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OPINION

Towards a "fair-efforts" metric for climate pledges

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It took twenty years of international negotiations for national governments to formally acknowledge our common responsibility for mitigating climate change. However, this success came at the expense of a key dimension of this responsibility enshrined in the UN Framework Convention of Climate Change, to differentiate countries' responsibilities based on capabilities and circumstances. To the contrary, the Paris Agreement deliberately side-steps issues of "fair-shares" [1], leaving countries to voluntarily submit Nationally Determined Contributions (NDCs) based on self-serving notions of fairness. Following the Glasgow Climate Pact, pledges from 83 countries, including by 51 mostly industrialized countries, aim for net zero by 2050 [2]. However, according to equitable principles of international environmental law, industrialized countries should pledge net zero by 2030 to achieve the Paris goals [1]. Instead, the 2030 targets are weak and push out deep cuts to mid-century. Furthermore, net zero pledges include those from low- and middle-income countries (LMIC) such as India and Nigeria, which have per capita incomes that are a tenth of European countries, albeit to be achieved after 2050. Although largely symbolic, the Glasgow experience may portend pressure on LMIC governments to ratchet ambition as the climate crisis worsens, public pressure to act intensifies, and as mitigation investments need to increase from the present level of hundreds of billions to the trillions that are required to achieve the Paris goals [3].

The urgency of achieving the Paris goals dictates that low-carbon investments must happen roughly contemporaneously around the world in all sectors to avoid lock-in to fossils and achieve global net zero not long after 2050 [4]. Yet, even political realism dictates that industrialized countries, including China, absorb technology risk of deep decarbonization by undertaking R&D and be early adopters of new low-carbon technologies [5] in applications that still lack commercially viable alternatives, such as in industrial process heat, long-term electricity storage, and freight transport. The combination requires global cooperation, and in turn a fairness benchmark that encourages stronger actions in industrialized countries but also maximize efforts in LMIC.

What metrics should then guide assessments of countries' fair efforts towards the Paris Goals? I argue here that the allocation principles that have dominated two decades of burden-sharing proposals are unsuitable for international agreements in part because they allocate shares of global mitigation targets to countries based on principles without accounting for the true costs of mitigation, which evolve with technology, or non-monetary social benefits. A key principle relates to historical responsibility, whose measure has been countries' cumulative emissions since industrialization. In essence, polluters should pay for the mess they created. Seen otherwise, industrialized countries reaped the benefits of abundant fossil-based energy without bearing its true cost, part of which were transferred through climate change to future

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generations in predominantly poorer countries. However, while responsibility may be a compelling principle to guide relative efforts among countries, it may create a moral hazard for LMIC to free ride on differentiated efforts. As such, they do not incentivize maximum efforts everywhere. There are two forms of action that should be incentivized: 'no regrets' mitigation, where low-carbon alternatives become cost-competitive, and actions that may be justified for their non-economic social benefits despite being more expensive than fossil alternatives ('co-benefits') [6].

I propose a new metric here that differentiates efforts based on countries' mitigation cost burdens. All the analytical elements exist in different energy-climate models, and the necessary data are available in most high-emitting countries. However, its implementation will require common analytical groundwork to be laid, and political consensus on normative assumptions.

The metric reflects the mitigation cost share of countries' income, incorporating reasonable expectations of market-driven mitigation costs and actions with co-benefits potential, and then adjusted for equity-weights. Let's take each element in turn. A metric needs to be dynamic to technological change to incentivize cost-competitive investments ('no-regrets actions) that may not happen due to market and governance failures (Fig 1A). For instance, electric grid expansion with renewables and storage at scale is fast becoming competitive than with fossils without even accounting for co-benefits [7]. Arguably the proscription of future coal power generation when renewables become cost-competitive should also be reflected in accounting for 'no regrets' actions.

There is now a vast body of evidence on the potential co-benefits of various GHG-reducing actions. Incorporating such actions into decision-making can increase the scope of justifiable mitigation in LMIC (Fig 1B) [8]. These co-benefits represent a complex landscape of interacting measures whose impact would vary by context and whose realization may depend on

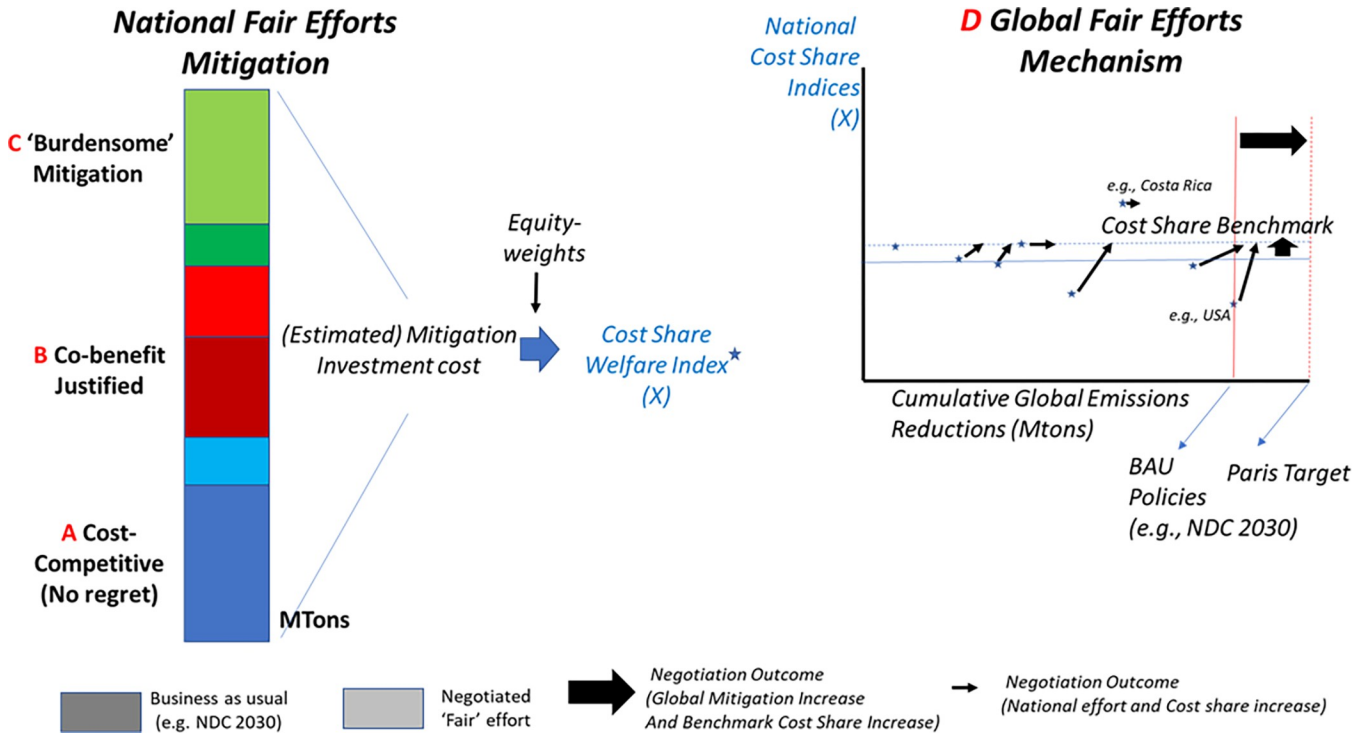

Fig 1. Schematic of the process of determining fair efforts by equalizing national equity-weighted cost-shares of mitigation actions that include no-regret and co-benefits justified actions.

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genuine capacity constraints. However, recent evidence suggests that there are a handful of actions, particularly on the demand side, that may be agreeable as a basis for ratcheting ambition, because they have been shown to improve health and quality of life, and reduce inequality [9, 10]. These include prioritizing shared infrastructure that disproportionately benefits lower income households, such as public transit, reasonably energy efficient public housing and basic utilities, over private consumption such as cars and luxury homes. Through negotiation, these actions may be included at scale with international support mechanisms to defray their incremental costs.

It is only beyond these justifiable measures that additional mitigation efforts should be expected (Fig 1C). This is the component that would be negotiated through the determination of fair efforts using the cost share benchmark, as described below. These three mitigation components would need to be costed out and then normalized by national income or wealth, to determine countries' mitigation cost shares. Actions included based on co-benefits should be incorporated in the cost-share metric at the lower of their real cost or that of the 'business-as-usual' alternative, rather than as an offset based on monetized estimates of social benefits. This would encourage their inclusion by host countries yet avoid value-laden judgments of hypothetical savings. Financial support for mitigation actions elsewhere should be included in donors' cost share calculations.

At this point, these cost shares do not yet factor the differential opportunity cost of mitigation to human development in different countries. This can be incorporated using equity weights based on a widely used prioritarian principle, that of the declining marginal utility of income, namely that a dollar is worth more to a poor person than to a rich person. The equity weight would inflate countries' cost share at lower income levels relative to higher incomes. This is commonly modeled in integrated assessment modeling (IAM) community as an inequality aversion [11] or equity weighting parameter that translates consumption to commensurable welfare [12]. Countries' equity weights can be chosen to make the resulting welfare inversely proportional to income (when set to 1), or to cumulative emissions (likely higher than 1). Or simply a scalar factor akin to progressive taxation. The application of such weights have justified drastic outcomes, such as requiring almost immediate net zero achievement in the US [11].

The idea of a cost share of essentials as a measure of poverty has a long history. A close precedent in the context of climate burdens equalizes countries' mitigation costs as a share of GDP while minimizing global mitigation costs to achieve a temperature target [13]. However, this egalitarian approach ignores the differential marginal utility of income as well as co-benefits.

Through this welfare adjustment these cost shares would then be commensurable across countries. A single, annually adjusted benchmark cost share should then be set corresponding to a global emissions budget. This benchmark cost-share should be adjusted every few years over the critical time horizon, 2020 to 2050, to account for changing technology and investments' lifecycle costs and emissions, and to ensure that overall commitments are consistent with the global chosen emissions budget and schedule. Countries would use this benchmark to increase the scope and scale of their mitigation portfolio until their adjusted cost share meets this benchmark (Fig 1D).

Much work would have to go into operationalizing this metric. It involves data-intensive bottom-up analyses by country governments using energy-economy models to select and cost out these mitigation actions. The determination of the cost share benchmark and its adjustment involves value judgments, including the equity weighting parameter and discount rates. Globally agreed protocols for technology cost reductions and valuation methods would be required to counter countries' incentives to game this metric by inflating mitigation costs and

understating future economic growth to justify a high cost-share and take on less mitigation. Norms for data inputs can be developed based on recent history and best practices. The extent and transparency of data availability has been ever-increasing. Countries would still have to negotiate the differential pace of investments in the chosen actions between industrialized countries and LMIC in exchange for financial support and/or unprecedented scale-up of these actions.

There will be no easy way to bridge the disconnect between present trends and the Paris goals. But in a world where we agree to ratchet ambition for real, this metric provides a systematic approach to assessing fair efforts in a transparent manner based on a widely accepted prioritarian principle, but also pushing LMIC countries to accelerate equitable development.

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