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Chapter I

Climate change and the development challenge

INTRODUCTION

We are living in the best and worst of times. Over the long sweep of history, our world has never been more prosperous, inventive or interconnected than it is today. Yet economic insecurity has become ubiquitous, social divisions are greater than ever, and the health of the planet has never been so fragile. These are interrelated challenges that can be effectively addressed only through cooperation and collective actions, at both the national and international levels.

In recent years, collective actions have been hampered by technocratic complacency, which privileged private means over public ends. Deregulation and corporate leadership were deemed to be all that was needed to find the quickest and most efficient solutions to contemporary policy challenges, from health care provision and urban renewal to poverty alleviation and climate change. This mindset has been surrounded by the rhetoric of targets, partnerships and synergies, which drains policy discussion of much of its substance and tends to gloss over the conflicts and difficult trade-offs involved in big policy challenges.

Climate change is not just a major challenge for the coming decades—it is an existential threat. Recent estimates suggest that 300,000 people die each year as a result of global warming, and the lives of 300 million more are seriously threatened. We know more than ever before about why this is happening. The Intergovernmental Panel on Climate Change (IPCC), established in 1988 by the United Nations Environmental Programme and the World Meteorological Organization, has provided invaluable information and analyses concerning why and how our climate is changing, and with what consequences. The wider scientific community has backed up their efforts with a mountain of supportive evidence and modelling exercises. Theirs is a sobering picture of how emissions of man-made greenhouse gases have already frayed our environmental fabric and threaten to rip it apart. The race to keep global temperatures within safe bounds is now a race against time. Global emissions have risen steadily in the last two decades, but to avoid potentially catastrophic impacts, a growing body of

research indicates, emissions must start dropping before 2020, and be down to 50–60 per cent below 1990 levels by 2050—with continuing declines required thereafter.¹

So far, knowledge of the science has not translated into a focused policy response. Although industrialized countries know that it is two centuries of their carbon-fuelled growth that underlies the warming trend, they have failed to commit the resources and political will needed to establish an alternative development pathway. At the same time, for most of the rest of the world, catching up through continued economic development remains a top priority. Given industrialized countries' inaction, it is difficult to persuade developing countries to find alternative (and expensive) energy sources to meet their own development objectives.

Hopes for a new round of climate negotiations have not yet been fulfilled; fundamental questions remain unanswered: How much emissions reduction should take place, and where and by when? How much will it cost to meet the targets, and how will they be covered? How should a proper and enhanced global adaptation response be framed in light of the significant impacts of climate change?

This book does not try to provide the answers—those can only be found through open, inclusive and frank negotiations among all the nations involved. But even assuming that an agreement is reached, the work of translating it into an effective programme of transformative change will require ongoing adjustments, continuous consultation and response to persistent policy challenges. Accordingly, our analysis looks at the building blocks of a long-term solution—mitigation, adaptation, technology and finance—in order to consider what is being asked of developing countries, and what the international community must do to ensure that they can meet those expectations without jeopardizing their development goals.

We proceed essentially by working back from 2050, by which time there are likely to be another 2 billion or more people on this planet,² the vast majority of whom will be living in the cities of the developing world. If current trends continue, not only will most of them be poor and insecure, but they will also be much more vulnerable to climate-related threats.

A crucial step toward the solution consists of lowering the level of emissions released into the atmosphere. This step is absolutely necessary—but it is not, alone, sufficient to achieve a sustainable solution to the crisis. In advanced countries, significant emissions reduction has to be accompanied by strong employment levels and a search for energy security. In developing countries, pursuit of a low-emissions path must be compatible with catch-up growth, industrialization and urban expansion.

Since this book focuses, to a great extent, on the interrelated climate and development challenges faced by the developing world, it pays particular attention to mitigation challenges around energy use (chap. II). But inasmuch as creating resilience to climate threats is essential for many poor countries, we seek to dispel the erroneous notion that countries must choose between mitigation and adaptation (chap. III). Thus we spell out the shared opportunities and synergies to be derived from investment-led responses to both these challenges, from forging truly integrated strategies, and from reviving the role of an effective developmental state (chap. IV).

The adjustments that are being asked of developing countries are unprecedented and will carry heavy investment costs, particularly in the initial stages of the transition. Those costs present the major obstacle to the development of low-emissions, high-growth pathways. But if properly managed, they can provide developing countries with a foundation for mobilizing their own resources to meet the climate challenge. Still, to ensure both sufficient technological transfers (chap. V) and sufficient access to financial resources (chap. VI) will require a level of international support and solidarity rarely mustered outside a wartime setting.

DEVELOPMENT IN A WARMING WORLD

The development challenge

The industrial revolution, beginning in the late eighteenth century, inaugurated two processes of far-reaching consequences. The first enabled a select few countries to embark on a modern economic growth path, breaking the constraints on development imposed by the natural environment and the localization of economic activity. New levers of wealth creation emerged around market specialization, innovation and scale economies, and in the context of industrialization, urbanization and the greater interconnection of communities. In the wake of this transformation, the income gap between the group of early starters and the rest of the world widened rapidly, all the more since the exploitation of resources and markets by colonizers suppressed economic opportunities in many countries and communities across the world for a century or more.

The second process transformed the relation between humans and nature: instead of merely adapting, humans now dominated the environment and placed ever-increasing demands on it in the service of expanding output. In particular, the traditional energy sources (biomass, water and wind) used to complement manual labour and animal transport were replaced,

initially by coal and then by oil, for the purpose of powering increasingly sophisticated machines and means of transport. Access to these cheaper fossil fuels has been a critical stepping stone on all modern development pathways. However, the full cost of exploiting carbon-based fuels and other natural assets has often gone unrecorded.

Over the past 50 years, developing countries have tried to close the economic gaps created over the previous two centuries. The process has not been smooth, and external constraints and shocks have persistently upset efforts in many countries. While some developing countries, particularly those in East Asia, have been successful, they have been atypical (see figure I.1). In fact, beginning with the debt crisis of the late 1970s, economic constraints tightened and shocks intensified, which led to a fragmented and divergent pattern of global growth. The most notable success story has been China, whose uninterrupted growth over the past 30 years has been one of the drivers of the positive aggregate trends in the recent social and economic performance of the developing world. Between 2002 and 2008, unprecedented strong growth was registered almost everywhere, including in the least developed countries, reflecting, in part, the growing economic interactions among developing countries themselves. However, that phenomenon came

Figure I.1:
The income gap between G7 countries and selected regions, 1980-2007

Source: UN/DESA calculations, based on WB-WDI online database.

^a Hong Kong Special Administration Region of China; Republic of Korea, Singapore; Taiwan Province of China.

^b Indonesia, Malaysia, Philippines, Thailand.

to an abrupt end with the onset of the most severe economic crisis since the 1930s. The heavy reliance on debt which fuelled much of that growth has proved an unreliable substitute for sound development strategy.

Government leaders in many developing countries are concerned that climate change is being used by those at the top of the development ladder to again hamper their nations' efforts to climb higher. How developing countries can achieve catch-up growth and economic convergence in a carbon-constrained world, and what the advanced countries must do to facilitate this, have become leading questions for policymakers at the national and international levels.

The climate challenge

The science is unequivocal: our climate is changing for the worse, owing to human activity. By causing an increase in emissions of greenhouse gases, human activity has led to an increase from the pre-industrial concentration of 280 parts per million (ppm) of carbon dioxide (CO₂) in the atmosphere, to more than 390 ppm today. This, in turn, is causing a major disruption in the natural climatic processes of the planet—and one that will not be eliminated overnight. Carbon dioxide and some other greenhouse gases have a long residence time in the atmosphere; in other words, once emitted, they remain there for decades.

Atmospheric carbon levels have reached such high levels primarily due to emissions from the production of energy for use by rich countries. Today fossil fuels are used to meet some 80 per cent of total energy needs. While energy emissions are the largest culprit by far, they are not the sole source of the problem (table I.1). Globally, forest ecosystems contained 652 billion tons of carbon in 2010, continuing a slow but steady decline over the last two decades;³ changes in that mass of embodied carbon also have a large effect on atmospheric concentrations. Deforestation and forest degradation are the primary sources of carbon emissions from some developing countries. In 2005, forestry and land-use change released about 5.4 gigatons of CO₂ into the atmosphere, accounting for 15.9 per cent of all human-generated CO₂ emissions, and 12.2 per cent of total greenhouse gas emissions.⁴

The consequences of rising emission levels are now becoming clear. Global average surface temperature increased by almost 1°C between 1850 and 2000, with a noticeable acceleration in recent decades (see figure I.2). The global average sea level increased at an average rate of 1.8 millimetres (mm) per year over the last 50 years. More recently, from 1993 to 2008, however,

Table I.1 Greenhouse gas emissions (carbon dioxide, methane, nitrogen dioxide, perfluorocarbons, hydrochlorofluorocarbons and sulphur hexafluoride) by sector, 2005		
Sector	Megatons of CO ₂ equivalent	Share (percentage)
Energy	28,432	64.4
Electricity and heat	12,365	28.0
Manufacturing and construction	5,207	11.8
Transportation	5,374	12.2
Other fuel combustion	3,744	8.5
Fugitive emissions	1,743	4.0
Industrial processes	1,884	4.3
Agriculture	6,075	13.8
Land-use change and forestry	5,376	12.2
Waste	1,419	3.2
International bunkers	941	2.1
Total	44,127	100.0
Source: World Resources Institute, 2010.		
Note: Details may not add to totals due to rounding.

it rose by 3.1 mm per year.⁵ There have been large changes in patterns of precipitation, with significant increases in eastern parts of North and South America, Northern Europe, and northern and Central Asia, and decreases in the Sahel, the Mediterranean, Southern Africa and parts of South Asia. The area affected by drought has increased. Extreme weather events have increased in number, scope and intensity. Climate change is significantly affecting forests: there have been changes in their physiology, structure, species composition and health, largely owing to changes in temperature and rainfall. Many tropical forests in Latin America have experienced losses in biodiversity. Increased temperatures and drought result in more frequent outbreaks of pest infestations, more forest fires, and increasing alterations in populations of plant and animal species, severely affecting forest health and productivity.

A synthesis of the findings of a major climate science conference in March 2009, which included contributors to Intergovernmental Panel on Climate Change (IPCC) reports, notes:

Many key climate indicators are already moving beyond the patterns of natural variability within which contemporary society and economy have developed and thrived. These indicators include global mean surface temperature, sea-level rise, global ocean temperature, Arctic sea ice extent, ocean acidification, and extreme climatic events. With unabated emissions, many trends in climate will likely accelerate, leading to an increasing risk of abrupt or irreversible climatic shifts.⁶

That the situation will worsen is no longer in doubt; the only question is by how much. Table I.2 presents the emission scenarios identified by the IPCC and their likely impact on temperatures and sea level by the end of this century. In general, greater emissions lead to greater changes in climate, while lower emissions lead to smaller changes. Moreover, as the IPCC has noted, its own scenarios report, released in 2000, and most scenarios developed since then fail to take into account the uncertainties regarding key climate processes and feedbacks. These include transmission of heat to lower depths of ocean, causing thermal expansion; contraction of the Greenland ice sheet; contraction of the western Antarctic ice sheet; reduction in the terrestrial and ocean uptake of atmospheric CO₂ as the CO₂ level rises; cloud feedback; and slowing down or even reversal of the meridional overturning circulation, among others. These feedbacks add another layer of complexity and uncertainty to future projections, but the uncertain risks largely point in the same direction, toward more severe or even catastrophic outcomes.

Table I.2 Emission scenarios and their impact				
Scenario	Greenhouse gas concentration in 2100 (ppm CO ₂ e)	Temperature change (°C) in 2090-2099 relative to 1980-1999		Sea-level rise (metres) in 2090-2099 relative to 1980-1999
		Best estimate	Likely range	Model-based range (excluding some future changes in ice flow)
Constant year 2000 concentration		0.6	0.3-0.9	not available
B1	600	1.8	1.1-2.9	0.18-0.38
A1T	700	2.4	1.4-3.8	0.20-0.45
B2	800	2.4	1.4-3.8	0.20-0.43
A1B	850	2.8	1.7-4.4	0.21-0.48
A2	1250	3.4	2.0-5.4	0.23-0.51
A1FI	1550	4.0	2.4-6.4	0.26-0.59
Source: Intergovernmental Panel on Climate Change, 2007a, Table 3.1.				
Note: The Intergovernmental Panel on Climate Change broadly identified four possible economic pathways (or “storylines”), referred to as A1 (a convergent world with fast economic growth); A2 (a non-convergent world with slow economic growth); B1 (a convergent and more environment-friendly world); and B2 (a non-convergent but environment-friendly world with an intermediate rate of economic growth). In addition to the above four broad storylines, the following three sub-variants of A1 have been distinguished, depending on the energy composition of economic growth: A1FI (relatively greater dependence on fossil fuels); A1B (a more balanced dependence on different energy sources); A1T (a greater reliance on non-fossil energy sources).				

Many models also suggest that if emissions continue at “business as usual” rates, the stock of greenhouse gas emissions in the atmosphere will reach double the pre-industrial level in the second half of this century, resulting in a high probability of dangerous temperature rises, with potentially destabilizing economic and political consequences.

The interdependency challenge

The climate and development challenges are inextricably linked. When the overriding policy priority is economic growth, expanding the reach of energy and transportation infrastructure and making them available to an increasingly urban population and industrial workforce are unavoidable. So are major land-use changes. If developing countries simply stay on the path followed by today’s rich countries, the impact on the earth’s climate will be devastating.

At the same time, the prospects for more sustainable development are likely to be undermined by the direct and indirect impacts of climate change on economic growth. If climate damages reduce the resources available to invest in diversification and resilience, there will be heightened vulnerability to future climate trends and shocks. This vicious circle is already apparent in many arid and semi-arid countries in Africa. Adverse impacts on food and water supplies as well as on health conditions are likely to tighten growth constraints in other parts of the world.

An understanding of the complex ways in which economic development and climate variables interact is still evolving. However, the cumulative and unstable nature of that interaction poses obvious challenges for policymakers. This book seeks to build its assessment of that challenge around the pivotal role of investment and to examine some of the linkages and feedbacks that, from this starting point, can help define development strategies in a warming world.

FROM FREE-RIDING TO BURDEN-SHARING

The Stern Review on the Economics of Climate Change, released by the British Government in October 2006, identified climate change as “the greatest market failure the world has seen” and provided a path-breaking attempt to model the cost of doing nothing compared with the cost of adopting an alternative strategy to hold emissions below a manageable threshold.⁷ This perspective rests on a form of “climate ethics”, centred on the challenge of providing a “global public good” and the need to realign social and private cost by making polluters pay for past, current and future damages from carbon emissions. The Stern Review concluded that future generations could be made much better off at relatively little cost to present generations.

Recognizing that a stable climate is a global public good makes an important point about the systemic nature of the challenge and the need for collective action to overcome it. Yet the interconnected problems of climate and development cannot be understood solely in these terms: while climate stability can only be provided to everyone at once, the same is clearly not true of economic development. There are intertwined problems of externalities, of vested interests and market power, and of uncertainty, making the market by itself an imperfect instrument for managing these challenges. Moreover, difficult distributional issues, rooted in a very uneven historical pattern of economic development, are obscured by the terminology of global public goods.

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Historically speaking, it is largely emissions produced by the industrialized countries that have caused a rise in greenhouse gas concentrations. As table I.3 shows, developed countries produced three-quarters of the world's CO₂ emissions from 1850 to 2005, and the per capita emissions of most developing countries are much lower than those of developed nations. (The exceptions, such as Brazil in table I.3, are often countries with large emissions from deforestation and land use changes.)

Table I.3 Share of cumulative CO ₂ emissions, 1850-2005, and per capita emissions, 2005, selected countries		
	<i>Share of global cumulative CO₂ emissions 1850-2005 (percentage)</i>	<i>Per capita emissions, 2005 (metric tons of CO₂e)</i>
Developed countries		
United States	29.2	23.5
European Union (27)	26.9	10.9
Russian Federation	8.2	14.2
Germany	7.1	12.2
United Kingdom	6.0	11.4
Japan	3.8	10.9
France	2.8	9.4
Canada	2.2	25.0
All Annex I	74.6	
Developing countries		
China	8.3	5.5
India	2.3	1.7
South Africa	1.1	9.2
Mexico	1.0	6.7
Brazil	0.8	15.3
Pakistan	0.2	1.6
Philippines	0.2	2.5
All non-Annex I	25.4	
<p>Source: World Resources Institute, 2010. Annex I and non-Annex I figures calculated by the authors from CAIT 8.0 data.</p> <p>Notes: Annex I grouping includes economies in transition. Global emissions 1850-2005 are for energy only. Per capita emissions include CO₂, CH₄, N₂O, PFCs, HFCs, and SF₆, including emissions from land-use change and forestry (LULUCF) and international bunkers. Brazil's per capita emissions are a particularly stark example of the impact of the LULUCF category on some developing countries' emissions; without it, Brazil's per capita emissions are 5.5 tons for 2005.</p>		

Responsibility for emissions is a major factor in discussions of who should bear the costs of mitigation, so the question of whether to look at historical or current emissions is crucial. Much has been made recently, for example, of the fact that China has replaced the United States as the single largest emitter. However, China's *per capita* emissions levels remain far below those of the developed countries (and in fact, below those of many other developing countries); indeed, China's 2005 per capita emissions, 5.5 tons CO₂e, were still less than half those of the United States at the start of the First World War. On a cumulative historical basis, China is even farther from catching up to developed country levels (see figure I.3).

Wealthier countries' climate policies could also have adverse spillover effects for developing countries in terms of international trade, financial flows and commodity processes—as is already the case with the market impacts of the growth in biofuel use, for example. Industrialized countries' stance on intellectual property rights, meanwhile, will have a significant impact on technology transfer, which is crucial for developing countries (see chap. V). Against this backdrop, it seems unreasonable to accuse developing countries of wanting to be “free riders” in climate mitigation because they resist commitments being imposed on them. In fact, a much more nuanced framework will be needed to manage the burden of protecting the climate on an equitable basis. Several proposals for advancing the discussions are currently on the table (see box I.1).

Figure I.3:
Annual per capita emissions, selected regions, 1950–2008

Source: See table I.3.

Box I.1: Burden-sharing proposals

Numerous burden-sharing mechanisms have been proposed by researchers and by participants in the global climate negotiation process, including:

Equal per capita emissions rights. A global limit on annual emissions is divided by world population, resulting in an equal per capita right to emit. Each country is allocated a level of emissions proportional to its population. The limit on global emissions would be reduced over time to achieve a desired stabilization trajectory (Agarwal and Narain 1991; Narain and Riddle 2007).

Individual targets. Again, a limit is set on world annual emissions, and a “universal cap” on per capita emissions is calculated. But then, to prevent high-emitting individuals from free-riding on low emitters’ unused rights, each country’s allocation is calculated as the sum of actual emissions for all residents with emissions below the cap, and the universal cap for all residents with emissions currently above the cap (Chakravarty et al. 2008).

Contraction and convergence. This plan phases in equal rights to emit by a target date. Each country is allocated emission rights based on its past emissions. Countries that exceed desired per capita global emissions have their allocation reduced in each succeeding year, while countries that emit less than this target receive a higher allocation each year. Over time, global emissions contract while high- and low- emitting countries converge on the same target per capita emissions (Global Commons Institute 2008).

One standard, two convergences. Each country gets an emission allowance based on the per capita emission reductions needed to meet a desired target. Different per capita ceilings are set for industrialized and developing countries, so developing countries have more room to grow their economies before having to decrease emissions to stay within their cumulative cap. The ceilings are adjusted annually until they achieve convergence. Trading of emissions rights makes it possible for all developing countries to use or benefit from their entire allowance (Gao 2007).

Greenhouse Development Rights. The burden of emissions reductions is allocated based on countries’ relative capacity to pay and their responsibility for past and current emissions. Both criteria exempt per capita incomes and emissions below a “development threshold” in order to safeguard the right of low-income countries to economic growth, and to ensure that only individuals above the threshold income level have to pay for emissions abatement. Each country is assigned an obligation to pay for abatement—whether at home or abroad—based on its share of cumulative emissions since a base year (such as 1990) and the cumulative income of its population, counting only emissions and incomes above the development threshold (Baer, Athanasiou and Kartha 2007).

Revised Greenhouse Development Rights. Formulated by researchers at Tsinghua University in a report prepared by the Chinese Economists 50 Forum, this framework adjusts the GDRs model by including cumulative emissions going back to 1850, and accounting for emissions based on consumption (rather than on production) within each country. The result is a greater responsibility on the part of industrialized countries to pay for emissions reductions around the world (Fan et al. 2008).

Source: Ackerman and Stanton, 2009.

Still, in a very real sense, the future of the planet rests with the efforts of the developing world. Already, rich countries represent less than one sixth of the global population, and almost all of the additional billions of people to be added to that population over the next few decades will be in the developing world. Though industrialized countries will likely bear most of the initial costs of climate change mitigation, commensurate to their historical responsibility and greater economic resources, developing countries themselves will have to take measurable and verifiable steps to protect their own future.

Developing countries' scepticism about international mitigation efforts has been driven as much by developed countries' recent performance regarding climate policy as by their past record on economic development. For example, the Clean Development Mechanism, established under the Kyoto Protocol to the United Nations Framework Convention on Climate Change, was supposed to be an important link between developed countries' emission reduction efforts and efforts of developing countries, but has failed to live up to expectations, in terms of both quantity and quality. Similarly, the level of support provided to various funds set up to help developing countries adapt to climate change has been very low so far (see chaps. III and VI). Lack of bold and generous leadership has given rise to a lack of trust, which now represents a serious obstacle to mustering the international cooperation needed to deal effectively with the climate challenge.

Charles Kindleberger observed that in a world of interdependent nation states with widely differing access to economic resources and political power, effective multilateral cooperation depends on "positive leadership, backed by resources and readiness to make some sacrifice in the international interest".⁸ He also recognized that the leadership role often goes unapplauded, particularly at home, and has a tendency to retreat or atrophy, but he argued that, particularly in a time of crisis, the hallmark of leadership is the willingness to assume responsibility. The urgency of the climate crisis certainly calls for a renewed leadership role from those countries most responsible.

International cooperation does not, however, hinge on leadership alone. Strong state capacities are needed, at all levels of development, to help shape a common and inclusive vision, to ensure that the limitations on national sovereignty in some areas are balanced by the opportunities opened up in others, and to guarantee effective participation in the negotiation and implementation of international rules, regulations and

support mechanisms. In this respect, the erosion of state capacity in recent years, particularly in developing countries, represents an obstacle to international cooperation and has contributed to the lack of transparency and democratic accountability in many multilateral institutions. Correcting this is an urgent priority if real progress is to occur on the climate issue (for further discussion, see chap. IV).

THE POLICY RESPONSE

The timid policy response to the climate crisis to date reflects the fact that climate change has so far been a slow-moving process; its impacts have been less perceptible than many other shocks and crises confronting policymakers in the “normal” political cycle. Moreover, its consequences may have seemed easy for some to ignore, since their brunt has been borne by the poorest countries and communities.

Yet, climate scientists have continued to build a vast array of evidence and analyses demonstrating the unprecedented historical scale and speed of greenhouse gas increases, the signs of acceleration, the damage that has already been done to the climate, and the risks of getting locked into irreversible pathways if trends continue. This has led some countries to adopt ambitious targets for emissions reduction—but opinion surveys suggest that there is still a long way to go to convince politicians and the public of the urgency of the challenge.

The environmental movement has a long track record of not only warning of the dangers of unchecked pollution and reckless exploitation of natural assets, but also organizing successful campaigns on local issues. The political parties, regulatory reforms and environmental ministries that have emerged from those campaigns have taken the lead in responding at the national level to environmental challenges, especially in developed countries. Moreover, this community has been on the front lines in the ideological battle against climate sceptics. On the other hand, it has struggled to forge its own integrated perspective on the economic, political and scientific dimensions of the climate challenge, particularly in the international arena. Even where such a perspective has begun to emerge in richer countries, the implications for the developing world, where rapid growth, industrialization and urbanization remain paramount goals, have not been clearly or convincingly spelled out.

Economists have contributed their own perspectives on climate change, focusing on policy options. Theirs is a language of risk assessment, measured trade-offs between costs and benefits, marginal price changes,

and discounting of future outcomes. Their “integrated assessment models” have an aura of quantitative rigour and precision, but they typically endorse an overly cautious approach, either by showing that a slow response is economically optimal, or by offering facile solutions to “externalities” so the market can reassume its central role.⁹ In the context of climate change, their practical policy advice has focused on the mechanics of carbon taxes or trading schemes, and on the dangers of ambitious climate initiatives constraining future growth.

Integrated assessment models also generally have little to say about structural inequality or historical development; this has been a long-standing target of criticism of conventional economic models. Perhaps more surprising, however, has been the cavalier attitude of many economists towards climate risk. The Oxford economist Dieter Helm has argued that current climate policy and targets are being designed on the basis of current economic structures and of how marginal emissions reductions can be achieved from such a starting point, but with very little attention paid to long-term structural trends.¹⁰ This approach is likely to seriously underestimate the size and cost of the challenge. One set of estimates of probabilities that scientists attach to the occurrence of higher temperatures are given in table I.4; they are far higher than risks that often lead individuals to take out insurance against worst-case scenarios. On this basis, some economists have suggested that the risks of catastrophic global warming merit a collective response that could be viewed as a planetary insurance policy.

Meanwhile, those who are shaping climate policy may not realize the implications of the adjustments they are asking of developing countries.

Table I.4
Probability of exceeding specified temperature increases at different greenhouse gas stabilization levels

<i>Stabilization level (ppm CO₂e)</i>	<i>Increase in temperature (°C above the pre-industrial level)</i>					
	2	3	4	5	6	7
450	78	18	3	1	0	0
500	96	44	11	3	1	0
550	99	69	24	7	2	1
650	100	94	58	24	9	4
750	100	99	82	47	22	9

Source: Stern, 2009, p. 26, citing Murphy et al., 2004.

Note: The probabilities are based on the Hadley Centre Ensembles.

Industrialization and urbanization are hard-wired into the development process; hence restricting these processes, and the attendant expansion of energy sources that they require, is not an option. Holding down emissions in developing countries will require not only a massive injection of renewable sources into the energy mix, along with improved energy efficiency, but also prevention of deforestation, changes in land-use planning, and reorganization of transport and water management. All of this entails major costs—costs that explain developing countries' objections to externally imposed emission commitments. Moving the climate agenda forward demands an integrated approach, a climate-inclusive developmental approach. Treating climate and development separately, as has largely been the case in the past, no longer provides a tenable framework for progress on either front.

INTERRELATED THREATS

Climate change and development are closely interconnected, with cumulative feedbacks and reactions in both directions, particularly through the production and use of energy. Economists, as suggested earlier, have a poor record when it comes to analysing these kinds of feedbacks and cumulative linkages. Policymakers, meanwhile, often appear predisposed to underestimate both the scale of the threats they are facing and the cost of removing those threats.

More recently, however, there have been growing signs of recognition of the urgency of the situation, and awareness that the international community faces a series of interrelated threats which can no longer be effectively tackled in isolation. A climate crunch, an energy crunch, a food crunch, and, most dramatically in recent years, a credit crunch have all exposed the danger of leaving risk management in the hands of the self-regulating forces of the marketplace.

Since 2008, policymakers in high-income countries have been struggling to deal with the interconnected shocks of a housing crisis, excessive energy consumption and financial collapse which have rippled and intensified throughout an increasingly fragile global economy. However, the challenges posed by the linkages among climate change, economic insecurity and political conflict are even greater for developing countries, and the consequences are likely to reach well beyond their own borders.

Adaptation without mitigation would ultimately be an ineffective response for developing nations, and the failure to deal with these interrelated threats

would almost certainly have widespread and damaging consequences. It is increasingly clear that the climate and development problems will be solved together, and soon—or not at all.

A New Deal?

Parallels have often been drawn between the climate challenge and the mid-twentieth century experience of overcoming global economic crisis, defeating fascism and rebuilding ravaged economies. Al Gore, the former United States vice president, has suggested a Marshall Plan of sorts to tackle global warming (see chap. VI). Since the sharp downturn in the global economy starting in 2008, however, the emphasis has shifted to trying to develop a global new deal that can respond to the economic and climate threats simultaneously.

Historical analogies always need to be treated with a degree of caution, but as noted in chap. IV, the original New Deal, the United States' policy response to the 1930s depression, did address a series of interrelated threats through the kind of expanded and transformative policy agenda that is needed today. The scale of the response is also worth recalling: The New Deal committed 3 per cent of gross domestic product (GDP) to domestic programmes each year between 1933 and 1939, and much more was added in military spending to counter the threat of fascism during World War II. After the fighting stopped, the United States, through the Marshall Plan, committed almost 1 per cent of its GDP each year for five years to rebuild Europe. This was a massive investment over a 20-year period.

Economists have suggested that a smaller effort will be needed to respond to climate change. That seems optimistic. As Nicholas Stern indicates, the multi-decade strategy that is needed to keep climate risk manageable will involve long-term planning and massive investment and will require the kind of leadership and cooperation that helped defeat fascism and rebuild shattered economies.¹¹ Time is also of the essence; the sooner we start investing in a transition to low-emissions development, the lower the costs and the greater the chances of success will be.

No country left behind

Gauging the costs of climate change is difficult and requires reliance on modelling assumptions and scenarios. Damage functions are difficult to specify, externalities are difficult to price, and costs rise with the

ambitiousness of the targets. Using standard economic models, the IPCC's *Fourth Assessment Report* estimated that the damage inflicted by climate change would entail, on average, a loss of 1 to 5 per cent of global GDP. However, the IPCC also noted that globally aggregated figures are likely to underestimate the damage costs, because they cannot include many "non-quantifiable impacts".¹²

Climate damages to developing countries are already perceptible. Indeed, one recent study estimated that for every 1° C rise in average global temperatures, annual average growth in poor countries drops by 1.1 percentage points, but there is no drop in rich countries.¹³ Table I.5 presents two sets of estimates, from one of the widely used economic models, of the damages under a "business-as-usual" (BAU) scenario. Under either scenario—using either average or much worse than average assumptions—the damage to developing regions (measured as a percentage of projected GDP in 2100) is more than double that for OECD countries excluding the United States, and more than five times the damage to the United States.

Climate change is also multiplying vulnerabilities in developing countries by heightening livelihood risks and weakening adaptive capacities. More

Table I.5
Business-as-usual damages in 2100: The PAGE2002 model

Region	Annual damages as percentage of GDP in 2100			
	Economic	Non-economic	Catastrophic	Total
A. Mean damages in 2100: 'no adaptation' scenario				
United States	0.3	0.4	0.1	0.8
Other OECD	0.7	1.0	0.2	1.9
Rest of the world	1.6	2.3	0.4	4.3
World total	1.2	1.8	0.3	3.4
B. 83rd percentile damages in 2100, no adaptation, increased catastrophic risk and increased damages scenario				
United States	0.6	0.9	1.2	2.6
Other OECD	1.4	2.0	3.1	6.2
Rest of the world	3.2	4.5	6.3	13.5
World total	2.5	3.6	4.8	10.8

Source: Ackerman et al., 2009.

Notes: The results are based on a Monte Carlo analysis of 5000 runs of the PAGE2002 model. Both scenarios "turn off" the default PAGE assumptions about low-cost adaptation. Scenario B also modifies the probability distributions for catastrophic risk and for the relationship between temperature and non-catastrophic damages. See source for details. As the impacts are closely but not perfectly correlated, the 83rd percentile of total damages is slightly less than the sum of the 83rd percentiles of the individual damage categories.

than one-third of the world's population lives within 100 kilometres of a shoreline, facing threats from sea-level rise and storms; one in 15 people lives in coastal areas at elevations below 5 metres, where sea-level and storm surge risks are extreme.¹⁴ In other areas, extended periods of drought have created a flow of environmental refugees and conflict with neighbouring countries. Similarly, tropical diseases are expected to become more common in areas with increased incidence of heat waves, while the prevalence of water-borne diseases is likely to rise in areas with an increased incidence of floods (see chap. III).

Populations that are already vulnerable because of low levels of economic and human development will be hit hardest by the growing threats from climate change. Poorer countries and communities with poor health care, lack of infrastructure, weakly diversified economies, missing institutions and soft governance structures may be exposed not just to potentially catastrophic large-scale disasters, but also to a more permanent state of economic stress as a result of climate impacts. That increased vulnerability, in turn, will deepen inequalities, with the least developed countries and small island States most affected.

In this context, adaptation is essentially a development challenge. It will require significant investments, not only to climate-proof existing projects and ensure effective responses to natural disasters, but also to diversify economic activity and address existing vulnerabilities. In many cases, adaptation will also dovetail with mitigation, which is equally important. For example, energy conservation measures could be classified under both mitigation and adaptation. Chap. III develops these arguments.

Common but differentiated mitigation challenges

Accumulating scientific evidence indicates that to prevent dangerous interference with the climate, atmospheric carbon concentrations should be stabilized at levels that keep temperatures from rising by more than 2° C above pre-industrial levels. As noted before, this would require reducing emissions by 50–60 per cent below 1990 levels by 2050, and even then, there is a serious risk. The longer we wait to start, the more rapidly we will have to reduce emissions later, and the greater the costs will be. Advanced countries should take the lead (see chap. II), both to reduce their own emissions, and to support the efforts of developing countries to establish a viable low-carbon development pathway.

Researchers have used both case-study evidence and modelling exercises to better understand the mitigation costs involved. Using the former approach, McKinsey & Company has developed a ranking of mitigation steps in order of increasing marginal costs (see chap. II). Others have identified “wedges” of alternate technologies, such as automobile efficiency improvements, increased reliance on renewable energy, or carbon capture and storage, that could displace a certain amount of emissions each year.¹⁵ The alternative has been to use integrated assessment-type models to estimate mitigation costs, but the two approaches are not mutually exclusive.

While the absolute values of required investment can appear quite high, the costs of inaction are even higher. It is also clear that the lower the stabilization level chosen, the safer the future, but the higher the initial investment costs. As noted above, very broadly, even an annual cost as high as 2 or 3 per cent of global GDP is small in comparison with the potential damage from following business-as-usual pathways. Thus the benefit-to-cost comparison is strongly in favour of rapid action to mitigate climate change.

DEFINING LOW-EMISSIONS, HIGH-GROWTH PATHWAYS

The shift to a low-carbon economy will pose different challenges for countries at different levels of development. For advanced countries, the emphasis may be on increasing employment and energy security, the core of the so-called “green jobs” agenda. For many developing countries, diversifying economic activity away from the primary sector and low value-added manufacturing remains an essential policy goal, combined with efforts to eradicate poverty and ensure a more balanced integration into the global economy.

Incremental change or a big push?

There are few historical precedents for the kind of transitions needed. One approach is to create incentives for private businesses to shift gradually from high-emitting activities and make investments in new high-risk, high-return, climate-friendly technologies. To create the right investment climate, it has been argued, there also has to be a good governance agenda that establishes a price for carbon, guarantees strong intellectual property rights and removes distortionary subsidies for high-emitting activities.

Alternatively, the transition could be driven by a series of large and long-lasting investments in energy infrastructure, land-use changes,

transportation, etc.—which would have to be undertaken simultaneously to have a significant impact on climate change. This is the approach adopted by this book and one also advocated by leading specialists, such as experts of the United Nations Committee for Development Policy (CDP).¹⁶ Price incentives by themselves are unlikely to trigger or sustain the required investments. Rather, a “big push” is needed to launch a successful low-emissions development pathway. This revives long-standing questions about the challenges facing poor countries in mobilizing investment resources and the relative roles of the public and private sectors. It also draws attention to the scale of the financing challenge involved; these issues will be discussed in greater depth in chaps. II, IV and VI.

Does technology hold the key?

The dual challenge of meeting development goals, including rapid industrialization, while controlling emissions and reducing carbon dependence will require the creation of new, scalable and powerful technologies in the next 10 to 20 years—technologies that transform not only how energy is produced, distributed and used, but also how we help vulnerable countries adapt to rising temperatures.

While there is broad agreement that technology will play a central role in meeting this dual challenge, there is less of a consensus on how to build technological know-how and capacity, particularly given the significant gaps between rich and poor countries. For some, stronger protection of intellectual property rights, both to encourage local innovators and to attract foreign direct investment, is key to leapfrogging over old technologies onto a cleaner technological highway. Others not only doubt the efficacy of such mechanisms in generating the required level of innovative effort, but also view them as a source of potentially significant obstacles for developing countries (see chap. V).

Experience indicates that, in many successful past instances of technology development, government support has extended beyond research and development, for example, through government procurement and loan guarantees for construction and equipment investments. Yet some question the wisdom of this approach, pointing to the difficulty of second-guessing the market and “picking winners”. Others worry about the high costs of learning and uncertainty that come with experimentation. Such initiatives, whether undertaken by the private or the public sector, constitute grounds for socializing the risks involved. These issues are discussed in greater detail in chaps. IV and V.

An expanded public policy agenda

If climate is, indeed, a global public good, then stopping free-riding, strengthening property rights, and ensuring good collective governance would seem to be the main resulting challenges. But that may be too narrow a framing, in part because the allocation of the atmosphere's limited remaining capacity to absorb emissions, as well as the distribution of the costs of abatement, are contentious, high-stakes issues. Moreover, achieving fast growth in developing countries and high employment in advanced countries along low-emissions pathways will entail complex decisions and trade-offs regarding consumption, settlement, transportation and urbanization. The climate challenge is also difficult to separate from food and energy security and global health issues.

Many disagreements on climate policy stem from diverging views on how best to meet these challenges: should there be a gradual shift away from business-as-usual scenarios or a transformative change? A central question concerns the relative roles of the private and the public sectors in making the needed investments. One way in which governments can act is by instituting a carbon price, through a carbon tax or a cap-and-trade policy, along with strong regulations. Much of the discussion of the climate challenge in developed countries is focused on the relative efficacy of alternative ways of establishing a carbon price. The policy mix in developing countries is likely to be different, with a much larger role for public investment and targeted industrial policies. At every level of development, all policy instruments, ranging from price incentives, taxes, subsidies, and regulation, to fiscal, monetary and financial measures, should be considered.

A LOW-EMISSIONS, HIGH-GROWTH SCENARIO

To assess the implications of various climate and development investment scenarios, a simulation was run with the Global Policy Model (GPM) developed in the United Nations Department of Economic and Social Affairs (UN/DESA).¹⁷ The model was created to investigate the spillover effects of macroeconomic policy scenarios in an interdependent world economy, but it also spells out energy production and demand for country groups and an international market (a pool) which sets the equilibrium price. The model does not specify carbon emissions linked to economic activity; therefore, inferences regarding climate change scenarios are drawn from trends in energy efficiency and energy use.

The business-as-usual (BAU) scenario used as the basis for the analysis assumes that after 2010, the world economy has recovered from the financial crisis and returns to the past pattern of growth. This entails a continuation of current trends in (high-emissions) energy intensity, and in economic inequality. The implication is that, in the BAU scenario, the world resumes growth on a path deemed unsustainable from both a development and an environment perspective.

The alternative, low-emissions, high-growth scenario, built as a policy-driven departure from BAU, requires international policy coordination. Three types of policy adjustment are considered:

- Countries worldwide are assumed to increase public spending levels by 1 to 5 per cent of GDP, with developed countries in the lower end of the range and developing countries in the upper end. The investment push is expected to trigger faster economic growth, promote energy efficiency, and help increase the supply of primary commodities and food at a rate consistent with the growth of world income.
- The investment push and international agreements contribute to reducing high-emissions energy demand (reflecting, for instance, a cap-and-trade mechanism), yielding lower emissions and greater energy efficiency. Such improvements in energy efficiency are consistent with the investment patterns discussed below.
- Economic resilience of developing countries is strengthened by providing those countries, especially the poorest, with full, duty-free market access to developed-country markets, leading to greater economic diversification.

Energy efficiency and energy diversification

To assess the implications of changing course, the model looks at the impact of increased public investments in infrastructure, diversification of economic activity and energy provision by governments worldwide. As discussed further in chap. IV, after possible financial “crowding-out” mechanisms are accounted for, such public spending is found on balance to “crowd in” (i.e., stimulate an increase in) private investment.

The assumption that growth in investment has the potential to boost energy efficiency is based on empirical evidence for a number of countries (see table I.6). Accordingly, the policy scenario assumes a boost in public investment, stimulating growth in total investments. Table I.7 summarizes the outcomes at the end of the simulation period in 2030.

Table I.6 Energy use and total investment, selected countries: 20-year averages, 1990			
	<i>Efficiency: change in energy use per unit of output (percentage per year)</i>	<i>Rate of growth of total investment (percentage per year)</i>	<i>Elasticity: ratio of efficiency gain to investment growth</i>
Switzerland	-1.18	2.10	0.6
Finland	-2.03	4.31	0.5
France	-3.21	3.30	1.0
Sweden	-5.79	2.59	2.2
Japan	-1.98	4.15	0.5
United States	-2.94	3.02	1.0
Source: United Nations, <i>Energy Statistics Yearbook and National Accounts Statistics</i> , various years.			

Table I.7 Energy use and total investment: 20-year averages, projected for 2030			
	<i>Efficiency: change in energy use per unit of output (percentage per year)</i>	<i>Rate of growth of total investment (percentage per year)</i>	<i>Elasticity: ratio of efficiency gain to investment growth</i>
Developed countries	-5.20	2.90	1.80
Japan	-5.00	3.75	1.30
Europe	-4.80	2.92	1.60
United States	-5.40	2.54	2.10
Developing countries	-5.80	6.80	0.90
China	-6.40	6.45	1.00
Least developed countries	-6.65	9.90	0.70
Source: United Nations, Department of Economic and Social Affairs, Global Policy Model simulations. See text for details.			

Such results may seem implausible at first sight, but they are within the range of recent experience. Based on the elasticities (ratio of efficiency gains to investment growth rates) shown in tables I.6 and I.7, the model simulation assumes that developing countries can achieve results comparable to those in a number of countries in the recent past. Developed countries would be achieving high efficiency improvements for the amount of investment, almost as high as in the best of the cases in table I.6.

The effects of these efficiency improvements on fossil fuel use and CO₂ emissions cannot be precisely established with this model. The model

projects world economic growth of about 5 per cent per year, and, under the policy scenario, a reduction in energy use per unit of output of 6 per cent per year. Thus global energy use, measured in physical units, declines at an annual rate of about 1 per cent.

While of great importance, this gradual decline in energy use alone is not sufficient to reduce global greenhouse gas emissions by 50–60 per cent by 2050. Energy efficiency improvements will need to be complemented by massive investments in renewable low-emissions energy sources, as assumed in the model simulations, leading over time to a drastic change in the composition of energy sources.

How rapidly can non-fossil energy use expand? In a 2007 study, UN/DESA and the International Atomic Energy Agency found that, between 1980 and 2000, biofuels and hydroelectricity supplied about 40 per cent of Brazil's total demand for energy, and grew at an average rate of 2.25 per cent per annum.¹⁸ Significantly better records have been obtained in France through its shift to nuclear energy. Biofuels and nuclear energy are not, of course, problem-free alternatives. However, other sources, such as wind, solar and hydroelectric power, are valid options and are likely to become far more efficient as technologies advance. Recent surges in installed wind and solar power capacity in many countries are the natural result of growing experience, increasing efficiency, and plummeting costs.¹⁹

Financing or access to markets?

There is no doubt that a low-emissions, high-growth strategy will carry high initial costs for both developed and developing economies. Developed countries are better prepared to carry it out, because they have the financial and technological resources; but even if they achieve the kind of targets proposed above, success in developed countries alone will not suffice to meet global climate goals.

Thus a plan is needed to supply the resources needed to launch such a strategy in the developing world. The initial investment push, as discussed in chap. VI, will inevitably require financial support from developed to developing countries, particularly the least developed countries. For the longer term, the goal is to make developing countries self-sufficient, creating a sustainable system of financing for their climate and development investment needs. The Global Policy Model scenario presented here assumes concerted action by policymakers, particularly in industrialized economies, to improve developing countries' access to their markets for

manufactures and services. If this is accompanied by an international accord that encourages steady-state growth of production of food and primary materials and thus stable terms of trade (as is the case for agricultural prices in the European Union and elsewhere), their rapid expansion will benefit developing and developed countries alike.

Once there is a plan to increase developing countries' market share in manufactures and services, their need for external resources will diminish sharply. Furthermore, in the absence of an external debt burden, a combination of stable commodities prices and sustained income growth in both the developing and the developed world will contribute to reducing the fluctuations in domestic prices, interest rates, exchange rates, etc., helping to avert the stop-go adjustment-stabilization processes which have been so damaging for long-term development over the last few decades.

Assessing the simulation results

This modelling exercise assessed the feasibility of a low-emissions, high-growth path from an economic point of view, finding that it clearly is feasible. It reduces absolute energy consumption despite sustained rates of global economic growth. It also yields significantly higher rates of growth in the developing world, and it allows developed countries to grow faster than under business as usual. The critical factor is public investment-led expansion on a significant, but not historically unprecedented, scale. In terms of income per capita, this scenario yields an improvement for all blocs, most dramatically for poorer countries. Finally, it contributes to export diversification, stable terms of trade, and a smooth reduction of external imbalances that have proved to be unsustainable.

The potential problems with this scenario are not attributable to the underlying economic principles of the model simulation, but rather to the political processes that are required for such a big push to take place. Without serious international policy coordination, this scenario cannot work. Hopefully the seriousness of the environmental challenge will impel policymakers to embrace a common goal such as this.

CONCLUSION: MANAGING CRISES

John Maynard Keynes famously remarked that "in the long run we are all dead." Keynes was responding to policymakers in the early 1920s who were postponing urgently needed action to counter immediate economic

hardships, in the belief that market forces would (in the long run) bring the desired recovery. Similar thinking has informed much of economic policymaking during the past three decades. His quip takes on a much more ominous meaning, however, in light of the combined threats to our economic and environmental security.

Price shocks during 2008 and again during 2010–2011 in food, fuel and financial markets laid bare the world economy's shaky foundations—excessive debt, unregulated capital flows and rampant speculation. The cost in terms of declining asset values and government bailouts of collapsed financial institutions was staggering, followed by more widespread damage from a multi-year slump in the economies of advanced, emerging and least developed countries alike.

Looking ahead, policy responses must be designed not just to help meet the short-term goals of creating jobs and securing homes, but also to achieve longer-term security goals, including a stable climate. Turning the page on “casino capitalism” and establishing truly sustainable low-emissions alternatives will require policymakers to draw some hard lessons from recent experience. They must realize, for example, that markets in general—not only financial markets—do not regulate themselves, but depend on an array of institutions, rules, regulations and norms to correct coordination failures, moderate their more destructive impulses, and manage the tensions these impulses can generate.

The shift to a low-emissions, high-growth development path requires a clear break from recent policy approaches, as well as a long-term commitment to doing what it takes to create jobs in advanced countries and support growth in poorer countries. It will involve smarter incentives, stronger regulations and, above all, significant investments, including in the public sector.

The economic crisis that began in 2008 serves as a reminder that financial institutions need to get back into the business of securing people's savings and of building stable networks and levels of trust that can support more socially productive investment opportunities. These policy challenges are of long standing in many developing countries, where financial markets have repeatedly failed to build long-term commitments. Adding in the climate challenge only reinforces the urgency of reforming the financial system, given the scale of resources that will have to be mobilized over the coming decades and the trade-offs that will have to be made if economies are to secure a low-emissions future.

Market forces have an important role to play, but real leadership will have to build upon a strong public policy agenda and a revitalized social

contract—at both the national and international levels. Markets are prone to generate incomplete or incorrect information, giving rise to perverse behaviour (ranging from moral hazard and free-riding to outright fraud) and undesirable outcomes (excessive leverage, the proliferation of toxic products, hidden accounting practices). Both the strengths and the weaknesses of price incentives need to be kept firmly in mind as market-based solutions are extended to meet the climate challenge.

The immediate response to the financial crisis provided a reminder that governments are the only agents capable of mobilizing the massive financial and political resources needed to confront large systemic threats. It also showed that policymakers can act with real urgency when faced with such threats. This is encouraging from both the development and the climate angles, given that both challenges involve large resource commitments over the long term, and at both the national and the global levels. Unfortunately, the subsequent years have shown that it is not easy to maintain this agenda after the moment of greatest crisis subsides. To meet the climate and development challenges, we must not only surmount traditional market failures that occur as a result of externalities and free-riding, but also deal with systemic threats, manage large-scale adjustments in economic activity—and stay with this agenda for the long haul. The only sensible response is to mix market solutions with other mechanisms, including regulations and public investment, and to commit ourselves to active, ongoing involvement.

NOTES

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- 13 Dell, M., Jones, B. F. and Olken, B. A., 2008. *Climate Change and Economic Growth: Evidence from the Last Half Century*. NBER Working Paper No. 14132. National Bureau of Economic Research, Cambridge, MA. <http://www.nber.org/papers/w14132>.
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