The communication between connected and distributed systems is a complex process. The interactions between these systems often require the exchange of data and information. This exchange is facilitated by various protocols and standards. The goal is to ensure that the data is transmitted accurately and efficiently. However, the complexity of these systems can lead to challenges in maintaining system integrity and security.

One of the key components of this process is the communication protocols. These protocols define the rules and procedures that are used to exchange data between systems. They include aspects such as the format of data, the methods of error detection and correction, and the mechanisms for ensuring data integrity. The choice of protocol can significantly affect the performance and reliability of the communication system.

Another important consideration is the security of the communication. Security is essential to protect the integrity of the data being transmitted. This includes measures to prevent unauthorized access, to ensure data confidentiality, and to protect against data tampering.

In summary, the communication between connected and distributed systems is a critical aspect of modern technology. It requires careful planning and implementation to ensure that the systems can work together seamlessly and effectively.

COMMUNICATIONS AND PROTOCOLS


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Globalizing Justice

The Ethics of Poverty and Power

Richard W. Miller
Global Harm and Global Equity: The Case of Greenhouse Justice

In the last chapter, unmet transnational responsibilities were derived from conduct in which some take advantage of others, without necessarily worsening those they wrong. This chapter will derive further unmet responsibilities to help people in developing countries from a different sphere: the requirement of due concern for unintended harmful side-effects of conduct which may, itself, be morally flawless.

Due concern for unintended harmful effects of our actions is a routine and deeply important duty. Crossing a street would be a perilous adventure if people did not take due care. In limiting harmful side-effects of our conduct, we express a proper valuing of trust. Without the expectation of such concern, wariness is the appropriate interpersonal attitude, and others' success merits anxiety about their heightened influence over our shared environment, natural, economic and social. Even someone with the resources to be successfully wary and to ward off others' harms ought to be repelled by this prospect, to aspire to mutual trust instead, and to express this aspiration in a special commitment to take due care.

While this aspect of moral responsibility is routine, its dictates depend on diverse considerations whose implications vary from case to case. For one thing, our duties to avoid and repair unintended harms due to our own conduct are limited by others' responsibilities to avoid being victims. I have done nothing wrong if I bump into my neighbor because he has rushed onto the sidewalk without looking to see who is coming. (In contrast, if I intentionally push him, I do wrong and am responsible for the consequences even if he thoughtlessly missed an opportunity to dodge my push.) Also, due concern for our unintended harms is sensitive to the costs of desisting. In a dry region, a farming family is justified in making use of water in ways that will, inevitably,

make matters worse for others. Granted, one should seek a mutually acceptable way of overcoming conflicts of interests in which one's self-advancement has harmful side-effects. But what terms ought to be accepted is far from clear; contributions to harmful processes, costs of desisting, advantages derived from others' harm, and others' responsibility for their victimhood all seem relevant considerations and are frequently in conflict. For example, those who contribute more to a water shortage may also need water more (say, for irrigation), and will bear disproportionate costs of proportionate reduction of use.

For these and other reasons, the dictates of due concern over transnational consequences of an unobjectionable economic activity will depend, in complex ways, on the specific character of the interaction. Because of these complexities, I will devote this chapter to the detailed study of one such process, the production of harmful climate change by the release of greenhouse gases, above all, carbon dioxide, in virtually all economic activities. This emphasis corresponds to the especially large impact of this process on duties of people in developed countries to give up advantages to help people in developing countries. As in the study of trade agreements in the previous chapter, the goal will be the discovery of underlying moral principles for meeting responsibilities generated by this particular human interaction. The possibility of using greenhouse regimes to satisfy moral obligations external to the greenhouse interaction will be put to one side, until the summary of transnational responsibilities in Chapter 8.

Questions of Greenhouse Justice

By thickening an atmospheric blanket of gases in which carbon dioxide is the most important ingredient, business-as-usual in economic activity poses a worldwide danger of grave harms, through consequences of increased warmth. The contribution of this process to duties of people in developed countries to help people in developing countries depends on the answers to two questions: what allocation of tasks is equitable in seeking to limit harms of global warming, and what goal of limitation is adequate, fulfilling the collective responsibility of humanity to limit the harm we jointly cause? If people in developed countries do less than their fair share in reducing the global harm, they owe it to people in developing countries to do more. What they are obliged to do in their fair share depends on the limit that ought to be sought in humanity's project of climate control.
In addition to the division of moral questions into adequacy and equity, the terminology of the greenhouse literature divides responses to the greenhouse challenge into mitigation, i.e., reduction of emissions and their climate consequences, and adaptation, i.e., improved coping with the residual climate consequences. In principle, there could be mitigation without emissions reduction, through direct intervention in climatic processes, for example, the sprinkling of particles in the atmosphere to reflect back sunlight and cool the earth’s surface. But there is a broad consensus that these interventions would be gravely risky, at best unfortunate last resorts in response to inadequate emissions reduction. While adaptation will be vitally important, developing countries have limited capacities to adapt and aid flows have limited efficacy in improving those capacities. So controversy over what developed countries should do to help developing countries in response to the greenhouse challenge has centered on the question of what allocation of emissions reductions is fair in an adequate mitigation regime. I will follow this emphasis and ultimately defend it. However, the moral principles that emerge for assessing proposed greenhouse regimes will also be suitable for judging proposals with varying degrees of emphasis on adaptation.

While the central, unavoidable questions, adequacy and equity, are distinct, they are also interdependent. If adequate containment is demanding, this creates a need to develop a standard of equity fit for assessing serious conflicts of interest. Conversely, a limit on climate change may have to be relaxed if it creates unacceptable burdens even in an equitable allocation of tasks.

As it happens, a global standard of adequacy has long been affirmed by a multigovernmental group. In 1996, the governing Council of the European Union declared that “global average temperatures should not exceed 2 degrees (Celsius = 3.6 degrees Fahrenheit) above pre-industrial level”—a position that the EU has periodically reaffirmed.6 A six years before, the Advisory Group on Greenhouse Gases of the World Meteorological Association and United Nations Environmental Program had argued for this upper limit.7 A petition by 315 climate scientists asked for it at the Bali conference of 2007 that set the stage for negotiations over a post-Kyoto greenhouse regime.8 To cope with the interactions between the two moral aspects of the greenhouse, I will start out by assuming this goal, argue for a standard of equity and then circle back to vindicate the goal of Two Degrees, helped by a conception of our shared duty to seek an adequate limit that will emerge from arguments about equity. The outcome will be a requirement of fair global teamwork in pursuit of a daunting goal, a requirement that imposes significant risks of sacrifice on many people in developed countries, while advancing interests of the global poor.

Because standards of adequacy and equity and the assessment of their consequences depend on the actual nature of the greenhouse challenge, these judgments must respond to a vast body of evidence, which currently creates wide margins of uncertainty on some important points. I will largely rely on the most authoritative recent summary of this evidence, the 2007 assessment report of the Intergovernmental Panel on Climate Change, and studies that significantly contributed to its findings. There will no doubt be major changes in the future, but as we shall see, the best evidence now is that a long wait for definitive evidence before taking decisive action would be a profoundly irresponsible bet.

**Equity: Some Proposals**

Equity is a topic of heated public controversy over what to do in response to the greenhouse effect. (Equity, not junk science, was George W. Bush’s reason for refusing—in agreement with a 95–0 vote of the U.S. Senate—to accept even the utterly inadequate constraints of the Kyoto Protocol. He rejected an arrangement that “exempts 80% of the world, including major population centers such as China and India...”) In this claim, many proposals have inherent appeal, as morally appropriate responses to the greenhouse challenge. One is a mandate of cheap rescue. People in developed countries are said to have the opportunity to keep the world below the threshold of inadequacy without morally significant risks to their companions, in a regime that imposes no burdensome restrictions on people in developing countries imperiled by climate change; since they can rescue without sacrifice, they should. On less optimistic assessments of the needed effort, fairness requires the justification of significant imposed burdens. This might be seen as a matter of fair teamwork, an impartially acceptable allocation of sacrifices in the work that is required to achieve the shared goal. Alternatively, special concern for poverty is sometimes treated as an independent requirement of climate equity. Often, equity is judged by some version of the precept, “Polluter pays.” The fair division of tasks can also be seen as the fair bargain in light of the benefits and burdens of alternative climate regimes.

My proposal is that only the teamwork approach to equity deserves fundamental status. What is right in some of the other approaches derives from consideration of the impartially acceptable allocation of sacrifices on the greenhouse team. Greater costs of emission constraint, lesser per capita emissions and greater climate harms will all turn out to play important roles, all heavily
favoring developing countries. However, they play their proper roles by contributing to the burdens that are to be impartially allocated.

Costs of Rescue

The search for climate equity should begin with detailed scrutiny of the standard we all want to be applicable, cheap rescue. If, as Al Gore conveniently implies in *An Inconvenient Truth*, no one in a developed country would have to bear significant costs in the implementation of an adequate regime that does not burden people in developing countries at all, then this virtually cost-free rescue is the way to go. Responsible people in developed countries would be glad to provide such cheap relief from dire dangers to people with so much else to worry about. But the Two Degree standard of adequacy threatens greater expense than this comforting argument admits. If our shared duty is to keep below Two Degrees, tasks ought to be allocated in light of a significant risk of serious consequent losses due to economic disruption for many people in developed countries.

Given the range of currently plausible estimates of the sensitivity of climate to greenhouse gases, the stabilization of atmospheric greenhouse gases at the carbon dioxide equivalent of 450 parts per million by volume by 2150 has an even chance of keeping temperature increase, at equilibrium, within Two Degrees; a seven in ten likelihood of avoiding excess would require reduction to 400, while 500 would pose a seven in ten likelihood of breaching the limit. These temperature equilibria would be reached after the end of this century. However, irreducible physical constraints and the avoidance of severe economic risks require a mid-century stabilization target at least as low as 450 ppm to avoid probable breaching of Two Degrees within this century.

When the Fourth Assessment Report of the IPCC appeared in 2007, the concentration of greenhouse gases was already at a carbon dioxide equivalent of about 450 ppm. The increase over the pre-industrial level was already 0.8%. On account of delayed processes of ocean warming, global mean temperature would have increased about a half degree more by the end of the century, even if concentration were immediately stabilized at 450 ppm. And immediate stabilization is not an option, if widespread industrial shutdown is to be avoided. Overwhelming the processes of terrestrial and ocean-based absorption that kept atmospheric concentrations of greenhouse gases stable prior to the industrial revolution, the annual addition to the atmospheric stock of greenhouse gases has amounted, in recent decades, to about half the year's emissions from the use of fossil fuels. From 1965 to 1975, average annual carbon dioxide emissions were about 45% less than the 2004 level, while atmospheric concentration increased by about 1 part per million per year. Because of the contribution of flow to stock, an emissions trajectory that achieves a mid-century stabilization target of 450 ppm while avoiding widespread economic shutdown must start out by overshooting the concentration target. This overshoot boosts near-term temperature increase. When the economic constraint is added to the physical constraints, trajectories stabilizing at 450 ppm, which have an even chance of avoiding Two Degrees at ultimate equilibrium, also have a mere even chance of keeping below this temperature limit in the twenty-first century.

Because emission reductions achieving the 450 ppm target (much less 400) are so daunting, they have not been much studied. Indeed, when the Fourth Assessment Report was issued, the only detailed studies considering how and at what cost reductions in the full range of greenhouse gases could achieve this target were by a team at the Netherlands Environmental Assessment Agency who use the label “FAIR” for their model, as in “Framework to Assess International Regimes for differentiation of commitment.” (Other work of broadly similar ambitions reached compatible conclusions.) Sensitive to the need to avoid global economic shutdown in a world in which factories last for decades (over thirty years in the case of electric plants), the FAIR team, in a 2007 proposal, postpone decline in the global emissions total until 2055. Then, their mitigation project requires a decline of 60% in the global total in the next thirty-five years, 60% per capita. At the end of the century, emissions are to be 30% of the 2000 total (20% per capita), a quarter of the 2015 peak, and a seventh of the emissions expected on the mid-level Business As Usual scenario they employ. The late century drop, which makes the initial permissiveness feasible, crucially depends on carbon dioxide capture technology "which still has to be proven in large scale application," the uncertain availability of aquifers for carbon dioxide storage, and uses of crop-based fuels whose energy potential is profoundly uncertain. Other studies of stringent targets were even more indulgent of optimistic technological speculations, such as the creation of a huge global carbon dioxide vacuum cleaner combining vast plantations, biofuels derived from them, and sequestration of the emissions from their use.

What would be the costs of this commitment? Detailed studies of stringent, long-term emissions trajectories do not currently answer this question. Instead, they estimate how much the value of goods and services would be reduced by a process that substituted the most efficient allocation of energy sources fitting the mitigation trajectory for energy use without mitigation measures, making
the substitution infallibly and without any further economic disturbance. This would, in effect, be a magic version of cap and trade, in which emission permits adding up to the permitted current total are exchanged through an auction among perfectly informed and rational traders confident of compliance with all commitments. In the FAIR team’s study, these annual costs would ascend, from 2015 to 2040, from a 0.3% to a 2% reduction of the Business As Usual baseline Gross World Product and then decline, after 2050, to 0.8% at the end of the century. In the idealized auction through which they determine direct abatement costs to people in particular countries and regions, FAIR’s preferred system for allocating permits strongly favors countries with low per capita GDP and low per capita emissions, so that the distribution of idealized direct abatement costs approximates the accommodation that Cheap Rescue envisions. For example, in the United States, an allocation that is 30% below the Business As Usual baseline for emissions in 2020 would be associated with idealized direct abatement costs amounting to 0.5% of baseline GDP, and these annual costs would rise to 2% of GDP in 2040 when the allocation would be 90% below baseline emissions; in China, idealized direct abatement costs of 0.2% of GDP in 2020 would rise to 1% in 2050.

The difference between magical least-cost reallocation and feasible efficiency, the indirect costs of macroeconomic disruption and the use of alternative, plausible Business As Usual scenarios would greatly increase these costs. Even in accommodation to the pathetically undemanding limits proposed in the Kyoto Protocol, direct abatement costs without trade in allocations would have been much greater than those from least-cost reduction through idealized global exchanges, about five times greater in the United States. But in actual permit markets, the uncertainties of trading and problems of monitoring and enforcement can be expected to yield fuel allocations that are much less efficient than the ideal, if emissions are to be kept in bounds. (Alternatively, in a carbon tax regime, optimal efficiency requires an internationally uniform tax, effectively imposed. If developing countries were spared, this would more than double direct abatement costs in the near term.) In assessing the prospect of U.S. participation in Kyoto, the U.S. Energy Information Agency estimated costs of macroeconomic disruption due to inflation and plant shut-downs to be more than four times the direct abatement costs, even assuming a domestic permit auction and revenues recycled through payroll tax reduction. In addition to these disturbances, global cap and trade would trigger reverberations in world trade and finance from vast transfers of dollars. The FAIR team takes two-thirds of U.S. emissions to be covered by emissions trading in 2010. (Transfers of carbon tax revenues from developed to developing countries in a globally comprehensive carbon tax regime would have similar consequences.) Among mid-range Business As Usual scenarios, the IPCC tends to treat A1B, a higher per capita growth and carbon dioxide emissions scenario than the FAIR team’s B2, as the paradigm intermediate case. A shift in scenarios would increase by three-fourths the percentage of Gross World Product lost in idealized direct abatement costs, with greater developed country costs and cuts, by FAIR’s equity rules.

Granted, more GDP per capita is not associated with more happiness on average in developed countries. The tendency at a given time of those with much more than the average to report more happiness, those with much less to report less, seems to reflect patterns of how others are doing within their society and goal-setting calibrated to the societal average, rather than the noncomparative need to have more, which does shape trends in developing countries. However, the disturbances in the pace and structure of the economy in developed countries, especially the United States, would put many people at risk of serious losses of disruption, which exact distinctive costs. For a middle-aged production worker in the United States, losing a job is typically a serious loss, an interruption, not infrequently a long one, in employment, which often ends the prospect of a successful lifetime economic trajectory that had been a focus of plans, hopes and self-esteem. Retraining programs do not seem to help much in developed countries now, and might well do worse in the face of rapid technological change with unpredictable winners and losers.

Perhaps the reasons to worry about job loss, economic displacement and insecurity are false alarms. Above all, the cautious optimism about the pace of technological innovation and its impact on investment that underlies the FAIR team’s cost estimates may be overly cautious. But similarly, the imposition of stringent emissions constraints to keep below Two Degrees might respond to a false alarm based on a misestimate of the future trajectory of economic activity. Indeed, one of the IPCC’s scenarios of Business As Usual in the twenty-first century has a significant chance of keeping below Two Degrees without any greenhouse-specific intervention. In response to both sorts of possibility of false alarm, a failure to take risks of over-optimism seriously is a failure to take the potential victims seriously.

Admittedly, risks of burden from commitment to the Two Degree target to people in developed countries, including the United States, are accompanied by possibilities of prevention of climate harms that people in those countries would otherwise endure. For example, commitment to Two Degrees, as compared to less stringent targets, might significantly reduce harms in the United States in this century from the drying of the Southwest. An assessment of proposed climate regimes should certainly respond to these possible benefits
The Model of Teamwork

The emissions involved in anyone’s own activity as consumer and producer would not, by themselves, cause climate harms. Indeed, the greenhouse gas emissions from activity in one country, even the United States or China, are not harmful by themselves. Greenhouse harm is a collective effect of our individually innocent pursuits taken together, generating a shared duty of containment. Because forbearance from those pursuits can constitute an important loss, we owe it to one another to work out a shared standard for the fair division of burdens in pursuit of the common goal.

Suppose we humans have a shared duty to pursue a certain goal of containment, say, of avoiding the Two Degree increase. As responsible people sharing a duty to reach this goal, we should all be equally willing to sacrifice to reach it. Unwillingness to sacrifice would be irresponsible, a lack of commitment to a goal one has a duty to help pursue. But if one has to do more to make up for others’ lesser commitment to the shared goal, then they are behaving parasitically. If everyone pursuing the goal were fully responsible, no one would have to make up for others’ lesser commitment. So insistence on equal willingness to make sacrifices needed to reach the goal would emerge from responsible deliberations, as a basis for equity.

This equal commitment need not lead to an overriding preference for schemes imposing equal sacrifices. There might be an adequate greenhouse regime in which people make unequal sacrifices and the greatest is less than in any other adequate regime. For example, the concentration of burdens of mitigation on people in developed countries might be an especially powerful driver of decarbonizing technological change that rapidly diffuses throughout the world, accompanied by an investment-driven economic boom. To insist that everyone, instead, bear equal, heavier burdens would be sadism, not fairness. But one shouldn’t be obsessed with minimizing the gravest costs, when this would impose somewhat lesser but serious sacrifices on a great many more. If utmost squalor in Saudi Arabia is the worst loss under an adequate regime in which hundreds of millions in India, Brazil and China can emerge from lesser but severe poverty, then a poor Brazilian does not show less than equal willingness to sacrifice for the common goal in preferring this regime to an alternative in which many more suffer the lesser loss of continued poverty while a few are saved from a greater loss of pauperization.

In these and other cases, an unequal set of sacrifices would be the preference of someone choosing among available loss sets behind a veil of ignorance, seeking to advance her interests but ignorant of which loss would be hers. These are impartial choices of who is to sacrifice what, so they express equal willingness to sacrifice.

Once the question of adequacy is settled, does greenhouse equity require anything more than the commitment to an impartially acceptable set of loss outcomes, which expresses everyone’s equal willingness to make sacrifices for the shared goal? It does not. Other considerations, which I will survey, are initially attractive. But their proper role in greenhouse equity can be ascribed through a proper understanding of equal willingness to make sacrifices.

The Relevance of Poverty

It might seem that this claim of completeness requires neglect of obviously relevant considerations of neediness. Even if greenhouse-external goals of poverty reduction are put to one side, a climate regime that is insensitive to the special needs of the world’s poor seems grossly inequitable. The model of teamwork does not deny this. To the contrary, the special needs are robustly relevant to the model because of the difference they make to sacrifices in pursuit of the shared goal.

The postponement of the ending of suffering from the nonfulfillment of acute need is a serious sacrifice. For example, in China, hundreds of millions suffer
from the destitution described in the previous chapter, including inadequate nutrition, inadequate health care, geographic isolation, and drudgery yielding meager subsistence. In 2035, one in three people in China lived on less than $2.00 a day. Emissions constraints that block or substantially postpone escapes from such destitution would impose a much more serious sacrifice than constraints producing the economic disruptions in developed countries that we have considered. The cost is more serious even if the constraints on developing countries only reduce the rate of increase in per capita emissions while the constraints on developed countries impose a larger per capita decline. While the job loss of a middle-aged production worker in a carbon-intensive industry in the United States is apt to be a serious matter, this disruption is not at all as bad as enduring lifelong fatigue, isolation and insecurity. And escapes from destitution in developing countries are closely tied to greenhouse gas emissions. Growth in GDP per capita has been by far the biggest contributor to the stupendous growth in Chinese carbon dioxide, eight times more important, in the last decade of the twentieth century, than the next most important factor—population growth. (There was a large decrease in energy used per unit of GDP.)

Fair teamwork, then, requires special permissiveness toward emissions that are needed by the global poor to escape to a better life—extending the special attention to "subsistence emissions" that Henry Shue incisively urged at the start of greenhouse concerns. However, sacrifices required of team-members in developed countries will still be significant, and could make one greenhouse regime (say, with more gradual mandated emissions reductions) more equitable than another. Simply to dismiss the concern about disruption of people in developed countries, as if their worry about losing a job had no more moral standing than a worry about postponing the advent of the next electronic gadget, is to dismiss these people.

Combined with currently warranted expectations about Business As Usual, these considerations of fair sacrifice suggest the broad shape of an equitable regime for avoiding Two Degrees. The warranted expectation at present is that there must be some constraint on emissions from developing countries to keep under Two Degrees. On a mid-range scenario of Business As Usual, developing countries will start to exceed the global carbon dioxide budget compatible with the 450 ppm stabilization target by around 2035. A greenhouse regime that accepts hard facts of adequacy while respecting equity will probably allow escapes from destitution in slowing the growth of emissions in the developing world. But it will be much sterner (in emissions terms, not in terms of sacrifice) in developed countries, cutting emissions sooner and more steeply to minimize the burden of thwarted escape among the climate team. In the least developed countries, where any additional economic burdens threaten to tilt lives toward death or misery, undue sacrifices would be avoided by limiting change to "win/win" arrangements that make emissions less than they would be without threatening the pace of growth. Although it correlates with benevolence, this attention to poverty is a dictate of fair teamwork in the joint task of controlling climate change.

"Polluter Pays"?

The most familiar standards of greenhouse equity are versions or variations of the theme "Polluter pays." Since disincentives to emit are essential to any satisfactory greenhouse regime, policies imposing costs on emitters will certainly play a role. But the proposed standards are addressed to a more fundamental level of moral assessment. A standard of proportionality between emissions and emission constraints is offered as an independent, basic criterion of justice in the imposition of constraints. In fact, these standards are either morally distortive or aspects of the more fundamental rule of impartially acceptable burdens on the climate team. Independent reliance on "Polluter pays" as a fundamental standard of greenhouse equity introduces undue retribution into the quest for climate justice, as independent reliance on considerations of poverty creates unmerited ascriptions of benevolence.

Sometimes a duty of people in developed countries to virtually monopolize emissions constraints is based on a duty to accept constraints on emissions from one's country in proportion to the contribution of emissions from this site to cumulative emissions in the history of human activity. But this seems an unreasonable response to pre-1990 emissions. It is hard to see why people living in developed countries now bear a responsibility to sacrifice their interests on account of past activities of people within the borders, mostly long-dead, which were not inherently illegitimate and whose harmful side-effects could not have been foreseen.

What about emissions after about 1990, when there began to be substantial evidence of harmful consequences? These past emissions will have a special role to play in any sound moral assessment of current proposals. If a country would have exercised more restraint post-1990 under all morally satisfactory greenhouse regimes, then its citizens have a political duty to compensate others, by accepting more stringent constraints now, in order to avoid transferring burdens of their government's irresponsibility onto foreign shoulders. But this instruction to compensate for recent negligence does not tell us what standard of negligence to apply.
Alternatively, a forward-looking variant of “Polluter pays” might require people to reduce their emissions, once the greenhouse harms are foreseeable, in proportion to what they would emit in the absence of constraint, to the extent required for adequate reduction over-all. But if everyone’s emissions are compatible with equal willingness to sacrifice in pursuit of an adequate climate goal, no one would seem to merit any further burden. And this requirement would be burdensome. A reduction of emissions in the near future would impose a significant sacrifice, involving postponed fulfillment of basic needs, on billions of poor people in developing countries.

To avoid unfairness due to proportionate reductions, those who emphasize emissions differences as the basis for greenhouse equity toward people in developing countries increasingly appeal to a right to equal per capita emissions. According to this sophisticated variant of “Polluter pays,” people whose emissions exceed the global average have, just by that token, a duty to compensate for taking more than is rightfully theirs. On closer examination, what is valid in the claim of an equal right to emit either is not helpful or derives from the commitment to impartially acceptable sacrifices on the greenhouse team.

Obviously, people in developed countries are in no position to respond to greenhouse proposals by complaining of violation of a moral right to higher emissions than others. The much greater emissions associated with the activities of a Swiss banker’s child as compared with an Angolan farmer’s child are, like so many other differences between them, consequences of her making use of greater opportunities and resources that she does not deserve. But the nonexistence of the right to emit more does not entail that it is wrong to emit more. What is undeserved is not, by that token, unjustly obtained or wrongly used. The banker’s child can accept that the permissibility of her emissions is not based on a right to emit more than others while denying that there is anything wrong with her using her undeserved superior life situation to pursue worthwhile goals in processes that do emit more.

In comparing typical Swiss and Angolans, the model of fair teamwork has already provided a powerful reason to favor the latter, based on gravity of burden of reduction, not amount of emission, and will provide more. The test of independent reliance on equal per capita emissions rights would be cases in which greater gravity of burden of reduction and lesser emissions single out different emitters. The impartial allocation of burdens takes account of the greater winter impact of emissions reductions suffered by more emissive Swedish Sven as compared to Italian Stefano. If, independent of impartial allocation of burdens, Stefano has an emissions right equal to Sven’s, then Sven’s emitting more in keeping warm could make him liable for compensation of Stefano, even if the difference generates no unfair burdens. This is vindictiveness, not fairness.

Still, there is something valid in insistence on equal emissions rights. When policies constraining emissions are assessed, regimes under which some people would emit much more than others stand in need of a justification explaining why that feature is morally acceptable under the circumstances. “Swedes need more emissive activity to keep from freezing in the winter” could be part of an adequate justification. “Don’t worry about these big inequalities. That is mere emissions-envy” is morally idiotic. What considerations internal to the greenhouse problem and the struggle to contain it might explain this moral pressure?

The right explanation derives from the limits of the atmospheric sink. A joint commitment to keep below a threshold of danger is a joint commitment to keep a single shared atmosphere into which everyone’s emissions mix below a dangerous level of saturation. If the Two Degree standard (or any plausible standard) specifies adequacy, then the responsible pursuit of equity must be governed by a daunting assumption: keeping below the threshold requires a downward trend in global emissions, starting soon, to a global level substantially below Business As Usual, with a sharp decline in worldwide per capita emissions. In this process, more emissions for some entail a corresponding increase in constraint on others, reducing opportunities to make use of nature. Even if people in developing countries are currently exempted from constraints, greater global emissions now entail a sharper subsequent decline in the global carbon budget, so that developing countries, where benefits from emissive activities are especially likely to meet important needs, will be subject to stronger constraints later. The reduction of opportunities is a burden, part of the burdening whose allocation must be impartially acceptable, if cooperation in containing climate dangers is to be fair. By the same token, if per capita emissions in one country are greater than those in another, this will, all else being equal, give rise to an unfair allocation of burdens, i.e., of opportunities reduced in pursuit of climate safety.

At the level of policy, the right response might or might not include the assignment of an equal per capita allotment of tradeable permits adding up to the global sum in the current phase of the agreed emissions trajectory. (Equal per capita untradeable allotments make no sense. Bangladesh had per capita carbon dioxide emissions of 0.2 tons in 2004, China 3.9, the United States 20.6, and the global average was 4.5. Per capita equality of permitted emissions would have entailed great loss and waste.) The appropriateness of this form of cap and trade partly depends on the much-debated comparison of permit auctions with carbon taxes as means of mitigation. For example, the permit
total can be directly constrained by the desired global maximum emission, but the uncertainty and volatility of the permit price may reduce incentives for desirable technological innovation.

What is required is a pattern of “Contract and Converge.” A strong correlation of decline in global emissions with convergence on rough equality among countries in per capita emissions. As time goes on, the capacity of people in currently developing countries to make productive use of fossil fuels grows, while the total global emissions budget must shrink in pursuit of an adequate global climate goal. So, in an adequate climate regime, there is an increasing tendency for inequality in per capita emissions to reflect imposed inferiority in opportunity to make use of nature. Since the inferiority would be imposed on those with greater need to spew carbon dioxide, failure to aim for rough convergence is incompatible with mutual respect among members of the climate control team.

Irrelevant Bargains and Greenhouse Duties

Finally, the model of fair teamwork contrasts with an alternative standard of fairness in meeting the greenhouse challenge, insistence on a fair deal, identified with equality of net benefit from mitigation. This alternative would place heavy burdens of mitigation on the global poor. Because of the special benefits of containing global warming to poor people in developing countries, a regime imposing large sacrifices in forgone development opportunities could still afford them net benefits at least as great as the net benefits of people in developed countries.

Keeping to the Two Degree threshold will disproportionately benefit poor people in developing countries, to an extent that is well-correlated with the depth of their poverty. In part, this is an outcome of the terrain in which people live. For example, huge numbers of people in east and south Asia live in coastal lowlands especially affected by rising sea levels. The melting of glaciers is especially important for the water needs of people in India and South America. Mostly, the greater impact reflects, not mere terrain, but the economic, social and political situations of people in developing countries, engaged in ways of life more sensitive to climate change with fewer resources for adjustment. More severe storms and drier droughts, the most likely important near-term consequences of Business As Usual, are the bane of farmers and a special burden for rural communities. In developing countries of Africa and Asia, about two-thirds of the population live outside of urban areas and agriculture contributes about a sixth of GDP, as compared to a fifth living rural and a 2 percent contribution in developed countries. The United States government can readily provide better levees and sea-walls, even where it does not. Bangladesh, Burma, India, Pakistan and Sri Lanka cannot so readily cope with the prospect that additional tens of millions of people on their coasts will be severely burdened by floods in the second half of the present century, if warming is not kept within Two Degrees and additional flood protection is not provided.

As a consequence of the inequality in benefits from constraints, net benefits from an adequate climate change regime could be equal, worldwide, even if poor people in developing countries suffered substantial losses in retarded development due to stringent constraints on their countries’ emissions. In such a greenhouse regime, people in India and Bangladesh could be required to pay for a reduced risk of suffering climate harms through an increased risk of postponement of development that fulfills basic needs. While they only come out a bit ahead of the game, the same is true of people in the United States. The Americans expect to bear lighter burdens due to mitigation, but they gain less by way of reduced dangers of loss from global warming. Those who need more insurance give up more for insurance. What is unfair about that? Contemplating a regime that will impose serious risks of disruption on him in order to seriously reduce risks of devastating flood and deadly disease for Bangladeshis forty years from now, a West Virginian coal miner would be a creep to say, “I just don’t care what happens in Bangladesh.” But if he is inclined to say, “Given the costs to me and the benefits to them and their children, people in Bangladesh should be willing to give up a lot for the extra safety,” this is an initially plausible appeal to equity.

In assessing the fairness of alternative contractual arrangements, someone’s complaint about having to spend more can certainly be countered by the observation that he is getting more. But such reasoning about fair sacrifice can be horribly out of place in other contexts. Rationing was important for the British war effort in World War II, and it was important that the rationing scheme be fair. The suggestion that British Jews accept shorter rations because they had more to lose from British defeat would have been absurd and appalling. Everyone’s commitment to the system of constraints was properly based on an interest in the continued freedom of all, not on his or her own interests together with a desire to be fair. An effective response to the coal miner’s complaint against departure from equal net benefit should, similarly, appeal to the moral foundations of the duty to limit greenhouse warming. Here, the investigation of equity requires inquiry into the grounds for upholding a standard of adequacy.
A reminder of the duty of concern for those in need will not be an effective response, given the limits of sympathy. The coal miner is not refusing to lift a finger to prevent dire harm in Bangladesh. Rather, he is not willing to impose on himself a significant risk of a worse life. If he has a strong conservation commitment to protect the global environment from deterioration, then he might count the protection of the Bangladeshi environment as a gain from his own point of view, that makes up for his material sacrifice. But presumably, he has no such strong commitment. In any case, those who seek to impose emissions constraints in their political society should seek justifications that are acceptable to everyone committed to values of free and equal citizenship. Not to seek such a justification in important political impositions shows intolerant disrespect of fellow citizens who are willing participants in civic cooperation. One can find such a justification of commitments to contain greenhouse harms in familiar political considerations of trust and trusteeship. Identification with a demanding goal of reducing greenhouse emissions expresses ordinary political commitments in response to an extraordinary crisis.

The central morally relevant fact that the coalminer’s complaint ignores is his contribution, along with his fellow citizens’, to the climate danger faced by Bangladesh. Insistence on equality of net benefit in containing harmful effects of activities in which all participate, but to a greater or a lesser extent, is, in effect, insistence that pollute pays: in international cooperation to reduce harm, citizens whose activity makes a disproportionate contribution to harm would bear lower costs on account of the additional need for relief that they have created. Acquiescence in this standard of equality would be rational for those facing calamity if they had no better option. Indeed, this standard provides an equal, rational incentive to all to accept a mitigation regime. But by rewarding the infliction of suffering that others could not willingly accept, this standard of equality violates the valuing of trust expressed in the political interactions of responsible compatriots.

In seeking fellow citizens’ agreement to arrangements advancing wellbeing within the borders, a responsible person seeks measures that all can willingly accept while affirming their equal worth, rather than arrangements to which those vulnerable to others would acquiesce as the price to be paid for dissuading others from exploiting their vulnerability. The strong, who could extract a better deal—whether through armed might or membership in stable, dominant electoral coalitions—will, if responsible, prefer to forgo the concessions they could exact, in order to base political stability on mutual trust rather than asymmetric fear. Otherwise, like tyrants, they base rule on the exploitation of vulnerability. In coping with the greenhouse challenge, a preference for the model of teamwork over the standard of equal net benefit expresses the same valuing of trust. In a greenhouse regime, as in the domestic system of institutions, the strong should treat gains from others’ vulnerability as a cost they seek to avoid, in pursuit of genuine cooperation.

The rejection of the standard of equal net benefit is also required for coherence with the ordinary political value of citizenship—without any need to rely on special environmentalist or religious values. Special concern for helpless compatriots partly depends on a duty of territorial citizenship: the assertion of exclusive ultimate control over a territory is irresponsible without acceptance of an obligation as ultimate protector of those in the territory from threats of grave loss. If the exclusion of outsiders from sovereign prerogatives is only responsible on this condition, sovereignty will also be irresponsible in the absence of concern for gravely harmful effects on outsiders of processes starting within the borders. In the one case as in the other, the trustees’ concern should extend to side-effects—paradigmatically, harms of environmental pollution—as well as intentionally inflicted harms.

The goals that underlie ordinary political responsibilities do not just explain why those less vulnerable to greenhouse harms should not insist on extra insurance charges to those more vulnerable. They create a further reason to favor them, on grounds of equity. Within borders, responsible citizens must be especially attentive to the interests of compatriots whose life prospects are inferior under the laws that shape terms of self-advancement in the territory. Those who support these laws do wrong unless they have an adequate answer to the reasonable complaints of those burdened by the inferior prospects they help to create. They must show equal regard for the interests of the disadvantaged despite conduct that imposes disadvantage. Suppose that a mitigation regime is instituted under which some are asked to put up with especially severe, unmitigated burdens from others’ emissions. Like those asked to put up with social disadvantages, they are treated unjustly, unless their complaint of greater burden is answerable in terms that show equal regard for their interests.

Such residual climate harm is, in fact, an inevitable outcome of the greenhouse effect, generating further duties of equity. The Two Degree threshold does not, by any means, mark the onset of severe greenhouse harms, which occur throughout the warming process. For example, the increase through the first decade of the twenty-first century, of about 0.8°C, is very likely to have caused drought and desertification in northern Africa, while shrinkage of Andean glaciers is expected to cause water shortages in Peru not much later, when 1°C is reached. Someone has serious reason to object to an arrangement under which she will suffer disproportionate greenhouse harm.

Such a complaint must not be regarded as decisive. Feasible mitigation arrangements inevitably involve greater climate harms for some than others,
and efforts to reduce such inequalities can have morally prohibitive costs. The just solution is to take account of the unmitigated climate impact on each member of the climate team of emissions under others' control in assessing the fairness of sacrifices under a proposed greenhouse regime.

These residual climate harms are independent of the reduction of opportunities for growth through emissions constraints or through filling of the atmospheric sink. So the pursuit of the impartially preferable allocation of burdens must, independently, take account of the human costs of the residual climate change. This adds the requirement of help to developing countries in coping with climate change to the other demands of climate justice.

In principle, foreign aid sent to developing countries to help in such adaptation to climate change could significantly lighten developed countries' responsibilities to reduce emissions, by using economic returns from emission activity in developed countries to reduce the worst climate harms. So could foreign aid to help developing countries adopt less emission technologies. In fact, foreign aid for these purposes should supplement, not displace, emphasis on emissions reduction in developed countries. The use of foreign aid to meet the greenhouse challenge would share liabilities with the long-proclaimed goal of using aid to improve economic growth. Both endeavors must cope with grave difficulties in fitting new projects and technologies to the local environment and to local social, political and economic processes. No doubt, the interests of the most powerful developed countries shape foreign aid in ways that add to these difficulties. Citizens of these countries should imagine better behavior by their governments, in framing an ideal aspiration. But they will do people in developing countries no favors in ignoring limitations due to processes in developing countries that severely diminish the benefits of aid—limitations of governmental capacity and integrity, which are sometimes made worse by large aid flows. (These constraints will be described in more detail in Chapter 8.)

Foreign funds for projects whose benefits are hard to estimate and monitor are especially ripe for diversion to nurture local client-networks and especially likely to serve as substitutes for more effective, demanding efforts by the local government. The history of Kyoto's Clean Development Mechanism, in which recipients and donors are rewarded on the basis of inevitably speculative reckonings of reductions of emissions from business as usual, already provides abundant evidence of limits to the usefulness of foreign aid.41

These are not reasons for abandonment of foreign aid for climate goals, which will probably reduce burdens in recipients while creating no comparable burdens in donor countries. They are reasons not to rely on this alternative as a basis for avoiding stringent enforced emissions reductions in developed countries. Avoiding intermediaries who interfere with help through foreign aid, the reduction of greenhouse gas concentration through developed country mitigation directly benefits those most at risk in developing countries. With climate harms prevented, the farmers of Ethiopia and the urban poor of Shanghai can cash in their improved opportunities on their own. In addition, the foreign aid process would be too slow to cope adequately with rapidly mounting devastation from rapidly escalating temperature. This danger plays an important role in setting the target of climate control, resolving the question of adequacy, to which I will now turn.

Adequacy, Trust and Constrained Impartiality

Political duties to take on burdens to reduce climate dangers to others have turned out to derive from ordinary political duties of trust: the duty to base joint commitments on mutually respectful trust and the duty of trusteeship over a sovereign territory.42 These duties of trust are not just important in establishing the equitable division of labor in humanity's common task of limiting the greenhouse effect. They also determine adequacy in the common climate goals that should be our shared aim. Within provisos that the greenhouse process can be expected to satisfy, duties of cooperation and due care make impartial acceptability of burdens—both burdens imposed by climate policies and unmitigated climate burdens—the criterion of greenhouse justice as a whole, including both equity and adequacy.

First, to properly value trustworthy cooperation, citizens responding to the greenhouse challenge must be willing to impose significant burdens on parties in the interest of global climate safety. So long as every citizen benefits as a whole from an international greenhouse agreement, reasonable deliberations would reduce the heaviest burdens worldwide due to unmitigated climate harms and restricted opportunities, impartially assessing the seriousness of each global set of burdens. Otherwise, as we saw in connection with trade deliberations, representatives could not act responsibly, protecting vital interests of those they represent while recognizing the force of similar reasons advanced by others. As in the case of trade deliberations, some citizens will suffer special losses of economic displacement in countries that benefit as a whole. But significant exemption from emissions constraint on these grounds would defeat the global response if parity of reasoning is observed among all parties.

Since commitment to the joint climate goal (say, keeping below Two Degrees), the division of tasks, and capacities for adaptation, all, interdependently, determine the allocation of burdens, the primary topic of moral judgment.
should be whole greenhouse regimes, i.e., total packages of mitigation and adaptation goals and divisions of responsibilities, for people throughout the world. The distinction between adequacy of goals and equity in their pursuit corresponds to different policies and different motivations for perseverance, but the same demand for impartial acceptability regulates the two standard topics of greenhouse justice.

This argument from the morality of trustworthy cooperation to impartial acceptability starts with the proviso that the ultimate agreement benefit each party, over-all and on balance, as compared to nonagreement. Greenhouse negotiations meet or, in any case, closely approximate this condition, so long as they adhere to the rule of impartial acceptability. Developing countries, with their special climate vulnerabilities, will benefit if burdens of thwarted development are taken into account. Given their greater technological capacities, greater wealth and the climate dangers of Business As Usual to their people, developed countries can take on disproportionate burdens of emissions reduction in an arrangement that is beneficial to their people as a whole. Even if the resulting trajectory of GDP, total or per capita, in developed countries, were to lag substantially behind Business As Usual, no great burden would be imposed. Over time, growth in GDP does not significantly contribute to happiness in developed countries. On the other hand, environmental degradation remains a source of unhappiness—so that, as economists say, the relative price of environmental goods increases.

Granted, a severe, prolonged downturn produced by the pursuit of an extremely stringent climate goal might give rise to harms in a developed country on the scale of the climate losses avoided there. But global economic interdependence would spread such harms to developing countries, thwarting escapes from destitution and efforts to adapt to unavoidable climate change. These special economic dangers of extremely stringent targets are as serious as the reductions in climate danger that they are expected to add to the protections of less stringent targets. So a regime of impartially acceptable burdens would not require them: no citizenry has an interest in a mitigation-induced economic crash. In general, the proviso of net benefit over-all in each country will be satisfied if impartial acceptability is pursued.

In the second place, in addition to trustworthy cooperation, due care is an alternative route from ordinary political values to greenhouse justice. Suppose that Canadians could expect to benefit, as a whole, from Business As Usual, through better harvests in the prairie provinces and the opening of the Northwest Passage. This consideration would violate the proviso about expected benefit. But it would not be an adequate reason to refuse to take on a fair share of a global effort to reduce the global emissions that threaten grave

damage in the world outside of Canada. Such a refusal would fail to show due care in a party to a gravely harmful process.

Further reflection on the goals of due care leads, once again, to the criterion of impartial acceptability of burdens. The goals of due care in climate policy are not limited to reduction of the harmful side-effects of greenhouse gas emissions. In the effort to mitigate the harms that they jointly create, those whose business-as-usual would harm must also take account of harmful side-effects of cures that they adopt. Concerned to reduce both unmitigated harms and thwarted opportunities due to mitigation, we joint producers of climate harms should give priority to the gravest combined burdens of climate danger and climate mitigation that people suffer, to grave burdens that more people suffer and to grave burdens that are readily relieved. In order to identify trade-offs among these dimensions of responsible mitigation, we ought to consult the familiar impartial perspective of choice among allocations of burdens that is made in ignorance of one's actual situation.

Might this much impartiality demand too much of a participant? This is a pressing question, because of limits to the risks that people are obliged to impose on themselves to avoid unintended harm to others. Soldiers have a duty to avoid unintended harm to civilians at some cost to their safety, but not at all costs. In a poignant example of Michael Walzer's, British soldiers clearing cellars of enemy troops in French villages during World War I recognized a duty to take on some additional risks by giving warning before they threw grenades down coal chutes, so that villagers huddled in those cellars could announce their presence and escape harm. Still, in a pitched house-to-house battle, announcing one's presence and giving civilians time to escape while the enemy responds to the announcement might be too much to ask. Similarly, if the Canadian economy were so rigidly tied to a promiscuously emission-smoking process that an impartially acceptable greenhouse regime would impoverish Canada, this seems a plausible reason for Canadians to reject it.

There is, at present, no well-established comprehensive, reasonably precise description of when costly forbearance from conduct with harmful side-effects is morally required. The establishment of such a standard would have to settle questions about the difference between intentional and unintended harm that are among the most obscure and contested in ethics, and provide a principled solution to a problem that theorists of justice in war have tried to solve for a long time, a reasonably precise prescription of adequate care to avoid causing civilian deaths. Just as a commitment to Christian stewardship is a sectarian basis for mandating a greenhouse regime, to be avoided if possible, so, at present, is any precise and general specification of due care. Nonetheless, limited, uncontroversial convictions combine with the nature of the global greenhouse
and the global economy to make an impartially acceptable allocation of greenhouse burdens the means of fulfilling everyone's duty of due climate care.

Uncontroversially, those taking part in an activity giving rise to grave harms must make a good-faith effort to reduce those harms. Just how much self-imposed risk is required for good faith is not clear. But some significant risk must be taken on. To adequately value civilians’ lives, the soldiers clearing the cellars had to increase their own peril. A citizenry who are good-faith participants in the project of reducing the climate harms they would otherwise help to cause have to be willing to impose costs appropriate to the pursuit in good faith of an important civic project. These normal civic costs are at least as great as the significant risks of disruption in developed countries that are part of an effort to pursue a climate target such as Two Degrees/450 ppm. After all, railroad workers are rightly told that their job security may be sacrificed to advance national prosperity by constructing a highway system. So workers in emissions industries may certainly be told that their security may be sacrificed in the project of avoiding grave climate harms.

The duty to accept risks of harms to one’s own in the cause of avoiding grave risks to others is especially compelling when there are alternative, plausible scenarios in which one’s own will not suffer harm, indeed, may well benefit from the project of protecting others. These are typical alternative expectations for large emissions reductions in developed countries. Within the realm of plausible hypotheses about technological change and economic responses to new costs, a greenhouse regime aiming to keep below Two Degrees might have significant economic costs, or might, on the other hand, stimulate investment-led growth in pursuit of new technology. Until targets become extremely stringent, there are, as usual, economists on all sides.

Admittedly, a cautious application of the duty of due care, restricted to moderate costs of care, will not establish a duty to participate in a regime imposing a requirement of emissions reduction which carries a substantial risk of pervasive, severe losses for the people of one’s country. But the severity of such losses will be taken into account in finding a regime that is impartially acceptable in light of all of its burdens. From this perspective, pervasive, severe economic losses to the people of a country from imposed emissions reductions will be avoided unless the imposition on this and relevantly similar countries is needed to avoid worse consequences in the rest of the world. So emissions reductions that would be economically devastating for a country whose relevant emissions, together with those of relevantly similar countries, are not a grave climate danger will not be imposed. If wellbeing in Cambodia is rigidly tied to methane-promiscuous rice-paddy agriculture, there is insufficient reason to devastate the Cambodian economy by methane restrictions. Similarly, in the fantasy of Canadian smelting, Canadians might have grounds for insisting on special treatment—though such a rigid, vital, special tie to a distinctively emissive process of production is not characteristic of any advanced economy, for fundamental economic reasons.

In contrast, all else being equal, the global climate damage avoided by economically devastating emissions reductions imposed on the leading per capita emitters might justify the imposition, in an impartial allocation of burdens. But all else is not equal: economic interdependence would extend the economic losses to the world at large. Because of the consequent severe harms to the global poor, such a regime could be rejected from an impartial perspective. Granted, there may be some countries, such as Saudi Arabia, with economies so rigidly tied to the sale of fossil fuels that their people would suffer severe pervasive losses in an impartially acceptable greenhouse regime. But the people of these countries can hardly require foreigners to depart from dictates of due care constraining their own economic activity to make purchases catering to the special needs of fossil-fuel sellers. The most that they should require is choice of a greenhouse regime from an impartial perspective in which their losses are taken into account.

Evidently, any citizenry worthy of trust will seek a package of global climate policies that is impartially acceptable to every person. This is the perspective for equity in pursuit of the global climate goal whose consequences were explored in previous sections. The remaining question is one of adequacy, how low to go in the global goal that is pursued.

**Costs and Gains: Toward Two Degrees**

The most important precept guiding pursuit of an answer very broadly resembles the standard economists’ prescription of policies equating marginal costs with marginal benefits. In choosing among long-term global emissions reduction projects, one should choose lower and lower targets until the costs of more stringent targets are not worth the gains. Here, worth is to be determined from the appropriate impartial perspective. There ought to be no assumption that numerical measures of aggregate gains and losses are relevant and accurate, that preferences in markets measure relevant worth, or that gains and losses due to small increases determine whether further stringency is worth it. The commonsense precept of rational choice only motivates standard marginalist techniques of cost-benefit analysis in special cases, without requiring them in the project of containing global warming.
The basic pattern of costs in emissions-reduction regimes is substantial increase as targets shift from low to very low, rapidly accelerating as the physical limit to temperature containment is approached. Small reductions in business-as-usual emissions are not just cost-free but cost-saving. The incentives to reduce—whether taxes, the need to buy permits or subsidies—lead to energy-efficient choices that more than pay for themselves, choices which sufficiently active, far-sighted economists would have made anyway. We procrastinators finally weatherize our houses. Further near-term reductions can make use of readily available technologies whose use can be substantially expanded at some but not much cost. But as near-term reduction goals become more ambitious, they start to encounter harder constraints. The needed additional inputs, equipment and infrastructure become difficult and costly to obtain and deploy, or generate harms of their own. For example, fewer windy prairies are available for wind-turbines; biofuel crops intrude more and more on food crops, significantly reducing the terrestrial carbon sink through deforestation and burdening the global poor through increased food prices; additional accessible uranium ore becomes low-grade and in need of more extensive processing, while controls over dangers of nuclear proliferation are strained. Losses from emissions reduction start to become substantial, and they substantially increase with yet more stringent goals. Moreover, increasingly stringent targets require more and more constraint on developing countries, whose business-as-usual emissions become more quickly and greatly in excess of the target-compatible global emissions budget.

Eventually, further pressure toward near-term emissions reduction reaches an economic cliff at which further substantial reduction would trigger widespread shut-downs of factories and energy plants with dire macroeconomic consequences. The FAIR team’s estimates suggest that this cliff would probably be reached in the course of pursuing a mid-twenty-second-century stabilization target around 425 ppm.

Of course, technological progress will push the frontier of economic stress and the economic cliff farther and farther back, as time goes by, until they finally disappear and energy production is carbon-free. But a good-faith effort to contain global warming within a fairly low limit—even Two and a Half Degrees, much less Two—cannot tolerate postponement of reduction from Business As Usual or a long postponement of absolute reduction. Continuing flow adds to the atmospheric stock that generates increased temperature, soon guaranteeing the breaching of the temperature limit. The lower the low target, the sooner steep reduction must begin—and so, the more poor people in developing countries will be affected by thwarted development and the less effective will be the available means of making production less emissive.

On the other side of the ledger, the gains in climate safety associated with costs of policies striving for emissions reduction will depend on the impact of emissions on atmospheric concentration, the impact of concentration on warming and the harms generated by this warming. In over-all assessments of these physical linkages, the 2007 IPCC report confined itself to mechanisms that were already well-established and securely within the reach of computational capacity. Given the IPCC’s mid-range guesses, emissions reductions with low costs in disruption and inefficiency are certainly worth the gains in climate safety. The mid-range IPCC Business As Usual scenarios are associated with best estimates of temperature increase averaging somewhat above Three Degrees by 2100. Trajectories that would lower such increase by a significant fraction of a degree without economic stress seem feasible. For example, the FAIR team estimate that a trajectory stabilizing at 650 ppm would lower the increase at 2100 by 0.7 without significant costs. By the end of this century, reductions in warming on this scale are apt to save at least a few million people from coastal flooding even if flood protection increases in line with income and only sea level change is taken into account. The increase in severity of storms that theory dictates (since vapor from warming powers storms) would add millions more to those saved from harm. These differences are smaller than the impact of enhanced flood protection. But there is no reason to suppose that economic loss would interfere with such adaptation in an equitable regime imposing such a mild global constraint on emissions. Similarly, moderate regimes would, on balance, reduce the tendency of new rain patterns to create additional breeding grounds for malaria-bearing mosquitoes, without canceling the health gains through interference with economic capacities to drain the pools, acquire impregnated mosquito nets and provide effective anti-malarial therapies.

However, as goals of climate control become more ambitious, the risks of increased economic harm, including lost ability to adapt to climate change, become more substantial, especially when macroeconomic reverberations are taken into account. As these dangers from extra mitigation increase, mid-range estimates of climate harms show a steep decline in incremental gains in safety. Even studies as fiercely opposed in tone and methodology as Nicholas Stern’s and William Nordhaus’ locate the turning point at which the expected climate gains are not worth their costs significantly above Two Degrees.

Two Degrees and Catastrophe

If harms through the mid-twenty-second century are in question, the case for a good-faith commitment now to a climate project aiming at Two Degrees
depends on possibilities that are increasingly significant but not, as yet, predicted as likely to occur. Possible interactions between atmosphere, land and ocean that would speed the increase in the atmospheric stock of greenhouse gases are especially troubling. In the IPCC's 2007 report, the diverse models based on the well-established feedbacks produced a broad range of concentration outcomes, which would sustain differences in estimates of temperature increase in the range of 2°C by 2100. Other processes, which might reduce terrestrial absorption of carbon dioxide or even convert the land surface from a sink to a source, were put to one side, as insufficiently understood, and have become bases for deeper concern through subsequent inquiries. Limitations in nitrogen and minerals needed for plant growth seem to severely inhibit plant uptake of additional carbon dioxide and increased concentration of carbon dioxide—by a factor of 3.8 in this century, according to one study. Wildfire, which already contributes a third of the carbon due to fossil fuel emissions, can be expected to increase substantially on account of drying from greater warmth, though the specific global balance between effects of drying from warmth and wetting from rain is unclear. The thawing of permafrost might give rise to emissions equivalent to a sixth of current fossil fuel emissions.

Because of the live possibility that mid-range expectations of concentration are much too low, climate policies that would, on mid-range expectations, keep substantially below Two and a Half Degrees throughout this century could, in fact, be necessary to avoid the harms characteristic of Three Degrees and higher. Ordinarily, the right response to such possibilities is to wait and see and correct if necessary. But robust estimates of complex natural feedback take a long time to establish. So does the negotiation of new, more restrictive global emissions policies, which have set demanding mandates for the intermediate if they are to quench the pace of technological innovation. Waiting for new evidence, new policies and new conduct means accepting an increase in the atmospheric stock of greenhouse gases that makes it impossible to avoid the harms that new evidence might establish.

A live possibility of steady increase in temperature to Three Degrees is troubling enough. Increase to Three Degrees would add about a billion to the number of people at risk of water shortage at Two Degrees, and would involve a global decline in cereal yields, especially steep in the tropics. According to one influential extrapolation of current sensitivities to habitat change, about a third of current species would be committed to extinction once Three Degrees is reached. In addition, there are live possibilities of rapid, large-scale harmful responses to initial increases well below Three Degrees, too rapid for adaptation by vulnerable people. In principle, positive feedbacks between warming and the degradation of tropical forests or the permafrost could produce a surge of global warming in a few decades. Even if warming keeps substantially below Three Degrees, some observations and theories of melting, run-offs, and the interaction between changes in sea-borne ice shelves and ground-based ice sheets suggest that global warming might induce rapid shrinkage of the Greenland Ice Sheet, the Antarctic Ice Sheet, or both, leading to a rapid rise in sea level. While this concern is not a firm prediction, it is within the range of past changes. At the end of the last ice age, polar warming on the scale produced by Two and a Half Degrees (which will be higher in high latitudes) led to deglaciation producing a rise in sea level of about a meter in a century. Such a steep increase now would flood coastal regions where hundreds of millions live.

Given these live possibilities, a refusal to adopt climate policies just because their likely costs exceed their likely benefits in prevention of climate danger is as foolish as a refusal to pay for a year's health insurance just because one is unlikely to have a serious illness that year. Still, the search for greater climate safety is burdened by deep uncertainty as to how much greater safety is purchased through a more costly climate policy. Rival models of the coupling between atmosphere, land and ocean that entail very different relationships between emissions and concentration fit current evidence equally well. The warming that might trigger rapid, irreversible widespread harm might occur above the limit that would be sought in any case on the basis of likely climate harms and mitigation costs, below the limit that the planet is already destined to reach, or somewhere in between. These potentially disastrous processes are sensitive to temperature, but current evidence does not sustain an estimate of the threshold of too hot.

In the face of these uncertainties, someone impartially concerned with human burdens, both climatic and economic, would purchase safety from the dire climatic possibilities through mitigation policies that does not expect, on balance, to impose widespread severe human costs through economic losses. Currently, a good-faith effort to keep increase below Two Degrees meets this standard of moderation. On some views of technological progress and investment, it will impose no net economic cost. On other views it will, but these hypotheses are not much more likely to be valid and the expected, moderate costs are within the normal range of burdens created in pursuit of important civic goals. The pressures to decarbonize that implement the aspiration to Two Degrees are unlikely to push the world economy over the cliff of widespread shut-down. In any case, a safeguard such as a maximum emissions permit price could serve as a fence against this calamity, without destroying incentives that are, on current evidence, likely to be enough to keep within Two Degrees.
A good-faith effort to keep substantially below Two Degrees is another matter. Adherence to the emissions regimes with about an even chance of keeping increase that low is more likely than not to cause widespread significant economic harm, and has a substantial likelihood of pushing the world economy over the cliff. Safety valves avoiding these dangers cannot be attached in a good-faith effort to keep substantially below Two Degrees: only the secure fear of severe penalties for over-emission is likely to be enough to motivate the needed technological changes.

Imposing risks that are severe, likely and widespread is not justifiable as a speculative means of avoiding speculative widespread calamities. Evidence available at the outset of negotiations over a successor to the Kyoto accord makes a target of Two Degrees about right.

Of course, the difference between 2.0°C over pre-industrial, 1.9°C or 2.1°C has no special moral standing, any more than whole numbers and the Celsius scale have special moral standing. But a standard of adequacy is not just a basis for assigning a grade of “Satisfactory.” It is a shared goal to which responsible people throughout the world would hold themselves and others in the face of inevitable scientific controversies, shifts in technologies and burdens, grounds for suspicion and temptations to bad faith. A single shared numerical commitment that is simple in the most common scale of measurement has obvious advantages in this stressful coordination of the greenhouse team. This function singles out Two Degrees within the approximate region.

The Horizon of the Grandchildren

The final ingredient in a case for Two Degrees is an appropriate perspective on time. Because of the endurance of greenhouse gases in the atmosphere and the high level of atmospheric concentration already reached, steep reduction of emissions will have to start soon in a good-faith effort to keep below Two Degrees. This will risk losses from economic dislocation and slowdown, starting soon. In contrast, the climate harms whose prevention has figured in the case for Two Degrees would become a serious global burden decades from now, with the main onslaught starting toward the end of the century. So a case for Two Degrees must give adequate standing to climate harms that will not be endured in the lifetimes of many people who are asked to agree to emissions reductions that may impose significant costs on them.

The valuing of trust that underlies our current political duty to limit the greenhouse effect entails an interest in others’ interests sustaining this concern for the future. One seeks to be worthy of the trust of those with whom one interacts when one takes responsibility for harms stemming from what one controls, avoids exploitation of others’ vulnerability in setting terms for joint activity, and promotes shared constraints on self-advancement that all who take on the constraints can self-respectfully uphold. Trust is an attitude among contemporaries, who rely on appropriate mutual concern for one another’s interests. But this is not to say that a trustworthy climate choice only attends to the immediate impact of the conduct in question. The relevant interests include contemporaries’ interests in meeting their own needs later in their lives, as well as now, and also their interests in nurturance, such as the interest in bringing up children who can themselves successfully meet their own needs, in turn. A similar interest in the next generation and their interests should be presupposed in the childless, in the search for terms fit to guide political interaction among those seeking justice. Someone who does not care how institutions in his society will affect people in the younger generation after he is dead does not care about the justice of those institutions. Given the centrality of these nurturing interests, climate impacts through the start of the next century—in the lifetimes of children of children alive today—will be a vital concern, which can only be expressed responsibly through an effort to keep increase from crossing a threshold of about Two Degrees.

This case for Two Degrees as a goal of people who want to live together with others responsibly does not attend to dangers to people who will live in the remote future. The presumed eventual loss of people who are young now for their eventual grandchildren might extend the temporal horizon a bit, but only within the next century. Does this limited time horizon, implicit in ordinary political duties, make a difference to greenhouse obligations? In particular, what kind of evidence now concerning the remote future might create a duty to impose even steeper emissions reductions, aiming for a limit significantly lower than Two Degrees, despite the substantial risk of severe additional economic costs?

At a minimum, a substantial body of evidence would have to establish a significant probability that a much more burdensome project than Two Degrees, plunging many people now into destitution and stripping them of means to cope with climate change, is necessary and sufficient to prevent a highly distinctive sort of calamity: much more extensive climate suffering, at least as acute for individual victims, in the remote future, through an irreversible process with a long time delay. Each feature of this grim possibility is essential to the deeper demand (though perhaps their combination is not sufficient.) One is not obliged to create a substantial probability of dire loss to oneself and those one loves in order to avoid a speculative danger to others. Dire losses need
not be imposed to avoid side-effects on others that are much less significant for each person affected—say, many billions of larger bills for air conditioning. Because of the irreducible uncertainty of the remote future, the enormous compounded future benefits forgone through the imposed economic loss, and the inevitable risk in forgoing resources which would have helped to cope with the many needs of the vulnerable human species, the future extra climate harms had better be much more widespread than the current economic burdens of avoiding them, not just individuallygrave. The many billions living between now and a remote effect will have their own responsibilities to prevent harm and, presumably, much greater material resources than humanity’s now; so the triggering of a process insensitive to future intervention, rendering these responsibilities irrelevant, must be part of the case for the deeper demand.

Currently, no dire prospect fits this demanding prescription. There is substantial evidence that global warming at a threshold somewhere between Two and Four and a Half Degrees would trigger a gradual meltdown of the Greenland Ice Sheet, unstoppable by any currently foreseeable means, that would add about 1.7 meters to sea level in three centuries, 7 meters in three thousand years. Since the FAIR team’s overshoot trajectory to 450 ppm has an even chance of exceeding Two Degrees, a much more demanding project would reduce this risk. But the extent to which the likely severe burdens now would reduce risks of triggering the meltdown is quite uncertain, as are the material and cultural capacities of people born centuries or millennia from now to cope with the threat of gradual meltdown. Some other possible outcomes of increase significantly lower than Two Degrees would certainly overwhelm future capacities. For example, such warming in the near future might, conceivably, slowly and irreversibly penetrate to the ocean depths, releasing a vastly lethal melt of frozen methane hydrate millennia from now. But these are, at present, mere speculations.

The failure to act now to head off possibilities of vast harm in the future at severe but lesser current cost now might seem incompatible with appreciation of the equal value of people’s lives whenever they are born. But in fact, it expresses an attitude toward choices and their possible effects that would be endorsed from a generationally impartial perspective. “Act in ways that are likely to inflict grave widespread harm on oneself, those one cares about and those alive to whom one bears special responsibility when there is a speculative possibility that this is necessary to avoid much greater harm in the remote future” is not a principle that one has a compelling reason to embrace when one puts knowledge of one’s own position in world history to one side. Speculative possibilities are too easy to come by.

Far from weakening the case for low targets, this refusal to base severe sacrifice in the near future on speculations about vast harm in the distant future strengthens it. For the harms that warming substantially above Two Degrees would inflict through the start of the next century might be needed to prevent much greater, more extensive harms, by preventing ice ages in the remote future. Ice ages, which last tens of thousands of years, seem to be triggered by a decline of northern summer temperatures below a threshold value allowing for sufficient long-term accumulation of snow and ice. The lowering seems to have depended, in the past, on variations in the earth’s orbit. While the next ice age-threatening orbital situation, three thousand years from now, seems to be a bit above the threshold, this prediction is uncertain. Emissions that will burden people in the near future with warming significantly above Two Degrees might well provide crucial protection. At the next point of orbital jeopardy, fifty thousand years from now, the warming that near-term-destructive emissions would provide seems likely to be crucial to avoiding an ice age. Of course, we do not have substantial evidence of how much protection from the dangerous natural process will be purchased through near-term climate suffering or of what the situations or psychologies of people born thousands of years from now will be. Perhaps they will have adequate means of regulating nature or will not be affected very much by a mile-high ice sheet over the latitude of what is now called “Chicago.” But the same can be said of the threat of yards of water, due to a melted ice sheet, over what is now called “lower Manhattan,” centuries from now.

The duty to limit global warming to no more than Two Degrees depends on special attention to harm within a limited time horizon. The proper valuation of trust has a limited horizon that extends far enough.

The Greenhouse Effect and Transnational Justice

The values of trust that generate political duties of concern for comparities have turned out also to generate a demanding political duty of people in developed countries to choose climate policies that help needy people in developing countries. The equitable pursuit of an adequate limit to global warming would impose significant risks of economic disruption on people in developed countries while reducing climatic harms to which people in developing countries are especially liable and minimizing obstacles to the development they need.

There is very little chance that the demands of adequacy and equity will be met. In the United States, fear of economic displacement, alarm at the prospect
of new taxes, the relatively small scale of near-term risks of local climate damage, the influence of firms helped by continued use of fossil fuels, and resistance to measures that would speed the overtaking of the U.S. by China will have an impact on choices shaping the global greenhouse regime quite out of proportion to moral reasons for limiting Americans’ role in meeting the greenhouse challenge. The political leadership of China, depending on continued rapid economic growth for continued deference, can hardly be expected to make large concessions to compensate for American reluctance. Meanwhile, the atmospheric concentration of greenhouse gases grows, making the target of Two Degrees even more arduous.

Soon, the target will no longer be attainable at acceptable cost to the global poor. But its moral significance will not end. The harm due to the failure to achieve it will generate a moral debt of repair, especially large for countries whose departure from greenhouse justice was especially grave and whose resources for compensation are especially great. For example, the United States will have the leading moral debt on account of irresponsible emissions. Every year of departure from adequacy and equity adds to this duty of repair, as surely as it increases atmospheric concentration.

Harmful side-effects of economic activity have turned out to add a great deal to the responsibilities to help people in developing countries generated by transnational manufacturing and the institutional framework of world trade. However, the morality of political concern for compatriots that emerged in Chapter 2 suggests that there may be another, exceptionally powerful source. Political duties to help compatriots in a modern society reflect the shaping of people’s self-advancement within the borders by a sovereign government; distinctive forms of concern must be shown in order to make this process of power justifiable to those whose lives are shaped. This suggests that transnational political power can generate its own demanding responsibilities.

The first step in exploring the consequent responsibilities is clarification of currently important relations of transnational power. In Chapter 2, domestic political duties of concern for the disadvantaged depended on specific features of the civic interaction of compatriots. While these can significantly differ in different political societies, relatively uncontroversial characterizations of civic interaction in stable modern societies were the basis for establishing the currently most important duties. There is much less agreement about how to characterize transnational relationships of power.

Here, the distinctive transnational power of the United States has special importance. It is especially important for the world at large since it has the greatest influence and, hence, presumably, generates the weightiest responsibilities. Obviously, citizens of the United States have a morally urgent concern to understand this transnational power and identify the political responsibilities it creates. The proper characterization of American global power also promises to clarify the responsibilities of people in other developed countries, since their governments are part of coalitions led by the United States and, in several cases, independently exert similar though lesser power.

I believe that American global power is accurately characterized, in a way that illuminates all of these responsibilities, dangers, and challenges, through a specification of the metaphor "the American empire." Because of its importance to the rest of this book, I will devote the next chapter to developing and defending this characterization. Then, I will argue that the exercise of American imperial power has created extensive, unmet imperial responsibilities toward people in developing countries.