Introduction

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The Costs of Human Challenges

The human race has always faced a wide range of challenges and, despite great progress, continues to do so. This book aims to produce a 150-year view of some of humanity's biggest challenges, and to present these in a new and thought-provoking way. The research presented here uses in-depth economic data analysis to establish the cost to humankind caused by its biggest challenges, and how the impact of these challenges evolved over the twentieth century and will continue to change until the middle of this century.

Understanding the change in impact of the different problems across centuries or even just their relative sizes at a particular moment is fraught with difficulty, since our understanding of world problems and progress is to a large extent shaped by vocal interest groups, the length of the media's attention span, and our perceptions – shaped by personal experience – of what matters and what does not.

In the developed world, the challenges that we hear the most about are not necessarily those that cause the biggest problems to humanity. Issues come and go from the front pages of newspapers: an African famine can be news one day, superseded by a terror threat in the developed world the next. Issues like the Y2K bug can create considerable alarm, and then fade away to nothing. Other times, there might be a perception that we have solved an issue – malnutrition, or the HIV epidemic, for example – because we hear a lot less about it than we once did.

What role can economic analysis play in helping us to get a clearer picture? One of my favorite examples comes from the USA in the late 1990s, and it shows how the media's focus can easily cloud our perspective.

In 1997–8, the weather pattern El Niño affected the United States – and it was widely covered on the TV news and in newspapers. The weather pattern was blamed for everything from wrecking tourism, causing more allergies, melting the ski-slopes, creating snow-storms, and even for causing a dip in Disney's share price. Based on the media's reporting, the average reader or viewer was left with the clear impression that El Niño was an overwhelmingly negative phenomenon.

But economic research provides a fuller picture. A peer-reviewed article tallied, in financial terms, all of the problems and all the benefits (which had been seldom reported) from El Niño in the USA.

The weather pattern caused storm damage – but it also raised winter temperatures which reduced the number of people who died from the cold and cut heating bills, reduced spring flood damage, led to transportation savings, and reduced Atlantic hurricanes. The total damages were estimated at $4 billion, whereas the total benefits were estimated at $19 billion. In this case, the economic analysis helps us to gain a better perspective on the true scale and impact of the challenge, in this case in the USA.

Economics can also serve to show us whether or not particular challenges are becoming more or less problematic for humanity over time. That is what this book will attempt to do.

Such an endeavor is important. If we don't focus on the right things, we will not respond adequately to the challenges that matter. If we worry that things are getting worse and spiraling out of control, we are likely to panic and such a state of mind is hardly conducive to making good decisions.

It is entirely possible to gain the impression that the world's challenges are piling up, and that

humanity is failing to respond to them. For instance, we often hear doomsday-style rhetoric from campaigners who paint a picture of ever-escalating pollution. It is easy to counter such claims with particular data and facts. You might remember stories of London's smog in the 1940s and 1950s when on bad days you literally could not see 10 feet ahead of you. Data clearly tells us that London air has gotten cleaner since the late nineteenth century, and is likely cleaner now than it has been since 1585.

Yet, it is easy to present data from other places that makes the opposite point: in many places, air pollution has increased (such as in Beijing and many other cities in developing nations). Moreover, if we only talk about outdoor air pollution, we ignore the much larger problem of indoor air pollution which causes perhaps 2 million deaths through people trying to cook or keep warm with dirty fuels.

This is where we need an analysis which takes into account *all* of the data across the world and looks at *both* indoor and outdoor air pollution, showing the individual and impact across the century and the likely development ahead. That is what the chapter on air pollution in this book has done.

Of course, we need to not only look at air pollution, but also at health, war, gender, food, and a host of other issues. Likewise, we need to realize that problems have not been evenly spread, and nor has progress. OECD members – the club of the world's richest countries – have a combined population smaller than China's, while in the rest of the world, nearly a billion people still suffer from chronic malnutrition. Yet, over a period when world population has tripled, the absolute number of malnourished people has remained pretty much the same. There are still far too many people who go to bed hungry, but global farming has managed to produce enough food for an ever-larger proportion of the world's rapidly burgeoning population.

This Book's Contents

In this volume, we include contributions from a range of authors who have been asked to do the seemingly impossible – to quantify the cost to humanity from ten diverse challenges:

- Air pollution
- Conflicts
- Climate change
- Biodiversity
- Education
- Gender inequality
- Health
- Malnutrition
- Trade barriers
- Water and sanitation.

In trying to find a common language, we have asked authors to evaluate the impacts in their area in terms of "percentage of GDP." With such a wide range of topics, this framework enables us to make more sensible comparisons of relative impacts in such diverse areas as biodiversity changes, malnutrition and trade barriers.

There are those who question the use of economics to put a cost on things that they would regard as beyond price: human life or biodiversity, for example. The simple if uncomfortable truth is that we do this all the time. For instance, politicians and bureaucrats regularly decide whether to build an extra roundabout or a safer road, which will save lives but comes at an extra cost. When we decide not to adopt the safest course in order to save money, we implicitly set a value on human lives. Likewise, policies to cut down forests have to weigh the benefits in timber and employment against values like biodiversity.

Rather as Churchill considered democracy to be the worst form of government – with the exception of all the others that have been tried – we could view placing an economic cost perspective on the human condition as the least bad approach to gaining an overview of the problems.

Based on the best available data and case studies, the authors in each case have used statistical modeling tools and descriptive historical economics to portray the trend, state, and outlook for each of the challenges. Their economic analysis provides one of the best possible estimates of the historic, present and future welfare cost from a given challenge.

To overcome data availability constraints and to ensure that credible cost estimates are made for each challenge, especially for the first half of the twentieth century and for less developed countries, many authors provide a sensitivity

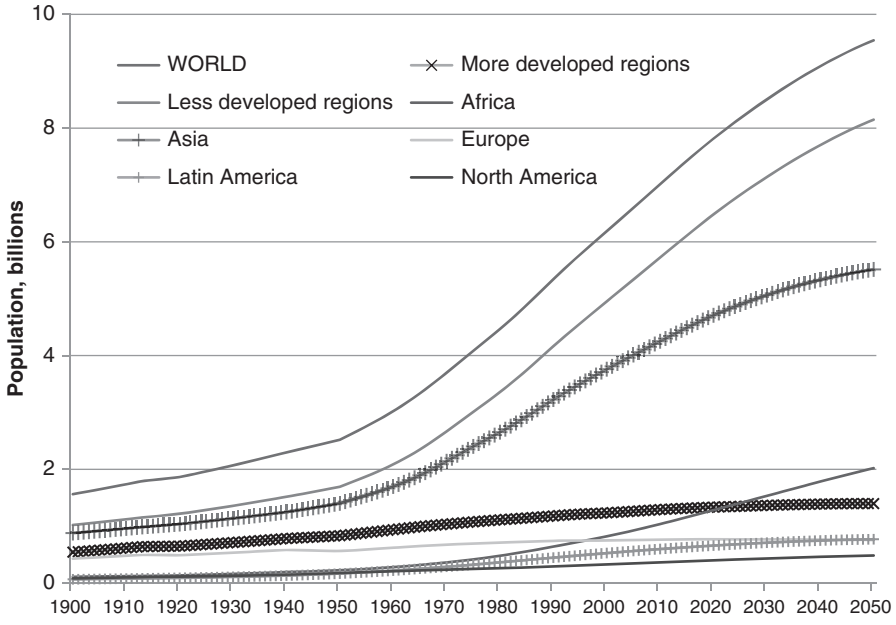

Figure I.1 *Population (billions)*

analysis to establish a better range for measuring uncertainties.

This is an ambitious project, pushing the frontier of economic historic assessments and forecasts, and one that required us to ask authors to broadly use the same assumptions about growth and population levels.

To guarantee a harmonious set of assumptions across the economic assessments, the Copenhagen Consensus – which commissioned the research – created a resource base for the authors including historic and future data for key economic variables – and population growth (see Figures I.1 and I.2). The smoothed data set only draws from credible sources; mainly United Nation Statistics and Historical Statistics of the World Economy by Angus Maddison.[1] Regions and income groups are defined according to the United Nations disaggregation (Table I.1).

While this may seem like a very rough generalization of the world divided in only two income categories or five regions, this has not been the real constraint on the authors when it comes to detail. The real constraint is the lack of the complementary challenge-specific time-series data which has in several cases made the disaggregation proposed by the Copenhagen Consensus Center impossible. Yet we are proud to learn that this project has forced the authors to think creatively and look in new places for better historical data that can tell the story of our human development, and in some cases this has created new longer time-series data, making the way for better economic statistical analysis. One can only hope that statistical databases continue to grow as that is necessary for good economic assessments help us make better judgments and investments for our common good, based on historic proof.

The high and low regional growth rate estimates are based on literature review of key economic institutions such as United Nations and the World Bank (Table I.2). As it is impossible to create a consensus on future growth rates, the ones used are indeed conservative estimates of a hopefully even brighter future.

Of course this geographical disaggregation covers great variations within regions and even within countries just as overall economic growth may hide the

[1] Maddison, A. (2006): *The World Economy: A Millennial Perspective (vol. 1), Historical Statistics (vol. 2)*. Paris: OECD.

Table I.1 Regions and income groups

- **More developed** regions comprise Europe, Northern America, Australia/New Zealand and Japan
- **Less developed** regions comprise Africa, Asia (excluding Japan/Australia/New Zealand), Latin America and the Caribbean
- **Africa** (includes all regions of Africa)
- **Asia** (includes Oceania)
- **Europe**
- **Latin America** (includes the Caribbean)
- **North America**

Table I.2 The low/high growth prospect is based on the following GDP growth rates

Low growth scenario	High growth scenario
• World: 2.5%	• World: 3.5%
• More developed: 1.5%	• More developed: 2.5%
• Less developed: 3.5%	• Less developed: 4.5%
• Africa: 2.5%	• Africa: 3.5%
• Asia: 3.5%	• Asia: 4.5%
• Europe: 1.5%	• Europe: 2.5%
• Latin America: 2.5%	• Latin America: 3.5%
• North America: 2.0%	• North America: 3.0%

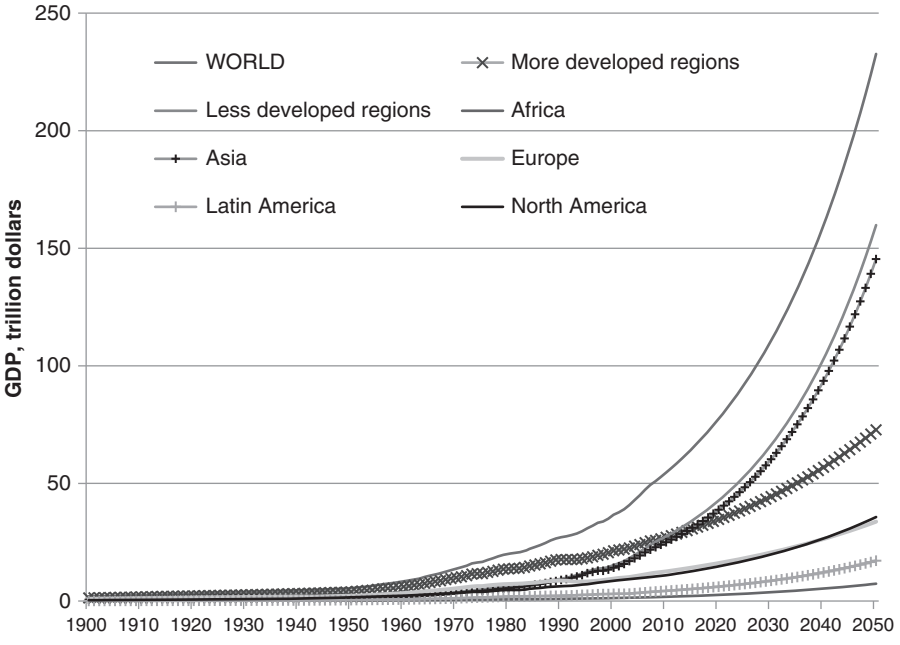

Figure I.2 *GDP 1900–2050; high growth scenario for 2010–2050 (trillion 1990 International Geary–Khamis dollars)*

inequality beneath. However, as this book shows it does achieve the objective of telling a detailed story of development in different tempi across different regions. The full data set is available on the Copenhagen Consensus Center Website.

Methodology and Coverage

It is important to realize that when we ask researchers to look at any area, the problems (or benefits) from several other areas will also influence their results. So, one cannot just add the GDP costs from the many different areas, because they will partially overlap.

For instance, much of the development in nutrition would not have been possible if it had not been for improved education making progress in food research possible as well as the development of better global infrastructure and distribution networks. Separating the challenges and our achievements into different categories is more a didactic

instrument that makes it easier to pinpoint progress or decline.

Moreover, when we look at the entire world across 150 years, it is impossible to include everything. We simply undertook a valiant first attempt to cover the world. Yet, it is perhaps worth briefly touching on the areas that we did not study. Common to them all was that we were not able to get sufficient numbers of researchers to study them in the time-frame available. Below, I've tried to indicate the likely direction of more studies to look at these problems.

Finance

It is clear – the 2008 crisis notwithstanding – that the increased availability of credit and finance has been important for the economic development across the last century and likely to be so for the coming decades. One can point to access to finance for consumers in terms of allowing consumption smoothing; for small businesses as start-up credit; for large businesses as access to bond issues or private equity; interest-rate swaps and exchange-rate insurance; for governments the ability to borrow large amounts, especially during the development phase, and a number of other areas. In total, it is likely that the increased access to financial tools has contributed and will continue to contribute positively to global development.

Demographics and Population

This has for a long time been a major concern, perhaps most poignantly described in *The Population Bomb*.[2] The worry has been that increasing populations could reduce life quality by stretching resources (see below), increasing pollution and diluting growth. In the current set-up of the question that we have asked the authors to address – namely measuring the size of the problems in terms of percentage of GDP at any given time – the issue of demographics is implicitly present in and contributing to all areas, since we are essentially measuring per capita impacts. Thus, if increasing populations have indeed increased pollution, this will show up as an increasing pollution problem in the studies.

However, there are also other impacts that could have been interesting to look at. For instance, one reaction to population concerns was the one-child policy in China, which has probably caused a severely skewed gender ratio in China today. Moreover, in many industrialized (and increasingly in many developing) countries the worry is about shrinking populations, aging demographic, and increasing welfare costs. Yet, increasing life expectancy is also an uncontroversial good for the individual, and this is measured in the health chapter.

The impact of population is included in the assessments in the individual chapters, and life expectancy in the health chapter, whereas the impact of the other demographic variables is hard to assess up-front.

Resources and Energy

It is clear that much of the development of the twentieth century is due to the abundant availability of energy (especially fossil fuels) and resources (like iron and cement). Concerns about global warming are dealt with in the chapter on global warming.

Many have expressed concerns for the depletion of resources, in the vein of a Club of Rome argument (1972). They have worried that by using so much fossil fuels and other resources we have left the world with fewer and less easily accessible options for the future, which would obviously indicate a negative impact on the development across the century. Against these theoretical worries, the empirical indicators show that we have generally found more new resources (including fossil fuels) than we have used, mostly through technological innovation. Most major resources have longer years-of-consumption, and show increasing availability, and for the past 150 years, the general price trend has been downwards. Thus it seems reasonable to expect that if energy and resources had been included, the increased access to lower-priced available resources has contributed and will continue to contribute positively to global development.

[2] Ehrlich, P. (1968) *The Population Bomb*. Cutchogue, NY: Buccaneer Books.

Physical and Communications Infrastructure

It is obvious that many of the developments in modern civilization (and into its future) have come about because information, goods, and services can move ever more easily. This is both because of increased availability of roads, trains, and ships for goods and people, as well as the advent of telegraphs, telephones, faxes, cell phones, and the internet for ideas and communication. Although we were unsuccessful in commissioning sufficiently high-quality papers to bear on these issues, it is clear that increased access to physical and communications infrastructure resources has contributed and will continue to contribute positively to global development.

Civil Rights/Human Rights/Democracy/Racism

While economics and statistics are powerful tools when it comes to measuring the world around us, there are many important issues and challenges that are almost impossible to measure. This does not mean that they are not important. Below you will see that we did manage to estimate a similar topic, namely gender. Overall, it seems difficult to say with great confidence whether civil rights and democracy have contributed and will contribute positively to human development, but it appears harder to claim that their development across the past 110 years has and will impact human development negatively.

Corruption

It is obvious that corruption constitutes a significant cost on human development, estimated today at around 1% of GDP. However, it seems almost impossible to estimate with any degree of precision what its signigicance across the past century has been. Thus, while important, the current project has not found it possible to estimate its change in importance going forward.

Politics

It is clear that politics and the ability to implement social decisions have a large impact on human welfare, and many observers agree that politicians often seem to be doing very badly compared to our loftiest hopes. Again, though, it appears almost impossible at present to show whether politicians and political structures have become less or more capable at advancing human well-being, and as such, the projects have not explored this important measure.

Happiness

Finally, there is the issue of happiness. This is important in two related respects. First, since human happiness arguably is the most fundamental measure of utility, maybe we should have tried to measure it across the past century and estimate it into the future. While an intriguing concept, the problem is that as happiness is almost entirely self-evaluated, it is necessarily relative and hard to compare across cultures and across time. Thus, it has not been included in this evaluation.

Second, many have suggested that happiness is potentially a better measure of human welfare than GDP, and thus questions the basic unit of comparison in this project. The problem is that none of the current attempts to make a 'better' GDP estimate on e.g. happiness have been broadly accepted, nor are the data available in high detail throughout the twentieth century and till 2050. Moreover, while no one would argue that GDP is a perfect measure, it is clear that higher GDP correlates with other attractive outcomes like economic freedom, freedom from corruption, better health and social outcomes, lower poverty, life satisfaction, etc.[3] Thus, for the current project, GDP is a reasonable first proxy for human welfare and happiness.

Development of Human Welfare

After these methodological considerations, it is worth looking at the actual results from the individual papers and then estimating the total costs imposed by some of the major human challenges

[3] See http://filipspagnoli.wordpress.com/stats-on-human-rights/statistics-on-gross-domestic-product-correlations/

over the twentieth century and their likely impact during the first half of the twenty-first.

This is very much a first attempt at an ambitious project, but the overall picture clearly is of major improvements to the lives of most, with many problems remaining and some issues moving in the wrong direction.

Let us look at the individual chapters. In Chapter 1, Guy Hutton examines the problem of air pollution. Today we associate this issue largely with urbanization, in both industrialized and developing countries. The soot from coal fires and industry may no longer be a problem in European cities, but there remains an issue with traffic emissions on busy roads, sometimes compounded by local weather conditions as in the infamous Los Angeles smog. In major cities in rapidly developing countries, domestic stoves and industry are still the main problem, highlighted by the Chinese authorities shutting down many local factories during the Beijing Olympics in 2008.

More overlooked, but in terms of deaths ultimately more important, is indoor air pollution. This is especially a problem in developing countries, where families often rely on dirty and inefficient fuels to cook and keep warm. Since women and children often spend more time indoors, they are especially prone to the consequences of indoor air pollution, from respiratory disease to premature death.

Looking at the first graph measuring deaths per year, the importance of indoor air pollution through the last 110 years is obvious. Hutton estimates that the total annual deaths from indoor air pollution in 1900 were about 2.7 million, with 2.6 million deaths in the developing countries and 100,000 in the developed world. Contrast this to about 177,000 annual deaths from outdoor air pollution, with 160,000 in the developed world. Across the past century, indoor air pollution deaths in the developed world almost disappeared. At the same time, more people, more frequently living in cities, with ever more cars, were a primary cause of increasing deaths in both the developed and the developing world. With environmental legislation and car saturation, deaths started declining in the First World after 1970. In the developing world, with increasing pollution, increasing urbanization and growing populations, deaths will continue to increase towards the mid twenty-first century.

However, the amazing story, which is somewhat hidden in this figure, is that the number of people dying from indoor air pollution in the Third World, although terribly high, has actually declined to about 1.85 millon today and is likely to drop below 1 million by 2050. Why is it amazing, when there are still so many people dying? Because at the same time the number of people in the developing world has increased eightfold, the annual risk of dying per person has dropped from 0.25% to 0.01% – or 25 times.

But clearly outdoor air pollution in the developing world has shot up at the same time. Is this not an indication that things are getting worse? Yes, it is unequivocally bad that the number of people dying is increasing. And even if we measure this in terms of risk per person, it has been increasing. However, even the outdoor air pollution is *only half as bad* for a person in a developing country in 2050 than it was for a developed country citizen in 1970, likely because of cleaner technology. And ultimately, while more people die from outdoor air pollution, many fewer people die from indoor air pollution in the Third World, making the entire number still decline (Figure I.3).

Moreover, death is not the only problem stemming from air pollution. There are also sickness days as well as indirect costs such as damage to buildings and crops, as well as costs of time required to collect firewood. Taking all of those costs into account, Hutton shows that the total cost of air pollution in 1900 ran to $446 billion 1990 dollars (all dollar amounts described here are in Gheary–Khamis 1990 US$) or about 23% of Gross World Product (GWP) in 1900, as is evident in Figure I.3.

Remember, this does *not* mean that the nations of the world in 1900 were suffering a 23% loss of their GDP, or that if there had been no air pollution, GDP would have been 23% higher. Most of the losses were in human lives cut short, which while a definite loss of human welfare would only obliquely show up in GDP (and possibly as a cost of care for older people). Rather the 23% indicates the size of the problem, the size of the loss of human welfare in an easily comparable metric.

From a loss of 23% in 1900, we see a loss of $3 trillion in 2010, or 5.6% of GWP, and a loss of 4% of GWP by 2050 ($7.5 trillion). So, has air pollution become a bigger problem or a smaller one?

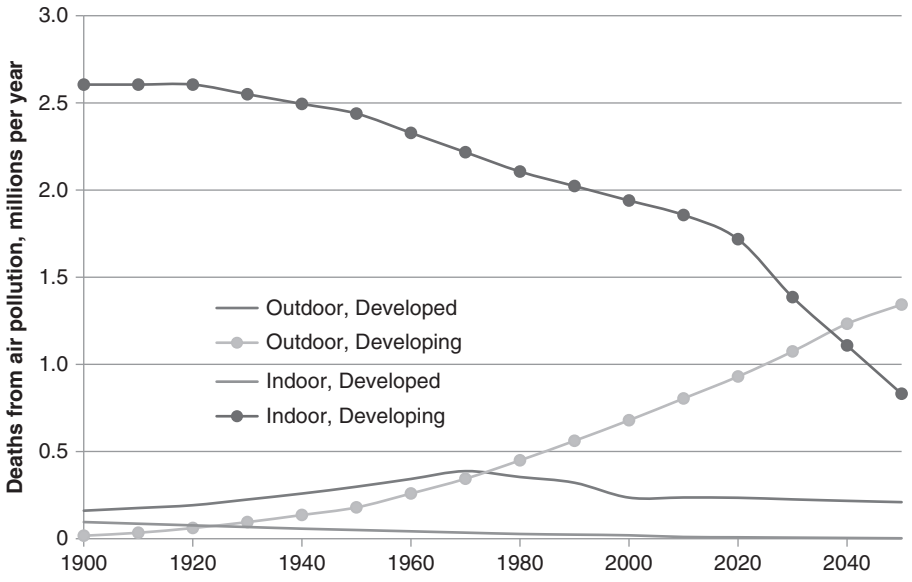

Figure I.3 *Deaths from air pollution*

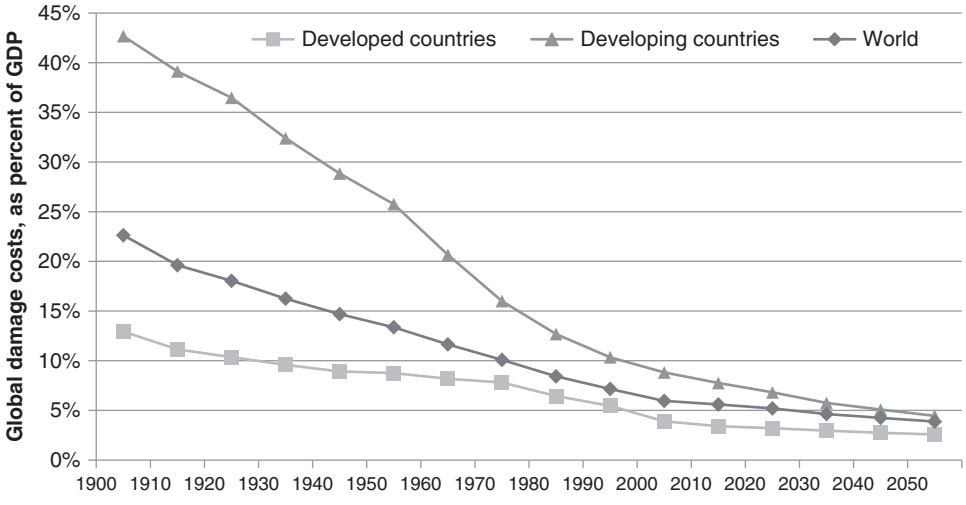

Figure I.4 *Global damage costs of all-cause air pollution, as percent of GDP*

The total cost has certainly gone up, which could indicate that air pollution has gotten worse. But this analysis neglects that at the same time, there are many more people living (which means that any air pollution can kill more people) while each person has gotten much richer (and hence each life is valued much higher). This is why a more accurate way to describe the problem is how big the problem is compared to the total wealth at the current time, as is evident in Figure I.4. Here, the problem has become less significant for both developed and developing countries, perhaps most dramatically for the developing world, where welfare damages of 43% were occurring around 1900, but have now declined to 8% and likely will end up at 4% by mid-century.

Another way to see why percentage of GDP is a more accurate way to describe whether the problem is growing or declining is to recast it as a risk issue

(since deaths are by far the biggest contributor to the damage cost, we can just look at death risks). If we look at the annual risk of dying across the 150-year period in Figure I.5, in 1900 it stood at about 0.18% – or one person in 550 would die each year from air pollution (mostly in the developing world from indoor air pollution). Now, that risk is about 0.04% or 1 in 2,500, and by mid-century it will be almost 0.02% or 1 in 5,000. When we ask if air pollution has gotten better or worse, we could reformulate that as a question behind the Rawlsian veil of ignorance – which time-version of society would you rather be a part of, if risk of death from air pollution was your only consideration? It is clear that this would be the latter part, or the lower part of the risk curve.

Notice that although the absolute number of deaths remains steady or slightly declining across the period, this is not important for the point here. Even if the *absolute* number of deaths had increased, what matters is that the *relative* numbers go down. (If you had to make a choice about which society to be born into, your decision is not influenced by whether there are absolutely more people dying from air pollution, if there are also even more people in total; what matters is your risk of being one of the people who die from air pollution.)

Indoor air pollution has been by far the most important air pollutant through the twentieth century, as is evident in Figure I.6.

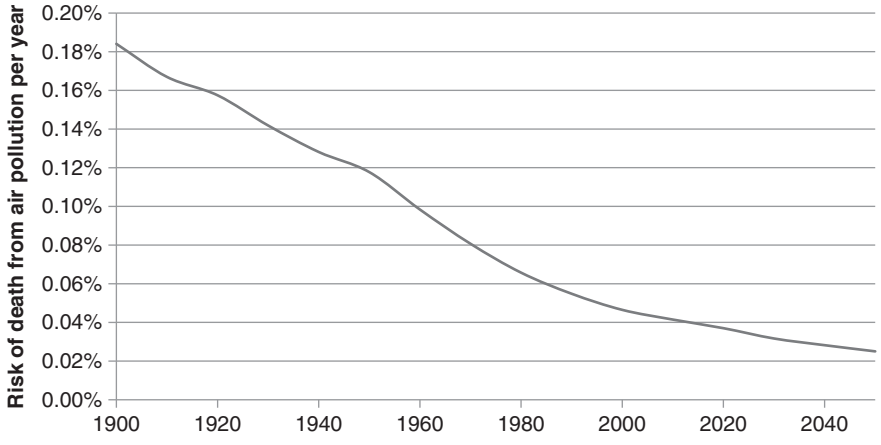

Figure I.5 *Risk of death from air pollution per year*

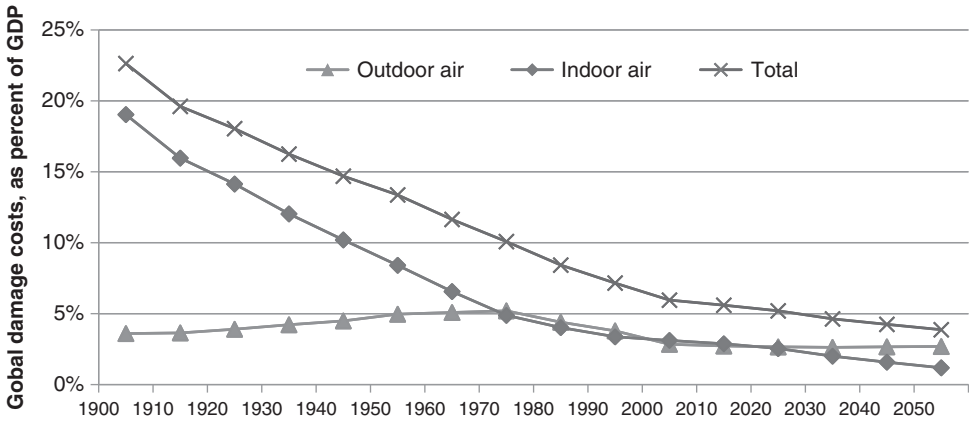

Figure I.6 *Global damage costs from air pollution, outdoor versus indoor, as percent of GDP*

However, Hutton's chapter also signals a change on the horizon: before mid-century, it is reckoned that outdoor pollution will become more important than indoor, as urbanization increases but most people have access to improved cooking stoves. Although absolute numbers affected continue to decline, the economic cost of mortality rises with increasing prosperity.

As Hutton explains, the decreasing trend of air pollution is encouraging. However, he points out that the projected reductions in damage costs beyond 2010 depend on the success of current and future policies to reduce exposure to air pollution in both urban and indoor environments. Maintaining progress requires us to ensure that appropriate policies are implemented, and sustainable economic growth continues.

Pollution is an unwanted side effect of developments which have also provided many benefits for humans: the burning of fossil fuels, and urbanization. However, the most-discussed and major impact of greater use of fossil fuel energy is clearly climate change, and in Chapter 3 Richard Tol addresses its economic costs. In particular, he tries to estimate past costs as a way to improve confidence in projections of future impacts. Generally, attention focuses on the likely negative impact of climate change, but Tol's chapter takes a more nuanced and balanced view. The model he uses includes a range of impacts: agriculture and forestry, sea level rise, various health issues, energy consumption, water resources, ecosystem effects and storms.

In some cases – agriculture in particular – the impact over the twentieth century has been very positive. In others, such as water, the impact has been generally negative, while for health effects the impact has been both negative and positive at different times.

Projecting forward through the twenty-first century, cold-related cardiovascular deaths fall steadily, while those caused by heat rise rapidly. Deaths from respiratory disease also increase, but those due to malaria and diarrhea fall with improving healthcare as a consequence of economic growth.

Overall, the greatest losses towards the end of the twenty-first century come from the energy sector. In the twentieth century most countries gained slightly from the moderate warming, because the higher costs of cooling were somewhat outweighed by reduced costs of heating. From 2035, however, extra cooling costs will increasingly outweigh the reduced heating costs, leading to a significant net cost of about 2% GDP by the end of the century.

It is important to emphasize that there is a clear divide between the rich, temperate countries which have overall benefitted from warming and poor, tropical countries, for whom the impact has been mostly negative. This trend looks set to become even more marked over the twenty-first century, highlighting the need to pursue an effective response to climate change.

Overall, Tol finds, the pattern of climate change over the twentieth century improved human welfare. In the first part of the twentieth century, climate change caused a welfare increase of 0.5% GDP, edging up to 1.4% by 2000. For the future, he estimates the welfare benefit will reach its maximum at 1.5% by 2025; it will be reduced to about 1.2% by mid-century, before going rapidly negative in the last two decades of the century, ending at −1.2% in 2100 (Figure I.7).

In Chapter 2, S. Brock Blomberg and Gregory Hess look at the cost of conflict. Military expenditures and the cost of human lives make war inherently wasteful but, for a range of reasons, it sadly still persists. Indeed, wars have led to an appalling loss of life during the twentieth century: 140 million or more deaths, with 78–90 million of those resulting from the two world wars.

Blomberg and Hess look at the balance between "Guns" and "Butter" – a convenient shorthand for military and consumption. A simple way to look at the cost of guns is, of course, how this spending cannot be used for consumption spending; that is simply to look at the cost of guns across time as the cost of conflict. However, the chapter also analytically looks at the utility of a decline in military spending, or essentially to estimate the amount which people would be willing to pay to avoid returning to a time of previous conflict and provide point estimates for this.

For the future, the authors look at three potential scenarios:

- High-conflict scenario – conflict and military spending, due to the events following 9/11, continues to grow at the trend rate from 2000 to 2007
- Medium-conflict scenario – conflict and military spending remain steady at the current ratios