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Broadening and Integrating Our Perspective

■ *Our base case tells a story of continued progress for system leaders and convergence toward their health conditions by other countries.* ■

This volume has gradually elaborated a story about possible long-term global health futures. The central thrust of our story has been one of continued human progress in meeting the challenges to living longer and healthier lives. Those challenges are many. The burden of communicable diseases globally, and especially in the developing world, remains heavy, greatly exacerbated by the surge of HIV/AIDS and the persistence and even resurgence of killers such as malaria. Progress against the burden of noncommunicable diseases has produced many additional and generally healthier years of later life, although the progress sometimes seems painfully slow. Nonetheless, most of humanity has experienced a steady path forward, and our story for the coming 50 years has quite consistently anticipated continued positive movement on two dimensions: continued progress in health for system leaders and convergence toward their conditions by other countries around the world.

How confident are we in that story, especially as we look out 50 years? It is quite possible that our base case forecast, built in substantial part on the foundation of past trends, could dramatically overstate or understate the pace of health progress that the world will actually experience in the coming years.

Past chapters have addressed our uncertainty—and our leverage—in a number of specifically targeted ways, such as exploring the impact of changes in individual distal and proximate drivers. Building on that earlier analysis, this chapter steps back, returning our perspective also to the broader and more integrative framing uncertainties that Chapters 1 and 2 introduced—namely, those that surround the biological context of health outcomes and the scope and nature of human activity affecting health. With respect to the biological context, Chapter 2 sketched the significant debate concerning the ultimate potential of the human genome to support significantly longer life expectancies and therefore a continuation of the

rate of advance in life spans of those countries at the leading edge. Within the biological context we also recognize, of course, the potential for mutational change in pathogens that could overwhelm even our best efforts to limit that change and contain its effects. There are many wild cards on this dimension.

Regarding human activity, Chapter 2 introduced three super-distal drivers or driver categories that frame our core model of interactions between distal drivers, proximate drivers, and health outcomes (see again Figure 2.4 and the discussion surrounding it). The first of those is technological change, which the distal-driver model includes implicitly within its time term, but only as a constant exogenous element. We must consider the possibility that technological advance could accelerate significantly because of remarkable insights from genetic analysis (for example), as well as the possibility that (in part in interaction with biological constraints) it might slow in its ability to advance frontiers against disease.

The second super-distal driver is the natural environmental context beyond human biology. Human activity directed intentionally or unintentionally at changing the natural environment and the human relationship with it has had both positive and negative implications for human health. In fact, even the same actions, such as spraying with DDT to kill mosquitoes, have often had both. What we now have come to understand is that at least one such unintentional change, that of global warming, could have quite dramatic implications for health in the longer run, albeit most significantly beyond our current forecasting horizon.

The third super-distal category contains human activity that shapes what we might term the social environment of human health. Global initiatives, national policy efforts, actions of nongovernmental organizations (including corporations), and behavior of subpopulations and individuals collectively shape factors as disparate as the pace of HIV/AIDS transmission, the level of obesity, and the rate of vehicle accidents. Human activity with respect to the social environment could be broad, deep, and well organized—it could also be underfunded, scattered in focus, and badly managed.

Intervening chapters have partially explored these super-distal categories in the process

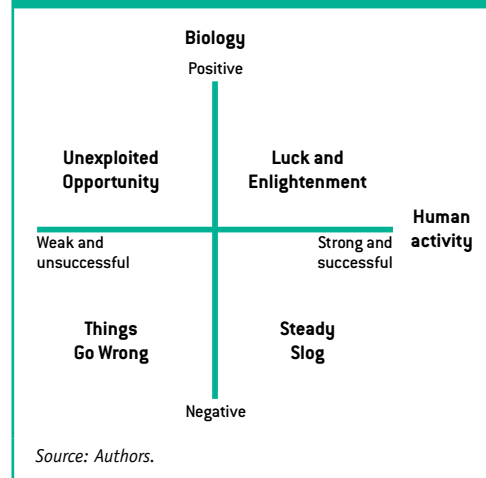
of analysis of distal and proximate drivers. In considering alternative assumptions about distal drivers, for example, Chapter 4 began to explore the implications of alternative assumptions concerning technological change. Chapter 5 considered the potential power of several proximate drivers, substantially linked to the social environment, to produce alternative futures. Chapter 6 extended consideration further to some of the changes in the natural environment that we know to be adding to our uncertainty. And Chapter 7 then addressed the derivative uncertainty concerning forward linkages from health to demographic and economic patterns; positive and negative feedback loops across economic and social change also can affect the long-term dynamics of health futures.

In Figure 8.1 we step back to suggest how these driving forces of health might interact with biological context and human activity to give rise to four very different global health futures.¹ Good human biological prospects and strong and positive human activity could create a future that combines Luck and Enlightenment. Should biological prospects prove less accommodating than we would hope, we could still aggressively and thoughtfully continue within that constraint a Steady Slog toward better health futures and continued convergence of health outcomes toward a maximum standard. Although it seems perverse that we would be so foolish as not to take advantage of a favorable biological context,

How confident are we in the story our base case tells?

To explore that question, we look at our forecasts relative to axes of uncertainty concerning the biological context of health and the super-distal human drivers of health.

Figure 8.1 Alternative health futures in broad context



one can in fact imagine a future of Unexploited Opportunity, especially in selected countries and regions, one major consequence of which might be further divergence in health outcomes between nations. And, unfortunately, it is quite possible also to imagine a future in which rising resistance to our current armory of drugs and other treatment modalities, and/or the emergence of new threats, is accompanied by a failure of global and state-level governance to respond well to the setback or new challenge. In this future, a future in which Things Go Wrong, progress in health would greatly slow or potentially even reverse.

This chapter will address two primary questions. First, where in the universe of possible health futures of Figure 8.1 does the base case forecast of this volume appear to sit? We cannot assume that the forecasts already provided (see especially Chapter 4) sit at the origin of that figure and that alternative movement into each quadrant of the figure is equally likely. It could be, for instance, that our forecasts already implicitly assume Luck and Enlightenment and that the downside risk relative to our base case is much greater than the upside potential. Second, what is the extent of uncertainty around our base case? We may be particularly interested in knowing something about the magnitude of downside risks.

How Might We Characterize Our Base Forecasts?

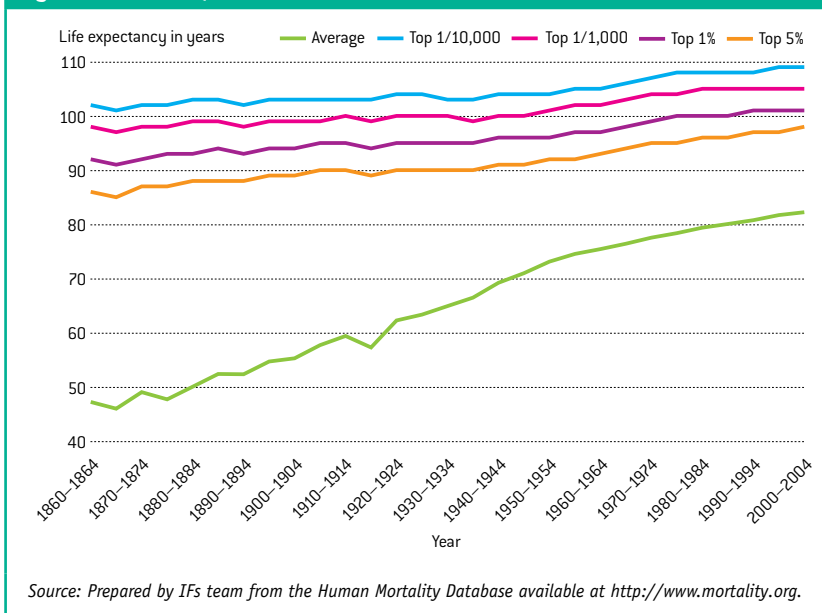
Two critical dimensions of variation in forecasts of health futures are (1) the rate of advance in mortality and morbidity reduction at the leading edge of human health, and (2) the extent of variation in those rates across countries and subpopulations within countries. Together, for example, rates of leaders and distributional patterns of followers determine the global average life expectancy. Before assessing the character of our forecasts (looking, in turn, at communicable and noncommunicable diseases), we consider the historical patterns.

Historical patterns as a reference point

The historical trend of recent decades has been very considerable improvement in levels of health across most societies, as well as considerable convergence between rich and poor countries. Going back somewhat further, Figure 1.4 (see also Table 4.1) showed that since the mid- to late 1700s the life expectancy of the world's longest-lived societies has continued to rise. These life expectancy gains resulted from a mix of improvements in the frontiers of the human life span and an increasing proportion of people who actually reach a higher, more typical life span (an increase that began in the currently rich countries and is still gradually spreading across the world).

For long-lived populations, longevity experts often summarize the practical human life span as being four standard deviations above the mean life span, or the life span that the longest-lived one in every 15,000 people experiences. It would be easy to assume that random genetic variation accounts for such incredible longevity, but this value has, in fact, increased consistently over time in many developed countries. For example, we see this in Figure 8.2, which charts both gains in the life-span frontier and gains in average life spans for Sweden since 1860. With respect to the recorded life-span frontier, the life span of the top one in every 10,000 people went from just above 100 years in 1860 to nearly 110 years at present. Similar patterns characterize gains in the top 1,000th of the population, the top 1 percent, and the top 5 percent. While the improvement in survival to 110 reflects sustained improvements in age-specific mortality at advanced ages, better

Figure 8.2 Historical trends in life expectancy and lifespan of high longevity segments: Sweden, 1860–2004



survival at younger ages accounts by far for the bulk of the average increase of life expectancy in Sweden during this period.

Historical change in life expectancy in Sweden has exhibited the process often referred to as *rectangularization* (discussed in Chapter 4), with the shape of the survival curve becoming more like a rectangle in which most people live to a certain (typically older) age and then die within relatively few years of one another. Rectangularization characterizes most historical life expectancy improvements in high-income countries and most current improvements in poor countries. While the failure to reach a typical life span clearly reflects some random variation in physical fitness, today's high-income societies display incredibly high probabilities of survival to age 60 or even 70 before a rapid increase in mortality. Societies achieved these historical improvements in survival through improvements in living standards and technology and also through a wide range of efforts to improve the governance and delivery of public health, hygiene, and medical services to broader segments of the population.

Given the long-term convergence of average life expectancy toward leading life expectancy within countries like Sweden and the generalization of the phenomenon of rectangularization around the world, it is not surprising that life expectancies have also been converging globally. In the early post-World War II and post-African independence period (that is, through the 1950s, 1960s, and 1970s), the average life expectancy of countries around the world rose more rapidly than did those of high-income countries. Figure 8.3 shows how, in particular, lower-middle-income and low-income countries significantly narrowed the gap in life expectancy between themselves and the high-income countries (which have also experienced convergence among themselves).

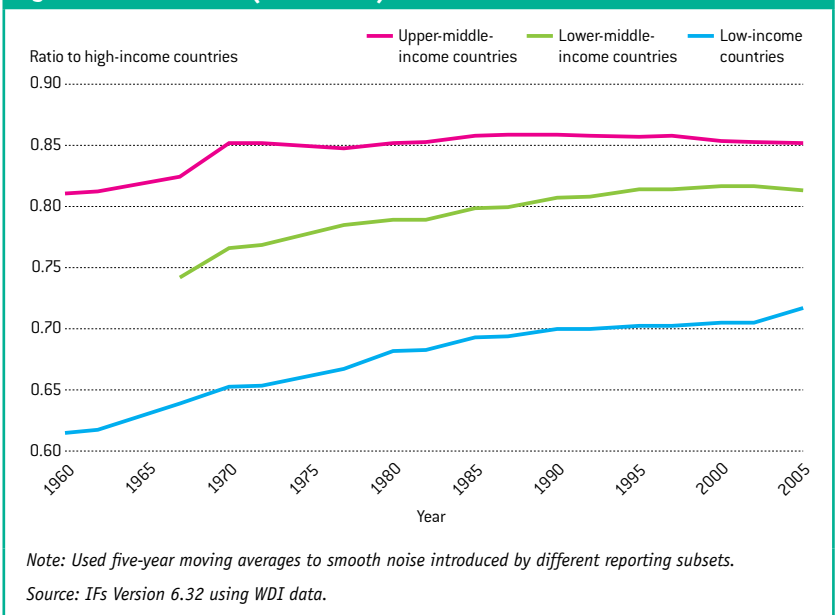
Yet the convergence pattern between developing and high-income countries has been by no means steady. As Chapter 4 noted (see also Figure 4.7, which shows mortality patterns for all World Bank regional groupings separately), the so-called Great Leap Forward in China disrupted life expectancy so much that we have omitted from Figure 8.3 the low values of 1960–1965 for lower-middle-income countries. This episode in China's history illustrates well how the human

activity dimension can be extremely disruptive to advances in health. More relevant to the issue of broad long-term global convergence, the developing economies as a whole largely ceased closing the gap with the high-income countries in about 1990, at which time the mostly low-income sub-Saharan countries began to diverge because of AIDS deaths. Thus, disruption related to the biological dimension substantially changed the global pattern of convergence in life expectancy. Yet the experience of even upper-middle-income countries (including Brazil, Mexico, Russia, South Africa, and Turkey) suggests that convergence may not always occur—as a group they have shown little or none since the 1960s. The major lesson of Figure 8.3 is that we should not take for granted the convergence that our forecasts demonstrate.

Given these historical patterns in which important dimensions of uncertainty in the global system have given rise to complicated paths around an overall trend improvement, let us turn more directly to the issue of how the base case forecasts of International Futures (IFs) appear to fit in the uncertainty space of Figure 8.1. We separately consider communicable and noncommunicable diseases; because accidents and injuries constitute a relatively small proportion of the global mortality and disability burden we do not include them in this discussion.

History tells us that we cannot take for granted the convergence that our forecasts project; paths around overall trend improvement are complicated. ■

Figure 8.3 Life expectancy: ratio of low- and middle-income countries to high-income countries (1960–2005)



■ *Our base case may too optimistically forecast the neutralization or near elimination of CDs in most countries by 2060.* ■

Communicable disease futures

Our base case forecast for communicable diseases (CDs) is on the whole more optimistic than our noncommunicable disease (NCD) forecasts. We essentially forecast the neutralization, if not the near elimination, of CDs, including HIV/AIDS, in most countries by the year 2060 (see again Chapter 4). Even such a positive forecast may be realistic, rather than optimistic, if the evidence supports the plausibility of such a trend. Does it?

Supporting the positive CD forecast is the reality that technologies already exist to treat almost every CD and that most high- and middle-income countries have applied them to great effect. One could argue that these favorable baseline technological conditions thus support placement of a very aggressive base case at the origin of Figure 8.1, leaving room for still greater technological improvements. We can, in fact, imagine a few potential technological advancements that would sufficiently reduce the costs or political barriers to disease prevention and mitigation so as to further accelerate CD reduction in even the world's most challenging environments. The two most relevant diseases in this regard are also the target of the most substantial investments in new technologies: HIV/AIDS and malaria. We argue, however, that the base case forecast, by predicting the elimination of most existing CDs through the effects of the income and time drivers, already incorporates a very high level of technological efficacy and is, in fact, optimistic. Optimistic forecasts do not well incorporate downside risks; for this and other reasons forecasting is subject to a well-known "optimism bias" (Armstrong 2001; Coates 2004).

One great source of uncertainty in our CD forecasts relates to disease governance at the global and national levels. The second half of the 20th century showed that countries could achieve very large CD reductions, even in the absence of economic advance, through the use of antibiotics, vaccination, and chemical spraying of infectious disease vectors in poor countries (Davis 1956; Easterlin 1999; Kremer 2002; Soares 2005). These improvements were the result not merely of technology but also of efforts to transfer technology, fund its delivery, and provide technical support, all carried out through the intergovernmental framework embodied in the World Health Organization

(Cutler, Deaton, and Lleras-Muney 2006; Mosley 1984; Preston 1975; 1980; 1996).² While continued progress in the fight against communicable diseases will certainly depend on the pace of new technologies, much of the progress will be determined by our ability to cooperate to address the proximate drivers of disease in poor countries.

Current global efforts at disease surveillance, control, and eradication all hold tremendous promise. As mentioned earlier, the new set of International Health Regulations (IHRs) now mandates active global reporting and surveillance of outbreaks of many communicable diseases. Global nongovernmental organizations and aid agencies are effectively targeting specific killers such as HIV/AIDS, malaria, and tuberculosis, and continue in efforts to eradicate a number of other diseases, most notably polio. And recent evidence points to impressive reductions in childhood mortality and even progress against HIV/AIDS. The magnitude and innovation of these efforts suggest that our present environment is indeed one of better-than-average CD governance, at least in comparison to the immediate post-Cold War era. While our forecasts do not incorporate these efforts explicitly, our base case forecasts of continued rapid decline of CDs suggest (and perhaps require) that these governance efforts will persist and succeed.

On the other hand, history tells us that such governance is not guaranteed. The experience of the post-World War II epidemiologic transition offers an example of the exhaustion and gradual dismantling of CD control regimes, events that if they were to occur again could create a global setting in which communicable diseases would not further abate or might reemerge. In addition, the disease-specific programs of earlier eras left many countries with little health system infrastructure to address recurrent, endemic, or challenging new disease risks. In fact, a number of the world's most politically and economically challenged nations saw limited progress against even easily preventable diseases.

Turning to the present and the future, there are a number of challenges to effective global health governance. Many analysts point to the fragility of the new IHRs, which create tremendous obligations for poor nations

but offer little financial support and few incentives for cooperation. And many argue that satisfaction with short-term successes or exhaustion with diminishing achievements could lead to a pullback of government, multilateral, and nonprofit financial support for further CD reductions. A continuing global economic crisis or a restructuring of global political alignments could contribute to this disruption of support (as was seen at the end of the Cold War).

The list of what could go wrong relative to the potential for human action (and its interaction with the biological environment) is very long. We have seen it go wrong before. At the end of World War II, the global community believed that it had the tools to beat back malaria and many other communicable diseases. Mass production of chloroquine was possible; DDT had proven effective in control of mosquitoes; and antibiotics were available for use around the world. The World Health Organization came into being in 1948 with a mandate to use such tools, and a global malaria eradication program rolled out in the 1950s and 1960s. In fact, 24 countries that eliminated malaria in that era remain malaria-free (Smith and Tatem 2009: 11). Yet progress slowed as resistance (biological and environmental) to DDT developed and donor fatigue appeared, and malaria bounced back strongly in much of the world. Yet it was not just known diseases that disrupted plans and much early success in reducing deaths from communicable diseases. The official recognition of the AIDS epidemic in 1981 preceded at least 20 years of spreading health catastrophe around the world—we still cannot be certain that the global peak of deaths is behind us. The epidemic of cholera in Zimbabwe under Mugabe is still another example. We can no longer doubt the ability of additional diseases, such as avian flu, to wreak havoc in our forecasts and our lives, and for poor human choices to contribute significantly to that outcome.

Noncommunicable disease futures

The world has experienced relatively uninterrupted historical progress in longevity extension on the one hand, alongside heightened worries about the growing burden of NCD risk factors on the other. The resulting tension is in part responsible for the tremendous variation between optimistic and pessimistic longevity

forecasts for the world's longest-lived population (see again Chapter 2, especially Box 2.3). Plausible forecasts for the year 2100 range from about 87 years, essentially unchanged from today's female population of Japan, to 105 years. The IFs base case forecast anticipates the life expectancy of females in the longest-lived society (still forecast to be Japan) to be 95.4 years in 2100, slightly below the mid-point of that range. Looking out just to mid-century, the IFs forecast of 91.3 years for Japanese females in 2050 is consistent with the United Nations Population Division's projection of 91.0 years for that year.³ Our cause-specific forecasts (see again Chapter 4) naturally imply a deceleration of longevity progress as causes of death currently in rapid decline (e.g., cardiovascular diseases) are gradually replaced by causes that we forecast will decline less rapidly (e.g., diabetes).⁴ Overall, we forecast much more modest decline for NCDs than for CDs.

Our reading of the considerable evidence on NCD-related risk factors such as obesity, smoking, alcohol abuse, and environmental factors suggests a reasonable case for a slow pace of NCD progress for most countries, particularly middle-income ones, perhaps even below those of our base case forecast. On the other hand, technologies may emerge to mitigate these risk factors (e.g., an anti-obesity pill).

Most probably, effective progress against NCDs for most countries—in particular, the closing of their gap with the longest-lived countries—will require considerable behavioral change efforts on a national and global scale. While rates of smoking have declined in many high-income countries, they remain high and even rising in many low- and middle-income countries that have not yet felt the full effects of earlier smoking on disease levels. Further progress against smoking-related deaths will depend on effective national programs. Progress may also depend on the Global Framework Convention on Tobacco Control and other multilateral treaties governing the export and sale of tobacco products.

Similar concerns pertain to obesity, alcohol use, and other health risk factors. For example, as lower-income populations grow increasingly wealthy, sedentary, and connected to global commodity chains, including fast foods and other calorie-dense foods, the possibility increases for a truly global obesity epidemic.

■ *Is our base case forecast of a much more modest decline in NCDs too pessimistic?* ■

■ *We conclude our base case CD forecasts are relatively optimistic with respect to both biological context and human activity.* ■

■ *And we conclude our base case NCD forecasts are relatively optimistic with respect to human activity but pessimistic on the biological dimension.* ■

Further concern arises from a growing burden of environmental risk factors, such as pollution, which may increase the risk of certain cancers. In each of these cases we can imagine a considerable downside uncertainty, as well as some upside arising from the potential for transformative treaties or social movements against chronic disease risk factors.

The current template for concern about the trajectory of NCDs lies in the Russian Federation, where recent sharp increases in chronic diseases and violent mortality among men have occurred (Men et al. 2003; Shkolnikov, McKee, and Leon 2001). Analysts generally attribute this mortality spike to increases in behavioral risk factors (e.g., alcohol abuse, smoking, and consumption of rich foods), stimulated in part by Russia's recent political situation, socioeconomic uncertainty, and environmental contamination (Leon et al. 2007; Zaridze et al. 2009). While Russia offers an extreme example of rising behavioral risks, we can point also to rising levels of obesity in many developed countries, a flattening of NCD mortality improvements in many parts of the United States, and a skyrocketing incidence of diabetes in India to support the pessimistic scenario (Cooper et al. 2000; Murray et al. 2006; Ramachandran et al. 2008; Rogers et al. 2007).

Above and beyond any increase in behavioral risks, at least some populations of countries currently undergoing epidemiologic transition may experience an elevated predisposition to NCDs. For example, a growing body of evidence suggests that the genetic, nutritional, and immunological histories of many populations in transition (e.g., South Asians) make them uniquely vulnerable to NCDs (Barker 1998; Barker et al. 1989; Barker and Osmond 1986; Finch and Crimmins 2004; Hales and Barker 1992). The co-occurrence of CD and NCD may also create negative synergies, for instance, in the possible tendency toward chronic disease among elders affected by the HIV epidemic (Hosegood et al. 2007). While some of these forces are “merely” transitional and were experienced by today's post-transition societies with only limited negative impact, the possibility remains that this scenario will play out differently in today's transition societies. If indeed—as evidence suggests is possible (McKeigue, Shah, and Marmot 1991; Mohan et al. 2007)—some populations have a

genetic predisposition to heightened chronic disease risk, a number of currently emerging countries could face tremendous operational challenges in scaling up treatment and prevention of chronic diseases compared to, say, the United States or Great Britain in the 1950s. On the other hand, while the potential for such downside possibilities derives from compelling evidence, we should also once again look to past examples of human mortality progress outstripping even our most optimistic expectations, as in the case of mortality reductions from cardiovascular diseases in the United States in the 1960s.

Overall, the relatively slow progress of life expectancy in leading countries makes the base case forecasts of NCD appear pessimistic on the biological dimension. In contrast, the relatively significant convergence of mortality rates across global income levels makes it appear relatively optimistic on the human activity dimension, especially in light of this recitation of challenges to rapid progress.

Summary characterization and adjustment of the base case

In light of the discussion above, Figure 8.4 summarizes our perception of the positioning of our base case forecasts for NCDs and CDs. We conclude that our base case CD forecasts are relatively optimistic on both dimensions, while our base case NCD forecasts are relatively optimistic on the human activity dimension but pessimistic on the biological dimension.

Adjustment to the base case in order to “correct” it for these subjectively assessed deviations from the most likely path forward is inevitably arbitrary.⁵ We have done so, quite conservatively, by bending the curves of the base case in two primary ways.

First, we have slowed down the rates of reduction in communicable diseases globally (the developing countries experience the greater impact). For instance, in the unadjusted base case, total global malaria deaths decline by 50 percent between 2005 and 2025 (this is even in the face of a growing global population). The adjusted base case pushes that point of reduction out to 2038. With respect to AIDS deaths, the point of 50 percent reduction in the adjusted base case moves from 2041 to 2060, and in the case of other communicable diseases the year slips from 2036 to 2044.

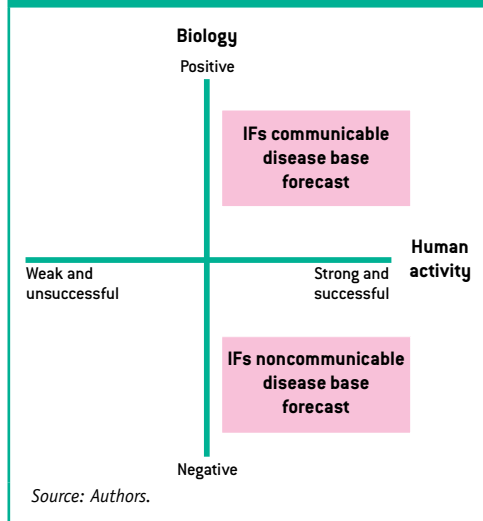
Second, we have accelerated the time factor of mortality reduction in the Global Burden of Disease (GBD) formulations, increasing it proportionately more for higher-income countries. The reason for this intervention was implicitly to relax the biological constraint for NCDs. The GBD formulations and our reproduction of them do not include any explicit representation of the biological constraint. The biological constraint and technology interact closely, however, and an acceleration of technological advance for NCDs is effectively equivalent to assuming a lesser constraint and therefore more leverage from technology. Although the time factor also affects CDs in high-income countries, the rates of those are so low that this adjustment strongly targets NCDs, the diseases of the old, and therefore the point at which relaxed biological constraints would appear. We focus on the high-income countries because (1) we do not want this “biological constraint relaxation” to affect the CDs of the developing countries; and (2) we assume that the lower-income countries have less economic and technological potential for taking advantage of relaxed biological constraints. These adjustments are obviously not normatively based; they seek to better project the path we appear to be on, as suggested by the earlier historical discussion.

Figure 8.5 shows the implications for mortality probabilities of adjusting the base case. In spite of quite dramatic declines relative to 2005 in both the base case and the adjusted base, child mortality is anticipated in 2060 to be somewhat higher nearly everywhere in the forecasts of the adjusted base case. In sub-Saharan Africa child mortality still drops very considerably by 2060 (in 2005, 146 of 1,000 children in sub-Saharan Africa died before their fifth birthdays), but 45 per 1,000 in the adjusted base case is more than one-third higher than in the unadjusted base.

Similarly, adult mortality in sub-Saharan Africa (the probability of a 15-year-old dying before reaching age 60) is somewhat more than 10 percent higher in the adjusted base case. For other regions the changes in adult mortality are mostly relatively minor increases.

Looking at older adults, however, the mortality pattern reverses, and most regions show small decreases relative to the unadjusted base case.

Figure 8.4 Axes of alternative health futures and the IFs base case



Based on these conclusions, we adjusted the base case to slow the rate of decline in CDs.

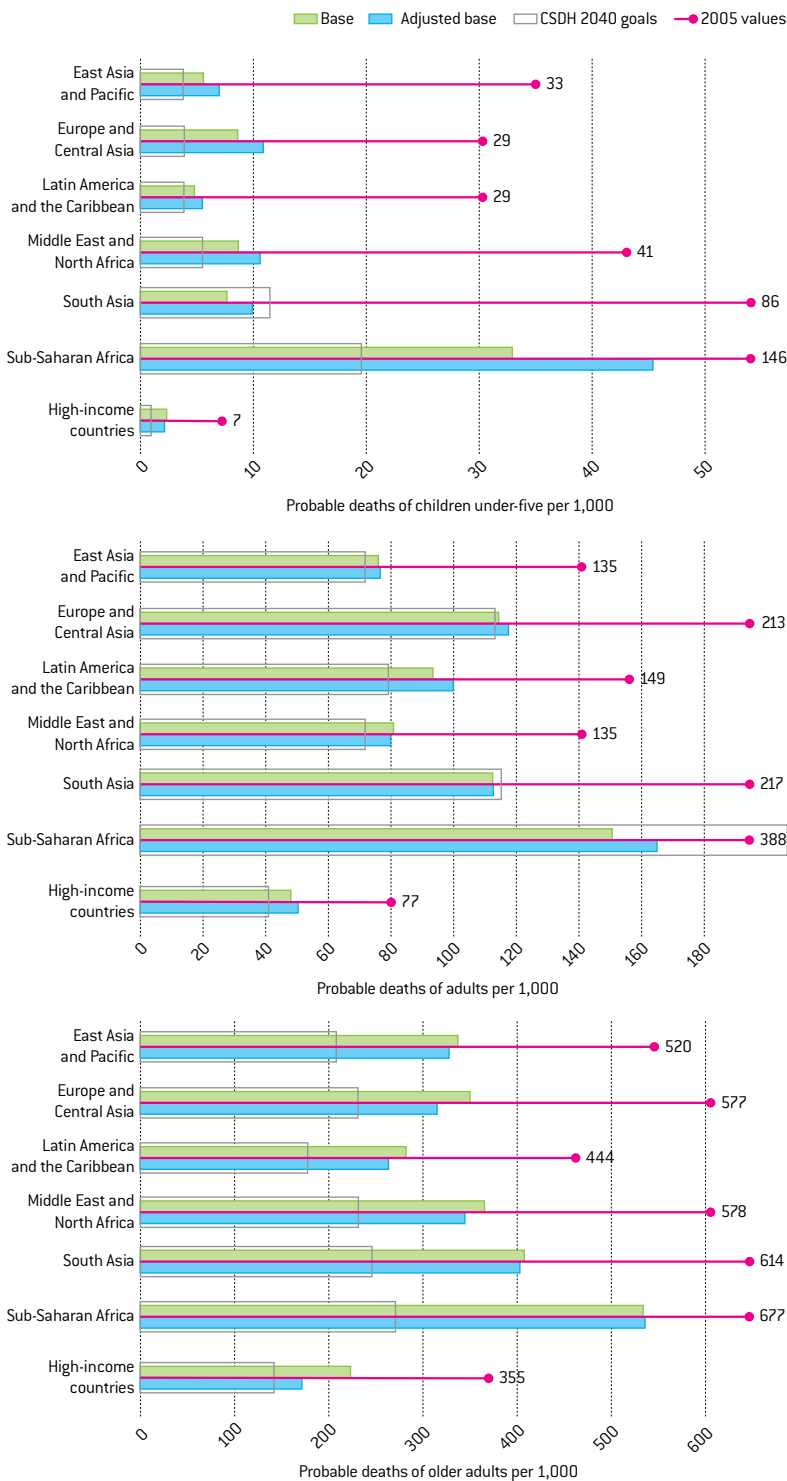
For high-income countries, the adjustments for noncommunicable diseases prove especially significant. In fact, because of the mortality declines for high-income older adults in the adjusted base (as rectangularization of the J-curve pushes deaths into still older years), life expectancy in richer countries increases by about two years relative to the unadjusted base case. Overall, life expectancy for high-income countries rises by about nine years between 2005 and 2060, and is more consistent than was the base case with the longer-term historical pattern of increase. Illustratively, Japanese women reach a life expectancy of 95 years in 2059, nearly three years longer than in the unadjusted base.

One of the important consequences of these seemingly relatively modest changes to mortality probabilities in the adjusted base case, however, is that the goals of the Commission on Social Determinants of Health (CSDH 2008) appear even less likely to be met than in our base case forecasts. With the exception of South Asia in the base case, even by 2060 the rates of child mortality reductions in both scenarios fall short of the 90 percent called for by CSDH between 2000 and 2040. And only sub-Saharan Africa meets by 2060 the 2040 goal for a 50 percent reduction in adult mortality (it meets it in the 2040–2050 decade in both scenarios).

In addition, the chances for narrowing the gap in life expectancy between the populations of the longest-lived third of countries and the shortest-lived third to 10 years by 2040 are

We made a second adjustment based on our conclusions—namely, we accelerated the effect of technology in reducing NCDs as income rises.

Figure 8.5 Comparison of mortality probabilities (expressed as probable deaths per 1,000) for 2060 in the base case and the adjusted base case



Note: Mortality probability is that of death before reaching end of age range (0–4 for child mortality; 15–59 for adult mortality; 60–79 for older adult mortality). “CSDH 2040 goals” refers to the mortality reduction goals of the Commission on Social Determinants of Health (2008).

Source: IFs Version 6.32.

further reduced with the adjusted base case. Even in the unadjusted base case, the gap remains at 12 years in 2040, and in the adjusted base case it falls only to 15 years. In fact, our forecast in the adjusted base case is that the gap will still be 13 years even in 2060.

The first question framing this chapter concerned the positioning of the base case within the likely range of longer-term futures with respect to global health. All in all, it appears reasonably well situated within the space of uncertainty that we have identified, but we have adjusted it modestly so as to capture somewhat slower likely progress with respect to communicable diseases and somewhat faster progress with respect to noncommunicable diseases. These corrections reconcile our base case somewhat more soundly with historical experience and our judgment of the likely trajectory, thereby establishing a foundation for discussion of the uncertainty space more generally.

Alternative Health Futures: Integrated Scenario Analysis

This volume has repeatedly emphasized the complexity of interaction among proximate, distal, and super-distal factors in the shaping of health futures. As difficult as it may be, a consideration of the long-term future of health should step back and at least speculate on the breadth of variation in alternative possible health futures across such factors in interaction. To help in doing so we structure and present the two most different alternatives framed by the dimensions of technology/biology and human activity, those that Figure 8.1 labeled Luck and Enlightenment and Things Go Wrong (hereafter often referred to as L&E and TGW, respectively).

In the analysis we take advantage of the full hybrid health modeling system unfolded in this volume. The adjusted base case reflects the combination of (1) the distal-driver formulations of the GBD project (with some extensions and adjustments discussed in Chapter 3); (2) the proximate-driver specifications (built into the base case along with the distal-driver formulations); (3) the backward and forward linkages of the health model to demographics, economics, environmental representations, and other elements of the IFs modeling system (also in the base case); and (4) the adjustments to the base case parameters discussed above.

Building the scenarios

The scenarios differ in a number of aspects from the adjusted base case and from one another (Box 8.1 summarizes the scenarios of this chapter). One is with respect to the interaction of technology and biology—the biology of the human genome may provide the headroom for health advances, but technology is needed to take advantage of it; or biological limits or evolution may retard or even reverse health advances (as in the case of pathogen mutation), making technology much less effective. In the L&E scenario we increased the rate of growth in the technological element of the distal-driver set by half (as in the framing scenario analysis of Chapter 4). In TGW we decreased it by half.

A second difference between the scenarios reflects different futures with respect to proximate risk factors. As discussed near the

end of Chapter 6, we have explored combined packages of risk factor variations. We built a package of aggressive but reasonable proximate risk factor improvements relative to the adjusted base case into the L&E scenario and a largely symmetrical package of slowing proximate risk factor improvements or actual deteriorations into the TGW scenario.

On these first two elements the two scenarios are mostly symmetrical. Other elements are more uniquely tailored to the scenarios. One asymmetrical element is of special importance to L&E. We have emphasized that proximate drivers (especially our limited set of eight drivers) do not fully represent the human action dimension of our uncertainty space. To help understand this, look again at Figure 2.5. That representation of the relationship between GDP per capita (as a proxy for income) and life expectancy shows a number of outliers.

■ *The adjustments to the base case somewhat accelerate progress against disease in leading countries and slow it in others, retarding the convergence process.* ■

■ *We can use the full IFs system to compare two very different scenarios on top of our adjusted base: “Luck and Enlightenment” (L&E) and “Things Go Wrong” (TGW).* ■

■ *L&E and TGW differ with respect to advance in technology and in the rate of proximate risk factor improvements.* ■

Box 8.1 Summary of Luck and Enlightenment and Things Go Wrong scenarios

Differences of the adjusted base case from the base case (see Box 4.1)

- Technological advance accelerates proportionally to income in high-income countries (a maximum of 50 percent for countries at \$40,000 per capita and higher)
- Advances against HIV infections are 40 percent slower for all countries
- Advances against AIDS deaths are 75 percent slower for all countries
- Mortality from diarrhea, respiratory infections, and other noncommunicable diseases is 40 percent higher in 55 years, with the percentage rising linearly over time
- Mortality from malaria is 150 percent higher in 70 years, with the percentage rising linearly over time

Differences of the Luck and Enlightenment scenario from the adjusted base case

- All proximate-driver interventions move to the values of the favorable scenarios of Chapters 5 and 6
- Technological advance accelerates by 50 percent for the portion of the population five years of age and above in all countries with GDP per capita above \$3,000, and for children under five in all countries coded as “0” (mainly high-income countries) in the GBD formulations
- Technological advance accelerates by 50 percent for everyone five years of age or older in all countries with GDP per capita below \$3,000, and for children under five in all countries coded as “5” in the GBD formulations (primarily countries in the Middle East and North Africa)

- Mortality for countries that initially have higher mortality than anticipated on the basis of distal drivers converges to anticipated levels over 55 years

Differences of the Things Go Wrong scenario from the adjusted base case

- All proximate-driver interventions move to the values of the unfavorable scenarios of Chapters 5 and 6
- Technological advance decelerates by 50 percent for people five years of age and above in all countries with GDP per capita above \$3,000, and for children under five in all countries coded as “0” in the GBD formulations
- Technological advance decelerates by 50 percent for everyone five years of age or older in all countries with GDP per capita below \$3,000 and for children under five in countries coded as “5” in the GBD formulations
- Advances against HIV infections are 50 percent slower for all countries
- Advances against AIDS deaths are 40 percent slower for all countries
- Multifactor productivity growth in technology leader (United States) declines 1.0 percent in absolute terms
- Multifactor productivity additive term declines 1.5 percent in China and 0.5 percent in sub-Saharan Africa, South Asia, and Latin America and the Caribbean

■ In L&E we also assume upward convergence of countries whose health outcomes are below those we would expect based on GDP per capita. ■

■ On the other hand, in TGW we assume a slowing of annual multifactor productivity growth. ■

■ We also slow the rate of recovery from the HIV/AIDS epidemic in TGW. ■

■ The differences between the two scenarios are huge in their aggregate global implications. ■

Although some countries sit somewhat above the curve in Figure 2.5 (for instance, Cuba), many sit significantly below the curve (including some of the AIDS-afflicted countries such as South Africa and Botswana).

The Russian Federation is among the countries with life expectancy considerably below the level we would expect based on income, illustrating some of the potential for health improvements relating to human action that lies deeper than the proximate and even the distal drivers (falling more clearly into the social environment category of the super-distal drivers). After the fall of communism, life expectancy also fell. Although immediately tied to factors such as a rise in alcohol abuse, deeper roots include the tremendous disruption of life for many adults, often previously at the peak of their careers, and major changes in the health care system. Russia and other countries that currently have significantly poorer health conditions than we would expect based on their distal drivers (notably income and education) are perhaps quite likely to experience convergence toward the expected values in the coming years. Along with changes in proximate-driver patterns, we have built such upward health outcome convergence to expected patterns into the L&E scenario, phasing in the convergence across our 2060 forecast horizon.

Other asymmetrical elements particularly affect TGW. A substantial share of the dramatic gains in life expectancy in our base forecast is driven by expected health improvements related to continued economic growth in rich and poor nations alike. It is at least possible, however, that the Great Recession (2008–2011 in the IFs base case) could ultimately morph into an interruption of globalization processes with significantly slowing economic growth prospects, especially for developing countries. There is, of course, an infinite set of possible unfoldings of such a scenario. Most versions would include a slowing of annual multifactor productivity growth in technologically leading countries, with transmission of that slowing around the world (we have posited a significant 1 percent reduction). Most would also include a somewhat related additional slowing of growth in developing countries (we have posited an additional reduction of growth in China by

1.5 percent annually and reductions elsewhere of 0.5 percent).

To this point we have introduced no direct change in assumptions about the biological context. We know, however, that both malaria and AIDS have surprised us before and that other communicable diseases, including dengue fever, could adversely surprise us again. There are an uncountable number of wild cards that could make our global health futures much worse. The earlier discussion of communicable disease risks and resultant adjustments to the base case elaborated some of the downside risk and noted the common optimism bias of forecasting.

Rather than speculate, however, about many specific possible scenario elements, most of which would involve worse trajectories with respect to communicable diseases, we explicitly introduce only some relatively modest further slowing of recovery from the HIV/AIDS epidemic (the scenario's slower economic growth implicitly carries with it assumptions of broader but non-specific setbacks in the advance against CDs). All in all, TGW is far from a worst-case scenario.

Contrasting Luck and Enlightenment versus Things Go Wrong

The differences between the two scenarios are huge in their aggregate global implications. The global difference in annual deaths grows in Things Go Wrong to 34 million more by 2060 than in Luck and Enlightenment. Based on death rates, the gap would be still larger were it applied to identical populations. However, the global populations of the two scenarios diverge markedly, to just over 10 billion in L&E and just over 9 billion in TGW (compared to an adjusted base case value of 9.4 billion).

In 2060, the large majority (a total of 800 million people) of the additional population in L&E compared to TGW are 65 and older. The global population between 15 and 65 in L&E is only 236 million greater than that in TGW, and the population under 15 is actually 39 million higher in TGW because higher fertility rates more than offset higher child death rates. Overall, the global dependency ratio (elderly plus children as a percentage of total population) is nearly 4 percent higher in L&E relative to the 37 percent rate in TGW (the percentage of those 65 and older is 6 percent higher in L&E).

These aggregate demographic implications of the global push for the elements of the L&E scenario are only now becoming widely recognized and explored—until very recently most attention in demography and health to alternative global population futures has focused on alternative assumptions concerning fertility rates. And interestingly, the aggregate demographic differences between L&E and the adjusted base case exceed those between TGW and the adjusted base. One reason is that the poorer health futures of TGW largely mean more deaths for children from communicable diseases with some offsetting upward adjustments in fertility (a negative or controlling feedback loop). In contrast, better health futures with longer-lived adults and seniors would not necessarily lead to an offsetting reduction in fertility; in fact, greater survival and better health of adults in their child-bearing years could increase fertility and further increase population in a positive feedback loop.

Even more, the economic implications of such different health futures are not well understood. It is important to emphasize, for instance, that one should not presume that any negative affect from the very large number of additional seniors would dominate the economic impact. The balance of economic consequences of the extra 236 million working-aged adults and the 800 million people aged 65 and older is not obvious on the surface (and would vary considerably by

region). Many of those additional working-age people would likely have extra years of life due to a reduction in child or young adult mortality and might potentially look forward to most or all of a 40-year or more working and savings life. Among other aspects of the two scenarios, the economic difference is one that we wish to explore.

Disease burden patterns across alternative health futures

Although the scenarios differ very significantly with respect to health futures, they also demonstrate one very fundamental and important similarity, the ongoing global shift from communicable to noncommunicable disease burdens. Figure 8.6 shows the strength of that steady march, even in the face of quite widely varying assumptions. In 2005, communicable diseases accounted globally for 32 percent of deaths and 55 percent of years of life lost (YLLs). In neither scenario nor the adjusted base case do communicable diseases in 2060 account for more than 12 percent of deaths or 31 percent of YLLs. Even in Things Go Wrong, YLLs from NCDs exceed those from CDs by about 2031.

Within the general context of this steady shift to NCDs, however, there are major differences between the scenarios. In L&E, for example, the portion of global deaths from CDs drops to about 4 percent in 2060, only slightly more than a third of the level in TGW. Figure 8.7 shows the differences in death patterns across the scenarios

■ **There are 1 billion more people in L&E in 2060, and a large majority of them are 65 and older. ■**

■ **In both scenarios, despite their quite widely varying assumptions, we see an ongoing global shift from CDs to NCDs. ■**

Figure 8.6 Global mortality by major cause of death across Luck and Enlightenment (L&E) and Things Go Wrong (TGW) scenarios and adjusted base case

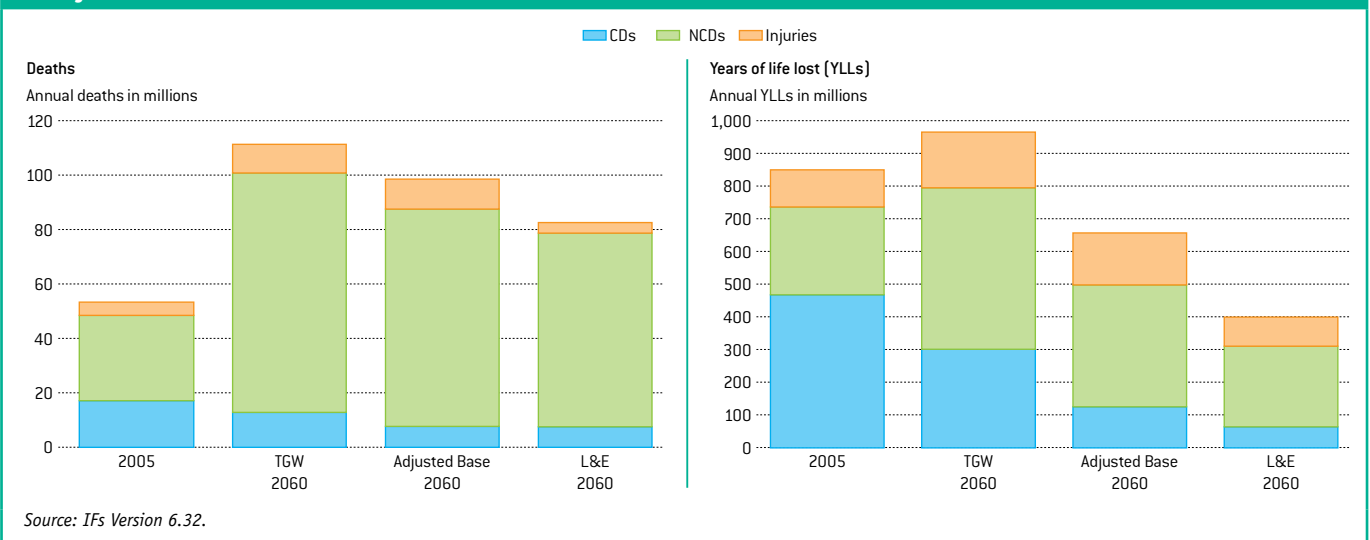
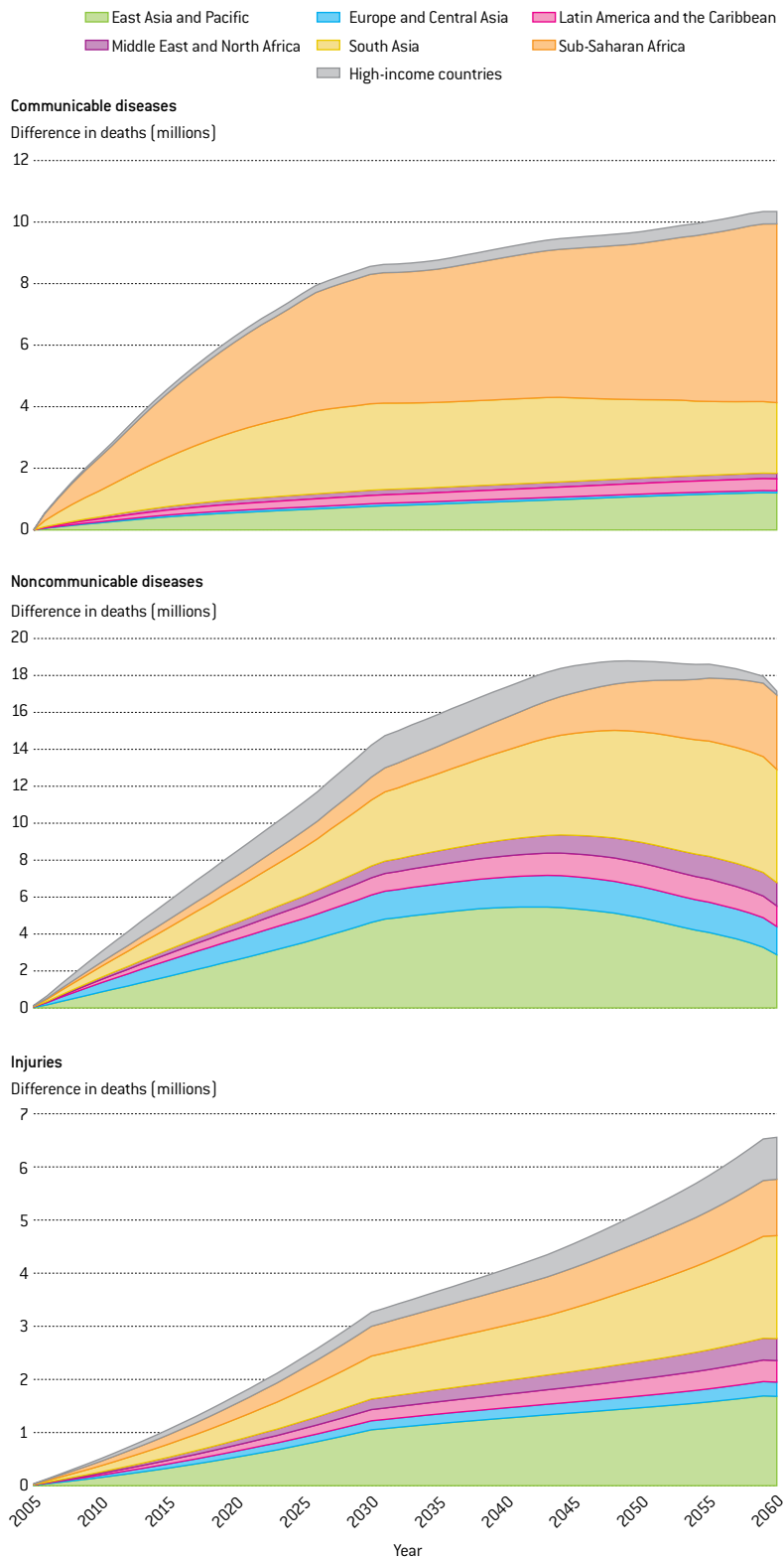


Figure 8.7 Annual death differences between Luck and Enlightenment and Things Go Wrong scenarios by death cause-group and region



Source: IFs Version 6.32.

by major disease groups and by region. Those differences represent a combination of changing mortality rates (to which we will return) and the dynamic demographic patterns that the scenarios set in motion.

Deaths are consistently higher everywhere and in every cause-group in the Things Go Wrong scenario. For instance, the global difference in annual deaths between the two scenarios for communicable diseases grows to about 10 million deaths per year and plateaus at that level. The largest differences in deaths from communicable diseases between the scenarios are in sub-Saharan Africa, followed by South Asia—not surprising because those regions now suffer the greatest numbers of such deaths. These two regions have a huge stake in maintaining and accelerating progress against communicable diseases.

The greatest difference in number of annual deaths between the two scenarios is, however, from NCDs, and it grows globally to almost 19 million before beginning a slow decline. Declines in differences in deaths from NCDs ultimately appear for two reasons: (1) the TGW scenario ultimately yields some decrease in death rates from NCDs; (2) although L&E postpones deaths relative to TGW, the resultant and substantially increased elderly population does ultimately die. Through 2030, East Asia and Pacific countries and South Asian countries dominate the cross-scenario variation in death numbers by virtue of their huge regional population numbers. After 2030, the differences between the scenarios begin to erode for East Asia and Pacific countries as well as for high- and upper-middle-income regions more generally. In contrast, the differences between the two scenarios continue to grow for South Asia and especially for sub-Saharan Africa. Again, one primary insight from these patterns is that, roughly over the next generation, sub-Saharan and other low-income countries have an especially great stake in continued progress against communicable diseases, but that thereafter the importance to them of chronic disease advances will also become very prominent.

Turning again to years of life lost, the difference between CDs and NCDs in health differentials of the two scenarios is much smaller than Figure 8.7 might suggest, because the average CD-related death is at a much younger

age. Through 2060, the cumulative difference between scenarios in global YLLs approximates 11 billion for communicable diseases versus about 8 billion for chronic ones. The cause-group with the smallest difference in deaths across scenarios is injuries, just as it is today by far the smallest category of absolute deaths. The growth in the difference between the two scenarios over time is steady, however, and that result may be counterintuitive. Like other “counterintuitive” results, however, understanding the larger dynamics of the system makes it clearer—many of the forces that create health improvement in the Luck and Enlightenment scenario have the least impact on injuries. Thus, when people do not die prematurely from other causes, the deaths attributable to injuries will rise. The difference between scenarios in annual global deaths grows steadily through 2060, reaching 6.6 million (about two-thirds the level of those from communicable diseases) and the cumulative difference in global YLLs reaches 3 billion. South Asian and East Asia and Pacific countries have the highest number of absolute lives at stake with respect to controlling the growth of injuries, but all regions exhibit steadily rising differences between the two scenarios.

It is obvious that the regional differences across the two scenarios are tied strongly to income levels (although the burden of tropical diseases in sub-Saharan Africa in particular has a strong geographic characteristic as well). By income level, the major break-point of scenario difference separates low-income countries from lower-middle-income countries (see Figure 8.3). For low-income countries, Things Go Wrong really means that *things go very wrong*, with an actual increase in child deaths in coming years and a huge gap, exceeding 3 million child deaths annually for most of the forecast horizon, between the patterns of that scenario and Luck and Enlightenment. For lower-middle-income countries, the World Bank category that includes China and India, the spread in total deaths is also large, exceeding 2 million for many years, but even TGW shows some significant, steady improvement. The difference in child deaths across scenarios becomes progressively smaller as income levels increase.

Drilling down further into comparison of the two scenarios, Figure 8.9 shows the child, adult, and older adult mortality probabilities.

The relative differences in probabilities are very large across all regions and mortality levels, with the mortality probabilities in the two scenarios varying quite often by a factor of two or even more. Relative differences are especially great for infant mortality, and those for sub-Saharan Africa and South Asia stand out. The level of absolute variation in adult and older adult mortality probability is also striking, however, particularly again for sub-Saharan Africa and South Asia. In the case of sub-Saharan Africa, the scope of the HIV/AIDS epidemic is so sweeping and the likelihood of some progress so great that the probability of adult mortality falls from 388 per 1,000 to 219 per 1,000 even under TGW; in L&E it falls much further, to 105 per 1,000. In South Asia and in Europe and Central Asia, where NCDs largely drive adult mortality, the two scenarios differ dramatically in the rate of progress over the next 50 years. In South Asia for instance, adult mortality probability in 2005 was 217 per 1,000. In the L&E scenario, South Asia’s adult mortality rate plunges to 64 per 1,000, comparable to today’s high-income societies, whereas in TGW the rate only falls to 165 per 1,000.

The gap between the outcomes in the two scenarios is so large that they significantly affect the likelihood of meeting goals such as

● *Deaths are consistently higher everywhere and in every cause-group in the TGW scenario; the biggest differences are in NCDs.* ●

● *For low-income countries, TGW really means that things go very wrong, resulting in annual increases in child deaths until about 2025.* ●

Figure 8.8 Annual child deaths in Luck and Enlightenment (L&E) versus Things Go Wrong (TGW) scenarios for low-income and lower-middle-income countries

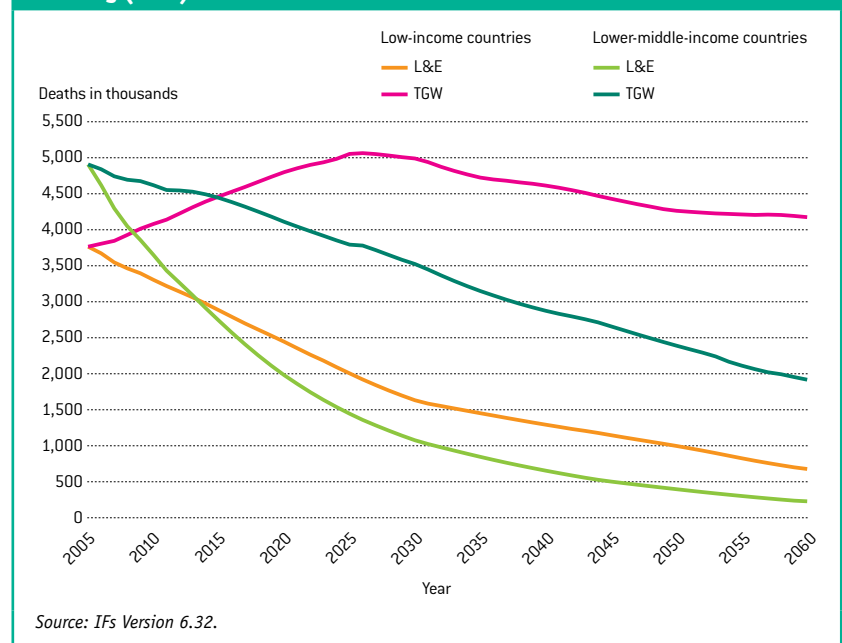
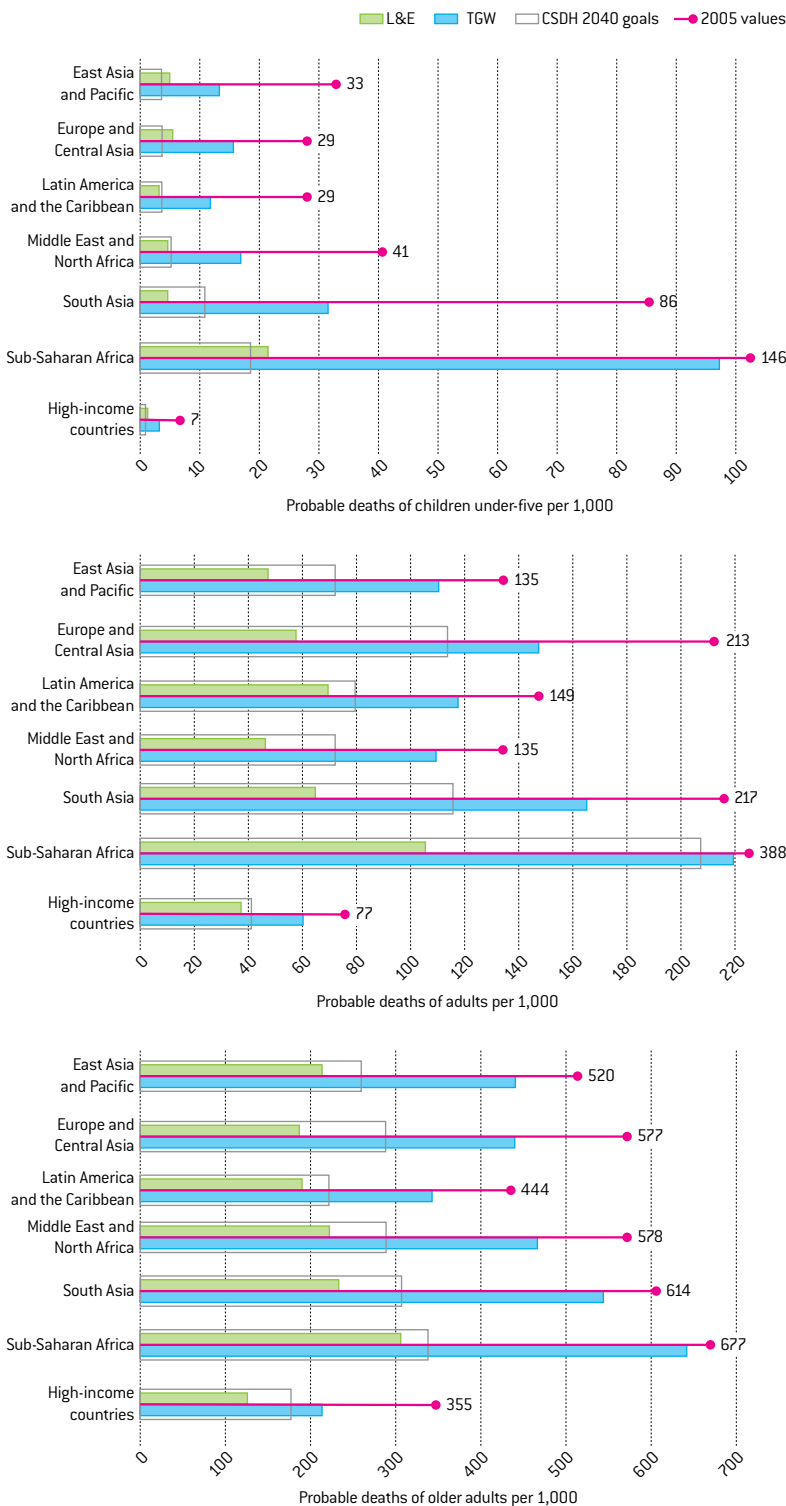


Figure 8.9 Comparison of mortality probabilities for 2060 in Luck and Enlightenment (L&E) and Things Go Wrong (TGW) by region



Note: Mortality probability is shown as the number of probable deaths per 1,000 before reaching end of age range (0–4 for child mortality; 15–59 for adult mortality; 60–79 for older adult mortality).

Source: IFs Version 6.32.

those of the Commission on Social Determinants of Health. If something even close to TGW came to pass, child and adult mortality rate reduction goals for 2040 would not be met even by 2060 almost anywhere. If something close to L&E came to pass, most goals would be met by 2060, and many even by 2040. For instance, only Latin America and the Caribbean and high-income country regions would fail to meet the CSDH goal of reducing adult mortality probability by 50 percent by 2040. Those failures would be largely because of the lack of “headroom” for upper-middle- and high-income countries, as it is difficult to cut already low mortality rates in half. In something of a reversal, if the 50 percent target is applied also to older adults, only high-income countries and Europe and Central Asia meet the goal by 2040 in L&E, although most regions other than sub-Saharan Africa are close. The major problem with respect to the CSDH goals is the target of 90 percent reduction in child mortality. We find in our analysis that no region will meet such a goal by 2040, even in Luck and Enlightenment.

The summary implications for life expectancy

Throughout this chapter we have given special attention to the extent of health progress by global system leaders and the convergence toward their conditions by other countries around the world. Figure 8.10 uses life expectancy as a summary measure to compare those two aspects of global health futures in the Luck and Enlightenment and Things Go Wrong scenarios, also providing historical data for context. We would certainly expect future trajectories for life expectancy to lie closer to the middle of the ones that the scenarios bracket (as does our adjusted base case), but the forecasts for the scenarios do not appear impossible. Further, although the range of uncertainty indicated for high-income countries is considerable (a difference of six years of life expectancy in 2060), the stakes are obviously considerably higher for developing regions. The differences are 17 years for sub-Saharan Africa and 16 years for South Asia.

In L&E there is very considerable convergence of those two developing regions toward high-income countries. Sub-Saharan Africa’s life expectancy climbs from 65 percent of that in high-income countries to 87 percent

(the gap falls to 12 years). South Asia's life expectancy moves to only five years less than that in high-income countries, a remarkable potential convergence. In TGW, however, the convergence is much less. Sub-Saharan Africa's life expectancy rises to only 74 percent of that in high-income countries, and South Asia's moves only from 80 percent to 83 percent. Figure 8.3 earlier sketched the rather complex historical patterns of convergence globally across World Bank groupings of countries by economy classifications. In TGW there is almost no convergence of upper-middle-income and lower-middle-income country groupings to life expectancies of high-income countries and only modest convergence of low-income countries as a whole (remember that low-income countries benefit from slow but quite steady reductions in communicable disease burdens even in TGW).

The regional stories cannot, of course, convey the rich diversity of situations across individual countries. There are more than 50 countries whose life expectancies in 2060 vary by 15 years or more between the two scenarios, a variation that at its maximum reaches 31 years. The countries that stand to benefit the most in life expectancy from L&E are those whose life expectancy trajectories have been held down by a variety of socio-political factors, both domestic and international. The countries at the top of the list include Afghanistan, Angola, Central African Republic, Chad, Democratic Republic of Congo, Republic of Congo, Equatorial Guinea, Gabon, Ghana, Rwanda, Somalia, and Tajikistan. Russia is also high on the list (the members of the BRICS grouping vary greatly, with China and Brazil showing much less difference across the two scenarios than India and Russia). As discussed earlier, countries that have unusually poor levels of health and life expectancy relative to income and education levels (as many of these countries do) are perhaps likely to converge upward over time, and we built such convergence into L&E. Still, as in TGW, the forces that have suppressed their life expectancies may either continue to exert a hold on these countries or even reach out to affect still other countries.

As we indicated earlier, even in the TGW scenario health conditions improve around much of the world over the next half century. Life expectancy globally climbs from 69 in 2005 to 73 in 2060, and in sub-Saharan Africa it rises from

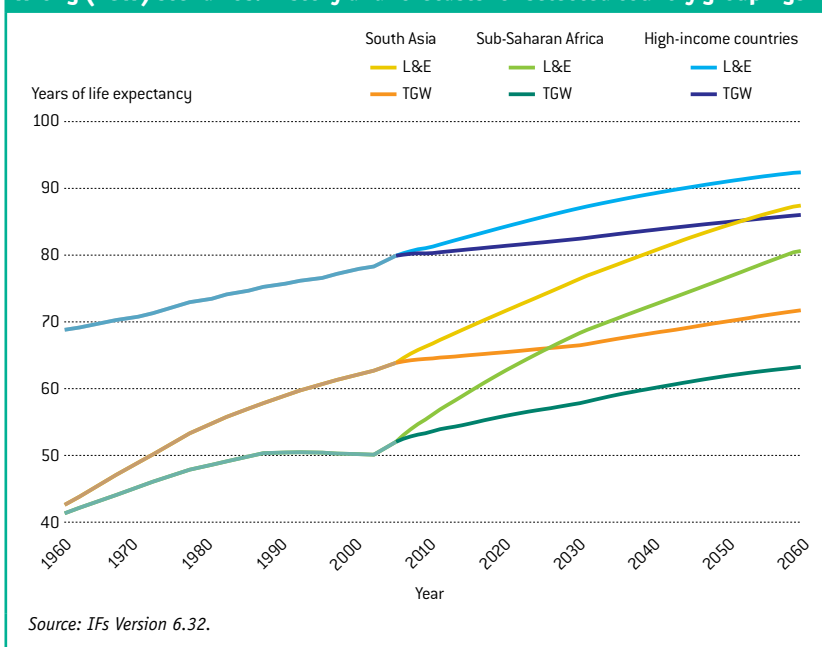
52 to 63. Although certainly not impossible, it appears highly improbable that the now several-centuries-long pattern of relatively steady improvement in global health would suddenly slow as much as in TGW. That said, however, and even considering implications for the fiscal and physical environments of hundreds of millions of additional seniors, humanity has a tremendous stake in pressing very hard to bring about some version of Luck and Enlightenment, with its global life expectancy approaching 87 years in 2060. The prospect of very significant global longevity improvements implied by L&E carries obvious implications for policy and planning with respect to population, aging, and labor markets, and so we return at last to look at the generally benign and moderately positive implications of this scenario for economic growth.

The economic consequences of alternative health futures

Chapter 7 analyzed a pair of "brute force" interventions with respect to health futures so as to explore the economic consequences of more- and less-healthy global futures. It concluded that healthier futures would bring at least marginal economic advantages, not negative consequences. Thus, it should not be surprising that L&E with respect to health could

■ *If something even close to TGW came to pass, child and adult mortality rate reduction goals for 2040 would not be met even by 2060 almost anywhere.* ■

Figure 8.10 Life expectancy in Luck and Enlightenment (L&E) and Things Go Wrong (TGW) scenarios: History and forecasts for selected country groupings



■ **Global life expectancy would climb from 69 years in 2005 to 87 in 2060 with L&E, but only to 73 years with TGW (the forecast is 79 in the adjusted base case).** ■

provide positive economic returns relative to the adjusted base case (TGW incorporates substantial exogenous economic slowing and is therefore incomparable with respect to the economic consequences of health).

Figure 8.11 suggests the potential magnitude of the positive impact from L&E by showing the ratios of GDP per capita of the L&E scenario to the adjusted base case. Unlike some of the analysis of Chapter 7, neither the scenario nor figure includes any variations or counterfactuals, such as accelerated fertility reduction or greater attention to food production.

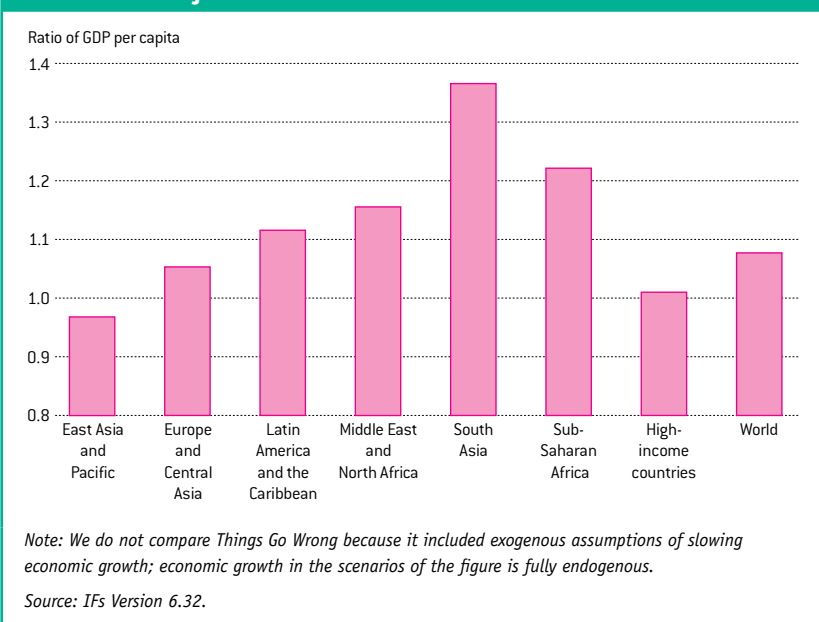
In all regions except East Asia and Pacific, the L&E scenario increases per capita GDP relative to the adjusted base case. As Chapter 7 explained, the different result in East Asia and Pacific flows from the large number of older adults (and of the elderly who are beyond the 60–79 age range) that China will experience relative to its working-age population in coming years—most of the reduced mortality for the region occurs in those age categories and intensifies the fiscal pressures the elderly will likely place on the society. The same phenomenon appears to a lesser degree in high-income countries, leading to an absence of economic difference between the two scenarios.

In sharp contrast, South Asia would benefit most from the L&E scenario, followed by sub-Saharan Africa and Middle East and North Africa.

The swing in GDP per capita for South Asia between the two scenarios reaches 37 percent in 2060 in spite of the increased population in L&E. As in Chapter 7, South Asia’s relative gains stem from the imminent arrival of its demographic dividend cohorts into prime working ages, and the larger numbers of relatively healthier new workers bring considerable benefit. Sub-Saharan Africa would experience about a 22 percent swing in GDP by 2060, while Middle East and North Africa would gain about 15 percent.

The economic boost of the L&E scenario is near or past its peak for most regions and the world as a whole by 2060. Given ongoing relative aging of populations in that scenario, and continued, century-long rise after 2040 in dependency ratios for all regions except sub-Saharan Africa, the economic gains decline somewhat thereafter. While the lag structure of forward linkages means that countries with relatively younger populations would still experience somewhat greater relative benefit from L&E after 2060, even sub-Saharan Africa as a whole is near its peak relative economic gains from the scenario by 2065. As discussed in Chapter 7, simultaneous attention to other aspects of development, including fertility reduction and food production (and therefore nutrition of larger populations) could further enhance the gains shown for L&E by itself—the incremental gain for sub-Saharan Africa would be especially great, moving the 22 percent improvement in GDP per capita from health alone to 36 percent.

Figure 8.11 GDP per capita (PPP) ratios in 2060 of the Luck and Enlightenment scenario to the adjusted base case



Conclusion

Forecasting human health through the middle of the century is subject to huge uncertainty. To a considerable degree this entire volume has been an effort to explore the extent of that uncertainty and to consider the factors that may shape alternative futures, especially human action. The considerations of key distal drivers in Chapter 4 and of selected proximate drivers in Chapters 5 and 6 provided some of the building blocks, as did the discussions of super-distal drivers and the exploration of forward linkages in Chapter 7. This chapter has brought a number of those elements together into an integrated analysis of better and less-good futures. We have been particularly interested in the combined opportunities and risks around different aspects of human activity because that activity, in

interaction with biological systems, frames the choices we have. Forecasters of health futures will almost certainly devote increasing attention to the impact of proximate, distal, and super-distal risk factors singly and in combination; by going beyond past efforts, we have hopefully contributed to that development.

The base case forecasts of earlier chapters, rooted in substantial part in distal-driver formulations developed by the Global Burden of Disease project, appear to us to build in expectations of a continued and relatively high level of human activity directed at creating better futures. In the case of communicable disease burden reduction, they also appear quite optimistic. The rather limited time horizon of the historical database on which we must all build our forecasting formulations in part explains such optimism. We have stretched forecasting with such formulations to and beyond the limits for which they were intended. Thus, it appears to us that there is greater downside risk than upside potential relative to such forecasts of communicable disease futures, even with the anticipated high levels of human effort. Hence, we began by reconsidering our base case for communicable diseases and adjusting it. In contrast, however, the basic distal formulations for noncommunicable disease appear implicitly to build in overly strong biological constraints with respect to continued progress; we relaxed those somewhat in our base case adjustment.

This chapter also developed and explored a Luck and Enlightenment scenario relative to a

Things Go Wrong scenario. The analysis suggests several conclusions. The first is the very broad range of health futures that may be possible, especially in middle- and low-income countries. A second is that the swing in focus of attention from communicable diseases to noncommunicable diseases and injuries will very likely move within our forecast horizon quite rapidly through middle-income countries and even into low-income countries. Another is that success of the type represented by the Luck and Enlightenment category could have a significant unintended consequence in terms of the expansion of global population, especially the elderly; it should nonetheless modestly enhance economic growth. Finally and most fundamentally, the analysis suggests strongly the great health-enhancing leverage of our human activity. We can exercise that leverage with proximate drivers and advances in technology. We can also do it through improvement of conditions (convergence toward more normal values) of poorly performing societies that may benefit from socio-political change (such as reduction in domestic conflict) and from the efforts of the global health governance system. Efforts within a broad range of systems have very considerable influence over health outcomes. By 2060, several years of life expectancy (in fact, well above a decade on average across our more extreme scenarios) for each of more than 9 billion people depend significantly on those efforts.

● *Global GDP per capita in 2060 would be 8 percent higher with L&E than in the adjusted base case; for South Asia the difference would be 37 percent.* ●

1 See Huynen (2008: 115–149) for a very useful analysis of the way in which various global scenario sets have treated (or not well treated) health futures and for her own set of health scenarios. Her *Age of Emerging Infectious Diseases* has much in common with *Things Go Wrong*. We might place her *Age of Medical Technology* (which she draws from Martens 2002) near the top of our vertical axis, because it presumes an accommodating biological context. And her *Age of Sustained Health* overlaps much with our Luck and Enlightenment, both building on positive human activity with respect to the natural and social environments and making clear that subscenarios build on each of these subdimensions. Finally, her *Age of Chronic Diseases*, focusing on non-Western countries, recognizes that technological ability to address chronic diseases might not transfer smoothly to developing countries, leaving them in a situation of Steady Slog. Throughout, she places much weight on the future character of globalization processes as a driver of different futures.

2 Following from the role of international cooperation in driving earlier survival improvements, some have attempted to attribute mortality reversals to the macroeconomic restructuring of the 1990s (McMichael and Beaglehole 2000; Stuckler, King, and Basu 2008; and Stuckler, King, and McKee 2009).

3 The two projects arrive at these similar numbers using very different methods. The UN bases its forecast on extrapolation of trends in all-cause mortality by age, an approach that would yield considerably higher life expectancy outcomes if they did not model a deceleration of longevity progress. The UN does not offer high-varient longevity forecasts in which this deceleration is turned off, but others do so and arrive at a best-practice life expectancy of around 97 years.

4 The use of logarithmic formulations in the GBD project's distal formulations also mechanically drives saturation effects within each death cause.

5 The specific adjustments in the model's "sce" file moved hltechshift to 1.5 (from 0) to introduce faster technological advance for high income countries and chronic disease (the faster technological advance becomes proportionately greater with higher GDP per capita); on the communicable side, changes reduced the annual advance in technology on HIV/AIDS by roughly 40 percent and gradually (over 60 years) increased the rates of mortality from all other communicable diseases by 40 percent relative to the base case.