Introduction

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This book is about doing what is rational instead of what is fashionable.

It is fashionable to declare that we want to tackle every major world problem. It is also a great thing to say. Unfortunately, it is not rational. We have limited resources. A dollar spent in one place cannot be spent elsewhere. But it is worse than that. When we say that we want to do everything, we are deceiving ourselves. A few big issues get the most air time, attention and money.

During this decade, there has been an incredibly intense focus on terrorism and global warming. Some surveys show these two threats scare people in rich countries more than any other problems that the world faces. Terrorism and global warming have not only dominated some sections of the media, but have attracted billions of dollars and used vast amounts of political capital.

Terrorism and climate change are both serious problems that deserve attention. But, as this book will show, there are many other threats that we hear less about, that also deserve our attention.

The Copenhagen Consensus exercise started as a simple but untested idea of applying economic principles to prioritize global opportunities. In 2004, the process was carried out for the very first time. The result was a prioritized list of opportunities to solve or ameliorate some of the world's greatest problems, compiled by some of the world's top economists. This attracted attention from all over the world. Denmark's government spent millions more on HIV/AIDS projects, which topped the economists' "to do" list.

Since 2004, the Copenhagen Consensus Center has carried out several similar "prioritizations." We are drawing on the experience of the Copenhagen Consensus prioritization with United Nations ambassadors in the USA in 2006, and on the Consulta de San José last year, where we did a Copenhagen Consensus prioritization for Latin America and the Caribbean. Basic principles of economics can be used to help any nation or organization to spend its money to achieve the most "good" possible.

Since 2004, of course, knowledge about the world's many problems has increased. New and smarter solutions have been proposed. That is why Copenhagen Consensus was always designed as a global project that would be updated every four years. This ensures that new, important challenges and solutions are included in the process and that research is updated.

We have learned from all of our past experiences that an informed ranking of solutions to the world's big problems is possible. We have learned that cost-benefit analyses (CBAs) do not lead to short-sighted solutions or a fixation on money. They lead to a focus on the best ways to approach the real problems of the world's poorest, most afflicted people. Time and again, the new research presented in this book shows we have the knowledge to do tremendous amounts of good in each of the biggest world challenges. The hurdle is often getting the right resources to the right place.

This book can give philanthropists or policymakers an assurance that the check they write out is going to achieve the most "good" possible. I hope it will help draw attention to solutions to the problems that we do not talk about.

Copenhagen Consensus 2008 started with one big question: If we had an extra $75 billion to put to good use, which problems would we solve first? To answer that question, we commissioned the research that is presented here.

Experts look at ten of the biggest issues facing the planet: Air pollution, conflict, diseases, education, global warming, malnutrition and hunger, sanitation and water, subsidies and trade barriers, terrorism, women and development.

Each challenge is significant:

- *Air pollution*: Air pollution causes 2.5 million deaths each year, the vast majority in the developing world.
- *Conflict*: Civil wars in small, poor countries cause untold suffering – a single conflict can cost $250 billion or more, takes many years to recover from and can block all other humanitarian interventions.
- *Disease*: Under the heading of "disease," the experts looked particularly at the plight of developing countries – they not only suffer much more than the industrialized world from diseases such as malaria, TB and HIV/AIDS, but also have to face an increasing burden of heart disease, cancer and other non-communicable diseases.
- *Education*: A lack of education commits many children to an impoverished future. Nearly a quarter of children in developing countries do not complete the fifth grade and, of these, 55 percent started school but dropped out: 26 million of today's four-year-olds will not complete five grades of schooling.
- *Global warming*: Global warming is by definition a global challenge, which could have a large number of important consequences such as increasing food and water insecurity, threatening ecosystem health and low-lying coastal populations while damaging the world economy.
- *Malnutrition and hunger*: Despite significant reductions in income poverty in recent years, under-nutrition remains widespread. One in four children under five – or 146 million children in the developing world – is underweight for his or her age; each year, under-nutrition contributes to the deaths of about 5.6 million children under the age of five.
- *Sanitation and water*: An astonishing 1.1 billion people lack good, clean water supplies, and 2.7 billion have no access to proper sanitation.
- *Subsidies and trade barriers*: Barriers to trade and migration have negative impacts that particularly affect the world's poorest people.
- *Terrorism*: this is a terrifying problem because it has no effective solution. Terrorist attacks are a cost-effective tactic of the weak against a more formidable opponent. Very cheap terrorist attacks can create significant anxiety and carnage.
- *Women and development*: Despite large strides in many countries, too many women continue to suffer discrimination, with negative impacts on the health and wellbeing of themselves and their children, as well as the broader economy.

We know that we could achieve good in any of the ten challenge areas. But with limited resources: Where can we do the most and least good? To answer that question, we need to focus on solutions, not problems.

This book presents some of the recommended solutions by specialist experts in each field. There is a range of fresh thinking and new approaches: You will find the first CBA of peacekeeping troops, by Paul Collier, for example (chapter 2). However, it is essential that we test and debate the experts' recommendations. That is why a second set of experts has carefully reviewed the research papers, and suggested other ways of viewing the problem.

The work presented in this book helps to undermine one of the many excuses that policymakers have used for not investing more in global aid and development projects. It provides sorely needed information about where money can achieve the most good.

As in previous Copenhagen Consensus exercises, in the Copenhagen Consensus 2008 project, an Expert Panel of eight economists – including five Nobel laureates – examined all of the research presented here. They engaged with all of the experts and came to their own conclusions about the merits of each suggested solution to each challenge. Seldom does such a high-powered group of world-class economists deal with such weighty issues.

I am often asked: Why economists? Many environmentalist campaigners would tell you that any extra money should be dedicated to battling climate change. That's certainly the global challenge we hear the most about. But an expert in air pollution will tell you that clearing the skies of killer smog should be a top priority. Someone who has spent his life studying conflict will tell you of the potential benefits from reducing the risks of civil war.

When it comes to setting economic priorities, the best people to turn to are economists: Experts in prioritization, they are the obvious people to provide a global overview. They put each challenge on an equal footing. The massive media hype about some problems is irrelevant to them. They focus on where limited funds could achieve the most good.

In choosing the best solutions to the world's biggest problems, the expert panel focused largely on the costs and benefits of different options. This is a transparent and practical way to show whether spending is worthwhile or not. It lets us avoid the fear and media hype that often dictate the way we see the world. Carefully examining where an investment would have the biggest rewards provides a principled basis upon which important decisions can be made. The Expert Panel discussed and debated all of the solutions to all of the challenges, in closed-door sessions designed to promote free debate. They weighed up each solution that you will find in this book, and compared it to the other options.

To provide another perspective on these problems and introduce fresh voices to the debate about prioritization, eighty students from twenty countries were invited to Denmark to analyze the research and come up with their own conclusions. The Copenhagen Consensus 2008 Youth Forum was a parallel meeting to the Expert Panel discussions, and the decision-makers of tomorrow enthusiastically embraced the difficult task of prioritizing between different solutions. The Youth Forum event was open to the general public and to journalists, to open up the decision-making process of the project. The Youth Forum and the Expert Panel produced their own prioritized lists, ranking solutions across all of the challenges. This highlights their view of the most (and least) cost-effective solutions.

It is vital, however, that these important issues are not just left to economists. That is why this book exists: I invite you to use this research to produce your own prioritized list of best and worst investments that the planet could make.

The easy thing – the fashionable thing – would be to say, "let's do everything." That is unrealistic. I hope that the quality of the research presented here will help you to form your own opinion on the best investments that all of us could make to help improve the planet.

PART I

The challenges

CHAPTER 1

Air Pollution

BJØRN LARSEN, WITH GUY HUTTON AND NEHA KHANNA

Introduction

Air pollution in its broadest sense refers to suspended particulate matter (PM: dust, fumes, mist, and smoke), gaseous pollutants, and odors (Kjellstrom *et al.* 2006). To this may be added heavy metals, chemicals and hazardous substances. A large proportion of air pollution worldwide is due to human activity, from combustion of fuels for transportation and industry, electric power generation, resource extraction and processing industries, and domestic cooking and heating, among others. Air pollution has many impacts, most importantly affecting human and animal health, buildings and materials, crops, and visibility.

In addressing the multiple burdens of air pollution, its related causes, and possible solutions, a broad distinction is necessary between *indoor* and *outdoor* air pollution:

- Human-induced *indoor air pollution* is to a large extent caused by household solid fuel use (SFU) for cooking and heating, usually involving open fires or traditional stoves in conditions of low combustion efficiency and poor ventilation. Indoor air pollution also originates from other "modern" indoor air pollutants associated with industrialization, with a variety of suspected health effects such as sick-building syndrome. However, from a global burden of disease point of view, these modern indoor air pollutants are relatively minor; this study therefore focuses on air pollution from SFU. Due to the close proximity and low or zero cost of solid fuels such as biomass in most rural areas, indoor air pollution is more of an issue in rural than in urban areas, although in many urban areas coal and charcoal are common household energy sources. Indoor air pollution from SFU is particularly hazardous given that pollution concentrations often exceed WHO guidelines by a factor of 10–50. Indoor air pollution is also related to environmental tobacco smoke ("passive smoking") and exposure to chemicals and gases in indoor workplaces.
- Human-induced *outdoor air pollution* occurs mainly in or around cities and in industrial areas, and is caused by the combustion of petroleum products or coal by motor vehicles, industry, and power generation, and by industrial processes. Outdoor air pollution is fundamentally a problem of economic development, but also implies a corresponding under-development in terms of affording technological solutions that reduce pollution, availability of more energy-efficient public transport schemes, and enforcing regulations governing energy use and industrial emissions.

Rates of exposure to these two types of air pollution therefore vary greatly between rural and urban areas, and between developing regions, given variations in vehicle ownership and use, extent and location of industrial areas and power generation facilities, fuel availability, purchasing power, climate, and topology, among other things. Indoor sources also contribute to outdoor air pollution, particularly in developing countries; conversely, outdoor air pollution may contribute to pollution exposure in the indoor environment (Kjellstrom *et al.* 2006).

Over 3 billion people are exposed to household air pollution from solid fuels used for cooking and heating, and over 2 billion people are globally exposed to urban air pollution in more than 3,000 cities with a population

over 100,000 inhabitants.[1] Epidemiologically, household SFU and urban air pollution differ in important respects. SFU disproportionately affects young children and adult females, while urban air pollution, according to current evidence and assessment methods, predominantly affects adults and especially the older population groups. There are also important differences in terms of solutions. Air pollution from SFU can be substantially reduced or practically eliminated by a few interventions such as installation of improved stoves with a chimney or a substitution of "clean" fuels such as liquefied petroleum gas (LPG), natural gas, or, potentially, biomass gasifier stoves. However, broad packages of interventions are often required to achieve any significant improvement in urban air quality.[2] Given these differences, this chapter discusses SFU and urban air pollution separately.

While there are many air pollutants, current assessment methods identify fine particulates (PM 2.5) as the pollutant with the largest global health effects. The focus of this chapter is therefore on particulates. Particulates are caused directly by combustion of fossil fuels and biomass, industrial processes, forest fires, burning of agricultural residues and waste, construction activities, and dust from roads, but also arise naturally from marine and land-based sources (e.g. dust from deserts). Particulates, or so-called "secondary particulates," are also formed from gaseous emissions such as nitrogen oxides and sulfur dioxide.

Household Air Pollution from Solid Fuels

The Challenge

An estimated 1.5 million deaths occur annually as a result of household air pollution from SFU, mainly for cooking as well as winter heating. The total disease burden, including morbidity, is estimated at 36 million DALYs (WHO 2007).[3] These deaths and DALYs arise mainly from acute lower respiratory infections (ALRI) in young children and chronic obstructive pulmonary disease (COPD) in adults and, to a lesser extent, lung cancer. There is also moderate evidence of increased risk of asthma, cataracts, and tuberculosis (Desai *et al.* 2004; Smith *et al.* 2004). While urban air pollution is strongly associated with elevated risk of heart disease and mortality (Pope *et al.* 2002), no credible studies of such a link are available for SFU because of the longitudinal data requirements. It is however plausible that SFU is a contributor to heart disease and mortality and, if so, the health effects of SFU might currently be significantly underestimated.

By WHO region of the world, use of improved domestic fuels (e.g. LPG, kerosene) in rural areas varies from under 15 percent in Sub-Saharan Africa and South East Asia, to 33 percent in the Western Pacific developing region, and closer to 50 percent in Eastern Mediterranean and Latin American countries. The main types of unimproved fuels used in rural areas are firewood, dung, and other agricultural residues, followed by charcoal and coal/lignite (Rehfuess *et al.* 2006). Indoor air pollution from SFU is generalized throughout the developing world. However, the health effects depend on many factors, including type of solid fuel and stove, household member exposure to solid fuel smoke (e.g. household member activity patterns, indoor versus outdoor burning of fuels, cooking practices and proximity to stove, and smoke venting factors such as dwelling room size and height, windows and doors, construction material, chimney), and household member age and baseline health status and treatment of illness.

About 1.2 million or 80 percent of global deaths from SFU occur in thirteen countries. Eight of these countries are in Sub-Saharan Africa and five are in Asia. India and China alone account for over 50 percent of global deaths from SFU (figure 1.1).

Average prevalence of household SFU is over

[1] The World Bank provides air quality modeling results for these cities. They are therefore used here as an indicator of global population exposed to urban air pollution.
[2] An exception is elimination of lead (Pb) from gasoline, or control of localized pollution from industrial plant(s) or thermal power plant(s).
[3] Estimated using baseline health data for 2002 and most recent available data on prevalence of household SFU.

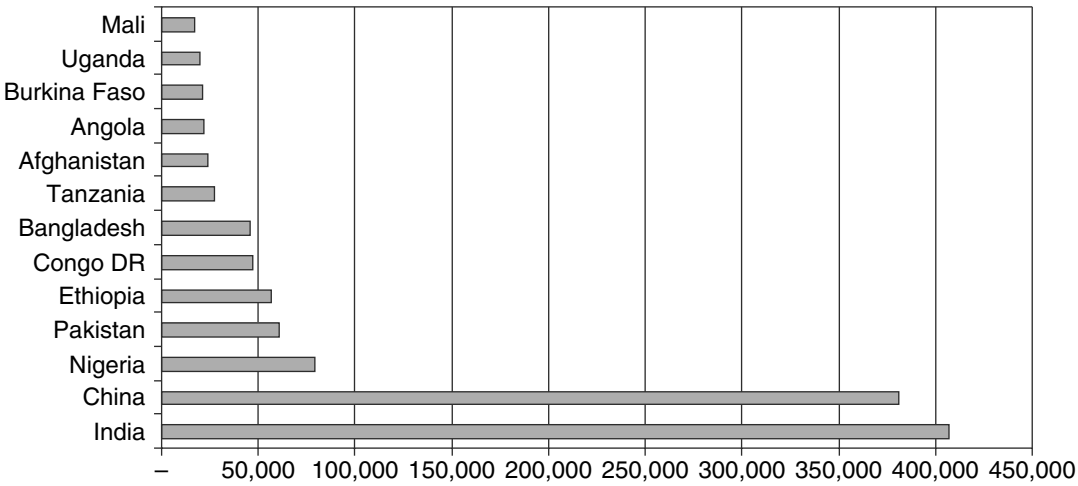

Figure 1.1 *Annual deaths from household SFU air pollution, 2002*
Source: Produced by the author from national estimates by WHO (2007). Mortality estimates are adjusted by the author for Pakistan to reflect the most recent data in the prevalence of SFU.

Table 1.1. Profile of thirteen countries with the highest mortality from SFU

	India	China	Other countries (11 with highest mortality from SFU)
Average SFU prevalence (most recent available)	82%	80%	> 90%
Deaths from SFU in 2002	407100	380700	421600
ALRI (% of deaths from SFU)	62%	5%	86%
COPD (% of deaths from SFU)	38%	90%	14%
LC (% of deaths from SFU)	0.1%	5%	0.01%
U5 child mortality rate in 2005	74	27	148
U5 child malnutrition (moderate and severe underweight)*	47%	8%	33%
GNI per capita in 2005	730	1740	480

Note: * Most recent data available from Unicef Global Database on Undernutrition.
Source: Author.

90 percent in these thirteen countries, ranging from 67 percent in Nigeria, 70 percent in Pakistan, some 80–82 percent in China and India, 89 percent in Bangladesh, and over 95 percent in eight of the other countries. With the exception of China, these countries are characterized by relatively high under-five child mortality rates, high malnutrition rates, and low national income levels (table 1.1).

Larsen (2007a) provides an estimate of mortality from indoor air pollution from household solid fuels in rural China. The central estimate of annual mortality is 460,000, assuming 50 percent of solid fuel stoves have a chimney and 355,000 if 100 percent of solid fuel stoves have a chimney, suggesting that mortality from SFU in China may be somewhat higher than presented in figure 1.1. The estimates are based on the

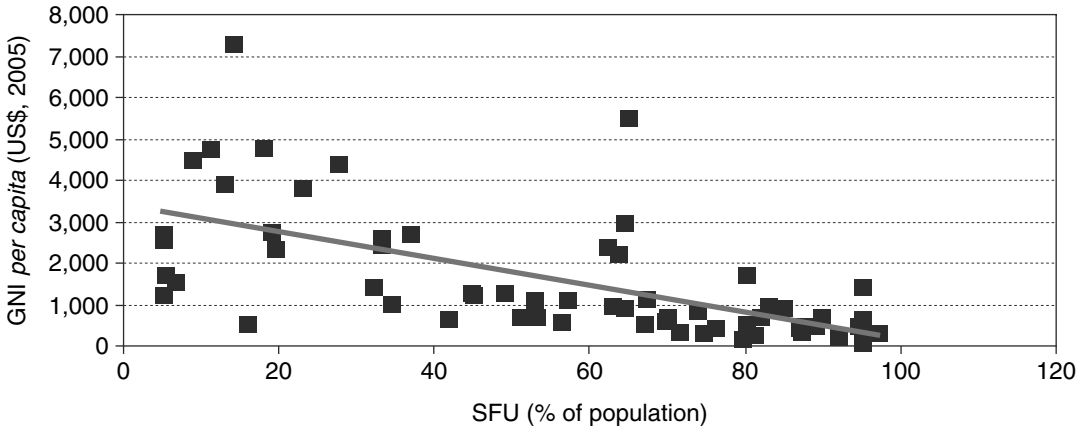

Figure 1.2 *Household SFU prevalence rates and GNI per capita*
Notes: GNI per capita is from WDI (2007). SFU is from WHO (2007).
Source: The author.

same health end-points as in Smith *et al.* (2004) and WHO (2007). A framework with multi-level risks is applied to reflect some of the diversity of solid fuels and stove and venting technologies commonly used in households in China. Seven indoor air pollution exposure and risk levels are applied: Households using predominantly biomass with or without chimney, a combination of biomass and coal with or without chimney, predominantly coal with or without chimney, and households using non-solid fuels (mainly LPG).

An important question is if countries will be able to grow themselves out of the SFU and associated health effects in the next few decades without any need for large-scale interventions. One argument is that prevalence of household SFU is strongly correlated with country income level, so that economic growth will solve the problem (figure 1.2). A second argument is that child mortality rates are declining, so under-five mortality from SFU will gradually decline (by reducing ALRI fatality rates) even without a reduction in SFU. A counter-argument is however that COPD mortality could possibly increase with aging populations even with a gradual decline in SFU. Each of these issues deserves attention and a set of simple projections is therefore presented in this chapter.

A linear regression analysis shows that an increase of US $1,000 in gross national income (GNI) *per capita* is associated with a 20 percentage point decline in SFU prevalence. Let us assume that this cross-country relationship holds intertemporally for the thirteen countries that account for 80 percent of SFU mortality. In the eleven countries other than China and India in figure 1.1, it would take about fifty-five years to reduce SFU prevalence to 50–55 percent and seventy-five years to reduce SFU prevalence to 10 percent, at a *per capita* income growth of 3 percent per year. In China and India it would take ten–twenty years and twenty–thirty years, respectively, at current economic growth rates. However, SFU prevalence in China has not declined at a rate anywhere close to the rate suggested by the cross-country regression results, although a substantial substitution from fuel wood to coal has been observed in the last two decades. Fuel substitution has also been quite slow in India despite rapid economic growth in the last decade.

In most countries, a majority of deaths from SFU is from ALRI in children under five. There is a strong correlation between SFU deaths per population and under-five child mortality rates. COPD mortality is to some extent correlated with life expectancy and an aging population (figure 1.3).

ALRI mortality from SFU has most likely

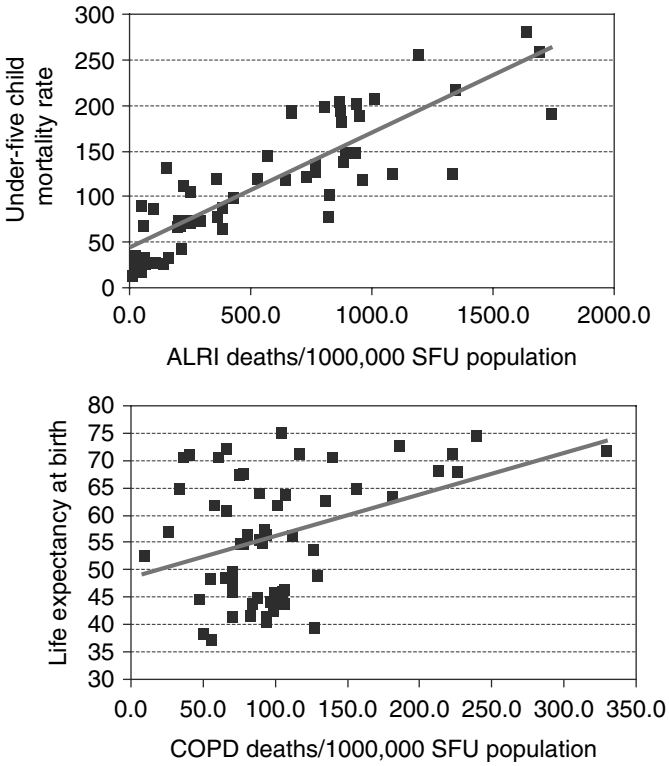

Figure 1.3 *Deaths from SFU in relation to child mortality rates and life expectancy*
Notes: Under-five child mortality rate and life expectancy at birth are for 2005 (World Bank 2007). ALRI and COPD deaths from SU=FU are from WHO (2007)> Countries with >= 1,000 deaths from SFU are included in the figure.
Source: The author.

declined in recent decades, and is likely to decline further even without a reduction in SFU or adoption of improved stoves. This comes about from a reduction in ALRI case fatality rates – through, for instance, improved case management and reduction in malnutrition rates – even in the event that incidence of morbidity does not decline.[4] In the countries with the highest SFU mortality (in the sample of thirteen countries), under-five child mortality rates have declined substantially since 1960 but appear to have stagnated in several of the Sub-Saharan countries. At rates of decline observed in the last two decades, it would take an average of thirty-five years in Bangladesh, India, and Pakistan for under-five child mortality rates to reach the current rate of 27 per 1,000 live births in China. It would take an average of seventy-five years in Ethiopia, Uganda, and Tanzania.[5] If all-cause ALRI mortality declines at the same rate as under-five child mortality, and there is no change in SFU, then in fifty years annual ALRI mortality from SFU would be 250,000, or 40 percent of the current level in this group of thirteen countries.

COPD mortality occurs largely in older population groups. With aging of populations over time, COPD mortality from SFU could increase over the next fifty years. The share of population aged forty-five+ years is expected to nearly double in China and India and more than double

[4] See Fishman *et al.* (2004) for a discussion of child mortality risk in relation to malnutrition.
[5] This calculation is based on average under-five mortality rates and rates of decline in the groups of countries. Years required to reach the level of China will be different in each individual country.

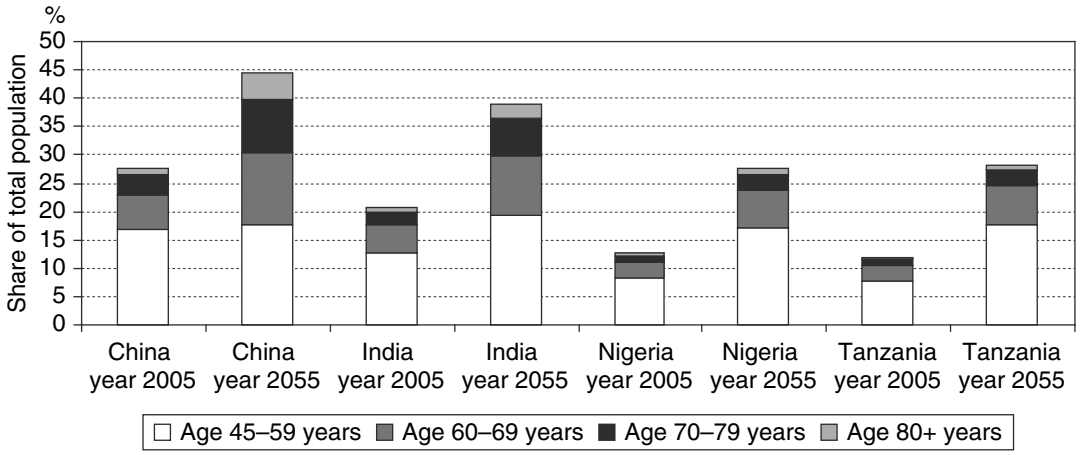

Figure 1.4 *Demographic projections, 2005–55*
Source: Prepared by the author using World Bank demographic projections.

Table 1.2. Projections of COPD deaths from SFU

SFU prevalence in 2055	COPD deaths: Ratio of deaths in yr 2055/yr 2005			
	China	India	Nigeria	Tanzania
0.6	2.67	2.52	4.10	2.77
0.5	2.23	2.10	3.42	2.31
0.4	1.78	1.68	2.74	1.85
0.3	1.34	1.26	2.05	1.39
0.2	0.89	0.84	1.37	0.92
0.1	0.45	0.42	0.68	0.46
0	0.00	0.00	0.00	0.00

Source: Author.

in Nigeria and Tanzania from 2005 to 2055. The fastest growth in China and India is expected to be for the population aged 60+ (figure 1.4).

To provide a simple projection of COPD mortality from SFU, consider a scenario in which age-specific COPD death rates (per 1,000 population in age group) are constant over time.[6] Using World Bank country demographic projections, we can apply the relative risks of COPD from SFU in Desai *et al.* (2004) to estimate COPD mortality by SFU prevalence rates in fifty years from now. The results are presented for China, India, Nigeria and Tanzania in table 1.2.

COPD mortality from SFU would be higher in 2055 than today in all four countries at SFU prevalence rates >25 percent in year 2055 (current SFU prevalence is 67 to 95+ percent). SFU needs to decline to <15 percent in Nigeria for COPD mortality to fall below today's level (table 1.3). The main drivers of these projections are aging of the population and population growth. But even COPD death rates (COPD deaths/population) would be higher than today unless SFU prevalence falls below 25–30 percent in China and Nigeria and below 35–40 percent in

[6] Age-specific COPD death rates are taken from Global Burden of Disease regional tables.