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'Fair' inequality, consumption and climate mitigation

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'Fair' inequality, consumption and climate mitigation

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E-mail: joeltmh@gmail.com**Keywords:** climate change, climate justice, energy consumption, fairness, inequality, meritocracy, povertySupplementary material for this article is available [online](#)**Abstract**

Economic inequality and climate change are pressing issues that have climbed high up the political agenda, yet action to mitigate both remains slow. As income is a key determinant of ecological impacts, the Global North—and wealthier classes elsewhere—are the primary drivers of global carbon emissions, while the least well off have contributed the least yet are set to be hit hardest by climate impacts. These inequalities are clearly unjust, but the interrelations between economic inequality and ecological impacts are complex, leaving open the question of whether reducing the former would mitigate the latter, in the absence of reductions in total economic output. Here, we contribute to these debates by estimating the carbon-footprint implications of reducing income (and hence expenditure) inequalities within 32 countries of the Global North to the levels people consider to be *fair*; levels that are substantially smaller than currently exist. We find that realising these levels of economic inequality brings comparable reductions in carbon-footprint inequalities. However, in isolation, implementing *fair* inequalities has a negligible impact upon total emissions. In contrast, recomposing consumption—by reducing inequalities in household expenditure and the overall levels, then reallocating the reductions to public services—reduces carbon footprint by up to 30% in individual countries and 16% overall and, crucially, still allows the consumption of those at the bottom to rise. Such reductions could be significant on a global level, and they would be additional to the full range of conventional technological and demand-side measures to reduce carbon emissions.

1. Introduction

Economic inequality and climate change are pressing issues that have climbed high up the political agenda in recent decades, each featuring in multiple UN Sustainable Development Goals (SDGs). However, action to mitigate both remains slow. Multiple planetary boundaries are being breached in a majority of countries [1] and—pandemics aside [2]—global carbon emissions are yet to show signs of peaking [3]. Currently, even if Nationally Determined Contributions are fulfilled, emissions in 2030 are expected to exceed the least-cost pathway for staying within 2° by ~30% [4]; this, while recent research traces all five mass-extinction events in Planet Earth's history to global heating processes [5].

Alongside these increasing ecological impacts, there has been a rise in economic inequalities. By some measures, inequalities have been rising since ~1980 and are returning to pre-World War II levels,

with the top 1% now taking ~10%–20% of income in countries across the Global North and South [6]. Such inequalities are forecast to increase further if rates of return on capital remain larger than economic growth (*ibid*). Even self-identifying plutocrats are openly fearful of the outrage and social instability this is bringing [7].

As income is a key determinant of ecological impacts, the Global North—and, increasingly, wealthier classes elsewhere—are primary drivers of global carbon emissions and the wider ecological damages of which we are only seeing the beginning [8]. Globally, the top 10% of emitters account for ~35%–50% of all emissions, while the bottom 50% account for less than 15% [8, 9]. Similar trends are found nationally—energy- and carbon-footprint inequalities across income groups are substantial in countries around the globe [10–12], and income inequalities within countries are becoming the dominant force shaping global inequality [8, 13]. Such

injustices will be exacerbated by the fact that the least well off will generally be the most negatively affected by issues they have contributed to the least—while food shortages and droughts devastate sub-Saharan Africa and beyond, the super-rich and better prepared of the middle-classes of the Global North may migrate to secret bunkers purchased on the now flourishing ‘apocalypse real estate’ market [14].

Existing economic and ecological inequalities are clearly unjust. However, the interrelations between economic inequality and ecological impacts are complex [15, 16] and the degree to which the former are a driver of the latter is unclear. There are, of course, a multiplicity of ways that income could be redistributed [17]. But whether reducing economic inequalities could mitigate global ecological issues remains an open (and contentious) question.

Herein, we contribute to the debate in a specific and novel way, by exploring the implications ‘fair’ economic inequalities could have for carbon footprints. By combining energy- and carbon-footprint models disaggregated across income groups for 32 countries of the Global North, with social survey data reporting the *fair* (or *ideal*) levels of income inequality people in these countries believe should exist [18], we estimate the changes in footprints that would follow if such public preferences were realised. The *fair* economic inequalities people express are far smaller than those currently existing, but in many countries the former remain substantial nonetheless [19]. This synthesis of surveys on public values and environmental footprint modelling represents a major part of the novelty of our work.

As expected, our results show that if these fair levels of income inequality were realised, energy- and carbon-footprint inequalities would also be significantly reduced. However, with all else being equal, total footprints would be unaffected. We thus explore both reductions in and recompositions of consumption [20], which may substantially lower total footprints, and which lower inequality may itself permit.

2. Background

2.1. Ecological inequalities

Large inequalities in nations’ carbon emissions go back to the beginnings of the industrial revolution; before 1930 over 80% of global emissions occurred within European and North American countries [8]. With the rapid economic growth of regions like China and Brazil, disparities between the Global North and Global South have reduced [13]. But large inequalities remain—territorial emissions and energy use are an order of magnitude larger in countries like the USA and Australia ($\sim 20 \text{ t CO}_2\text{e cap}^{-1}$) than in low-income countries within sub-Saharan Africa and elsewhere ($\sim 1\text{--}3 \text{ t CO}_2\text{e cap}^{-1}$) [21].

However, to fully understand inequalities it is necessary to consider consumption-based measures.

Referred to as ‘footprints’, these allocate supply-chain carbon or energy use to the point of final consumption—a task normally achieved using environmentally extended input–output models (EEIO) [22, 23]. When footprints are considered, international inequalities appear larger still. The USA, EU and Japan are net emissions importers, with carbon footprints $\sim 12\%$ – 23% higher than their territorial emissions, while countries in the Global South are often net emissions exporters [24]. Sub-national inequalities are also substantial: in low- or lower-income countries, per-capita carbon footprints of those in severe poverty can be two orders of magnitude less than those of the upper-classes, now that footprints of the latter frequently match those of wealthier classes in the Global North [9, 13].

The difficult questions involve exploring what reducing these inequalities could mean for ecological impacts. Many studies suggest there exist trade-offs between inequality [25] (or poverty [26]) and carbon emissions, such that mitigating the former increases emissions [13, 27, 28]. This finding is common for wealthier countries [29]. But beyond the Global North, any such trade-offs may be minor. Eliminating extreme poverty—bringing everyone up to $\$1.90 \text{ d}^{-1}$ —may increase global emissions by only a few per cent, while capping all national income Gini coefficients to 0.3 would increase global emissions by $<1\%$ [27]. Even these minor trade-offs may be exaggerated, as researchers often equate poverty alleviation and development with increasing affluence, despite the assumption’s crudeness [26]. *Decent living standards* like adequate nutrition, access to clean water, and sanitation services are not tightly coupled to overall carbon emissions; rather, widespread provision is normally achieved at low per-capita carbon footprints and relationships saturate thereafter (*ibid*). And in some contexts, increasing the incomes of the poorest can reduce their emissions due, for example, to their ability to then purchase cleaner and healthier fuels [30]. Interactions between inequality and carbon emissions thus remain unclear.

2.2. The notion of fair inequalities

We focus upon income inequalities within countries of the Global North, reducing them to the *fair* levels emerging from survey data. But what is meant by *fair inequality*? The important distinction to draw is between *fairness* and *equality* [31]. Starman *et al* argue the tendency often found in public discourse to assert that humans have an aversion to inequality is unsubstantiated, and that ‘people prefer fair inequality over unfair equality’ [18, p 1].

But how to define *fair*? In economic contexts, fairness is widely thought to be achieved when a condition of *equality of opportunity* exists, which eliminates all privilege so inequalities in outcome perfectly reflect people’s merit—their aptitude, hard work, dedication and willingness to take risks. In a word,

meritocracy [32]. There are no countries in which a genuine meritocracy exists, but the degree to which people believe their society represents a one varies substantially. The USA, while not unique [33, 34], is one example of a society where a widespread belief in the existence of meritocracy is found alongside an entrenched class system [35] (hence the popular joke—Person 1: *Do you know how the USA's class system works?* Person 2: *I didn't think the USA had a class system?* Person 1: *Yes, that's how it works*). Within countries, belief in the existence of meritocracy varies in predictable ways—upper-income groups are more likely than lower-income groups to see economic inequalities as resulting from merit [36]. Further, the ideals of meritocracy are deeply questionable in themselves, as John Rawls argued decades ago [37] and as many egalitarian hunter-gatherers have figured out themselves [38, 39]. The argument, in short, is that one's aptitude, capacity for hard work, and numerous other physical and psychological traits emerge from a complexity of social, developmental and genetic factors which one can hardly claim to have controlled [40].

With this in mind, how do researchers determine people's *fair* levels of economic inequality? Typically, this is via national surveys asking how large people think current inequalities are, and how large they think they should be. The latter question is sometimes approached semi-quantitatively—by, say, asking how much people agree with the statement *income differences in your country are too high* [41]. Alternatively, people are asked to specify their *ideal* income ratio between the highest earners and unskilled workers [19]. One detailed study asked people to describe their preferences for fair wealth distribution across quintiles [42], but the data is only available for the USA.

A key finding of this research is that most people drastically underestimate existing economic inequalities in their country [43], while also asserting that even their perceived inequalities are unfairly large [19]; a result surprisingly consistent across income groups and political identities (*ibid*). Yet, the inequalities people believe are fair remain considerable in many countries. Nationally averaged *fair* income ratios of the highest to lowest earners frequently exceed 10:1 [19, 34] and one study reports fair wealth ratios in the USA to be 50:1 [44]. Further, people fully embracing meritocratic values do not seem concerned with whatever inequalities prevail, provided meritocratic procedures are in place [45]. Despite these variations, however, even within the USA—where political polarisation is severe—the 'ideal' levels of wealth and income inequality expressed by people of different political leanings, socioeconomic status and genders are remarkably similar [42].

The challenge for our work is to take these data describing public notions of *fair* inequality, most widely available for income inequality, and translate

them into household *expenditure distributions*, which our footprint models require. We now briefly describe these models.

3. Methodology

3.1. Modelling environmental footprints

Footprints—for energy, carbon, etc—are equivalent to $I - E + D$, where I and E are the impacts embodied in imports and exports, respectively, and D those occurring domestically. Conceptually simple as footprints are, tracking the impacts of *all* global extraction, production and distribution activities and allocating these to final consumption remains a data-intensive process, given the complexity of globalised trade networks. EEIO models are typically used, which utilise monetary data on international trade flows to reallocate the direct ecological impacts of industries to where the goods/services these industries produce are eventually consumed [23, 24, 46, 47]. Footprints are calculated for different product categories, and various sources of final consumption, of which *households, government, and capital formation* (i.e. infrastructures) dominate [48, 49]. Households are most significant, with consumption accounting for over 60% of global greenhouse gas emissions and 50%–80% of land, material, and water use [50]. EEIO modelling details are described in the supplementary materials (SMs) (available online at stacks.iop.org/ERL/16/034007/mmedia).

We focus upon carbon footprints (including all greenhouse gases), considering inequalities in *household* footprints only. We do not consider inequalities in government and capital footprints, as allocating these to income groups would be non-trivial and highly contentious. Our model utilises recent work calculating final energy footprints for income quintiles across 86 countries [10]—work expanded to include The USA and Japan—and we extend the model to carbon. We report results for final energy in the SMs. We focus upon 32 Global North countries among these data, including the USA, Japan and 30 European countries. Analysis is restricted to Global North countries assuming that average income levels are sufficient and hence, in contrast to the Global South, the primary issue is redistribution *within* countries. However, as described later there are a small number of Global North countries in our data where average incomes are low.

Within EEIO models, calculating footprints for the quintiles in each country involves multiplying household expenditure vectors of each quintile with energy- or carbon-intensity matrices for each country. Footprints across quintiles can then be used to calculate footprint-expenditure elasticities for each country by fitting a power law to the carbon- or energy-expenditure curve (figure 1). The exponent of the power law (or *elasticity*) gives the percentage increase in footprint for each percentage increase in

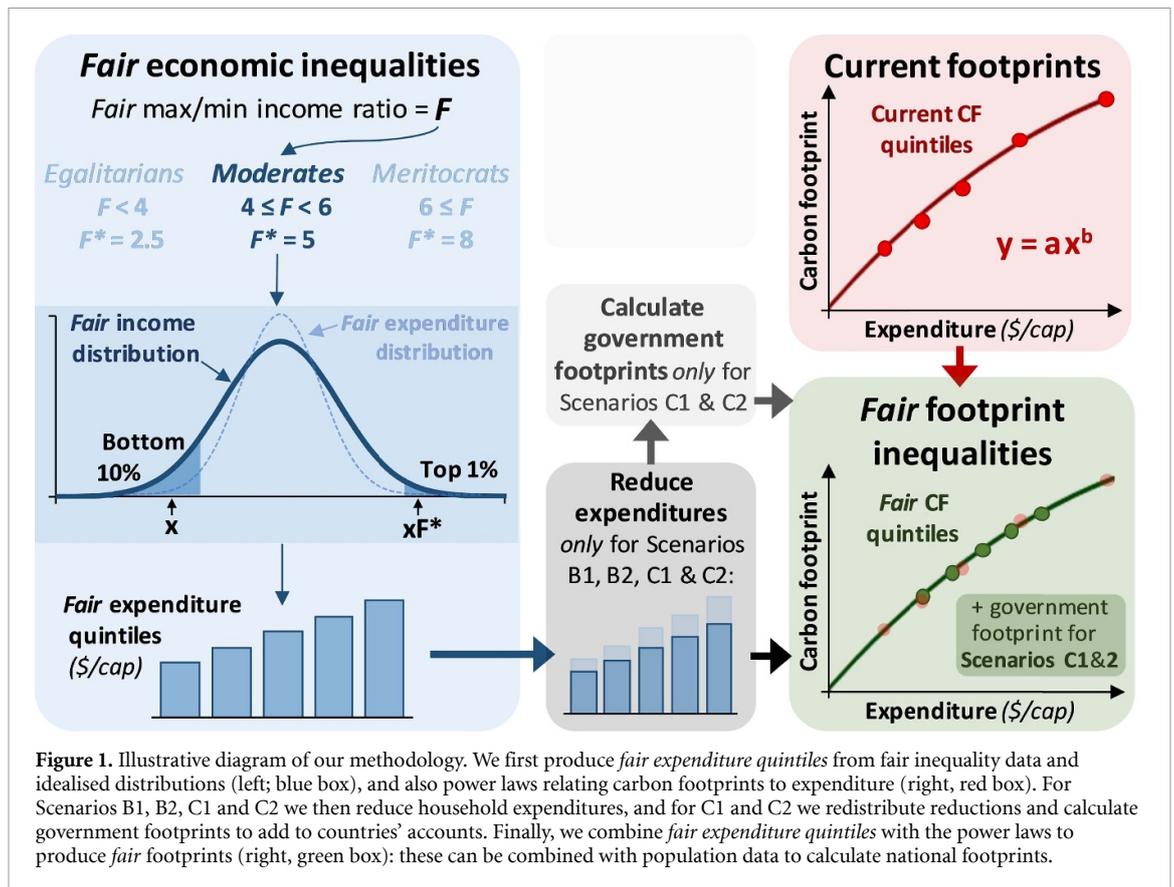


Figure 1. Illustrative diagram of our methodology. We first produce *fair expenditure quintiles* from fair inequality data and idealised distributions (left; blue box), and also power laws relating carbon footprints to expenditure (right, red box). For Scenarios B1, B2, C1 and C2 we then reduce household expenditures, and for C1 and C2 we redistribute reductions and calculate government footprints to add to countries' accounts. Finally, we combine *fair expenditure quintiles* with the power laws to produce *fair footprints* (right, green box): these can be combined with population data to calculate national footprints.

expenditure. To introduce *fair* inequalities for each country, we first narrow the spread of household expenditure quintiles to fair levels. Second, we combine these quintiles with the power laws to give *fair* inequalities in carbon and energy footprints (figure 1, bottom right). However, the elasticities we obtain, while generally less than 1, range from 0.8 to 1.1, which is towards the upper end of those found in similar work (0.6–1) [25, 29, 51–53]. We therefore combine our fair expenditure quintiles with carbon-expenditure elasticities of 0.7 for all 32 countries to give an additional set of outputs more in-line with the lower end of the literature.

3.2. Modelling fair expenditure distributions

Defining *fair* distributions of expenditure quintiles requires various calculations. We start with survey-based data from Kiatpongsan and Norton [19] describing *fair* income ratios for the highest earners (CEOs, specifically) to lowest paid unskilled workers, for 40 countries across six continents. Denoted F in figure 1, these ratios are lowest in Scandinavian and various Eastern European countries ($F = 2$ –3) and higher in places like Germany and the USA ($F \approx 7$). We simplify our model by categorising each country as *egalitarians* (when $F < 4$), *moderates* ($4 < F < 6$) or *meritocrats* ($6 < F$). We then produce idealised, fair income distributions for each—lognormal distributions, for which we denote the average of the upper 1% relative to the lowest 10% as F^* , setting F^* to 2.5,

5 and 8 for *egalitarians*, *moderates* and *meritocrats*, respectively. As income inequalities are larger than expenditure inequalities (and wealth inequalities larger still) [6], these income distributions are then narrowed by considering the relationship between income inequality and expenditure inequality (see SMs section 2), and note that due to date limitations our assumptions here are crude. However, we vary our assumptions in a sensitivity analysis and our key findings are unaffected (SMs section 3). Further confidence in our method of moving from *fair* income ratios to *fair* expenditure quintiles is gained by comparing our outputs with survey data from the USA that indicates preferences for fair wealth distribution across quintiles [42] (SMs section 2).

3.3. Maintaining, reducing and recomposing consumption

3.3.1. Scenario A

We consider five scenarios, and in our first we simply set the means of our lognormal, fair expenditure distributions to be equal to current household expenditures for each country. Scenario A thus maintains total expenditure for each country.

3.3.2. Scenarios B1 and B2

In our B scenarios, we reduce expenditure by centring the means of the fair expenditure distributions upon either current *medians* (Scenario B1) or 2nd *quintiles* (Scenario B2) of household expenditures.

The rationale for Scenario B1 is that current income distributions are long-tailed, with wealthier groups taking disproportionately high shares of income [6], and hence the median may be a better measure of the average income and a reasonable centre for the fair distribution. This results in modest reductions in total household expenditure ($\sim 11\%$ on average across countries) while, in contrast, Scenario B2 assumes households spend significantly less on average ($\sim 31\%$). However, this approach is arguably not as contentious as it seems: social psychologists have long argued that with basic needs met, *relative* incomes most strongly affect life satisfaction [54–56]. In a widely cited study in the USA, half of respondents preferred a 50% lower *absolute* income provided their income level was *relatively* higher [57]. Studies in Sweden [58] and Costa Rica [59] came to similar conclusions, adding that income-related preferences were shaped roughly equally by considerations of absolute and relative levels. The lower household expenditures we assume could thus be publically acceptable (or even preferable) if living standards were high across a population and inequalities close to ‘fair’ levels. However, it would be speculative for us to claim with any certainty that this situation would be publically attractive.

3.3.3. Scenarios C1 and C2

In our final scenarios, we assume that the reductions in household expenditure arising in Scenarios B1 and B2 from centring on the medians and 2nd quintiles, respectively, are reallocated to national government services. This gives us Scenarios C1 and C2, and like Scenario A these keep total expenditure consistent. As discussed further herein, this could be considered as part of a public policy shift to *recompose consumption*, as recently argued necessary for addressing both ecological impacts and social and economic inequalities in the affluent world [20].

For all scenarios, we first produce a new set of what we call *fair* expenditure quintiles. These are input into the footprint-expenditure power laws for each country to produce *fair* carbon- and energy-footprint inequalities (figure 1). For Scenarios 3A and 3B, the reallocated expenditures are multiplied by the carbon (T/\$) intensities of government spending calculated from the EEIO model (but these footprints are *not* allocated to income groups).

3.4. Methodological limitations

It is worth highlighting some limitations of our approach before describing our results. These limitations arise from two primary reasons: (a) the static nature of our analysis and (b) coarse disaggregation in some parts of the model.

Regarding the former, we consider aggregate (not product specific) elasticities of carbon- and energy-footprints within countries, and only a single

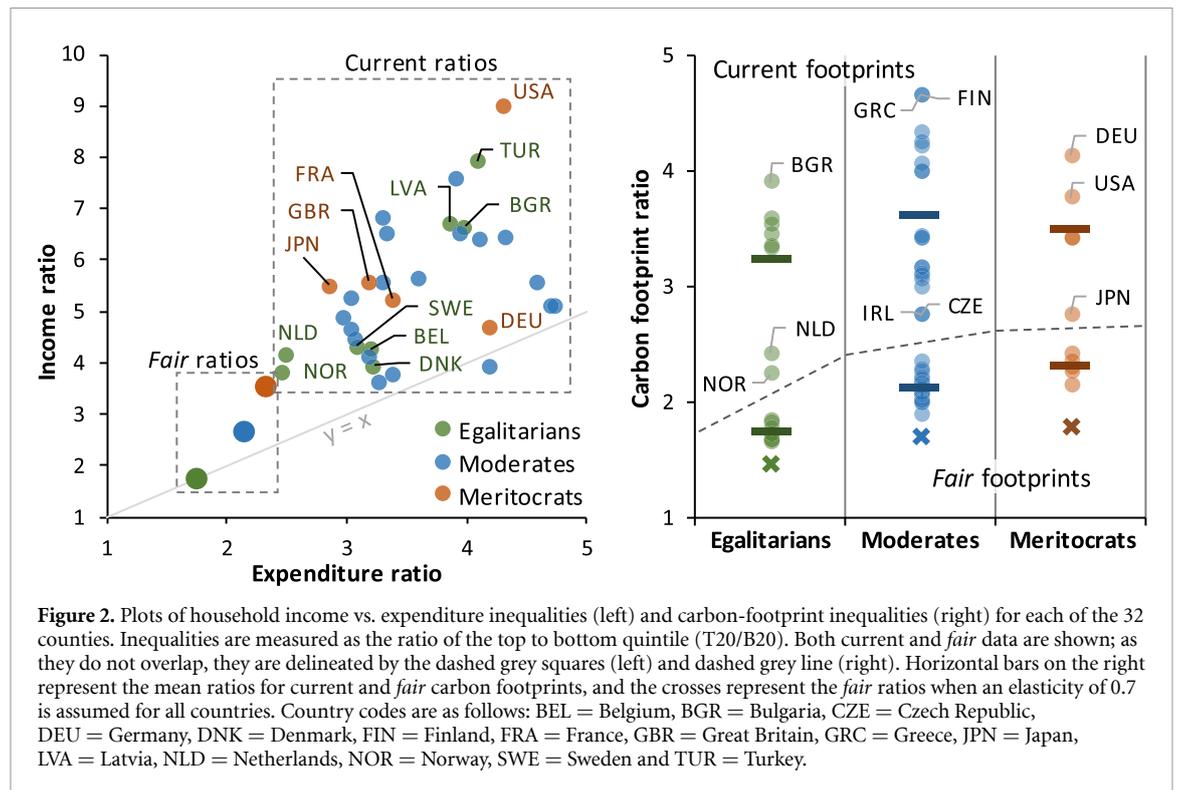
year of data. Consequently, we assume that the composition of consumption at each income level is not affected either by the level of income inequality or the reallocation of spending to public services (although by narrowing income distributions, we implicitly assume shifts in the composition of countries’ overall consumption). In reality, the substantial recomposition of consumption we assume may lead to very different spending patterns, which become more apparent in the longer-term.

Regarding aggregation, when reallocating to government expenditure, we only consider average carbon intensities rather than separate ones for delivering healthcare, education, etc (which is not possible with our EEIO model’s categories). Further, we reallocate to government services, but not infrastructure formation. The latter are more carbon-intensive in terms of impact per unit-spent, but, in contrast, they can be designed to cultivate low-carbon social practices. Finally, there is the resolution of our income groups; five per country. One consequence of this is that in moving from current to *fair* income ratios, we make crude assumptions that could be substantially improved (see SMEs, section 2). More granular income groups would also allow for more detailed predictions of elasticities and hence analysis of ecological inequalities. However, there is a conflicting issue: the energy and carbon intensities for each product category in EEIO models are generally fixed such that, for a given product category, a unit of expenditure by the lowest and highest income groups is assumed to have the same footprint, and neither is there a distinction between ‘green’ and conventional purchases. The former assumption becomes increasingly tenuous for highly disaggregated income groups, so our quintile-approach prevents it from becoming overly problematic. Together, these limitations leave substantial room for future research.

4. Results

4.1. Implications for footprint inequalities

Our method of translating public notions of *fair* income ratios into fair expenditure quintiles gives inequalities consistently lower than current found in all of the 32 countries (figure 2; left). We focus on the ratio of the household expenditure of the top quintile to that of the bottom quintile; a ratio independent of our scenarios. Currently this is ~ 2.5 – 4.5 across the 32 countries, while *fair* ratios for *egalitarian*, *moderate* and *meritocratic* countries are 1.7, 2.1 and 2.3, respectively. Current expenditure inequalities thus exceed fair levels even in countries where the largest inequalities are preferred. Income inequality is higher than expenditure inequality and, by this ratio, only weakly correlated with it—it is highest in the USA at 9, and lowest in various Scandinavian countries at ~ 4 . The lack of correlation between current and fair levels



of inequality present is unsurprising considering literature suggests *perceived* (not *existing*) inequalities influence ideals of fairness [45, 60].

Carbon-footprint inequalities closely resemble inequalities in expenditure, for current and *fair* distributions. Current ratios of top to bottom quintiles are between 2.2 and 4.7—lowest in Norway and the Netherlands; highest in Finland and Greece. *Fair* inequalities in carbon footprints are much lower, with ratios of 1.6–1.8 for *egalitarian* countries, 1.9–2.3 for *moderates*, 2.1–2.4 for *meritocrats*, or 1.5, 1.7 and 1.8 when an elasticity of 0.7 is used (crosses on figure 2 right). Again, there's no clear relationship between current and *fair* footprints: Bulgaria stands out as a country where preferences for low economic inequality exist alongside high current economic and footprint inequalities, while in Japan the situation is reversed. Similar patterns are found for final energy (see SMs). Overall, applying *fair* levels of income and expenditure inequalities leads to substantial reductions in footprint inequalities within countries, particularly when current inequalities are high.

Although our focus here is on within-country inequalities, it is worth briefly discussing inequalities across countries. As we only consider countries in the (wealthier) Global North, one may expect that substantially reducing inequalities within countries—as implementing *fair* inequalities does—would also lead to a substantial reduction in inequality measured across all countries. However, the latter change is modest, as current within-country inequalities between upper and lower quintiles are comparable

to between-country inequalities in average carbon footprints. For example, Luxemburg, the USA and Norway have per-capita footprints 4–5 times larger than Bulgaria and Turkey; equal to current ratios for more unequal countries (figure 2; right). Consequently, between-country inequalities, and the still significant *fair* inequalities within countries, together mean that inequality across all 32 countries remains substantial. Gini coefficients are reported in figure 3.

4.2. Implications for total footprints

4.2.1. Scenario A

While implementing a notion of *fair* income inequality substantially reduces carbon-footprint inequalities within nations, overall footprints change negligibly if mean household expenditures are fixed (figure 4 left). This is true even when elasticities are uniformly set to 0.7, which maximises the carbon trade-off of redistribution in our model—total emissions increase <2%. Thus, all else being equal, reducing inequalities is not a means to mitigate carbon emissions, and whether a country is *egalitarian* or *meritocratic* is inconsequential for its overall carbon footprint.

4.2.2. Scenarios B1 and B2

Centring the mean of the *fair* distributions upon current median household expenditures in Scenario B1 leads to reductions in carbon footprints of up to 20%, or 11% aggregated across all countries. Comparable numbers for Scenario B2 are footprint reductions of up to 40%, or 31% across countries.

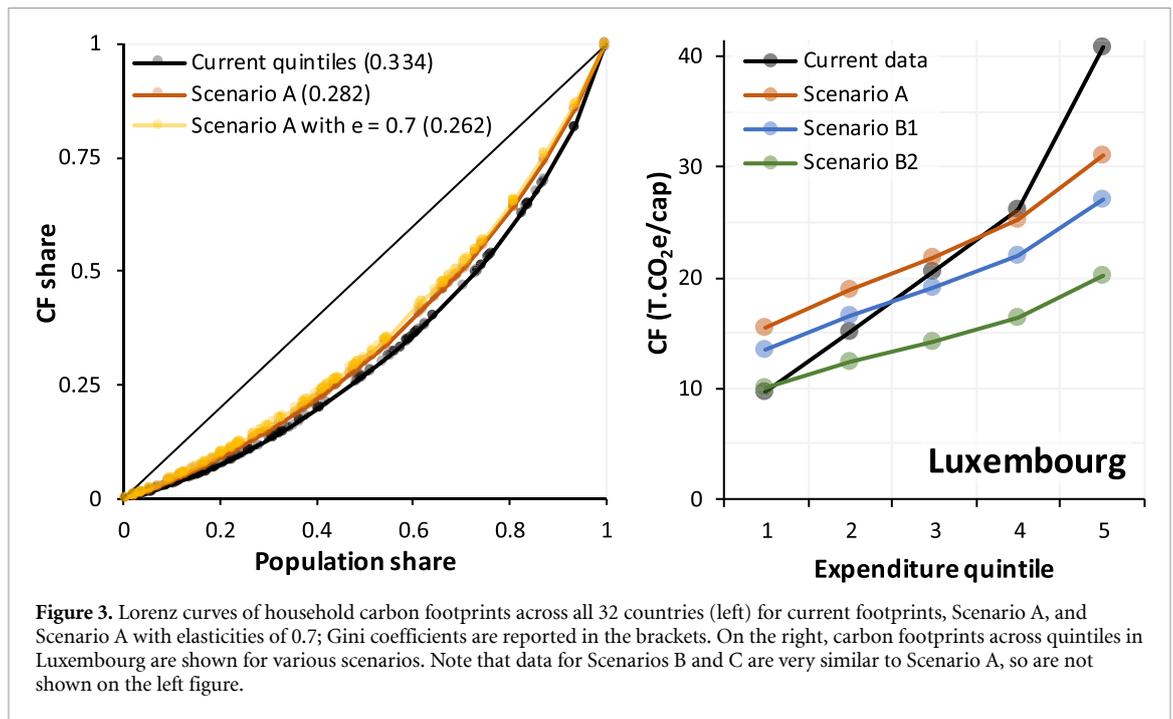


Figure 3. Lorenz curves of household carbon footprints across all 32 countries (left) for current footprints, Scenario A, and Scenario A with elasticities of 0.7; Gini coefficients are reported in the brackets. On the right, carbon footprints across quintiles in Luxembourg are shown for various scenarios. Note that data for Scenarios B and C are very similar to Scenario A, so are not shown on the left figure.

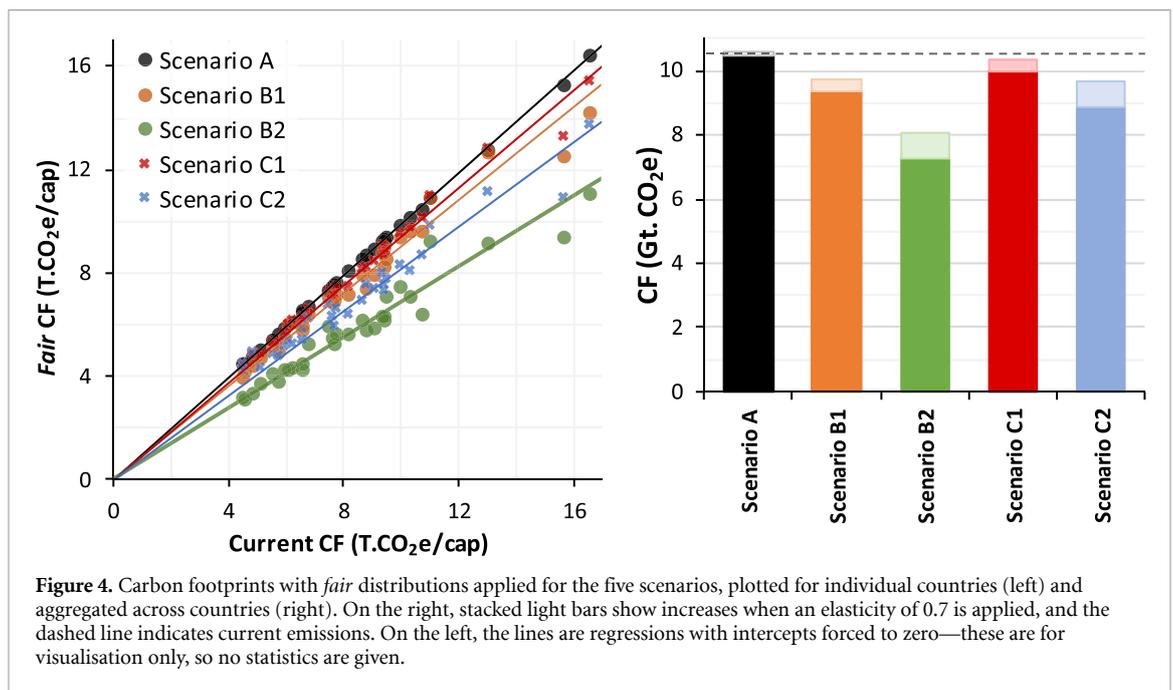


Figure 4. Carbon footprints with *fair* distributions applied for the five scenarios, plotted for individual countries (left) and aggregated across countries (right). On the right, stacked light bars show increases when an elasticity of 0.7 is applied, and the dashed line indicates current emissions. On the left, the lines are regressions with intercepts forced to zero—these are for visualisation only, so no statistics are given.

These reductions are proportional to the reductions in household expenditure—therefore, if the same reductions in countries’ average expenditures were applied but with levels of inequality left unchanged, footprint reductions would be almost the same. However, this would imply proportional reductions in expenditure for those already at the bottom. In contrast, footprint and expenditure reductions in Scenario B1 are absorbed largely by the upper two quintiles, while footprints of the lower two quintiles rise (figure 3, right). Implementing *fair* levels of inequality thus allows for significant reductions in average expenditure without a notable effect on those in the middle and while increasing consumption of those at

the bottom. Even with the more significant reductions of Scenario B2, the lowest quintile remains unaffected (figure 3, right), or when we fix elasticities to 0.7 footprints of the bottom quintiles increase by ~25% while those of the top quintiles decrease by ~40%. However, lowering elasticities also means aggregate footprint reductions of Scenarios B1 and B2 are reduced by 1/3 and 1/4 (to 8% and 21%).

From a global perspective these reductions are significant. The total carbon footprint of the 32 countries is 10.5 Gt CO₂e (figure 4 right)—20% of global levels for the same year (53 Gt CO₂e) [3]. Scenario B1 and B2 reduce the total carbon footprint of these 32 countries by 1.2 Gt CO₂e and 3.3 Gt CO₂e,

respectively. The latter is equivalent to a 6.2% reduction in global emissions—significant, given these 32 countries cover only 1/7th of the global population, we apply no reductions to carbon intensities, nor do we assume any shift to greener consumption. In other words, the reductions we find could be additional to all the strategies considered in conventional mitigation scenarios.

4.2.3. Scenarios C1 and C2

In our scenarios that reallocate reductions in expenditure to national government spending footprints remain substantially reduced, as the carbon intensity of government spending is significantly lower than of households (except in Bulgaria). Scenario C1 leads to reductions in carbon footprints of up to 15%, or 6% aggregated across all countries—just over half the reductions of Scenario B1. Reductions for Scenario C2 are up to 30%, or 16% in aggregate. At 1.7 Gt CO₂e in absolute terms (figure 4 right), Scenario C2 is equivalent to a 3.2% reduction in global emissions. Note again that these footprint reductions could be made without reducing inequalities, but with the associated cost of substantially reducing the consumption of those at the bottom.

5. Discussion and conclusions

We have found that reducing economic inequalities within countries of the Global North, in line with public notions of economic fairness, substantially reduces national energy- and carbon-footprint inequalities. However, there are no reductions in overall footprints unless total household expenditure is also reduced. Without broader economic changes, then, the level of inequality publically considered *fair* appears inconsequential for ecological impacts. Reductions in footprints can be achieved by *recomposing consumption* [20]—specifically, by reducing household expenditure inequalities to *fair* levels, reducing mean household spending to current median levels (or current 2nd quintiles), and then reallocating savings to national government spending. Narrowing inequalities is not necessary for these footprint reductions—the same can be achieved through reductions in mean household spending alone. Crucially, however, the combination of reducing inequalities to *fair* levels and lowering total household spending means footprint reductions are largely absorbed by the upper two income quintiles, while the consumption of those at the bottom still rises. It thus reduces excessive luxury spending [61] of wealthier groups—where the returns for well-being are marginal at-best [62]—while allowing increases in consumption at the bottom where it is needed the most.

Reducing carbon footprints by recomposing consumption in this way also leaves available the full range of conventional measures to reduce carbon

emissions, both technological (e.g. renewable energy) and demand-side (e.g. low-impact diets). And there could be a number of other positive impacts. For one, this could satisfy public desires for economic inequalities to be reduced; desires reported in surveys universally across the Global North. Further, increased national government spending could be directed towards social goods like national healthcare systems—whose weaknesses have been exposed by Covid-19—or, more broadly, towards things like *universal basic services (UBS)*. UBS could have additional redistributive effects by guaranteeing the housing, healthcare, educational and mobility needs of the less affluent are met [61].

But what are the practicalities of this? Our model assumes that widely held public notions of economic fairness are realised and we have not considered the political feasibility of this. There is evidence that widening economic inequalities increase support for redistribution [63], but desires for less inequality are not always backed by equal support for redistribution [45]. Even when they are, there's no guarantee action will follow, given the wealth and power of the super-rich [64]. These questions are beyond our scope, but it is worth highlighting that in the present political climate, while the idea of placing a floor on consumption to alleviate substandard living conditions is widely accepted, capping consumption and affluence remains a contentious topic despite arguments of the ecological importance of such a step [65]. Reducing inequality is the 10th of the UN's SDGs, but with no caps on high consumers it is difficult to imagine this being achieved without ecological limits being substantially overshot, along with any chance of meeting the other SDGs.

This brings us to a final quite serious limitation of our work, namely that we have focused only upon redistribution within countries—an approach that has been criticised for side-lining a crucial global perspective on inequality [25]. Rationales for redistribution between countries are numerous, ranging from poverty alleviation through colonial reparations to funding climate adaptation programmes in regions that, despite negligible contributions, are placed to be hit hardest by climate change. Yet international economic inequalities remain substantial, and the gaps between rich and poor countries cannot be justified via the meritocratic ideals people drawn upon to justify *fair* inequalities within countries.

It is worth noting, then, that in Scenarios C1 and C2, where we lower and narrow household expenditure distributions and reallocate reductions to government spending, the total amount reallocated across the 32 countries is substantial at \$1.4 and \$3.8 trillion—3.5% and 9.6% of these countries' collective GDP (in Scenarios C1 and C2, respectively). Redistributing just ~3%–10% of this expenditure internationally would match the amount of *Official*

Development Assistance flowing from OECD countries to the Global South (ODA was \$0.12 trillion in 2011—just 0.3% of contributors' GDP; www.oecd.org/dac).

While it may be important and timely to focus, as we have, upon public preferences for reducing levels of economic inequality within wealthy countries, this is clearly insufficient for dealing with the fact that even average consumption in such countries is typically excessive and leaves insufficient space for the development needs of poorer countries. Moreover, if the levels of economic inequality publically deemed to be fair were realised within wealthy countries of the Global North, but poorer countries of the Global South were left underdeveloped and overheated by climate change, this could not possibly pass any reasonable definition of fair.

Data availability statement

The data that support the findings of this study are available upon reasonable request from the authors.

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