bureau of Economic Research, Boston, MA.

WHO (World Health Organization). 2001. *Report of the Commission on Macroeconomics and Health*. Geneva: WHO. whqlibdoc.who.int/publications/2001/924154550x.pdf.

Wößmann, Ludger, and Gabriela Schütz. 2006. *Efficiency and Equity in European Education and Training Systems: Analytical Report for the European Commission*. Munich: European Expert Network on Economics of Education.

Wolfe, Barbara. 1986. "Health Status and Medical Expenditures: Is There a Link?" *Social Science and Medicine* 22 (10): 993–99.

World Bank. 2005. *World Development Report 2004: Making Services Work for Poor People*. Washington, DC: World Bank.

_____. 2008. *Global Monitoring Report: MDGs and the Environment*. Washington, DC: World Bank.

Young, Alwyn. 2005. "The Gift of the Dying: The Tragedy of AIDS and the Welfare of Future African Generations." *Quarterly Journal of Economics* 120 (2): 423–66.