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Ethical choices behind quantifications of fair contributions under the Paris Agreement

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The Parties to the UNFCCC and Paris Agreement agreed to act on the basis of equity to protect the climate system. Equitable effort sharing is an irreducibly normative matter, yet some influential studies have sought to create quantitative indicators of equitable effort that claim to be value-neutral (despite evident biases). Many of these studies fail to clarify the ethical principles underlying their indicators, some mislabel approaches that favour wealthy nations as 'equity approaches' and some combine contradictory indicators into composites we call derivative benchmarks. This Perspective reviews influential climate effort-sharing assessments and presents guidelines for developing and adjudicating policy-relevant (but not ethically neutral) equity research.

All 197 nations agreed to the core principle of the 1992 UNFCCC that nations would act to "protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities" (Article 3.1)[1]. The language has persisted: 189 of those countries have ratified the 2015 Paris Agreement, which included nearly identical wording and reaffirmed that "this Agreement… aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty" (Article 2.1) and to do so "on the basis of equity" (Article 4.1)[2]. Every five years, countries are expected by the Paris rules to explain how their planned efforts are fair, to respect equity and enable ambition.

Arguably, the primary reason to integrate equitable effort sharing in the climate convention is to enable countries to protect their most vulnerable residents and promote sustainable development while facilitating an ambitious international climate mobilization. A series of studies, as well as the IPCC, have evaluated a range of quantitative approaches for assessing equitable and adequate mitigation efforts. Here we consider a number of those studies that profess, either explicitly or implicitly, to provide impartial or 'value-neutral' assessments.

The idea that an equity assessment of countries' efforts can be value-neutral is invariably premised on the assertion that the assessment is based on an impartially assembled and suitably diverse set of equity approaches. It presumes that a comprehensive ensemble of approaches, or an appropriately representative sample of approaches, is unbiased, and that further quantitative analysis is also unbiased, yielding results that can serve as impartial inputs to a political process[3,4]. We argue that such analyses of 'all relevant equity perspectives' place a value-neutral gloss over deeply contested and irreducibly normative perspectives. This is exacerbated in cases where the quantitative analysis distils and aggregates the various equity approaches into a single indicator, such as an overall score of 'fairness'.

Any form of action (or inaction) on climate change necessarily imposes burdens on some while conferring benefits on others, so any form of policy-making entails normative choices. Scholars debate how political decision processes might best be supported[5,6]. In this Perspective, we argue that approaches presented as value-neutral represent a technocratization of what is ultimately a political debate. We evaluate a selection of recent effort-sharing studies to determine whether they purport to be value-neutral or are explicit about the ethical choices underlying their analysis. To do this, we first sketch the moral bases for equity in the international climate regime. We then review which effort-sharing approaches are considered in recent studies, how they are treated and how they compare with the full range of equity viewpoints relevant to effort sharing. We propose a way forwards that emphasizes transparency in communicating the ethical underpinnings of assessments of climate action and suggest guidelines for developing policy-relevant—but not ethically neutral—equity research.

Foundations of equity in the climate regime

During the climate regime's 30-year history, equity reasoning has been based on three foundations: protecting the most vulnerable,

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guaranteeing sustainable development and encouraging greater ambition by states with greater capability. Equity and justice are essential for effective international cooperation[7]. Therefore, assessment of adequate action on climate must reflect core principles of equity and justice in ways that inform and facilitate political debate. Although concerns of equity and climate justice (which we treat interchangeably) are much broader than nation states and include individuals and corporations among others, the Parties to the UNFCCC and its Paris Agreement are countries, and they should be held accountable for their actions[8,9].

At the core of equitable climate action is a mandate to protect the vulnerable against deprivation. Powerful parties routinely promote their own interests, but vulnerable parties frequently cannot. Principles of equity include guarantees designed to provide security for the vulnerable. Such guarantees are reflected in early calls to distinguish "the 'survival emissions' of the poor" from "the 'luxury emissions' of the rich" and to protect the former under all schemes for reducing total global emissions[10]. The UNFCCC emphasizes the protection of the most vulnerable through several provisions, including the commitment that "the Parties have a right to, and should, promote sustainable development" (Article 3.4)[1].

Article 3.1 of the UNFCCC[1], as noted above, is another acknowledgement that not all countries can afford to be equally ambitious. The acknowledgement that responsibilities are differentiated protects the vulnerable because respective capabilities are unequal.

Although survival and promotion of sustainable development represent different levels of guarantee for the most vulnerable, they both rest on a core principle of climate justice: that, at the very least, the urgent, basic needs of poor people and poor countries ought to be secured against the effects of climate change and of measures taken to limit it[11]. Sustainable development was introduced as a purposefully vague term, utilized to garner consent but always guaranteeing a floor of human well-being[12]. Indeed, the capabilities approach—used as the basis for the human development index and central in the sustainable development goals—is built on the explicit recognition of the inherently multifaceted nature of human well-being. From this perspective, multiple capabilities are required for the very notion of human freedom[13].

Any set of principles for equity in climate action that does not protect the vulnerable by recognizing differentiated responsibility due to different capabilities ignores both the actual history and a fundamental purpose of including equity in the assessment of climate action[14]. It also raises pointed questions about equity analyses in which approaches that run contrary to this core concern, such as grandfathering or cost optimization, are treated as foundational elements.

Grandfathering has been interpreted by some as the burden-sharing basis of emissions reductions in the 1997 Kyoto Protocol, since developed nations agreed to emissions entitlements proportional to their current emissions. These mitigation commitments might be considered an example of an instrumental use of grandfathering. This approach cannot be considered an acceptable principle for equity in the global climate context, and ought not be presented as such in analyses. Studies including grandfathering, often presented implicitly as 'staged approaches', reward Parties with permissions to emit in the short term in proportion to their past emissions. Although grandfathering is advocated by some for purely pragmatic reasons, to consider it as a principle of equity is morally perverse[15].

In a global context characterized by vast imbalances of political power and material wealth, grandfathering directly contradicts the ethical imperative to protect the most vulnerable. It is also diametrically at odds with another principle: that the polluter should pay. The protection of the most vulnerable requires rapid and transformative climate action, led and paid for by those with the most responsibility and resources (capacity); grandfathering would significantly slow such action[16]. We find little support among moral and political philosophers for any moral principle that justifies grandfathering, and indeed many philosophers have disavowed it[17–20]. The term was first coined in the post-civil-war United States in the context of racist and sexist laws intended to undermine any equal right to vote[21]. The parallel to the contemporary use of the term in the climate discourse is striking, as both uses serve to justify the perpetuation of an unjust allocation of rights on the basis of the previous unjust allocation of the same rights.

Quantified approaches also often implicitly assume that cost optimization is neutral, requiring no ethical justification. Imposing the same least-cost solution in a highly unequal world, however, is inherently unjust. An equal distribution to parties starting out with different capacities, different needs and vulnerabilities or different responsibility for the problem does not yield an equitable result.

Equity principles

Commonly used equity principles, in part because of their resonance with common but differentiated responsibilities and respective capacities, include need, responsibility, capacity and equality. We draw on an extensive normative literature to sketch the bases of these principles here. The full range of equity considerations is much broader, as shown in a recent systematic overview of the normative aspects of climate justice[22].

In determining a party's equitable contribution to addressing climate change, need takes account of the requirements for sustainable development and poverty eradication. For example, an agreement can exempt the poorest from contributing to climate action because meeting their basic needs has moral priority. This commitment to enabling the least advantaged to meet their needs can be derived from a number of different philosophical traditions, including those that affirm basic rights to socio-economic goods[23], utilitarian arguments[24], social contract arguments[25] and global egalitarianism[26]. Although these traditions reach different conclusions on the ideally best world and employ different concepts (some appealing to rights and others emphasizing the promotion of welfare), they all give paramount importance to enabling the world's poorest to meet their needs[27].

Responsibility connects parties' obligations in addressing climate change to the degree to which they have caused it. It is a widely shared principle of justice that agents can be held responsible for their actions and thus for the harmful consequences of their choices and policies.

Capacity reflects the principle that those who can afford to contribute more than others towards solving the climate problem should do so. Those with the greatest financial resources to bear a larger proportion of costs towards implementing a shared goal can reasonably be asked to bear them. Because capacity is an exclusively forward-looking indicator of equity, capacity should be utilized along with others that, like responsibility, are partly backward-looking.

Equality reflects the principle that each human being has equal worth and therefore ought to have equal rights. Concrete interpretations are, admittedly, contentious. One interpretation of equality requires those in equal positions to contribute equally to addressing the problem. A more common approach is to affirm an equal right to emit GHGs, often employed as an equal-per-capita (EPC) indicator starting from current emissions in each nation[28,29]. This view encounters a number of problems. EPC emission rights ignore the inequalities in people's needs, their level of development, internal economic stratification and access to other sources of energy. Emission rights matter to people only insofar as they serve important human interests. It is a mistake, then, to focus on the distribution of emissions rather than the distribution of what really matters to people: their capacity to meet their needs and pursue their goals in life[20,30]. Moral equality and an equal ability to lead decent lives is

important, but equality without consideration of unequal needs and vulnerabilities, unequal capacities and unequal responsibility leads to equality for unequals, which philosophers since Aristotle have condemned as gross inequity[31].

Some competing principles can be usefully combined in the pursuit of an overarching goal such as a fully lived life by splitting the difference or assigning 50% weight to each of two (that is: work and family, safety and excitement, responsibility and capability). Other principles, however, are directly contradictory, and attempts to include both in a composite index turn the composite into nonsense. This is the case when a principle affirming a guarantee that the vulnerable should be able to attain a decent minimum standard of living is combined with grandfathering, which guarantees existing advantages for the wealthy and in practice denies the vulnerable the resources to meet their basic needs. Here, no meaningful middle ground is available.

Approaches to quantification of fair shares

There is a rapidly growing body of scholarship examining other equity dimensions of climate change, including vulnerability and adaptation[32], fossil fuel extraction[33], loss and damage[34], accounting metrics[35] and climate modelling[36]. Here we focus on equity studies that attempt to quantify effort sharing among nations in mitigation. We reviewed 16 studies that quantify the equitable effort sharing of a country or group of countries under the UNFCCC and its Paris Agreement.

Without space for a comprehensive literature review, we have chosen recent and influential studies that represent a diversity of approaches. We assessed this literature to identify the different claims to authority made, the equity perspectives and other allocation approaches incorporated, and how these are combined. Of the selection of studies evaluated, we find that nearly two-thirds (ten studies) present as neutral or value-free, while six studies are explicit about their application of effort-sharing criteria and the ethical implications. The good news is that the recent papers tend to be more upfront about their normative assumptions, implying a shift from a perceived utility of presenting value-neutral analysis to policymakers, to presenting ethically explicit analysis that informs political debate.

Value-neutral approaches. We identified different ways that equity and effort-sharing frameworks tended to 'signal' that the approach utilized was neutral or value-free. These include: metastudies creating composite indicators and presenting them as value-neutral, studies including contradictory measures in one composite index, studies claiming to reflect the IPCC's full range of indicators and studies relying on grandfathering. Some studies take more than one of these problematic approaches.

Comprehensive approaches. A number of metastudies claim objectivity through the comparison of a comprehensive range of approaches to effort sharing, each based on different ethical or normative positions[37–42]. These are then synthesized into composite indicators or ranges that purportedly reflect all identified equity principles. Their aim is to offer an 'objective' assessment to avoid the fraught negotiations that typically attend efforts to arrive at an ethical or political consensus. These papers often use definitive language such as 'equitably determined' contributions or the 'relative fairness' of the nationally determined contributions[41] without conceding that any assessment is relative to the specific approaches adopted.

Many of these studies claim that their benchmarks or ranges are neutral and value-free because they derive from a supposedly comprehensive set of peer-reviewed quantitative models. However, benchmarks are highly sensitive to settings, such as the time horizon for historical emissions, temperature goals, exceedance probabilities and other factors. Sampling is often biased and parameter choices

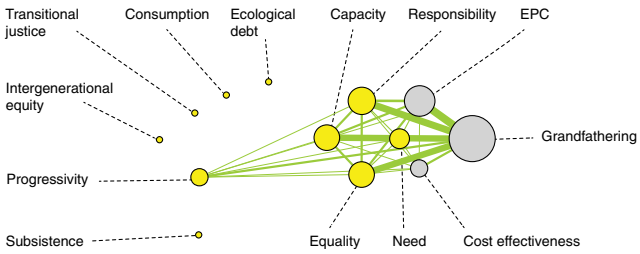

Fig. 1 | Equity principles included in studies presented as value-neutral. Coverage of equity perspectives is shown in yellow, and coverage of other allocation approaches is shown in grey. The size of the nodes represents the relative number of times each allocation principle is invoked. Green lines link approaches occurring in the same paper, and the thickness of the lines reflects the relative frequency of the link. Unlinked nodes are not utilized in any study reviewed.

are arbitrary or reflect implicit value judgements, with no reference to the underlying normative choices. The choice of parameters is far from comprehensive, and critically important variables are often excluded. This is illustrated in Fig. 1, where we can see that these studies cluster around a narrow set of equity perspectives.

These comprehensive approaches often include cost effectiveness as a value-free point of comparison[37–40], yet economic cost optimization is itself one normative choice that requires justification.

Contradictory composites. Other studies claim objectivity via reflecting a spectrum of equity approaches. But rather than aiming to represent all equity approaches, these studies choose a subset, commonly excluding need (a principle that reflects the right to sustainable development) in favour of variations of grandfathering and EPC allocation[38,39,41,43]. The goal of this strategy is to reflect a plurality of often contradictory equity approaches without having to achieve an ethical or political consensus.

The Climate Action Tracker[39,40] is a prominent example of such work, generating a 'fair share' range of emissions allowances for each country that is widely used by media, academia, civil society and governments to assess countries' mitigation ambition. This range is constructed from estimates in the literature as a way to avoid the ethically fraught process of "deciding on an approach to determine what is fair"[39]. For each country, a large number of studies are untransparently excluded from further analysis on grounds of being statistical outliers[39]. This approach excludes whole categories of ethical positions, while nonetheless claiming to represent the "spread of results across all these categories in the underlying studies"[39].

On the basis of its methodology, the Climate Action Tracker grades countries on a range from highly insufficient to role model, but in doing so mixes the incompatible indicators and ethical principles that underlie them.

Spanning the space. Other approaches to span the equity space include adopting extremes, such as equality and grandfathering, to ostensibly represent the spectrum of equity approaches[29,44], or conversely excluding numerical 'extremes', such as need and grandfathering, as statistical outliers[43]. These approaches leave out many important equity principles, including need and capacity, which are essential to protect the most vulnerable. Often, when equality is interpreted as EPC, they include no ethically sound principles at all[29,44]. Raupach et al.[29] introduced the concept of a 'blended approach' based on a spectrum of 'sharing principles' represented as EPC (termed equity) and grandfathering (termed inertia). Given that pure grandfathering would allow vulnerable countries little access to sustainable development, and EPC would pose high mitigation demands on developed countries, the authors concluded that

"a blend of these endpoints emerges as the most viable option"[29]. They do not say for whom blended approaches would be most viable, nor do they discuss their underlying ethical assumptions. This blended approach forms the basis for subsequent studies[45,46].

Appeal to IPCC authority. Some studies claim objectivity through presenting what they claim to be IPCC endorsed 'equity categories'. An influential paper[37] developed six categories of equity approaches, and the same authors took these categories into Chapter 6 ref. [47]) of the Working Group III contribution to the IPCC Fifth Assessment Report (AR5 WGIII)[48]. The six categories are based on one or more of the equity principles of capability, responsibility and equality, while need is included through combinations of approaches. Staged approaches are used, beginning with grandfathering, which is gradually phased out in favour of more equitable allocations. Subsequent studies suggest that these six categories are somehow endorsed by the IPCC[41,43,49]. One study references as its organizing framework the "IPCC categorization of over 40 studies", and signals the comprehensive nature of this categorization by referring to "the … concepts of equity"[41]. In fact, climate equity principles have been developed over many decades of scholarship, and other chapters in the same volume review that scholarship to reach quite different conclusions. Chapters 3 (ref. [50]) and 4 (ref. [51]) of AR5 WGIII provide a recent summary of some of this broader range of equity perspectives, including environmental justice and transitional justice, ecological debt, intergenerational equity, survival emissions, progressivity, prioritarianism and egalitarianism. In our view, the six categories of Chapter 6 (ref. [47]) "cannot be considered an authoritative and ethically robust taxonomy of equity approaches in any sense"[16].

Invoking grandfathering. The ten quantified studies reviewed that claim to be value-neutral commonly focus on a small subset of the available indicators for effort sharing (Fig. 1, see Supplementary Data 1 for details). Instead of presenting a comprehensive view of the equity landscape, these studies are dominated by inequitable approaches such as grandfathering and EPC.

Our analysis finds that grandfathering is most frequently and centrally invoked. The inclusion of blended or staged approaches (the latter shifting from grandfathered allocations to more just ones) introduces grandfathering into the other allocations to varying extents. This causes a systematic bias in favour of wealthier, higher-emitting countries. In some studies, nearly half of the remaining carbon budget is grandfathered[16]. With emissions needing to rapidly decline to near zero under the goals of the Paris Agreement, the dominance of grandfathering contradicts concern for the most vulnerable, undermines sustainable development and discourages ambition by the more capable.

Ethically explicit approaches. In contrast to effort-sharing frameworks that are presented as value-neutral, we found other quantified allocation approaches that are explicit about the ethical and moral implications of their underlying assumptions[46,52–56].

One study assessed national mitigation pledges relative to 'equity benchmarks' in which a range of effort-sharing parameters were combined and weighted in a deliberative stakeholder process to determine the most accepted range of specific expressions of the equity principles used[52]. The resulting effort-sharing framework adopts responsibility, capacity and right to development (need), all principles repeated in UNFCCC agreements. Other studies consider fairness in the distribution of mitigation effort in the context of a rapidly dwindling global carbon budget[53,54].

Other recent examples show deliberate and transparent ethical choices applied in national case studies. In approaches that calculate fair-share carbon budgets for Ireland[55], the UK and Sweden[54], the results suggest Paris Agreement-compliant emissions targets that are approximately twice as ambitious as current national policy positions. These papers acknowledge that the methods used "embody tacit ethical values and choices which can, and should, be the subject of wide societal discussion and critique"[55]. In explicitly distinguishing between emissions and allocations, the authors of one study propose a "pragmatic apportionment regime", where effort sharing is constrained on the basis of what is "still physically possible to deliver within a Paris-compliant global carbon budget"[54]. The authors acknowledge that such an approach "falls far short of an equitable sharing of the climate burden"[54].

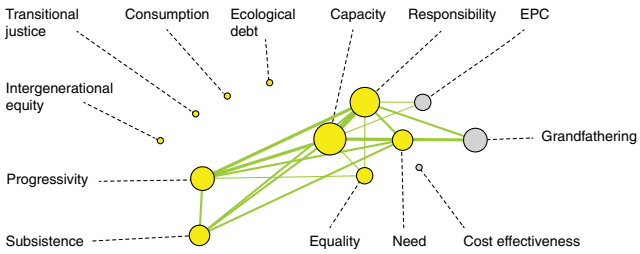

Fig. 2 | Equity principles included in studies presented as ethically explicit. Coverage of equity perspectives is shown in yellow, and coverage of other allocation approaches is shown in grey. The size of the nodes represents the relative number of times each allocation principle is invoked. Green lines link approaches occurring in the same paper, and the thickness of the lines reflects the relative frequency of the link. Unlinked nodes are not utilized in any study reviewed.

The equity principles included in ethically explicit approaches incorporate the most commonly used principles of capacity and responsibility (Fig. 2, see Supplementary Data 1 for details). These approaches however, also cover a broader range of less frequently quantified perspectives, such as need, progressivity and subsistence emissions. Grandfathering is far less prominent in this group of studies, and is not combined with other principles.

Yet, across all of the quantitative effort-sharing frameworks we reviewed, the broader range of equity perspectives (as outlined in Chapters 3 (ref. [50]) and 4 (ref. [51]) of AR5 WGIII[48]) is not well represented, highlighting the limitations of the entire current body of literature concerned with quantified approaches. Indeed, the focus on core aspects of equity in the academic literature can be seen as a narrowing of the broader normative conceptions of climate and environmental justice[57].

Guidelines for research on equity in climate action

Fair shares indices, against which national pledges of action are ranked in ways that judge some nations to be leaders and others to be laggards, are central to climate diplomacy. They should be transparent about their ethical foundations. The processes of creating such indices are themselves rooted in the same power dynamics into which these products are intended to provide insight[58,59]. Central to climate and environmental justice conceptualized more broadly, and highlighted in political theory and justice studies, is an awareness that the way analyses are conducted can privilege some and marginalize others[57,60,61]. Grandfathering of emissions, in particular, should not be included in equity assessments of global climate action; it is not a defensible general principle of equity. Grandfathering undermines the foundations of climate equity reasoning by contradicting principles that aim to protect the vulnerable and promote sustainable development. It allows polluters to evade paying their due and discourages ambition.

Analyses that attempt to provide meaningful insight into the political process of navigating equity in the climate context therefore must accomplish at least three things. First, they must reflect the core principles of equity, which requires centring the needs of

the most vulnerable (in the context of sustainable development). Second, they must refrain from combining contradictory principles of equity into a purportedly neutral composite index. Third, analysis should inform, rather than supplant, the political process.

This leads to inevitable debates about how climate equity should be analysed and communicated as inputs into political processes. We propose several guidelines aimed at authors, editorial boards, the IPCC and other users of these analyses for adequately evaluating policy-relevant contributions about equity in an inherently political climate policy context:

- Do not claim value neutrality. As there is no ethically neutral position in the climate context, pretending to be value-free obscures unconscious biases under a veneer of neutrality, particularly in quantitative modelling. Analysis may be rigorous, replicable and systematic, but it should also explicitly outline normative assumptions and values within the specific political landscape of climate equity debates[62]. Transparency about values enables all users to place the analysis in the context of other work and evaluate it accordingly.
- Analysis needs to ensure that the losses of those who are potentially marginalized remain clearly visible. This requires explicit recognition that some forms of analyses are inaccessible to some audiences, and that extremely important dimensions of climate loss and vulnerability may be difficult to accommodate in quantitative analysis[36]. Recognition is central to climate justice and is frequently invoked in the language of those marginalized. Failing to acknowledge or normalizing losses of those who are most vulnerable would only heap further injustice on those who have historically been unseen and unheard, and who may have most to lose.
- Analytical work should aim to support inherently political processes. Technical analysis is not a substitute for political debate about inherently normative decisions. Instead, to facilitate negotiation, good-quality work will clarify differences in interests or ethical positions, identify key issues of divergence, suggest points of convergence and be explicit about its limitations.

Although we found that many studies did explicitly acknowledge the ethical underpinnings of their allocation frameworks while taking a range of different stances[52,54,55], many did not. Such acknowledgement should become standard practice for equity research to be grounded in the wider ethical literature and to meaningfully inform political debate. Reliance on quantification can systematically exclude loss of life, subsistence livelihoods, culture, spirituality and identity. Many of these losses are particularly pressing for those who are most vulnerable to climate impacts. At a minimum, the exclusion of such losses inherent in standard quantification, and the ethical implications of relying on these results to inform political debate, must be acknowledged.

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Author contributions

All authors contributed to the conception of the work. K.D., C.H., S. Kartha, S. Klinsky, H.S., T.R. and H.W. jointly wrote the paper. K.D., C.H., S. Kartha and G.H. contributed to the analysis and interpretation of data, including the figures. All authors contributed to discussions of revisions and improvements to this paper.

Competing interests

The authors declare no competing interests.

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