Chapter 7

Economic Approaches to Valuing Global Health Research

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Health research has contributed tremendously to advancing health and welfare throughout the world. Gains in health have already been attained, and health research continues to have great potential to contribute to the well-being of persons in both low-income and high-income countries. The "10/90" reports of the Global Forum on Health Research (GFHR) have helped highlight that, although the burden of disease attributable to morbidity and mortality is greatest in developing countries, most health research has focused on the needs of developed countries and relatively little on the needs of lower-income countries (GFHR 2003). Despite the relative dearth of health research focused specifically on their most important health problems, lower-income countries have also benefited from health research, often as much from research originally motivated to serve high-income countries as from research specifically designed to address the needs of low-income countries.

In the future, health research aimed primarily at addressing the needs of affluent countries is likely to continue to produce benefits for lower-income countries, even in the absence of efforts to manage scientific research in the interest of lower-income nations. Indeed, as lower-income countries increase in income, their health problems will likely come to resemble more closely the health problems of higher-income countries. However, "trickle-down" approaches are not an efficient way of producing knowledge to advance the health and well-being of the populations of lower-income nations. Instead, a rational approach is needed that appreciates both the value of health in lower-income nations and the potential for rational scientific management to efficiently allocate resources for scientific research. The work of the GFHR and other organizations in this regard is an important step in this direction. Moreover, recent advances in understanding about the value of improvements in health and in approaches to the value and priorities of health research provide powerful theoretical tools to address these issues.

Although the application of these principles is still in its infancy, these tools provide a valuable framework for determining the value of health research relevant to low-income countries and for maximizing the value of research that aims to promote health in those countries. In the following section, recent innovations in determining the value of health research at an aggregate level are reviewed. The conclusion is that the value of health research has been immense and is likely to increase dramatically in coming years, especially in lower-income countries. In deriving these conclusions, not only health-oriented measures of improved health, such as life years, disability-adjusted life years (DALYs), or quality-adjusted life years (QALYs), were considered, but also how increases in income may increase the value of such improvements. In a later section, recent methods that can be used to estimate the value of specific research projects are reviewed. The application of such methods promises to better identify the value of health research in specific instances, which can enhance the case for research spending to improve health in developing countries and can increase the efficiency with which available research funds are spent.

THE VALUE OF HEALTH RESEARCH

Health research can be valuable for a variety of reasons. The most obvious reason is simply the value that people place on improvements in health. Those health improvements may be reflected in increased length of life or quality of life. Other reasons that health research can be valuable include the improvements in productivity, decreases in medical care costs, and greater ability to plan for and invest in the future when health improves. Health research can also sometimes decrease costs independent of any effects on health—for example, when a lower-cost treatment can replace a higher-cost treatment of similar efficacy.

A large body of work has attempted to assess and quantify the economic value of health from these perspectives. The goal of some of this literature is a comprehensive assessment of the cost of illness (for example, Rice 1994). Such comprehensive assessments are often attempted in order to assess the cost-effectiveness of medical or public health interventions, which are frequently measured in terms of quality-adjusted life expectancy (Gold and others 1996) or DALYs (WHO 1994; World Bank 1993). Other aspects of this literature focus on single dimensions of the economic value of health. For example, Ram and Schultz (1979) performed an early analysis showing the effects of malaria eradication on productivity. Similarly, Meltzer (1992) attempted to identify the effects of mortality on investment in education, the demographic transition, and the onset of sustained economic growth. In that work, it was suggested that health can increase income because increasing life expectancy raises returns to investment in education, in turn encouraging decreases in family size and further increases in investment in the education of children and a transition to sustained human capital–based economic growth. These and other mechanisms, including shifts in the ratio of productive adults to dependents and changes in savings rates with increasing life expectancy, have been suggested to produce positive effects of health on per capita income in both the short and the long run (Bloom, Canning, and Jamison 2004).

Although some evidence suggests the importance of all these effects, recent work on the value of health in developed countries has focused primarily on the value that people place on improvements in their health. Such studies for the United States have suggested that increases in longevity over the past several decades are valued in the tens of trillions of dollars, indeed, contributing about as much to increasing welfare over the period as increases in per capita income. Subsequently, similar findings have been reported for other countries, and cross-national studies have found that the value of growth in life expectancy compared with the value of income growth has been even greater for low-income countries (Becker, Philipson, and Soares 2003). These studies have been influential in developing a broad consensus that the returns to health research are large and in producing dramatic increases in the budget for the National Institutes of Health (NIH) in the United States. The conclusions of these studies in the United States have been based on assessments of both the high value of health and the role that health research has played in improvements in health. Although both the connection of health research to health and the valuation of health differ in important ways between lower-income and higher-income countries, these studies provide a useful framework for understanding the past and likely future value of health research in lower-income countries.

The Value of Improved Health

Several authors have contributed to the literature on the value of improvements in health: Becker, Philipson, and Soares (2003); Cutler and others (1997); Murphy and Topel (2003); and Nordhaus (2003). Although these studies differ somewhat in the analytic framework they use, the basic form of their analyses is quite similar. In essence, they all use estimates of the value of longevity on the basis of revealed preference techniques and multiply these values by the increases in longevity that have been observed to determine the value of improvements in health. Revealed preference estimates of the value of life are most commonly derived by assessing the wage premium required by workers to accept riskier jobs. This idea dates back at least to the work of Adam Smith, but the modern treatment of this issue stems primarily from the work of Thaler and Rosen (1975). For example, if the lifetime earnings of a risky mining job that has a 1/1,000 increased risk of death compared with another mining job is US$1,000, then the statistical value of a life would be said to be US$1,000,000, since paying 1,000 workers would result in one extra death on average and require that the employer pay wages equal to 1,000 workers $\times$ US$1,000/worker $=$ US$1,000,000.

A simple example considering the value of increases in life expectancy in the United States from 1970 to 2000 illustrates well how these sorts of estimates have been used to estimate the value of increased longevity. From 1970 to 2000, life expectancy at birth for Americans grew by a little more than 5 years, from about 75 years to about 80 years. With about 300 million Americans living during this period, this increase constitutes about 1.5 billion life years. Using a conservative revealed preference estimate of about US$4 million as the statistical value of a life (Viscusi and Aldy 2003), assuming a life expectancy of 75 to 80 years, and assuming discounting is somewhere between 0 and 3 percent annually, one gets a value of about US$50,000 to US$100,000 per life year saved. Multiplying this gain in life years and the estimate of the value of a life year, one gets a value of increased longevity over this period of about US$75 trillion to US$150 trillion, or about US$2 trillion to US$4 trillion per year. The average of these numbers translates into almost US$10,000 per person per year, which is about as large as the increase in per capita income in the United States during this period. In essence, this analysis is a simplified form of that performed by Murphy and Topel (2003).

An alternative approach to obtaining a similar number may help some readers better understand the intuition behind these effects. Over this 30-year period, the 5-year increase in life expectancy that occurred raised life expectancy by about two months (or one-sixth year) per year. With each life year valued at about US$75,000, these gains in life years are readily seen to be worth about US$10,000 per person per year.

Understanding the value of improvements in health in lower-income countries requires data both on increase in longevity and on how such increases in longevity might be valued. Data on increases in longevity are relatively easy to obtain for most countries and vary substantially across countries over time. For example, many countries that had low income in 1950, including the Arab Republic of Egypt, Mexico, and Thailand, have had an increase in life expectancy since 1950 of more than 20 years, or about three months per year, which is about 50 percent greater than the rate of growth in life expectancy in the United States. Although some countries that had low incomes in 1950 and did not experience much economic growth during this period did not increase in life expectancy over this period, the vast majority of countries with low incomes in 1950 experienced increases in life expectancy far exceeding the rate of increase in the United States and other developed countries. This fact suggests that the potential for increases in life expectancy is greater for lower-income countries than for higher-income ones, so the increase in life expectancy for lower-income countries might be expected to slow in coming years. If the rate of change in the value of health gains were determined primarily by the rate of increase in life expectancy, growth in the value of health in lower-income countries would be expected to slow in the future.

Assessing the importance of changes in life expectancy relative to changes in the value of increased life expectancy in influencing the value of health requires data on the value of increased longevity. Such data on the value of mortality reductions are limited but do exist. Viscusi and Aldy (2003) reviewed the literature on the statistical value of life across countries that vary in income. One key finding is that the statistical value of life increases with income, with an elasticity of approximately 0.5 to 0.6, so that a 100 percent increase in income leads to a 50 to 60 percent increase in the statistical value of life.

One implication of this finding is that economic growth is likely to result in increases in welfare through improved health, both because economic growth improves health and because the value of those health improvements increases as income increases. This statement can be assessed formally by analyzing change over time in the value of life (VL) $= VLY \times LY$, where VLY is the value of a life year, and LY is life expectancy. Such numbers easily show the value of health gains that have been achieved. For example, India is the poorest country for which calculations of revealed preference estimates of the statistical value of life have been done (Viscusi and Aldy 2003). This study suggests a statistical value of life of US$0.6 million, or about US$10,000 to US$20,000 per life year saved. With gains in life expectancy of about 25 years since 1950 and a population in 2000 of about 1 billion persons, the gains in life expectancy in India alone over the period are worth about US$400 trillion, or US$8 trillion per year, equivalent to about US$800 per person per year.

Thus, as large as the US$75 trillion to US$150 trillion estimate for the health gains for the United States is, such gains are only about one-fourth as large as the gains for India. The value of the gains for India is larger for several reasons. One is just the longer period considered—30 years for the United States compared with 50 for India—although, in fact, gains in the United States were small enough between 1950 and 1970 that the longer period explains relatively little of the difference. Much larger factors are the fivefold greater increase in life expectancy in India than in the United States over the period (25 years compared with 5 years) and a population about five times as large. Thus, if health gains are valued in U.S. dollars, the value of such gains for India over this period far exceeds that for the United States. Given the 5:1 size of India and the gains in life expectancy, the ratio of those gains would be more like 25:1 than 4:1 (US$400 trillion as opposed to US$75 trillion to US$150 trillion) were it not that the statistical value of life in the United States is greater than that in India. Even if one does not feel comfortable assigning differential valuation to lives across countries, the fact that the valuation of gains in India is so much larger than the valuation of the gains in the United States using this method provides a powerful reminder of certain basics of the value of improving health in lower-income versus higher-income countries: many more people live in low-income than in high-income countries, and the potential for large increases in life expectancy is thus far greater.

Such statistics provide some insights into the value of historical improvements in health, but in terms of considering future investments, considering what can be said about the growth of the value of health in lower- versus higher-income countries in the future is useful. To do so, one finds it useful to decompose growth in the value of health into growth in life expectancy and growth in the value of longevity (growth in the value of life years). We begin with $VL = VLY \times LY$ and differentiate to obtain the finding that growth rates can be decomposed to find that $g_{VL} = g_{VLY} + g_{LY}$, so that the growth in the value of life is the sum of the growth in the value of a life year and growth in life expectancy.

To understand the meaning of this relationship, one finds it useful to consider the Viscusi and Aldy (2003) estimate of the elasticity of the value of life with respect to income. Substituting this elasticity income in the above equation, $g_{VL} = 0.5\ g_Y + g_{LY}$, where g_Y is the growth rate in per capita income. The relative magnitude of these two components is instructive. In developed countries such as the United States, where growth in life expectancy has been on the order of two months per year from a base of 75 or so years, the growth in life expectancy is (2/12)/75 = 0.2 percent per year. This rate is substantially smaller than the component of increased value of life related to growth in the valuation of gains in life, even with long-run real growth rates of only 2 to 3 percent, so the component attributable to growth in the value of life is 0.5 × (2 to 3 percent) = 1 to 2 percent per year. In lower-income countries in which growth in life expectancy is greater and baseline life expectancy is lower, life expectancy growth may be more important but is still not likely to exceed the effects of growth in per capita income. For example, Mali experienced dramatic growth in life expectancy of 1 percent per year (from 30 to 45 years from 1950 to 1990), but growth in per capita income in Mali from 1980 to 2000 was about 3 percent annually, translating into effects on the value of life of 1.5 percent annually. More striking perhaps is China, where growth in life expectancy from 40 to 70 years from 1950 to 1990 represented an increase of about 2 percent per year, whereas growth in per capita income (from 1980 to 2000) was about 8 percent per year (translating into effects on the value of life of about 4 percent per year). Two implications are immediately obvious:

- First, the growth in the overall value of health over the period has been large—about 2 to 6 percent annually for these initially low-income countries.
- Second, the major driver of the value of health over time has not been an increase in health per se but, instead, increases in income that produce increases in how health is valued. This finding is likely to be even more true as life expectancy increases so that continuing large increases in life expectancy become more difficult to achieve.

As noted previously, estimates such as these of the statistical value of life can understandably be criticized on the basis of associating a greater value with saving lives of wealthier persons than saving lives of poorer persons. Nevertheless, it is striking to note that in India—the only relatively low-income country for which data on the statistical value of life are available—the total value of recent health gains far exceeds even the immense gains in the United States. Data on the value of life for other low-income countries would help reinforce this finding, but the combination of the greater potential for large increases in life expectancy and for greater growth in per capita income in low-income countries in the future suggests that the total value of health gains for such countries may far exceed those of higher-income countries. Indeed, it bears emphasis that, in attempting to value health in monetary terms rather than merely health terms, such as life years or QALYs or DALYs, an important new avenue is opened by which the value of health research can increase over time even as gains in life expectancy slow with increasing life expectancy, as they have in developed countries. Despite the concern that economic approaches undervalue the health of persons with lower incomes, such valuations clearly suggest that the potential value of health research for these countries is immense. That this discussion has focused only on the value of mortality reductions and neglected those of reductions in morbidity even further reinforces the potential gains from health research.

Not only is the magnitude of the value of these improvements in health immense in regard to how people value being healthier, but the total value of health also includes increased productivity, decreased medical care costs, and increased ability to plan for and invest in the future when health improves. Although these effects are often not easy to quantify, they may prove to be important components of the total economic value of improvements in health.

The Connection between Gains in Health and Health Research

To move from the finding that gains in health are highly valued to the finding that health research is highly valued, gains in health must be connected to health research. Making such associations is difficult even in high-income countries, but it has been done with some success. For example, Cutler and Kadiyala (2003) argue that the major recent gains in life expectancy in the United States have come from reductions in cardiovascular disease, about two-thirds of which can be tied to advances that have resulted from medical research as opposed to secular trends in nonmedical factors that promote health, such as per capita income and education. Similar calculations for lower-income countries have not been done. Nevertheless, although growth in income and education seem more likely to be important in producing increases in life expectancy for such countries, the major role of reductions in childhood infectious disease in recent gains in life expectancy suggests the great value of the research that has produced such innovations as childhood immunizations, improved sanitation, and oral rehydration therapy. Similarly, the high burden of cardiovascular disease in lower-income countries will be expected to decline in the coming years if the benefits of research can be applied in those settings.

Such conclusions speak to the value of health research as a whole for lower-income countries, and they reflect the gains that come both from research done initially to benefit higher-income countries and from research done to benefit lower-income countries. Although both of these classes of research may produce benefits for lower-income countries, discussion of their differences is in order. In the case of research done initially with the needs of high-income countries in mind, clearly some types of research benefit low-income countries more than others. For example, research that has demonstrated the power of relatively inexpensive medications to reduce mortality from cardiovascular disease (for example, aspirin in acute myocardial infarction) has much greater potential to produce large benefits for lower-income countries in the foreseeable future than does research that advances techniques for expensive acute treatments, such as cardiac catheterization. In this particular case of cardiovascular disease, estimates summarized by Cutler and Kadiyala (2003) suggest that higher-income countries have also benefited more from research that advanced such low-technology treatments than from research on high-technology treatments.

Such patterns may not be maintained across other health conditions, but they do hold out the tantalizing thought that health research initiated by high-income countries in their own interest may sometimes be directed toward work of greater value if issues of cost and generalizability to lower-income settings are reflected more greatly in decisions about research priorities. When research directed toward the needs of lower-income countries is considered, cost and feasibility must, of course, receive great attention. However, the immense reductions in mortality that have come from advances in knowledge about public health efforts—such as efficient and effective sanitation, immunization, and oral rehydration programs, all of which were developed primarily with the needs of low-income countries in mind—suggest the value of research targeted toward the needs of lower-income countries. Rigorous studies of the value of these innovations akin to those studies done to assess the value of health research for the United States are sorely needed to inform potential funders of the potential returns to such research.

METHODS OF ASSESSING THE VALUE OF HEALTH RESEARCH PROJECTS

Although the aggregate value of health research has unquestionably been large, not all health research projects are sufficiently valuable to justify their costs. Some of these latter projects are inevitable because the outcome of research is intrinsically unpredictable. However, even if one abstracts from such uncertainty by considering the expected returns from a project before one embarks on it, research projects clearly vary in their likely value relative to their cost. Such assessments are obviously difficult to make, yet they are routinely done as part of the process of deciding the allocation of research funds. These assessments have traditionally been done rather informally, even in the most closely structured settings in which research funding is sought, such as the NIH study sections in the United States that review research proposals for NIH funding.

An active discussion over the past decade has helped to identify valuable strategies for priority setting in global health research and determine their implications for research priorities in the field. The 2004 report on health research of the GFHR summarized the major contributions to this discussion (GFHR 2003). The approaches that are described date back to as early as 1990 with the work of the Commission on Health Research for Development. They include the essential national research approach developed by the Council on Health Research for Development and approaches developed by the Ad Hoc Committee on Health Research, the Advisory Committee on Health Research, and the GFHR's own Global Forum combined matrix approach. The 2004 report compares these approaches along several dimensions that include the following:

1. Objective of priority setting
2. Focus at global or national level
3. Strategies or principles (especially relating to the process for participation by stakeholders)
4. Criteria for priority setting:
   - Burden of disease
   - Analysis of determinants of disease burden
   - Cost-effectiveness of interventions (resulting from proposed research)
   - Effect on equity and social justice
   - Ethical, political, social, and cultural acceptability
   - Probability of finding a solution
   - Scientific quality of research proposed
   - Feasibility (availability of human resources, funding, facilities)
5. Contribution to capacity strengthening.

In addition to describing the dimensions considered in these approaches to priority setting, the 2004 report also summarizes several efforts to apply these approaches in individual countries or for individual diseases or disease areas (see, for example, Remme and others 2002). The priorities identified include many of those identified in chapter 4 in this volume.

Examining these dimensions of priority setting, one finds that some are intrinsically qualitative in nature but quantitative analysis also sometimes plays an important role. For example, several approaches, including the GFHR's combined matrix approach, use DALYs to quantify the number of healthy years of life lost to the disease toward which the research is directed.

Looking forward, one may find additional quantitative approaches helpful in assessing the value of research. For example, new methods based on value-of-information (VOI) techniques have begun to be proposed to better inform such assessments. In essence, VOI techniques model the uncertainty in the outcomes of research and the value of research contingent on that uncertainty in order to assess the expected value of the research. For example, a research project that has a 5 percent chance of success that it would produce health gains worth US$100 million and a 95 percent chance of failure, would have an expected value of $(0.05 \times$ US$100 million$) + (0.95 \times$ US$0) = US$5 million. Although these techniques have rich roots in statistical and economic theory, they are often difficult to apply well because of the difficulty in valuing health outcomes and modeling the uncertain outcomes of research. As a result, these methods often can provide only loose bounds on the value of a research project (Meltzer 2001). Indeed, in the worst-case scenarios, in which the available information about the likely outcomes of research is essentially uninformative, VOI techniques only reproduce information on the burden and costs of illness. Nevertheless, in settings where more structure can be put into the problem, these techniques have begun to be applied successfully to specific research questions, such as the prioritization of research in Alzheimer's disease (Claxton and others 2001). In general, the more remote the connection of the research to health outcomes, the harder it is to gain meaningful information from a VOI approach. Thus VOI approaches are far better at providing information on the value of applied research than they are at providing information on the value of basic research.

For lower-income countries, this ability to illustrate the value of applied work may be especially valuable because often a technology has already been developed and the question is how best to apply it in a given setting. With the limited funds that have traditionally been available for research in lower-income countries and the high value that appears to be placed on improvements in health in these countries, VOI studies, as discussed previously, seem likely to frequently show that the benefits of research in lower-income countries far exceed the costs. It is hoped that such findings may be used to increase the pool of funds available for research in these settings. However, even if VOI techniques do not lead to increases in the total funding available for research in low-income countries, they may be helpful in informing resource allocation decisions, given available resources. In the context of a fixed research budget in which some research projects whose expected benefit exceeds their costs could still not be funded, rigorous data on the high rates of return on projects that did not make the funding line would then serve to highlight the returns to greater research in these settings. Because VOI calculations need not be complex (see box 7.1), the most important barriers to their

Box 7.1

Value of Information

Although VOI calculations can be quite complex (for example, Claxton and others 2001), they need not be. For a researcher seeking funding, much simpler calculations may be sufficient to build a compelling case for funding. For example, quantifying the burden of illness in life years, QALYs, or DALYs lost and converting this into a burden or cost-of-illness measure in economic terms using an estimate of the statistical value of life may even be sufficient. To take a simple example, imagine a research program in a country with a statistical value of life of US$0.6 million (for example, the estimate for India) for a disease that currently kills 1,000 people per year. If one abstracts from issues such as the age of death and how one might differentially value deaths at different ages, this would have a potential value of US$0.6 billion per year. If the research study were viewed as having a 10 percent chance of preventing 50 percent of those deaths, its expected value would be P(success) $\times$ percent efficacy $\times$ statistical value of life $= 0.1 \times 0.5 \times$ US$0.6 billion = US$30 million per year. Potential annual productivity gains produced by a successful treatment and annual costs of the treatment could be added to, or subtracted from, these US$0.6 billion annual benefits as well. One could go further, arguing that the research would be valuable into the future, and discount an infinite stream of those annual returns. At a discount rate (R) of 10 percent, this stream would have a value of US$20 million/$R$ = US$200 million. This result suggests that a research program costing up to this amount would be worthwhile if it could be expected to have this likelihood of success and percent efficacy. Even if those probabilities could not be reliably estimated, minimum values could be calculated at which the research program would continue to be worthwhile.

As in their use in affluent countries, such calculations are likely to suggest that health research is of great value, often being predicted to return value many times its cost even accounting for uncertainty. In the preceding example, for instance, even an immense US$100 million research program would have an expected return 20 times as large. Such results would reflect the immense value in health research but would also suggest caution: with limited research funds, not all programs whose benefits exceed their costs should be funded if more valuable projects remain unfunded. In this area, funding agencies can be helpful to the research community by highlighting how they have used calculations such as these and publicizing the ratio of research costs to returns for those projects they have been able to fund. Even when a project is not funded despite a favorable ratio of expected returns to research costs, reporting the missed opportunity will serve as a reminder to the world community of the potential of health research for lower-income countries that remains unrealized and thereby, perhaps, promote greater investment in health research to benefit the people of these countries.

useful application to research in developing countries are the lack of awareness and acceptance of these methods on the part of researchers and funders focused on these settings. Organizations concerned with international health can exercise valuable international leadership by exposing these researchers and funders to these methods and encouraging their use.

CONCLUSIONS

Improvements in health in recent decades have been of great value in both high- and low-income countries. Furthermore, future improvements in health are likely to be highly valued as the value of health increases with continuing growth in income. Health research has played a major role in the advances in health that have occurred, and the great potential value of future gains in health suggests that health research continues to merit increasing investment. New tools to prospectively assess the value of research offer the promise of even greater returns from health investment, especially for more applied research that can be closely connected to measurable benefits at the population level. Because low-income countries may often particularly benefit from applied research, these techniques to assess the value of research may be especially helpful in ensuring that the value of applied research in these settings is recognized. Providing researchers and policy makers in low- and high-income countries with the analytic tools needed to better identify and advocate for valuable opportunities for health research may be an important avenue to increasing the level and effectiveness of spending for health research.

REFERENCES

Becker, G. S., T. J. Philipson, and R. R. Soares. 2003. "The Quantity and Quality of the Life and the Evolution of World Inequality." NBER Working Paper 9765, National Bureau of Economic Research, Cambridge, MA.

Bloom, D. E., D. Canning, and D. T. Jamison. 2004. "Health, Wealth, and Welfare." *Finance and Development* 41 (1): 10–15.

Claxton, K., P. J. Neumann, S. Aranki, and M. C. Weinstein. 2001. "Bayesian Value of Information Analysis: An Application to a Policy Model of Alzheimer's Disease." *International Journal of Technology Assessment in Health Care* 17 (1): 38–55.

Cutler, D. M., and S. Kadiyala. 2003. "The Return to Biomedical Research: Treatment and Behavioral Effects." In *Measuring the Gains from Medical Research: An Economic Approach*, ed. K. M. Murphy and R. H. Topel, 110–62. Chicago: University of Chicago Press.

Cutler, D. M., E. Richardson, T. E. Keeler, and D. Staiger. 1997. "Measuring the Health of the U.S. Population." Brookings Papers on Economic Activity: Microeconomics 21782, Brookings Institution, Washington, DC.

GFHR (Global Forum for Health Research). 2003. *The 10/90 Report on Health Research 2003–2004.* Geneva: GFHR.

Gold, M. R., J. E. Siegel, L. B. Russell, and M. C. Weinstein. 1996. *Cost-Effectiveness in Health and Medicine.* New York: Oxford University Press.

Meltzer, D. 1992. "Mortality Decline, the Demographic Transition, and Economic Growth." Ph.D. dissertation, University of Chicago, Department of Economics.

———. 2001. "Addressing Uncertainty in Medical Cost-Effectiveness Analysis: Implications of Expected Utility Maximization for Methods to Perform Sensitivity Analysis and the Use of Cost-Effectiveness Analysis to Set Priorities for Medical Research." *Journal of Health Economics* 20: 109–29.

Murphy, K. M., and R. H. Topel. 2003. "The Economic Value of Medical Research." In *Measuring the Gains from Medical Research: An Economic Approach,* ed. K. M. Murphy and R. H. Topel, 41–73. Chicago: University of Chicago Press.

Nordhaus, W. D. 2003. "The Health of Nations: The Contribution of Improved Health to Living Standards." In *Measuring the Gains from Medical Research: An Economic Approach,* ed. K. M. Murphy and R. H. Topel, 9–40. Chicago: University of Chicago Press.

Ram, R., and T. W. Schultz. 1979. "Life Span, Health, Savings, and Productivity." *Economic Development and Cultural Change* 27 (April): 399–421.

Remme, J. H., E. Blas, L. Chitsulo, P. M. Desjeux, H. D. Engers, T. P. Kanyok, and others. 2002. "Strategic Emphases for Tropical Diseases Research: A TDR Perspective." *Trends in Parasitology* 18 (10): 421–26.

Rice, D. 1994. "Cost-of-Illness Studies: Fact or Fiction?" *Lancet* 344 (8936): 1519–20.

Thaler, R., and S. Rosen. 1975. "The Value of Saving a Life: Evidence from the Labor Market." In *Household Production and Consumption,* ed. N. Terleckyj, 265–68. New York: Columbia University Press.

Viscusi, W. K., and J. E. Aldy. 2003. "The Value of a Statistical Life: A Critical Review of Market Estimates throughout the World." *Journal of Risk and Uncertainty* 27 (1): 5–76.

WHO (World Health Organization). 1994. "Global Comparative Assessments in the Health Sector." In *Disease Burden, Expenditures, and Intervention Packages,* ed. C. J. L. Murray and A. D. Lopez. Geneva: WHO.

World Bank. 1993. *World Development Report: Investing in Health.* Washington, DC: World Bank.