BEFORE COLLAPSE:

A POLITICAL THEORY OF

CLIMATE CATASTROPHE

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Doomsday predictions can no longer be met with irony or disdain. We may well be leaving to coming generations debris, desolation and filth. The pace of consumption, waste and environmental change has so stretched the planet's capacity that our contemporary lifestyle, unsustainable as it is, can only precipitate catastrophes, such as those which even now periodically occur in different areas of the world. The effects of the present imbalance can only be reduced by our decisive action, here and now. We need to reflect on our accountability before those who will have to endure the dire consequences.

—Pope Francis, *Ladauto Si*, pp. 119-120

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What is the late November doing
With the disturbance of the spring
And creatures of the summer heat,
And snowdrops writhing under feet
And hollyhocks that aim too high
Red into grey and tumble down
Late roses filled with early snow?
Thunder rolled by the rolling stars
Simulates triumphal cars
Deployed in constellated wars
Scorpion fights against the Sun
Until the Sun and Moon go down
Comets weep and Leonids fly
Hunt the heavens and the plains
Whirled in a vortex that shall bring
The world to that destructive fire
Which burns before the ice-cap reigns.

—T.S. Eliot, from "East Coker," *Four Quartets*

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…this most
excellent canopy, the air, look you, this brave
o'erhanging firmament, this majestical roof fretted
with golden fire, why, it appears no other thing to
me than a foul and pestilent congregation of vapours.

—Hamlet, Act 2, Scene 2

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[L]et them only think that a situation offers the prospect of some profit, even a small one, and they wreck cities and ruin friendly nations by fire and sword; they hate, and are hated in return, with savage and pitiless loathing… Not only this, they inevitably become so stupid that they proclaim by their very actions that, as compared with gold and silver, everything society regards as good and valuable is…so much trash.

—Plato, *Laws*, 697e-698a

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The greatest injustices, in any case, are committed because of excess and not because of the necessities. For example, no one becomes a tyrant to escape the cold.

—Aristotle, *Politics*, 1267a12-15

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Thus the law of nature stands as an eternal rule to all men, *legislators* as well as others. The *rules* that they make…[must] be conformable to the law of nature, i.e. to the will of God, of which that is a declaration, and the *fundamental law of nature being the preservation of mankind*, no human sanction can be good, or valid against it.

—John Locke, *Two Treatises*, Chapter XI, par. 135

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It is a mistake to believe that a just and good society must wait upon a high material standard of life. What men want is meaningful work in free association with others, these associations regulating their relations to one another within a framework of just basic institutions. To achieve this state of things great wealth is not necessary. In fact, beyond some point it is more likely to be a positive hindrance, a meaningless distraction at best if not a temptation to indulgence and emptiness.

—John Rawls, *A Theory of Justice*, pp. 257-8

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Like winds and sunsets, wild things were taken for granted until progress began to do away with them. Now we face the question of whether a still higher 'standard of living' is worth its cost in things natural, wild, and free. For us, of the minority, the opportunity to see geese is more important than television, and the chance to find a pasque-flower is a right as inalienable as free speech.

—Aldo Leopold, *A Sand County Almanac*, p. vii

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[M]an, the still-unconquered eternal-futurist who finds no more rest from the pressure of his own strength, so that his future mercilessly digs into the flesh of every present like a spur: – how could such a courageous and rich animal not be the most endangered as well, of all sick animals the one most seriously ill, and for longest? … His 'no' that he says to life brings a wealth of more tender 'yeses' to light as though by magic; and even when he wounds himself, this master of destruction, self-destruction, – afterwards it is the wound itself that forces him to live . . .

—Nietzsche, *On the Genealogy of Morality*, Third Essay, Chapter 13

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Acknowledgments

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1. Introduction: Environmentalism or Barbarism

"In the face of an absolutely unprecedented emergency, society has no choice but to take dramatic action to avert a collapse of civilization. Either we will change our ways and build an entirely new kind of global society, or they will be changed for us."

—Gro Harlem Brundtland, James Hansen, and others[1]

"Why…are climatologists speaking out about the dangers of global warming? The answer is that virtually all of us are now convinced that global warming poses a clear and present danger to civilization."

—Lonnie G. Thompson, renowned glaciologist[2]

In the mountains of northern Uganda resides a remote tribe of about 10,000 people called the Ik. According to Colin Turnbull's highly influential account,[3] after several years of extreme resource scarcity, the Ik exhibited an almost complete breakdown of "family, cooperative sociality, belief, love, hope" and other social values.[4] As a later commentator explains, the Ik came to

[1] Brundtland et al. 2012.

[2] Quoted in Klein, 15*n*.21.

[3] Turnbull 1972. Turnbull's study has attracted considerable criticism over the years (see, e.g., Wilson et al., 1975; Heine 1985).

[4] Turnbull, 289.

> …display almost nothing of what could be considered societal organization. They are so highly fragmented that most activities, especially subsistence, are pursued individually… Sharing is virtually nonexistent. Two siblings or other kin can live side-by-side, one dying of starvation and the other well nourished, without the latter giving the slightest assistance to the other. The members of a conjugal pair forage alone, and do not share food…
>
> Each conjugal compound is stockaded against the others… Villages have no political functions or organization, not even a central meeting place. Children are minimally cared for by their mothers until age three, and then are put out to fend for themselves. The separation is absolute.

According to Turnbull, the Ik people show us that integral values like reciprocity, fairness, and mutual aid "may indeed be basic to human society, but not to humanity."[5]

We need not accept Turnbull's account of the Ik to accept the basic plausibility of this thesis. Political philosophers have long maintained that the principles and rules of justice can only function amidst a backdrop of reasonably favorable material conditions. Faced with extreme scarcity, David Hume famously warned, "the strict laws of justice" give way "to the stronger motives of necessity and self-preservation."[6] Hume's claim stands behind John Rawls's more developed account of the "objective circumstances of justice," which he defines as "the normal conditions under which human cooperation is both possible and necessary."[7] Central to the objective circumstances for Rawls is the "condition of moderate scarcity," which holds: "Natural and other resources are not so abundant that schemes of cooperation become

[5] Turnbull, 289.

[6] Hume 1751, sec. III, pt. I.

[7] Rawls 1999, 109. NB: Rawls directly attributes his account to Hume.

superfluous, nor are conditions so harsh that fruitful ventures must inevitably break down."[8] Under extreme scarcity, relations of justice and political order cannot be realized or sustained.[9] I refer to this condition as a "political catastrophe."

The central claim of this manuscript is that climate change threatens political catastrophe on a global scale. Failing to take immediate and aggressive climate action thus amounts to jeopardizing the conditions in which fairness, mutual aid, peace, and political stability are possible.

There are innumerable examples of extreme material scarcity precipitating social and political breakdown. As I write this, for instance, *The New York Times* is reporting the following:

> In the few, long days since [Hurricane] Irma pummeled the northeast Caribbean…the social fabric has begun to fray in some of the hardest-hit communities. Residents…spoke about a general disintegration of law and order as survivors struggled in the face of severe food and water shortages.[10]

Similarly, after months of food scarcity so extreme that people were forced to eat dried mud cakes,[11] food riots erupted in Haiti. A week later—on April 12, 2008—the Haitian government fell.[12] The year before this, Mexico was roiled by "tortilla riots" as drought, market speculation, and demand on corn from bio-fuel producers sent prices surging. Reflecting on his country's experience, Mexico's former President Felipe Calderon cautioned that it was just one instance

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[8] Rawls 1999, 110.

[9] I set aside the former state here. For discussion, including doubt about whether justice would become superfluous in a condition of plentitude, see Estlund 2016.

[10] Ahmed and Semple 2017.

[11] Katz 2008. As one woman explained, eating a mud cake "stops the hunger… You eat them when you have to" (Carroll 2008).

[12] Delva and Loney 2008.

of a larger dynamic: the "problems in Africa, even the Arab spring…are [all in] some way or another related to the price of food… All the countries should do something and quickly in order to avoid any social and political turmoil around the world."[13]

Perhaps nowhere is this dynamic more apparent today than in Syria, which has been locked in civil war since 2011. Before conflict erupted, Syria experienced a severe, three-year drought—the worst on the instrumental record. Massive water shortages followed, which devastated crops and farmed animals. In turn, food prices soared, forcing many farming and rural families into already overpopulated urban centers.[14] Coupled with strident inequality, corrupt government administration, and other pressures, these developments helped ignite conflict. Over the last six years, up to 465,000 people have been killed, and many millions more permanently displaced.[15]

These phenomena are harbingers of what is to come in an era of climate change. In the wake of Hurricane Irma—one of two immensely powerful, category-5 storms to hit the Caribbean in as many weeks—climate scientists emphasized the role climate change was playing: for every 1°C of planetary warming, 7% more water is absorbed into the atmosphere, resulting in more violent wind-speeds, rainfall, and storm surges.[16] Similarly, in the case of Syria, researchers studying "century-long…trends in precipitation, temperature, and sea-level pressure" found that human-caused global warming "increased the probability of severe and persistent droughts in this region, and made the occurrence of a 3-year drought as severe as

[13] Jegarajah 2008.

[14] Kelley et al. 2015; Welch 2015.

[15] Reuters 2017.

[16] Worland 2017.

that of 2007−2010 2 to 3 times more likely."[17] Syria is not uniquely vulnerable in this regard. Without drastic cuts in emissions, by 2080, southern Europe, Iraq, Syria, "the breadbasket regions of China," and "some of the most densely populated parts of Australia, Africa, and South America" will all be in a state of "permanent extreme drought," far more severe than the worst of the American Dust Bowl. If this happens, "[n]one of these places, which today supply much of the world's food, will be reliable sources of any."[18]

Weather changes and events, like historic droughts and massive cyclones, are just two ways that climate change threatens a new period of extreme food and water scarcity. Consider seafood, a dietary staple for a fifth of humanity.[19] Ocean warming, along with the pollutants that cause climate change, increase the likelihood that fish—and those who consume them—will become sick.[20] Perhaps more worryingly, ocean warming causes marine species to migrate toward the poles. This effect could be dramatic: according to the IPCC, with just 2°C of warming, fish catches in the tropics are likely to "drop [by] 40–60%."[21] This is a major threat to many seafood-dependent nations—some of which are among the hungriest in the world. Warming is only part of the problem, however. Increased carbon-dioxide (CO_2) levels are also making earth's oceans significantly more acidic,[22] which has vast implications for marine life. Ocean acidification prevents animals like mollusks and crabs from forming hard shells (as

[17] Kelley et al. 2015.

[18] Wallace-Wells 2017, citing Cook et al. 2014.

[19] Morello 2012.

[20] Marques et al. 2010.

[21] IPCC, AR5, WG2, Part A, p. 414.

[22] Currently, the ocean is about 30% more acidic than it was before the Industrial Revolution (Morello 2012).

calcium-carbonate dissolves in acidic water).[23] It decreases birth-sizes and impairs senses in species like salmon, which could permanently depress population sizes or cause extinction.[24] Ocean acidity also creates or exacerbates "dead zones," which can devastate whole fisheries—an effect well underway in the Gulf of Mexico and around Namibia.[25] Perhaps most disconcertingly, ocean acidification is causing massive coral-reef die-offs, or "coral bleaching." In 2016 alone, nearly a third of the coral in the Great Barrier Reef died as a result of bleaching.[26] This is an enormous problem because live coral reefs provide breeding grounds for many oceanic species—including ones that humans rely upon. (Food shortages owing to coral bleaching have already been felt in Kenya, after nearly half of their reefs died in 1998.[27])

Land-based agriculture is similarly vulnerable to a changing climate. One major area of risk involves sea-level rise. Glacier melt and thermal expansion are both elevating sea-levels at an accelerating rate. According to a recent NOAA report, without serious efforts to reduce emissions, we could see as much as eight feet (or 2.5 meters) of global rise by 2100.[28] This would critically undermine rice harvests. As Lester Brown explains, just three feet would "inundate half the rice-land in Bangladesh, home to 160 million people" and "devastate the rice harvest in the Mekong Delta, which produces more than half the rice in Viet Nam, the world's number two rice exporter." A six-foot increase would threaten "[e]very rice-growing

[23] Casey 2015.

[24] Casey 2015; Asch 2015.

[25] Minogue 2014;Wallace-Wells 2017.

[26] Australian Associated Press 2017.

[27] Morello 2012.

[28] National Oceanic and Atmospheric Administration et al. 2017.

river delta in Asia."[29] In short, eight feet of sea-level rise would almost certainly cause starvation on an unprecedented scale.

Crops further inland are hardly less vulnerable to climate change. For every degree (centigrade) of warming, scientists now expect crop yields to decline by about 10% (some estimates range up to 17%).[30] Having just exceeded about 1°C of warming, we have already begun to witness serious crop failures the world over. The mechanisms for this are manifold:

(a) Even short exposure to very high temperatures—say, through heat waves, which are becoming more common—critically damages plant tissue and depresses yields.
(b) Higher temperatures mean more rapid plant development, resulting in smaller plants and thus lower yields.
(c) Higher temperatures cause higher rates of water evaporation in soils, killing plants in the short term, and contributing to the aridification of arable lands in the long term.[31]

Each one of these effects is potentially catastrophic. Consider (a). The United States currently produces about 41% of the world's corn and 38% of the world's soybeans. These staples are highly sensitive to temperature. According to recent research, "average yields [of corn and soybeans] are predicted to decrease by 30–46% before the end of the century under the slowest warming scenario and decrease by 63–82% under the most rapid warming scenario."[32] This,

[29] Brown, 7.

[30] Battisti and Naylor 2009. Some estimates are as high as 17% (see, e.g., Wallace-Wells 2017).

[31] National Research Council 2011, pp. 159*ff*; Schlenker and Robers 2009; Biello 2009.

[32] Goldenberg 2014.

again, would lead to a food crisis of unimaginable scale and intensity—millions, if not billions, of people would go hungry as prices skyrocket.

All told, the U.N. estimates that higher temperatures, changing rain patterns, and other disruptions will cause food prices to increase between 3 and 84% by 2050 (relative to 2015 prices).[33] A tempting view is that technology will save us from these climate shocks to the food system, as it has so many times before. But this appears highly unlikely in the present context. Of course, predictions about the limits of agricultural expansion have been made and discredited many times since Thomas Malthus's first ominous declaration, but there are reasons to be pessimistic about the potential for new Promethean solutions (and old ones).

Consider the agricultural technologies ushered in since the 1940s that collectively comprise the "Green Revolution"—including, e.g., the breeding of disease-resistant, high-yielding crops, the use of potassium fertilizer and chemical pesticides, the introduction of intensive plowing machines, and new irrigation techniques. These technologies were meant to feed a rapidly growing human population, and, in important ways, succeeded at this. Yet, as Les Thiele notes, this revolution had unintended consequences, "many of dire significance."[34] Most critically, contemporary agricultural practices have (1) severely depleted virtually every aquifer in the world[35]; (2) depleted topsoil—to the extent that some believe we have lost nearly a third of all arable land since 1960[36]; (3) expanded deserts (especially in Asia and South

[33] Schlenker and Robers 2009.

[34] Thiele, 104.

[35] Brown, 14, 32.

[36] Thiele, 104; Brown 4*ff*, 32*ff*. According to Volkert Engelsman, an activist with the International Federation of Organic Agriculture Movements, "We are losing 30 soccer fields of soil every minute, mostly due to intensive farming" (quoted in Arsenault). At this rate, by

America[37]); and (4) seriously contaminated waterways and deltas via pesticide and excrement runoff, creating or exacerbating oceanic dead zones.[38] In effect, the Green Revolution has provided only a temporary solution to the Malthusian problem—and, crucially, one that has rapidly exhausted much of the earth's natural resources.

Even if we could find ways of preserving the productivity gains afforded by the Green Revolution without irreversibly damaging our arable land and water supplies, we have another problem. The Green Revolution has left little room to improve productivity: as we approach the bounds of photosynthetic efficiency, further gains become more and more difficult to achieve, and may soon become impossible.[39] In effect, agricultural yields right now are nearly as good as they ever will be. We therefore cannot depend on technology to make up the difference for climate-related declines in agricultural yields.

These problems are made more dire by two long-term trends unfolding against the backdrop of climate change. First is population growth. Around the beginning of the Industrial Revolution in 1800, there were roughly 1 billion people on the planet; by 1927 the human population had doubled to two billion; we hit three billion in 1960, 4 billion in 1974, 5 in 1987, 6 in 1999, 7 in 2011, and are projected to top 11 billion by 2100.[40] The meteoric population growth rate over the last century can, in part, be explained by the same agricultural practices that imperil us today: by ensuring that many more people could be fed in the short term, the

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2050, we will have only ¼ of the arable land on earth that we had in 1960 (Wallace-Wells 2017).

[37] Brown, 37*ff*.

[38] Diaz and Rosenberg 2008.

[39] As Brown (p.8) explains, "the rise in grainland productivity dropped from 2.1 percent a year from 1950 to 1990, to 1.3 percent from 1990 to 2008."

[40] United Nations 2017.

Green Revolution also, paradoxically, ensured that there would be many more people to feed over the long run.[41] Tragically, this amplifies the problems of food and water scarcity: if feeding 7 billion people is already difficult (and likely to become more so for the reasons cited above), feeding 11 billion may be impossible—especially if significant further productivity gains are unlikely.

Another, often overlooked trend is "nutrient collapse."[42] There is increasing evidence that higher concentrations of atmospheric carbon dioxide (CO_2)—the greenhouse gas most responsible for climate change—*negatively* affects plant growth. This marks a striking reversal of the long-held view that higher concentrations of CO_2 simply and straightforwardly promote plant growth. (This point is often played up by American climate deniers, like Chair of the House Committee on Science, Representative Lamar Smith, who recently wrote that a "higher concentration of carbon dioxide in our atmosphere would aid photosynthesis, which…correlates to a greater volume of food production and better quality food."[43]) *Pace* the standard view, researchers have found that higher CO_2 concentrations depress the production of essential nutrients and minerals in key staple crops like wheat, rice, barley, and potatoes. This has vast implications for human health. For example, researchers estimate that, by 2050,

> 150 million people could be put at risk of protein deficiency, particularly in countries like India and Bangladesh… [A] loss of zinc, which is particularly essential for maternal and infant health, could put 138 million people at risk. …[Moreover] more than 1 billion mothers and 354 million children live in countries where [plant-based] dietary

[41] Thiele, 104.

[42] Evich 2017.

[43] Smith 2017.

iron is projected to drop significantly, which could exacerbate the already widespread public health problem of anemia.

Because of nutrient collapse, meeting a given nutritional baseline will require greater consumption—again, precisely when our ability to produce (more) food will be seriously strained.

Together, then, population growth and nutrient collapse make preventing extreme material scarcity all the more urgent. For if we ignore these issues, food deficits will be even greater, and the food we do produce will be less capable of satisfying basic nutritional needs.

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The problems I have been describing have grave moral implications. Extreme and enduring food and water scarcity portend massive suffering, displacement, and death. In this sense, climate change is a moral catastrophe, likely beyond anything we have dealt with as a species.

But climate change is also a *political catastrophe*, insofar as it threatens our most basic political values and institutions—and thus our ability to respond to the very real moral threats it poses. Once we are no longer able to meet our basic needs without denying others the ability to do the same,[44] the possibility of fair social cooperation, reciprocity, and mutual aid disappears. We enter into a state beyond justice.[45] In its most extreme form, political catastrophe results in a war of all against all—not Hobbes's state of nature, where coordination

[44] I defend this conception of climate harm in chapter 2.

[45] This is not to deny that other moral or ethical values might guide our conduct—like supererogation.

and security are the major problems, but something more hellish, where meeting one's basic needs actively fuels conflict because cooperation can do little if anything to overcome scarcity.

This not to say that justice does not pertain to political catastrophe. A central proposal of this dissertation is that we commit a grave injustice whenever our unnecessary actions or inexcusable omissions force people into such justice-less conditions. We—those of us who contribute to climate change in unnecessary ways—bear responsibility for inflicting climate-induced extreme scarcity on others, and we all bear responsibility for not doing more to protect the most vulnerable (among us now, and into the future) from the same. Justice requires each of us to take all reasonable measures to prevent a loss of the conditions that make justice possible.[46] So far we have largely failed at this.

Beyond compromising justice, extreme scarcity weakens states and fractures coalitions, thus imperiling political stability—within states and globally. These strains make responding effectively to climate change even more difficult and thus unlikely to succeed. In many cases, the problem of scarcity compounds itself in a politically mediated positive-feedback loop. Once crops fail, pressures on governments increase, which (in many cases) leads to conflict, erratic policies, and/or state failures, which in turn further disrupts agriculture, lowering yields and increasing prices still more, leading to greater conflict, and so on.[47] This dynamic is evident in Syria. Since war broke out, much of the country's agricultural infrastructure has been destroyed, and the government's ability to distribute seeds, buy crops, and regulate prices critically weakened.[48] Syrian farmers able to produce crops are often unable to bring them to market. Thus, whereas before the war Syria produced nearly 4 million tons of wheat annually

[46] I defend this claim in chapter 2.

[47] World Bank Group 2016.

[48] Peel and Blas 2013; Bulos 2016; Dahan 2016.

(using about 2.5 million and exporting the rest), last year farmers there produced just over 450,000 tons—far short of what would be necessary to feed even the government-held portions of the country.[49]

Syria is not unique in this regard. Every year *Foreign Policy* and the Fund For Peace rank countries according to "their vulnerability to violent internal conflict and societal deterioration."[50] This "fragile state index"[51] is based on a score derived from 12 economic, political, social, and military (or "cohesion") indicators.[52] The number of failed (or seriously "fragile") states on the list has been rising at an alarming rate. In 2005, for instance, just seven states had scores in excess of 100, which qualifies as "high alert."[53] In this year's report, there were fifteen—seven of which occupy a relatively new category called "very high alert."[54] Of those fifteen, six also topped the Global Hunger Index report,[55] and five more likely would if data were available.[56] Of course, this is not to say that states always or exclusively fail *because* of extreme material scarcity, or even that, in every case, extreme scarcity originally causes state failure and not the other way around. It is merely to note that extreme scarcity and political

[49] Dahan 2016.

[50] Brown, 20.

[51] Previously, it was referred to as the "failed states index."

[52] Information about which can be found here: http://fundforpeace.org/fsi/indicators/

[53] Amburn 2009.

[54] On these classifications, see The Fund for Peace, 7.

[55] Specifically, Central African Republic (1), Yemen (7), Chad (2), Afghanistan (8), Haiti (4), Ethiopia (11) (Global Hunger Index).

[56] These states include South Sudan, Somalia, Sudan, Syria, and the Democratic Republic of Congo (Global Hunger Index). Given the political breakdown in those countries, a lack of data is not surprising. According to the UN World Food Programme website, however, each of these countries receives food assistance (http://www1.wfp.org/).

instability are deeply linked, and that these problems often compound one another, crippling an effective response to the morally catastrophic elements of extreme scarcity.[57]

Whatever the precise relationship, climate change is only likely to exacerbate the dynamic. At our current rate of emissions, a recent World Bank report explains, "we're on track for a 4°C warmer world [by 2100] marked by extreme heat waves, declining global food stocks, loss of ecosystems and biodiversity, and life-threatening sea level rise"; in such a world, the report adds, there is simply "no certainty that adaptation…is possible."[58] If this is right and adaptation to a much hotter world is extremely difficult or impossible, bare assertions of power and violence may offer the only viable means for attaining essential resources. In other words, climate change poses a major security concern.

There is a rapidly expanding literature on this subject. Some researchers anticipate that for every 0.5°C of warming, armed conflict becomes 10-20% more likely to occur.[59] The reasons for this are manifold, but resource insecurity is central. As Stanford University climate researcher Marshall Burke explains: "Hot temperatures reduce agricultural productivity, lower crop yields, and…for farmers who are close to subsistence, this could alter their incentives to

[57] In this sense, it may be helpful to think of a concern over political catastrophe as a second-order concern; we want to preserve states and order to preserve our ability to respond to (and mitigate) the moral effects of extreme scarcity, which is our primary or first-order concern. I am grateful to George Klosko for this point.

[58] Klein, 13.

[59] Burke, Hsiang, and Miguel 2015; Carleton, Hsiang, and Burke 2016; both cited in Wallace-Wells 2017. In some cases, temperature increases alone are enough to spur aggression. According to one report, we could see as much as a 54% increase in armed conflict in sub-Saharan Africa by 2030 (Burke et al. 2009).

start or join a conflict… They need to put food on the table. And joining a conflict is one way to do that."[60]

These kinds of conflicts all too often manifest in ethnic violence. In 1998, for instance, after serious long-term food shortages and mass unemployment, riots erupted throughout Indonesia, resulting in up to 1,000 deaths, dozens of rapes, and hundreds of millions of dollars in property damage.[61] Many of the murders, virtually all of the reported rapes, and much of the property damage were directed toward the ethnic Chinese population,[62] which, of course, played no role in the food crisis. Indonesians are, of course, not unique in this regard. In important recent work, historian Timothy Snyder elaborates the food-security issues and "ecological panic" Germany experienced in the early 20th century, and how that fueled Nazi aggression. On Snyder's reading, Hitler obsessed over the idea that Germans could not be fed "from their own land and territory," and used this to justify his *Lebensraum* policies.[63] Joseph Goebbels took a similar view, arguing that a war of territorial expansion and mass extermination was necessary to ensure "a big breakfast, a big lunch, and a big dinner" for all Germans.[64] Snyder finds the same logic in more recent ethnic-fueled atrocities:

> The mass murder of at least 500,000 Rwandans in 1994 followed a decline in agricultural production for several years before. Hutus killed Tutsis not only out of ethnic hatred, but to take their land, as many genocidaires later admitted. In Sudan, drought drove Arabs into the lands of African pastoralists in 2003. The Sudanese

[60] Quoted in Wallace-Wells 2017, fn.108.

[61] BBC News 1998; Purdey 2006.

[62] Panggabean and Smith 2011.

[63] Snyder 2015.

[64] Snyder 2015.

> government sided with the Arabs and pursued a policy of eliminating the Zaghawa, Masalit and Fur peoples in Darfur and surrounding regions.[65]

He takes this as evidence that "contemporary environmental stresses could encourage new variations on Hitler's ideas, especially in countries anxious about feeding their growing populations or maintaining a rising standard of living."[66] Climate change is the largest threat in this regard—a key driver of a new ecological panic.

Even without inciting ethnic hatred, it is all too easy to imagine how regimes could exploit panic over *actual* water and food scarcity to justify authoritarian policies: e.g., tightly restricting immigration (and emigration), militarizing police forces, increasing detention rates, and denying essential resources to refugees, prisoners, and the poor. Europe offers a case in point. As millions of Syrians have fled to Europe, a kind of hyper-nationalist retrenchment has re-appeared on the continent, with far-right parties advocating for far stricter border enforcement and the end of the European Union.

The potential dissolution of the E.U.—an institution founded on the aspiration of continental peace and prosperity—makes vivid the extent to which climate-induced resource scarcity could give rise to a new era of international brinkmanship and inter-state conflict.[67] This, at least, appears to be the view of various security agencies and officials. Consider the U.S. Department of Defense's most recent "Quadrennial Defense Review":

> Climate change may exacerbate water scarcity and lead to sharp increases in food costs. The pressures caused by climate change will influence resource competition while

[65] Snyder 2015.

[66] Snyder 2015.

[67] Notably, Peter Gleick (1991) predicted precisely this kind of conflict as the Cold War concluded.

> placing additional burdens on economies, societies, and governance institutions around the world. These effects are threat multipliers that will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions – conditions that can enable terrorist activity and other forms of violence.[68]

In a report to the U.S. Senate in 2013, then Director of National Intelligence James Clapper claimed that "extreme weather events" of the sort threatened by climate change "will increasingly disrupt food and energy markets, exacerbating state weakness, forcing human migrations, and triggering riots, civil disobedience, and vandalism."[69] Similarly, when asked what he regarded as the biggest contemporary threat, Navy Admiral Samuel Locklear—"America's top military officer in charge of monitoring hostile actions by North Korea, escalating tensions between China and Japan, and a spike in computer attacks traced to China"—cited climate change.[70]

Those who stand to gain from climate-fueled conflict have also taken note of the potential for resource-based conflict. In 2013, for instance, a report from the global arms giant Raytheon notes that, "climate change may cause humanitarian disasters, contribute to political violence, and undermine weak governments," before concluding that "[e]xpanded business

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[68] U.S. Department of Defense 2014a, 8. In another report, the DoD warns that "Rising global temperatures, changing precipitation patterns, climbing sea levels, and more extreme weather events will intensify the challenges of global instability, hunger, poverty, and conflict. They will lead to food and water shortages, pandemic disease, disputes over refugees and resources, and destruction by natural disasters in regions across the globe" (U.S. Department of Defense 2014b; cited in Scranton, 15). Notably, NATO also refers to climate change as a "threat multiplier" (Nuccietelli 2017).

[69] Scranton, 15.

[70] Bender 2013.

opportunities are likely to arise as a result of these security concerns and the possible consequences."[71] Although robust quantitative research on the exact relationship between conflict and climate change is just emerging, evidence suggests that the frequency of "intergroup violence"—i.e., war—could increase by as much as 50% by 2050.[72]

Although it is impossible to predict precisely how these new, climate-resource wars may unfold, scholars have already drawn attention to one plausible route.[73] Affluent, food-importing nations have begun purchasing or leasing huge tracts of arable land and freshwater rights—often in countries that have high domestic rates of food insecurity and hunger.[74] For instance, by 2009, China had purchased rights to nearly 2.8 million hectares (or 6.9 million acres) of arable land in the Democratic Republic of Congo (DRC).[75] The DRC tops the "Fragile State Index" (which, again, measures political instability), and has a poverty rate of nearly 64%.[76] More strikingly, from 1998 to 2007, an estimated 5.4 million DRC citizens died mostly through starvation (as conflict severely disrupted agriculture), and to this day the country relies heavily on food aid.

China is not the only country participating in what some are calling "land-" and "water-grabbing."[77] Many states—including Saudi Arabia, the U.S., the U.K., Qatar, the U.A.E., South Korea, Kuwait, India, Egypt, Japan, Jordan, and others—and even private corporations are appropriating land and water in Ethiopia, Sudan, Turkey, Russia, Ukraine, Kazakhstan, the

[71] Schulman 2013. See also Klein, 9.

[72] Hsiang, Burke, and Miguel 2013.

[73] Aton 2017.

[74] Brown, 10; Swanson 2015; Johnsson et al. 2016.

[75] Brown, 11.

[76] World Food Programme.

[77] Rulli, Saviori, D'Odorico 2013.

Philippines, Vietnam, Brazil, Angola, Congo, Zambia, Myanmar, and Mozambique, among other places.[78] By and large, the purchasers are affluent states dependent on food imports, while many of the host countries are, like the DRC, politically unstable, relatively poor, and, ironically, dependent on U.N. food lifelines.[79]

Among the many concerns land- and water-grabbing raises, chief is the potential for neo-colonial assertions of power and outright conflict. In some places already, security forces have been introduced to protect land purchases from displaced farmers and hungry citizens.[80] As climate shocks constrain supply, this dynamic will almost certainly become more aggressive. At what point will export zones simply become "fortified colonies?"[81] When will states think it appropriate to assert, through military might, their "right" to the resources they purchased or leased? When will these states simply topple the already weak regimes whose resources they depend upon and install new powers, more amenable to an explicitly colonial relationship? It is impossible to answer these questions now, and we may hope that we never have to. But considering that virtually every powerful country on earth—including every permanent member of the U.N. Security Council—now possesses land or water rights in other countries, a future of resource colonialism and conflict is hauntingly plausible.

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[78] Brown 10-11; Swanson 2015. See also Seaquist, Johansson, and Nicholas 2014; Rulli, Saviori, D'Odorico 2013.

[79] Brown, 10-11. There are of course exceptions.

[80] Brown, 12.

[81] Snyder 2015.

Though in some ways the future world I am describing is not far off, it has yet to fully arrive. We *can* still avert politically catastrophic climate change, globally. The title of this manuscript—"*Before* Collapse"—means to convey this radical hope.[82] Importantly, what makes hope radical in this context is its nearly complete detachment from optimism. The world has now known about the causes and potential consequences of climate change for decades. Yet, political leaders have failed to take all but the most minimal and hollowly symbolic actions. In fact, since the first international climate-change treaty was signed in 1992—which committed states "to protect the climate system for present and future generations"—annual emissions have actually *increased* by more than 44%.[83]

Thus, while not yet inevitable, climate catastrophe has become imminent. We have scant time left to prevent crises of unimaginable scale and magnitude—crises of thirst, hunger, neo-authoritarianism, colonial domination, war, and moral-political collapse from which we may never recover.

Apart, perhaps, from the specter of nuclear annihilation, political theory has never had to reckon with a threat so complete as climate change.[84] The prospect of climate catastrophe often defies ordinary ways of thinking about justice, liability, obligation, virtue, the value of democracy, and our relationship to the natural environment.[85] This basic insight informs my approach throughout this manuscript; much as Michael Walzer argued that "supreme

[82] I thank Michael Payne for this point.

[83] As of 2014; World Resources Institute data.

[84] I am reminded here of George Kateb's remarks in "The Adequacy of the Canon."

[85] Several political theorists have recognized this—though perhaps none more than Dale Jamieson. See, e.g., Jamieson 1992.

necessity" alters the contours of what is permissible in war,[86] I claim that politically catastrophic climate change challenges some basic assumptions of liberal-democratic theory.

This is perhaps clearest in chapter 2, which takes as its starting point the following core political question: assuming the fairest distribution of burdens will not always be the most effective, which value should take priority? Contemporary political thought routinely prioritizes fairness—so much so that many would sooner abandon cooperation before accepting an unfair allocation of burdens. This view, however, becomes problematic in the context of climate change: for, after decades of inaction, we may be unable to prevent catastrophe without imposing unfair costs on the least well-off. This is particularly clear in the intergenerational context: there is likely no way to prevent climate catastrophe unless those of us alive today make serious sacrifices for the sake of future generations—who are widely expected to be far wealthier than we are now. But the same may also hold intra-generationally. Effective precautionary action may require imposing costs or developmental delays on relatively poor states like China and India, for which they may never receive full compensation.

What, if anything, justifies this? I argue that whenever the material conditions of justice themselves are at risk—i.e., whenever agents are faced with the prospect of political catastrophe—we should prioritize precautionary efficacy over concerns of fairness or equity in the political calculus. The essential idea here is that that preserving the conditions that make justice possible is more important than any particular instance or application of justice. This is directly relevant to climate change. By threatening extreme and enduring (perhaps even irreversible) food and water scarcity, climate change endangers the possibility of fair social cooperation, reciprocity, mutual aid, and, by extension, political stability. Consequently, I

[86] Walzer 2015, chapter 16.

argue, agents must take all reasonable measures to prevent politically catastrophic climate change, even if this undermines fairness or equity.

An important problem raised by this proposal is how to specify the limits of precaution: how much should we sacrifice today to prevent a given loss 50 or 100 years from now? Chapter 3 approaches this question by way of the future discounting debate. Discount rates express the present value of future consumption.[87] The debate over discounting currently cleaves along support for a low positive rate, favored by most economists, and a zero rate, favored by most egalitarians. Positive rates express present favoritism, whereas a zero rate treats present and future consumption as equally valuable. *Pace* both camps, I argue for a low *negative* rate, which favors future consumption over present. If goods (particularly water and food) are comparatively scarcer, as would be the case in a future world marked by political catastrophe, every additional unit of consumption is more valuable. A negative rate reflects this. Moreover, a negative rate captures the idea that each generation has a duty to protect future ones from scientifically plausible, reasonably likely threats of catastrophe—a point I defend in chapter 2.

The discounting debate is central to establishing the "social cost of carbon," and thus for pricing emissions. The lower the rate, the more expensive emissions become; at and below zero, emissions become *very* expensive. In this sense, a negative rate is valuable also because it serves the practical purpose of seriously disincentivizing risk-enhancing activities like emitting greenhouse gases. In this way, a negative rate again best reflects a commitment to preventing catastrophe.

[87] Or, future costs and benefits, or welfare. For simplicity, I use welfare here, though the object of discounting remains contentious.

Of course, imposing heavy taxes on emissions would seriously burden current generations. Given serious inequalities within and among states, how should we distribute the burdens of climate action? This comprises the focus of chapter 4. One popular answer—the polluter-pays principle (PPP)—stipulates that those responsible for causing the problem should pay to address it. While intuitively plausible, scholars have subjected the PPP to withering criticism in recent years. Through responding to the most important objections, I develop a new version of the PPP. Unlike most accounts, which focus on historical *production*-based emissions, mine allocates climate burdens in proportion to each state's annual *consumption*-based emissions. Since wealthy states tend to be the biggest consumers, my principle supports a distribution of costs that is economically fair and effective at reducing emissions. Yet, my revisionist PPP is incomplete in one key respect: it cannot allocate burdens in the (distant) future, when climate change endures but consumption emissions are low. I therefore supplement it with an ability-to-pay principle. The end-result is a pluralist, bi-phasic account of burden-sharing justice that is comprehensive (it covers all of the major climate action burdens—mitigation, adaptation, and compensation), but that remains sensitive to states' differing contributions and capacities.

In chapter 5, I examine an increasingly salient proposal for responding to climate change: geo-engineering, i.e., the deliberate, large-scale manipulation of the earth's climate system. Proponents argue that, before long, geo-engineering may offer the most cost-effective option for preventing climate catastrophe. Should this be the case, many contemporary political theorists will have difficulty explaining the sense of aversion and tragedy many feel about intentionally manipulating the climate. Appeals to precaution only partially explain these feelings. Drawing on Buddhist and Aristotelian theory, I argue that even *if* geo-engineering could prevent (or indefinitely postpone) climate catastrophe, it should remain a measure of

last resort, as it threatens to sustain environmentally destructive appetites that cannot but result in injustice and unfreedom. My intention in this chapter is not to pronounce on whether geo-engineering is morally "right" or "wrong," but to highlight reasons for thinking it unattractive in a broader sense, thereby strengthening the case for exhausting conventional emissions-reductions options.

Chapter six concludes the project and points the way to future research. Important questions about the nature of personal responsibility for climate change, the continued relevance and legitimacy of democratic processes and institutions, and the role of coercion in ensuring compliance remain unanswered. Taking the possibility of catastrophic climate change seriously warrants new research into these and other issues.

2. Climate Change, Catastrophe, and the Circumstances of Justice

1. Introduction

It is a tragic feature of human cooperation that the most efficacious allocation of burdens is not always the fairest. A central problem of politics, then, is determining which should take priority in a given situation.

Fairness holds so much weight in contemporary political thinking that we often believe it better to abandon a common project rather than accept an inequitable distribution of benefits and burdens. Yet, in some cases, the ends of our shared endeavors are not elective or are so valuable that we may think cooperation should proceed regardless of fairness concerns. This appears true of warfare and diplomacy, for instance, and often for healthcare services. In such cases, we may *hope* that our shared goals can be met without unduly or arbitrarily burdening any particular party. Nevertheless, trade-offs often are unavoidable, such that we must sacrifice some part of fairness if our goals are to be met, or efficacy if uncoerced cooperation is to continue.

In this chapter, I argue that the imperative of preventing catastrophic climate change presents an important example of this dilemma. After decades of inaction, we may no longer be able to prevent the worst effects of climate change—including sea level rise, the proliferation of mosquito-borne diseases, mass extinctions, agricultural collapse, and extreme water scarcity—without imposing unfair burdens on some parties. This is particularly clear in the intergenerational context: there is likely no way to prevent climate catastrophe unless those

of us alive today make serious sacrifices for the sake of future generations, who are widely expected to be far wealthier than we are now. But the same may also hold *intra*-generationally: effective precautionary action may require imposing significant costs or developmental delays even on relatively poorer states like China and India, for which they may never receive full compensation.

The real or potential tension between fairness and efficacy in the context of responding to climate change has not been well explored in the literature. It therefore remains unclear under what conditions, or to what extent, prioritizing effective precautionary action over distributive fairness is permissible. These questions comprise the focus of this chapter.

I begin my inquiry, in section 2, by considering the possibility that no trade-off is necessary, at least in the intergenerational context. This view is popular in the intergenerational justice literature on climate change. It is staked on the claim that current generations can defer the costs of presently undertaken action onto richer, future people. For various reasons, I argue that this proposal fails.

I then turn, in section 3, to recent work by Simon Caney. Caney acknowledges the potential for conflict between the goals of avoiding harm and fairly distributing burdens, and offers a sophisticated account of when we might prioritize the former over the latter. What results is an improvement over the intergenerational-justice approach; however, I argue that it also falls short in several key respects.

I thus propose an alternative account in sections 4 and 5. Broadly, I argue that prioritizing efficacy over fairness is justified when faced with the prospect of "political catastrophe." Political catastrophe occurs whenever material scarcity is so extreme that fair social cooperation and political stability become impossible to realize or sustain. My argument,

then, is that preventing the loss of the conditions that make justice possible ought to be given greater weight than satisfying any particular instance or application of justice.

Defining catastrophe in relation to the circumstances of justice helps explain how precaution coheres with broader theories of justice, making my priority argument less ad hoc than alternatives. It also clarifies the specifically *political* stakes of precaution in the context of climate change: we should take action both to avoid harm *and* prevent moral-institutional collapse. The prospect of collapse provides a strong moral and prudential base of motivation for states and other temporally unbounded actors to take immediate and decisive action.

In section 6 I identify several ways in which climate change poses a credible risk of political catastrophe, and argue that we are obligated to take all reasonable measures to address it—including, e.g., reducing emissions, enhancing sinks, supporting adaptation measures, and ensuring that losses and damages do not precipitate extreme scarcity. Crucially, I claim, this obligation must be fulfilled even if it upsets ordinary conceptions of fairness.

2. Intergenerational Justice Approaches

One well-discussed example of conflict between fairness and efficacy in the context of climate change appears in the intergenerational justice literature. Virtually every economist expects future generations to be wealthier and more technologically advanced than we are.[1] If this is correct—i.e., if future generations *will* be better off—then imposing strenuous climate-

[1] Schelling 2002; Godard, 33; Dasgupta, 6. For discussion, see Rendall, 884*ff*; but cf. Posner and Weisbach, 77-9.

action burdens on current generations seems unfair, as it amounts to unfairly burdening poorer people for the benefit of richer ones.[2]

We can call this the "intergenerational equity objection" to immediate climate action. There are many examples of this objection in the literature. Robert Lind, for instance, asks: "Can we justify current generations sacrificing 2–3% of GWP to increase the wealth of future generations who even after deduction for the high damage scenario are 2–15 times richer than the present generation?"[3] Similarly, Bjorn Lomborg argues that, even accounting for the likely costs of climate change, "it will be far more expensive to cut carbon-dioxide emissions radically than to pay the costs of adaptation."[4] On this view, justice would be better served by devoting

[2] Of course, not everyone takes this view. Broome (2012, 45*ff*), for instance, argues that imposing burdens on current generations would be justified in accordance with the polluter-pays principle (PPP) because current generations are contributing to the problem, while the future is not. There are a couple of problems with this view, however. First, if applying the PPP compromises minimal standards-of-living, as it might do in China, India, and other high-emitting developing states today, then an (unqualified) intergenerational PPP would likely generate as much unfairness as it purports to solve. Moreover, while the PPP may be able to establish that current generations should pay (at least some of) the costs associated with reducing emissions, it cannot as easily establish duties for another crucial aspect of mitigation: maintaining and enhancing carbon sinks (like rainforests). Thus, because an intergenerational PPP risks unfairness in an intergenerational context (for its failure to take economic considerations into account), and because it is incomplete with respect to climate duties, I set it aside here. This of course is not to deny that a defensible, *intra*-generational application of the principle could be developed, as chapter 4 means in part to show.

[3] Lind 1995, 384; quoted in Rendall 2011, 886.

[4] Lomborg 2001, 318. There are reasons to doubt Lomborg about this, as I explain below.

our scarce resources to assisting the global poor alive today—even if this means continuing fossil-fuel-intensive development.[5]

Political theorists and climate ethicists have developed various responses to the equity objection, aimed at making space for effective precautionary action without undercutting the priority of fairness.[6] Most commonly, scholars argue that even if we grant that future generations will be richer,[7] imposing climate action burdens on those alive today is justified *so long as* the costs of present action are shifted onto the future (e.g., through heritable debt).[8] In other words, by separating the costs of climate action from the actions themselves, we can ensure that the (richer) future pays, thus preserving intergenerational equity. Any apparent conflict between effective precaution and intergenerational fairness therefore disappears.

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[5] Lomborg 2001, 310-318. For additional statements of this objection, see Nordhaus 1997, 2008, and 2009; Lomborg 2007; and Solow 1974. But cf., Gardiner 2011, 248 and passim; Caney 2009; and Cole 2003.

[6] One response challenges the damage-estimate models economists use. I am not qualified to assess this response, suffice to say that elements of these models certainly do appear questionable: e.g., the assumption that damage costs of low-level warming (e.g., 0.5ºC) can be scaled up linearly (rather than exponentially) to provide estimates for greater increases in temperature (Wagner and Weitzman, esp. 60*ff*). Similarly, the common tendency to exclude "fat-tailed uncertainties" from damage estimates seems defensible only as a simplifying assumption (Rendall 2011, 889; Wagner and Weitzman; Furman et al. 2014; IPCC, AR5, WG3, 246).

[7] Some theorists doubt this assumption, pointing out that growth in the costs associated with climate change may well outpace general economic growth over the relevant time scales. I address this below.

[8] Some variant of this proposal has been endorsed by Matthew Rendall (2011), Simon Caney (2012, 2014), John Broome (2012, 45*ff*), and others.

While this seems plausible on first blush, a number of issues arise on closer inspection. Most pressingly, significant doubt exists about whether shifting costs onto future generations is even possible. Many economists argue that wealth can only be transferred between contemporaries, *not* generations.[9] As Matthew Rendall explains, "it does not seem possible for the present generation *taken as a whole* to borrow money from the future," because any "loan made now comes out of today's spending and investment, and will in turn be repaid to future people."[10] If this is right, then an essential task becomes clarifying which agents should be the debtors and which the lenders, and on what terms. Doing this while preserving intergenerational equity would require disaggregating generations, sorting agents with differing debt-bearing capacities into distinct economic strata, producing some reliable estimate of how those agents' capacities will change over time (will they continue occupying the same strata?), and, finally, selecting a global-justice principle that takes these factors into account in order to allocate burdens fairly.[11]

Suppose for the sake of argument that this can be done or that some other mechanism for fairly deferring the costs of present action can be found. Two problems remain. First, even if *some* of the costs of present climate action could be deferred (or compensated for at the expense of the future), it is nonetheless impossible to defer *all* of the costs.[12] For instance,

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[9] For discussion see, e.g., Cooper 1986, Labonte and Makinen 2005, and Ferguson 1964; all cited in Matthew Rendall's (2011, 892) helpful discussion.

[10] Rendall 2011, 892; citing Buchanan, 2004, 324–5.

[11] This problem holds even if heritable debt is not the mechanism of intergenerational transfers. For instance, some have proposed diverting research and development investments. As this, too, would require only some countries to forego welfare gains, the same question arises: who should sacrifice now and why?

[12] This point, and the following example, draws on Caney 2014b, 133-4.

effectively addressing climate change will entail many workers losing their jobs—particularly in the fossil-fuel and animal-agriculture industries. Occupations are integral parts of many people's identities, and the ability to work is often basic to one's sense of self-respect. (Consider farmers or Appalachian coal miners.) Moreover, many displaced workers may have limited ability to adopt a new profession. These costs and sacrifices cannot be deferred, and pecuniary compensation can only go so far. Thus, some residual injustice remains.

We might also worry that any plan that proposes transferring costs onto the future ultimately depends on unverifiable assumptions about future economic conditions. Should it turn out that future generations are poorer, or that growth in the costs associated with climate change outpace general economic growth, then deferring even some of the costs will turn out to have been unfair and so unjust. When we defer costs, we take a gamble with justice that might not bear out.

This point suggests a broader problem. To justify any particular program of action, intergenerational-justice approaches must regard certain assumptions about the future as matters of fact. This is necessary for specifying unambiguously what each generation owes to future ones.

For our purposes this means that, to require current generations to act, intergenerational-justice theorists must maintain that the future effects of unmitigated climate change will, *in fact*, be grave. Regardless of scientific consensus about the anthropogenic origins of climate change, however, it remains impossible to predict precisely what (or when) climatic changes will occur, or how such changes will impact human well-being. Consider, e.g., the IPCC's prediction that a doubling of atmospheric CO_2e[13] will "likely" increase global mean

[13] That is, "carbon dioxide equivalent," a shorthand metric representing all greenhouse gases.

temperature by 1.5 to 4.5ºC.[14] If warming falls at the low end, most states should be able to adapt without serious damages. Warming at the high end, however, may prove devastating for ecological, economic, and political systems. This variability weakens intergenerational-justice theorists' ability to allocate climate-action burdens. For if we *know* that temperature increases will be low, present generations can justifiably leave the bulk of climate action to the (likely wealthier and more technologically advanced) future. Conversely, if we were certain that temperature increases will be great, the case for imposing stringent burdens on present generations would be much stronger.[15]

There is still another issue: in the absence of certainty, the normative motivation for immediate climate action on intergenerational-justice approaches goes unstated. Scholars likely wish to reduce the likelihood that climate change will overwhelm the response capacities of future generations, leaving them a ruined world. But if this is right, then these scholars are implicitly relying on a notion of precaution without considering the implications this might have for their other theoretical commitments.

Even if solutions to these various problems could be devised, we might still worry that deferring costs provides only a contingent (and thus precarious) case for precautionary climate action: on this view, immediate action is permissible *if and only if* present generations can shift

[14] Scientists use the term "climate sensitivity" to describe the total global mean temperature increase after a doubling of CO_2e. Pre-industrial CO2e was 280 ppm; today, it is over 400 ppm. Without additional emissions reductions, it may exceed 700 ppm by 2100. IPCC, AR5, WG1, p. 16; cf. IPCC, AR5, WG3, p. 13. See also Wagner and Weitzman, 53.

[15] Notably, the timing and form of climate changes are just two areas of uncertainty. Others concern the physical effects of climate change and their costs.

costs onto the future. Such a qualified position is likely to be unsatisfying for anyone centrally concerned with preventing catastrophe.

3. Prioritizing Precaution: Caney's Argument

Recent work by Simon Caney offers another way of navigating potential conflict between fairness and efficacy. Caney starts with "the assumption that it is of paramount importance that humanity avoids dangerous climate change."[16] But he acknowledges that it may be impossible to achieve this goal, however, without upsetting distributive justice. He therefore attempts to specify the conditions under which effective preventative action justifiably takes priority over fairness.[17]

Central to Caney's account is a distinction between "first-" and "second-order responsibilities." First-order responsibilities cover core climate duties—i.e., to "mitigate climate change," "enable adaptation," "compensate people for harm done"—and also to the need to pick up the slack on these duties in instances of non-compliance.[18]

Caney does not specify to which agents, in particular, first-order responsibilities fall, though based on his earlier work, it is likely some construal of "the most advantaged"[19]—in particular, the most advantaged states.[20] He also does not indicate clearly what the normative foundations for these responsibilities are, though the imperative to prevent harm or the erosion of just entitlements (to health, safety, and a decent standard-of-living) likely fulfills this

[16] Caney 2014b, 127-8.

[17] Caney (2014b) presents this as a trade-off between two kinds of climate justice: one focused on ensuring that burdens are fairly distributed, the other focused on the avoidance of serious harms.

[18] Caney 2014b, 134, 135.

[19] See Caney 2005, 769. This reference is suggested by Caney 2014b, n.32.

[20] Caney 2005, 751.

role.[21] Most pressingly, Caney does not specify under which conditions, if any, first-order responsibilities to prevent climate catastrophe should take priority over ensuring that burdens are distributed fairly.[22]

These ambiguities owe to the fact that Caney is principally concerned with "second-order responsibilities," which are those agents have (a) to ensure that others (ostensibly, states) comply with their first-order responsibilities, and (b) to promote a normative-institutional context in which preventing climate catastrophe is likely to succeed.[23] His priority argument is meant to apply only to these second-order responsibilities.

Caney's essential claim is that those who have the *power* to prevent dangerous climate change (in the second-order sense) have a *responsibility* to do so. He refers to this as the "power/responsibility principle" (hereafter, PRP).[24] The PRP applies when the following, jointly sufficient conditions obtain:

(1) "humanity faces a prospect of disastrous harms"[25];
(2) certain agents have the capacity to "reduce, or severely limit, the chances of these dire outcomes" coming to pass[26];

[21] This is suggested by his focus on avoiding harm, and (in earlier work) the impact of climate change on core human rights (Caney 2009).

[22] Caney may believe that a trade-off between fairness and efficacy in the context of first-order responsibilities is unnecessary.

[23] He formulates (b) quite capaciously to include "norm entrepreneurship," disobedience, incentivization, enablement, and undermining resistance to action (2014b, 136-8).

[24] Caney 2014b, 141.

[25] Caney 2014b, 142.

[26] Caney 2014b, 143.

(3) moreover, these agents are *uniquely* able to prevent catastrophe—viz., others lack their capacities and, thus, "if disaster is to be averted, [all qualified agents] must act."[27]

(4) there are no "sufficiently weighty countervailing considerations" that "take priority" over the responsibility to act.[28]

Caney argues compellingly that the first three conditions are met in the context of climate change, and he offers a plausible defense of (4). But a number of issues remain.

First, and most pressingly, we are looking for a priority argument that applies to core—i.e., first-order—climate duties. Caney notes repeatedly, however, that his argument applies *only* to second-order responsibilities.[29] His reasoning appears to be that first-order responsibilities can be distributed in accordance with a principle of corrective justice (for past emissions), and no trade-off is necessary.[30] Yet, so long as it is at least possible that the most efficacious distribution of climate-action burdens will not be the fairest or must just (however construed), our original inquiry remains relevant. Whichever justice principle we employ, we must still ask: under what conditions and to what extent should efficacy take priority over fairness in the context of addressing global climate change?

One way to answer is to simply extend Caney's priority argument for second-order responsibilities to cover first-order responsibilities. Specifically, we might stipulate that, whenever the four conditions noted above obtain, all states (or other actors) with the power to prevent catastrophic climate change (in a first-order sense) also have the responsibility to

[27] Caney 2014b, 143.

[28] Caney 2014b, 143-4.

[29] Caney 2014b, 135, 142, and *passim*.

[30] Caney 2014b, 140-1.

do so. Granting, *arguendo*, that such an extension is possible, we can consider what problems, if any, Caney's account faces.[31]

Starting with condition (1), Caney is right to argue that climate change portends serious future harms without decisive and immediate action. But whenever we speak about the need for preventative action against *future* harms, some account of how probability affects responsibility is needed. At what point, exactly, does the threat of climate catastrophe generate an obligation to act? Does the strength of one's responsibility scale up with increased likelihood, or is it categorical—i.e., does one have an obligation only above a certain minimal threshold of probability? Caney does not address these points.

Regarding conditions (2) and (3), we can note two problems. First, particularly with respect to first-order responsibilities, every capable agent is *not* needed for effective climate action; a critical mass suffices. Consider that, in 2013, the top ten state polluters alone were responsible for more than 73% of global emissions, while the bottom hundred countries accounted for only about 3.5%.[32] Of course, many of the countries between the top ten and bottom hundred have the power to reduce their emissions substantially—but their reductions are far less important for preventing catastrophe, and are perhaps even unnecessary *if* the top polluters act.

Caney later recognizes that, even for second-order responsibilities, "it may be too strong to say that the intervention of all [capable] agents is necessary," but he holds nonetheless that "[w]hether dangerous climate change is averted…depends on whether a sufficient number of…agents take up these roles."[33] The problem with this is not only the

[31] It is worth emphasizing that the following is not a critique of Caney's account, per se, as this extension was not his intention. That said, some of the problems noted may apply also to his argument for prioritizing second-order responsibilities.

[32] The U.S., China, and the E.U. produced about 51% of global emissions (Friedrich, Ge, and Pickens 2017).

[33] Caney 2014b, 143.

ambiguity surrounding what counts as a sufficient number; Caney's admission also undercuts the basic motivational force of the PRP, which holds that "acting on it is *necessary* to protect those whose interests are threatened."[34] Even accepting the (sound) assumption that that the actions of some capable agents *are* necessary to prevent catastrophe, in most cases, complying with the PRP will *not* be necessary for any particular agent.

This implies a collective action problem. If the concerted action of a certain number of capable agents is necessary to avert disaster, but the participation of any particular agent is unnecessary, then individuals have considerable incentive to free-ride.[35] Without a coordination mechanism or a principle that can allocate responsibility in instances of redundancy, how can the PRP be effective?[36]

This problem becomes more worrying if we accept that fulfilling climate duties may come at a cost to an agent's other important values or ends. Then, instead of just lacking an incentive to comply, agents will have an incentive to not comply. Perhaps in recognition of this, condition (4) stipulates that agents possess no "sufficiently weighty countervailing considerations" that "take priority" over their responsibility to act. While this *may* hold true

[34] Emphasis added; Caney 2014b, 144.

[35] This holds even at the level of second-order responsibilities: if agents X, Y, and Z all have the power to enforce compliance with first-order responsibilities (say, to reduce emissions), but the actions of one or two agents is sufficient to accomplish this, then X, Y, and Z each has an incentive to shirk her duty and hope the others comply.

[36] To see the problem this poses for motivation, consider a modified version of Peter Singer's (1972, 231*ff*) famous drowning baby example, which—Caney notes—relies on a structurally similar line of reasoning as his own argument (2014b, 146n.47). If I was not alone in walking by the pond in which the baby is drowning, but was accompanied by many people capable of rescuing it, who has the final responsibility to act, and why? If we all do, but only one of us is needed, how should we decide who should wade in?

for second-order responsibilities, it almost certainly does not for first-order. Reducing emissions, enhancing sinks, establishing and financing compensation mechanisms, enabling adaptation, and so on is difficult and expensive. This is especially true for poor states, for which general climate inaction and fossil-fuel industrialization are regarded as expedients to essential developmental gains.[37] More importantly, even if costs were not a concern, we still might worry that (4) is tautological and ambiguous: tautological in the sense that it stakes the priority of preventative action on the ground that there are no considerations that take priority over preventative action (and thus asserts what it is meant to prove); and ambiguous in the sense that it does not indicate clearly what kind of consideration, if any, would be sufficiently weighty so as to overpower our responsibility to prevent climate catastrophe.

Thus, while Caney's account is laudable for directly addressing the essential problem—how should we balance efficacy and fairness in in the context of preventing dangerous climate change?—it suffers from a number of important issues when extended to cover core precautionary actions, like reducing emissions. Consequently, we are still in need of an account that explains under which conditions, and to what extent, the imperative to prevent climate catastrophe justifiably takes priority over fairness constraints, whenever the two conflict.

4. Prioritizing Precaution: An Alternative Approach

Over this section and the next, I set out such an account. I argue that prioritizing efficacy over fairness is justifiable whenever the conditions that make justice and political stability possible are themselves compromised or credibly imperiled. I refer to such situations as political catastrophes, a concept I explain below.

[37] Cass Sunstein (2006, 882) argues this point forcefully against Stephen Gardiner.

4.1. Catastrophe

The idea of climate catastrophe is frequently invoked when attempting to motivate the need for (or otherwise justify) precautionary action. But what catastrophe signifies is often ambiguous. There are many distinct possibilities. The most recent OED entry, for instance, defines catastrophe as a "sudden disaster, wide-spread, very fatal, or signal." Sunstein describes them as instances of harm that "involve a large number of human deaths."[38] Perhaps more stringently, Richard A. Posner defines catastrophes as events that "threaten the survival of the human race."[39]

The focus on death in these accounts accentuates the moral relevance of precautionary action. Yet, we might wonder if death is a necessary or sufficient feature of catastrophe. Aren't instances of extreme suffering catastrophic, before or apart from human death? What about cases of severe political instability, in which it is impossible to sustain fair social cooperation or just institutions?

To capture these phenomena, I propose a different conception—what I call *political catastrophe*.[40] Political catastrophe is not defined by a body count, though it may follow from, or result in, human death. Rather, political catastrophe is characterized foremost by a state of extreme material scarcity, in which meeting one's basic needs can only be done by denying another (or others) the ability to do the same. This scarcity must be enduring, though not necessarily irreversible. It must be irremediable by local efficiency gains or redistributions, and

[38] Sunstein, 869.

[39] Posner, 6.

[40] Even if these phenomena fall outside of catastrophe, conventionally understood, we might still think them sufficiently grave as to warrant precautionary action.

must afflict at least a sizable minority of a given population.[41] When extreme and enduring scarcity of this sort occurs, it becomes impossible to realize or sustain relations of justice and thus uncoerced social cooperation, critically endangering the stability of democratic governance structures (or any governance structure at all).

The idea of political catastrophe I am presenting here follows from John Rawls's conception of "the objective circumstances of justice," which he defines as "the conditions under which human cooperation [is] both possible and necessary."[42] Central to these circumstances is "the condition of moderate scarcity," which obtains when "[n]atural and other resources are not so abundant that schemes of cooperation become superfluous, nor are conditions so harsh that fruitful ventures must inevitably break down."[43] In describing this condition, Rawls refers to a passage by David Hume, in which Hume describes a society that has fallen

> …into such want of all common necessaries, that the utmost frugality and industry cannot preserve the greater number from perishing, and the whole from extreme misery; it will readily…be admitted, that the strict laws of justice are suspended in such a pressing emergency, and give place to the stronger motives of necessity and self-preservation.[44]

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[41] One might wonder what counts as "local," and who comprises the relevant "population." For present purposes, we may assume that local pertains to any defined, geographically continuous political-administrative unit (like a state), and the relevant population is all human-beings at a specific point in time.

[42] Rawls, 109.

[43] Rawls, 109&n, 110.

[44] Hume, sec. III, pt. I.

This makes vivid the idea that, without adequate material resources, justice becomes difficult (if not impossible) to realize or sustain. Without redress, extreme scarcity must lead to social and political collapse.[45]

Responding to political catastrophe sanctions deviations from ordinary moral constraints—not the complete and self-centered abandonment of justice Hume portends,[46] but rather shifts in the allocation of burdens and benefits necessary to alleviate or resolve the catastrophe quickly and effectively. (I develop a justification for this claim and address some potential objections to it in sections 4.2 and 6, respectively.)

This idea is already widely, if often only tacitly, accepted in certain contexts. Medical triage offers a clear example. Under normal conditions, clinicians are expected to "devot[e] maximum time and resources to the sickest patients,"[47] without respect to morally arbitrary factors like age, weight, expected recovery time, etc. Yet, when medical supplies are limited and/or services are under extreme duress, these expectations change, and factors previously considered arbitrary for allocating medical resources may become determinative. For instance, in the case of vaccine shortages, officials may discriminate based on age, prioritizing the very young and the very old. Likewise, in military triage situations: those likely to recover quickly and resume action may be prioritized.[48] In short, under conditions of extreme scarcity, the principles, rules, and values normally governing the dispensation of medical care are

[45] The link between food and/or water scarcity and political collapse is compellingly expounded in Tainter 1989. For discussion, see chapter 1.

[46] Except, perhaps, in very extreme political catastrophes. On this, I follow Barry 1978.

[47] Moskop and Iserson, 282.

[48] Moskop and Iserson, 283.

outweighed by—and are justifiably subordinated to—higher-order concerns like effectively protecting the most vulnerable or preserving the war effort.

I claim that the same holds in general instances of extreme scarcity: the principles and values that normally predominate in the moral-political calculus—like distributive fairness—may be justifiably subordinated if doing so is necessary to restore the material basis of justice.

This raises the question: are deviations from normal fairness principles justified to prevent *future* political catastrophe? If so, why, and to what extent (i.e., within what limits)? The remainder of the chapter is devoted to these questions.

4.2. Two Priority Arguments

4.2.1. Contractualist Argument

One way we can justify prioritizing efficacy over fairness when faced with the prospect of future political catastrophe is by adopting an impartial decision-making framework that, in effect, melds the perspectives of justice's beneficiaries and burden-bearers.[49] We can model impartiality within such a framework by prescinding information about the place or time to which each person taking part in the decision-making process belongs.[50] Within this framework, participants should assume that the actions or inaction of some agents can precipitate extreme scarcity for others, and thus that political catastrophe must be deliberately avoided.[51] Ignorant of their location in time or place, rational, self-interested agents occupying

[49] We should consider both when structuring intergenerational relations, as Shue and Caney stress (Shue 1996, 164–6; Caney 2005, 762).

[50] Much like Rawls's original position.

[51] While this seems to modify the original position, Rawls may tacitly stipulate similar constraints. Consider where he refers to a "basic needs principle" in later work (Rawls 2005, 7, 166, 228-9). For an attempt to extend this principle to climate change, see Wolf 2009.

such a framework would, I claim, seek to ensure that every generation takes all reasonable measures to reduce the likelihood of political catastrophe.

Of course, preventative action is not without costs.[52] Thus, these agents will also want to ensure that the burdens on any person or group are not so great that they themselves artificially induce political catastrophe. Deliberators could therefore be expected to reject an austerity program that forces extreme scarcity in the present simply to avoid the same later on.[53] Yet, it would be rational for them to accept any necessary burdens falling below this upper limit. In sum, from an impartial perspective, representing the interests of all people and generations, imposing strenuous (but not politically catastrophic) burdens on some to prevent political catastrophe from befalling others is morally justified.

This final point bears emphasis. From this perspective, efficacy justifiably outweighs fairness whenever the two conflict. Thus, should it be the case that protecting future generations from political catastrophe requires imposing stringent burdens on earlier, poorer generations, this would be justified. From the vantage of the least-advantaged members of the least-advantaged generation,[54] prioritizing effective precaution over standard moral concerns, including those of equity or fairness, is rational, provided the least-advantaged position is occupied by those in future generations facing political catastrophe.[55]

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[52] Sunstein 2006, 879, 881, and passim.

[53] Such a program violates Rawls's "strains of commitment" argument, which stipulates that deliberating parties should reject agreements they "can adhere to only with great difficulty" or that "may have consequences they cannot accept." (Rawls 1999, 153).

[54] Rawls, 258.

[55] Gardiner (2006) argues that climate catastrophe is a worst-off outcome, in the Rawlsian sense, and should be avoided through precaution. See also Rendall 2011; Wolf 2009.

Indeed, future generations consigned to previously preventable political catastrophe would likely find any other conclusion unacceptable. For them, it would be no consolation (or justification) at all to learn that their plight is simply what fairness required. For anyone in such a position, it would be far more rational prefer an *unfair*[56] schedule of burdens that prevents political catastrophe to a *fair* one that does not. The same holds internationally: for those facing a credible threat of political catastrophe, fairness is a secondary concern to efficacy.

4.2.2. Paradox of Justice

Another way of justifying the priority of precautionary efficacy to fairness is suggested by Karl Popper's famous discussion of the "paradox of intolerance." Popper claims that "[u]nlimited tolerance must lead to the disappearance of tolerance." For if a society tolerates the expression of all beliefs, including those that are intolerant, it will be unable to sustain tolerance if intolerant views take hold. In this way, "the tolerant will be destroyed, and tolerance with them."[57] Rawls shares Popper's view, and argues that, if "the tolerant [in a given society] sincerely and with reason believe that their own security and that of the institutions of liberty are in danger," they may justifiability "restrict the freedom" of "intolerant sects."[58]

A similarly paradoxical relationship appears to hold with respect to justice. If, in some cases, justice (e.g., as distributive fairness) can be realized only at the cost of preventing political catastrophe, and political catastrophe marks a dissolution of the conditions that make justice possible, then it follows that particular applications of justice can sometimes undermine

[56] Say one that assigns heavier burdens to earlier and/or poorer generations *simply because* they are earlier or poorer.

[57] Popper, 226*n.*4.

[58] Notably, for Rawls (1999, 193), this restriction is necessary for preserving tolerance *and* political stability.

the continued existence of justice in general (in a specific society or at a specific time). In such cases, we would be justified in limiting or subordinating those particular applications of justice, to safeguard political stability and preserve the possibility of justice in the future.

5. What Does Effective Precaution Entail?

So far, I have argued that efficacy should be prioritized over fairness in the context of responding to or preventing political catastrophe. Assuming this is plausible as a general principle, I must now consider what precaution against political catastrophe entails.

5.1. General Precautionary Posture

We can approach this question by considering standard notions of precaution. The precautionary principle developed significantly in the context of environmental policy and law. Consider Principle 15 of the Rio Declaration:

> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

The U.N. Framework Convention on Climate Change (UNFCCC) employs similar language, as do the Montreal Protocol, the Maastricht Treaty, and the Third North Sea Conference.[59]

But while these policy documents refer to "the" precautionary principle or approach, there is no single, universally accepted formulation. (One scholar has identified nineteen

[59] For many more examples, see Gardiner 2006, 35; for discussion of the role of precaution in international law, see Wiener 2016.

versions.[60]) Nevertheless, following Jonathan Weiner, we can delineate a general "precautionary posture," common to most precautionary principles, with the following five elements:

(1) "A threat of serious or irreversible or catastrophic risk or damage."

(2) An epistemic position that does not preclude action on the basis of scientific uncertainty about the magnitude or likelihood of a given risk.

(3) A tendency to favor "earlier measures" that "anticipate and prevent the risk" preceding harm.

(4) A tendency to favor "greater protection," though permitting degrees of stringency (from simple preventative measures to complete prohibitions).

(5) A "qualifying stance on the impacts of the precautionary measures themselves, calling for assessment of their cost-effectiveness" and "improvement over time as knowledge is gained."[61]

In sum, precautionary principles enjoin agents to act early to prevent or attenuate major risks or damages, despite uncertainty and within reasonable limits, with the intention of securing the greatest protection possible.

5.2. What risk?

This statement of precaution requires further refinement to be practicable. Some of what we have already said is useful here. We can stipulate, for instance, that the relevant notion of (1) is political catastrophe—viz., this is what precautionary action is meant to prevent.

[60] Sandin 1999.

[61] Wiener 2016, 168. See also Jordana and O'Riordan 1999; Raffensberger and Tickner 1999b, 2; Gardiner 2006, 36.

5.3. Uncertainty

We have not yet addressed the point in (2), though, which stipulates that agents should not preclude precaution on the basis of uncertainty about the likelihood of a given risk. While reasonable, (2) is ambiguous. We need a clearer idea of what level of probability is necessary to warrant precautionary action.

One possibility is to stipulate that risks should be "scientifically plausible" and "reasonably likely" to occur. The former requires that we understand the means by which catastrophe could occur, and can explain that process to others in the language of public reason. Thus, for instance, even if Ba'al worshippers truly believe that failing to make certain sacrifices risks planetary destruction, this is a matter over which people might reasonably disagree, and without a clear way of settling this disagreement—e.g., by scientific consensus—there are no grounds (on my account) for taking public action against it.

The reasonably likely criterion, on the other hand, requires that the causal mechanisms capable of causing catastrophe are observably at work. This excludes very remote possibilities from our consideration, but it does not rule out all low-probability or uncertain events. Drawing a line without raising the charge of arbitrariness is difficult. A defensible threshold should be sensitive to potential magnitude, likelihood of occurrence, and societal aversion to risk. One candidate, suggested by the recent history of US foreign policy, is that high-impact events with a greater than 1% likelihood of occurrence warrant a response.[62] While this may appear too stringent, note that expensive insurance policies are routinely taken out by US homeowners, despite the fact that, from 2009–2013, only about one of every 250 insured

[62] This is Dick Cheney's so-called "one-percent doctrine." See Suskind 2007.

households (0.40%) filed a claim each year.[63] Whatever the threshold, the key point is that events falling below it will not warrant consideration.

We can refine these two criteria further with Henry Shue's "anti-paranoia requirement." Shue argues that we should only take precaution when (i) "we can understand the mechanisms by which [political catastrophe] would happen," and (ii) "can see conditions favorable for the working of the mechanisms arising."[64] For a risk to be scientifically plausible, (i) must apply; and for it to be considered reasonably likely to occur, (ii) must hold. This precludes action against all merely *conceivable* or *possible* threats of political catastrophe, stipulating instead that action is warranted only against risks that that we understand and can see unfolding.

5.4. Normative Bases of Precaution

Points (3) and (4) above suggest two normative bases for precaution: harm-prevention and protection. For conceptual clarity, it is helpful to distinguish between these.

5.4.1. Duty Not to Harm

First is the negative duty not to harm,[65] which covers cases in which deliberate actions or omissions constitute a credible risk of significant future harm.[66] Following Lukas Meyer and Dominic Roser, we can define harm in relation to a threshold, such that "an action (or

[63] See Insurance Information Institute.

[64] Shue 2010, 149.

[66] The use of deliberate in this context raises important epistemic questions about the conditions necessary for an action to be counted as intentional and/or blameworthy, which I must set aside here. Deliberate should be taken here simply to refer to actions undertaken in awareness of potential ill consequences, or in inexcusable ignorance of such consequences.

inaction) at time t_1 harms someone only if the agent thereby causes (allows) this person's life to fall below some specified threshold."[67] In these instances, an agent causes or allows others to be worse off than they are "entitled to be."[68] Of course, to assess harm in this way, we must specify a particular threshold, which is difficult to do without arbitrariness.[69] But our conception of political catastrophe offers one plausible candidate: i.e., a person, P, is harmed whenever the unnecessary actions or inexcusable omissions of an agent or group causes or allows P to be in a situation of extreme material scarcity, such that P can only meet his or her basic needs by denying others the ability to do the same.[70]

We can understand "unnecessary action" in two ways. First are those actions that are necessary for a satisfactory life but that are undertaken in ways that *unnecessarily* exacerbate given risks. A relevant example here is energy production: while generally considered necessary for a satisfactory life, the way in which energy is currently produced is unnecessarily harmful, particularly when cost-effective carbon-neutral technologies are available. A second class of unnecessary action are those that contribute to a given risk but that are unnecessary for a satisfactory life.[71] For example, consuming animal products appears unnecessary for (and even detrimental to) a healthy and satisfying life, at least for most people in the West.[72] If this is

[67] Meyer and Roser 2009, 228; cf. Shiffrin 1999.

[68] Meyer and Roser 2009, 229.

[69] Arneson 1999 and 2000.

[70] Thus, like those put forward by Meyer and Roser 2009, Wolf 2009, and Rendall 2011, this conception also centers on the ability to meet basic needs.

[71] I set aside the question of what constitutes a sufficiently satisfactory life, but see, e.g., Shue 1999, 542; Wolf 1998; Nussbaum 2000; Sen 1984. See also Rawls 1999, 54-5, 78*ff*.

[72] One might object that certain gustatory delights, particularly those of consuming animals, are necessary for a satisfactory life. I do not need to deny this to establish that there is an obligation to exclude animal products from one's diet, so long as affordable alternatives are

right, then the fact that the livestock sector has exploded in the last 50 years, and is now "responsible for 18 percent of greenhouse gas emissions"—i.e., more than all the world's trains, planes, cars, boats, and other transport vehicles combined—is a grievous injustice.[73]

The duty not to harm also proscribes "inexcusable omissions." An omission, or failure to act, is excusable if the party failing to act is (i) ignorant of the consequences and (ii) lacks the means to overcome that ignorance. Otherwise, it is *in*excusable. Thus, it may be wrong to hold generations before, say, 1990 accountable for harming present and future generations with GHG emissions, given the lack of broad scientific consensus about the causes and effects of climate change up to that point.[74] Failing to take preventative action today, however, is inexcusable, as this ignorance no longer exists.

5.4.2. Duty to Protect

The positive duty to protect represents another normative basis of precaution.[75] Much like the duty to rescue, the content and scope of the duty to protect is controversial. In

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available that do not unnecessarily subject other persons to political catastrophe. To counter this, one must establish that *only* animal products can provide gustatory pleasure of the sort that constitutes a satisfactory life, which is unlikely. Moreover, one must argue that those delights are more significant to a satisfactory life than the basic goods (e.g., access to clean water and food) threatened by animal-agriculture-induced climate change. Further, even if this could be shown in the aggregate—i.e., that the total pleasure received from consuming animal products outweighs the suffering animal agriculture risks—those committed to non-utilitarian justice theories must also establish how the particular pleasure of consuming animals justifies the harm animal agriculture inflicts on others (possibly including nonhuman others).

[73] Steinfeld et al. 2006, xxi. See also Wellesley, Happer and Froggatt 2015, vii.

[74] I survey the debate on excusable ignorance in the chapter 4.

[75] Gardiner 2006.

standard formulations, however, the duty to protect holds that when one is able to prevent harm from befalling another (or others) at reasonable cost to oneself, then one ought to do so. Here again harm may be defined in relation to a threshold, such that others (future people) are harmed whenever their quality of life falls below a certain level. Unlike the negative duty not to harm, however, the positive duty to protect holds whether or not an agent is responsible for the potential harm. Thus, assuming climate change threatens political catastrophe (a point I defend below), this duty would require us to take precautionary action to abate it *even if* we were not personally or chiefly responsible for having caused it.

While the duty not to harm is absolute—only ignorance or necessity can excuse deviations—the duty to protect must have limits or it will be overly demanding. This is intimated by (4) and (5), which suggest that, while we should favor a greater degree of protection over a lesser one, considerations of cost-effectiveness may limit what actions we take. This again is ambiguous, however. How stringent should we be in protecting others against risks of political catastrophe?

A point from the contractualist priority argument laid out above is relevant here. Recall that, from an impartial perspective, a rational limitation to precaution is given by political catastrophe itself. In allocating burdens to prevent political catastrophe, none should be so great that they themselves result in extreme material scarcity. This prevents precaution from becoming self-defeating and thus preempts the so-called "black-hole problem," which affects principles that prioritize the prevention of worst-case scenarios.[76] The concern is that strictly prioritizing such scenarios would quickly exhaust society's resources. For this reason, many

[76] Wolf 2009, 356-7. Note that Wolf considers this problem in application to prioritarian intergenerational equity principles, but the general concern applies here, too. For a statement of a similar concern with regard to precautionary principles see Sunstein 2006, 869*ff*.

prefer principles that minimize aggregate or average deprivation.[77] Although my argument gives strict priority to preventing political catastrophes, it hedges against the black-hole problem by precluding the complete material sacrifice of any group for the sake of others.

5.6. Summary

In light of these considerations, we can begin to discern a more precise account of precautionary climate justice. We can formulate this as follows:

(1) GENERAL PRECAUTIONARY DUTY: All agents have a general duty to prevent political catastrophe where possible. This implies two correlate duties:

   (a) DUTY NOT TO HARM: Agents should not harm others. Harm occurs whenever some agents, by their unnecessary actions or inexcusable omissions, cause or allow political catastrophe to befall others.

   (b) DUTY TO PROTECT: Agents should take all reasonable measures to protect others from scientifically plausible, reasonably likely threats of political catastrophe.

      i. REASONABLENESS PROVISO: The limit of reasonability in (1b) is given by political catastrophe itself: justice cannot impose a burden on any agent or group that itself causes extreme material scarcity.

(2) FAIRNESS PRINCIPLE: Agents should ensure the burdens of precaution are distributed fairly to the fullest extent compatible with satisfying (1a) and (1b).[78]

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[77] See, e.g., Wolf 2009, 357; Sunstein 2006, 893; Rendall 2011, 888; Meyer and Roser 2009.

[78] I set aside here the question of which principle or standard of fairness (e.g., sufficientarian, prioritarian, strict egalitarian) we should employ after the general precautionary duty has been satisfied.

For ease of reference, we can refer to this set of principles as the "integrationist approach," as it combines elements of ordinary justice thinking and precaution.

6. Objections

In what remains of the chapter, I consider several potential objections to the integrationist approach.

6.1. Climate Change Will Not Be Politically Catastrophic

The first charges that although climate change may cause serious future damage, it is unlikely to precipitate political catastrophe; thus, immediate precautionary action is unwarranted.

This is an empirical question that we can settle by examining the evidence. I argue that climate change threatens political catastrophe both *globally* and *regionally*. The former pertains to climatic changes and events that are global in scope, totalizing in effect, and irreversible, though unlikely to occur before 2100. The latter pertains to less severe, but more immediate, climate changes and events capable of upending the objective circumstances of justice in vulnerable states or regions.

6.1.1. Globally Politically Catastrophic Climate Change

Climate change threatens global political catastrophe in two main ways, via (i) linear increases in average surface temperatures (in excess of, say, 6°C); and (ii) severe climate events—also called "climate catastrophes"—that can abruptly and devastatingly alter weather patterns and ecological systems.

[*i*] As noted above, the IPCC reports that a doubling of CO_2e will "likely" result in a net increase of 1.4°C to 4.5°C in mean temperatures over preindustrial levels. The IPCC

defines "likely" as having a 66% chance, meaning that *if* we stabilize CO_2e at around 550 ppm—an ambitious goal, given that the atmospheric stock of CO_2e is already in excess of 400 ppm and rising—there remains a 34% chance that global warming will fall outside the 1.4°C – 4.5°C range. It is considerably more likely that temperature increases will exceed 4.5°C than fall below 1.4°C[79]; in fact, on one estimate, there is as much as "a 10% chance of eventual temperatures exceeding 6°C."[80]

Although six degrees of warming may sound innocuous, it is enough to extinguish or severely endanger much of the planet's plant and animal life (much as a fever of 6°C above normal body temperature is enough to kill a human being).[81] According to Nicholas Stern, with just a 5°C rise, "[h]uman life would probably become difficult or impossible in many regions that are currently heavily populated, thus necessitating large population movements…[which] often bring major conflict."[82]

The links between global warming and political catastrophe are manifold. Higher temperatures mean higher rates of tropical diseases; increasingly volatile weather patterns; rising sea levels; "climate refugees"; more frequent drought and flooding (and thus more frequent crop failure); and extensive water scarcity.[83] Stern is not alone in predicting conflict—the White House, the Department of Defense, NATO, etc.,[84] all emphasize the possibility of intra- and inter-state violence arising from global warming. As Martin Weitzman describes,

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[79] Due to a "fat-tailed distribution"; see Wagner and Weitzman, 49–51.

[80] Wagner and Weitzman, 53.

[81] Gernot Wagner made this analogy during a University of Virginia Environmental Humanities Colloquium presentation, on December 1st, 2015.

[82] Stern 2010, 44.

[83] Singer 2010, 183; Posner and Weisbach, 29; Stern 2010, 44.

[84] White House 2015; Department of Defense 2015; Vitel; Partnership for a Secure America.

"[t]he massive unrest and uncontainable pressures [higher temperatures] might bring to bear on the world's human population are almost unimaginable."[85]

[*ii*] Another path to global political catastrophe involves surpassing "tipping points"—i.e., "thresholds beyond which major changes occur that may be self-reinforcing and are likely…irreversible over relevant time scales."[86] These thresholds are typically defined by specific warming thresholds. Yet, it is impossible to predict precisely how much temperatures must increase to set off a given tipping point; in other words, we may pass critical thresholds suddenly and without warning. According to a 2013 National Research Council report, one tipping point may have already been crossed: the destabilization of the Greenlandic and West Antarctic Ice Shelves.[87] This threatens to greatly accelerate sea-level rise and, worse, shut down the North Atlantic thermohaline circuit, which plays a crucial role in moderating temperatures in Europe. (When the thermohaline circuit last stopped, global temperatures dropped 5ºC within ten years and icebergs extended down to Portugal's coast, precipitating a severe global drought.[88]) Other potential tipping points, like the release of methane stores in the Northern hemisphere's thawing permafrost, risk "runaway" global warming.[89] In general, events like these could have enormous ramifications for well-being and political order—viz., crossing tipping points credibly risks future global political catastrophe. The only way to prevent the crossing of tipping points is by reducing GHG emissions as quickly as possible.

[85] Weitzman 2012, 232.

[86] Furman et al. 2014, 20.

[87] National Research Council

[88] Gardiner 2004, 562-3.

[89] See Whiteman, Hope, and Wadhams 2013; cited in Wagner and Weitzman, 185.

6.1.2. Regionally Politically Catastrophic Climate Change

Catastrophic linear temperature increases and many of the most disruptive tipping points may not occur until the end of the 21st century. But in the meanwhile, climate change poses a credible risk of political catastrophe on a smaller scale, in particular regions and states. Economists and policy-makers have paid this possibility far less attention, perhaps because the changes and events culminating in regional politically catastrophic climate change are less sweeping and may be (partly) remediable through international action.

To understand how these climate changes and events risk political catastrophe, note first that, when scientists speak of temperature increases, they are typically referring to global averages. This can obscure the fact that even minor increases in global mean temperature can entail considerable increases for certain areas.[90] Moreover, tipping points can be localized—increases of just 1°C to 2°C can abruptly change regional weather, resulting in protracted droughts, topsoil aridification, etc. Warming in the Pacific, for instance, has already led to considerably more frequent and severe cyclones in east Asia.

Regional climate change does not *necessarily* entail political catastrophe. This will only occur when affected states' or regions' anticipatory and response capabilities are overwhelmed and international assistance is lacking. This suggests two areas on which to focus precautionary action, beyond abatement: (i) ensuring that affected states or regions are prepared for climatic changes by providing the necessary resources or knowledge for implementing effective

[90] Posner and Weisbach, 18-20.

adaptation measures[91]; and (ii) providing assistance or compensation to attenuate the effects of unavoidable loss and damage.[92]

6.2. Precaution Is Superfluous

The second objection holds that sufficientarian accounts of intergenerational justice—like Rawls's just-savings principle or Locke's more inchoate "enough-and-as-good" proviso—already adequately insure against future political catastrophe by requiring that contemporaries not deprive future people of adequate material resources. This obviates the integrationist approach, along with general theories of precaution.

This objection misses the difficulties sufficientarian accounts face in the following, pertinent case: when contemporaries engage in (economic) activities that enrich future people in pecuniary terms but destroy or deplete the natural environment. Because accounts like Rawls's and Locke's assume fungibility between natural and other material resources, even irreversible environmental damage is thought to be compensable. (Hence Brian Barry's observation that, on accounts like these, a relevant question becomes: what amount of manufactured plastic trees, astroturf, and singing electronic birds can compensate for the loss of real trees, real grass, and real birds?[93]) On this view, even if future generations are forced to adapt to severe environmental austerity, their greater wealth and productivity should make this, on balance, acceptable to them.[94]

[91] On this point, see Posner and Weisbach, 22.

[92] Walliman-Helmer 2015.

[93] Barry 1999, 102.

[94] Notably, economists like Lomborg, Nordhaus, and Boyer explicitly endorse this view.

In this sense, Rawlsian or Lockean intergenerational sufficientarianism appears to favor promoting economic growth over preventing environmental loss. It is by no means clear, however, that adapting to unmitigated climate change will remain a viable option for future generations, even granting extensive wealth accumulation. Insisting otherwise requires the implausible assumption that no amount of ecological devastation can exceed our ability to adapt. This reproduces the problematic assumption challenged above—that the condition of moderate scarcity is invulnerable to human action—with the sole difference that artificial goods are construed here as suitable replacements for natural goods. The objection thus fails to take seriously the potential for political catastrophe. So long as credible doubt exists over whether endless adaptation is possible, precaution remains necessary.

6.3. The Integrationist Approach is Prescriptively Ambiguous

A third objection holds that it is difficult to identify minimum requirements for preserving the condition of moderate scarcity, and this indeterminacy should lead us to reject the integrationist approach (or at least exclude it from practical deliberation).

One way to respond is to assert a simple baseline: that justice requires material conditions to be such that all individuals can (continue to) meet their basic needs without denying others the ability to do the same.[95] While this may be vague, defining an exact target is not essential. It suffices to fix on credible risks of political catastrophe (like those posed by climate change), and structure action to reduce their likelihood and/or magnitude.

[95] Cf. Rawls PL, 7; Wolf 2009; Meyer and Roser 2009, 225*n.*11.

6.4. The Integrationist Approach Sanctions Dangerous State Power

The final objection holds that subordinating fairness to efficacy in any context entails vesting states with dangerous emergency powers, opening the door for the diminution of rights or other abuses. Thus, the integrationist approach should be rejected.

In response, we should first note that there is no reason to suspect that undertaking precautionary measures would require sacrificing any of the most cherished individual freedoms and rights—e.g., freedoms of conscience or speech, the right to peaceably assemble, etc. Indeed, to the extent precaution impinges on individual rights at all, it would do so only with respect to property rights, and then just to the extent necessary for alleviating or preventing (the effects of) political catastrophe.[96]

Another response is available that concerns the weight of moral duties. Political obligation theorists commonly argue that duties only hold in a *pro tanto* sense—viz., our duties are justifiably outweighed in certain (exigent) circumstances. But these theorists also carefully stipulate that, while exigency may override duty, it never erases it. For this reason, an *ex post facto* explanation is owed to adversely affected parties. Crucially, this suggests a requirement of accountability. Continuing with the intergenerational example, such a requirement would mean that an explanation is owed to current generations who are to bear the heaviest burdens of preventing politically catastrophic climate change. Such explanations exist—as this chapter is, in part, meant to show. But in addition to general explanations, specific explanations for particular policies are necessary. These should clearly specify who is responsible for acting, why, when, and how. Accountability can thus protect against ineffective or unnecessarily burdensome policies.

[96] For example, the stocks of food retailers might be justifiably seized during a famine.

7. Conclusion

This chapter considered under what conditions, and to what extent, we are justified in prioritizing efficacy above fairness in the context of preventing catastrophic climate change. We began by surveying two main responses to these questions. The first, prominent in the intergenerational justice literature, attempts to avert any trade-off by distinguishing the costs of climate action from the actions themselves, and arguing that the former should be deferred to richer, future generations. With this, the most efficacious distribution of climate-action burdens (one that imposes strenuous requirements on earlier, poorer generations) remains equitable. As we saw above, however, this solution fails. It is simply not possible to defer all of the costs of present action, if it is possible to defer any.

The second response, found in recent work by Simon Caney, takes as its starting point the urgent need to prevent climate catastrophe. It then proceeds to elucidate a set of conditions under which we would be justified in prioritizing the prevention of harm over ensuring that the burdens of cooperation are fairly distributed. While in many ways compelling, extending Caney's account to cover core climate actions—like reducing emissions or enabling adaptation—proved problematic. We also found that several of the conditions Caney sets out are ambiguous: e.g., how likely must a risk of future harm be before action is justified?; which agents should act when all are not needed?

I therefore proposed an alternative: the integrationist account. Like Caney's, this account starts with the assumption that preventing catastrophe is essential. Yet, it focuses on a unique conception of catastrophe. What I refer to as political catastrophe occurs whenever material scarcity becomes so extreme that agents are unable to satisfy their most basic needs without denying others the ability to do the same. Under such conditions, fair social cooperation and political stability cannot be realized or sustained.

When faced with a political catastrophe, I argue that agents are justified in prioritizing efficacy over fairness or equity. This is not for reasons external to justice, but for the sake of justice itself. In other words, whenever precaution is necessary to preserve the material conditions that make justice possible, efficacy becomes the highest-order concern.

This argument is especially relevant in the context of climate change. As I argue above, preventing politically catastrophic climate change may be possible only at the cost of distributive justice—i.e., by imposing unfair burdens on the least well-off. This is especially clear in the intergenerational context: climate action is likely only to succeed if current, (presumably) poorer generations act now. But the same may hold true intra-generationally: it may be impossible to avert catastrophe without requiring high-emitting but relatively poor states like China and India to delay industrialization or undertake it only in carbon-neutral ways—burdens for which they may never be fully compensated.

None of this is to say that fairness must be totally abandoned. Quite the opposite. When weighing comparably effective schemes of action, we should always prefer the fairest one. Nevertheless, if some trade-off between fairness and efficacy in the context of preventing politically catastrophic climate change *is* necessary—as it may be in the intergenerational context—then an account that specifies the conditions and extent to which such a trade-off is justified is valuable. This chapter offers such an account. Assuming climate change poses a credible risk of political catastrophe as I have argued, we should act now to address it, even if the burdens of action cannot be distributed fairly.

Many questions remain. For instance, how should we price activities, like emitting greenhouse gases, that increase the risk of politically catastrophic climate change? Moreover, assuming current generations have a duty to bear significant costs, how should those costs be distributed among them? I address these and other questions in the following two chapters.

3. Pricing Emissions: Climate Change and the Social Discount Rate

Someday, our children, and our children's children, will look at us in the eye and they'll ask us, did we do all that we could when we had the chance to deal with this problem and leave them a cleaner, safer, more stable world? And I want to be able to say, yes, we did. Don't you want that?

—(Former) President Barack Obama[1]

PREFACE

According to the World Health Organization, the average life expectancy globally is 71.4 years and increasing. In twenty-nine countries, it exceeds 80.[2] Many children born today, therefore, have a reasonable chance of living until the end of the century. Without immediate action, over the course of their lives, these children will witness the most profound environmental changes to have occurred in hundreds of thousands, if not millions, of years—changes wrought by anthropogenic climate change. By century-end, temperature increases could top 6°C (10.8°F), ending a 12,000-year-long period of thermal stability and moderation,

[1] Remarks from a speech delivered on June 25, 2013. Full transcript available at https://www.whitehouse.gov/the-press-office/2013/06/25/remarks-president-climate-change

[2] World Health Organization 2016, 7*ff*, esp. 9.

and rendering large portions of the globe virtually uninhabitable for much of the year.[3] Average sea-level will rise up to 2 meters (6.5 feet), globally, displacing millions living on coasts.[4] Glaciers, particularly those over the Himalayas and in eastern Africa, will disappear, leaving billions without clean drinking water. Rain belts will push away from the equator, desiccating vast swaths of the world's most fertile agricultural lands. Droughts, wildfires, floods, and other extreme weather events will increase in frequency and intensity, leaving people homeless and hungry.

States have numerous tools at their disposal to prevent some of these bleak outcomes from coming to pass. Perhaps most crucial is the ability to affix a price to greenhouse-gas emissions in the form of a tax,[5] which would disincentivize activities that contribute to climate change. While there is general consensus that such a tax is can and should be implemented, economists and policy-makers disagree about what the price should be. The prominent American economist William Nordhaus, for instance, argues for a gradually increasing tax "ramp" that would start around $7.36 per ton of CO_2, and peak at about $54.54 per ton in 2100.[6] The British economist Nicholas Stern, on the other hand, argues instead for an initial

[3] Herring 2012; Scott 2014; Pal and Eltahir 2016.

[4] DeConto and Pollard 2016. NB: This is just projected sea-level rise by 2100. The last time atmospheric CO_2 concentrations were as high as they are at present, sea-levels were 60 to 80 feet above current levels (Jamieson 2015, 108).

[5] It need not be a tax—it could also be a permit system, which, in ideal circumstances, should effect to the same (Posner and Weisbach).

[6] Nordhaus 2008, 14-16. Note that these are approximations, since Nordhaus (along with a few others) present prices per ton of *carbon*, rather than the usual *carbon dioxide* (CO_2). Carbon is approximately $^3/_{11}$ the size of CO_2. Thus, the $7.36 price per ton quoted above is roughly equivalent to Nordhaus's actual price, $27/ton/C.

tax of about $85 per ton.[7] National governments have proposed or adopted rates ranging from less than $1 per ton (in Mexico) to $130 per ton of CO_2 (in Sweden).[8]

The considerable discrepancies between these figures owe largely to the different positions adopted on a—perhaps *the*—central normative question in the climate-change literature: to what extent, if at all, should contemporaries discount future costs[9] resulting from climate change? Put another way: how much is it worth to us, today, to prevent climate-related loss and damage in the future?

Policy-makers typically answer this question in the form of a "social discount rate"—i.e., "the rate by which the claims of future generations to resources currently held by current generations diminishes or increases or remains constant over time."[10] In other words, the extent to which a state or society will sacrifice present resources to prevent future harms (or increase future benefits) depends on the discount rate it adopts.[11] In the context of climate change, a lower social discount rate means greater investments in climate action, especially mitigation efforts (which aim at reducing future costs). The gulf between Nordhaus's and Stern's preferred carbon tax rates is reducible entirely to the discount rates they adopt:

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[7] Stern 2007, chapter 16.

[8] Jenkins and Karplus 2016. The current US rate, which is only used for internal calculations, is about $36/ton (https://www.epa.gov/climatechange/social-cost-carbon).

[9] More fully, future costs and benefits, but since climate change will likely generate far more costs than benefits, the abbreviation is justified.

[10] Caney 2009, 164.

[11] Caney 2009, 163; Caney 2014, 321. The discount rate is not the only factor, however. Future damage estimates also matter, as they comprise the figure that is to be discounted. While estimates, like the discount rate, remain controversial, the debate is largely technical, concerning model specification, and so I set the issue aside here.

Nordhaus uses a variable rate schedule that starts at about 5.5% and declines to 4% over 100 years, whereas Stern employs a fixed rate of 1.4%.[12]

Currently, the discounting debate cleaves along support for a positive rate (typically between 1% and 5%)[13] and a zero rate. At zero, future costs and benefits are regarded as equally valuable to present, such that it would be worth spending $1,000 today to avoid $1,000 in damages fifty years from now. As rates exceed zero, the present value of future costs and benefits declines; at 5%, for example, we should only be willing to spend about $87.20 to avoid $1,000 in damages fifty years from now. By and large, economists favor a positive social discount rate while political theorists and climate ethicists favor a zero rate.

In this chapter, I argue that there are significant problems with both views, though the case for a positive rate is particularly dubious. I show this by examining three of the most common justifications for discounting:

(1) The Pure-Time Preference Argument: A positive social discount rate is appropriate and justified because future costs and benefits are simply less valuable than present ones, from the perspective of current generations.

(2) The Opportunity Cost Argument: A positive social discount rate equal to the market rate for returns on investments is appropriate and justified, because anything lower would be an inefficient and irrational investment of societal resources.

(3) The Growth Argument: A positive social discount rate is appropriate and justified because future wealth will be greater than current wealth, and so the same resources today will have a lower effect on marginal utility in the future.

[12] Nordhaus 2008, 61; Stern 2007. See also, Jamieson 2015, 115-6; Nordhaus 2007.

[13] Environmental Protection Agency.

This chapter is not purely critical, however. Part of my aim in challenging these arguments is to open up space for a largely overlooked position: a *negative* discount rate. Adopting a negative rate entails putting a premium on (particular) future costs and benefits. Thus, at a negative rate of 1%, we should be willing to spend $1000 today to avoid $605 in harm in fifty years. Of course, sacrificing a set amount of resources today to save comparatively[14] fewer resources in the future sounds like a bad deal, and so defending a negative rate is bound to be controversial. I argue below, however, that a negative rate is appropriate and justified under certain circumstances—particularly when faced with the prospect of politically catastrophic climate change, which, again, is characterized by conditions of extreme material scarcity. Should extreme scarcity come to pass, each additional unit of consumption in the future will be worth more than it would be today; a negative rate captures this. Moreover, a compelling practical upshot of adopting a negative rate in the context of climate change is that it entails placing heavy costs on risk-enhancing activities (like emitting greenhouse gases), offering a kind of "insurance" against climate change. (I explain these points more below.)

The chapter has two parts. Part I deals with the pure time preference argument, which, I claim, is far more complex than most philosophers allow. Part II considers the opportunity-cost and economic-growth arguments for discounting. At the end of each part, I summarize the problems with the arguments surveyed and discuss the implications for a negative rate.

[14] This is not to say proportionately. Because of marginal utility curves and the potentially severe costs of climate change in the future, comparatively fewer benefits in the future may be proportionately more valuable than the same benefits today.

Before getting started, a few clarifications are necessary. First is the question of what is being discounted. In principle, anything quantifiable can be discounted.[15] Hence one can find discussions of discounting utility, consumption, welfare, or costs and benefits, to name just a few. In the context of climate change, however, costs and benefits or consumption are most common. I preserve this focus here, and refer interchangeably to consumption, and costs and benefits.

Second, I set aside questions about the intrinsic, unquantifiable value of certain goods. Climate change undeniably threatens many things that are dear to us, or that are valuable in ways that exceed our ability to measure. (How should we quantify value of a beautiful landscape, the continued existence of a species, or the preservation of a culture? We cannot, for instance, fully understand the loss of the Great Barrier Reef by measuring its impact on local tourism or its effect on the fishing industry.[16]) This is a real limitation of cost-benefit analysis (CBA), and suggests that any discount rate we adopt will likely be too conservative, simply because it omits so much from consideration.[17] Nevertheless, CBA captures *some* of what we value, and ultimately some form of economic analysis is necessary to guide public judgments on policy matters. For this reason, the chapter makes ample use of economistic

[15] This has not stopped some from discussing the discounting of future persons, however (e.g., Dietz et al. 2009, cited in Gardiner 2011, 276; Revesz cited in Posner and Weisbach, 166). As lives are not quantifiable, this makes little sense. That said, discounting the value of a statistical life (VSL) can be and often is used in discounting formulas, but this is not the same as discounting persons qua persons (Posner and Weisbach, 166-7).

[16] Heron, Maynard, and Hooidonk 2016.

[17] NB: I do not believe (or mean to insinuate) that most who utilize CBA believe that *all* value can be reduced to economic value; rather, most who utilize CBA regularly likely recognize its limitations and regard it simply as an instrument for making rough comparisons over time.

reasoning along the lines of CBA. But this should not be taken as an endorsement of the idea that the value of natural goods can be expressed fully in economic terms.

Another important limitation of CBA is its reliance on accurate estimates of future costs and damages.[18] It is extremely difficult to anticipate the full gambit of costs that will stem from climate change over the next eighty years, let alone after. Moreover, even if we understood precisely what changes are imminent, say in terms of sea-level rise or temperature increases—which we do not—we would then have to translate those effects into plausible damage estimates. The prevailing models for doing this—integrated assessment models, or IAMs—are far too simplistic. For instance, most models use basic quadratic damage functions, which assume that the costs of warming scale up in predictable and consistent ways as temperatures increase.[19] This is almost certainly misguided; costs are more likely to raise *exponentially* as temperatures continue to increase (not linearly).[20] This is just one example of a range of controversies in the field of environmental economics, the sum of which I cannot settle, or even enumerate, here. For our purposes, it suffices to note that for a discounting equation to work, we must have robust estimates of future costs, which are very difficult to produce.

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[18] On the importance of damage estimates, see Stern 2007, 669-70 (cited in Gardiner 2011, 269).

[19] On a quadratic damage function, if a 1°C increase causes $10 in damages, a 2°C increase would cause about $40 (Wagner and Weitzman, 61). Most IAMs—including Nordhaus's DICE—estimate that 6°C of temperature rise would only cause about a 10% loss to GDP (Wagner and Weitzman, 61; see also Johnston 2016, 39).

[20] Wagner and Weitzman, 62*ff.*

A final clarificatory remark concerns the discounting equation itself. Economists standardly employ the "Ramsey equation" to determine the discount rate, which is expressed as follows:

$$\rho = \eta\gamma + \delta$$

In this equation, rho (ρ) represents the social discount rate. On the right side, the first term, eta (η), is a measure of "the elasticity of the social marginal utility of consumption."[21] Eta captures the basic utilitarian premise that additional units of consumption matter less and less the better off an agent is (in terms of consumption). For this reason, eta is often interpreted as a measure of aversion to inequality, "because a positive eta implies that, for a given increment of consumption, more utility can be produced by allocating it to those who consume less."[22] Eta is multiplied by the variable, gamma (γ), which represents the per-capita economic growth rate (or rate of consumption growth). Different economists employ different values for gamma, though most opt for something between 1% and 3%.[23] The final variable, delta (δ), represents the pure-time preference rate. (Part I of this chapter focuses on delta exclusively.)

To see how this formula works, we can return to the social discount rates I noted earlier.[24] I reported that Nordhaus employs an initial rate of 5.5%, which he derives as follows:

$$5.5\% = (2 * 2\%) + 1.5\%$$

[21] Jamieson 2015, 117.

[22] Jamieson 2015, 120-1. See also Posner and Weisbach, 157. Cf. Heath 2016, 6-7*n.*17, who argues against this interpretation of eta.

[23] I discuss this in Part II, section 3.

[24] This paragraph, including the two equations, pulls directly from Jamieson 2015, 118.

In this equation, Nordhaus sets eta equal to 2, estimates gamma at 2%, and uses a pure-time preference rate of 1.5%. Compare this to Stern's rate of 1.4%:

$$1.4\% = (1 * 1.3\%) + 0.1\%$$

As this shows, Stern sets eta to 1, gamma to 1.3%, and delta to 0.1%. Stern's motivation for setting delta close to zero is explicitly ethical. As the *Stern Review* explains, "if a future generation will be present, we suppose that it has the same claim on our ethical attention as the current one."[25] This kind of intergenerational egalitarianism is ordinarily thought to imply a *flat* zero rate for delta; however, the *Stern Review* factors a measure of risk into that variable. Specifically, their 0.1% rate is meant to reflect the possibility that future generations will stop existing at a certain point (due, say, to a sudden extinction event). I return below to the question of whether including risk in the delta is well-motivated.[26] We can note here, however, that the amount of risk Stern includes is extremely pessimistic; taken literally, it implies that there is a 10% chance the human species will no longer exist 100 years from now, and a 50% chance we will not make it 500 years.[27]

These variables factor into the following discussion in different ways. Part I is concerned exclusively with the pure-time preference rate, represented by delta. There is an extensive literature on just this variable, which is why I consider it in isolation from arguments dealing with other elements of the equation. I examine these in Part II, which has two sections. The first, on the opportunity-cost argument, concerns the discount rate as a whole (i.e., rho).

[25] Stern 2007, 31.

[26] NB: Many have criticized Stern for this idiosyncratic interpretation of delta (e.g., Gardiner 2011, 277; Jamieson 2015, 122; but cf. Heath 2016, 7).

[27] Jamieson 2015, 122.

The second, on the growth-discounting argument, focuses on economic-growth rates (gamma) and aversion to inequality (eta).

With these clarificatory remarks in mind, we can begin investigating the social discount rate.

PART I: PURE-TIME PREFERENCE RATE

1. Introduction

In this part of the chapter, I investigate arguments for and against pure-time preferencing. The pure-time preference (PTP) rate—which, again, is represented by delta (δ) in the Ramsey equation—is the most explicitly normative variable in the social discount rate: when we select a particular PTP rate we are making an evaluative judgment, not stating an empirical fact. This evaluative judgment corresponds to the following question: to what extent, if at all, should we (as a transgenerational society) value present consumption over future?

Time-preference questions are familiar to us on a personal level. Should we spend our whole paycheck now, or save some for retirement? Knowing that we must replace our tires soon, do we act immediately, or put off the expense as long as possible? The positions we take on these questions reflect our judgments about the extent to which we prefer present over future consumption.

Time-preference becomes more obviously political in application to social forms of consumption over generations. Consider the case of climate change: states and societies can pay a certain amount today (in the form of mitigation investments) to avoid a certain amount of costs later on (in the form of climate damages). Whether they will (or should) depends on the strength of their preferences for present versus future consumption; or, to put it another way, on the present value they assign to the avoidance of future costs.

Whether it is morally permissible to discount the value of costs and benefits *simply because* they occur later in time is a matter of debate. As with the general discounting debate, there are two prevailing views: on the one hand are those who endorse a positive PTP rate (like Nordhaus) on the grounds that it alone reflects normal human behavior and so avoids

paternalism. We can call this the descriptivist argument. On the other hand are those (like Stern) who endorse a zero (or near-zero) rate on the grounds that this alone avoids arbitrary discrimination against future persons. Below, in section 2, I reject the descriptivist argument for a positive PTP rate. Then, in section 3, I turn to evaluating the case for a zero rate. While most ethicists agree with Stern that a zero rate is the only morally justifiable position (because it treats all people, present and future, as equals), important recent work by Joseph Heath calls this position into question. I engage Heath's two major criticisms of a zero rate in section 4, and conclude that both fail—though the second for practical rather than theoretic reasons. Following this, in section 5, I consider Heath's normative arguments in support of a positive PTP rate. While original, I argue that these arguments also fail. Finally, in section 6, I introduce and defend a largely overlooked position in the debate: i.e., I argue that, at least under certain circumstances, a *negative* PTP rate is justified.

2. The Descriptivist Argument for a Positive Rate

Many if not most economists favor a positive PTP rate. In the past, this was often a matter of unthinking convention; indeed, until recently, standard practice was simply to pluck a discount rate out of the air.[28] Regarding climate change, however, the issue has become contentious, forcing proponents of a positive rate to offer a defense.

The most common tack has been to defend a positive PTP rate by appealing to ordinary human behavior. The claim is that, judging by personal savings and investments tendencies, most individuals demonstrably prefer present over future consumption. Using this descriptive standard in economic models is appropriate, so the argument goes, because any

[28] Krahn and Gafni 1993, 415; cited in Heath 2016, 3.

other rate would amount to paternalism. This view is expressed in Nordhaus's foaming reply to Stern's (near) zero PTP rate:

> The [*Stern*] *Review* takes the lofty vantage point of the world social planner, perhaps stoking the dying embers of the British Empire, in determining the way the world should combat the dangers of global warming. The world, according to Government House utilitarianism, should use the combination of time discounting [delta] and consumption elasticity [eta] that the *Review*'s authors find persuasive from their ethical vantage point.[29]

On Nordhaus's view, economists should avoid ethical prescriptions. Their mission should simply be to interpret the world as it is and peoples' preferences as they are—*not* force some abstract notion of the good onto them.[30] In short, the "sovereignty" of individual preferences provides the "essential rationale" for time preferencing[31]; no other reflection is needed.

There are several, by now well-known, problems with this descriptivist argument. For one, the data economists use do not seem relevant to individuals' views about intergenerational justice. In other words, when interpreting the "real world," descriptivists like Nordhaus invariably rely on proxy measures, like personal savings and investment rates. It is not at all clear, however, that these rates offer any insight into what the *social* PTP rate should be according to the individuals they are observing. For even if we grant that individuals do, in fact, exhibit a positive time preference in their own financial lives, it is not as if this behavior is guided by reflection over the question: "How much should I set aside for posterity?"—or,

[29] Nordhaus 2007, 691.

[30] A stated aversion to paternalism prevails in the economics literature. See, e.g., Lomborg 2001, 314; Samuelson and Nordhaus 2005; Posner and Weisbach 2011, chap. 7.

[31] Pearce 1993, 54, as quoted in Gardiner 2011, 276.

more aptly, "What value should I place on future damages (that I have a part in causing), as an impartial citizen?" Rather, individual behavior in these cases corresponds to questions like: "How much should I set aside now so that I will not have to work when I am older?" or, "How much should I save to insure myself against some potential misfortune?" If we think that "the *social* discount rate should reflect explicitly moral, other-regarding judgments about the relative importance of well-being that exists far into the future," as Paul Kelleher argues, then the self-regarding savings and investment behaviors of individuals are inappropriate proxies.[32] Indeed, these behaviors fail to illuminate "what even *those same individuals* believe we owe to future generations."[33]

For the descriptivist argument to succeed better proxies are needed. Recent work attempts this. Giglio et al., for instance, investigates the different values individuals place on real-estate that can be owned in perpetuity versus that which can only be leased for long durations (99 to 999 years). From this they deduce that the long-run social discount rate should not exceed 2.6%.[34] Even if we grant that this measure captures a more relevant form of individual behavior (i.e., one that more closely parallels views on intergenerational savings), we might still worry that *any* attempt to use individual behavior as a standard for social ethics and political action commits a kind of ecological fallacy. The actions of a forward-looking, morally motivated individual do not themselves tell us what a forward-looking, morally motivated *society* should do. At the very least, we ordinarily think that governments, unlike

[32] Italics in original; Kelleher 2012, 47. For similar criticisms of the descriptivist approach, see, e.g., Stern 2010, 51. Cf. Posner and Weisbach, 155, 160-2.

[33] Italics in original; Kelleher 2012, 47. For similar criticisms of the descriptivist approach, see, e.g., Stern 2010, p.51. Cf. Posner and Weisbach, 155, 160-2.

[34] Giglio, Maggiori, and Stroebel, 2015. They offer further support of this conclusion in a more recent NBER working paper (Giglio, Maggiori, Stroebel, and Weber 2015).

individuals, have a duty to (impartially) defend the well-being of all its citizens, now and into perpetuity. (This opens up a basis of political and social criticism that is lacking in the individual context: i.e., we can rightly condemn a state that unnecessarily defers action and accumulates damages or debt as temporally discriminatory and unfair.[35])

This suggests that concern with paternalism is poorly motivated. Many believe that governments ought to make and enforce a range of ethical prescriptions and proscriptions: e.g., requiring buildings to provide access to disabled persons, preventing exploitation, ensuring fairness in admissions and hiring processes, protecting against harm, and so on. Many also think it permissible for governments to require individuals to acquire some form of retirement savings, as with the U.S.'s Social Security program, and to help those most in need, as with food-assistance programs. Why, then, should paternalism be so hotly contested precisely where it seems most relevant—i.e., with respect to policies that are meant to protect today's *children* and those yet to be born from grievous harm? If the government can rightfully act to prevent harm and provide basic protections intra-generationally, it is up to descriptivists to show why they cannot do the same in intergenerationally. Otherwise, the invocation of paternalism rings like a hollow ideological cover for an unjustifiable aversion to burdens.[36]

In short, the descriptivist position is politically and ethically dubious. Its essential claim that we should take what people actually do as a standard for what they should do is

[35] On this point, see Gardiner 2011, 277.

[36] I thank Colin Bird for this point.

unfounded. Indeed, making precisely this distinction is necessary to derive an ethically sound and politically responsible PTP rate.[37]

3. The Case against Time Preferencing (or for a Zero Rate)

Making this distinction has led many—indeed, virtually all—moral philosophers to conclude that time preferencing is an unjust form of discrimination.[38] Simon Caney, for instance, argues that just as we think that "persons should not be discriminated against because of their race or gender or socioeconomic class," we should also regard it as "inappropriate to discriminate against a person simply because of their location in time"; none of these factors (race, gender, class, temporal location) is a "morally relevant feature of persons."[39] Some economists reject positive time preferencing on ethical grounds, as well.[40] Roy Harrod, for instance, famously claimed that a positive "pure time preference [is] a polite expression for rapacity and the conquest of reason by passion," produced by "human infirmity."[41] More recently, Nicholas Stern has argued that while "[i]t is, of course, possible that people actually

[37] Of course, one might respond here that ethics must trade-off at a certain point with feasibility, at least for political decision-makers. I address this objection below (sections 5.2 and 6.2).

[38] See, e.g., Sidgwick 1890, Bk. IV, chap. 1, sec. 2; Parfit 1984; Rawls 1999, §45; Broome 2008; Gardiner 2011, chap. 7; Posner and Weisbach, chap. 7.

[39] Caney 2009, 168.

[40] See, e.g., Ramsey 1928, 543; Pigou 1932, 24-5; Harrod 1948, 37-40; Solow 1974, 9; Stern 2007; Dasgupta 2008; Cline 1992 [cited in Stern review]

[41] Harrod 1948, 40, 37.

do place less value on the welfare of future generations, simply on the grounds that they are more distant in time[,]…it is hard to see any ethical justification for this."[42]

The argument, then, for a zero PTP rate is essentially two-fold.[43] First, a zero rate represents something of a default position: it is what we end up with once we reject time preferencing.[44] Thus, rebutting the case for a positive PTP rate goes a considerable way toward making the case for a zero-rate. This is relatively easy to do, as in many cases, positive rates are defended on ethically dubious grounds (as discussed above).

Second, the widely shared commitments to impartiality and equality strongly support a principle of intergenerational neutrality (or temporal non-discrimination). A person has no more control over when she is born than where; both factors are morally arbitrary from the point of view of distributive justice. Granting this, only a zero rate treats everyone as equals, by avoiding unjustifiable discrimination or partiality.

4. Objections to a Zero Rate

Despite its normative attractiveness, critics have registered several objections to a zero PTP rate. I consider three here.

4.1 A Zero Rate Is Overly Demanding

The first charge is that a zero PTP rate would result in the imposition of "absurdly" demanding burdens on current generations.[45] To understand why this might be the case,

[42] Stern 2007, 31.

[43] NB: I set other arguments we could adduce for a zero time preference rate aside here. For discussion, see Greaves, 13*ff*.

[44] This, at least, is the common view. But cf. Gardiner 2011, 292*ff*.

[45] See Heath 2016, 13*ff*. See also Posner and Weisbach, 149.

consider first that, much like compounding interest, economic growth is exponential. Thus, in growing economies, every dollar invested in the present will yield much more in the future—and those returns, if reinvested, will grow larger still. This is true even at seemingly low rates of interest. Consider the following chart, which indicates returns on a $1 investment, at two different rates over three time periods.[46]

In / **At**	**50 years**	**100 years**	**500 years**
1.5%	$2.11	$4.43	$1710.10
3.0%	$4.38	$19.22	$2,621,877.23

At 3% interest (compounded annually), every dollar invested today generates a four-fold return in just fifty years, and a nearly 20-fold return in 100 years.

This basic fact has serious practical implications for a zero PTP rate. For if we deny that the timing of consumption is morally relevant (which adopting a zero rate implies), and if (as a society) we prefer more over less consumption, then it will make sense for us to save and invest as much as possible today,[47] as this will create proportionately greater wealth later.[48] It is easy to see how this quickly results in absurdity. Following this logic, each (and every) generation should defer as much consumption as possible—even sacrificing minimal living

[46] I am using the equation $A = P(1 + r)^t$ where *A* equals the total accrued amount, *P* equals the initial principal invested, *r* equals the rate of interest, and *t* equals time (in years).

[47] Assuming, of course, that investment options with return rates >0% are available.

[48] Kenneth Arrow (1999, 14) explains, "strictly speaking, we cannot say that the first generation should sacrifice everything, if marginal utility approaches infinity as consumption approaches zero. But we can say that given any investment, short of the entire income, a still greater investment would be preferred" (cited in Heath 2016, 15).

standards[49]—to invest their resources, since any finite loss in current consumption would be more than outweighed by the (exponentially) greater benefits their investments would produce in the future. Tjalling Koopmans, who first identified this problem, refers to it as the "paradox of the indefinitely postponed splurge."[50] If this paradox holds, adopting a zero PTP rate will entail a "policy of total current sacrifice."[51] We must address this problem if we are to overcome the demandingness objection.

In response, we should first note that the paradox does not pertain to the PTP rate in particular, but to the social discount rate in general. Even if we set the PTP rate equal to zero, other variables in the discounting equation—i.e., those pertaining to the consumption elasticity of utility (eta) or the economic growth rate (gamma)—may still lead us to endorse a less demanding overall rate. If that is the case, then the objection may fail.

Suppose, however, for the sake of argument that the PTP rate *exclusively* determines the overall social discount rate. Even in this case, the demandingness objection only works if we also accept that every generation has a duty to maximize utility over time. There are plenty of reasons to reject this, however. For instance, we might argue, with John Rawls, that this assumption fails to take seriously the distinction between persons.[52] Any conception of justice that requires the near-total sacrifice of some for others is morally untenable, and exceeds what can be rightly demanded of others. In other words, a transgenerational imperative to maximize utility would fail the "strains of commitment" test, which stipulates that, when deliberating

[49] Posner and Weisbach 149, Heath 2016, 15.

[50] Koopmans 1967, 8; cited in Heath 2016, 15. Others call it the "infinite time horizon" problem (see, e.g., Vallentyne 1994; Liedekerke and Lauwers 1997). For related discussion, see Arrow 1999; Lomborg 2001, 314. Cf. Gardiner 2011, 294.

[51] David Pearce 1993, 58 (cited in Gardiner 2011, 294).

[52] Rawls 1999, 253, 255, 24, 163.

over which standards of justice to endorse, individuals should rule out any that they "can adhere to only with great difficulty" or that "have consequences they cannot accept."[53] A conception of intergenerational justice that entails an "indefinitely postponed splurge" bought by extreme and perpetual sacrifice surely fails in this regard.

Note that in rejecting the utility-maximization imperative, we need not reject a zero PTP rate. This is clear, again, in Rawls's account, which endorses a zero PTP rate on ethical grounds, while also stressing that utilitarianism provides an overly demanding standard for intergenerational justice.[54] This of course raises the question: if we reject utility maximization, which alternative principle(s) of intergenerational justice should we adopt? And what (if any) role will discounting play in fulfilling that principle (or those principles)?

In chapter 2 I proposed a non-utilitarian conception of intergenerational justice. I argued that each generation should refrain from causing unnecessary harm to future ones (the no-harm principle). I also argued that each generation should take all reasonable measures to insure future ones from credible risks of extreme material scarcity (the protection principle).[55] Fulfilling these duties, I claim, requires present generations to take immediate action on climate change (and any other threat of serious future harm). Note further that, if our concern is with preventing catastrophic climate change, then we can limit the scope of discounting to just the damages associated with that risk. In other words, instead of imposing responsibility on the present for the entire range of costs and benefits extending into the future, we need only maintain that current generations should attend to the costs and benefits related to preventing

[53] In other words, it fails the "strains of commitment test." See Rawls 1999, 153.

[54] See Rawls 1999, 259*ff*.

[55] For further discussion, see chapter 2.

catastrophic climate change. Thus, the discounting question becomes, "How much should we be willing to spend today to prevent catastrophic climate change in the future?"

A critic might respond that if the future costs of catastrophic climate change were large enough, then a zero PTP rate might still require imposing extremely demanding burdens on current generations. This misses three critical points, however.

First, as others have noted, this objection could, in principle, apply to any PTP rate—including positive rates.[56] In other words, if estimates of future damages are sufficiently high, then even a positive discount rate will imply placing extreme burdens on current generations.[57] This provides no principled reason for rejecting a zero rate in particular. Rather, to determine whether a given burden is overly demanding, our first concern should not be the PTP rate, but the size of the burden itself. In other words, we must ask: at what point does a burden qualify as excessively demanding? (One possibility, defended in chapter 2, is that a burden is excessively demanding if it precipitates a state of extreme material scarcity among those tasked with bearing it, such that they are unable to meet their basic needs without denying others the ability to do the same.)

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[56] Gardiner 2011, 294.

[57] Heath dismisses this point, arguing that it fails to recognize a "significant disanalogy" between zero and positive rates: that in order for a positive rate to imply extreme burdens on current generations, "the size of the [future] returns [or avoided costs] must grow over time"—a scenario he thinks is extremely "uncommon, and probably non-existent" (Heath, 14*n.*40). For the sake of space, I cannot fully respond to this point here, suffice to note that economists like Stern and Weitzman argue that climate change will not simply result in damages, but productivity losses (Stern 2007; Wagner and Wetizman, 64). Costs associated with productivity losses would compound in precisely the manner Heath suggests is unlikely or impossible. And should those losses, measured as a percentage of economic growth, exceed the positive discount rate, then the same demandingness objection would apply.

Once we have identified a standard of demandingness and produced a robust estimate of future climate-related costs, we can determine whether or not a given PTP rate (selected for independent, moral reasons) is practically feasible—viz., whether or not it imposes excessive burdens on current generations. Approaching the problem in this way shows that questions about demandingness can and should be considered in isolation from questions about which PTP rate is morally appropriate. A discount rate may be far too demanding, but nonetheless morally sound. To navigate such a discrepancy, we need not alter or abandon the PTP rate—which would be, at best, an ad hoc correction; rather, we need simply to assert that, for reasons independent of time preferencing, we cannot take on the full burdens of climate action.

This point requires further clarification. When we factor an estimate of future climate-related costs, equal to X, into a discount formula with an overall rate of zero, that formula simply tells us that we should be willing to spend everything up to X today to avoid X in the future. In this sense, X represents the maximum burden that justice can *potentially* demand. Now, if what I argued above holds, we may have independent reasons for thinking X too stringent, such that we can justifiably spend less than X. This adjusted burden (X-ADJ) denotes the maximum amount justice can *actually* demand. Note, however, that both X and X-ADJ may considerably exceed the minimum cost of effective action, X-MIN—i.e., the amount it would cost current generations to prevent costs equal to X befalling the future.

We can see this in the case of climate change. Stern estimates that effective mitigation would cost about 1% of global GDP, which is roughly equal to $780 billion annually (in 2015

USD$)—a large but by no means infeasible sum.[58] (To put this figure into perspective, the estimated U.S. defense budget for 2015 was $636.6 billion; $797.8 billion if you include veteran benefits.[59] Perhaps more strikingly, the personal wealth of the richest 62 people in the world in 2016 was approximately $1.76 trillion—more than double what would be needed.[60]) On the other hand, Stern claims that failing to mitigate climate change may result in costs "equivalent to losing at least 5% of global GDP each year, now and forever."[61] (Stern warns further that if we take a "wider range of risks and impacts" into account, this figure could "rise to 20% of GDP or more."[62]) This suggests that mitigation offers a natural return on investment in terms of avoided costs: 1% of GDP invested may prevent a loss of up to 20% GDP later.[63]

In short, the discount formula can *only* help us to identify X, the maximum burden justice can potentially demand. The figures we must identify to satisfy intergenerational justice, however, are represented by X-MIN and X-ADJ; as a general rule, we should satisfy X-MIN up to the point of

[58] Stern 2007, 258-262. For similar estimates, see Stern 2010, 45; Weitzman 2007, 720; Nordhaus 2008, 90. For discussion, see Caney 2009, 182*n.*9; Page 2011, 412; Rendall 2011, 890.

[59] U.S. Government Publishing Office.

[60] Oxfam, 2.

[61] Stern 2007, vi.

[62] Stern 2007, vi. Stern has subsequently stressed that these estimates are likely overly conservative (Stern 2010; Stern 2016).

[63] Cline (2008) estimates that Stern's ordinary "benefit-cost ratio" for mitigation efforts is about 12:1, meaning that every $1 invested now avoids $12 in costs later.

X-ADJ.[64] On this view, the discounting formula only provides a rough guide—a starting point for our ethical and political reflections on intergenerational justice, not the last word.

4.2 Time Preferencing Does *Not* Violate Equality or Impartiality

There is a second, more powerful objection to a zero pure-time preference (PTP) rate. To understand this objection, recall the prevailing view in the climate ethics literature, which holds that a zero rate alone reflects a commitment to intergenerational equality and impartiality. On this view, we can reject positive PTP rates as expressions of arbitrary temporal discrimination.

Joseph Heath challenges this view. He argues that a positive PTP rate applied consistently over time *is* compatible with intergenerational equality and impartiality. Heath claims that this is obscured by the fact that most work on discounting employs a problematic conception of time: one that tends to take an analogy with space too literally. According to Heath, future persons do not occupy a temporal "location" as people today occupy different territories. Rather, time is better thought of as a kind of conveyor belt, atop of which are seated all persons, past, present, and future.[65]

It is wholly in keeping with equality, Heath argues, that there should be various stations—with different responsibilities and privileges—along this conveyor belt. We can see

[64] This raises the question: what if the burdens necessary to avoid catastrophic harm (X-MIN) exceed what any generation can justifiably be expected to bear (X-ADJ)? I cannot answer this question here, though it seems to me in such a case, preventing harm would be a matter of supererogation rather than justice. In other words, we might hope that earlier generations would act for the sake of the future in such cases, but justice cannot compel self-sacrifice.

[65] Heath, 10.

this more clearly by considering the different ways *existing* people of different ages are treated in contemporary societies. We deny driving privileges to youths, for instance, yet, we do not think this violates equality. For although youths are not are not allowed to drive so long as they remain young, they will be allowed to once they reach the requisite age, which everyone is expected to do (at least in the abstract). Thus, the privilege of driving is, in principle, denied to no one; a person need only first reach the relevant point on the conveyor belt. The same often holds for voting, recreational drug use, holding certain political offices, retirement, etc. In each case, restrictions based on age are not inequitable or discriminatory, so long as they remain consistent over time—i.e., so long as they treat "everyone the same over the *course* of their lives."[66]

Heath extends this reasoning to future persons, whom he claims are simply farther back on the temporal conveyor belt than today's youngest children. On this view, consistently discounting the *present value* of future persons' consumption is not a violation of equality.

> Under a positive rate of time preference, the benefits to all persons are still given exactly the same weight at the time at which they are realized, just as they are all given the same weight when they are temporally removed from the present by the same duration.[67]

A society can thus justifiably regard costs and benefits 100 years in the future as less valuable than present ones, again, so long as the rate at which it discounts those costs and benefits remains constant over time.[68] If this is right, then a commitment to equality and impartiality

[66] Italics in original; Heath, 9.

[67] Heath, 8.

[68] Heath, 8.

provides no reason to reject a non-zero PTP rate.[69] Rather, "all that the equality of persons requires is…a *non-capricious* discounting policy that is applied consistently over time."[70]

This argument is powerful, and (I think) sound in a general and abstract sense. Once we descend from the realm of the abstract, however, we quickly encounter two issues. First, by stipulating that the discount policy should be consistent over time (to avoid temporal discrimination), Heath tacitly presumes that the entailments of a given discount rate will remain relatively constant over time. In other words, Heath seems to believe that applying a positive discount rate, ϱ, at time T_1 is morally equivalent to the application of ϱ at all subsequent times, T_{1+n}. But this is surely wrong. For it misses the fact that a society's material form of consumption changes over time, and that some forms of consumption, including those prevailing today (which depend on burning fossil fuels), are inimical to the interests of future generations.[71] Thus, when current generations adopt a positive discount rate with respect to costs and benefits 100 years into the future, this may have a very different effect than when people living 100 years in the future adopt the same discount rate with respect to costs and benefits 100 years further out still.[72] Put another way, present favoritism practiced today generates far greater risks and harm than present favoritism practiced at virtually any point in the past and perhaps at most points in the future. Heath's defense of time preferencing, which overlooks the practical effects of positive rates, obscures this point.

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[69] Heath, 10. Note, this does not rule out a zero PTP rate; it simply shifts the burden back onto proponents of a zero rate to show why it is necessary on alternative grounds. Heath seems doubtful this can be shown, and supports a positive rate.

[70] Heath, 9.

[71] Or at least pose grave risks to future interests.

[72] Assuming that the next century sees a shift away from harmful, emissions-intensive forms of consumption.

Heath's account also fails to establish which PTP rate is best; rather, he only establishes that a non-zero rate of some sort is morally acceptable if applied consistently over time.[73] He proceeds from this, however, to argue for a *positive* PTP rate. But that is not the only possibility his account opens up. It could equally be taken to support a *negative* rate, which would place a higher value on future consumption (relative to present). I return to this point below (in section 6). First, however, we must examine why Heath favors a positive rate.

5. Further Arguments for (and Against) a Positive Rate

Heath offers two, freestanding arguments for a positive PTP rate. First, he claims that positive pure-time preferencing is supported by a reflective equilibrium methodology. Second, he argues that positive rates are justified as part of an "institutional morality"[74]—viz., because "temporalizing" moral duties can increase everyone's welfare, just as "territorializing" duties does (or can do). Neither of these arguments, I argue below, is as persuasive as Heath believes.

5.1. The Reflective Equilibrium Argument

Heath's first argument for a positive PTP rate appeals to Rawls's idea of "reflective equilibrium" (RE).[75] For Rawls, RE refers to the outcome of a process of theory construction, which occurs when one's most confident moral judgments and intuitions come to cohere with a particular set of ethical principles. This process has two major steps. It begins with the design of a theoretical mechanism (like Rawls's "initial situation") for generating principles that

[73] Heath, of course, recognizes this (see, e.g., Heath 10).

[74] This is essentially just a pragmatic argument.

[75] Heath, 18.

"represent generally shared and preferably weak conditions."[76] Second, the generated principles are tested against one's most basic and deeply held ethical judgments—e.g., that slavery is wrong or that wanton cruelty is evil. To the extent that the principles conflict with these judgments, we either revise the mechanism that yielded them (and thus generate new principles) or revise our basic judgments against which the principles have been tested. This process continues until we "find a description of the initial situation that both expresses reasonable conditions and yields principles which match our considered judgments duly pruned and adjusted."[77]

Heath employs a truncated version of RE. He claims that we reach RE "by formulating an abstract principle (the social discount rate), examining the specific consequences of its application to various cases, then making mutual adjustments between the two until an equilibrium is reached."[78] By omitting reflection over the mechanism by which an "abstract principle" (like the social discount rate) might be generated, Heath's version of RE does not function as a method for the construction of a moral theory, but as a way of doing applied ethics.[79]

[76] Rawls TJ, 18. According to John Arras, by "generally shared," Rawls has in mind that the model conforms with the "background social, psychological, and philosophical theories" of the society in which it is being developed (Arras, 47). I return to this point below.

[77] Rawls, 18.

[78] Heath, 18.

[79] I set aside the question of whether it makes sense to use RE in this way, suffice to note that some commentators have expressed doubts about this (e.g., Arras 2009).

Heath identifies an argument of Kenneth Arrow's that exemplifies this kind of RE in action.[80] According to the Heath-Arrow approach, the "first step in assessing the plausibility of any particular discount rate is to examine some of its policy implications, and see if they are plausible, and if the same principles can be applied consistently in other domains."[81] Considering other domains is necessary, Heath explains, because it is nearly impossible to have solid intuitions about what a proper discount rate should be.[82] This is due to the confounding effects of compound interest; even minor variations in the rate (e.g., 4.5% vs. 5%) can result in enormous differences over time. For instance, at a discount rate of 4.5%, the present value of $1,000,000 in 50 years is $110,709.65, while at 5% it is only $87,203.73—a difference of $23,505.92.[83] Because intuitions are so unclear, Heath claims, we should "start with something more tangible, like the savings rate, and then extrapolate the rate of pure time preference implied by that value."[84] Indeed, according to Heath, it "is only by situating the discounting issue within this richer framework of policy issues, and making adjustments between the more abstract and specific levels, that we can apply the method of reflective equilibrium."[85] Once

[80] Heath laments that there are no philosophers to cite on this score. This may be due to the point just noted: that many philosophers have doubts about using RE as a method for practical ethics. Note moreover that Arrow, who is deeply familiar with Rawlsian theory, does not refer to his method as RE in the paper Heath cites.

[81] Heath 21.

[82]According to Heath (2016, 20), Arrow and Partha Dasgupta share this view.

[83] Using the equation $FV = PV * (1 + r)^{-t}$.

[84] Heath, 21. The discount rate corresponds directly to a savings rate, at least when applied generally.

[85] Heath 22

we do this, Heath believes we will reject a zero (or near-zero) PTP rate, and endorse a positive rate.

It would take another paper to fully address the problems with Heath's use of RE in reaching conclusions about discounting. For our present purposes, it suffices to discuss a few of the most pressing issues.

The first is that RE is not sufficient for *justifying* an ethical principle or view, as Heath seems to assume.[86] At most, RE can establish the *coherence* of an ethical view, or rather the coherence of assorted principles and intuitions on a particular subject. This is especially relevant here. A person's or society's views about any particular subject, including time preferencing, may be generally coherent but substantively wrong or immoral.[87]

In addition to this theoretical issue, there are significant methodological problems with Heath's use of RE. He starts, for instance, with the claim that intuitions are extremely unclear or indeterminate with respect to the appropriate discount rate.[88] If this is correct, then it is difficult to see how RE is relevant to begin with, given that our intuitions are meant to help us rule out certain principles in the process of mutual refinement that reaching RE requires. Perhaps Heath's repeated claim that a zero rate will lead to overly demanding outcomes can fill this gap by acting as one stable, intuitive anchor. Although Heath does not state this explicitly, the idea here would be that overly demanding burdens are intuitively unacceptable, and so any principle that yields such burdens ought to be ruled out. Yet, it is not at all clear

[86] It may be that RE is necessary, but that is another question. For discussion, see Arras, 67.

[87] This is why, as Arras explains, Rawls stressed the "competence of moral judges" in these processes (Arras, 49, 68; Rawls 1951, 178*ff*). Other commentators also draw attention to the insufficiency of RE, and to the need for the development of moral capacities in actual agents (see, e.g., DePaul 1993, 174; Nussbaum 1992; both cited in Arras, 68).

[88] Heath, 20, 21.

that the aversion to demanding burdens is a durable intuition—i.e., one that can shape principles but not be shaped by them in the process of reaching RE. Rather, it seems that aversion to demandingness is precisely the kind of intuition that would need to be pruned or revised. This seems especially likely if it were to conflict with other, more powerful intuitions, like those against harming others or in support of holding the guilty accountable—both of which are pertinent to the case of climate change.

Even if this is wrong, however, and the aversion-to-demandingness intuition is particularly durable, Heath does not provide any strong evidence that a zero PTP rate would, in fact, be overly demanding.[89] (As we saw above, the zero rate is not as vulnerable to the demandingness objection as Heath assumes.) Rather, he simply argues that the near-zero PTP rate Stern endorses would impose "self-evidently outrageous" costs on the present *if* that rate was "applied consistently to all areas of either private or public decision-making."[90] This criticism is misguided, however: Stern does not intend for his rate to be applied widely, but only to climate-relevant industries. This restricted application is in keeping with the normal use of discount rates in public policy. We should note further that, in their criticisms of Stern, Arrow and Dasgupta rely on very simple economic models that assume the only engine of economic growth is generational savings. This makes Stern's rate look more stringent than it actually is. Heath ultimately concedes this point, noting that "[i]f one includes other factors,

[89] Perhaps we can take his later claim that adopting a zero rate of PTP may entail sacrifices for more pressing, present-oriented activities like "malaria eradication" as support for this (Heath, 22). The idea that addressing climate change must come at the cost of redressing present health concerns or global poverty is dubious. Rich states command more than sufficient resources to mitigate climate change *and* attend to global health and poverty.

[90] Heath, 20-21.

such as technological change, then it is not obvious that Stern's discount rate implies such a wildly unreasonable rate of savings."[91]

Let us suppose, for the sake of argument, that a zero PTP rate *would* imply an intergenerational savings burden radically out of sync with what individuals ordinarily save, or how much societies devote to future-oriented activities like medical research. What would this establish? Discrepancies matter here only if we assume that what people ordinarily save, or devote to medical research, or etc., shed relevant light on the question of how much we should discount the future effects of climate change. As I argued above when rejecting the descriptivist approach, however, when people invest in personal savings or, as a society, in medical research, they are guided by fundamentally different objectives, intuitions, and principles than they are (or should be) when responding to climate change. It seems much more plausible to suppose that responding to climate change warrants a disproportionately large "savings" burden, given the very real threat of catastrophe we face and how crucial "saving" (i.e., mitigation) is for addressing that threat.[92] Given similarly exigent circumstances—say, a global pandemic—I expect that the implied discount rate of medical research investments would far exceed (say) individual savings rates. If this is right, then Heath's claim that we should want a uniform or roughly equivalent discount rate across these

[91] Heath 21.

[92] In this sense, perhaps a better analog—one that Heath and other descriptivists do not consider—are the behaviors people exhibit in preparing for large-scale war. Submitting to rationing, purchasing treasury bonds, volunteering for potentially deadly service—these all seem to imply a zero or negative rate. (I develop this argument further below.)

different areas is misguided. Coherence across policy domains is not desirable in and of itself, and is even inappropriate when circumstances vary considerably across domains.[93]

These remarks suggest a broader problem with Heath's account. It neglects the fact that climate mitigation is not like other forms of saving.[94] To treat it as such is to ignore the considerable and potentially irreversible harm climate change portends. This point is critical. For whereas savings aims at benefitting future generations, mitigation aims at preventing or attenuating harm—specifically, harm that we, in the present, are causing. This implies a whole different range of intuitions, including (as suggested above) ones about what is too demanding.[95] Heath's RE argument cannot succeed, then, unless he provides a more compelling argument for regarding other forms of intergenerational saving as appropriate standards for selecting climate-related discount rates.

5.2. The Institutional Morality Argument

Heath's second argument for a positive PTP rate appeals to the idea of "institutional morality," a concept he attributes to John Garthoff.[96] The basic idea behind institutional morality is that, for certain abstract moral commitments, a system of rules is necessary to specify "exactly who owes what to whom."[97] Crucially, such rules can attach moral weight to

[93] Again, this is because various domains of activity are guided by different values, motivations, and ends. Even within domains of activity—say within the field of investments—circumstances can change markedly depending on the actors taking part and the objectives of their investments.

[94] See, e.g., Heath, 21.

[95] Gardiner 2011, 266*n*.51.

[96] Heath, 23, citing Garthoff 2004.

[97] Heath, 23.

certain properties of individuals that would otherwise possess "no intrinsic moral significance…as a way of creating determinate moral obligations."[98] Developing an institutional morality is necessary, Heath insists, not just for rule-utilitarians, but for anyone wishing to avoid the coordination problems and distributional indeterminacies that adhere to collective moral duties.[99]

Heath claims that we see institutional morality most clearly with respect to spatial location. One's spatial location is essentially morally arbitrary. Yet, for certain imperfect[100] duties, like administering aid during a famine, it can make sense to adopt a system of rules that allocates responsibility in accordance with spatial proximity. This provides an authoritative answer to the question, "who should help whom?"—and, importantly, one that confers certain practical benefits, like minimizing the difficulties of transporting food aid over long distances. The most relevant point for our purposes is that these rules transmute what was once a "morally irrelevant factor"—spatial location—into "a morally salient feature of persons."[101]

It is easy to imagine how this reasoning might extend to the discounting question.[102] As Heath explains:

> It is all well and good to say that every person, throughout all of history, has an obligation to help every other person, regardless of what time the beneficiary happens to exist. Nevertheless, there is an enormous amount to be said for making this

[98] Heath, 23.

[99] Heath, 23.

[100] Heath focuses on imperfect duties throughout his discussion of institutional morality; although he does not specify, I assume he has in mind the Kantian sense of imperfect.

[101] Heath, 24.

[102] Note that Heath was not the first to analogize spatial and temporal aid; see Schelling 1995.

> imperfect duty more determinate. … If one were looking for a principle that could be used to divide up time into convenient slices, in order to create determinate obligations of assistance, a plausible principle would be to suggest that each generation of persons should, first and foremost, look after its own, and that their obligation to other generations should decline at some fixed rate, the further removed they are in time.[103]

Thus, just as territorializing certain moral duties provides important practical benefits, so too does temporalizing them.[104] Introducing a system of rules (or institutional morality) to this effect, Heath argues, would involve adopting a positive PTP rate, which again favors the interests of present generations over those of future generations.[105]

If this argument succeeds, we should not regard time preferencing as unfair or discriminatory, but instead view it as a useful tool in the service of morality.[106] I contend that the argument fails, however. As before, I limit myself to discussing the most significant problems.

5.2.1. The Nature of Intergenerational Duty: Helping vs. Not Harming

The first and perhaps most considerable issue is that Heath construes intergenerational justice as a program of helping others (i.e., of conferring benefits), or as an extension of a

[103] Heath, 26.

[104] Heath (2016, 26) stresses that "we cannot just airlift goods to the future, the best we can do is pass them along to younger generations (i.e. those with whom we 'share a border' temporally)."

[105] Heath, 27, 23.

[106] Heath, 23.

general duty to provide charity to those in need.[107] On this view, the preference for helping contemporaries over future persons seems reasonable: we can determine, much more readily, who among our contemporaries is in need, and we are better equipped to ensure that our aid reaches them. Of course, this does not mean that we have *no* reason to help future persons, just that benefitting them should be a lower priority, given that assisting contemporaries is (ostensibly) more effective.

This interpretation of intergenerational justice may ring true for certain kinds of future-oriented investment. But I am interested in climate mitigation, specifically. And while one might hold, as Heath does, that climate mitigation is a way of "helping" (by benefitting) future generations, this would be euphemistic, if not outright misleading.[108] By releasing greenhouse gases beyond the earth's natural absorptive capacity into the atmosphere, current generations are effectively *harming* future generations.[109] At this late stage, virtually every mile we (contemporaries) drive, every flight we take, and every burger we eat will contribute to the premature deaths of hundreds of thousands, if not millions, of future persons—at least if we fail to drastically reduce our carbon footprint very soon. At a certain point, remedial action will no longer be possible; with enough emissions, climate change will accelerate in a self-reinforcing feedback loop that will almost certainly result in catastrophic and irreversible

[107] NB: He clearly maintains this assumption throughout, presenting future-oriented action as "eleemosynary" in nature, and aimed at generating "benefits" (rather than reducing harms) (see, e.g., Heath, 2, 14, 21, passim). Heath also refers to duties to future generations as "imperfect," recalling Kant's understanding of the duty to charitable assistance.

[108] Heath 2016, 2, 5, and *passim*. In other words, for Heath, climate mitigation is a "cost" or form of savings, which aims at generating "benefits" in the future.

[109] Gardiner (2011, 266*n*.51) also identifies this distinction, but does not develop its implications.

loss.[110] Mitigation is therefore necessary to attenuate the real risks we are imposing and harm we are causing future people—not to benefit them.[111] Construing mitigation as a positive endowment is like presenting the antidote for an infection I have caused as philanthropic beneficence.

Once we take this more appropriate view of climate change, a positive PTP rate appears far less defensible. Future-oriented investments like mitigation, which aim at attenuating harm and risk, are not extensions of charitable duty or gifts. Rather, mitigation is an extension of the general[112] moral duty not to harm others, which applies even when harming

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[110] See my discussion of "tipping points" in chapters 2 and 4.

[111] One might object here that in talking about future "harm" I am running afoul of Derek Parfit's non-identity problem (Parfit 1984, chap. 16). I address this to some extent elsewhere (chap. 2). But we can briefly note two points of response here. First, the conception of climate harming I defend in chapter 2 holds that we harm others when, by our unnecessary actions or inexcusable omissions, we cause or allow them to enter into a state of extreme scarcity, in which the only way to meet their basic needs is by denying others the ability to do the same. This is a threshold conception of harm, which is less vulnerable to Parfit's problem (as Meyer and Roser [2009] explain). Second, the non-identity problem assumes that future lives, however degraded (because of present policies), are still worth living. If we fail to mitigate, though, this may not hold true. For at a certain point climate change will become "politically catastrophic"—viz., it may result in widespread and enduring scarcity of the sort I just described, and (subsequently) a loss of justice and political stability. Under such conditions, life may not be worth living, particularly if there is no hope of redress or restoration. (I argue in chapter 2 that climate change threatens potentially permanent political catastrophe.)

[112] Or, we might say, "perfect," following Kant's universal prohibition against intentionally harming others, and in contrast to Heath's construal of intergenerational duties as "imperfect."

offers personal benefits.[113] (We might add that mitigation, on this view, makes it more likely that current generations are able to satisfy the moral duty to leave "enough and as good" for future generations.) A system of rules, or institutional morality, that does not (at minimum) take the prohibition against intentional and unnecessary harming into account, makes little practical or moral sense. And without such a system, a positive PTP rate lacks justification.

Heath does offer a limited response to this concern. He concedes that territorializing or temporalizing the general "obligation to refrain from recklessly endangering other people" appears to offer little practical benefit.[114] In other words, just as we can assume that one should not act in a way that "recklessly endangers" people, regardless of which territory they reside in, we can also assume[115] that it is unacceptable for people in one time period to act in such a way that needlessly endangers others living later in time. Strangely, Heath does not argue that those who violate this duty are responsible for remedying the fallout. Instead, he claims that those who share a territory or temporal location with the victim of the "accident" should be responsible for shouldering the collective burden of responding to the harm.[116] In other words, Heath appears to be arguing that culpability is irrelevant in allocating responsibility for cross-territorial or cross-generational harming.[117] This is obviously problematic. We typically think that those responsible for causing a problem should shoulder (at least part of) the burden

[113] I return to this point below in section 5.2.

[114] Heath, 24.

[115] Heath here is focused on his preliminary example of dividing duties based on spatial location. He explicitly links this discussion to his argument for dividing duties based on temporal location, but does not revisit this point.

[116] Heath, 25.

[117] I say this with some uncertainty, as Heath relies here on vague (and potentially misleading language)—"it might not be unreasonable…" "accident," and so on.

involved in redressing it—particularly if the agents acted in full awareness of the potential consequences of their action(s).[118]

5.2.2 Evidence of Practical Benefits

This brings me to the second issue. Heath might respond to what we have said so far by insisting that the practical benefits of temporalizing remedial action outweigh the costs.[119] In fact, this kind of claim would appear to be necessary for the institutional morality argument to succeed, as that argument holds that temporalizing certain moral duties is justified *because* doing this offers significant practical benefits. Given that these benefits comprise the key justification for adopting a positive PTP rate, Heath must present compelling evidence that they exist and that they outweigh the relevant costs.

This evidence is absent from Heath's argument, however. This is made problematic by the fact that many economists take the opposite view,[120] arguing that leaving climate action to future generations may result in far greater overall costs—the opposite of efficiency gains. Deferring action also increases the risk of sudden catastrophe and irreversible loss.[121] A 2014 White House Council of Economic Advisors report supports these claims. Using times-series

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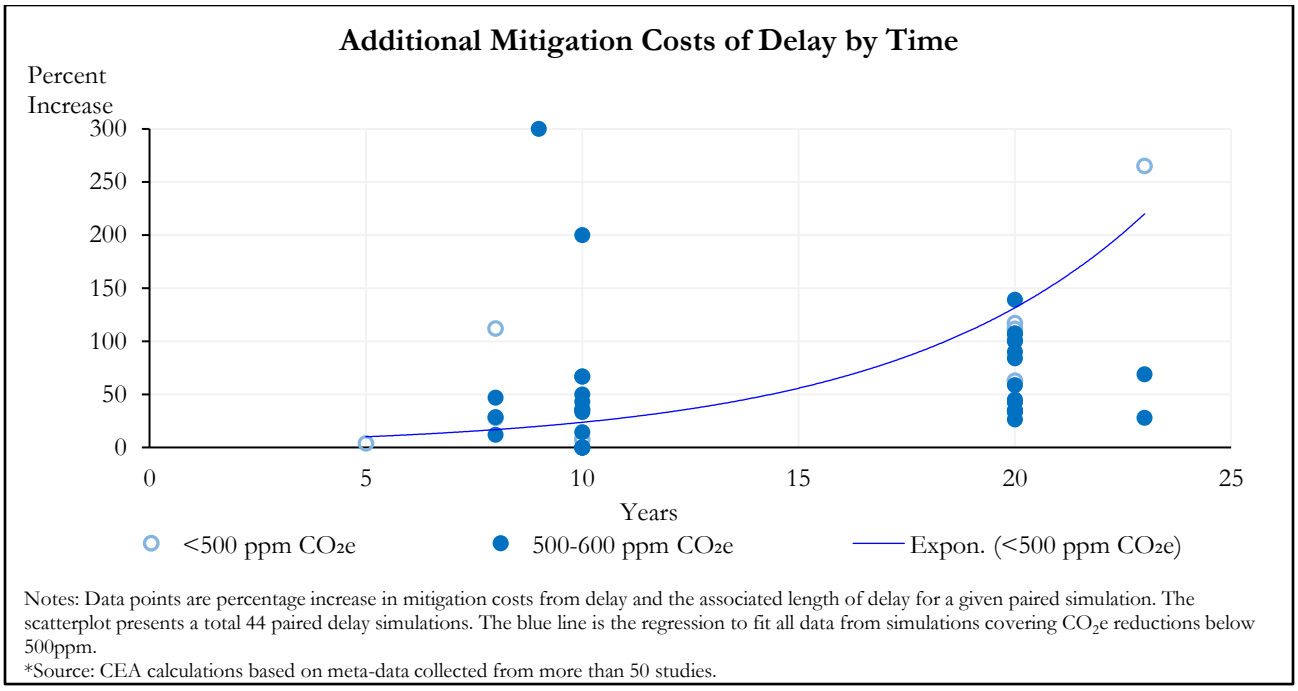
[118] See chapter 4. See also Miller 2001.

[119] This is a test he explicitly lays out for himself (Heath, 25).

[120] Though not all. William Nordhaus is probably the most prominent counter-example. Nordhaus's work has attracted considerable criticism, however, from fellow economists and climate ethicists (see, e.g., Gardiner 2011; Jamieson 2015; Caney 2014 and 2009; Wagner and Weitzman 2016; Stern 2010). Despite relying on Nordhaus's work more than any other throughout his article, Heath does not closely consider these criticisms.

[121] Martin Weitzman argues on this ground that current generations should be willing to pay greenhouse gas taxes as a kind of "insurance premium" against future catastrophe. (Weitzman 2009 and 2012; see also Jamieson 2015, 140).

data covering roughly one generation (25 years), the report shows that the costs of achieving even modest climate goals (like stabilizing CO_2e concentration levels 500 ppm) rises exponentially the longer action is delayed.[122]



Notes: Data points are percentage increase in mitigation costs from delay and the associated length of delay for a given paired simulation. The scatterplot presents a total 44 paired delay simulations. The blue line is the regression to fit all data from simulations covering CO_2e reductions below 500ppm.
*Source: CEA calculations based on meta-data collected from more than 50 studies.

Beyond just minimizing costs, the report argues forcefully that immediate action offers the best chance of keeping increases in global mean temperature below 2°C.[123] Indeed, delaying efforts would also almost certainly require the use of "negative emissions" (or "carbon capture") technologies, none of which have been proven to work on a large scale, and many of which are likely to be extremely expensive.[124]

[122] I am grateful to Rod Shadbegian, Jim Stock, and especially Josh Linn (with the Council of Economic Advisers) for providing me with these data. My figure is adapted from Furman et al.'s "Figure 2" (p. 16).

[123] Most environmental scientists agree that keeping temperature increases below 2°C is essential for avoiding the most harmful environmental changes.

[124] Hansen et al. 2016. Stern 2010, 45.

In short, delaying action increases the overall costs of climate action, while reducing the likelihood that such action will succeed in preserving safe temperatures.[125] If this is right, then temporalizing climate duties along the lines Heath suggests is not practically beneficial. We should therefore reject a positive PTP rate. In fact, if we take the institutional morality argument seriously, it seems plausible that a *negative* PTP rate would be justified, as this would temporalize duties in a way that ensured the highest chance of success at the lowest overall cost.[126] I pursue this point below. For now, though, the critical takeaway is simply that Heath fails to justify a positive PTP rate on practical or moral grounds.

6. The Case for a Negative Pure Time Preference Rate

Although Heath offers little reason for endorsing a positive PTP rate, which again would privilege the interests of present generations over the future, he does show that the case *against* time preferencing—i.e., the case *for* a zero PTP rate—is not definitive either. In particular, Heath's claim that a non-zero PTP rate applied consistently over time is compatible with intergenerational equality and impartiality appears to be right, at least in principle.

As I noted earlier, however, we cannot evaluate a discount rate in isolation from its likely effects. If the same rate applied consistently over time leads to vastly different effects on

[125] These findings have been echoed by many others. See, for instance, Stern 2007, 193 ("Delaying the peak in global emissions from 2020 to 2030 would almost double the rate of reduction needed to stabilise at 550 ppm CO_2e. A further ten-year delay could make stabilisation at 550 ppm CO_2e impractical."); Stern 2010, 44, 58 ("The basic statement that the costs of strong and timely action are much less than the costs of weak and delayed action is very robust"); Jamieson 2010, 269.

[126] Furthermore, by placing a high present value on avoiding future climate-related damages, a negative rate captures the benefit of avoided risk. I return to this in Part II, section 2.

people temporally equidistant from the present, then we have grounds for rejecting it, especially if that rate risks serious harm befalling some generations. A positive PTP rate is particularly susceptible to this, at least when applied by generations like ours in which the dominant forms of material consumption involve processes (like the combustion of fossil fuels) that threaten the lives or basic well-being of future generations. For this reason, we should reject positive time preferencing.

What PTP rate, then, should we adopt? In what follows, I sketch an argument for a negative rate. This, of course, is highly controversial, as it involves valuing the consumption of future generations above that of the present. Nevertheless, I argue that a negative rate is appropriate, at least under certain conditions, which I specify below.

6.1. A Negative Rate Confers Important Practical Benefits

Heath's institutional morality argument can actually help make the case for a negative rate. Recall that this argument holds that we can confer moral weight to ordinarily arbitrary factors, like temporal location, if doing so helps us to make collective moral duties more determinate and thus likely to be fulfilled effectively.

In chapter 2, I argue that everyone has a general duty to prevent avoidable political catastrophe, like that threatened by climate change, and that this implies two correlate duties:

(a) DUTY NOT TO HARM: Agents should not harm others. Harm occurs whenever some agents, by their unnecessary actions or inexcusable omissions, cause or allow political catastrophe to befall others.

(b) DUTY TO PROTECT: Agents should take all reasonable measures to protect others from scientifically plausible, reasonably likely threats of political catastrophe.

Both correlate duties are collective—they apply to all agents and groups of agents. They are also, admittedly, vague. Providing a set of rules that enables the effective realization of these duties would therefore be beneficial.

One way of doing this is to temporalize the duty. People living currently are better able to prevent politically catastrophic climate change than those who will live in the future. There are a number of reasons for this, which I outline in chapter 2. Briefly, though, the actions of earlier generations are likely to be more effective (and less costly) for three reasons. (1) Sequestering greenhouse gases (GHGs)—naturally or artificially—takes a long time. Even with serious efforts to decarbonize, some GHGs will remain in the atmosphere for millennia. If we wish to prevent catastrophic climate change, therefore, it is better to avoid emitting in the first place rather than attempt to sequester later. (2) As the effects of climate change become more severe, political instability and conflict are likely to increase, diminishing the capacities of states and other actors to address the problem.[127] Thus, again, it is better for us to act now, while our capacities are likely to be less diminished, then later, when government may be weaker. (3) Finally, and perhaps most importantly, the longer we delay climate action, the more likely crossing critical "tipping points" becomes, after which point irreversible and catastrophic changes will be unavoidable. In these ways, earlier generations are better positioned to satisfy the general duty to prevent catastrophic climate change. Thus, we should temporalize this duty accordingly.

I leave aside here the general question of whether earlier generations are always better suited to fulfill the general precautionary duty to prevent political catastrophe. It suffices that in the case of climate change this appears true. We might stipulate, however, that whenever

[127] For discussion of this point, see chapter 1.

placing (even disproportionately heavy) burdens on earlier generations provides the only or best (i.e., most effective and least costly) means for preventing credible threats of future catastrophe, doing so is justified (within certain limits[128]). A negative rate best captures this temporalization of our collectively held precautionary duties because it places a premium on avoided harms or damages in the future. This is appropriate, again, because the future faces grave risks that can only (or at least best) be prevented by present sacrifice.

6.2. Objections

6.2.1. Why Favor the Future over the Present?

One might grant that agents have a duty to prevent catastrophic climate change, and even that temporalizing duties as I have suggested makes sense, but worry that a negative rate is an overly extreme way of giving content to these claims. Indeed, even if adopting a negative prevents suffering in the future, it may also seriously depress economic growth today, harming current people. Why should we assume this is an acceptable trade-off?

The first response to this is to note that a negative PTP rate does not itself entail a negative discount rate. Remember that the PTP rate is just one part of the full discounting equation. Should the other variables turn out to be positive and sufficiently great, then the overall discount rate could be zero or positive regardless of the PTP rate.

Yet, even if adopting a negative PTP rate meant the overall discount rate would be negative, it is important to remember that the discount rate does not represent the whole of justice. It is simply a tool meant to help us address problems surrounding the intergenerational

[128] In chapter 2, the limits I endorse are given by the "reasonableness proviso," which holds that justice cannot impose a burden on any agent or group that itself causes extreme material scarcity.

distribution of costs and benefits. Chapters 2 and 4 stress precisely this point: once we accept that the current generation has a duty to address climate change, it is then imperative that intra-generational burdens be fairly distributed among states and people. One way of achieving a fair distribution, discussed in chapter 4, is to anchor responsibility to consumption. Moreover, by endorsing something like the "economic justice qualifying principle,"[129] we can ensure that burdens are not allocated in such a way that the poorest people are unnecessarily deprived of the ability to satisfy their basic needs. To these points, we can add the need for international support in way of technological transfers and green infrastructure financing. Rich countries have a duty to help poor states develop in ways that reduce climate change and promote the welfare of their people. A negative rate does not detract from these ends. If anything, it gives a further (economic) reason for propagating clean energy technologies and promoting other green initiatives globally by disincentivizing dirty energy production. (A negative rate disincentivizes dirty energy production by placing a high tax on emissions.)

A final point. Throughout I have made a distinction between not helping (or not helping at the same rate) and actively harming. This distinction applies here as well. The idea that a negative discount rate would harm certain people by depressing economic growth is misleading. Even if a negative rate depresses economic growth to a significant degree—which, we must note, is an empirical question, and by no means a settled matter of fact[130]—it does not follow that those who impose the tax harm anyone. Such a tax would simply slow the rate

[129] See chapter 3.

[130] Many argue that while greenhouse-gas taxes could have bad short-term economic effects, in the long run they would spur innovation, create new jobs, lower health costs, etc. Indeed, some believe that the economic benefits and "co-benefits" (a concept I return to below) could outweigh the total financial costs of greenhouse taxes and other climate policies. For discussion, see Part II, sec. 3.

at which economic growth and prosperity benefits people.[131] This is not harm.[132] We *do* harm people, however, when we continue to serve ourselves (by, e.g., burning fossil fuels, eating meat, flying planes) at the knowing expense of others' ability to meet their basic needs. (As I argue in chapters 1 and 2, this is precisely what unmitigated climate change portends.)

6.2.2. Exactly Which Rate Is Appropriate?

At this point one might accept that a negative PTP rate is, in general, justified, but object to the fact that I have not specified an exact rate. Which rate is most appropriate: -0.5%, -1%, -5%? Furthermore, should we prefer a static rate, or one that changes over time?

It is difficult to answer these questions in the abstract. With respect to the first, my sense is that best option would be a relatively low rate, somewhere between -1% and 0%. This is speculative, however. To the extent an answer could be defensibly informed by observing behaviors in the world, the best frame of reference would probably be that of insurance, or its equivalent in finance—especially insurance (or insurance-like investments) undertaken by temporally unbounded agents like states or corporations. The relevant question here would be, to what extent do these entities devote resources to insuring themselves against grave future damage or collapse? Yet, this is not a perfect proxy. For one, the motivation for these actors to seek insurance is likely to be more prudential than moral. Moreover, the risks they hedge against are not likely to be as systemic as those presented by climate change.

[131] We note here that while the poor (especially in developing countries) certainly benefit from greater economic growth, the rich typically gain more.

[132] At least not on the conception of harm I defend in chapter 2, which again holds that a person, P, is harmed whenever the unnecessary actions or inexcusable omissions of an agent or group causes or allows P to be in a situation of extreme material scarcity, such that P can only meet his or her basic needs by denying others the ability to do the same.

Nonetheless, as we shall see below,[133] mitigation efforts have important structural similarities to insurance, and exploiting this similarity may provide insight into an appropriate rate.

As regards the second question—should we prefer a static or variable rate?—insurance and its parallel in finance may again offer a clue. Bob Litterman argues that, for situations in which a negative rate is appropriate, it should ease toward zero "as the problem diminishes and uncertainty is resolved."[134] In other words, a variable rate schedule is appropriate: we start with a high negative rate (perhaps around -1%), and thus a high emissions price, and allow it to approach zero as the risk of catastrophe diminishes and/or as we know more about the magnitude of future climate-related damages. So long as damages could be very high (or catastrophic), it makes sense to price emissions comparably high—via a negative rate—and thus incentivize mitigation. (In this sense, mitigation serves a kind of insurance function, by diminishing the threat of serious future loss and damage.[135])

In short, then, adopting a negative PTP rate may be appropriate to the extent that doing helps to prevent catastrophic climate change from coming to bear. So long as this policy is applied consistently over time (i.e., so long as we temporalize our precautionary duties in this way whenever we are faced with similar threats of future catastrophe), it does not violate intergenerational equality or impartiality. Of course, I have not established definitively that a negative rate is appropriate; or, if it is, what rate in particular we should adopt. I have merely

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[133] Part II, sec. 2.

[134] Litterman 2013, 42. Note that while Litterman here is speaking of the discount rate as a whole, this basic view could apply to the PTP rate (i.e., delta) in particular, which, following Stern (2007), might be taken to reflect some measure of risk or uncertainty. On this point, see also Heath 2016, 7; cf. Gardiner 2011, 277, and Jamieson 2015, 122.

[135] It is unlike insurance, however, in that it is not meant to compensate us if the loss and damage come to bear. The point is just that mitigation offers a way of attenuating future risk.

highlighted reasons why we might think a negative rate plausible, which might help guide future work on this question.

7. Conclusion

As we have seen in Part I, the pure-time preference question—i.e., "whether the mere fact that a particular cost or benefit is to be experienced in the future provides sufficient ground for treating its present value as less than its eventual value"[136]—is far more complex than most philosophers allow. Until recently, the debate has been confined to those who endorse a positive PTP rate on purely descriptive grounds and those who endorse a zero rate for moral reasons. The former attempts to avoid paternalism, the latter arbitrary discrimination. Both of these views are flawed, however. *Pace* descriptivists, how people ordinarily act does not always correlate to how they should act as a matter of moral principle. This is especially true with respect to climate change. Observing behavior in the realm of personal savings and investments tells us little about whether we can justifiably count future costs and benefits *experienced by other people* as less valuable than those we experience today.

Those who reject time preferencing, on the other hand, appear to be mistaken in thinking only a zero rate is compatible with intergenerational equality and impartiality. So long as a future-oriented discount policy remains consistent over time, it does not violate any egalitarian precepts. This becomes clear when we abandon a strong spatial model of time and adopt something like Heath's conveyor-belt conception: people can be treated differently at different temporal stages along the conveyor belt, so long as they are treated the same as everyone else over the full course of their ride.

[136] "The most difficult question that arises concerns whether the social discount rate should incorporate some form of time preference." (Heath 2016, 3)

Heath is wrong, however, to think that this supports a positive PTP rate—at least today. He neglects the fact that forms of material consumption change over time, and that some forms are far more harmful to the interests of future persons than others. Present modes of consumption, which revolve around fossil fuels, animal products, deforestation, and pollution are a clear example. If we want an intergenerationally consistent policy, we cannot consider a numerical discount rate in isolation from its effects. And, at minimum, we must avoid adopting rates that will seriously harm (or violate the rights of) certain generations.

Granting this, however, Heath's essential claim still stands: a non-zero discounting policy is compatible with intergenerational equality and impartiality so long as it remains consistent over time. This, along with Heath's institutional morality argument, may be taken to support a negative PTP rate. Specifically, I argue that each generation should adopt a negative PTP rate if doing so provides the best means for satisfying the general duty to prevent scientifically plausible, reasonably likely threats of future catastrophe. This appears to be the case with respect to climate change. Thus, privileging the future at the expense of the preset seems justified today, at least with respect to those forms of consumption and production that pertain to climate change.

PART II: ALTERNATIVE ARGUMENTS FOR DISCOUNTING

1. Introduction

This part of the chapter considers two additional arguments for discounting future costs, neither of which presupposes time preferencing[137]: the opportunity-cost argument and the growth-discounting argument. I contend that both arguments fail to justify a positive social discount rate. Moreover, I show how, with reasonable revisions, both arguments could support a negative rate. As in Part I, my primary aim here is to identify flaws in the prevailing arguments for a positive rate and demonstrate the plausibility of a negative discount rate, which has been largely overlooked.

2. The Opportunity Cost Argument

One of the most common arguments for positive discounting in the recent literature concerns opportunity costs.[138] Roughly, the opportunity-cost argument (OCA) holds that whenever a society is tasked with choosing between projects meant to generate future benefits, it ought to choose the one with the highest return rate. On this view, a society should invest in climate-change mitigation *if and only if* the benefits this yields exceeds those of other investments. To act otherwise, i.e., to choose "any project that has a lower rate of return than

[137] For clarity, we can suppose throughout Part II that the pure-time preference rate—represented by delta in the Ramsey equation—is equal to zero.

[138] See, e.g., Parfit 1984, 482-3; Posner and Weisbach 2010, chap. 7; Caney 2014, 331*ff*; Mendelsohn 2008; Meyer and Roser 2012.

the market rate of return[,] throws away resources."[139] Importantly, the "thrown away" resources are only potential ones—viz., the loss is not one of extraneous debits in the societal ledger, but one of foregone gains. We ordinarily refer to "losses" from suboptimal investments as "opportunity costs." As each society has limited resources, there is a strong incentive to avoid these costs, whenever possible.

In the context of climate change, the OCA takes the following form:

(a) Mitigation is one kind of future-oriented investment: every dollar spent on mitigation today yields some benefit in the future.

(b) Other investments are available, with different rates of return.

(c) Current generations have a duty to leave future ones some kind of financial legacy or endowment.

(d) It is wrong to leave future generations a lesser endowment when a greater one is possible at no additional expense.

Thus,

(e) Current generations should devote resources to mitigation if and only if mitigation has the highest return rate of all possible future-oriented investments.

Accepting the OCA is compatible with regarding future persons or consumption as equally valuable to current persons or consumption. In other words, the OCA is compatible with a zero pure-time preference rate.[140] Moreover, the OCA does not require potentially tenuous

[139] Posner and Weisbach, 159. As Posner and Weisbach explain elsewhere (p. 146), the market rate of return is "the rate of return on capital investments broadly construed"—i.e., the rate that one could expect to receive on stock market investments.

[140] That said, many proponents of the opportunity cost argument endorse positive time preferencing. On this point, see Meyer and Roser 2012.

assumptions about future economic growth (represented by gamma, γ, in the discounting equation).[141] Whether or not future people are richer than we are now, the OCA simply advises selecting whichever investments are most cost-effective.

Minimizing opportunity costs is clearly appealing for conscientious law-makers. I argue, however, that the OCA does not justify a positive social discount rate. Rather, given certain plausible conditions, I argue that the OCA may in fact support a negative rate.

2.1. The OCA Ignores Insurance Benefits

The OCA has several problems. The first is that the narrow focus on market return rates misses another relevant criterion: risk. To explain, consider premises (a) and (b) above, which together hold that climate mitigation is just one investment among others. This requires explanation: why is it appropriate to conceive of mitigation on the model of savings or investments? The most common response is that, as with saving or investing, the objective of mitigating climate change is to generate future benefits—i.e., to reduce the harm that climate change will cause future people.[142] In this sense, like other investments, mitigation has a rate of return. Determining this rate requires ascertaining the ratio of benefits that mitigation will generate relative to the costs it will incur. If, e.g., spending $1 on mitigation today yields $4.38 in benefits fifty years from today, then the implied interest rate of the initial investment is about 3%.

Once we determine mitigation's return rate, we can compare it to other investment options. According to Posner and Weisbach, in doing this, we "should ensure that our decision on how much to invest in climate change abatement is efficient…[compared to other]

[141] Caney 2014, 331. I examine this argument for discounting in the following section.

[142] I challenge this view above (Part I, section 5) and will again below (section 3).

methods of redistribution across generations."[143] In other words, we should only pursue climate mitigation *if* it has the highest (implied) return rate; otherwise, we would be foregoing potential gains or cost savings,[144] which is to say we would be incurring opportunity costs. The stock market typically provides the highest return rates on investments. Thus, investing in projects—including "climate-change abatement" [145]—with return rates below the market rate would be an inefficient use of resources. From this, Posner and Weisbach conclude that "discounting at the market rate of return is appropriate and ethically justified."[146]

It is helpful to explain briefly why Posner and Weisbach are able to conflate discount rates and interest rates (or rates of return on investments). This is common in the literature because of the close mathematical and conceptual relationship between accumulating (compound) interest and discounting. An example helps to clarify. Imagine that a bank in need of liquidity asks a wealthy account-holder, Melissa, how much she would be willing to deposit today if they could offer her $1,000,000 in twenty years. Suppose Melissa is only willing to deposit $610,280. In that case, Melissa's offer has an implied discount rate of approximately 2.5%: i.e., her response suggests that a $1,000,000 payout in twenty years is only worth $610,280 for her in foregone present consumption. We can make the same point in terms of interest rates. If the bank accepts Melissa's offer, the interest rate (or rate of return) it provides will equal the same: about 2.5%. In short, discount rates and (compound) interest rates both signify the present value of future benefits. Moreover, return rates imply discount rates, for

[143] Posner and Weisbach, 145.

[144] If the aim is to maximize future benefits, then opportunity costs pertain to foregone gains. Alternatively, if the aim is to minimize present costs, then opportunity costs pertain to foregone savings.

[145] Posner and Weisbach, 145.

[146] Posner and Weisbach, 145.

whenever either increases, the present value of future benefits decrease, and vice versa. So, for example, saying that, at a *discount* rate of 5%, the present value of $1,000,000 in fifty years from the present is $87,204, is equivalent to saying that the future value of $87,204 at an *interest* rate of 5% is $1,000,000. In short, whenever an agent adopts a low discount rate or invests at a low interest rate, that agent (in effect) places a high present value on the acquisition of future benefits.

Investing (or discounting) at a low rate is not itself inefficient or irrational. But it becomes inefficient and irrational, according to the OCA, if an agent invests at a low (discount/interest) rate when other options are available with higher rates, since this needlessly results in lesser gains. Thus, the OCA holds that a given state or society should match its discount rate to the highest on-offer investment rates—which, again, are typically those we can find in the stock market.

A major problem with this argument is that it cannot explain why so many investment portfolios include treasury bonds, which have return rates of only 1 to 2%—viz., rates far below the market average, which hovers around 7%.[147] From the OCA's perspective, buying treasury bonds seems incontrovertibly irrational: every dollar spent on these comes at the cost of a higher-yielding market investment. Why, then, is purchasing treasury bonds common practice—not just among ordinary people but financial experts?[148]

A key reason is that, for most, the return rate is not the only relevant consideration for selecting between investments, as the OCA suggests. Another important factor is an investment option's "beta." In finance, the beta is a measure of volatility and correlativity

[147] Wagner and Weitzman, 71.

[148] This question is commonly referred to as the "equity premium puzzle." For discussion, see Mehra 2008, cited in Wagner and Weitzman, 190.

between the returns on a particular investment and the returns of the market in general.[149] Roughly speaking, a beta of 1 indicates that an investment moves with the market, such that when the market does well, the investment does proportionately well, and vice versa. High-beta (>1) investments are strongly correlated with the market, but more volatile: they have higher-than-market returns in "up" markets, and greater-than-market losses in "down" markets. Low beta (<1) investments suggest a weak link to market performance and low volatility: an investment with a beta of, say, 0.62 is expected to underperform market-rate investments by 38% when the market rallies, and outperform market-rate investments by 38% when the market drops.[150]

A treasury bond purchase is perhaps the most common example of a low-beta investment.[151] By paying out in bad economic times (as well as good), treasury bonds offer a kind of insurance against economic catastrophes, like the various "black" days of market failure over the past 150 years.[152] These insurance benefits add considerable value[153] to low-beta investments, especially for risk-averse agents.

Economists Gernot Wagner and Martin Weitzman make a direct analogy between low-beta investments and climate mitigation:

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[149] Wagner and Weitzman, 71.

[150] Investopedia.

[151] Other common examples of low-beta investments are utilities stocks and certain (long-established, highly profitable) corporate bonds.

[152] For instance, Black Monday in October 1987, Black Friday in September 1896, or the Black Week in October 2008 (Wagner and Weitzman, 72).

[153] The value here being one of marginal utility: investment returns matter more when the market is doing poorly, which is what low-beta investments offer.

> Potentially catastrophic climate events demand a 'risk premium.' The higher the chance of these catastrophes, the more we ought to seek out the climate-equivalent of risk-free government bonds: avoiding carbon emission in the first place.[154]

Just as we value low-yield treasury bonds for insulating us against potential future losses, so too might we value mitigation investments for providing protection against future climate harm. In both cases, insurance benefits compensate for sub-market "yields" (or lower discount/interest rates). [155] If the insurance benefits are great enough, the rates may be very low. In fact, as Wagner and Weitzman explain, "[s]tandard asset pricing models"—including the Capital Asset Pricing Model developed by Goldman Sachs's former risk-management director, Bob Litterman—"value [low-beta] investments by assigning [them] a low, sometimes even *negative* discount rate."[156] A negative rate becomes acceptable whenever there is a credible risk of serious future losses that an investment can prevent or attenuate. This is highly relevant to climate change. Investing strongly in mitigation makes sense, on this view, because it provides the best kind of insurance we can obtain against catastrophic climate change.

Chapters 1 and 2 outline the catastrophic potential of climate change. Whether the insurance benefits mitigation provides are great enough to justify a negative discount rate is, however, an empirical question that I cannot settle here.[157] For present purposes, the key point

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[154] Wagner and Weitzman, 73. Other economists stress this point as well, in speaking of a "climate beta." See, e.g., Sandsmark and Vennemo 2007; cited in Wagner and Weitzman, 190.

[155] Litterman, 42.

[156] Emphasis in original; Wagner and Weitzman, 73. See also Litterman, 42.

[157] To determine whether climate mitigation warrants a low-positive, zero, or negative discount rate, we need a compelling range of estimates outlining the likelihood, extent, and timing of the damages climate change may cause. We also need a clearer picture of how

is that standard defenses of the OCA in the climate justice literature, including Posner and Weisbach's, overlook insurance benefits, and thus fail to register when low-yield, low-beta investments (like treasury bonds or, perhaps, climate mitigation) could be a rational use of scarce resources. Once we take these insurance benefits into account, we have strong reason to doubt that the social discount rate should equal the market return rate on investments.

2.2. The Problem with Maximizing Logic

Notably, nothing I have said so far calls the OCA's basic logic into question—I have simply expanded the range of relevant factors for evaluating potential investments to include risk (or insurance benefits). Yet, there are deeper concerns we might have about the OCA. Suppose for instance that the precise insurance benefits associated with climate mitigation could be determined and agreed upon, and that market investments still provide the most cost-effective means for accruing benefits in future generations. Putting this in light of premises (c) and (d)—which stipulate that each generation should pass on an endowment to the next, which, costs being equal, should be as large as possible—the OCA would instruct us not to mitigate until higher yielding market investment opportunities are exhausted.[158]

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damage scenarios would affect economic growth. We would then have to weigh these projections against the probable costs of mitigation and determine under what circumstances the "return" would be sufficient to justify a given level of investment. These are technical questions, and ones I am not qualified to engage. That said, many experts have examined the evidence and argued that a negative rate *may* be justified (Litterman 2013; Wagner and Weitzman; Fleurbaey and Zuber 2013; cf. Pindyck 2013). Yet, given the variability of climate science and economic damage models, few express confidence about this.

[158] Posner and Weisbach, 162, 163.

In other words, premises (c) and (d) make a kind of maximizing logic central to our deliberations about intergenerational endowments. This logic does not apply at the level of ends—that is, the OCA does not hold that each generation ought to leave as much as possible to future ones, as that would be far too strenuous a goal.[159] Rather, the OCA applies only at the level of means, stipulating that each generation ought to select the highest-yield means for delivering whatever legacy is appropriate. Thus, the question of how much we ought to set aside for future generations is kept distinct from the question of which mechanism we should use to transfer that endowment onto them. (The former, more fundamental question about what we owe to the future must be determined independently and in advance.[160])

While the idea that we should select the highest-yield vehicle for any given investment makes sense as a general strategy, it seems less plausible as a theory of intergenerational obligation. It seems far more natural to define our intergenerational duties against a threshold of harm or rights.[161] Doing this, however, alters the secondary questions (concerning means) that arise. For instance, if a key part of what we owe to future generations is the prevention of unnecessary harm, then determining whether climate mitigation has a higher or lower return rate than market investments is irrelevant. A more pertinent question would be: which actions or investments most effectively secure future generations against said harm? On this, we would

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[159] The idea that each generation must maximize the amount it sets aside quickly leads to absurd conclusions, at least if we grant that every dollar invested will grow at a positive rate. This is related to Koopmans' time-horizon problem, discussed above (Part I, section 4.1).

[160] This feature of the OCA is implicit in Posner and Weisbach's account, though they do not make it very clear or consider its implications. See, e.g., Posner and Weisbach, 161-2, 165-6.

[161] Meyer and Roser 2009, 229; Caney 2009, 175, and 2014, 330. Or, following Brian Barry (1999), in terms of equality of opportunity. For discussion of this point, see chapter 2.

be guided by beta scores before interest rates. This is not to say that considerations of return rates or cost-effectiveness do not factor in at all—just that they are subordinated to efficacy in preventing harm. Thus, we still might take cost-effectiveness into account when determining which of several harm-avoidance policies to prioritize—e.g., enhancing carbon sinks, reducing animal agriculture, or greening energy infrastructure. But, crucially, taking this into account would not justify setting the discount rate equal to the market rate of return—or any rate. Rather, on this view of intergenerational justice, the discount rate we select would have to be justified on alternative grounds—e.g., as a way of capturing insurance benefits.[162]

One might object to this conclusion on the grounds that mitigation is not the only way to protect future generations from unnecessary harm, preserve their rights, or maintain some other threshold. Indeed, high-yield investments could generate significant wealth in the future, which could help future people adapt to climate change or compensate them for unavoidable losses.[163]

For this objection to succeed, we must have a compelling estimate of the potential damages caused by delaying mitigation efforts. Otherwise, we cannot be certain that the future wealth generated by present investments will provide returns that exceed the costs of adaptation and compensation. Based on what we know now, it appears that failing to mitigate could result major economic losses, extreme scarcity, and political instability—changes that

[162] For generations—unlike ours—that do not live under the shadow of grave existential risk, questions about appropriate endowment size or investment vehicles may be exhaustive of intergenerational justice. But in all cases, the avoidance of harm must take priority over the conferral of benefits.

[163] Versions of this claim have been advanced by a number of economists—most notably, Bjorn Lomborg (2001 and 2007). For discussion, see, e.g., Gardiner 2011, 284*ff*; Caney 2014, 327*ff*.

would very likely overwhelm our adaptive capacities. The objection is thus epistemically vulnerable. Given that the path it recommends involves considerable risk, it is up to proponents of this view to defend it.

2.3. The Fungibility Assumption

Even if accurate projections could be made, we might still question the objection's implicit assumption of fungibility—i.e., that all goods can be exchanged in relation to a monetary equivalent. Some losses are irreversible—once gone, they are gone for good. What price can be put on the extinction of a species, the desolation of a natural habitat, or the loss of a distinctive human culture? Climate change threatens all of this.

We might also believe that each human life is a kind of incommensurable good, the loss of which cannot be compensated for financially.[164] Richard Revesz, for instance, argues that discounting is only appropriate with respect to goods that can be invested, which excludes human lives.[165] Thus, insofar as discounting climate change *in effect* means discounting human lives and health in the future, we ought to abstain. And, indeed, it does appear that unmitigated climate change threatens this. One recent article argues that relatively modest mitigation efforts today would likely prevent between 300,000 and 700,000 premature deaths in the year 2030 alone.[166] And Stern argues that, with only 2° to 3°C of warming, by 2100, "an additional

[164] As I address this issue in chapter 2, I focus here only on the example of human lives. In doing this, I do not mean to imply that individual non-human animal lives lack a similar kind value. Indeed, I believe the opposite is true (particularly among cetaceans, elephants, and simians). I set this point aside here, however.

[165] Revesz 1999, cited in Posner and Weisbach 166.

[166] West et al. 2013, 885.

165,000 – 250,000 children could die compared with a world without climate change" every year, in South Asia and sub-Saharan Africa alone.[167]

Posner and Weisbach respond to Revesz's objection by stressing that discount rates only apply to money. Insofar as human lives enter the picture, they do so in the form of "statistical risks of mortality," which can be converted into "monetary equivalents." Thus, they argue:

> If a life today and a life in two hundred years are both "worth" the same amount in terms of money, we need to discount the dollars allocated to the future life because money put aside for the future grows.[168]

This response is specious, however. Revesz's complaint does not concern whether we should be willing to spend the same amount to save a person living today as we would someone living in the future. Rather, what I take Revesz to be arguing is that, given a choice between (a) spending a given amount, *X*, to mitigate climate change and thereby prevent unnecessary death and suffering in the future, or (b) spending *X* to purchase market investments that make the future comparatively wealthier but unable to prevent unnecessary death and suffering, we should prefer (a). This is because human lives have a value that cannot be expressed in purely monetary terms, and because no amount of future wealth can sufficiently compensate those who will experience preventable suffering or premature death. In other words, if we can enrich the future in more than one way—if more than one investment option is available—we should not select ones that result unnecessarily in incompensable loss, even if those options maximize wealth (or minimize present cost). This is not about how much we should be willing to spend

[167] Stern 2007, 55.

[168] Posner and Weisbach, 166.

to save lives, as Posner and Weisbach suggest, but about the impermissibility of ending lives for the sake of amassing wealth at a low cost.

This concern is made graver when we consider the catastrophic potential of climate change. In chapters 1 and 2, I argue that climate change may result in a situation in which the only way one can meet one's own needs is by denying others the ability to do the same. Once we enter into this state of extreme scarcity, it becomes impossible to realize or sustain relations and principles of justice. Without this, political conflict and instability become inevitable. Many human lives will be lost. Many more will experience tremendous suffering. Simply no amount of monetary wealth can compensate for such catastrophic and irreversible harms.

2.4. Summary

In short, there are strong reasons to doubt that the OCA can support a positive discount rate—particularly one anchored to the market return rate for investments. For one, the OCA focuses too narrowly on return rates, when other investment features, including insurance benefits, are also relevant. Taking insurance benefits into account helps explain why people purchase low-yield investments, like treasury bonds, and why it would be rational to devote resources to climate mitigation. To adequately reflect these benefits, a discount or interest rate far below the market rate—perhaps even a *negative* rate—may be justified.

Yet, the OCA does not just fail to take into account all of the relevant factors. It is an argument that assumes the question of intergenerational obligation can be reduced to one about which investment vehicle will provide the highest return rate for a given (monetary) endowment. Yet, I argue that a more fundamental intergenerational obligation consists in preventing unnecessary harm or the loss of basic rights. Critics may argue that selecting the highest-yield investments available provides the best means for securing these ends. This

assumes that future loss and damage can be compensated monetarily. This assumption misses the fact that some goods are non-fungible and some losses irreversible. No amount of money can compensate for the loss of a human life, let alone for many human lives. Insofar as unmitigated climate change threatens catastrophic and irreversible harm, are focus should be on addressing this risk, not maximizing our monetary endowment to future generations. For all of these reasons, we should reject the OCA as a coherent basis for positive discounting.

3. The Growth Argument

The basic thesis of the growth discounting argument (GDA) is that favoring present over future consumption is justified because future people will likely be wealthier and thus additional consumption will matter less to them. This is an argument about declining marginal utility. It bears on climate change because investing in mitigation requires sacrificing current consumption to bring about future benefits (or to reduce future costs). Thus, William Nordhaus—one of the GDA's main proponents—argues that current generations "might well feel that it is appropriate for later, richer generations to pay a larger fraction of greenhouse gas (GHG) control costs, just as high-income people pay a larger fraction of their income in income taxes."[169] As this claim shows, the GDA contains an empirical supposition and an ethical claim, both of which figure in the Ramsey equation.

The empirical supposition is reflected by gamma (γ), which, as I noted earlier, represents the rate of aggregate consumption growth per capita. In other words, gamma is an estimate of future economic growth. Although the value of gamma varies depending on the

[169] Nordhaus 1997, 317.

economist, there is broad consensus that the value should be positive, and most use values ranging between about 1% and 3%. (I consider whether this is well motivated below.)

The basic ethical claim of the GDA is expressed by eta (η), which formally represents the elasticity of the social marginal utility of consumption, but which is often regarded as a measure of aversion to inequality.[170] As Dale Jamieson explains, "a positive *eta* implies that, for a given increment of consumption, more utility can be produced by allocating it to those who consume less."[171] Because the value selected for eta reflects a value judgment, it remains controversial.[172] Nevertheless, most economists set eta equal to 1 or 2.[173] If the value is positive, as eta increases, aversion to inequality also increases (exponentially).[174] More concretely, William Cline argues that setting eta equal to 2 or 3 would entail an income tax rate "on the moderately rich, such as the president of a top university, [of] about 90 percent, whereas a value of 1.5 translates to a rate of about 40 percent."[175] Recall that, in the discounting equation, eta multiplies gamma. Thus, assuming a reasonable aversion to inequality (i.e., an eta between 1 and 2), and a positive economic growth forecast (i.e., a gamma above 0%), the result will be a positive social discount rate.[176]

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[170] Nordhaus 2008, 60 (cited in Gardiner 2011, 279); cf. Heath 2016.

[171] Jamieson 2015, 120.

[172] Stern 2010, 53. For discussion, see Gardiner 2011, 279-280; Jamieson 2015, 119*ff*.

[173] Nordhaus and Boyer 2000 and Stern 2007 use 1; Nordhaus 2009 uses 2. This is a massive change. For discussion, see Gardiner 2011, 279-280; Jamieson 2015, 119*ff*; Dietz et al. 2009. Stern, William Cline, Simon Dietz, and others note that most societies adopt an eta closer to 1 or 1.5 (Stern 2010, 53-4; Dietz et al. 2009; Cline 2008.)

[174] Jamieson 2015, 120.

[175] Cline 2008; cited in Jamieson 2015, 119.

[176] As noted earlier, the GDA does not presuppose any particular value for delta (δ), the pure-time preference rate. Thus, for ease of analysis, we can simply assume a delta of zero.

In this section I object to some of the major assumptions underlying growth discounting, and reject the claim that the GDA supports a positive social discount rate. I also raise the possibility that the GDA supports a negative discount rate. To facilitate analysis, I begin with a formal statement of the GDA, as it is normally presented[177]:

(a) Mitigating climate change imposes costs on current people for the sake of future benefits.[178]

(b) Future people are likely to be wealthier than current people.

(c) It is unjust to impose costs on poorer people for the benefit of richer ones.

Thus,

(d) all else being equal, requiring current people to expend resources mitigating climate change, which will primarily benefit future people, is unjust.

I argue that premises (a) and (b) are highly suspect. Moreover, I claim that (c) provides an incomplete picture of intergenerational justice, and that, even on its own terms, it does not support a positive discount rate. To the extent any of these premises fail, the case for growth discounting also fails.

3.1. The Temporal Distribution of Climate Action's Costs and Benefits

Many believe that the most severe effects of climate change will not occur until after 2100 (unless, again, strong mitigation efforts are undertaken). Hence the first premise, which holds that the costs of climate action will fall on the shoulders of current generations, while the benefits will be realized almost entirely in the future.

[177] This partially follows Caney 2009, 170.

[178] Of course, above, I have already refuted the idea that mitigation is about benefits rather than avoiding harm. I set this point aside in this section, however, to focus on other issues.

This assumption is often and uncritically reproduced on both sides of the discounting debate.[179] Posner and Weisbach, for instance, claim that "[i]f the world cuts emissions immediately, the beneficiaries of its action will be people living decades from now, not people living today."[180] Similarly, Simon Caney asks, "if [future people] enjoy the benefits [of mitigating climate change] should they not pay for some of the cost and sacrifice involved in the safe creation of those benefits?"[181] Joseph Heath offers another example: "While some action must be taken in the near term in order to avoid a harmful rise in global temperatures, the major benefits of any carbon abatement policy adopted will be realized only in about a century."[182] This assumption—that future generations will be the primary beneficiaries of present climate action—motivates the popular argument that current generations would be justified in shifting the financial burdens of immediate climate action onto future generations.[183]

I have already challenged the idea that mitigation aims primarily at benefitting future people, rather than sparing them harm. I set this point aside here. What I am interested in

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[179] See, e.g., Broome 1992, 72; Schelling 1995, 401; Broome 2012, chap. 3; Rendall 2011; Meyer and Roser 2012, 179; Nordhaus 2008, 105 ("inertia").

[180] Posner and Weisbach, 145.

[181] Caney 2014, 336

[182] Heath 2016, 2, 27.

[183] Broome 2012, Rendall 2011, Caney 2014. NB: Caney (2014) distinguishes between the "delaying action" and "deferring costs" versions of the GDA, and concludes that the former is indefensible, but that the latter—which stipulates that current generations undertake climate action but transfer the costs of that action onto future generations—may be morally permissible (or even required). I reject the "deferring costs" argument in chapter 2, and identify further reasons to doubt it below.

challenging, instead, is the idea that the benefits of mitigation will largely or entirely fall to future people.

What shape the distribution of costs and benefits will take over time is an empirical question. To answer it, we must ensure that all the relevant costs and benefits associated with climate mitigation are accounted for. Many climate ethicists and economists neglect this point.[184] More specifically, they do not consider the significant "co-benefits" present generations could enjoy immediately by undertaking stringent mitigation efforts.

Co-benefits arise chiefly from reducing emissions. They can be estimated with a much higher degree of certainty and geographical precision than the "long-term distributed global benefits of slowing climate change."[185] In other words, we can be much more confident about the extent and impact of immediate co-benefits than we can be about the long-term effects of climate mitigation. It is therefore surprising that co-benefits are often omitted in cost-benefit analyses of climate-change.

There is a wide range of co-benefits associated with climate mitigation, but perhaps the most widely cited are the health gains that would come from reduced air pollution.[186] West et al. estimate that stabilizing CO_2e levels at a relatively high 525 ppm[187] would prevent

[184] There are of course exceptions to this. Among economists, Stern is a clear example (see, e.g., Stern 2007, 247; Stern 2010, 48). There are also ethicists who have suggested that the benefits of climate action may outweigh the costs, but have not pursued the point.

[185] West et al. 2013, 888.

[186] IPCC, AR5, WG3, p.233.

[187] This is the IPCC's "Representative Concentration Pathway" (RCP) 4.5. Disconcertingly, if RCP 4.5 is followed, the median estimate of temperature increases by 2100 exceeds 4°C.

hundreds of thousands of deaths a year, compared to no climate policy.[188] They estimate further that the monetized global average co-benefits of avoided mortality "are US$50–380 per tonne of CO_2 for the worldwide average," or "US$30–600 for the US and Western Europe, [and] US$70–840 for China."[189] An OECD report reaches similar conclusions: under a 50% GHG emissions reduction scenario, health-related "co-benefits could range between 0.7% of GDP in the European Union to 4.5% in China in 2050."[190] (Recall that effective mitigation efforts would likely cost only about 1% of global GDP per year.) In a 2014 report detailing the benefits of the US's relatively modest "Clean Power Plan," White House researchers claim:

> From the soot and smog reductions alone, for every dollar invested…, American families will see up to $7 in health benefits. In the first year that these standards go into effect, up to 100,000 asthma attacks and up to 2,100 heart attacks will be prevented. … The benefits increase each year from there.[191]

The report predicts that, by 2030, the Clean Power Plan will prevent 2,700 to 6,600 premature deaths per year in the US alone.

Mitigation offers many non-health co-benefits, as well. Stern, for instance, notes that: "Cleaner energy can provide greater energy security and energy access. It can give reductions

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[188] NB: West et al. do not consider the effects on people under 30 (including effects on children and neonatal care); nor do they examine the effects of reduced pollutants coming from wildfires (which occur more frequently as temperatures rise); nor the effects of indoor air pollution (which is greatest in developing states). Thus, health co-benefits may be considerably higher than they report.

[189] West et al. 2013, p. 886. The range includes differences between the years in their analysis (2030, 2050, and 2100) and the differences between high and low "values of a statistical life" (or VSL).

[190] Pearce et al., 7.

[191] The White House 2014, 5

in local air pollution… Combating deforestation can protect watersheds, sustain biodiversity, and promote local livelihoods." An OECD report also emphasizes the potential cost-saving "synergies between climate change and local air pollution" policies.[192] Recent research on this topic suggests that, by 2030, global mitigation efforts could save "US$100–600 billion per year in air pollution control and energy security expenditures."[193] Moreover, climate-mitigation policies and regulations could spur innovation and efficiency gains.[194] Such cost-reductions and innovations would likely considerably reduce the costs associated with mitigation, conceivably within the range that any remaining costs would be outweighed by health co-benefits alone.

Notably, co-benefits would be greatest in developing countries. The monetized health benefits (of avoided mortality and lower rates of sickness) in east Asia, for instance, may be up to 10 to 70 times greater than the median costs of mitigation.[195] In this sense, global mitigation is economically progressive. This is so even without accounting for the avoided future harm of climate change, which will likely disproportionately impact poor and developing countries.

In short, in many cases the co-benefits we are aware of and can estimate may cover all or nearly all of the present costs of immediate mitigation. If this is correct—if the present benefits equal or outweigh the present costs—then the question of growth discounting is

[192] Pearce et al., 6.

[193] McCollum et al. 2013; cited in West et al. 2013.

[194] Stern 2007, 273.

[195] West et al. 2013, 886.

moot. The benefits and avoided harm that accrue for later generations would simply count as desirable positive externalities.

3.2. Will Future Generations Be Wealthier?

As noted above, most economists agree, and ethicists accept, that future generations will be wealthier than we are now. There are good reasons for thinking this: the last century has seen extensive and consistent gains in worker productivity and technological advances. Nevertheless, we should be wary of regarding this as a matter of fact, for several reasons.

First, quite apart from uncertainty about the economic effects of climate change, there are scant empirical or theoretical grounds for assuming that past growth will continue indefinitely over into the future—especially at any particular rate.[196] Nordhaus assumes a continued growth rate (gamma) of about 2% per annum, and Stern 1.3%.[197] Both are very optimistic figures. According to the economic historian Bradford DeLong, the economic growth rate from the beginning of human civilization (about 10,000 years ago) through 1800 was only about 0.00002% per annum.[198] Of course, since 1800, growth has been far more rapid—e.g., the US reached a peak growth-rate of about 3.5% per annum in 1950.[199] According to recent work by Robert Gordon, this great acceleration in economic growth owes to the phenomenal technological progress that occurred between 1870 and 1970. Gordon believes, however, that these post-Industrial rates are an exception, not a new rule. Indeed, he argues that growth rates will likely never reach these levels again, and will instead steadily decline,

[196] Weitzman and Gollier, 350; cited in Jamieson 2015, 118.

[197] Jamieson 2015, 118.

[198] Nordhaus 2016.

[199] Nordhaus 2016.

precisely because we have exhausted major productivity-enhancing forms of technological innovation.[200] In support of this, Gordon notes that economic productivity has halved in the last 70 years, from 2.7% over the period of 1947 to 1970 to about 1.3% over the period of 2000 to 2015.[201]

The difference between Stern's estimated 1.3% growth rate and the 0.00002% rate experienced for the great majority of human history is enormous: on the former, the economy doubles every 50 years and triples every 100; on the latter, doubling takes about 10,000 years. If growth will slow as Gordon predicts, then even if future people become wealthier than we are today, they may not be *much* wealthier.[202]

Another, even more critical concern with premise (a) is that economic-growth models standardly exclude catastrophic scenarios. The reasons for this are generally sound: calculating probabilities is virtually impossible for most potential catastrophes. Moreover, even for cases where this is not a problem, it is exceedingly difficult to determine corresponding damage estimates, which is also necessary for accommodating catastrophic scenarios in standard economic models.

With climate change, some progress has been made on these fronts. As noted in chapter 2, scientists and economists can calculate the probability of certain climate scenarios with some confidence. There is, for instance, approximately a 10% chance that average global temperature increases will exceed 6°C by 2100 if CO_2e concentration levels reach 700 ppm,

[200] Gordon 2016; for a review of this work, see Nordhaus 2016.

[201] According to Nordhaus (2016), Gordon's figures close track other estimates of the same periods.

[202] Automation and population growth may further depress growth, particularly in per-capita terms.

which is likely to occur under a business-as-usual scenario.[203] What a given temperature increase entails in terms of future damages is still a matter of debate. Yet, Gernot Wagner and Martin Weitzman argue compellingly that as temperatures rise, damages will increase exponentially (rather than linearly, as Nordhaus and others assume).[204] They also show that the costs of mitigating climate change are likely to increase exponentially the longer action is delayed.[205] If this is right, then it may well be the case that climate-related costs grow at a rate that outpaces global economic growth, resulting in proportionately far higher costs for future generations than we would face if we took action today.[206]

Another, related, problem with the assumption of future growth is that the models on which it is based typically conceive of climate-related costs as only affecting economic output. In other words, most economic models regard climate damages as charges that can be neatly subtracted from gross economic product each year.[207] Wagner and Weitzman argue, however, that climate damages could affect "output growth *rates* rather than output *levels*," in which case "the cumulative effects of damages could be much worse over time."[208] So climate change may result not just in losses to economic production, but to economic productivity—resulting in far greater total losses over time.

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[203] Wagner and Weitzman, 53.

[204] Wagner and Weitzman 57-8, 61, 63.

[205] For discussion of this point, see Part I, section 5.

[206] Others have made this point. See, e.g., Caney 2009; Rendall 2011.

[207] Wagner and Wetizman, 63. For an example of this view, see, e.g., Nordhaus 2008, 15.

[208] Wagner and Weitzman, 64. Stern (2007, 193) takes a similar view. For an interesting discussion of how the price and availability of environmental goods will affect future welfare levels, see Sterner and Persson 2008, and Summers and Zeckhauser 2008 (both cited in Jamieson 2015, 115).

In sum, there are strong reasons to doubt that future generations will be much wealthier, or at least that economic growth will outpace the growth rate of damages stemming from unmitigated climate change. And if this premise fails, so too does the GDA argument for positive discounting.

3.3. Does Mitigation Unjustly Benefit the (Future) Rich at the Expense of the (Contemporary) Poor?

There are at least two possible justifications for premise (c), which holds that it is unjust to impose costs on the poor for the benefit of the rich. We can call the first justification *the argument from utilitarianism* and the second *the ability-to-pay argument*. Both, I claim, represent problematically incomplete conceptions of intergenerational justice, and neither supports positive growth discounting (at least with respect to the intergenerational distribution of climate-related costs).

3.3.1 The Argument from Utilitarianism

Consider first the argument from utilitarianism, which is particularly relevant to discounting because its essential rationale—that of declining marginal utility—is contained within the variable eta. To see this, recall the Nordhaus quote above: "Society might well feel that it is appropriate for later, richer generations to pay a larger fraction of greenhouse gas (GHG) control costs, just as high-income people pay a larger fraction of their income in income taxes."[209] In both the inter- and intra-generational contexts, the guiding idea is the same: the same unit of consumption generates greater overall utility when consumed by those who have less relative to those who have more. Thus, Nordhaus concludes, "if average living

[209] Nordhaus 1997, 317.

standards [are] improving" over time, it is just to "discount future costs."[210] Indeed, a commitment maximizing social welfare *requires* policies that impose lower net costs on, or provide higher net benefits to, the less well-off. Climate mitigation fails this test, so the argument goes, because it imposes financial burdens on current, poorer generations to generate benefits for future, richer ones.[211] Leaving mitigation to future people is thus morally justified (and maybe even requisite).

A major problem with this argument is its view of generations as undifferentiated aggregates. Even if we grant that future generations will be wealthier overall,[212] it does not follow that everyone in the future will be better off than everyone living today. Indeed, even with high and consistent growth rates, it is unlikely that most living in poor and developing states in 50 or 100 years will have achieved the standards-of-living enjoyed by many in affluent states today.[213]

This fact may require us to adopt a very low, or even negative discount rate. To see this, consider the following three points. First, according to the U.N., approximately 70% of the world's population currently resides in "less developed regions," 13% in "least developed" countries, and 17% in "more developed regions."[214] But by 2100, the U.N. predicts that 89% will live in less developed regions, 28% in the least developed countries, and just 11% in more

[210] Nordhaus 1997, 317.

[211] Again, I set aside here arguments about separating action from costs, and deferring only the latter. For proposals along these lines, see Caney 2014, Rendall 2011. For discussion, see chapter 2.

[212] Which, as I argue above, is not clearly something we should regard as a matter of fact.

[213] Schelling 1995, 398*ff*; Fleurbaey and Zuber 2013, 585-586.

[214] United Nations 2015a.

developed regions.[215] In other words, the great majority of the world's people live in poor and developing states today, and this will be even more the case in the future. Second, those in poor and developing states are much more vulnerable to climate change, and are therefore the biggest beneficiaries of climate mitigation policies, now and in the future.[216] Finally, we can allocate the costs of climate action today so that the heaviest burdens are shouldered by the global affluent.[217]

If these conditions all hold, then immediate climate action would *better* serve economic justice, as understood by the argument from utilitarianism, because immediate action entails imposing costs on the current rich for the sake of the (more numerous) contemporary and future poor. Put another way, mitigation offers a way of transferring resources from where they are relatively less valuable (i.e., where they have lower marginal utility) to where they are more valuable (i.e., where they have greater marginal utility). Notably, this kind of transfer implies a *negative* discount rate. As Fleurbaey and Zuber explain, the "discount rate is negative when the present donor is richer than the future beneficiary."[218] In short, then, once we disaggregate generations, the argument from utilitarianism does not support a positive discount rate, but a negative one.[219]

There is another way that a concern with declining marginal utility could lead us to endorse a negative rate. As I argue in chapters 1 and 2, climate change threatens extreme and enduring material scarcity for many of the world's people (under the most extreme scenarios,

[215] United Nations 2015b.

[216] World Bank 2014; Schelling 1995.

[217] Say, in accordance with the account defended in chapter 4.

[218] Fleurbaey and Zuber 2013, 586.

[219] Other economists have made this point. See, e.g., Schelling 1995, 398*ff*. See also Fleurbaey and Zuber 2013, 585-586.

for *all* of the world's people). By extreme material scarcity, I mean any situation in which an individual is unable to meet his or her basic needs without denying others the ability to do the same. If this is right, then each additional unit of consumption would be far more valuable in the future than it would be today. Assuming some aversion to inequality (i.e., a positive eta), a credible threat of extreme future scarcity may lead us to adopt a negative discount rate.

3.3.2 The Ability-to-pay Argument

There is another argument for premise (c), given by the ability-to-pay (APP) principle. Roughly, the APP holds that the wealthy ought to pay for climate action in proportion to their wealth. Clearly, this is also vulnerable to the objection above: once we disaggregate generations, immediate climate action seems to involve imposing costs on the (contemporary and future) wealthy for the sake of less-advantaged people to come.

Setting this aside, however, we can note another problem with the APP. Even if it distributing burdens in accordance with economic capacity reflects an important part of justice, it does not reflect the whole. Indeed, most believe that contribution to a problem matters as much as (or more than) one's relative capacity to address it. Hence the polluter-pays principle (PPP), which holds that those who are responsible for causing climate change, should pay for addressing it.[220] The same logic applies intergenerationally. Indeed, it is far easier to identify lines of culpability in the intergenerational context: current generations contribute enormously, every year, to climate change, while future generations, at least right now, remain *entirely* blameless. There thus appears to be a strong prima facie case for making current

[220] I defend a version of the polluter-pays principle in the next chapter.

generations pay to fix it—assuming that this will not push them below a minimum level of material well-being.[221]

In short, the APP argument, just like the argument from utilitarianism, fails to sustain premise (c). And, as with the other premises, if premise (c) fails, so too does the growth-discounting argument for a positive rate.

3.4. Summary

This section has shown that the case for positive growth discounting is deeply fraught. There are strong reasons to doubt that future generations will be wealthier or at least that the proportional costs of climate change will be lower if climate action is delayed, which is our central concern. Even if we accept the assumption of future economic growth as a fact about aggregate development, it is nonetheless likely that the great many living in the future will be less well-off than today's rich. Moreover, the common supposition that climate mitigation only or even primarily yields future benefits appears mistaken. Substantial co-benefits will be realized immediately, which may meet or exceed the costs of effective mitigation policies. Finally, the general claim that it is unjust for poorer, current generations to sacrifice for the benefit of future, richer generations fails on closer inspection. It may be true, all else being equal, that it is wrong to require poorer people to sacrifice for the benefit of richer ones. But this, in itself, does not support a positive rate. For if we disaggregate generations and distribute climate burdens fairly among contemporaries, the same principle appears to support a *negative* discount rate. This is because immediate climate mitigation benefits the future (and contemporary poor) at the expense of today's wealthy. Even without disaggregating generations, however, economic capacity is not all that matters for justice—most agree that

[221] As noted earlier, this seems a fairly safe assumption.

those who contribute to a problem have a duty to redress it, assuming that fulfilling this duty does not undermine a minimal standard of living. As current generations—and *not* future ones—are responsible for climate change and have the means to address it, they should be responsible, at least in part, for the costs of action.

5. Conclusion

Part II of this chapter pursued two goals: first, to reveal that two of the most common arguments for a positive social discount rate fail on close inspection; and, second, to show that revising some of the fundamental assumptions underpinning these arguments opens the door for defending a negative social discount rate—a position that has been largely ignored by climate ethicists and political theorists.

The OCA fails for various reasons. For one, it adopts a maximizing logic that does not coincide with ordinary understandings of intergenerational justice. Moreover, the OCA assumes that our duties to future generations can—at least in large part—be expressed in monetary terms. Yet, this elides our concerns with protecting or passing on incommensurable goods, including biodiversity, natural beauty, and individual human lives. Climate change threatens these goods, and it is not clear that greater future wealth could adequately compensate for their loss. If this is right, then it is inappropriate to compare the effects of climate mitigation with those of market investments.

Even *if* the comparison was apt, the OCA nevertheless falls short by focusing narrowly on return rates at the exclusion of other factors giving investments value. More specifically, standard formulations of the OCA neglect the *insurance benefits* of low-beta investments, like treasury bonds and, I argue, climate mitigation. Once we account for these benefits, it becomes less clear that the social discount rate should be set equal to the market return rate on

investments, as proponents of the OCA claim. Indeed, if the insurance benefits associated with climate mitigation are great enough, a negative social discount rate would be justified.

The GDA is perhaps less flawed structurally or conceptually, but it nonetheless incorporates numerous problematic assumptions. A clear example concerns the temporal distribution of costs and benefits related to climate mitigation. As we have seen, climate mitigation does not simply amount to a transfer of wealth from poorer, current generations to richer, future ones. Rather, undertaking mitigation today promises considerable immediate (or near-future) *co-benefits*, which may outweigh related costs. If this is the case—i.e., if every dollar spent today on mitigation generated a dollar in immediate benefits—the growth discounting question would not even arise, and we could regard all future benefits as positive externalities.

Yet, even if we suppose that the standard assumption is correct—i.e., that climate mitigation imposes costs on the present primarily or exclusively for the sake of future benefits—there are other reasons to doubt that the GDA supports a positive social discount rate. For instance, it is by no means certain that future economic growth will outpace the rate of climate damages. Failing to mitigate would thus result in proportionately higher costs overall, undermining economic justice.

Moreover, future generations may not, in fact, be wealthier than we are today—or at least the global affluent today are likely to be wealthier than most people in the future. If this is right, and if (as many claim), immediately undertaken climate mitigation will disproportionately benefit—or, better put, failing to mitigate will disproportionately harm—the global poor, then the GDA would not support a positive discount rate, but a negative one. For, as Fleurbaey and Zuber explain, the "discount rate is negative when the present donor is

richer than the future beneficiary."[222] All that is needed is a defensible principle for imposing the costs of climate action on the contemporary wealthy, which comprises the focus of the next chapter.

This is not an exhaustive summary, but two points should be clear: (1) standard arguments for a positive discount rate are less sound than most believe; and (2) once we revise some of the most problematic assumptions in the discounting debate, it appears that a negative social discount rate may be appropriate, at least for economic activities related to climate change. Of course, this chapter does not provide a full defense of a negative discount rate. Rather, it only attempts to show that, under certain conditions pertinent to climate change, a negative discount rate may be warranted. Whether or not these conditions hold is a matter for empirical inquiry, which I am not qualified to undertake. But I hope to have shown that such an inquiry is worthwhile, politically and ethically. For how we price emissions, and thus how we respond to climate change, depends on the discount rate we select.

[222] Fleurbaey and Zuber 2013, 586.

4. Allocating the Burdens of Climate Action: Consumption-based Carbon Accounting and the Polluter-pays Principle

1. Introduction

That human activity is causing profound and potentially catastrophic climate change is no longer a matter of serious debate among climate scientists. By century end, average sea-level may rise as much as 2.5m (8 ft), displacing millions living on the coasts.[1] Warming will exacerbate droughts, flooding, heat waves, and soil aridification, all of which seriously threaten agriculture. Zika, dengue, malaria, cholera, and other mosquito-borne illnesses will proliferate as hotter climates expand the insect's range. Warmer winds and water portend more powerful and frequent storms, and thus increased strains on critical infrastructure.

Developing a fair and effective response to these threats is essential. Central here is the question of how to allocate the costs of climate action among states.[2] Indeed, for the last thirty years, this has been *the* question of climate politics at the international level.

[1] National Oceanic and Atmospheric Administration et al. 2017. Cf. IPCC, AR5, WG2, chap. 5, esp. 366, 368-9, which predicts 0.98m.

[2] Throughout, I assume that states are the relevant duty bearers (Page 2011, 413). For a critical discussion of who should bear climate duties, see Caney 2005.

While virtually everyone agrees that the distribution of costs should be fair, there remains serious disagreement about what constitutes fairness. This disagreement follows from a vague but critically important provision in the U.N. Framework Convention on Climate Change (or UNFCCC), which holds that states "should protect the climate system…on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities."[3] Political leaders have exploited the ambiguity here, invoking fairness every time they find a policy or treaty too stringent for themselves, or not stringent enough for others. For example, after being criticized for its less-than-ambitious emissions targets, India—the world's third largest emitter of greenhouse gases (GHGs)—argued that, (1) at least on certain metrics, Indians have contributed very little to the climate problem, and (2) even if they are responsible in a collective sense, expecting further action would be unfair, insofar as it would impede their ability to achieve critical development gains.[4] Of course, India is not the only country to advance claims like these: many poor and developing states invoke a "right to grow" or develop when pressed for greater climate action.

Wealthy, developed states likewise appeal to fairness to justify climate inaction—though their claims are clearly more duplicitous. The U.S. Senate, for instance, cited fairness

[3] United Nations Framework Convention on Climate Change 1992.

[4] Quoting directly: "Both in terms of cumulative global emissions and per capita emissions, India's contribution to the problem of climate change is limited but its actions are fair and ambitious. … Nations that are now striving to fulfill the 'right to grow' of their teeming millions cannot be made to feel guilty [about] their development agenda" (India's Intended Nationally Determined Contribution, pp. 33, 1).

as one of its reasons for refusing to ratify the Kyoto Protocol.[5] More recently, President Donald Trump invoked fairness concerns to defend withdrawing from the Paris Accord.[6]

The debate among nations closely tracks scholarly debates over fairness in the context of climate change. Although this debate is still ongoing, climate ethicists have largely converged upon three main principles:

- The polluter-pays principle (PPP): Those responsible for causing climate change should pay, in proportion to their contribution.
- The ability-to-pay principle (APP): The wealthy should pay, in proportion to their wealth.
- The beneficiary-pays principle (BPP): Those who have benefitted from activities that cause(d) climate change should pay, to the extent they have benefitted.

Of these, the PPP is widely regarded as the most intuitively plausible. It also has the strongest basis in international environmental law (as I describe in section 2). In recent years, however, scholars have subjected it to extensive criticism, for reasons I explain in section 3.

In this chapter, I attempt to resuscitate the PPP by taking into account consumption emissions—i.e., embedded in global trade flows. Although others have proposed adopting consumption-based emissions accounting, there has been no attempt to connect this change up to the PPP—or any other distributive principle. Moreover, virtually no attention has been

[5] Senate 1997.

[6] Specifically, Trump (2017) said: "The bottom line is that the Paris Accord is very unfair, at the highest level, to the United States. …I will work to ensure that America remains the world's leader on environmental issues, but under a framework that is fair and where the burdens and responsibilities are equally shared among the many nations all around the world."

paid to the ethical justifications for holding consumers, rather than producers, responsible—a point I address in section 4. Adopting a consumption-based emissions accounting method, the resultant distribution of burdens closely tracks economic capacity without resorting to problematic attributions of historical responsibility, as standard formulations of the PPP do. This change also offers a way to address emerging problems, like carbon leakage.

Before proceeding, it is helpful to explain what the "climate burdens" are that must be allocated. The literature typically elucidates two, though a third is increasingly recognized.[7] First is the duty of mitigation, which involves reducing GHG emissions *and* enhancing natural "sinks," which absorb and store or convert emissions into non-insulating chemicals. We fulfill this duty by, e.g., reducing energy usage or adopting carbon-free forms of energy production, supporting the development of green infrastructure (e.g., through technology transfers), consuming fewer animal products,[8] travelling less in motorized vehicles (especially planes), preventing deforestation, and promoting afforestation.

A second duty is that of adaptation, which involves helping people (and perhaps other animals) adjust to climate changes.[9] We fulfill this duty by, e.g., promoting access to vaccinations, constructing sea walls, and developing infrastructure (like water pumps and levees) to manage flooding and drought.[10]

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[7] In particular, since the 18th Conference of the Parties (COP 18), in 2012.

[8] Wellesley, Happer, and Froggatt 2015, vii and passim; Steinfeld et al. 2006.

[9] The IPCC defines adaptation as any "[a]djustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, AR4, WG3, 18.1.2). See Jamieson 2010, esp. 265-6.

[10] On the last point, see Eckersley 2015.

Finally, there is the duty to provide compensation for the "adverse effects of climate change that cannot, or will not, be prevented through policies of mitigation or adaption."[11] What this duty entails in practical terms remains controversial. At minimum, though, it requires the establishment of an international mechanism—like a risk-pooling insurance scheme[12] or direct-aid fund—capable of providing support to states or people affected by climate change. The Warsaw Mechanism is a first step in this direction.[13]

Most agree that all three duties are essential. Mitigation is necessary, for instance, to prevent the crossing of "nonlinear threshold points"[14]—also known as "tipping points"—"beyond which major changes occur that may be self-reinforcing and are likely to be irreversible over relevant time scales."[15] Tipping points are unpredictable and very dangerous. Some tipping points, like the release of methane in the northern hemisphere's (already thawing) permafrost, risk positive feedback cycles that could generate "runaway" global warming.[16] Given this, reducing emissions and enhancing sinks is essential. Climate change has already progressed passed the point that all harmful changes can be avoided by mitigation alone, however. Because GHGs remain in the atmosphere long after they are released, even sharp emissions cuts now will not prevent global temperatures from continuing to rise well

[11] Page 2016, 84. Specifically, policy-makers define loss as "negative impacts of climate change that are permanent" and damage "as those impacts that can be reversed" (Huq and Fenton 2013).

[12] Arrow et al. 1995, 72.

[13] James et al. 2014, 938.

[14] Gardiner 2004, 562; Caney 2010, 205.

[15] Furman et al. 2014, 20.

[16] One analysis suggests that a large-scale methane release could generate $60 trillion in damages (Wagner and Weitzman 2016, 185).

into the future.[17] Adaptation is thus also necessary to avoid grave threats to plant, animal, and human life. Yet, there are many climate changes and events that will exceed our anticipatory adaptation capacities; thus, establishing a compensation fund for losses and damages is also crucial.

Fulfilling these three duties is quite costly. On some estimates, for instance, effective mitigation alone would cost around $780 billion (in 2015 USD$) every year, for the foreseeable future.[18] Hence our original question: according to which principle(s) should we allocate climate-action burdens? A satisfactory answer must be *comprehensive*—able to cover all three action burdens effectively, now and into the future—and *fair*—sensitive to differences in states' contributions to the problem and their differing capacities to deal with it. Anything less will fall short of the demands of accountable and effective climate governance.

In their standard formulations, none of the three principles cited above satisfy both of these desiderata. Yet, I argue that by reformulating the PPP to take account of emissions embodied in global trade flows, we can get close. Remaining shortcomings, which I outline in section 5, can be overcome by supplementing the principle. The end-result is a pluralist, bi-phasic theory of distributive climate justice that is fairer and more environmentally effective than alternatives.

2. The polluter-pays principle

Many believe that those who cause harm or damage should (pay to) fix it (or compensate for any resultant suffering). Perhaps for this reason, the PPP is considered highly

[17] Caney 2010, 204-5.

[18] Stern 2007, 258-262. For similar estimates, see Stern 2010, 45; Weitzman 2007, 720; Nordhaus 2008, 90. For discussion, see Caney 2009, 182*n.*9; Page 2011, 412; Rendall 2011, 890.

intuitive, and has been a fixture of international environmental law well before climate change was recognized as a major problem.[19]

The principle first appears in the climate-change context in Principle 16 of the Rio Declaration on Environment and Development, which states: "National authorities should endeavor to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution." Notably, this formulation is (1) present-oriented,[20] and (2) focused primarily on reforming the behavior of economic actors. It calls on governments to require agents under their jurisdiction to include any negative environmental externalities in the price of their goods. This economistic formulation of the PPP is used widely. Nicholas Stern, for instance, argues that continued growth of GHG-emitting activities represents a major market failure, the main solution for which is to force agents to shoulder the social costs of their emissions by "[p]utting an appropriate price on carbon."[21] Notably, this way of formulating the PPP is present-oriented, which simply means that it is focused on *current* pollution only—on taxing the GHGs being emitted in the here and now (or at some regular interval—e.g., annually).

The present-oriented PPP is not only economically important—say, as a way of eliminating inefficiencies.[22] As a principle of liability, it also captures an important part of moral

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[19] An early example is the OECD's 1972 *Recommendation of the Council on Guiding Principles* (OECD, 12). See also, Article 130R of the Maastricht Treaty, the Commission on Global Governance, and IPCC, AR5, WG3, 217-8, 318, 1268.

[20] While the literature commonly refers to principles focusing on current emissions as "forward-looking" (e.g., Shue 1999, 534), to allay confusion, I opt instead for the term "present-oriented."

[21] Stern 2007, xviii.

[22] Broome 2012, 45*ff*.

and political duty. Morally speaking, we want agents to get what they deserve. If someone harms or endangers others, we typically believe that agent should be held accountable. And this falls to government. As John Rawls explains, making agents pay for the "full social cost of their action" is an "essential task of law and government" in a just society. Hence he defends a present-oriented PPP, pointing to "striking cases of public harms, as when industries sully and erode the natural environment." In such cases, Rawls argues, government must correct the "divergence between private and social accounting that the market fails to register."[23] In practice, this means pricing emissions in a way that reflects the harm they are causing *and* some estimate of the harm they may cause (in the form of a risk premium).[24] Such a tax would provide a "double dividend"[25]: i.e., it would curb emissions (by making them more expensive) while providing a revenue stream for financing adaptation and compensation efforts. (As I explain below, this makes the principle an attractive basis for international climate policy.)

3. The case for, and problems with, a backward-looking PPP

Despite its appeal, the present-oriented PPP has attracted trenchant criticism in recent years. Henry Shue, Eric Neumayer, Simon Caney, and others object to its neglect of historical emissions, arguing that agents most responsible for the emergence of climate change owe a debt of corrective justice to those adversely affected by it.[26] These scholars also contend that a purely present-oriented PPP unduly burdens developing states, which rely on emissions-

[23] Rawls 1999, 237.

[24] I elaborate this point below.

[25] See Caney 2010, n.31. But cf. Stern 2010, 62.

[26] Shue 1999, 534*ff.*

heavy industrialization to sustain minimal standards-of-living. For these reasons, they endorse backward-looking PPPs,[27] which allocate climate duties in proportion to cumulative (historical) emissions.

Concerns that a purely present-oriented PPP would heavily burden developing states are not unfounded.[28] Using standard accounting methods, six of the top ten emitters in 2012 were developing states,[29] and nearly two-thirds of all emissions came from developing and poor states. Thus, insofar as a present-oriented PPP ignores historical emissions, it manifests a compound unfairness: it forgives post-industrial states their harmful historical emissions while placing heavy burdens on those least able to bear them. On this view, corrective and distributive justice are better served by including historical emissions in assessments of responsibility.

3.1. Disappearing perpetrators

As others have noted, however, this solution is practically and theoretically fraught.[30] We can note two commonly cited issues here. First, many historical polluters are now dead and therefore cannot be made to pay. Forcing their descendants to pay, as Edward Page notes, violates the "ethos" of the PPP, which "presupposes that only agents that actually caused an

[27] See Caney 2010; Neumayer 2000, 185-92; Moellendorf 2012. Note that Shue (1999) does not refer to his principle as a PPP, but—as Caney (2005, 753) notes—it fits the mold.

[28] The following is based on measures using the CAIT dataset.

[29] Specifically, China (1), India (3), Russia (4), Indonesia (5), Brazil (6), and Mexico (10). This ranking includes emissions from land-use changes, and counts any state with a per-capita GDP below USD$12,000 as "developing." Notably, several developing states also top the list for per-capita emissions and post-1990 emissions growth.

[30] For further critique of backward-looking principles, see Kingston 2014. See also Shue 1999; Singer 2002; Caney 2005 and 2010; and Page 2011 and 2016.

environmentally adverse outcome can be held" responsible.[31] This is the "disappearing perpetrators" problem. A commonly proposed solution to this problem is to hold temporally unbounded actors like states responsible. But this raises new issues. First, many states have undergone one or more revolutions since industrializing. Should states with new constitutions or leadership be responsible for the actions of the regimes they supplanted?[32] Similarly, what of former colonies? (Should emissions generated in Ghana before 1957 be attributed to the UK or the current government of Ghana?) Moreover, unless we take the implausible view that states have agency distinct from the human authorities directing them, it also seems problematic that many former authorities are dead. (For instance, the most intense deforestation in the USA occurred between 1850 and 1920[33]; are current citizens responsible for those land-use changes, despite having no part in authorizing them?) In short, making present generations responsible for historically remote emissions fails to satisfy the central dictum "the polluters should pay."[34]

3.2. Excusable ignorance

Furthermore, until the problem of climate change became firmly established scientifically and widely known, all agents—including states—could be said to have been

[31] Page 2011, 415.

[32] Page (2011, 415) argues that it would be inappropriate to hold new governments responsible for the actions of former regimes. See also Kingston 2014, 284*ff*; Caney 2006, 469*ff*, and Miller 2009, 151*ff*.

[33] MacCleery 2011, xii.

[34] Also problematically, many (and perhaps most) climate-change *victims* do not yet exist, since grounding corrective-justice claims usually requires establishing an identity between victim and wrong-doer (Posner and Weisbach, 108-9).

acting in "excusable ignorance" of the harm their actions (particularly emitting GHGs) were causing. In response to this, Peter Singer, Eric Neumayer, Henry Shue, and others have proposed establishing a "cut-off date" for excusable ignorance: a date after which knowledge of climate change was readily available and thus agents could be held responsible.[35] Most often, the date proposed is 1990, which is the year the first IPCC report was released.

Although this seems a compelling (if only partial[36]) solution, there are two complications. First, the disappearing perpetrators problem still applies, if in attenuated form. That is, many "knowing" polluters in the period since 1990 have also died. Moreover, many of the people alive today are children, or were for much of the time since 1990. Assuming we cannot hold people accountable for what happens while they are (or were) children, the number of fully culpable adults (i.e., those who were adults in the year 1990 and are still alive now) is quite small relative to all those who are alive now or were at some point between 1990 and today. If our aim is to make the polluters pay, these considerations must be taken into account when assigning responsibility—viz., we must determine how much of the global stock of atmospheric GHGs is attributable to actors no longer alive or who are or were children in the period from 1990 to today. This is a daunting, if not impossible, task. We might avoid these issues by designating states as the relevant agents, but this would raise anew many of the above issues.

[35] Singer (2002, 34) and others have proposed 1990 (e.g., Shue 1999, 536), while Neumayer (2000, 181, 189) suggests the mid-1980s. For critical discussion, see Caney 2005, 762, 769; Page 2016, 93; and Page 2011, 415.

[36] Some resist this move because it curtails the PPP's reach and thus its ability to serve corrective justice (see, e.g., Caney 2010, 209, and Page 2016, 93).

Even setting these complications aside, it quickly becomes clear that focusing on post-1990 cumulative emissions does little to resolve the initial concern with the present-oriented PPP—viz., that it entails economically regressive burdens. Indeed, in 2012, five of the top ten states for *post-1990* historical emissions were developing economies.[37]

3.3. Modifying the principle

Many have proposed revisions to the backward-looking PPP to address these and other issues. For instance, some advocate a principle of strict liability, arguing that agents should be held responsible for emissions whether or not they understood the consequences of their actions, or even could have known.[38] Others charge that strict liability is morally questionable,[39] however, and likely unserviceable as a basis for international climate policy.[40]

Another solution involves importing a notion of "benefitting" into the PPP: i.e., to argue that those who have gained "unjustly" from historical emissions ought to pay. Caney, for instance, modifies his PPP to hold that "if people engage in activities which jeopardize other people's fundamental interests … they should bear the costs of their actions even if they were excusably ignorant [provided] *they have benefited from those harmful activities*."[41] Shue similarly argues that "current generations [in affluent states with high historical emissions] are, and future generations probably will be, continuing beneficiaries of earlier industrial activity"—

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[37] Specifically, (2) China, (3) Russia, (4) India, (7) Brazil, (10) Mexico. NB: This is the list for emissions *excluding* land-use changes. The list *including* land-use changes is even more regressive.

[38] Shue 1999, 531-45; Neumayer 2000; Gardiner 2004.

[39] Kingston 2014, 287-8; Caney 2010

[40] Posner and Weisbach, chap. 5; Baer 2010, 248; Moellendorf 2012; Bell 2011; Schussler 2011.

[41] Emphasis in original; Caney 2010, 210.

and thus should pay.[42] Whether or not this offers a coherent way forward,[43] it means abandoning the PPP for a BPP, and with it the central moral intuition that those responsible for causing a problem should pay to address it.[44] If we are to preserve this intuition, we must determine whether an alternative formulation of the PPP is available—specifically, one that tracks a plausible notion of contribution while remaining sensitive to different states' economic capacities.

4. A revised, present-oriented PPP

I argue that a properly formulated, present-oriented PPP can accomplish this. Recall that the present-oriented PPP stipulates that those who contribute to climate change should pay for climate action, in proportion to their contribution. Thus, the more emissions an agent generates, the greater that agent's burdens should be. Above, we noted the concern that this entails imposing heavy costs on developing countries (e.g., China, India, and Mexico), which generate significant yearly emissions.

This concern is valid *if* we adopt standard "production-based" emissions accounting. I say "standard" because production-based accounting (PBA) is virtually ubiquitous: it forms the basis of the UNFCCC and Kyoto Protocol calculations and is almost always used in public discussions of national emissions totals.[45] Perhaps because of this, PBA has attracted little

[42] Shue 1999, 536. For similar arguments, see Neuamyer 2000, 189; Gosseries 2004; Page 2016.

[43] I suggest that it does not in section 5.4.2.

[44] Caney (2005, 757) recognizes this in an earlier article, but does not register the point against himself in the piece quoted above (Caney 2010). For criticisms of the BPP, see Kingston 2014, 288*ff*. For a defense, see Page 2016.

[45] Peters and Hertwich 2008; Davis and Caldeira 2010; Steininger et al. 2014.

critical attention from climate ethicists.[46] It is not the only accounting method, however; nor, I claim, is it the most normatively compelling.

An increasingly recognized alternative—consumption-based accounting (CBA)—traces emissions "embodied"[47] in trade goods, and attributes responsibility for those emissions to the country in which the goods are consumed. So, for example, using CBA, emissions generated in China to produce goods consumed in Norway are attributed to Norway. This small modification helps reveal often obscure neo-colonial relations, whereby rich and powerful states outsource the production of goods to countries with cheaper labor markets, and then blame those countries for having higher emissions profiles. Chinese officials and environmental advocates have expressed particular frustration with this. For instance, at a press conference Qin Gang, China's foreign ministry spokesman, once reminded Western news outlets that "A lot of what you use, wear and eat is produced in China…On the one hand, you increase production in China; on the other hand you criticize China on the emission reduction issue."[48] Similarly, Yang Ailun of Greenpeace China claims that, in the last 30 years, "[a]ll the West has done is export a great slice of its carbon footprint to China and make China the world's factory."[49]

Taking these outsourced emissions into account could radically transform how we understand state responsibility. As Davis and Caldeira note: "Approximately 6.2 gigatonnes (Gt) of CO_2, [or] 23% of all CO_2 emissions from fossil-fuel burning [in 2004]…, were emitted

[46] Some in the climate-policy community have raised fairness concerns, however. See Steininger et al. 2014; Davis and Caldeira 2010; Kander et al. 2015; Steininger et al. 2015.

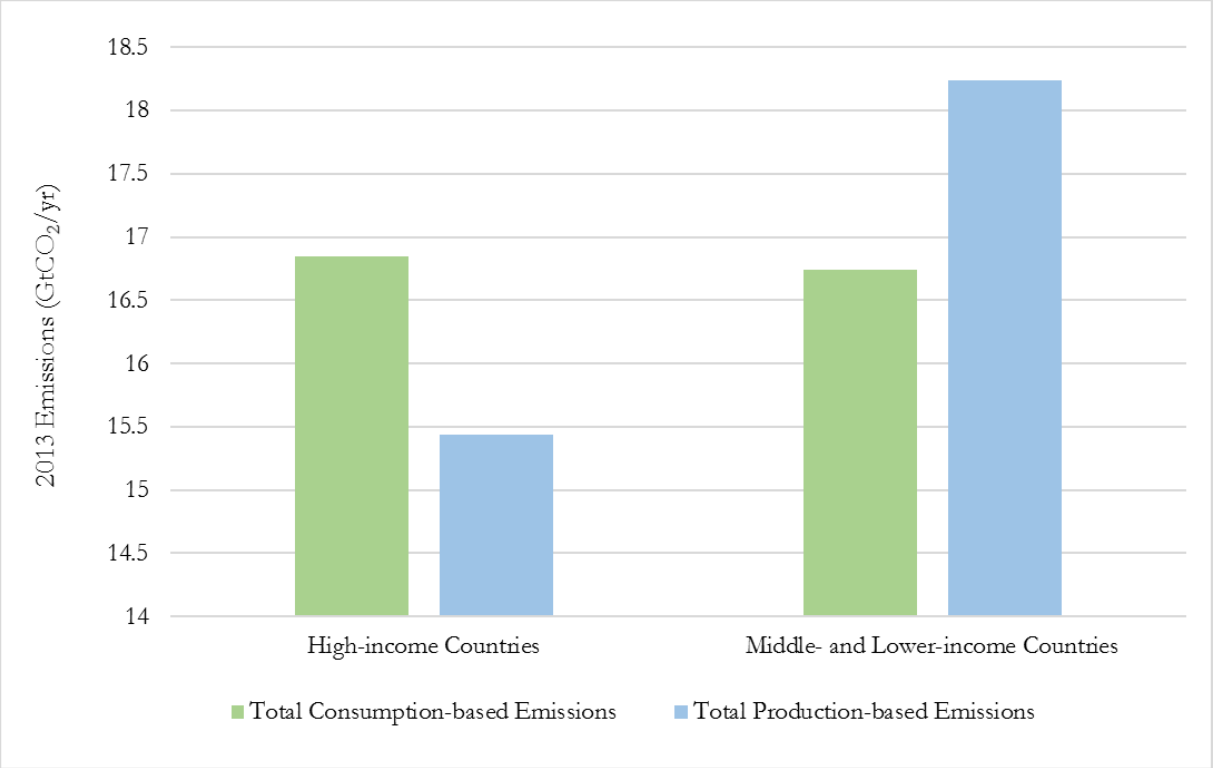
[47] IPCC, AR5, WG3, 306; Davis and Caldeira 2010.

[48] Scientific American 2018.

[49] Scientific American 2018.

during the production of goods that were ultimately consumed in a different country."[50] Consequently, CBA provides a very different picture of national emissions than PBA.

We can see this in the following graph. The difference between the blue and the green columns for high-income countries, on the one hand, and middle- to low-income countries, on the other, shows that many of the emissions produced by the latter are embodied in goods consumed by the former.[51] This "off-shoring" of emissions—from rich to poor and developing countries—is made possible through international trade.



Given that the biggest importers of goods from the developing world are affluent states, we should expect them to top the list for consumption-based emissions. The data show

[50] Davis and Caldeira 2010, 5688. See also Caldeira and Davis 2011;

[51] This follows the World Bank's state income grouping scheme, in which countries with a GNI per capita above USD$12,475 are considered high-income. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519

precisely this.[52] In fact, in a dataset covering 119 countries[53] for the year 2013,[54] regression analysis shows that a state's GDP was a very strong and statistically significant predictor of its total consumption emissions (R-squared = 0.76; p = 3.62E-38).[55] Notably, this relationship is appreciably stronger than that between a state's GDP and its total production emissions.[56]

Of course, GNI (or GDP) *per-capita* better reflects affluence than GNI alone.[57] Using this metric, we find that, in 2013, of the 25 countries with the highest per-capita consumption emissions, all (save one[58]) had a per-capita GNI above $12,475, placing them in the World Bank's highest-income bracket.[59] Conversely, of the states among the lowest 25 per-capita consumption emitters in 2013, *none* had a per-capita GNI exceeding $2,700 (the average was

[52] Emissions data from Peters et al. 2011. Economics and demographic data from World Development Indicators (last updated 1/3/17), supplemented, to include Taiwan, by https://eng.stat.gov.tw/ct.asp?xItem=37408&CtNode=5347&mp=5. All economic information is reported in current USD$, unless otherwise stated.

[53] NB: Poor countries are under-represented in this dataset—a tendency among most CBA datasets. If they were fully included, the results would likely be even more striking.

[54] At the time of writing, 2013 is the most recent year for which most data are available.

[55] Similar results are found for GNI; R-squared = 0.74, p = 1.32E-35.

[56] The data do report a statistically significant correlation between GDP and production-based emissions (p = 8.42E-30), but with less explanatory power (R-squared = 0.67).

[57] China and India, for instance, have high GDPs/GNIs but are still relatively poor because of their large populations. Because of this the World Bank uses a per-capita measure as the basis of its income groupings.

[58] Mongolia.

[59] The average per-capita GNI of this group was $42,863.44—almost triple the world average at the time, $14,928.37.

$1,030.40).[60] In short, the countries with the highest per-capita consumption emissions are also the wealthiest.

Furthermore, the top 25 per-capita consumption emitters in 2013 were responsible for 33.46% of all emissions generated that year,[61] despite representing only 10.64% of the global population.[62] Comparatively, the bottom 25 per-capita consumption emitters, which represent 14.40% of the global population,[63] were responsible for just 1.62% of all emissions.[64] This, again, strongly suggests that consumption emissions closely track affluence.

Of course, using a consumption-based emissions accounting method effectively means shifting responsibility from producer to consumer—viz., the underlying premise of the CBA model is that consumer demand (particularly in affluent states) is the proper locus of responsibility. There are several reasons for accepting this view.

For one, it is for the sake of satisfying consumer demand that producers undertake emissions-generating activities. Now we might worry that, while consumer demand gives the reason for production, it does not, all else being equal, say anything about how production should be conducted—especially, whether producers should employ higher- or lower-emission productive processes. That decision, it seems, falls to producers. Yet, this might be too hasty. A basic axiom of supply and demand (and rational decision theory) is that when deciding between identical goods, consumers will, all else being equal, prefer whichever is

[60] Again, this is even more striking given that the dataset excludes many poor and developing states.

[61] The consumption emissions of these states totaled 12,040.71 $MtCO_2$, while global emissions in 2013 totaled approximately 35,986.20 $MtCO_2$.

[62] Or 760,609,121 of 7,147,749,368 people.

[63] Approximately 1,028,951,328 people.

[64] That is, about 581.86 $MtCO_2$.

cheapest. There are of course exceptions, carved out by marketing, ethical considerations, and so on. But, in most cases, price is the surest determinant of demand. If this is right, then consumers are, in effect, driving a specific kind of production: namely, cheap—which often means emissions-intensive—production. In other words, consumer preferences for cheap goods dictate—in a general, but direct and significant way—producers' decisions about *how* they produce goods.

There are two additional reasons to hold consumers responsible. Affluent, consumerist states are the chief architects of today's highly liberalized trade system and global division of labor, which enables multinational firms to offshore high-emitting productive processes. In other words, the reason why production proceeds in emissions-insensitive ways is, in an important sense, because the political leadership of consumerists societies has structured it that way, to ensure an unimpeded stream of cheap goods. Finally, locating responsibility with consumers gives practical expression to the widely shared idea that successfully combatting climate change requires the wealthy to undertake meaningful lifestyle changes.[65] Holding consumers responsible will have the result of curbing consumption.

These points notwithstanding, clearly producers bear *some* responsibility. For in many cases, they have the ability, if not the will, to lower their emissions by adopting alternative modes of production. Yet, even granting this, two considerations should lead us to be wary about treating producers as equally responsible as consumers. First, in many if not most cases, producers lack an incentive to reduce their emissions unilaterally, for doing so would raise the price of their goods and thus decrease their market competitiveness. Of course, governmental regulation offers a potential solution to this dilemma: by requiring all productive firms in a

[65] On this, see IPCC, AR5, WG3, 6.8, 7.9, 8.3.5, 8.9, 9.2-3, 9.10, 10.4, 11.4, 12.4-7, 15.3-5.

given territory to lower their emissions, none will be made less competitive on that ground. Yet, as the graph on page 160 shows, we may worry that at precisely the moment stringent emissions-reduction policies are implemented by any given state, multinational firms will simply relocate to a country without such restrictions. This dynamic is a perverse feature of our global trade system, which, again, was designed largely *by* and *for* affluent states to ensure access to cheap consumer products.

Still, conscientious producers could, e.g., use advertising to instill consumer demand for lower-emissions goods (much as organic agricultural suppliers have done for pesticide-free produce), or undertake lobbying efforts to create industry-wide regulations, eliminating perverse incentives from the decision-making process. To the extent, then, that producers have failed to inform consumer preferences or reform the system, they appear to be fit objects of blame. A problem with this view, though, is that successful productive firms are often directed by agents who, themselves, are high consumers—for consumption largely tracks wealth at the individual level, just as it does on the international level.[66] This suggests another layer of perverse incentives. Calling on the leaders of productive firms to reform themselves or their industries is, in effect, calling on the most prodigious global consumers to make their own consumption more expensive.

Taking all of this into account, it seems that, on-balance, there is a stronger case for holding consumers responsible. Doubtlessly, though, there are relevant counter-examples and exceptions in particular cases and contexts. For this reason, we might conclude that the best accounting method would be one capable of isolating the relative causal impact of consumers

[66] It is for this reason that John Rawls prefers consumption-based over income-based taxation at the domestic level (Rawls 199, 246).

and producers, and assigning "shares" of responsibility. Parsing the causal impacts of consumers versus producers, however, is—philosophically and practically—infeasible.[67]

We must therefore pick between second-best methods, and attribute responsibility accordingly. This does not detract from my argument, though, as I am not principally interested in which accounting method tracks the truth about responsibility, but in which provides the most ethically compelling basis for allocating climate burdens. In other words, choosing between PBA and CBA is less a matter of which method better captures contribution (which both do imperfectly), but of which performs better with respect to pertinent ethical factors: especially, fairness, environmental efficacy, and cost-effectiveness. In these three regards, I argue, CBA is superior.

4.1. Fairness

As already noted, CBA and PBA offer starkly different views of national emissions: CBA provides a lower emissions count for lower- and middle-income countries, and a proportionally higher one for affluent states.[68] In this way, CBA satisfies what we might call the convergence view in the literature: that the rich ought to pay for climate action.[69] For, as shown above, a significant and robust correlation exists between GNI (per capita) and consumption emissions (per capita). This relationship is stronger on a present-oriented CBA model than a PBA model. Moreover, the same data used above show that there is no statistically significant relationship between per-capita GNI and (post-1990) historical

[67] Steininger et al. 2014, 78.

[68] This finding is affirmed also in the most recent IPCC report (AR5, WG3, 127).

[69] Gardiner (2004, 579) discusses this widely shared view.

production-based emissions.[70] In other words, contemporary affluence is *not* a good predictor of cumulative production emissions. This suggests that those who propose counting historical emissions to satisfy the convergence view would do better to advocate a present-oriented, consumption-based PPP.

One might object that imposing a border tax (or tariff) in accordance with a present-oriented CPP would unfairly harm those in developing states, which are net exporters. I address several versions of the unfairness objection in section 5.1-2. We can address the trade objection here, however. This objection can be more formally stated as follows:

(a) *If* universally (or nearly universally) implemented GHG taxes are necessary, as most believe, to combat climate change successfully[71];

(b) and *if* such taxes necessarily dampen trade, thereby negatively affecting developing states;

(c) *then* we must choose between temporarily depressing international trade and addressing climate change.

There are strong reasons to doubt (b), or at least the provision that depressed trade must come at the cost of those in developing states. Through international aid programs, guaranteed minimum trade deals, international investments in green infrastructure, etc., any negative trade effects brought on by GHG taxes could be significantly mitigated or even reversed.

Yet, even granting (b), we should note that failing to address climate change now will almost certainly depress economic activity in the future, especially in poor and developing

[70] Regression analysis between GNI per capita and cumulative production emissions since 1990 returns a p-value of 0.18—far below any significant threshold.

[71] I defend this point in the next subsection.

states, which are disproportionately vulnerable to environmental changes. Furthermore, this harm would likely far exceed any foregone welfare gains related to GHG taxes.[72]

Suppose then that we are justified in imposing GHG taxes today.[73] The question then becomes: is it fairer to place GHG taxes directly on producers or consumers? Although under ideal conditions there should be no difference, in our fragmented global system, placing taxes on consumption will more likely ensure that the rich pay—because, again, net consumption (consumption in excess of production) increases in rough proportion to wealth. Thus, a consumption-based model appears to be economically fairer.

4.2. Environmental efficacy

Understanding environmental efficacy in terms of a principle's or policy's ability to "reduce the causes and impacts of climate change,"[74] CBA has a crucial advantage: it can help prevent "carbon leakage." Carbon leakage is the by-product of international free-trade agreements and fragmented mitigation policies. Scholars distinguish between two variants: "strong" and "weak." Strong leakage occurs when unilateral mitigation policies prompt domestic, polluting firms to relocate offshore.[75] Weak or "consumption-induced" leakage owes to the global division of labor, which, today, concentrates production in states with

[72] I return to this point below, via Rendall 2011.

[73] I provide a much fuller defense of this point in chapter 3.

[74] IPCC, AR5, WG3, pp. 1009, 236.

[75] According to the IPCC: "Carbon leakage is…the increase in CO_2 emissions outside the countries taking domestic mitigation action divided by the reduction in the emissions of these countries" (AR4, WG3, chap. 11.7.2).

energy-inefficient infrastructure.[76] In both cases the result is the same: reductions in emissions in one state are offset by equal or greater increases in another.

Carbon leakage poses a problem for PBA so long as mitigation policies are not unified—i.e., so long as there is not a single price for carbon enforced internationally. For whenever emissions-producing activities are relocated to states with less stringent policies, regulation is undermined. To clarify, imagine that country X imposes and strictly enforces a tax on GHG emissions, while country Y does not. Assuming a lack of trade barriers between X and Y, we can expect that X's policy will induce some heavily polluting companies to relocate to Y, and simply export back the goods they produce there. In this way, the emissions X sought to curtail continue, unabated. Certainly, PBA can (and will) reflect lower national emissions for X, but the aim is to reduce *global* emissions, not those of any particular country (except in an intermediate sense).

CBA can combat this, even within a fragmented system. Through the medium of international trade, country X can enforce mitigation policies (e.g., a price on GHGs) outside its borders by applying tariffs to imported products. Economists call such tariffs "border carbon adjustments"; they work by adjusting imported-product prices to reflect the social costs of GHG emissions embodied within them.[77] CBA is thus able to deter free-riding by subjecting all goods exported from states that lack (sufficiently stringent) mitigation policies to emissions taxes as a condition of market participation. By minimizing or preventing carbon leakage in this way, CBA increases the efficacy of mitigation efforts undertaken by any trading state.

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[76] On weak vs. strong, see Steininger et al. 2013, 76, 79ff; Peters and Hertwich 2008; Droege 2011; IPCC, AR5, WG3, 386.

[77] Steininger et al. 2014, 76; Brooks 2015.

4.3. Cost-effectiveness

By "bringing the export sectors of the developing and emerging economies" that affluent states trade with "into the scope of [the latter's] policy," CBA also has an advantage in cost-effectiveness.[78] In other words, CBA is able to capture a broader share of global emissions and because the costs of mitigation increase with the fraction of total emissions abated, this means that CBA will help identify cheaper mitigation targets. This is an example of declining marginal costs: it is cheaper and easier to reduce emissions in countries that have not decarbonized much or at all—which is the case in many developing states—and more difficult and expensive to reduce emissions in states that are already decarbonizing—which is the case for many affluent states.[79] In other words, by making consumers responsible for the emissions embodied in trade goods, we incentivize emissions-reductions efforts in net-exporting countries, which can often be less costly than comparable reductions efforts in net-importing countries.

4.4. Additional considerations

A present-oriented, consumption-based PPP offers two further advantages. First, it is sensitive to changing economic fates. As developing states become wealthier, it is essential that they commit more resources to combatting climate change. The consumption-based PPP can explain why, and to what extent, they should contribute. A backward-looking principle cannot do this; nor can it accommodate economic decline. For on a backward-looking principle, present circumstances matter little if at all. Insofar as consumption emissions

[78] Steininger et al. 2014, 81.

[79] Steininger et al. 2014, 81; Barrett 1998; Stern 2007.

decrease in accordance with economic capacity, a consumption-based, present-oriented PPP offers security: should the rich become poor, or the poor rich, burdens change accordingly.

Second, as Davis and Caldeira note, "to the extent that constraints on emissions in developing countries are the major impediment to effective international climate policy, allocating responsibility for some portion of these emissions to final consumers elsewhere may represent an opportunity for compromise."[80] In other words, a consumption-based PPP may facilitate negotiations by ensuring that the poor will not be punished for production, and that the rich will shoulder the greatest burdens without being held liable for historical emissions—something they have dearly attempted to avoid.

4.5. Summary

In short, a present-oriented, consumption-based PPP better satisfies the convergence view that the rich ought to pay for climate action, and is more environmentally effective. It is also more sensitive to changing economic fates and may prove more politically feasible than alternatives.

The consumption-based PPP is not free from problems, however. In what follows, I consider four potential objections concerning the applicability of the principle, and its effects on the global poor. To avoid confusion with alternative PPPs, I hereafter refer to the present-oriented, consumption-based PPP as the *consumer-pays principle*, or CPP.

5. Objections

The first two objections elaborate on a concern expressed above: that present-oriented principles, like the CPP, *unduly* burden poor and developing states. I reject this concern in one

[80] Davis and Caldeira 2010, 5690.

form but accept it in another, which leads me to endorse a qualifying principle that limits the CPP's application and provides protections for economically disadvantaged states.

The latter two objections charge that the CPP is incomplete. One of these charges is valid, and so I respond by supplementing the CPP with an ability-to-pay principle (APP). The end-result of these modifications is a pluralist, bi-phasic account of international climate justice, which I outline formally in section 5.

5.1. Unfair to the global poor (i): the CPP does not secure "just entitlements" to emit

A popular view—defended (in various forms) by Paul Baer, Neumayer, Caney, Dale Jamieson, Peter Singer, and others—is that everyone has an equal "right" to generate a certain amount of emissions,[81] with quotas defined by the total absorptive capacity of the climate system divided by the number of people alive today.[82] On this view, the global rich, who have exceeded their quota, should pay for climate action, while the global poor, who are "in credit,"[83] are entitled to further emissions (or owed compensation). Those taking this view might charge that, insofar as the CPP lacks a theory of just entitlements, it deprives the developing world of its "fair share" of the atmospheric commons.

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[81] See, e.g., Gardiner 2004, 583*ff*; Caney 2012; Caney 2005, 770; Neumayer 2000, 185–192; Athanasiou and Baer 2002, esp. 76–97; Agarwal and Narain 1991; Jamieson 2001.
Singer 2002, 39–40; and Baer 2002. Politically, this view has been advocated by China, India, and many less-developed countries.

[82] Gardiner 2004, 583; Caney 2012.

[83] Because "their cumulative emissions are smaller than the global average per capita absorption" (IPCC 1995, 94; quoted in Gardiner 2004, 584).

Although the intuitions behind claims about equal rights to emit appear generally sound, they become problematic in the particular context of climate change. I note two objections.[84]

First, given the extent to which climate change has already progressed, it is difficult, in consequentialist terms at least, to distinguish a right to emit from a right to harm. Simply too many emissions have been generated for fossil-fuel-based development to continue safely. Indeed, global mean temperatures will continue to increase as the total stock of GHGs in the atmosphere increases. And already atmospheric CO_2e concentration levels have reached unprecedented and dangerous levels—as of February 2018, atmospheric CO_2e exceeded 407 ppm, well above the commonly cited "safe" upper-limit of 350 ppm.[85] All new emissions beyond the earth's natural sequestration capacity can only compound the harmful effects of climate change.

One might respond here by emphasizing the relationship between emissions and standards-of-living—that is, by insisting that people must emit to sustain a minimally satisfactory life. Shue, for instance, defends a right to "subsistence emissions"[86]—i.e., emissions necessary for securing a person's "vital interests"[87]—and argues that this right places a duty on the rich to reduce their "luxury emissions." If this duty is observed, Shue and others argue, poor states could emit without jeopardizing current or future generations.

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[84] For additional criticisms, see Gardiner 2004, 583ff.

[85] Notably, according to ice-core samples, levels never exceeded 300 ppm in at least the last 800,000 years, and before the Industrial Revolution, CO_2e concentrations were around 280 ppm (Lüthi et al. 2008).

[86] Shue 1993.

[87] Shue 1999, 541. Caney (2005) also adopts a vital-interests argument in defending a right to emit.

This response contains a fallacy, however: it conflates the right to a certain quality of life with a right to emit. Of course, until very recently, emissions and standards-of-living were tightly correlated, such that increases in emissions were necessary to generate economic gains and thereby improve aggregate welfare. But this relationship is not as rigid today. Breakthroughs in renewable energy have made affordable, carbon-neutral development possible.[88] To be sure, fossil-fuel industrialization may (in some cases) still offer the most expedient or inexpensive means for realizing welfare gains, but the desire to secure a certain standard-of-living does not justify using any means available. Moral prohibitions against harming must also be respected. That other states achieved development through fossil-fuel industrialization does not alter this, as merely citing the wrongdoing of others is insufficient for establishing standards of right or fairness.[89]

We should therefore reject claims about a right to emit founded on the right to a decent standard-of-living. Emitting GHGs in excess of the earth's absorptive capacity is harmful, and activities that unnecessarily[90] cause emissions should be limited if not prohibited.

5.2. Unfair to the global poor (ii): the CPP is not poverty-sensitive

One might concede that a right to emit is problematic but still argue that the CPP is insensitive to developing states' interests—or sensitive only in a contingent way. For while a

[88] See, e.g., Delucchi and Jacobson 2011.

[89] This would be a *tu quoque* fallacy.

[90] Unnecessarily can be interpreted in two ways here: (1) activities that contribute to climate change but are unnecessary for a satisfactory life (e.g., eating carbon-intensive foods, like meat and dairy products, when a plant-based diet is nutritionally sufficient and widely available); and (2) activities that are necessary for a satisfactory life but are undertaken in ways that unnecessarily result in GHG emissions (e.g., producing energy with coal or fracked gas when effective and clean alternatives like solar and wind are available).

focus on consumption emissions *tends* to place the biggest burdens on the wealthiest states, should a poor country have high consumption emissions, as some (albeit not many) do, the CPP will impose correspondingly large burdens on them. Such burdens would jeopardize some states' ability to realize or maintain a decent standard-of-living.[91] The CPP should thus stipulate that climate-action burdens shall not undermine any state's ability to secure decent standards-of-living for its citizens.[92]

A few things to note about this proposed revision. First, while many argue that environmental-justice should not neglect broader distributive-justice concerns,[93] we must consider the possibility that combatting climate change may not always comport with addressing economic injustice.[94] It is also possible that, given climate change's catastrophic potential, intergenerational justice may require deprioritizing today's global poor for the sake of future generations. Matthew Rendall, for instance, argues that while "policies that deprived the poor of necessities so that the rich could continue their 'luxury emissions' … would be a crying injustice," this "would be a lesser injustice than risking long-term catastrophe," because "the prospect of condemning several more generations in the South to poverty—terrible in

[91] Caney 2010, 213. See also Shue 1999, 542.

[92] I set aside the question of what counts as a sufficient minimum. Shue (1999, 541) defines it as "enough for a decent chance for a reasonably healthy and active life of more or less normal length," which extends beyond bare survival to those goods necessary for "a distinctively human, if modest, life." For other thresholds, see, e.g., Shue 1993; Caney 2005; Caney 2010, esp. 218; Singer 2002.

[93] Shue 1999; Caney 2005; Caney 2012, 258-9. But cf. Posner and Weisbach 2011.

[94] Posner and Weisbach (2011) stress this. I also take up this point in chapter 2.

itself—dwindles next to the danger of *permanent* impoverishment."[95] In other words, so long as unabated climate change threatens the essential interests of future generations in a more intense or enduring way than poverty affects today's global poor, justice may require us to prioritize addressing the former ahead of the latter.

Yet, accepting this does not alter the basic intuition that allocating climate-action burdens in a way that *unnecessarily* undermines sufficient standards-of-living is unjust. Fortunately, there appears to be no strong reason to assume that responding to climate change must come at the cost of intra-generational economic justice.[96] The thrust of the objection must still be answered, then: ideally, fair allocations of climate burdens should strictly track contribution to the problem *and* be sensitive to capacity.[97] The CPP succeeds on the first front, but not necessarily on the second: i.e., it *tends* to impose greater burdens on rich states but is not constitutionally committed to this.

To meet this objection, we must recognize a qualifying principle external to the CPP. This principle presupposes a distinction between climate action itself and the costs of that action. For example, if the CPP results in the imposition of a universal carbon tax, this qualifying principle might hold that, at regular intervals, more-advantaged states have a duty to provide tax rebates to less-advantaged states. We can call this principle the economic justice qualifying principle (or EJQP). It can be expressed alongside the CPP as follows:

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[95] Emphasis in original; Rendall 2011, 891; see also, p. 885. Rendall later argues that imposing costs on poor states is probably unnecessary, assuming it is possible to shift the burdens of climate change onto future generations.

[96] Singer 2010, 186; Gardiner 2006, 55; Rendall 2011.

[97] This idea is reflected in the "common but differentiated responsibilities" doctrine (UNFCCC, 1).

> *CPP*: Climate-action burdens should be allocated in proportion to contribution, measured in terms of each state's annual consumption emissions.
>
> *EJQP*: However, wealthy states[98] have a duty, in proportion to their wealth, to ensure that climate-action costs do not unnecessarily compromise any state's ability to attain or preserve decent standards-of-living.

One need not accept a thick cosmopolitan ethic to endorse the EJQP; rather, one need only maintain that it is wrong to harm others, wherever they are in the world.[99] The IPCC's *Third Assessment Report* stresses that "[a]ny individuals' or nations' actions to address the climate-change issue, even the largest emitting nation acting alone, can have only a small effect."[100] In other words, each state requires the cooperation of all or most others to mitigate climate change successfully. Consequently, attempting to structure international climate action in a way that unnecessarily undermines the realization or preservation of a decent minimum standard-of-living in developing states amounts to a will to harm—provided, as Shue notes, "that interfering with people's ability to maintain a minimum for themselves count[s] as a serious harm."[101] Put more simply, if forcing the least advantaged to sacrifice is unnecessary, it is also harmful and unfair, regardless of other considerations.

Note, however, that this does not relieve poor and developing states of their climate *action* responsibilities—it does not imply, for instance, that poor states are entitled to delay mitigation policies. Poor and developing states, like all states, have a duty to not exacerbate

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[98] In this context, "wealthy" refers to states belonging to the World Bank's "high income" and "upper middle income" groups. For an inventory of these states, and of those in the "lower middle" and "low income" groups, see IPCC, AR5, WG3, A.II.2.3, pp. 1287–8.

[99] The argument in this paragraph draws on Shue 1999, 541*ff*.

[100] IPCC, AR3, WG3, 607. See also IPCC, AR5, WG3, pp. 5, 214, 136.

[101] Shue 1999, 542.

climate change. But satisfying this duty can rightly be predicated on more-advantaged states fulfilling their obligation, specified by the EJQP, to ensure that the strains of international cooperation do not unnecessarily compromise the vital interests of the least well-off.

5.3. Incomplete (i): the CPP cannot ground duties to enhance carbon sinks

Simon Caney distinguishes between "atomist" and "holist" accounts of climate justice. Atomist accounts offer a separate and distinct principle for each climate burden (i.e., mitigation, adaptation, and compensation), whereas holist accounts treat climate burdens "en masse," with a single principle.[102] I have presented my account as holist. One might challenge this, however, on the grounds that the CPP is fundamentally aimed at discouraging bads (e.g., the generation of GHG emissions), not promoting goods, and thus cannot provide for the *enhancement* of carbon sinks, like forests and certain marine habitats.[103] Thus, for any account to be truly holist, it must be able to offer a principled basis for ensuring that sinks are properly maintained and duly expanded.

Although this is a serious objection, a simple response may be available. With estimates of the annual sequestration capacity of particular forests and marine habitats, credits could be awarded to the states maintaining them. This would simply require regarding the sinks as consumable goods that provide annual returns (in the form of carbon-sequestration capacity)—a kind of rent-deriving property.

Several advantages would follow from this. First, providing credits for sinks would open a stream of benefits for poor and developing states, thereby correcting for the disproportionate burdens they currently bear in preserving what are, after all, collective

[102] Caney 2012, 258-9. Caney also notes that there can be intermediate accounts covering some but not all climate burdens.

[103] Armstrong 2016; Page 2016, 85; Duarte et al. 2013.

goods.[104] Relatedly, if an international market was established in which the rights to these credits could be leased out, poor and developing states could secure direct financial transfers from wealthy states seeking to lower their yearly emissions totals, without ceding control of the territories hosting the sinks. Second, awarding credits would incentivize the maintenance and expansion of carbon sinks. Indeed, a credit system effectively doubles the value of a sink since, e.g., razing a forest would entail both losing a credit (equivalent to the sequestration capacity) and incurring a fee (equivalent to the carbon emitted from the land-use change). These calculations may seem complex, but factoring sequestration credits and land-use changes into national emissions estimates is already common practice. Incorporating them into a consumption-based model thus poses no insuperable difficulties.

5.4. Incomplete (ii): the CPP cannot allocate burdens without human pollution

The final objection is that the CPP cannot provide a coherent basis for allocating climate-action burdens in two important cases: when human activity (i) is not or (ii) is no longer driving climate change. I consider each in turn.

5.4.1. Anthropogenic and non-Anthropogenic climate change

Consider, first, the IPCC's claim that "most of the warming observed over the last 50 years is attributable to human activities."[105] As this implies, other natural processes also contribute to global warming, if in a far less pronounced way. This poses a problem for the CPP. Specifically, because the CPP allocates burdens in proportion to contribution, distinguishing between anthropogenic and non-anthropogenic climate change seems

[104] Page 2016, 89; Armstrong 2016.

[105] IPCC, AR3, WG3, 5; cited in Caney 2010, 211.

necessary. In making this distinction, however, another problem arises: the CPP appears unable to address non-anthropogenic climate change.[106]

In response, we should first note that non-anthropogenic climate change would almost certainly not be a cause for concern were it not for our gross exacerbation of the problem.[107] Given this, I argue, polluters should be held responsible for the problem as a whole. An analogy helps to clarify this point. In George Eliot's *Middlemarch*, a mortally sick man, John Raffles, is left in the care of wealthy banker, Mr. Bulstrode. Bulstrode must decide whether to (a) care for Raffles as prescribed (which may lead to his recovery), or (b) hasten Raffles's death by administering more of the substance that made him ill. For self-interested reasons Bulstrode elects (b). When this is discovered, Bulstrode is regarded as culpable for Raffles's death, even though Raffles was mortally ill before Bulstrode acted. This suggests that once a problem bearing significantly on others' or another's welfare is detected, willfully exacerbating it is sufficient to ground a more general responsibility for the effects of that problem. We know (and have known for decades) that climate change is real and that human activity is causing changes that almost certainly would not have occurred without our interference. In this sense, when we contribute to climate change, in awareness of what our actions entail, we are figurative Bulstrodes, while those vulnerable to our actions are Raffleses. If this is right, then the very act of emitting confers on us a general responsibility for the outcomes that follow, *even if* the problem might have occurred, to some extent, without our interference.

Moreover, by dint of being present-oriented, the CPP has a more expansive notion of contribution—one that includes damages caused *and* risk imposed. That is, when internalizing an activity's social costs, the CPP includes a "risk premium," which reflects the magnitude and

[106] Caney (2010, 211) registers a version of these concerns against his backward-looking PPP.

[107] United States Environmental Protection Agency.

likelihood that damages or losses associated with that activity will come to pass. Notably, such risks need not be caused *exclusively* by human activity. If a given risk is great enough, society may simply wish to ensure that all activities contributing to it are discouraged or stopped. Consequently, distinguishing between anthropogenic and non-anthropogenic climate change is unnecessary. A reasonable aversion to risk in general, and the knowledge that human activities are increasing the likelihood or potential magnitude of a given risk, suffices for grounding responsibility.

5.4.2. Climate change without polluters

The second charge—that the CPP cannot allocate shares of responsibility once human activity ceases to contribute to climate change—is more difficult to address. Consider the following. If the CPP is successful, emission flows will decline, perhaps falling below the earth's sequestration capacity before long. Yet, even with an immediate and precipitous emissions drop, climate change may continue to cause problems for centuries to come. This, again, is because many GHGs endure in the atmosphere long after they are emitted.[108] Consequently, distributing the costs of adaptation and compensation will likely remain an important international issue well after we reach the point of carbon neutrality. Given that the CPP allocates duties in proportion to present contribution, however, it seems inapplicable during a "post-mitigation" period. As emissions decline, eventually the revenue the CPP generates from justly priced taxes on GHGs will be insufficient for covering the expenses related to adaptation and compensation. Thus, the CPP is incomplete.

[108] For instance, while about 60% of carbon dioxide (CO_2)—the most common GHG—will cycle out of the atmosphere within 200 years after being released, up to 20% will remain for "tens of thousands of years" (Hausfather 2010).

To answer this objection, we must supplement the CPP with a principle capable of explaining how to correct for any deficits between the revenue generated by taxing emissions and the total cost of climate-action burdens for any given year. There are two clear possibilities: a BPP or an APP.

Recall that a BPP assigns burdens to those who have benefitted from the activities that gave rise to climate change, in proportion to their benefit.[109] While this seems plausible within intermediate time horizons, it becomes incoherent when applied to the distant future. Suppose again that climate change continues for hundreds of years, far after the point that dangerous emissions are generated. What would a BPP commit us to? Would it be fair, 500 years from today, to hold a completely carbon-neutral country responsible for the remaining burdens of climate action because of the benefits its citizens once received from fossil-fuel industrialization? What about 1,000 years from now? Would it matter if economic fates shift over this time—if a once-rich country becomes relatively poor, for instance? What if it is no longer a state at all? As time progresses, these questions compound, making the BPP less and less coherent.

We might attempt to preempt these issues by isolating the stream of wealth directly generated by GHG-emissions and using this as the limit of liability. Page, for instance, argues that responsibility under the BPP ought to end at the point that the "benefits traceable to activities that drive climate change are exhausted."[110] Isolating the particular benefits derived from climate-inducing activities would be a tremendous practical challenge.[111] Assuming this

[109] Page 2016.

[110] Page 2016, 91.

[111] How can we isolate a benefit that arose from activities that cause climate change from those resulting from, e.g., sea access, education investments, or luck? An agent's economic

could be done, however, we might wonder what to do when the limit is reached. Given the long atmospheric lives of many GHGs, it is possible that this stream of wealth will be exhausted well before adaptation and compensation are no longer concerns. If this is right, then the BPP will itself have to be supplemented, thus raising again the original problem.

A more parsimonious—and less theoretically fraught—solution would be to supplement the CPP with the APP, which again holds that the wealthy should pay for the costs of climate action in proportion to their wealth. Darrell Moellendorf, Caney, Page, and others have used the APP to supplement the central principles in their accounts (typically a backward-looking PPP or BPP).[112] This seems appropriate here as well. In other words, in a post-mitigation phase of climate change, the APP likely offers the most coherent basis for allocating climate duties.

6. Conclusion

We now have a pluralist, bi-phasic account of climate justice, the three pillars of which are as follows:

> *CPP*: Climate-action burdens should be allocated in proportion to contribution, measured in terms of each state's annual consumption emissions.
>
> *EJQP*: However, wealthy states have a duty, in proportion to their wealth, to ensure that climate-action costs do not unnecessarily compromise any state's ability to attain or preserve decent standards-of-living.

success is predicated on numerous factors, a mere inventory of which would be confounding.

[112] See, e.g., Page 2011; Moellendorf 2002, esp. 97–100; Caney 2005, 2010; Shue 1999.

> *APP*: Once consumption emissions decrease to the point that the revenue gained from taxing them can no longer sustain the remaining costs (related to adaptation and compensation claims), wealthy states should shoulder those burdens in proportion to their wealth.

While this account is not as picturesque as one that simply holds "the polluter should pay," it is markedly more coherent. Because it covers all the relevant climate burdens, now and into the future, it is also comprehensive. Moreover, the account is alive to both the contributions and capacities of different actors in both phases. In particular, the first phase of the account, covered by the CPP and EJQP, is contribution-determined and capacity-sensitive, while the latter phase, covered by the APP, is determined by and sensitive to capacity. In this regard, my account is responsive to the claims of both compensatory and distributive justice.

Several questions remain. For instance, my account takes no position on how, or even if, historical emissions after the excusable ignorance cut-off date should be addressed. I also have not considered whether the CPP applies all the way down—i.e., at the national or subnational level. Finally, I have not discussed the role of discounting in establishing emissions tax rates. These questions must be addressed in future work. My aim here, however, has been simply to show that the PPP (*qua* CPP) can provide a politically feasible, ethically compelling, and environmentally effective basis for allocating climate burdens.

5. What's the Problem with Geo-engineering?

"Environmentalism for the last 40 years has maintained as one of its key tenets the idea that humans must change their ways and learn to live within the ecological parameters presented to them. In contrast, climate engineering is a way to modify earth's parameters so that humans do not need to change."

—Christopher Preston (2011, 465)

"…is it not cavalier to assume that the *only* issue that arises with climate change is whether to employ a 'quick' and 'cheap' technological fix?"

—Stephen Gardiner (2011, 348)

1. Introduction

On June 14, 2016, the FDA approved use of a new device for combating obesity called the "AspireAssist." In a televised segment on the device, an ABC News anchor claimed that it "could hold the key to consequence-free indulgence."[1] This is because the AspireAssist does not require diet or exercise to work. Rather, it helps patients lose weight by mechanically dumping the pre-digested contents of their stomachs into the toilet 20 to 30 minutes after

[1] Neporent 2017.

eating—a process that some critics call "assisted bulimia," and that the news anchor described as "cringe-inducing."[2]

Why should we consider a device promising consequence-free indulgence cringe-worthy? If it has the potential to save lives, improve welfare, and is generally safe (or at least safer than morbid obesity), what objection could there be to it?

A standard concern is that the mere existence of the AspireAssist could discourage conventional responses to weight gain, particularly diet and exercise. This is bad because diet and exercise are safer, less costly, and more conducive to health than the AspireAssist, if altogether less convenient. Yet, even granting the comparative advantages of diet and exercise under normal conditions, few would deny that drastic measures like the AspireAssist are justified at the point that obesity seriously threatens health. In other words, considerations of cost and risk only count *against* the AspireAssist for so long, and, in the context of a health emergency, may even count *for* it.

There are, however, reasons beyond cost and risk why one might think the AspireAssist problematic. For instance, regardless of its life-saving or welfare-improving potential, one might worry that the device follows from, and threatens to sustain, the same excessive appetites that gave rise to the need for the device in the first place. The AspireAssist does not require changing unhealthy appetites or outlooks; instead, it allows for their preservation by removing a particularly visible and deleterious downstream effect (weight gain). (Perhaps for this reason, a year into the American pilot study, approximately 70% of patients asked to keep the AspireAssist installed indefinitely.[3])

[2] Neporent 2017.

[3] Neporent 2017.

If obesity is an individual health crisis, we might say that anthropogenic climate change is a planetary one. Of the 17 hottest years ever recorded, 16 have occurred since 2000.[4] And with this, sea-levels are rising, weather is becoming more extreme, drought and flooding are destabilizing agriculture (especially in poor and developing countries), and disease-bearing mosquitoes are expanding their range (as the recent proliferation of the Zika virus evinces).[5] This is culminating in a global climate crisis, which threatens serious human suffering and political instability.

We have long known ways to prevent this crisis. The planetary equivalents of diet and exercise include, e.g., transitioning our energy system away from fossil fuels and toward solar and wind, replacing gas-powered vehicles with electric cars, significantly reducing our consumption of animal products (especially meat and dairy), and reducing the use of plastic goods. We can refer to these activities as "abatement measures," as all of them involve reducing greenhouse-gas (GHG) emissions, which drive climate change. Like diet and exercise, abatement measures can be hard work, and implementing them fully would cost many (powerful) people a lot of money. Largely for these reasons, in the 25 years since the Rio Earth Summit made climate action an international priority, annual emissions have not decreased but have rather *increased* by more than 44%.[6]

Because we have done so little to abate climate change for so long, and because abatement measures take time to affect the climate system,[7] we are rapidly approaching a point after which conventional measures will be insufficient for preventing climate catastrophe.

[4] NASA.

[5] Inside Climate News.

[6] World Resources Institute data.

[7] See, e.g., Hausfather 2010.

Thus, scientists have begun investigating "emergency back-stop" solutions for cooling the earth: viz., climatic equivalents of the AspireAssist.

These schemes are often grouped under the broad umbrella of geo-engineering (or "climate engineering").[8] According to one influential conception, geo-engineering is a "deliberate large-scale intervention in the Earth's climate system, in order to moderate global warming."[9] Although scientists have discussed many possible geo-engineering schemes, the most prominent proposal involves mimicking a volcanic eruption by injecting sulfate aerosols directly into the stratosphere. Stratospheric sulfate injection (SSI) promises to quickly and inexpensively cool the planet. (In this chapter, all references to "geo-engineering" should be taken to refer to SSI, in particular.) Yet, SSI comes with some serious risks and costs (as I discuss below). For this reason, most scholars agree that it should be deployed "out of despair only."[10] That said, should we reach that moment of despair—when conventional abatement measures are no longer adequate for preventing temperature increases that imperil many human lives (or even just familiar environmental values[11])—virtually everyone agrees that geo-engineering would be morally justified and perhaps even requisite.

This chapter offers no exception: should the risks of geo-engineering be outweighed by those of climate catastrophe, and should no other options remain, I agree that SSI would be morally justified. But, as with the AspireAssist, this conclusion should not mark the end of our evaluative reflections. For even if we are confident that it is *right* to deploy geo-engineering

[8] For a helpful critique of this term, see Heyward 2013.

[9] Royal Society 2009.

[10] Schellnhuber 2011, 20277-8; See also Hamilton 2013, 49&*n.*

[11] Preston, 473.

under certain (exigent) circumstances, we might still question whether deployment is ethically justified (i.e., whether it is *good* to do).[12]

This kind of ethical reflection, I argue, is necessary for understanding the deep unease many feel about geo-engineering quite apart from its relative costs, benefits, and risks. It also helps clarify why reasonable people might accept the moral necessity of geo-engineering under particular circumstances, yet nonetheless think such an outcome tragic.

I develop this critique below. This begins, in section 2, with an examination of the geo-engineering debate so far, which is almost entirely tendered in the currency of costs, benefits, and risks. I claim that this narrow focus is (i) endemic to neutralitarian political thought and (ii) incapable of fully explaining what is problematic about geo-engineering. I then argue in section 3 that a key part of the problem with geo-engineering is that it follows from (collective) intemperance, which invariably results in injustice and unfreedom. Geo-engineering only becomes necessary in a world in which our addictions to fossil fuels, animal agriculture, and cheap goods are so extreme, and go unchecked for so long, that they *cannot but* precipitate catastrophe. I claim moreover that, like the AspireAssist, geo-engineering does not treat these underlying addictions—rather, as a palliative, it helps sustain them by relieving one of their worst downstream effects (global warming).

Before moving forward, two clarificatory remarks are necessary. First, it is worth stressing again that my intention in this chapter is not to deny that, at some point, geo-engineering may become necessary for saving lives and thus would be the morally right course of action. Rather, I am simply arguing that other considerations or values—beyond those central to public judgments of right or wrong—must be taken into account if we are to

[12] We might also wonder whether it is aesthetically justified, though I set that point aside here.

understand why many people feel averse to geo-engineering and would continue to do so even if it became the most cost-effective and least risky option available for preventing climate catastrophe. Second, throughout the chapter I (implicitly) rely on a distinction between *morality* (which I take to cover questions of right and wrong, ought and ought not) and *ethics* (which I take to cover questions of good and bad, virtue and vice, should and should not). This distinction is of course artificial, but it should help distinguish my critique of geo-engineering from the prevailing moralist critique, as I explain below.

2. The (Moral) Debate over Geo-engineering

According to Alan Robock, "the oldest and most persistent argument against geoengineering"[13] concerns its potential to undermine abatement efforts. Specifically, critics worry that merely acknowledging the possibility of geo-engineering could (and perhaps already has begun to) stymie support for combatting global warming in conventional ways—i.e., by reducing the sources of GHG emissions and enhancing carbon sinks.[14]

Examples of this objection—which we can call the "moral hazard objection"—are manifold. Robock himself argues that "[i]f humans perceive an easy technological fix to global warming that allows for 'business as usual,' gathering the national … and international will to change consumption patterns and energy infrastructure will be even more difficult."[15] Similarly, Stephen Gardiner claims that "[m]any people worry that substantial research on

[13] Robock 2008, 17. See also Schneider 2001 and Cicerone 2006.

[14] Robock 2008; Robock et al. 2009, 1; Jamieson 2013, 533-4; Gardiner 2011, 356 and passim; Crutzen 2006, 211-2.

[15] Robock 2008, 17. In a later piece, Robock et al. 2009 argue similarly that "[i]f geo-engineering is seen as a potential low-cost and easy 'solution' to the problem, the public backing toward a mitigation agreement…may be eroded" (p. 1).

geoengineering will itself encourage political inertia on mitigation, and so help to…[make the need for] deployment…a self-fulfilling prophecy."[16] Dale Jamieson argues "that talk about geoengineering has *already* to some extent dampened our willingness to reduce emissions."[17] In short, just as one might argue that the very possibility of liposuction or a device like the AspireAssist stymies support for dieting and exercising, so too do many climate scholars believe that the mere possibility of geo-engineering could (and perhaps already has) inhibit(ed) a strong commitment to abatement.[18]

One initial response to this objection is: so what? What does it matter if abatement is displaced by geo-engineering? Why does preferring the latter to the former constitute a "moral hazard"? The most common response is that, under present circumstances, abatement measures are less *costly* and less *risky* than geo-engineering. I examine each of these points in turn.

2.1. Costs and Benefits

The first argument against geo-engineering is that, currently, abatement appears to be a less costly option. Of course, the estimated economic costs of deploying geo-engineering are surprisingly low.[19] According to Crutzen, "a continuous deployment" of stratospheric sulfate aerosols could be achieved "for a total price of US $25–$50 billion, or about $25–$50 per capita in the affluent world."[20] Examining a range of SSI delivery schemes, Robock et al. find

[16] Gardiner 2011, 356.

[17] Emphasis added; Jamieson 2013, 533-4

[18] Keith 2009, 498.

[19] Jamieson 2013, 534; Nordhaus 1992, 1317 .

[20] Crutzen 2006, 213.

that some would cost as little as $225 million per year.[21] In comparison, many believe that effective abatement measures would have costs equivalent to 1 percent of global GDP—or roughly $780 billion per year.[22] This appears to undercut the cost objection to geo-engineering—but, for several reasons, this conclusion would be too hasty.

First, when we account for the significant co-benefits of emissions reductions (e.g., the prevention of millions of premature deaths and pollution-related illnesses like asthma) and the efficiency gains that would come with greater public investment in reduced-emissions technologies (e.g., clean energy), abatement costs are likely to be *far* lower than $780 billion.[23] In fact, on some estimates, the monetary value of co-benefits and efficiency gains would be great enough to cover all (or nearly all) of the present costs of abatement. A recent OECD report notes that reducing GHG emissions by 50% by 2050 would generate health-related co-benefits equal to "between 0.7% of GDP in the European Union to 4.5% in China in 2050."[24] Another study finds that, by 2030, relatively modest global abatement efforts could save "US$100–600 billion per year in air pollution control and energy security expenditures."[25]

Abatement also offers less-easily-quantifiable benefits. Perhaps most notably, investing in energy efficiency upgrades and renewable energy infrastructure will "achieve something that geoengineering approaches do not even care to consider: … a sustainable global energy supply system that (i) can virtually exist forever, and (ii) offers more equitable

[21] Though this excludes an initial start-up cost of about $1 billion (Robock et al. 2009, 3).

[22] In 2015 dollars. See Stern 2007, 258-262. For similar estimates, see Stern 2010; Weitzman 2007, 720; Nordhaus 2008, 90.

[23] Stern 2007, 247, 273; Stern 2010, 48; Schellnhuber, 20278.

[24] Pearce et al., 7.

[25] McCollum et al. 2013; cited in West et al. 2013. Pearce et al. (p. 6) also emphasize the potential cost-saving "synergies between climate change and local air pollution" policies.

opportunities for the developing world than the fossil–nuclear complex."[26] In other words, abatement policies, particularly those that aim at developing green infrastructure, promise abundant energy from sources open to all: i.e., the sun and the wind. Thus, abatement promises to be more ecologically responsible *and* egalitarian than geo-engineering.

Moreover, geo-engineering cost estimates are often speculative and incomplete. Deployment schemes for geo-engineering have not yet been fully worked out, let alone rigorously tested. This helps to explain the large discrepancies in cost estimates (e.g., Crutzen's $25–50 billion/year vs. Robock et al.'s $225 million/year). Geo-engineering will also result in many negative externalities that are difficult to estimate precisely, at least in advance. For instance, releasing sulfate aerosols into the stratosphere will further deplete atmospheric ozone, "prolonging the end of the Antarctic ozone hole by several decades and producing [new] ozone holes in the Arctic."[27] This means higher rates of skin cancer and other health problems. Geo-engineering will also decrease the effectiveness of solar panels, and could induce unseasonal drought (particularly in Asia and Africa), causing potentially significant agricultural disruptions.[28] Moreover, geo-engineering fails to prevent ocean acidification, which (along with over-fishing) may soon cause serious problems for the approximately 3 billion people who depend on seafood for their diets or livelihoods.[29]

Some costs associated with geo-engineering completely defy quantification, and so are routinely omitted from economistic comparisons with abatement. For example, geo-engineering will render useless expensive terrestrial telescopes by creating a permanent cloud

[26] Schellnhuber, 20278.

[27] Robock et al. 2009, 2.

[28] Robock et al. 2009, 1.

[29] World Wildlife Foundation.

of pollution above the earth, seriously disrupting astronomical research.[30] How can we quantify the loss of these portholes to the universe? By the decrease in the number of astronomy publications? More strikingly, many climate scientists predict that geo-engineering will visibly whiten the sky, resulting in "no more blue skies."[31] How should we quantify the loss of blue skies? By loss in worker productivity? (Would this be offset by growth in the sales of anti-depressants?)

Of course, none of these considerations definitively establish that abatement will remain less costly than geo-engineering in the long run. For even if we were confident that abatement was the least expensive option right now, technological and climatic developments could quickly upend this calculus. Some use geo-engineering's potential cost-effectiveness to argue for further research and development. According to William Nordhaus's imaginative estimates, for instance, developing "nonintrusive climatic engineering" would have "a net value of around $17 trillion in present value because it would allow the globe to avoid most of the damages from climate change."[32] Nordhaus of course concedes that no such geo-engineering technologies exist today; yet, he asserts that geoengineering remains "the only economically competitive technology to offset global warming."[33] Whether or not Nordhaus is correct, his view suggests that cost-effectiveness may one day—if it does not already—

[30] Robock et al. 2009, 2.

[31] Robock et al. 2009, 2. See also, Robock 2008.

[32] Nordhaus 2008, 77, 19; see also Nordhaus and Boyer 2000, 126-7, 132, 176. NB: Nordhaus (2008) concedes that feasible, low-cost geo-engineering technology does not yet exist; yet, he argues, "the net benefits…are so high as to warrant very intensive research" (p. 19; see also p. 88).

[33] Nordhaus 2008, 78.

provide just as strong a justification *for* deploying geo-engineering as it ostensibly does now *against* it.

2.2. Risk

Another common argument against geo-engineering is that it is far riskier than abatement. We generally understand abatement and know what to expect from it. But with geo-engineering, the universe of potential risks is vast. This concern typically takes one of three forms.

Some fear that geo-engineering's anticipated negative effects will be of a far greater magnitude than predicted: e.g., that its impact on the Asian monsoon season will be much worse than expected, devastating agricultural yields for billions of people.[34] Preparing for these kinds of worst-case scenarios is, of course, very difficult if not impossible.[35]

Others worry about geo-engineering's *unintended but possible* consequences. What if the technology becomes weaponized,[36] or is wielded by the powerful in some other fashion to subjugate the weak?[37] Alternatively, what if international conflict, economic depression, or political instability causes an abrupt cessation of geo-engineering, precipitating a rapid (and

[34] Jamieson 2013, 531; Robock 2008, 15.

[35] For material, psychological, and political reasons. For discussion of these, see Posner 2004; Bostrom and Cirkovic 2008; Sunstein 2009.

[36] This is a real concern—during the Vietnam War, for instance, the US would release atmospheric chemicals aimed at inducing rain to swamp enemy supply lines and disrupt antiwar protests led by Buddhist monks. (Hence the U.N. Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques.) Robock 2008, 17, citing Fleming 2007, 46–60.

[37] Gardiner 2013.

perhaps catastrophic) bounce-back in global temperatures?[38] Given that most geo-engineering schemes require continuous deployment, this is a plausible concern. Moreover, sudden temperature changes would likely have even *more* severe effects on global agriculture and political stability than the kind of warming that would occur without geo-engineering.

Finally, noting our climate system's tremendous complexity, some stress that geo-engineering is extremely liable to human error and wholly unforeseen consequences.[39] Such "unknown unknowns"[40] must, by definition, be omitted from cost-benefit analyses conducted prior to deployment. Consequently, the costs of geo-engineering may far exceed initial expectations.

These risks lead Hans Joachim Schellnhuber to conclude that "the (moderately) affordable" geo-engineering schemes, including SSI, "are no good."[41] In other words, despite being relatively "inexpensive," economically, the risks of geo-engineering are grave enough to justify setting it aside.

As with cost, however, risk may prove an insufficient objection to geo-engineering in the long run. For, as others have argued, at a certain point (perhaps before the end of this century), the relevant comparison will not be between abatement and geo-engineering (as two distinct strategies for dealing with climate change), but between that geo-engineering and climate catastrophe. This, again, is because the effects of abatement are realized at a significant time-delay. Once GHGs are released into the atmosphere, many of them remain there for

[38] Robock 2008, 17.

[39] See, e.g., Robock 2008, 17; Victor et al., 72; Crutzen 2006, 213.

[40] NERC, 25.

[41] Schellnhuber, 20278.

decades, some even for millennia.[42] Thus, even if we were to reduce emissions to the point of carbon neutrality tomorrow, we would still experience climate changes for many years to come. And, of course, we are nowhere near carbon neutrality currently. Quite the opposite: every day we commit ourselves (and future generations) to more and more warming,[43] making it increasingly likely that we will cross a critical threshold or "tipping point," after which point climate catastrophe will become unavoidable through abatement alone.[44]

In contrast to abatement, the effects of geo-engineering are realized very quickly—i.e., within about six months.[45] According to Paul Crutzen, this makes geo-engineering an attractive "escape route against strongly increasing temperatures," as when the "climate heats up by more than 2°C globally or when the rates of temperatures increase by more than 0.2°C/decade."[46] Others have similarly hailed geo-engineering as an important "emergency," "back-stop," or "fail-safe" mechanism—a way of protecting ourselves from the most dangerous effects of climate change after the point abatement alone becomes inadequate.[47] As Launder and Thomson summarize, while geo-engineering interventions may themselves "be risky, the time may well come when they are accepted as less risky than doing nothing."[48]

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[42] Hausfather 2010.

[43] Barring "negative emissions," feasible mechanisms for which are so far still hypothetical (Hansen et al. 2016).

[44] On tipping points, see chapters 2 and 4.

[45] Crutzen 2006, 216.

[46] Crutzen 2006, 216.

[47] Nordhaus 2008; Goodell 2010; Victor et al. 2009. For criticism, see Gardiner 2011; Jamieson 2013, 531-2.

[48] Launder and Thompson 2010, xv; cited in Preston 2011, 466.

Of course, regarding geo-engineering as the "lesser of two evils" (vis-à-vis climate catastrophe) has attracted its own criticisms. Dale Jamieson, for instance, asks: "How do we know when we are experiencing a climate emergency?" and "who has the authority" to declare it?[49] Stephen Gardiner argues, more broadly, that focusing on emergency-deployment scenarios tends to obscure the extreme moral corruption that would give rise to geo-engineering.[50] These criticisms require far more attention than they have been afforded so far. Yet, even among the staunchest critics, few deny that geo-engineering would be morally justified if other options are unavailable and climate catastrophe is imminent.[51] Hence Christopher Preston argues that, even granting Gardiner's claim that merely pursuing geo-engineering research constitutes a "tarnishing evil," "one might still insist…that this tarnishing evil may not be as bad as the evil of subjecting millions of people to increased drought, disease and food shortages caused by unabated anthropogenic climate change."[52] According to Preston, geo-engineering becomes the lesser evil precisely when "severe warming poses a devastating threat to the human population and to familiar environmental values[53]."[54]

Whether or not we endorse Preston's or Crutzen's thresholds for what counts as a climate emergency, the basic point remains the same: although geo-engineering undeniably presents grave risks, should we reach the point that abatement measures can no longer prevent dangerous climate change, these risks may pale next to those of inaction.

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[49] Jamieson 2013, 531.

[50] Gardiner 2011, chap. 10. See also, Shue 1978; Gardiner 2013.

[51] Jamieson 1996 may be an exception.

[52] Preston, 467-8. For his part, Gardiner seems to concede this point (2011, 357*f*).

[53] By "familiar environmental values," Preston has in mind, e.g., the preservation of species or ecosystems, which are threatened by warming.

[54] Preston, 473.

To be clear, I am not claiming that this justifies undertaking geo-engineering research now (though it may). Rather, I am simply arguing that, should feasible geo-engineering technology exist at a future time when climate catastrophe (however defined) is imminent and otherwise unavoidable, the risk-based objection to deployment would no longer hold much weight.

2.3. Neutralitarian reasoning

To summarize then, if Robock et al. are right in asserting that the "decision to implement geoengineering … require[s] a comparison of its benefits, dangers, and costs to those of other responses to global warming,"[55] there may, for now, be a solid moral case against deployment.[56] However, if conditions change and climate catastrophe becomes imminent (and unavoidable via abatement and adaptation alone), then geo-engineering may become justified and even morally necessary. In other words, the cost and risk objections to geo-engineering are temporally contingent; should geo-engineering ultimately prove necessary to improve welfare and save lives, the same criteria would provide the moral case *for* deployment.

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[55] Robock et al. 2009, 1.

[56] NB: Other, seemingly non-moral objections to geo-engineering exist that I have not surveyed here—e.g., those concerning how deployment might be governed. I call these objections non-moral because they routinely take an interrogative rather than an argumentative form, e.g., "How will deployment be governed?" rather than "Deployment cannot be governed well because…" These kinds of objections are not very powerful, as they could, in principle, be answered—the "Oxford Principles" for geo-engineering offer a tentative step in that direction (Rayner et al. 2013), as do Dale Jamieson's reflections on these questions (Jamieson 2013).

At this point, we might ask: are cost and risk all that distinguish abatement from geo-engineering? Are there no other reasons for preferring abatement to geo-engineering, or at least for thinking geo-engineering deeply problematic (even if morally necessary)?

I argue below that there are. Before getting to this, though, it is worth briefly inquiring into why the geo-engineering debate so often excludes all considerations beyond those of cost, benefit, and risk. I think this has much to do with the deep commitment to neutralitarian reasoning in contemporary moral-political thought (especially for liberal thinkers following John Rawls). As Tal Brewer explains, this commitment entails that, when debating core political issues, we "seek reasons whose force we can expect other citizens to recognize, despite the fact that they do not share our parochial interests and can reasonably disagree with our fully elaborated conception of the good."[57] The relative costs, benefits, and risks of geo-engineering count as public reasons (for or against deployment) in this sense because they impact everyone, regardless of their other values or ends. Most other considerations fail this test. We could not, for instance, permissibly reject geo-engineering on the grounds that it fails to protect certain eco-systems that some regard as intrinsically valuable but that others think are worthless. (As David Miller argues, "from the perspective of social justice," any claim that an ecosystem deserves protection for its own sake is "on a par with the claim that church C is the true church, since it is a claim with which others may reasonably disagree."[58]) In short, by excluding considerations related to particular conceptions of the good life, the commitment to neutralitarianism significantly limits the range of reasons that can count for or against any response to climate change in the public calculus.

[57] Brewer 2002, 108.

[58] Miller 1999, 300n.33. Cf. Rawls 1999, 249-251; Rawls 2005, 214, 246; Rawls 2001, 152n.26.

This narrowing of evaluative reflection, I argue, obscures the full range of concerns many (if not most) reasonable people share with respect to geo-engineering. It also makes it impossible to explain why, at the point of climate catastrophe, reasonable people might accept the need to engineer the climate but nonetheless find such an outcome tragic. To clarify the ethical stakes of geo-engineering—and to explain why we might regard it as tragic—we need to look beyond cost-benefit-risk analysis.

Importantly, this is not to deny that cost, benefit, and risk can illuminate much of what is right (or wrong) with geo-engineering; rather, it is to suggest that rightness and wrongness are not exhaustive of what is at stake, evaluatively speaking. Most of us also care about what is good (and bad), beautiful (and repulsive), particularly with respect to environmental issues. Such considerations are deeply relevant to the geo-engineering question, and (more generally) for understanding the situation we have put ourselves in with respect to the climate.

Yet, because these ethical and aesthetic values lie beyond the neutralitarian confines of the moral debate over geo-engineering, they are routinely omitted from consideration. While there are often good reasons for this—chiefly, the desire to ensure fair deliberation in pluralistic communities—in what follows, I consider one *ethical* reason for resisting geo-engineering (or, again, for thinking it tragic should exigency make such an intervention morally necessary). While this discussion is likely to be controversial precisely because it does not originate from a position of neutrality about "the good," the ethical reason I present is, I argue, widely shared across cultures and time. Thus, even if the following discussion fails the test of public reason in its strictest application, I hope it nonetheless illuminates a greater range of what matters for many people with respect to geo-engineering.

3. An Ethical Argument against Geo-engineering

I noted previously that the most common objection to geo-engineering is that it threatens to derail abatement efforts. This is the moral hazard objection—moral because abatement is, today, still considered the less costly and risky option, and therefore the *right* one. Yet, we also noted that cost and risk are temporally contingent—if our failure to undertake abatement persists long enough, geo-engineering may become morally justified (as it will become less costly and less risky than climate catastrophe).

In this section, I reframe the moral hazard objection by arguing that, to the extent geo-engineering undermines the public commitment to abatement, it is not just a moral but an *ethical* hazard. Geo-engineering is an ethical hazard (among other reasons) because it follows from, and threatens to sustain, the vice of intemperance. Notably, this objection to geo-engineering is *not* temporally contingent: if conditions change, and geo-engineering becomes morally justified, we may still think it ethically problematic because of its relationship to intemperance.

Focusing on intemperance might strike some as an odd or even antiquated of criticizing geo-engineering (or a world that must resort to it). First of all, what does it mean to say geo-engineering follows from and threatens to sustain intemperance? Moreover, even if we grant that point, who cares, especially if our primary interest is in preventing harm and promoting welfare?[59]

I begin this section by elaborating the link between geo-engineering and intemperance. I then argue that we should care about this ethical hazard for two important political reasons:

[59] Notably, many economists and political theorists measure improvements in welfare precisely by increased consumption.

intemperance is a source of unfreedom and injustice. This opens up several objections, which I address in turn.

3.1. The relationship between geo-engineering and intemperance

3.1.1 What is temperance and intemperance?

Perhaps a better term than temperance is the more encompassing Greek word *sophrosune*, which is alternatively translated as temperance, moderation, or self-restraint. For Aristotle, *sophrosune* is best understood as a middle state between extreme indulgence in certain pleasures and "insensibility" to pleasure, the latter of which he claims is exceedingly rare and ostensibly inhuman.[60] Of course, *sophrosune* is a virtue not just among the Greeks; something similar is lauded by Buddhists, Hindus,[61] (especially pre-modern) Christians,[62] and Jews.[63] (This is not to deny the important differences among how different cultures and belief-systems understand temperance, or the relative importance they place on it, but to suggest the possibility of common ground.) For instance, in the *Dhammacakkappavattana Sutta*, the Buddha praises the temperate life much in the same way as Aristotle later does: i.e., as a "middle way," albeit one between addiction to sensual indulgence and devotion to self-mortification and extreme asceticism.[64]

[60] Aristotle 2009, 1119a1-21.

[61] See, e.g., the *Brihadaranyaka Upanishad*, verse 5.2.3, which praises the virtue of *damah*, or self-restraint.

[62] See, e.g., Galatians, 5:22-23; 2 Peter 1:5-7; Philippians 4:12.

[63] Consider, e.g., Proverbs 25:16, 20:13, 23:1-3.

[64] See Bhikku 1993.

Importantly, for Aristotle, temperance is not merely "continence" [*enkrasia*]—i.e., a state characterized by a reluctant or even painful observance of temperate behavior[65]; rather, the temperate person "finds no intense pleasure in any [bodily sensations], suffers no pain at their absence, and has no appetite for them, or only moderate appetite, not to the wrong degree or at the wrong time."[66] In other words, the temperate person's desires, not just her actions, are appropriately mild and oriented to the good; she thus feels no "pain at the absence of what is pleasant, or at refraining from it."[67]

Intemperance, on the other hand, typically refers to just one of the two "vicious" poles: specifically, excessive indulgence in sensual pleasures and material gratification.[68] At the individual level, intemperance manifests in "insatiable" desires for food, sex, or the consumption of certain (sometimes trivial) goods.[69] Consequently, intemperance is closely related to *pleonexia*—a rapacious grasping for more than one's fair share or what one needs for a healthy life.[70] (I return to this point in section 3.2.1.) We are intemperate when we eat past the point of being full, or drink to the point of heedlessness.[71] In this sense, intemperance can be understood as corruption-by-augmentation of our natural appetites, which exist to prompt us to "fill[] a lack."[72]

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[65] An *enkratic* person is someone who acts the right way, but longs to do otherwise. In other words, his desires are out-of-sync with what reason tells him it is right and good to do.

[66] Aristotle 2009, 1119a10-21; see also, 1118b30-35.

[67] Aristotle 2009, 1118b30-35.

[68] Aristotle 2009, 1118b15-25, 1118a15-19, 1118a30-b4.

[69] Aristotle 2009, 1119b8-14, 1118a15-19, 1118a30-b4, 1119a1-5, a20-1

[70] Lane, 32*ff*.

[71] Aristotle 2009, 1118b15-21.

[72] Aristotle 2009, 1118b17-18

Intemperance is also characterized by an over-valuation of pleasure or pleasurable goods. According to Aristotle, the intemperate person "has an appetite for all pleasant things, or rather for the most pleasant of them, and his appetite leads him to choose these at the cost of the other things"[73]—i.e., at the cost of a virtuous life's goods. This may sound strange: would not the person who consumes pleasurable goods all the time live a pleasant life? Aristotle thinks not: "appetite involves pain," which is why the intemperate person suffers "both when he fails to get something and when he has an appetite for it."[74] In the first poem of the *Atthakavagga* (or *Book of Eights*), the Buddha expresses a similar view:

> When desire for sensual pleasure // Is fulfilled // One will surely be delighted. […] //But if this pleasure fades away, // The person with this desire […] // Is pained as if pierced by an arrow // […] Through greed for…lots of sensual pleasures // One's weakness overpowers; // Crushed by many troubles, // Suffering pours in // As water into a leaking boat.[75]

For both Aristotle and the Buddha, then, intemperance manifests in rapacious and ultimately painful desires for pleasure-bearing goods and activities—desires that reflect confusion about, or over-valuation of, those goods and activities.

An aggregation of intemperate individuals makes an intemperate group. At the collective level, intemperance manifests as unnecessary and ecologically irresponsible over-consumption. It occurs whenever a group eats, drinks, breeds, and/or consumes resources

[73] Aristotle 2009, 1119a1-3; see also 1119a20-1

[74] Aristotle 2009, 1119a3-5; see also 1118b30-35.

[75] Fronsdal 2016, 41-2.

beyond the limits of the ecosystem in which that group is embedded, ultimately harming themselves and the other beings and elements within that ecosystem.[76]

Collective intemperance is not just a human vice. In "Thinking Like A Mountain," Aldo Leopold recounts his experience extirpating wolves so that there would be more deer to shoot: "I thought that because fewer wolves meant more deer, that no wolves would mean hunters' paradise."[77] His and his fellows' efforts worked, for a time: as the wolves were killed off, the deer population exploded. Unanticipated ecological consequences soon followed, however. Spared natural predators, the deer exhibited their own kind of collective intemperance, both in eating and breeding. Before long "every edible bush and seedling" was reduced "to anaemic desuetude, and then to death." Having exhausted their sustenance, the deer population soon collapsed, "dead of its own too-much."[78] The collective intemperance of the hunters, which unleashed that of their prey (the deer), devastated an entire ecosystem—harm that would, on Leopold's estimation, take at least "two or three…decades" to repair.

The collective intemperance of human beings differs from that of deer in at least one key respect, however. For the deer, wolves served as a natural barrier to excessive consumption. Only once that barrier had been removed did the deer eat and breed to the point of intemperance and collapse. In contrast, technology and agriculture mean that ecology's ordinary checks and balances—predators, disease, exposure—often have little impact on human populations and behavior. The only effective limit to our collective over-consumption—and, by extension, our only long-term security against collapse—is

[76] Aristotle stresses that intemperance runs counter to "health and fitness" in the individual (Aristotle 2009, 1119a17-21; 1119b8-14).

[77] Leopold, 130.

[78] Emphasis added; Leopold, 132.

temperance, cultivated through practice and sustained by social reinforcement. In other words, for us, temperance cannot be externally imposed; it must be internally won and socially promoted. Unlike the deer whose *pleonetic* appetites are ever present (if not always gratifiable), human appetites can be moderated or channeled to good ends through training and habituation.[79]

The value of temperance (and the dangers of intemperance) were well understood among Western ethicists for much of the last two millennia. Alongside the oft-cited "Know Thyself" inscription at the Temple of Apollo at Delphi was another: "Nothing in Excess."[80] Melissa Lane argues that this began to change in the 18th century, as political philosophers promoted the cultivation of *pleonetic* desires—especially those for material accumulation and wealth—as a way of dampening the violent passions of religious fanaticism and creating employment for the increasingly dispossessed poor. To be clear, as Lane notes, these philosophers were not arguing that "greed is good" or that the intemperate life was somehow praiseworthy. Rather, they simply felt that the danger *pleonetic* desires posed to individual virtue was outweighed by the social advantages engendered by promoting such desires: "[S]ociety as a whole could benefit from the greed for luxury…[as] consumption would stimulate production and so provide employment for the poor."[81] In other words, the social advantages of intemperance were enough to justify vice at the individual level.

[79] Aristotle 2009 1119b5-15; 1998, 1267a1-15.

[80] Lane, 33.

[81] Lane, 35.

More than two hundred years later, the effects of this gamble are everywhere present. While Westerners have not relapsed into religious wars,[82] our passions for sectarian violence have not diminished (a point to which the nationalist wars of the 20th century and the race-based terrorism of the 19th, 20th, and 21st centuries can attest). In the meanwhile, human beings—particularly the most affluent—have learned to consume virtually everything in excess. This is reflected in the basic idioms of modern consumerism: we "binge-watch" television, "feast" at "all-you-can-eat" buffets, treat ourselves to "shopping sprees," etc. The cumulative effects of these unbridled desires are perhaps nowhere more apparent than with respect to the environmental degradation of the last 50 years. In the words of Pope Francis: "We may well be leaving to coming generations debris, desolation and filth. The pace of consumption, waste and environmental change has so stretched the planet's capacity that our contemporary lifestyle, unsustainable as it is, can only precipitate catastrophes…"[83] Fittingly, he attributes these societal problems to "today's self-centered culture of instant gratification"[84] and argues that "[o]nly by cultivating sound virtues will people be able to make a selfless ecological commitment" to rehabilitating the earth.[85]

3.1.2. Geo-engineering and intemperance

We can now ask: how exactly does geo-engineering follow from and threaten to sustain intemperance?

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[82] Of course, many countries and regions still experience religious-motivated violence, e.g., Ireland throughout the 20th century. Moreover, over the past 20 years religious-based violence appears to be on the rise again.

[83] Pope Francis, 119-120.

[84] Pope Francis, 120.

[85] Pope Francis, 154.

To answer the first part of this question, we need only consider the massive amount of GHG emissions that are produced by contemporary appetites for dirty energy, animal products (particularly meat and dairy), quick and easy travel (especially by plane), air conditioning and heat in mild weather, and cheap consumer goods. Often enough these goods and activities are entirely frivolous; as Gardiner aptly describes, climate change is significantly driven by our desires for "relatively modest" pleasures like "the joy of wearing t-shirts indoors in winter."[86] In other words, the environmental crisis is fueled largely by the *pleonetic* desires of the global affluent, whose collective intemperance is apparent both in the climatic effects of their over-consumption, and in the irrational over-valuation of certain pleasures that such consumption reflects. The willingness to indulge these desires, often in (at least tacit) awareness of the harm entailed by doing so, is characteristic of intemperance.

If this is right, then an appropriate response to the problem of climate change must involve moderating excessive appetites—viz., cultivating greater temperance. There is already some traction for this idea in the policy literature. The Intergovernmental Panel on Climate Change (IPCC), for one, repeatedly emphasizes the need for behavioral and "lifestyle" changes, particularly among the global affluent: "Emissions can be substantially lowered through changes in consumption patterns…and dietary change and reduction in food wastes."[87]

As Crutzen laments, however, international efforts in this direction have, so far, been "grossly disappointing," making successful abatement appear increasingly like "a pious

[86] Gardiner 2013, 30.

[87] IPCC, AR5, WG3, p. 20; see also, IPCC, AR5, WG3, sections 6.8, 7.9, 8.3.5, 8.9, **9.3**, 9.10, **10.4**, 11.4, 12.4-7, 15.3-5; and IPCC, AR5, WG1, TS, p. 57

wish."[88] The interest in geo-engineering derives foremost from (researchers' increasing acceptance of) our collective failure to cultivate temperance. For in facing a crisis precipitated by intemperance, two options are available. The first is to moderate excessive appetites through practice and concerted effort, until the pain of desire is no longer apparent. The second is to attend narrowly to the downstream effects of intemperance—to treat the wounds of excess, without worrying about the disease that brought them to bear. Geo-engineering falls in this second category. In Dale Jamieson's words, geo-engineering is an attempt "to manipulate nature in order to make it conform to our desires rather than shaping our desires in response to nature."[89]

Once this superficial fix is made available, an important impetus to cultivate temperance is lost. For if our only major concern vis-à-vis 21st-century collective intemperance is its problematic tendency to warm the planet, geo-engineering offers an appealing solution. Recall the analogy to the AspireAssist. Why undertake the hard work of dieting and exercising when a low-cost solution to weight-gain—the most directly harmful effect of dietary intemperance—exists that does not require limiting one's appetites? Likewise, why do the hard work of abatement when a lower-cost solution to warming—the most anthropically harmful effect of climate-related intemperance—exists that allows society's appetites to carry on unchecked? Geo-engineering, like the AspireAssist, promises to dissolve the causal link between intemperate appetites and their most serious harmful effects—in this way, geo-engineering threatens to sustain intemperance.

Geo-engineering, on this view, can only ever be a treatment, not a cure, for climate change. Just as, in many cases, reducing the fever will not cure the disease (even if it saves the

[88] Crutzen 2006, 217.

[89] Jamieson 2013, 534.

patient), deploying geo-engineering may cool the planet and save lives, but nevertheless leave intact the problem (intemperance) that gave rise to the need for such a solution in the first place. Thus, geo-engineering only appears like a plausible solution to the problem of climate change if we deflate that problem to its most superficial effects. It is only a partial, external fix for what is ultimately an internal behavioral issue brought on by constant social inducements to burn, eat, travel, and buy more and more and more.

3.2. The good of temperance and the bad of intemperance

Yet, if geo-engineering can even partially sever the link between the practice of collective intemperance and its most harmful (external) effects, the question naturally arises: why should we care about cultivating temperance? In other words, if geo-engineering removes the instrumental justification for temperance, what impetus remains for being temperate?

In response, we should begin by noting again that geo-engineering can only attend to some of the external effects of our collective, climatic intemperance—specifically, global warming. Other important problems will remain or continue to worsen (e.g., ocean acidification). Geo-engineering will also cause its own problems, perhaps necessitating further interventions. This is all to say that geo-engineering does *not* completely erase the instrumental justification for cultivating temperance.

Nevertheless, by slowing or reversing warming, geo-engineering does present a way to attenuate one of the most harmful effects of climate change for humans over the medium term. Thus, we should consider other reasons for cultivating temperance. In what follows, I identify two internal goods of temperance, and two corresponding bads of intemperance. I can only limn these goods and bads here. My hope, however, is that this suffices as a

provisional argument for why we should care about temperance, apart from its potential to slow global warming.

3.2.1. Justice and Injustice

The first bad of intemperance concerns its relation to injustice. For, Aristotle argues, whenever human beings "have a desire for more than the necessities, they will seek to remedy it by committing injustice."[90] The operant form of injustice is that of *pleonexia*. When guided by *pleonetic* desires, people tend to take what is not theirs. Buddhist thought also strongly cautions against the vice of *pleonexia*. Of the five precepts or virtues [*pañca-sīla*] defined in the Mahayana tradition, the second involves abstaining from taking what is not freely given.[91]

The potential need for geo-engineering follows very directly from a situation wherein some have used or are using much more than their fair share of the "atmospheric commons."[92] To understand this point, imagine that each generation has a "greenhouse gas budget"—measured in emission flows—that it can expend without jeopardizing the safety of future generations.[93] On any reasonable measure, current generations—particularly, the affluent within current generations—have emitted far beyond their allowance. Consequently, the world is warming, and future generations will not be able to emit much (if any) GHGs if they are to avoid further harm. Geo-engineering arises as a response to this budgetary over-reach: a way of borrowing on the already exhausted credit of future generations. Geo-engineering does

[90] Aristotle 1998, 1267a1-15

[91] Bhikku 1997.

[92] Caney 2009; Singer 2002, esp. 39–40. See also Gardiner 2004, 583*ff*; Caney 2012; Caney 2005, 770; Neumayer 2000, 185–192; Jamieson 2001; and Baer 2002.

[93] The idea of a greenhouse gas budget is Simon Caney's (2012), though I use it somewhat differently here.

nothing to reign in the desires that give rise to this over-reach; rather, it threatens to sustain them, in part, by providing current generations the solace of thinking that at least some of the harm stemming from their consumption can be mitigated.[94]

In this sense, geo-engineering is a handmaiden to injustice: it provides current generations moral cover for continuing to emit more than their fair share. Indeed, geo-engineering is no more a remedy to injustice than would be a company compensating some victims of its pollution while nonetheless continuing to pollute. Justice, more fully conceived, would require also ending the practice that gives rise to the problem (i.e., polluting). According to Aristotle, the only way to extirpate the injustice that follows from *pleonetic* desires is to cultivate temperance.[95] Only with self-control and moderated appetites will people stop grasping for more than their fair share.

3.2.2. Freedom and Unfreedom

There are not just other-regarding reasons—like those of justice—to cultivate temperance. Temperance can plausibly be understood as a condition of personal freedom. Consider the following. Intemperance is fueled by *pleonetic* desires—i.e., desires for material gratification and pleasure in excess of one's needs or fair share. In thrall to these desires, a delay or denial of satisfaction is painful or uncomfortable. To allay this pain, we may do things that we believe to be wrong or bad (or, in milder cases of intemperance, we may do what is right or good but only reluctantly).[96] For this reason, Aristotle repeatedly construes

[94] Keith et al. 2010; Gardiner 2011; Jamieson 2013, 533*f.*

[95] Perhaps better put, Aristotle (1998, 1267a1-15) believes that the cure rests in cultivating temperance and redirecting one's remaining desires toward the kinds of pleasures that are unaccompanied by pain (namely, those of philosophy).

[96] The difference here is between *akrasia* and *enkrasia*.

intemperance as a kind of "slavishness."[97] In the grips of intemperate desires, our rational faculty, which Aristotle most closely associates with our personhood, becomes subordinated to our appetites, which are sub-human.[98] On this view, intemperate actions do not follow from a rational will to the good but from a non- or irrational will to indulge our desires, whatever the cost (in way of health or virtue), and however trivial the benefit (recall Gardiner's t-shirt-in-winter example). Typically, when we act intemperately, we are acting against our better judgment, almost as if we are without a choice.

Buddhist doctrine and scholarship similarly links enslavement to intemperance, and freedom or liberation [*moksha*] to the mastery of desire, though for slightly different reasons. So long as we are guided solely by our desires, we will subsist in ignorance and fail to address the sources of our suffering. Escaping *samsara*—the painful cycle of life, death, and rebirth—requires throwing off the yoke of desires (especially those for sensory pleasures); only in this do we achieve the liberation of nirvana.[99] Thus, the *Theranamo Sutra* ends: "Not enslaved by anything, // It is possible to put aside all craving, // Resulting in a life of peace and joy."[100] In short, intemperance gives life to cravings that overwhelm us, and that keep us locked in a cycle of suffering and unfreedom.

Many of the global affluent's *pleonetic* desires are deeply implicated in the climate crisis. To take just one example, the average American consumes about 381g of meat and 756g of eggs and dairy every day. In comparison, the average Indian consumes just 29g of meat and

[97] Aristotle 2009, 1118b15-22, 1118a25-b6

[98] Which is why Aristotle refers to intemperate behavior as counter-rational or irrational. See, e.g., Aristotle 2009, 1119b8-14.

[99] Fronsdal 1998, 164-174; Williams 2002; Samuel 2008.

[100] Hanh 2012, 231

235g of eggs and dairy per day.[101] There are no health-based justifications for this difference; in fact, excessive consumption of animal products is known to cause heart disease, (especially colorectal) cancer, diabetes, obesity, and other serious illnesses.[102] Nor is this difference completely reducible to wealth[103]: the average person in the United Kingdom and in Germany each consumes only 283g of meat per day, despite similar per-capita incomes.[104] Simply put, Americans have excessive appetites for meat and dairy—appetites which contribute enormously to climate change and their own dishealth.[105]

While it may be wrong to say that, in every case, excessive appetites express a kind of unfreedom, it is striking how often our very non-Buddhist, non-Aristotelian culture attributes over-consumption to addiction, cravings, or compulsive eating habits—viz., internal, behavioral tendencies compounded by biochemical cues and social/commercial reinforcement. This strongly suggests a kind of unfreedom—a slavery to unhealthy desires. By contrast, a temperate person (or society) is unbound by compulsion and addiction,[106] and thus free from painful and persistent desires for ever more.

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[101] National Geographic.

[102] Bouvard et al. 2015.

[103] Though meat consumption does track wealth, as the example of China attests.

[104] National Geographic.

[105] Most estimates attribute between 11 and 18% of all emissions to animal agriculture—a figure often exceeding cumulative transportation-related emissions. See, e.g., Steinfeld et al. 2006, xxi; Wellesley, Happer, and Froggatt 2015, vii.

[106] Aristotle 2009, 1118b30-35, 1119a12-20

4. Conclusion

The moral debate over whether or not to engineer the climate centers on the potential costs, benefits, and risks associated with doing so. Proponents argue that geo-engineering could be carried out at a fraction of the cost of abatement. Others doubt this, emphasizing the many co-benefits of abatement, the non-quantifiable costs of geo-engineering (like the loss of blue skies), and the serious hazards associated with a large-scale intervention into a system as complex as earth's climate. Yet, among even the staunchest critics of geo-engineering, few reject the conclusion that, if faced with catastrophe, engineering the climate to lower temperatures would be morally justified. I share this view. But there remains a problem with this conclusion—and with the debate as a whole. By narrowly focusing on costs, benefits, and risks, scholars are unable to explain fully the reservations many (if not most) people have about geo-engineering.

Clarifying these reservations requires thinking outside of the neutralitarian confines of contemporary political discourse. Doing this, I argue that one key issue with geo-engineering is that it follows from, and threatens to sustain, excessive appetites for environmentally destructive forms of consumption. Of course, according to its proponents, geo-engineering offers a way of severing the connection between collective intemperance and its most harmful effects for humans (i.e., global warming). But even if preventing harmful warming were all that mattered for us environmentally, I argue that we would still have reason to resist geo-engineering: i.e., because intemperance leads to injustice and unfreedom.

Unlike cost- and risk-based objections to geo-engineering, this objection is not temporally contingent. Even if geo-engineering were to become the most cost-effective and least risky option, all things considered—as may be the case in the near future—reasonable

people might still regard geo-engineering as tragic, precisely because it follows from, and helps to sustain, collective intemperance (and thus unfreedom and injustice).

This suggests that to evaluate geo-engineering (or any response to climate change) solely in relation to costs, benefits, and risks is to miss an essential part of what's at stake. To uncover this, we must also consider whether a given response is politically and ethically justified. In the case of geo-engineering, this kind of reflection provides a strong basis for demanding immediate and aggressive abatement efforts.

6. Conclusion: Exiting Eden

In *Works and Days*, Hesiod claims that in the first, "golden" era of the Earth, humans (or some proto-human race) "lived like gods without sorrow of heart, remote and free from toil and grief…for the fruitful earth unforced bare them fruit abundantly and without stint."[1] In his treatise on agriculture, Virgil describes a similar time, when

> Fields knew no taming hand of husbandmen
> To mark the plain or mete with boundary-line—
> Even this was impious; for the common stock
> They gathered, and the earth of her own will
> All things more freely, no man bidding, bore.[2]

In Genesis we find more of the same: "Out of the ground the LORD God made trees spring from the ground, all pleasant to look at and good for food."[3] The very name Eden captures this sense of natural abundance—its Aramaic root signifies a place that is "fruitful, plentiful" and "well-watered."[4]

As with Hesiod and Virgil, agriculture in Genesis marks the point of descent from this happy state. Indeed, after Adam and Eve eat the only forbidden fruit in Eden, agricultural toil features centrally in the package of punishments God imposes: "Because you have…eaten from the tree which I forbade you, accursed shall be the ground on your account. With labour

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[1] Hesiod, 114-121.

[2] Virgil, *Georgics*, Book 1: 125–28

[3] Genesis, 2:9

[4] Cohen 2011, 229.

you shall win your food from it, all the days of your life. It will grow thorns and thistles for you…. You shall gain your bread by the sweat of your brow."[5]

Like the Greek myth of the Golden Age and the biblical story of the Garden of Eden, recent archaeological work on the Neolithic Revolution suggests that our earliest human ancestors lived in conditions of natural material abundance, in which agriculture was unnecessary to satisfy basic needs. In fact, anatomically modern human beings (*homo sapiens*) existed for up to 300,000 years[6] before they first began relying on intensive agriculture. Moreover, scholars increasingly believe that this transition made life for many fare more nasty, brutish, and short:

> The fossil record shows that life for [the earliest] agriculturalists was harder than it had been for hunter-gatherers. Their bones show evidence of dietary stress: they were shorter, they were sicker, their mortality rates were higher. Living in close proximity to domesticated animals led to diseases that crossed the species barrier, wreaking havoc in the densely settled communities.[7]

The turn to agriculture also gave rise to serious (and often coerced) labor on a scale that had not existed in traditional hunter-gatherer societies. We can still see this today. A 1966 study of the Ju/'hoansi—a still existing, if increasingly beleaguered, hunter-gatherer tribe in southern Africa—found that the average tribe member worked about 17 hours a week to procure food, and spent about 19 hours a week on domestic chores, while maintaining an average caloric intake of 2300. Compare this to the contemporary American worker, who spends 40 hours a

[5] Genesis, 3:17-19.

[6] Callaway 2017.

[7] Lanchester 2017.

week at work (putting "food on the table"), and nearly 36 hours a week on domestic chores, while consuming roughly the same daily calories.[8]

The cost in extra work and ill health has led Jared Diamond to call the Neolithic Revolution "the worst mistake in human history."[9] What would lead us to make this mistake? Scholars increasingly believe that it was less a choice than a matter of circumstance. About 12,900 years ago, a changing climate abruptly ended an era of natural abundance, forcing many of our ancestors into what one commentator calls "late-Neolithic multispecies resettlement camps."[10] The climatic change occurred when massive ice sheets fractured and fell into the ocean, shutting down the Atlantic thermohaline circuit and causing global temperatures to plunge between 2 and 6°C. In a matter of decades, glaciers stretched down to southern Portugal, and the Northern Hemisphere experienced a severe and protracted drought.[11] This cooling period, which lasted about 1,200 years, is referred to as the Younger Dryas.[12] During this time, communities turned to intensive agriculture as traditional food supplies became far less dependable.[13]

The uptake of agriculture provided the basis for complex social, economic, and political organization—farmers' crops formed the basis of the first tax collections (cereal crops are easy to assess and weigh), and their land the first real fiefdoms requiring protection. A stable means of food production spurred the development of classes (farmers, soldiers, rulers), a precise and consistent division of labor, and the introduction of sciences (especially

[8] Lanchester 2017, citing Suzman 2017.

[9] Quoted in Lanchester 2017.

[10] Scott 2017.

[11] Gardiner 2004, 562-3.

[12] Scranton, 32.

[13] Anderson et al. 2011.

agricultural engineering and meteorology).[14] Eventually, though, the Younger Dryas ended, giving way to current geological epoch—the Holocene. This epoch has been characterized by remarkable climatic stability and relative warmth—evidently the most stable climatic interval in at least 650,000 years.[15] The favorable conditions of the Holocene could have supported a return to hunting and gathering. Yet—perhaps because our post-agricultural populations had grown too large or institutional inertia had become too great—once the glaciers of the Younger Dryas receded, humans remained largely agricultural.

Our species nevertheless began to flourish in a different way during this second, fecund period. Virtually every work of art and scientific discovery, and all of our written history and major civilizations were produced during this time. Babylon, the airplane, penicillin, Wagner, the Kama Sutra, Sappho, Rome, the Olmec, constitutional democracy, the Catholic Church, Al-Farabi, the Japanese Shogunate, Egypt, the Huns, Nazis, Napoleon, the novel, nuclear bombs, Buddha, and Beethoven are all products of the Holocene. What makes this so remarkable is that the Holocene has been a very short episode in our species' history (not to mention geologically). As Roy Scranton aptly puts it: "If human existence on Earth were a day, our approximately five millennia of recorded history would take up the last half hour before midnight."[16]

Providing amply for our needs, while supporting an astounding array of cultural and bio-diversity, the Holocene has proved to be its own kind of Golden Age—even if our divisions of labor, social stratifications and oppression, and political conflict have sometimes

[14] Scott 2017. See also, Scranton, 32.

[15] Scranton 38, citing Archer, 130.

[16] Scranton, 33.

obscured the fact. Sadly, without immediate and drastic action, we will (soon) be exiled from this second Eden into a new epoch marked by severe scarcity, conflict, and collapse.

What accounts for this second fall? Perhaps the crucial moment was James Watt's invention of the steam engine in 1781. Fueled by England's vast supply of coal, the steam engine powered the Industrial Revolution by providing a portable, efficient, and continuous source of energy.[17] Hence, rapid industrial development became tied to the combustion of fossil fuels. Two centuries later, fossil-fuel industrialization is globally ubiquitous, providing for an unprecedented accumulation of wealth *and* atmospheric GHGs.

The climatic consequences of this are everywhere around us. For as far back as we can measure accurately (about 800,000 years), atmospheric concentrations of carbon dioxide (CO_2)—one of the most prevalent GHGs—never exceeded 300 parts-per-million (the pre-industrial average was about 290 ppm). Today, however, it is well above 400 ppm, and steadily rising.[18] Similarly, atmospheric concentrations of methane (CH_4)—an even more potent, if shorter-lived GHG deriving chiefly from animal agriculture and fracked-gas production—have nearly *tripled* since the Industrial Revolution, far exceeding any previous high in the 800,000-year ice-core record.[19] The last time Earth's climate had a similarly dense concentration of CO_2 and CH_4 was about 3 million years ago in the Mid-Pliocene era.[20] During that time, sea levels were 50–82 feet higher and global temperatures were about 2–3°C hotter.[21] This would, itself, be disastrous. Yet, if we continue on our present path, by the end of the

[17] Scranton, 34.

[18] Wagner and Weitzman, 49–51.

[19] Lüthi et al. 2008.

[20] Scranton, 34. Oburgn 2013.

[21] IPCC, AR4, WGI, chapter 6.3.2.

century we may reach GHG concentration-levels not seen since the Paleocene-Eocene Thermal Maximum (PETM), which occurred around 55 million years ago.

During the PETM, huge amounts of carbon and methane were released into the atmosphere over a period of 10,000 to 20,000 years—rapid on a geological scale.[22] Temperatures rose quickly, peaking at about 5–8°C above pre-PETM levels.[23] This was enough to sustain sea-levels 300 feet higher than today's, and to enable palm trees and crocodiles to flourish near the arctic circle.[24] Temperatures did not return to prior levels for almost a million years.

Today we are emitting GHGs ten times faster than they were released during the PETM.[25] Without serious changes, there is roughly a 10% chance that temperatures could increase 6°C *by the end of the century*.[26] In other words, we may force a PETM-like shift not over tens of thousands of years, but in a matter of decades. The effects of a change so momentous and so rapid are unfathomable (because they are unprecedented). But we can certainly expect large-scale ecological collapse, massive loss of biodiversity (exacerbating the "sixth mass extinction event" we are already experiencing), more frequent and violent extreme weather, mass displacement of people and animals, and agricultural collapse. And this is just from linear warming. Even more dramatic and abrupt changes ("tipping points") may occur along the way, including the rapid disintegration of the Greenlandic and West Antarctic Ice Sheets. If

[22] Why this occurred is still unclear, though increasingly scientists think it had to do with large-scale volcanic eruptions (Painting 2011; Cui et al. 2011).

[23] IPCC, AR5, WG1, chapter 5.3 (esp. pp. 399); McInerney and Wing 2011.

[24] Scranton, 35.

[25] Penman et al. 2014.

[26] Wagner and Weitzman, 53.

this were to happen, the Atlantic thermohaline circuit would likely shut down, putting Europe under thick glacier cover in as little as 10 years, much as occurred during the Younger Dryas.[27]

These changes would cause unimaginable suffering. As water disappears and crops wither in the field, people will face a situation in which the only way to meet their basic needs is by denying others the ability to do the same. On a large enough scale, this kind of extreme scarcity precipitates political catastrophe. For in such zero-sum conditions, it becomes impossible to sustain principles and relations of justice—viz., fair terms of social cooperation, mutual aid, and reciprocity must inevitably break down. Once this occurs—that is, once justice no longer meaningfully applies—even the most robust social and political orders cannot be preserved.

Thus, whereas the climatic changes that lead to the Neolithic Revolution made justice and stable political order necessary (by transforming a state of natural material abundance into one in which larger-scale social cooperation was necessary to satisfy everyone's basic needs), the climatic changes following from the Industrial Revolution threaten to make justice and political stability impossible (by plunging us into a state of extreme and enduring scarcity, in which people can satisfy their basic needs only by denying others the ability to do the same).

Whether or not most of our species realizes it, we live in a time of great exigency. Our window to prevent moral and political catastrophe is closing; if we continue on our current path, many alive today will witness the politics that extreme scarcity breeds—new modes of authoritarian coercion, neo-colonial domination, international conflict, and (eventually) collapse. We will have to reckon with the moral anguish of leaving others—especially, our

[27] I discuss these possibilities in chapter 2 and 4.

children and subsequent generations—vulnerable to thirst, hunger, conflict, and premature death.

This manuscript attempts to walk back from this precipice of despair by intervening in several key debates surrounding climate justice, precaution, and policy. This starts in chapter 2, where I argue that, for certain problems, we must prioritize precautionary efficacy over fairness or equity. This reverses the standard, if often implicit, view in the literature, which regards the fair distributions of costs as a precondition of cooperation—on climate change as with most other issues. This view cannot be sustained in the context of climate change. For after decades of inaction, it may no longer be possible to prevent climate catastrophe except by imposing heavy (and potentially unfair) burdens on the least well-off. This is particularly clear intergenerationally: averting catastrophe requires immediate action, whether or not the costs of that action can be deferred onto richer, future generations. But it may also be true contemporaneously: viz., it may be necessary to impose costs or developmental delays on poorer, but heavily emitting states like China and India. Chapter 2 argues for subordinating fairness or equity whenever the material conditions that make justice possible themselves are at stake—i.e., whenever the alternative is political catastrophe. On this view, precautionary efficacy becomes the organizing value of social cooperation.

Chapter 3 considers how taking the prospect of politically catastrophic climate change shifts the future discounting debate. Discounting helps to clarify the limits of precaution by telling us how much we should sacrifice today to prevent a given loss (or attain a given benefit) at some point in the future. Permitting some simplification, there are two main camps in this debate. On one side are most economists who support a positive rate, which places a higher value on present welfare; on the other are most ethicists, who support a zero rate, which treats present and future welfare as equally valuable. I reject both, arguing instead for a low *negative*

rate. A negative rate, I claim, best reflects a commitment to preventing catastrophe, both theoretically and practically. The theoretic advantage of a negative rate is that it places a higher value on future costs and benefits than present ones, which we should do if there is a reasonable chance the future will be characterized by extreme scarcity. The practical upshot of a negative rate follows from this. Discount rates form the basis of carbon taxes, with taxes increasing as rates decrease. A negative rate would make emitting GHGs very expensive, thus disincentivizing further emissions.

Of course, a negative rate imposes significant costs on present generations. This raises the following question: given serious inequalities between and within states, how should these costs be allocated? I take up this question in chapter 4. Perhaps the most popular answer is given by the polluter-pays principle (PPP), which stipulates that those responsible for causing the problem should pay to address it. While intuitively plausible, scholars have subjected the PPP to extensive criticism. Their chief complaint is that the PPP is regressive: it puts burdens on those least able to bear them. This is correct *if* we adopt standard, production-based emissions-accounting models. Yet, I argue, if we allocate burdens in proportion to annual consumption-based emissions, the result is considerably fairer—because it places burdens on wealthy states, which are typically the biggest consumers—and more environmentally effective—chiefly because it helps solve the problem of "carbon leakage." I call this revised PPP the "consumer-pays principle." While the consumer-pays principle outperforms standard formulations of the PPP, it remains incomplete in one key respect: it cannot allocate burdens in the (distant) future, when climate change endures but consumption emissions are low. I therefore supplement it with an ability-to-pay principle, which requires that all remaining burdens be shouldered by the wealthy, in proportion to their wealth. The end result is a pluralist, bi-phasic account of climate justice that covers all the major climate burdens

(mitigation, adaptation, and compensation for loss and damage) while remaining sensitive to states' differing contributions and capacities. Chapter 4 shows that although efficacy is our primary concern, fairness still plays an important role in the moral-political calculus.

As climate catastrophe has become more likely, scientists have begun researching emergency "back-stop" solutions for cooling the planet. These are often referred to under the collective header of "geo-engineering," i.e., the deliberate, large-scale manipulation of the Earth's climate system. Although scientists have discussed many possible geo-engineering schemes, the most prominent proposal involves mimicking a volcanic eruption by injecting sulfate aerosols directly into the stratosphere. Stratospheric sulfate injection (SSI) promises to quickly and inexpensively cool the planet. Yet, SSI comes with some serious risks and costs. For this reason, most agree that it should be deployed as a measure of last resort. But should that moment come—when conventional abatement measures are no longer adequate for preventing catastrophic climate change—virtually everyone agrees that geo-engineering would be morally justified and perhaps even requisite. Chapter 5 shares this view, but claims that this should not mark the end of our ethical reflections. For even if we are confident that it is *right* to deploy geo-engineering under certain (exigent) circumstances, I argue, we might still question whether deployment is ethically justified (i.e., whether it is *good* to do). This kind of ethical reflection, I argue, is necessary for understanding the deep unease many feel about geo-engineering quite apart from its relative costs, benefits, and risks. It also helps clarify why reasonable people might accept the moral necessity of geo-engineering under particular circumstances, yet nonetheless think such an outcome tragic.

I argue further that neutralitarian political theorists will have difficulty explaining this sense of tragedy. Appeals to precaution only partially explain these feelings. To provide a fuller picture, I recruit insights from classical Buddhist and Greek thought, and argue that one key

issue with geo-engineering is that it follows from, and threatens to sustain, excessive appetites for environmentally destructive forms of consumption. This kind of intemperance is problematic, I claim, because it inevitably results in unfreedom and injustice. We become unable to control our appetites even as they gravely harm us, or cause harm to others. Unlike standard cost- and risk-based objections to geo-engineering, my argument is not temporally contingent. Even if geo-engineering were to become the most cost-effective and least risky option, all things considered—as may be the case in the near future—reasonable people might still regard geo-engineering as tragic and unattractive, precisely because it follows from, and helps to sustain, collective intemperance (and thus unfreedom and injustice). This conclusion helps strengthen the case for exhausting conventional emissions-reductions options, and for continuing to view geo-engineering as a measure of last resort—taken "out of despair only."[28]

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These chapters mark only the beginning of a fuller political theory of climate catastrophe. As I note in the introduction, the prospect of climate catastrophe challenges ordinary ways of thinking about fairness, liability, obligation, virtue, the value of democracy, and our relationship to the natural environment, among other core features of contemporary political ethics.

Consider, for instance, the argument—notably defended by James Lovelock—that democratic states are fundamentally incapable of addressing large-scale problems like climate change, and thus that a new green authoritarianism may be warranted.[29] Understanding the limitations of democratic responses to catastrophe and ways of addressing those limitations is

[28] Schellnhuber 2011, 20277-8; See also Hamilton 2013, 49&*n.*

[29] Hickman 2010; Dobson, 112.

crucial for responding to arguments like Lovelock's and defending the continued legitimacy of representative government—assuming, of course, that it should be defended.

We must also soberly countenance the fact that effectively addressing climate change at this late stage will likely require some emergency measures that conflict with individual rights. Determining how to navigate these conflicts is an essential task for political theory. For instance, can we suppress climate change denialism? Or lifestyles characterized by excessive or conspicuous consumption? If so, how does this cohere with widely held commitments to neutrality about the good life?

Consider also recent reports showing that, if we are to prevent catastrophic climate change, we must keep the vast majority of known fossil-fuel reserves in the ground. Does justice require us to compensate the oil barons and energy executives who own these reserves? Or, rather, does it require us to punish them for continuing to invest in dangerous assets long after their harmful nature became clear? We might worry similarly about workers in fossil-fuel industries: does justice require aiding them during the transition to a carbon-free energy system? Answering these questions requires engaging problems of corporate agency and volition in capitalist marketplaces, and examining how standard justifications for property rights fare under exigent circumstances. Paired with empirical research into the tobacco and chlorofluorocarbon industries, this work could help establish a broader theory of transitional justice in an era of imminent (climate) catastrophe, with specific principles for regulated industrial decline.

Addressing these questions will also require engaging broader debates over personal responsibility. Ultimately, we all contribute to climate change, if often in mundane ways: by, e.g., heating or cooling our homes, consuming animal products, or traveling. Determining whether or not people have a moral duty to stop or limit such actions depends considerably

on how we understand the nature of the harms being caused and the intentions of the agents in question. These points remain contentious. Yet, I argue, invoking moral responsibility may be unnecessary to motivate individual action. Rather, if climate change presents an existential threat to political stability and just social cooperation, then our responsibility to address it may be better understood on the model of conscription during a just war or aid during a disaster-relief effort—i.e., as a shared, positive duty that can be justifiably allocated by the state, and that is unrelated to culpability for past actions. Although important work has already been done on this question, future research could reflect more deeply on how the prospect of catastrophe shifts standard assumptions about what individuals should (be made to) do.

More radically, we must rethink the role of anthropocentrism in contemporary political thought. Doing this will clarify the duties we owe to individual animals and species, who, in many ways, face more harm from climate change than humans. It may also provide insight on the broad range of environmental concerns that do not always or directly impact human-beings, like the preservation of wilderness areas.

These questions will remain relevant regardless of the path practical politics takes in the coming decades. For the climate crisis has revealed to us the fragility of the natural environment. Our continued disregard of ecological limits not only imperils those alive today, but the possibility of life for millennia to come. Climate catastrophe is an almost divinely destructive force, a shard of hell, and we must do everything we can to confront it.

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