



## UvA-DARE (Digital Academic Repository)

### The Social Cost of Carbon, Abatement Costs, and Individual Climate Duties

Hickey, C.

**DOI**

[10.1080/21550085.2022.2133939](https://doi.org/10.1080/21550085.2022.2133939)

**Publication date**

2022

**Document Version**

Final published version

**Published in**

Ethics, Policy and Environment

**License**

CC BY-NC-ND

[Link to publication](#)

**Citation for published version (APA):**

Hickey, C. (2022). The Social Cost of Carbon, Abatement Costs, and Individual Climate Duties. *Ethics, Policy and Environment*. <https://doi.org/10.1080/21550085.2022.2133939>

**General rights**

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

**Disclaimer/Complaints regulations**

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

# The Social Cost of Carbon, Abatement Costs, and Individual Climate Duties

Colin Hickey 

University of Amsterdam, Institute for Biodiversity and Ecosystem Dynamics, Amsterdam, The Netherlands

## ABSTRACT

In this paper I examine the relation between Social Cost of Carbon (SCC) estimates, abatement cost analyses, and individual climate duties. I first highlight the stakes that SCC and abatement cost estimates potentially have for the content of individual duties to either pay the full or fair cost of their carbon emissions, or offset the volume of their emissions. I survey four methodological options (a minimalist approach, a precautionary approach, an averaging approach, and what I call a 'sufficiency-bounded' precautionary approach) for conceptualizing the terrain of individual duties in light of SCC and abatement cost estimates that are both contentious and evolving.

## KEYWORDS



Climate change; individual duties; Social Cost of Carbon; abatement costs

## Introduction

Normative work on climate change requires a good understanding of the toll of its damages, as well as the burdens of potentially avoiding them. Two of the most important concepts in climate ethics, policy, and economics to help provide such understanding are the Social Cost of Carbon (SCC) and the notion of abatement costs. In this paper, I examine the relationship between individual climate duties and SCC and abatement cost estimates. I raise a range of methodological considerations about how to conceptualize various proposals for individual climate duties in light of SCC and abatement cost estimates that are variable, contentious, and evolving.

The Social Cost of Carbon reflects a monetized estimate of the total damages incurred from the emission of an additional ton of CO<sub>2</sub>. It can be used to establish the baseline costs of unmitigated climate change, as well as provide an assessment of the costs averted by mitigating climate change through reduced emissions. In principle, the SCC is meant to indicate the 'optimal' carbon tax and show, via a price mechanism, how to internalize the globally problematic externality associated with carbon emissions.<sup>1</sup>

Abatement costs, on the other hand, reflect how much it costs to reduce or eliminate a certain amount of CO<sub>2</sub> (usually per ton). The cost of abating a ton of CO<sub>2</sub> varies by emission source or intervention (as well as geographic factors), so for policy purposes abatement cost estimates are typically depicted in terms of 'cost curves' (e.g. McKinsey & Company, 2009) which arrange various emission sources or interventions according to the cost of abating a ton from the respective source, alongside the total abatement potential

**CONTACT** Colin Hickey  [c.j.hickey@uva.nl](mailto:c.j.hickey@uva.nl)  University of Amsterdam, Amsterdam, P.O. Box 94240 1090 GE The Netherlands

© 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.  
This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

of each source (i.e. the number of tons of emissions that can be eliminated from the source).

Together SCC and abatement cost estimates provide crucial insight into the benefits of reducing emissions (or costs of failing to do so) as well as the resources required. Generally, discussions of SCCs and abatement costs are conducted from the perspective of public policy.<sup>2</sup> They are meant as tools for governments, policy-makers, and other large-scale, collective actors to craft efficient climate policy.

In this paper, I turn the standard perspective around, and consider how SCC and abatement cost estimates might interface with individuals, particularly the content of their climate duties, instead of with an eye toward policy. There are many who think that climate responsibility is fundamentally located at the collective level, and therefore not the job of individuals to attend to such things. On this view, individuals might have duties to work toward collective solutions, but prior to the existence of a specific policy or a regulatory scheme facilitating it, they shouldn't be thought of as having any direct duties to, e.g. reduce their own emissions, pay the full cost of them, or offset them by paying for reductions in emissions elsewhere.<sup>3</sup>

On the other hand, a wide range of scholars (and lay people alike) do take seriously individual duties to reduce emissions, internalize their cost, or offset them, even prior to the existence of legal requirements like a tax, carbon ration, or some other coercively enforced mechanism.<sup>4</sup>

My goal in this paper isn't to settle the dispute between these two camps. Instead, it is to interrogate the implications that SCC and abatement cost estimates might have for views which do endorse these kinds of individual duties. It is therefore meant as an internal discussion to such views, bracketing skepticism about the existence of such duties. Ultimately, it may be worthwhile to consider whether certain progress or clarity with respect to SCC or abatement cost estimates could help *provide* (or bolster) an argument for the existence of individual duties to the skeptics.<sup>5</sup> However, persuasively doing so is beyond the scope of this paper.

Instead, among those already committed to these kinds of individual climate duties, the paper aims to inquire how we should understand their content in light of the contestation, variability, and uncertainty of SCC and abatement cost estimates. In order to discharge such duties, what price(s) should we be paying, either to internalize the costs of our emissions or offset their volume? How should individual moral agents navigate the diverse and evolving range of price estimates, and the dramatically different action-guiding requirements they would issue?

To think through such questions, in Section Two I clarify how SCC and abatement cost estimates intersect with views of individual climate duties to reduce, offset, or pay the full/fair cost of our carbon emissions. Doing so highlights the potential stakes of SCC and abatement cost estimates for the content of those duties. In Section Three, I survey a range of methodological options for conceptualizing the terrain of individual duties in light of contentious and evolving SCC and abatement cost estimates and methodologies. I consider the reasons for and against taking a minimalist approach, a precautionary approach, an averaging approach, and what I call a 'sufficiency-bounded' precautionary approach. Rather than a clear and decisive solution, Section Four concludes with some parting thoughts about moving forward in this domain.

## The Stakes: SCCs, Abatement Costs, and the Content of Individual Climate Duties

In this section, I briefly explain the ways in which SCC and abatement estimates might matter greatly to the specification of the content of individual climate duties. To begin, it is worth distinguishing between four different types of individual climate duties that proponents might have in mind.

*Duty to reduce.* In the first instance, proponents of individual climate duties might simply have in mind a duty of individuals to reduce their direct carbon emissions, for example by adjusting their behavior or finding less-emissive alternatives (see Baatz, 2014, esp. p. 15). How extensive the reductions might be will vary according to the theorist, and we need not try to settle an answer here. The most important takeaway, for our purposes, is that this kind of individual duty will remain largely untouched by the details or specification of SCC or economy-scale abatement cost estimates (at least not directly), so my attention will focus on the subsequent three kinds of individual duties.<sup>6</sup>

*Duty to offset.* Additionally (or alternatively), some might have in mind a duty to offset the volume of one's emissions. For example, in John Broome's landmark book, *Climate Matters*, he argues that individuals have a duty of justice to have net zero carbon footprints. This doesn't require eliminating all emissions, per se, but instead involves a combination of reducing emissions and 'offsetting'. Of course, one could also defend a duty to offset some but not all of one's emissions. While there is a nest of complications regarding the theory and practice of carbon offsetting (see Cripps, 2016; Hyams & Fawcett, 2013; Jamieson, 2014), offsets essentially serve as a way to purchase a reduction in carbon emissions elsewhere in the carbon cycle to compensate for one's own emissions. That might amount to funding renewable energy generation or efficiency projects, supporting carbon sinks (e.g. preventing deforestation or supporting reforestation or afforestation), or countless other options.<sup>7</sup> Duties to offset will be primarily affected by variation in abatement cost estimates/options, rather than SCC estimates.

*Duty to pay full cost.* On the other hand, in contrast to a duty to offset the volume of one's emissions, some might have in mind a duty to pay the full cost of whatever emissions one produces. Again, this kind of duty could be paired with either (or both) of the first two types.<sup>8</sup> Moreover, instead of being most affected by abatement cost estimates, this kind of duty is particularly sensitive to variations in SCC estimates, as it is the SCC that will fill in the content of what paying the 'full cost' means.<sup>9</sup>

*Duty to pay fair cost.* Lastly, rather than a duty to pay the *full* cost of their emissions, some might have in mind an alternative duty to pay a *fair* cost for one's emissions. As with the previous duty, an understanding of the fair cost of one's emissions will also heavily rely on specifying the SCC. But it will supplement that estimate with other considerations, such as about how responsible one is for the emissions (perhaps responsibility should be distributed and therefore part of the cost shared), or one's ability to pay the cost relative to other needs (wealthy persons might be in a position to pay the full cost, or an even higher price, whereas a fair price for someone less well-off might be lower).

These last three conceptions of individual climate duties (i.e. to offset, pay the full cost, or pay a fair cost for one's emissions), all essentially function like different forms of a private carbon tax—one that is intended to be morally justified even if not politically implemented. In the abstract, the philosophical content of each kind of duty can be

understood without reference to abatement cost or SCC estimates; that is, as a duty to offset *whatever* carbon emissions one uses, a duty to pay the full cost of one's emissions, *whatever that might be*, or a duty to pay the fair cost of one's emissions, *whatever that might be*.

However, in order to figure out what any of that means, concretely, it is necessary to know how to fill in those placeholders. For instance, how much would we need to spend on offsets to follow Broome's understanding of the duty to have net zero emissions? What is the full (or fair) cost of one's emissions, such that one could theoretically pay it? And how would one actually attempt to pay it? Establishing answers to such questions is the critical step for providing meaningful action-guidance. It will also reveal how demanding the duty actually is, which may be relevant to the plausibility of the existence of the duty itself.<sup>10</sup> With an eye toward this level of practical action-guidance, the details, and particularly the *variability*, with respect to abatement cost and SCC estimates take on potentially significant normative weight.

Beginning with the latter, over the years there have been countless efforts to produce SCC estimates. Often, these attempts employ integrated assessment models (IAMs), which combine socioeconomic projections, with models of how the climate will change in response to CO<sub>2</sub> emissions, how much damage such changes will do, as well as an assessment of how much to discount future costs in current dollars. Variation in methodology and assumptions along each of these dimensions can result in figures that range orders of magnitude; from a few dollars per ton, to a few hundred (for a brief sample of this variation see, Nordhaus, 2017, esp. his table 1).<sup>11</sup>

Tasked with determining the SCC for the U.S. Government, the Interagency Working Group (IWG) on the Social Cost of Greenhouse Gases combined the outputs from three main integrated assessment models (DICE, FUND, and PAGE) in order to generate its estimate (National Academies of Sciences, Engineering and Medicine, 2017). For 2020, after being disbanded by the Trump administration, the Biden administration adopted the IWGs 'interim' estimate of \$51/tCO<sub>2</sub>.<sup>12</sup> Even in adopting this figure, the IWG recognized a range of estimates based on variation in the discount rate that span an order of magnitude (including the 95<sup>th</sup> percentile value of \$152, at a 3% discount rate, a price that would go even higher with a lower discount rate, which many favor), and explicitly acknowledge that their ranges 'likely underestimate societal damages from GHG emissions'. Many scholars agree, and argue for a significantly higher SCC. Carleton and Greenstone (2021) argue that, pending the full IWG update, it should immediately be raised to \$125. Moore and Diaz (2015) have suggested that implementing temperature effects on economic growth assumptions in modeling would result in a SCC of \$220. Modeling from Katherine Ricke et al. (2018) suggest that the figure should be \$417.<sup>13</sup>

Needless to say, these differences, if attached to an individual duty to pay the full cost of their emissions, can result in significantly different real-world specifications of the duty. For an American emitting 15 tons of CO<sub>2</sub> a year, the IWGs \$51 figure would amount to an annual price of \$765 to discharge the duty. On the other hand, a SCC at the IWG's 5% discount rate of \$14 would amount to an annual price of \$210 for that same individual, and at the \$417 figure defended by Ricke, et al., would balloon to \$6,255. Such divergence would also affect the duty to pay a fair cost for one's emissions, depending on how fairness considerations suggest departures from the full cost.

Before going further, let us also briefly consider the potential stakes of abatement cost estimates for individual duties. At one level, the duty to offset the volume of one's emissions (where abatement costs are more relevant) is much simpler than trying to estimate the actual social cost of one's emissions. All of the controversies about discount rates, uncertainty about climate sensitivity, and assumptions involved in estimating damages can be functionally black-boxed, if focused exclusively on offsetting the volume of emissions. This isn't to say that someone concerned with trying to specify individual climate duties should default to abatement costs and duties to offset. In fact, there are very good reasons to want to understand the full scope of the moral harms and damages of noncompliance, which invites the complications back in, even on a duty to offset.<sup>14</sup> But regardless, attempting to specify the duty to offset the volume of one's emissions must navigate its own form of variability associated with abatement cost estimates. First, abatement costs can vary by orders of magnitude between different emissions sources or interventions (Gillingham & Stock, 2018, p. 59; McKinsey & Company, 2009). Second, even among the same kind of source or intervention, abatement costs can vary by at least an order of magnitude depending on local geographic and economic facts (Aldy et al., 2016; Gillingham & Stock, 2018; Hof et al., 2017; McKinsey & Company, 2009). Third, abatement costs of different emissions sources and interventions are dynamic through time, which complicates the duty to offset the volume of one's emissions because frontloading offsets of the same volume could be orders of magnitude cheaper than offsetting at intervals throughout the duration of the individual's emissive behavior.<sup>15</sup> Moreover, any discrete estimates along these dimensions all rely on technological/engineering, economic, political, and behavioral assumptions (Gillingham & Stock, 2018; Kesicki & Ekins, 2012). Adjustments to any of these can lead to variation in both the cost estimates, and in principle to our epistemic confidence of the true 'additionality' of some proposed offset effort (i.e. to ensure that the reduction in emissions is actually additional to what would have happened without one's offset).

Abatement cost estimates are policy tools, not direct options for individuals to offset. For that, there are markets where one can purchase individual offsets that attach to discrete carbon abatement projects. As mentioned above, there are concerns about offsetting markets in general, but regardless there are reputable organizations, backing quality projects, with high standards for additionality.<sup>16</sup> Purchasing individual offsets through such organizations might range between \$10-30/tCO<sub>2</sub>, which is both significantly less variable than between SCC estimates or within economy-wide abatement cost curve estimates. However, in order to truly understand the moral content of the duty to offset the volume of one's emissions we have to consider the whole range of variation among abatement cost estimates across the economy, not just the lower and relatively narrow band of the current offset market. There might be reasons why abatement cost estimates of particular emissions sources or interventions, or in particular geographical locations, or at particular time frames are relevant for determining an individual's duty to offset that looking merely to the offset market obscures. For instance, some less efficient projects might be an important part of one's duty to offset because of special obligations accrued in the production of the emissions, or as part of fair burden-sharing of necessary decarbonization costs rather than capitalizing on the cheapest options. Even though not all of these options will be accessible markets to individuals for offsetting, understanding their dynamics might be relevant for adjusting the quantitative or qualitative demands they

face on the offsetting market that is accessible. Or consider the temporal frontloading point. Could an individual fulfill their duty by purchasing a lifetime of offsets at a low price, and then live an emmissively profligate life as the price precipitously rises? On one hand, early adopters help the market settle and help establish new norms, on the other, doing so might confer an unfair advantage to early adopters, capturing all the 'low-hanging fruit'. I won't settle these issues fully here, but the broader point is that there are morally relevant questions and assumptions that need to be interrogated, which require looking at the full range of variability in abatement costs, not just what is contained within the current offset market.

From all of this, we can see that the details of estimating abatement costs and the SCC have the potential for significant downstream effects on views that maintain individuals have duties to offset and/or pay the full or fair price of their emissions.

## Methodological Responses

Given the contention and variation among experts, continually evolving estimates, and the complicated normative and empirical assumptions at play, we sit in a position of significant uncertainty with respect to the prospective content of individual duties. In this section, I survey a range of methodological options for navigating this landscape. The four approaches I examine are not exhaustive options, of course, but they help carve up the normative terrain in an informative way that together serve as an important step for clarifying, narrowing, or specifying individual climate duties.

### *The Minimalist Approach*

At one end of the spectrum, we might take this position of uncertainty, contestation, and variability to direct us toward a minimalist interpretation of individual duties. For duties to pay the full or fair cost of one's emissions that might mean that individuals are *obligated* to pay only the most conservative reasonable estimate for their use of carbon. Of course, what counts as minimally 'reasonable' invites further questions, both morally and epistemically. Would a 5% discount rate and SCC of \$14/tCO<sub>2</sub> count? Or might it mean the IWGs \$51 figure which they admit is already likely an underestimate (Interagency Working Group on Social Cost of Greenhouse Gases, 2020, p. 5)?<sup>17</sup> In presenting the minimalist methodology as a category, I don't mean to settle that issue here. However, it is important to constrain the minimalist approach by some notion of reasonableness, to foreclose someone using a 10% discount rate to estimate the SCC, essentially eliminating the duty in clearly unmotivated way. Exactly what it would mean to actually 'pay' any discrete SCC estimate without a carbon tax to price it into one's emissions is also worth consideration. One straightforward and accessible way might be to purchase a fixed dollar value of offsets corresponding to one's emissions and the relevant SCC, even if that translates to more reductions through offsets than one has emitted, given the current offset market price.<sup>18</sup> But there are other options to consider as ways to approach paying the full or fair cost of one's carbon, such as direct aid or funding for adaptation efforts rather than mitigation projects. Doing so would rely on alternative pricing strategies for such efforts, and invite further complications beyond our scope, but it is worth mentioning. In that case, the SCC wouldn't alone clarify the contours of an individual's duty to pay the full/fair



cost of their emissions, but instead function to set a monetary (or perhaps demand-ness-equivalent) target.

For duties to offset the volume of one's emissions the minimalist approach might amount to a permission to offset at the lowest cost on the certified market, regardless of source, location, or project; or include no fairness constraints on frontloading, such that someone could offset at a significantly lower price than it would be at the time of subsequent emissions.

On the minimalist approach, abiding by a higher SCC estimate, or accepting more constraints and paying higher offset prices would be *supererogatory*. It might be virtuous or praiseworthy, but wouldn't be *required* as part of one's duty (at least until such a price is fixed in an authoritative legal structure).

This approach is bound to be appealing from one angle, as it generates the least invasive outcome for individual duties. While I've been assuming the existence of such duties for the sake of argument, generating a less demanding duty decreases potential defeaters to the duty, thereby making the case more plausible that it actually is a *duty* proper (rather than a mere benefit or reflection of good character). Depending on how secure or fragile one finds the foundation of such duties, the strategy one takes to fill in their content may be relevant.

Although the minimalist approach requires a lower justificatory burden for the duty's existence, which may be a boon, there are also significant concerns associated with this strategy. Most glaringly, there are concerns regarding the rationality of the decision procedure to take the minimalist approach and the magnitude of moral risk it is willing to tolerate. It amounts to a substantial moral gamble, which is likely to be indefensible both rationally and morally.<sup>19</sup>

Particularly in settings involving conceptual or epistemic vagueness, Newey (2016) has recently highlighted the risk of 'self-serving bias' infecting our judgments about fairness. Self-serving bias is what psychologists and economists have come to call our tendency to subconsciously identify the option that is most beneficial to ourselves and (sincerely) judge it to be fair, all-things-considered – often by glomming on to some third-personal consideration in favor of the option and using that as a cudgel to justify or rationalize the option. As Newey argues, this bias becomes more evident as situations get more complex and the ideas or norms at play show more vagueness. The complexity articulated above regarding the assumptions and considerations at play in SCC and abatement cost estimates makes this setting particularly ripe for self-serving mechanisms to be operational, and should raise warning flags for the minimalist approach.

Perhaps a select few individuals who are experts involved in generating SCC estimates or assessing abatement costs may (depending on one's theory of expert disagreement) be justified in steadfastly holding to their initial estimates, if at the low end of the spectrum.<sup>20</sup> That would, of course, take a substantive and controversial position in the literature on disagreement, and nevertheless only apply to a very select subset of individuals.<sup>21</sup> Rather than being engaged in peer disagreement, the rest of us will have to depend on testimony. Without well-formed and epistemically responsible initial judgments about the SCC or relevant abatement costs and what kind of offsetting price we should be paying, pursuing the minimalist account seems to be a rationally defective decision procedure that illegitimately ignores the weight of expert evidence pushing against the



minimalist's result; evidence that most are not in a position to rationally dismiss or discount.

Furthermore, we should be concerned with the magnitude of moral risk the minimalist approach accepts. Because the minimalist approach, by definition, uses a cost estimate at the lowest end of the spectrum, the probability that one ultimately underpays is high.<sup>22</sup> Moreover, if the actual social cost of emissions is significantly higher (as many scholars seem to think), one could in fact dodge many *thousands* of dollars of un-internalized externalities, which seems particularly unfair. Given the alternative approaches to the uncertainty we will examine below, it seems negligent to adopt the minimalist approach, even if we can't know the details of the unfairness in advance. Similarly for a duty to offset the volume of one's emissions. While there is less variation on the offset market and therefore a smaller potential gap among prices, if there are significant fairness constraints on what offset price one is permitted to pay (e.g. to distribute the abatement costs across different emission sources or locations to prevent the unfairness of early adopters getting all the 'low-hanging fruit'), the minimalist approach would still position individuals with significant risk of under paying.

At the fundamental geophysical level, it can be easy to casually overlook a prospective moral wrong of emitting a few tons of CO<sub>2</sub> without paying the full/fair cost of their externalities or offsetting them by volume (Broome, 2019). It's just a tiny drop in the bucket leading to climate disruption. But when we start integrating those emissions with SCC or abatement cost estimates and realize what it amounts to (e.g. someone potentially illegitimately benefitting by *thousands of dollars* by paying a SCC a few orders of magnitude lower than the real SCC), it is easier to feel the force of the proposed wrong and see the free-riding in full relief. We can start situating it against things like committing thousands of dollars of tax fraud, or skimming thousands of dollars in extra income from one's workplace.

We can, and indeed must, tolerate *some* moral risk in life. But there are irresponsible ways to approach moral risk and this seems to be one of them, especially when situated among alternative strategies to coping with the controversies and reasonable expert disagreement about SCC or abatement cost estimates.

### **Precautionary Approach**

On the other end of the spectrum, we might take the uncertainty and variability of SCC and abatement cost estimates to push in the opposite direction and approach the problem from a precautionary perspective, such that the content of one's individual duty would be specified at the highest reasonable ranges. Unlike the minimalist approach, doing so takes seriously, and essentially eliminates, the moral risk of unfairly underpaying.<sup>23</sup>

If the minimalist was overly accepting of moral risk, and thereby not demanding enough, the precautionary approach might not tolerate enough moral risk and, symmetrically, be problematically *over-demanding*. While individuals would be very likely to pay the true cost of their emissions, that guarantee brings with it very hefty carbon bills and a real risk of overpaying.<sup>24</sup>

Of course, some duties just are burdensome and their demands don't necessarily weigh against their deontic status. It may simply be a fact of moral life in a tragic and broken

world. That said, by significantly increasing the demandingness (and risk of its being over-demanding) this approach strengthens justificatory requirements for the existence of the duty. If one is absolutely confident in the underlying justification of the duty, it is more comfortable to let the chips fall where they may, even if that means a very demanding duty. But for those more concerned that an increasingly demanding SCC estimate, or constraints around abatement costs and the offsetting market, could potentially undermine the plausibility of the existence of the duty, as such, this is a more serious worry.

It is, however, worth exploring what the *risk of overpaying* amounts to, because it is significantly different than the moral risk of underpaying on the minimalist approach. Consider the duty to pay the full cost of one's carbon emissions, and imagine fulfilling it by paying for a fixed cost on the offsetting market. On the precautionary approach, imagine that's \$500/tCO<sub>2</sub>. Imagine that upon further research we realize that the SCC should be (or should have been) significantly lower (e.g. because new empirical information clarifies assumptions and reduces tail risk). If the individual is still generating emissions, the over-payment could simply count toward those. But if a surplus persists (perhaps because of rapid economic decarbonization), those costs are, for the individual, unlikely to be recouped (compared to 'overpaying' our taxes throughout the year, essentially as a loan to the government, and being refunded once the details of our true tax burden are clear). Perhaps, of course, future policy could be crafted to mitigate this worry and reimburse people for demonstrable historical over-payment. But that is not the context of our current decisional environment, trying to understand and fulfill our moral duties without such governance structures, where the precautionary approach really does run a risk of undue *personal loss*.

Nevertheless, it is worth considering what this risk of loss actually amounts to. Because we are talking about the demands of a moral duty in a context independent of, for example, a coercively enforced tax, the risk isn't about illegitimate state overreach or political threats to freedom. This is worth reiterating because the standards for justification are different when coercive enforcement isn't attached to the demands. It might be a justifiable approach to risk for morality to demand, even if not a government. Furthermore, while an admitted cost to the individual, over-priced payments that are made (even if therefore not technically paying for one's own climate damages on account of the over-inflated price) are likely to dovetail with other poverty relief and development efforts. In general, they are likely to serve an important redistributive, basic-rights supporting purpose and unlikely to be wasted on morally frivolous endeavors. If arguments in the global justice literature are credible, this might be part of non-climate-specific duties of global justice anyway (e.g. Young, 2006; Gilibert, 2012; Moellendorf, 2002; Shue, 1996; many others). For these reasons, the 'risk' here seems rather more palatable from the moral point of view than the risk of underpayment for the minimalist approach. In many cases, the risk of overpaying on the precautionary approach will amount to a transfer of material resources that would have gone toward satisfying the mere preferences of a wealthy duty-bearer to funds and projects for the provision of basic rights (though we will see exceptions to this in detailing a preferable alternative below).

### **Averaging Approach**

There may, however, be better methodological options amidst the uncertainty and variability for trying to determine the content of individuals' climate duties. For example,

we might navigate the concerns with the minimalist and precautionary approaches by instead trying to determine a mean or median SCC or abatement cost value for an individual to use. This would be a less forgiving general methodology than the minimalist strategy, but also less demanding than the precautionary approach.

There is a wide literature on the so-called ‘wisdom of crowds’ phenomenon (Surowiecki, 2004) touting the benefits of assembling widely distributed informational inputs for problem-solving and decision-making (see also Anderson, 2006; Landemore, 2017). In the context of expert disagreement about a value on a continuum, we can think of an averaging approach to SCC or abatement cost estimates as an attempt to secure the epistemic value of the ‘wisdom of crowds’ phenomenon. In combining multiple models, the IWG already embraces a similar concept in practice.

What it would mean to actualize this approach, however, is up for grabs. For the duty to pay the full/fair cost of one’s emissions, for instance, one could try to use a meta-analysis of published SCC studies (e.g. as discussed in Tol, 2018). Or one could pick the median values floated in the literature for the all the relevant inputs (e.g. climate sensitivity, discount rate, etc.) and see the associated SCC. Recently, Robert Pindyck (2019) has used a survey methodology of climate scientists and economists to assemble (excluding responses that fell outside the 5<sup>th</sup>-95<sup>th</sup> percentile) a mean SCC between \$209-295/tCO<sub>2</sub>. Even if ‘trimmed’ for respondents expressing high confidence in their estimate, Pindyck’s survey methodology produces a mean SCC between \$108–140 (Pindyck, 2019, p. 155).<sup>25</sup> While both ranges are less than the \$417/tCO<sub>2</sub> figure we saw calculated by Ricke, et al., they are both significantly more than the IWGs figure of \$51/tCO<sub>2</sub>.

Inevitably, certain assumptions inform the various ways one could approach calculating a mean or median value. Moreover, there are more sophisticated approaches to responding to peer disagreement among experts than merely finding the mean or median. As we’ve just seen, we might trim the statistical outliers, or on the basis of expressed confidence.<sup>26</sup> If Carleton and Greenstone’s (2021) argument is right that we can *at least* be confident that we shouldn’t use a discount rate above 2%, we might build our average from within that parameter (or at least weight those estimates more highly). For the duty to offset the volume of one’s emissions, beyond merely averaging the \$10–30 prices on the offset markets, navigating the relevant assumptions might involve departing from the market price to offset a ton of CO<sub>2</sub> and instead settling on a local or global average among abatement costs of particular sources (or combining all sources).<sup>27</sup> Or it might involve permissions to offset at average costs only within certain time horizons. The point here isn’t to settle these issues, but instead sketch a general methodological approach to frame them, given the decision context. As above, it may still be rationally defensible for some individual experts to maintain their favored estimate instead of reverting to the mean, for the purposes of specifying their duties. I am less interested, here, in how experts rebalance their judgments on the total basis of evidence in light of new estimates or assessments. Instead, I am concerned with the pragmatic import for lay-people trying to assess and plausibly fulfill their climate duties where such sophisticated deliberative steps are not viable strategies, but a more basic averaging is.<sup>28</sup>

Methodologically, an averaging approach is a significant improvement on the minimalist approach. It fares better as a rational decision procedure in the wake of expert disagreement and greatly reduces (though doesn’t eliminate) the moral risk of

underpaying. It is more commensurate with, and better signals, our best understanding of the moral and epistemic landscape of the problem of climate change.

It is also likely an improvement over an unqualified precautionary approach for selecting a SCC amidst reasonable peer disagreement, or determining constraints on how abatement cost estimates should inform fair offsetting burdens. While more tolerant of the moral risk of under paying, overall it likely fares better balancing the (partially) competing matters of fairness, demandingness, and the seriousness with which it takes the problem.<sup>29</sup> However, it still has vulnerabilities, which can be exposed by looking at yet another methodological approach.

### ***“Sufficiency-Bounded” Precautionary Approach***

I want to suggest one final methodological strategy for navigating the tensions of the minimalist and precautionary approaches, and to rival the averaging approach. Call it the ‘sufficiency bounded’ precautionary approach. The basic idea is that the content of an individual’s duty would be determined by the highest reasonable rate that one could pay without being pushed below some sufficiency threshold. How to adequately defend the choice of sufficiency threshold would, obviously, be an important subject for debate. But for illustrative purposes, consider a basic rights or capabilities approach. For someone earning \$400,000/year and using 20 tons of CO<sub>2</sub>, paying at the highest reasonable end of SCC estimates might amount to \$10,000. This is a *substantial* price, far more than the roughly \$1,000 if using the IWG’s figure \$51/tCO<sub>2</sub>. That said, paying it is unlikely to sacrifice their basic rights or capabilities (and if it does, because of extenuating circumstances or special needs, that is exactly what the sufficiency-bounded precautionary approach is meant to accommodate). On the other hand, someone making \$20,000 and using 20 tons at the high end of SCC estimates plausibly would. On the sufficiency-bounded precautionary approach, the poorer person would be required to pay at a SCC estimate only insofar as doing so didn’t sacrifice their basic capabilities; a price which will vary depending on their circumstances, and may even be \$0. For a duty to offset the volume of one’s emissions, informed by abatement cost estimates, sensitivity to this sufficiency boundary might involve accepting or relaxing constraints on offsetting at certain prices, or for certain sources, locations, or time horizons, depending on one’s position (e.g. perhaps someone in the middle class could permissibly offset at the low market rate, while the wealthy would need to offset at prices of the higher abatement cost sources).

While likely not a perfectly just payment scheme, this approach has a number of things going for it. First, it avoids the problem of not taking the moral risk of under-paying seriously enough. Additionally, over-demandingness objections are much harder to levy against it than the original precautionary (or averaging) approach, because the demands are buffered by fundamental entitlements of justice one is owed. This, in part, helps justify the departure from the potential epistemic case in favor of the averaging approach in a non-arbitrary way. It also provides a more progressive distribution of the moral costs than the averaging approach, and is therefore less likely to problematically exacerbate inequalities.

We might also consider various hybrid accounts in an effort to fine-tune. For instance, if still concerned by the risk of over-paying (among the wealthy who wouldn’t trigger the

sufficiency constraints), a *Sufficiency-Bounded Averaging* approach could solve the problem by capping the highest price one might pay (without falling below the sufficiency threshold) at the value established by the averaging approach (rather than the highest reasonable value). This would bring the view into closer alignment with the purely epistemic values of the averaging approach and therefore reduce the risk of overpaying. It also retains the ability to explain the reasons (in virtue of basic rights or capabilities) for why someone might justifiably pay less than the full cost, or offset less than the full volume, of their emissions. However, it does so at the cost of decreasing the progressive or redistributive power of the original sufficiency-bounded precautionary approach, and potentially risking collective under-payment without the compensation of wealthy individuals paying the above-average rates.

Again, the point isn't to resolve these differences, but instead seed the discussion space with some potentially important parameters. By that measure, working through the preceding methodological approaches hopefully lays some valuable groundwork and provides a useful way to frame deliberation about the demands of individual climate duties going forward.

## The Road Forward

It is uncomfortable to have considerable ambiguity in the content of one's prospective duties. In surveying the above methodological approaches, I suggested that the *Averaging* and *Sufficiency-Bounded Precautionary* approaches (or perhaps even a hybrid, *Sufficiency-Bounded Averaging* approach) are particularly worthy of further consideration for clarifying the content of individual climate duties. I want to close with some final thoughts about where this might leave us and how to proceed in future work.

While I hope this paper helps reduce the ambiguity (and points in the right direction to help further narrow the option-space), this is a domain where some level of ambiguity and indeterminacy is likely a fundamental feature of our best moral analysis. Given the scope and structure of climate change as a moral problem, and the epistemic horizons we inevitably face, the pursuit of complete specification is likely to remain elusive.

The range of plausible values may shift or narrow as our understanding improves. For instance, some arguments against the minimalist approach might be partially vitiated if the minimum someone had in mind was the \$125/tCO<sub>2</sub> that Carleton and Greenstone's (2021) suggest, or that van den Bergh and Botzen (2014) argued was a plausible 'lower bound' estimate. Or we might be able to eliminate some tail-risk to constrain the numbers at the high-end of estimates. In that case, the differences and trade-offs between certain methodological options would similarly narrow and could take on a different valence. But the same structural debate would need to be played out, within this more constrained band.

Even if some reasonable global SCC were implemented, or constraints were placed on the offsetting market to address some of the distributional fairness issues regarding the price one pays to offset the volume of one's emissions, the fundamental moral indeterminacy regarding individual duties is unlikely to go away. Of course, we regularly rely on political determinations to specify the content of our individual obligations (e.g. the duty to drive safely is specified as, in part, a duty to drive on the right side of the road in the U.S., but the left side in England).<sup>30</sup> However, even with the most carefully crafted policy

(something we should obviously welcome!), at the level of individual moral requirements, we will always be able to ask whether the scheme is completely fair or whether certain individuals might be *morally* permitted/required to pay a lower/higher cost.<sup>31</sup> This is simply a fundamental feature of the way political and moral duties don't always translate neatly.

Moving forward, then, I think we have to be comfortable with some level of indeterminacy regarding the content of individual climate duties; not as a bug to be eliminated, but as the cost of doing business. I hope the methodological landscape I articulated above can serve as part of the foundation for bringing things into more fine-grained focus; that it can serve as a platform from which to perform the task of reflective equilibrium. We are inevitably going to need to bounce back and forth between the foundational arguments for these moral or political duties, the plurality of values at play, and the specification of content that would be entailed by various decision-points and epistemic standards involved in generating SCC and abatement cost estimates. We may even have to accept some (non-principled, non-algorithmic) private exercises of practical reasoning and judgment on behalf of individual duty-bearers. But with any luck, such exercises won't float untethered and unconstrained by more structured norms guiding such deliberations.

## Notes

1. A common criticism of SCC estimates is that their focus on economic costs prevents them from doing justice to the full topography of moral values at stake (some of which cannot be reduced to economic costs), and so are likely to be *morally* conservative. Fleurbaey et al. (2019) have argued that SCC estimates can in fact be more accommodating to values like inequality, or regarding positions on moral risk, population ethics, and the interests of non-human species. While they are right in principle, the broader point is worth keeping in mind when discussing the SCC.
2. In this journal, Mintz-Woo (2018) has explored the moral case for implementing a global SCC, because it would reinforce norms and we understand the climate and economic mechanisms well enough that we can't justify excluding the costs on the basis of uncertainty.
3. For a recent summary and sense of the literature, see Kingston and Sinnott-Armstrong (2018).
4. See Broome (2012, 2019), Hickey (2021) and Baatz (2014), as well as Hourdequin (2010), Nolt (2011), Hiller (2011), Schwenkenbecher (2014), Vance (2017), among others.
5. The arguments offered against individual duties to reduce, don't necessarily apply to duties to offset or pay the full cost of one's emissions.
6. There may be pricing effects on reduction strategies and when choosing among alternatives, and they may help inform the threshold of demandingness that could be required from reductions, but there aren't direct effects like the other kinds of individual duties.
7. For a general overview see <https://cdm.unfccc.int/about/index.html>.
8. However, if paired with a duty to offset all of one's emissions that one can't reduce, its content may be empty, unless there is moral residue when emitting and offsetting that the SCC helps capture. Combining them raises important questions about priority and overall cost, as the price to offset and the full cost may diverge.
9. I am focused here on the negative externalities of emissions. Mintz-Woo and Leroux (2021) have argued that we should ultimately disambiguate the positive and negative externalities from emissions and that both need to be considered. They suggest a principle whereby emitters are required to fully compensate the victims of the negative externalities for their harms, but once they've done so, passive beneficiaries of the positive externalities of emissions (i.e. net winners from climate change over the medium term, both regional and sectoral) are required to compensate emitters. While I can't consider their view in full, and

think there are some questions to be raised about it morally and politically, if they are right, the story I am telling here can be joined with an account that also incorporates positive externalities; it can do so either regarding how we conceptualize the “full” cost or, as below, how we adjust the “full” cost to arrive at a “fair” cost, or simply as a separate and additional consideration on an individual’s moral ledger.

10. There is reason to be skeptical of many general attempts to defeat duties with charges of over-demandingness, as they can often seem to be self-serving rationalizations, but it is quite plausible – depending on contextual features of the individuals in question and the outputs of SCC or abatement cost estimates – that the price to adequately offset or pay the full cost could be so high as to be an impossible or unreasonable demand on at least *some* people. This risk is, obviously, less significant for a duty to pay the fair cost of one’s emissions, because it is already meant to be contextually sensitive to such considerations in setting the terms of what counts as “fair”.
11. Elsewhere, some estimates can range into the thousands, depending on variation and uncertainty around the various socioeconomic inputs, climate sensitivity, the damages function, or discount rate; however these tend to fall outside the 95<sup>th</sup> percentile, so I will largely bracket their potential to add another order of magnitude. Recently, Kelleher (2018) has conducted a thorough and careful analysis of the complex philosophical assumptions and decision points involved in SCC calculations. The variation, contested assumptions, and uncertainty has led some to look in other directions. Granger et al. (2017) suggest alternatives like focusing on temperature, atmospheric concentration, or emission reduction targets rather than trying to calculate damages. Kaufman et al. (2020) argue for a “near-term to net zero” approach that similarly bypasses attempts at calculating damages. Stern and Stiglitz (2021) similarly focus on temperature and emission pathway targets. Assessing how individual duties might interface with such alternatives is a project for another day, though may look more like Hickey (2021).
12. Interagency Working Group on Social Cost of Greenhouse Gases (2020) Fully updated estimates were meant to be released in January of 2022, but have been delayed amid legal disputes.
13. In disaggregating the costs on a country-level basis, Ricke, et al., try to capture the “winners and losers of climate change”. The country-level breakdown of costs helps better understand regional impacts, and helps “quantify noncooperative behavior” in order to better understand and perhaps change the “determinants of international cooperation”. One upshot is that these country-level figures may help serve (in addition to potentially sketching fiduciary duties governments might have to their own citizens) as a proxy for where duties of corrective or restorative justice are owed, indicating who may be owed compensation, where to direct resources for adaptation, how to prioritize, etc. (though care would be needed because some of the highest economic costs may not overlap directly with the highest costs to, say basic human rights or capabilities). For quite different country-level estimates, however, see Tol (2019).
14. This is important for understanding the true nature of the wrong being done, but it also has potential social, political, and communicative import. The kinds of norms and narratives that can be structured around someone failing to offset an abstract volume of emissions are different than what can be structured around, e.g. doing hundreds or thousands of dollars of damage.
15. For clear comments on in the temporal context of abatement costs for other greenhouse gases, see Harmsen et al. (2019). SCC estimates are also time-sensitive, with projected steep increases over the century, but duties to pay the full/fair cost of emissions informed by them don’t face a similar structural issue because the estimated moral costs, and therefore duty content, are conceptually connected to the time of emission rather than being an abstract ledger of the net volume of emissions.
16. For example, Atmosfair and ClimateCare, among others. In addition there are a number of offset certification organizations such as American Carbon Registry, Climate Action Reserve, Gold Standard, Plan Vivo, and Verra. For an accessible collection of resources, see Vidal (2019), <https://www.theguardian.com/travel/2019/aug/02/offsetting-carbon-emissions-how-to-travel-options>.



17. Though Carleton and Greenstone's (2021) suggest it should be at most 2% and thus at least \$125. Similarly, van den Bergh and Botzen (2014) have argued for a \$125 "lower-bound". If correct, considerations around the minimalist approach would shift.
18. For example, if I emit 10 tons and the SCC is \$51/t, I might purchase \$510 worth of offsets, even if that offsets 25 tons of carbon, given the offset market. A gap in prices might mean that our offset markets aren't pricing in all of the morally relevant considerations of emitting carbon.
19. The government may be obligated to prevent individuals from taking such moral risks (e.g. by collectively implementing a solution and less morally risky price mechanism), but that doesn't affect the point in its absence.
20. Though, as we've seen, not all of the assumptions required to arrive at low estimates are simply technical in nature, some are instead moral.
21. See Elga (2014), Frances (2014), Christensen and Lackey (2013), and for a nice survey of options for how to rationally approach expert disagreement, Frances and Matheson (2018).
22. If, qua Carleton and Greenstone's (2021) and van den Bergh and Botzen (2014), one's conception of "reasonableness" entails that the lowest "reasonable" price is \$125 (and thus significantly higher than the \$14 mark we presumed), the concern would be partially mitigated. But unless the "reasonable" range from low to high is incredibly narrow, it will remain in some form. For a duty to pay a fair cost, this risk of "underpaying" might be significantly lower for those with fewer resources where less can be fairly demanded.
23. Martin Weitzman (2011, 2013, 2014) has done significant work to focus attention on the tail risk in SCC estimation. The precautionary approach is a way of heeding some of his concerns at the level of individual duties.
24. However, there are persisting worries that SCCs can't capture all of the relevant values, and leave important moral values out of the accounting that can't be reduced to a single monetary scale.
25. Interestingly, Pindyck found that on average climate scientists estimated a significantly higher SCC value than did economists.
26. Tol (2018) excludes estimates above \$7,600 and uses a linear function to discount estimates between \$1,150 and \$7,600.
27. If those markets are inaccessible, one might need to compensate in markets that are.
28. Specifying the epistemic responsibilities that individuals have in this domain is important. While I can't do justice to the issues here, I am assuming they could be strong enough to require being informed about an average SCC, but not so strong as to require becoming "experts" with full justifications at hand for following, e.g. a particular SCC.
29. Though, especially for the wealthy, given the asymmetry in the moral risk of overpaying versus underpaying, it is possible that the advantage over the precautionary approach is less than one might think.
30. Indeed, one of the basic reasons Kant (1996, see 6:233) thought we needed to leave the state of nature was, precisely, to eliminate indeterminacy with respect to our duties and specify them with "mathematical exactitude", via political mechanisms.
31. I have intended this discussion to operate internal to the mechanics of the proposed individual duties. I want to bracket whether other moral considerations or opportunity costs (e.g. better uses of the money directly alleviating poverty) would affect an all-things-considered judgment. So we can think of all of these claims existing pro-tanto.

## Acknowledgement

First, I would like to thank the editors and reviewers of this journal for their thoughtful comments, which substantially improved this paper. Special thanks also to Ingrid Robeyns, Dick Timmer, Tim Meijers, Matthias Kramm, Petra van der Kooij, and Stephanie Collins for their valuable feedback, as well as audience members at the University of Reading. This work was supported by the Climate Futures Initiative at Princeton University.

## Disclosure Statement

No potential conflict of interest was reported by the author.

## Funding

This work was supported by the European Research Council (ERC) under the European Union's Horizon 2020 program for research and innovation [726153].

## ORCID

Colin Hickey  <http://orcid.org/0000-0003-2275-8130>

## References

- Aldy, J., Pizer, W., Tavoni, M., Reis, L. A., Akimoto, K., Blanford, G., Carraro, C., Clarke, L. E., Edmonds, J., Iyer, G. C., McJeon, H. C., Richels, R., Rose, S., & Sano, F. (2016). Economic tools to promote transparency and comparability in the Paris agreement. *Nature Climate Change*, 6(11), 1000–1006. <https://doi.org/10.1038/nclimate3106>
- Anderson, E. (2006). The epistemology of democracy. *Episteme*, 3(1–2), 8–22. <https://doi.org/10.3366/epi.2006.3.1-2.8>
- Baatz, C. (2014). Climate change and individual duties to reduce GHG emissions. *Ethics, Policy and Environment*, 17(1), 1–19. <https://doi.org/10.1080/21550085.2014.885406>
- Broome, J. (2012). *Climate matters: Ethics in a warming world*. W. W. Norton and Co.
- Broome, J. (2019). Against denialism. *The Monist*, 102(1), 110–129. <https://doi.org/10.1093/monist/ony024>
- Carleton, T., & Greenstone, M. (2021). Updating the United States government's social cost of carbon. *University of Chicago, Becker Friedman Institute for Economics Working Paper No. 2021-04*.
- Christensen, D., & Lackey, J. (Eds.). (2013). *The epistemology of disagreement: New essays*. Oxford University Press.
- Cripps, E. (2016). On climate matters: Offsetting, population, and justice. *Midwest Studies in Philosophy*, XL(1), 114–128. <https://doi.org/10.1111/misp.12050>
- Elga, A. (2014). Reflection and disagreement. *Noûs*, 41(3), 478–502. <https://doi.org/10.1111/j.1468-0068.2007.00656.x>
- Fleurbaey, M., Ferranna, M., Budolfson, M., Dennig, F., Mintz-Woo, K., Socolow, R., Spears, D., & Zuber, S. (2019). The social cost of carbon: Valuing inequality, risk, and population for climate policy. *The Monist*, 102(1), 84–109. <https://doi.org/10.1093/monist/ony023>
- Frances, B. (2014). *Disagreement*. Polity Press.
- Frances, B., & Matheson, J. (2018). Disagreement. In E. N. Zalta (Ed.), *The Stanford encyclopedia of philosophy*. <https://plato.stanford.edu/archives/spr2018/entries/disagreement/>
- Gilbert, P. (2012). *From global poverty to global equality: A philosophical exploration*. Oxford University Press.
- Gillingham, K., & Stock, J. (2018). The cost of reducing greenhouse gas emissions. *Journal of Economic Perspectives*, 32(4), 53–72.
- Granger, M., Vaishnav, P., Dowlatabadi, H., & Azevedo, I. L. (2017). Rethinking the social cost of carbon dioxide. *Issues in Science and Technology*, 33(4). <https://issues.org/rethinking-the-social-cost-of-carbon-dioxide/>
- Harmsen, J. H. M., van Vuuren, D. P., Nayak, D. R., Hof, A. F., Höglund-Isaksson, L., Lucas, P. L., Nielsen, J. B., Smith, P., & Stehfest, E. (2019). Long-term marginal abatement cost curves of non-CO<sub>2</sub> greenhouse gases. *Environmental Science & Policy*, 99, 136–149. <https://doi.org/10.1016/j.envsci.2019.05.013>

- Hickey, C. (2021). Climate change, distributive justice, and “pre-institutional” limits on resource appropriation. *European Journal of Philosophy*, 29(1), 215–235. <https://doi.org/10.1111/ejop.12569>
- Hiller, A. (2011). Climate change and individual responsibility. *The Monist*, 94(3), 349–368. <https://doi.org/10.5840/monist201194318>
- Hof, A., den Elzen, M. G. J., Admiraal, A., Roelfsema, M., Gernaat, D. E. H. J., & van Vuuren, D. P. (2017). Global and regional abatement costs of nationally determined contributions (NDCs) and of enhanced action to levels well below 2 °C and 1.5 °C. *Environmental Science & Policy*, 71, 30–40. <https://doi.org/10.1016/j.envsci.2017.02.008>
- Hourdequin, M. (2010). Climate, collective action and individual ethical obligations. *Environmental Values*, 19(4), 443–464. <https://doi.org/10.3197/096327110X531552>
- Hyams, K., & Fawcett, T. (2013). The ethics of carbon offsetting. *WIREs Climate Change*, 4(2), 91–98. <https://doi.org/10.1002/wcc.207>
- Interagency Working Group on Social Cost of Greenhouse Gases (2020). Technical support document: Social cost of carbon, methane, and nitrous oxide. Interim estimates under Executive Order 13990. United States Government . [https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument\\_SocialCostofCarbonMethaneNitrousOxide.pdf](https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf)
- Jamieson, D. (2014). Review: Climate matters: Ethics in a warming world by John Broome. *Ethics & International Affairs*, 28(2), 263–265.
- Kant, I. (1996). *The metaphysics of morals* (M. Gregor, Ed. & Trans.). Cambridge University Press. (Original work published 1797).
- Kaufman, N., Barron, A. R., Krawczyk, W., Marsters, P., & McJeon, H. (2020). A near-term to net zero alternative to the social cost of carbon for setting carbon prices. *Nature Climate Change*, 10(11), 1010–1014. <https://doi.org/10.1038/s41558-020-0880-3>
- Kelleher, J. P. (2018). The social cost of carbon from theory to Trump. In R. Kanbur & H. Shue (Eds.), *Climate justice: Integrating economics and philosophy* (pp. 209–229). Oxford University Press.
- Kesicki, F., & Ekins, P. (2012). Marginal abatement cost curves: A call for caution. *Climate Policy*, 12(2), 219–236. <https://doi.org/10.1080/14693062.2011.582347>
- Kingston, E., & Sinnott-Armstrong, W. (2018). What’s wrong with joyguzzling? *Ethical Theory and Moral Practice*, 21(1), 169–186. <https://doi.org/10.1007/s10677-017-9859-1>
- Landmore, H. (2017). *Democratic reason: Politics, collective intelligence, and the rule of the many*. Princeton University Press.
- McKinsey & Company. (2009). *Pathways to a low-carbon economy: Version 2 of the global greenhouse gas abatement cost curve*.
- Mintz-Woo, K. (2018). Two moral arguments for a global social cost of carbon. *Ethics, Policy and Environment*, 21(1), 60–63. <https://doi.org/10.1080/21550085.2018.1448038>
- Mintz-Woo, K., & Leroux, J. (2021). What do climate change winners owe, and to whom? *Economics & Philosophy*, 37(3), 462–483. <https://doi.org/10.1017/S0266267120000449>
- Moellendorf, D. (2002). *Cosmopolitan justice*. Westview Press.
- Moore, F., & Diaz, D. (2015). Temperature impacts on economic growth warrant stringent mitigation policy. *Nature Climate Change*, 5(2), 127–131. <https://doi.org/10.1038/nclimate2481>
- National Academies of Sciences, Engineering and Medicine. (2017). *Valuing climate damages: Updating estimation of the social cost of carbon dioxide*. The National Academies Press.
- Newey, C. (2016). Fairness as “appropriate impartiality” and the problem of the self-serving bias. *Ethical Theory and Moral Practice*, 19(3), 695–709. <https://doi.org/10.1007/s10677-015-9665-6>
- Nolt, J. (2011). How harmful are the average american’s greenhouse gas emissions. *Ethics, Policy & Environment*, 14(1), 3–10. <https://doi.org/10.1080/21550085.2011.561584>
- Nordhaus, W. (2017). Revisiting the social cost of carbon. *PNAS*, 114(7), 1518–1523.
- Pindyck, R. S. (2019). The social cost of carbon revisited. *Journal of Environmental Economics and Management*, 94, 140–160. <https://doi.org/10.1016/j.jeem.2019.02.003>
- Ricke, K., Drouet, L., Caldeira, K., & Tavoni, M. (2018). Country-level social cost of carbon. *Nature Climate Change*, 8(10), 895–900. <https://doi.org/10.1038/s41558-018-0282-y>

- Schwenkenbecher, A. (2014). Is there an obligation to reduce one's individual carbon footprint? *Critical Review of International Social and Political Philosophy*, 17(2), 168–188. <https://doi.org/10.1080/13698230.2012.692984>
- Shue, H. (1996). *Basic rights* (2nd ed.). Princeton University Press.
- Stern, N., & Stiglitz, J. (2021). The social cost of carbon, risk, distribution, market failures: An alternative approach. *NBER Working Paper No. 28472*.
- Surowiecki, J. (2004). *The Wisdom of Crowds*. A Division of Random House, Inc.
- Tol, R. (2018). The economic impact of climate change. *Review of Environmental Economics and Policy*, 12(1), 4–25.
- Tol, R. (2019). A social cost of carbon for (almost) every country. *Energy Economics*, 83, 555–566. <https://doi.org/10.1016/j.eneco.2019.07.006>
- Vance, C. (2017). Climate change, individual emissions, and foreseeing harm. *Journal of Moral Philosophy*, 14(5), 562–584. <https://doi.org/10.1163/17455243-46810060>
- van den Bergh, J. C. J. M., & Botzen, W. J. W. (2014). A lower bound to the social cost of CO<sub>2</sub> emissions. *Nature Climate Change*, 4(4), 253–258. <https://doi.org/10.1038/nclimate2135>
- Vidal, J. (2019 February, 08). Offsetting carbon emissions. *The Guardian*, Retrieved April 5, 2021, from <https://www.theguardian.com/travel/2019/aug/02/offsetting-carbon-emissions-how-to-travel-options>
- Weitzman, M. (2011). Fat-tailed uncertainty in the economics of catastrophic climate change. *Review of Environmental Economics and Policy*, 5(2), 275–292.
- Weitzman, M. (2013). Tail-hedge discounting and the social cost of carbon. *Journal of Economic Literature*, 51(3), 873–882.
- Weitzman, M. (2014). Fat tails and the social cost of carbon. *American Economic Review: Papers & Proceedings*, 104(5), 544–546.
- Young, I. M. (2006). Responsibility and global justice: A social connection model. *Social Philosophy & Policy*, 23(1), 102–130.