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A fairer and more effective carbon tax

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Given available technologies, current consumption behaviour is incompatible with the goal of keeping global warming below 2 °C. Economists present carbon pricing as the most efficient tool to induce people to adjust their consumption behaviour. This Perspective critically analyses the ethics, economics and politics of one key form of carbon pricing: carbon taxes are levied to discourage fossil-fuel-intensive consumption. The core claim of this Perspective is that progressive individual carbon taxes (that is, taxes whose rate increases the more emissions an individual generates) are not only more effective but also more just than the flat-rate carbon taxes prevalent today.

Carbon taxes are widely accepted as the policy instrument of choice[1] to make people change their consumption patterns, emit fewer greenhouse gases (GHGs) and thus contribute to keeping global warming below a tolerable threshold[2]. However, challenges arise when it comes to achieving this goal effectively and doing so in a way that distributes both the emission reduction obligations and the tax payments fairly. This paper identifies three such challenges. It then shows that the debates surrounding carbon taxes and their design in the real world have thus far responded to these challenges to varying degrees of success, addressing one challenge adequately, only starting to address a second one, while ignoring a third one altogether.

We see that taking all three challenges seriously leads to a clear policy recommendation: states should adopt a highly progressive carbon tax for individuals. In other words, people who emit more should pay a higher marginal carbon tax rate. Such a measure would not only be more effective than a flat carbon tax at reducing emissions and thus meet climate targets but, perhaps surprisingly, I argue that it would also be more just.

The clearest way to present the three challenges and appreciate how they relate to one another is by analysing carbon taxation through the prism of three different literatures (Fig. 1): the literature on carbon taxes as a tool of fiscal policy, the literature on socioenvironmental inequality, and the theories of justice literature on inequalities in income and wealth. Connections between these three literatures today are partial and incomplete, with important consequences for the justification and design of carbon taxes.

In a nutshell, flat, single-rate carbon taxes face the well-known 'regressivity challenge': even though rich people consume more than poor people, they spend a lower percentage of their income on consumption and thus pay less in carbon taxes in relative terms[3–5]. So-called carbon rebates for people on lower incomes represent a remedy successfully adopted by some jurisdictions[6–8]. However, a second challenge beckons in the form of the 'effectiveness challenge': the rich are not only the biggest polluters[9,10] but their wealth also makes them less sensitive to carbon taxes as a disincentive to consume and pollute. Making carbon taxes progressive looks like a potential solution but is sometimes considered to impose too high a 'tax burden' on the rich. Yet, this alleged trade-off between effectiveness and an unfair burden on the rich disappears when faced with the 'baseline challenge': progressive carbon taxation can only impose an unfair 'tax burden' on the rich if their income and wealth is legitimately theirs. If, as suggested by a consensus in the theory of justice literature, part of the income and wealth inequalities of today are not only regrettable but also unjust, then discouraging the wealthy to use this part of their income in carbon-intensive ways through progressive carbon taxation emerges not only as an effective way to reduce emissions but also as a requirement of justice.

Let me unpack and analyse these three challenges in more detail.

Carbon taxes and regressivity

States raise taxes for a number of different reasons[11]: to finance public goods, to promote a fairer distribution of income and wealth, to incentivize or disincentivize certain kinds of behaviour, and to smooth the ups and downs of the business cycle. Carbon taxes clearly fall into the third category. They represent Pigouvian[12,13] or steering taxes whose primary goal lies in disincentivizing carbon-intensive activities by making them more expensive. Generating tax revenue is a mere biproduct of such a tax.

Pollution through GHG emissions represents a negative externality; that is, a social cost that is not reflected in the private costs of either the producer or the consumer of the product in question[14]. Negative externalities lead to an inefficiently large quantity of the good in question to be produced and consumed. Think fossil fuels as an example. The objective of carbon taxes as a Pigouvian tax is to raise the price of fossil fuels, thus disincentivizing their use and lowering it to an efficient

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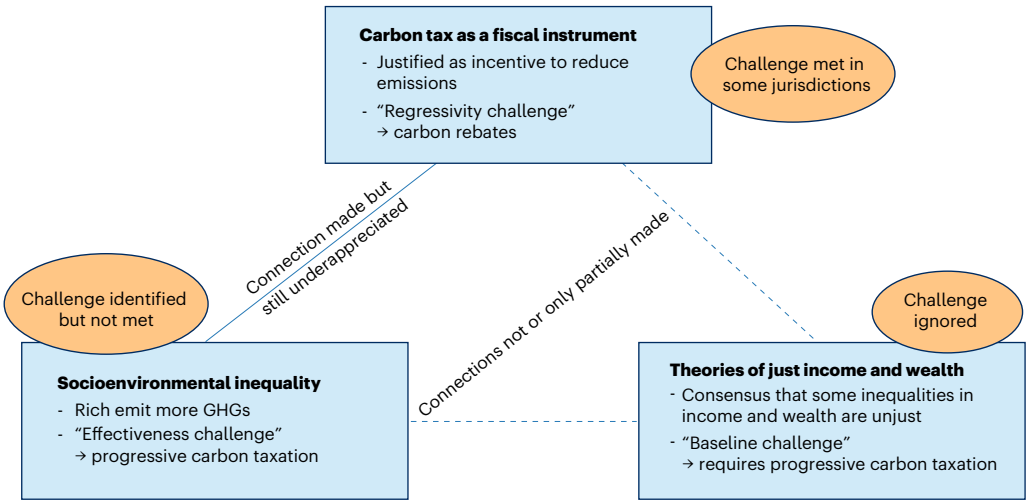

Fig. 1 | Three challenges. Blind spots in the understanding of carbon taxes emerge when connecting the three literatures on fiscal policy, socioenvironmental inequality and social justice.

level. They do so by internalizing the negative externality, also known as the social cost of carbon. Standard Pigouvian taxes are single-rate taxes, although we modify this parameter later.

However, even when focused on the disincentivizing effects of the carbon tax, policymakers want to make sure not to undermine the other goals of the tax system. Imagine you impose a $100 per ton of CO_2 equivalent (tCO_2e) on carbon-intensive activities. As a percentage of their disposable income, lower-income individuals will tend to pay more carbon taxes for a variety of reasons[4,15,16]. For example, they tend to not be able to save and therefore to consume more as a percentage of their income; they also might not be in a position to afford greener technologies such as electric cars that (still) require a higher up-front payment. For these reasons, the initial incidence of a flat, single-rate carbon tax (that is, the incidence before we look at how the revenues from the tax are spent) is likely to be regressive in most countries[5], impacting lower-income individuals more than higher-income ones[3–5]. This is in tension with the second goal of taxation mentioned above, namely, to achieve a fairer distribution of income and wealth, which is usually done through progressive tax policies. Hence the 'regressivity challenge'.

Fiscal theorists will be quick to point out that any assessment of the progressivity or regressivity of a tax needs to take into account not just how revenue is collected but also how it is spent. The regressivity challenge can and has been met by many jurisdictions by various forms of revenue recycling[4,5,7,17,18] including notably the earmarking of revenues for climate mitigation in ways that protect vulnerable populations or the adoption of so-called carbon rebates for low-income individuals and households[15,19]. As an illustration, Box 1 summarizes the main features of carbon taxes and low-income rebates in the Canadian province of British Columbia. Meeting the regressivity challenge in this way makes the carbon tax more just, albeit only in a narrow sense. It distributes the tax obligations fairly under the assumption that we take the background distribution of income and wealth as given. We come back to this important caveat later.

Combining carbon taxes with carbon rebates for low-income individuals and households not only helps to meet the regressivity challenge but also affects the level of public acceptance[7,20] for carbon taxes. In the case of British Columbia, seeing a revenue-neutral carbon tax operate for a number of years helped to transform initial opposition to the tax into public support[6]. By contrast, the attempt by the French president Emmanuel Macron in 2018 to increase the French carbon tax but use the proceeds for a reduction of the wealth tax was one of the main factors behind the outrage of the yellow vest movement[21].

BOX 1

Carbon tax and rebate schedule in British Columbia, Canada, July 2023 to June 2024

The provincial carbon tax in British Columbia[60] meets the requirements of the federal carbon tax at present, which sets minimum standards across Canada[61].

Carbon tax:
- Can$80 per tCO_2e, generating in excess of Can$2 billion of revenue per year
- Set to rise to Can$170 per tCO_2e in 2030 (as mandated by Canada's federal government)
- What does this mean in practice? At Can$80 per tCO_2e one pays 17.61 cents of tax per litre of gasoline, for example.

Climate action tax credit[62]:
- Individuals below a threshold of Can$39,115 annual income (Can$50,170 for families) are eligible for the tax credit
- Individuals can receive a maximum of Can$447 per year (plus Can$223.50 for spouses, common-law partners or the first child in a single-parent family; Can$111.50 for other children)
- A reduced credit is available for a subsequent income bracket before the credit is reduced to zero.

Revenue neutrality:
- When introduced in 2008, the British Columbia carbon tax was revenue-neutral; that is, all revenues were handed back to individual and corporate taxpayers through tax breaks, including the climate action tax credit described above.
- Since 2017, British Columbia carbon tax is no longer revenue-neutral, although most revenue still goes to tax credits of various kinds.

The effectiveness of carbon taxes

The previous section suggests that, when done right, carbon taxes are a success story. However, one has to remember that the objective

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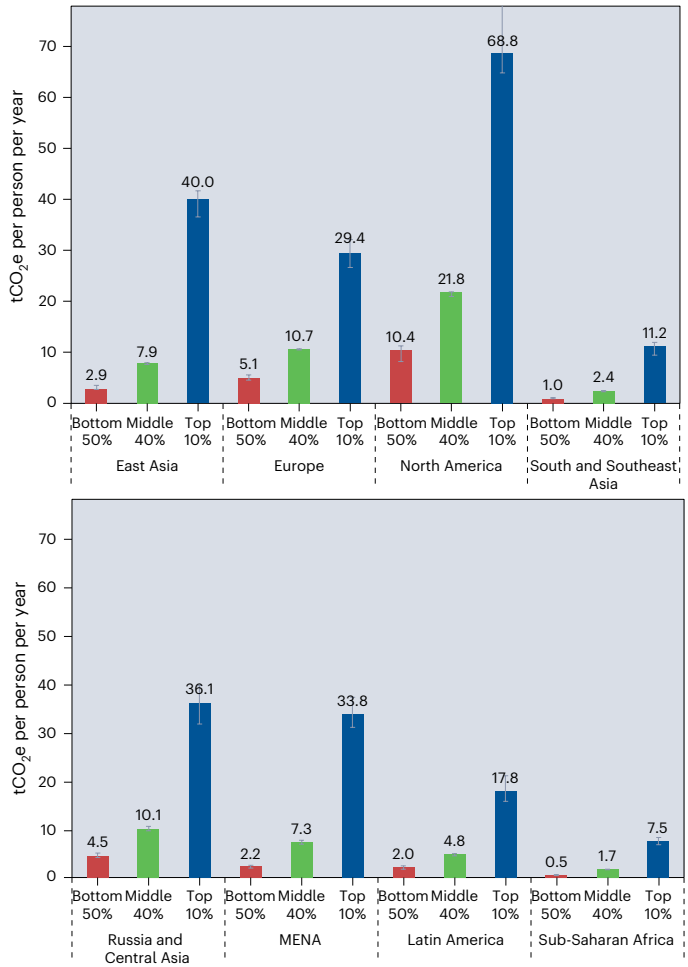

Fig. 2 | Per capita emissions by group in 2019 (tCO_2e per capita). Per-capita emissions incorporate emissions resulting from domestic consumption, public and private investments, and imports and exports of carbon embodied in goods and services traded with the rest of the world. Combined tax data, household survey and input–output tables are used to obtain the benchmark scenario. Emissions are split equally within households. Error bars show estimates for extreme scenarios (with $\alpha = 0.4$ in one case and $\alpha = 0.8$ in the other). MENA, Middle East and North Africa. For sources and series see ref. 24. Figure reproduced from ref. 24, Springer Nature Ltd.

is not to raise revenue but to reduce GHG emissions. The 2015 Paris Agreement commits states to "reduce global greenhouse gas emissions to hold global temperature increase to well below 2 °C above pre-industrial levels"[22]. To do so, the Paris Agreement requires states to formulate so-called nationally determined contributions (NDCs) to set out their climate mitigation plans. For instance, Canada has committed to reducing its GHG emissions by 40–45% below 2005 levels by 2030, as well as to net zero by 2050[23].

As the literature on socioenvironmental inequality has highlighted[9,10,24,25], setting emission reduction targets at the aggregate, national level[26,27] can be misleading because it obscures from view an important inequality in the individual responsibility for GHG emissions. As shown by Fig. 2, across the globe, the average level of emissions among the 10% of the highest individual emitters is considerably higher compared with the next segments of emitters. Emissions strongly correlate with wealth; that is, the highest emitters invariably tend to come from the wealthy segments of the population[10,28].

These observations clearly show that if one wants to reduce emissions, setting a flat-rate carbon tax that creates equal incentives for everyone to change their consumption behaviour is unlikely to be the most promising approach. What is needed is a policy instrument that targets those with the largest potential for emission reduction; that is, those with the highest per capita emission levels. In fact, a flat carbon tax rate is unsuitable for this task for another reason, too: wealthy individuals tend to be less responsive to steering taxes because their budget constraint is considerably weaker. As economists would put it, their demand for goods and services, including carbon-intensive ones, is relatively price-inelastic[29].

Taken together, these considerations ground the 'effectiveness challenge' against carbon taxes. As designed today in most jurisdictions, a single-rate Pigouvian tax is unlikely to actually bring about the behavioural change required to lower emissions. Why? Because the group that has the highest emission reduction potential, wealthy individuals, is least responsive to the disincentivizing effects of a flat carbon tax. If you can afford a private jet, a yacht, or even a Porsche or BMW, will you really be bothered by what will look to you like a small surcharge for fuel?

Against this background, some scholars have called for shifting the policy focus from country-level emissions to individual emissions. Chancel and Piketty, for instance, made this point in the build-up to COP21 in 2015[9,10], which led to the Paris Agreement. Yet, thus far, the international community continues to use national emission reduction targets rather than specifically targeting the highest individual emitters. Chancel and Piketty[9] also take the logical next step and advocate for making the Pigouvian tax progressive in the sense that those who emit more should pay a higher marginal tax rate. They argue that the ideal solution would be "a many-bracket progressive carbon tax with graduated rates on the different intervals of carbon emissions" (page 36 in ref. 9). Just as one does not pay income tax up to a certain threshold of income, one would not pay any carbon tax up to a certain threshold of emissions, with marginal tax rates increasing with emission levels above that threshold.

I need to make two additional remarks on this proposal of progressive carbon taxation. First, not all references in the literature to progressive carbon taxation actually mean progressive carbon taxation at the individual level as advocated in the present paper. Among others, Boroumand et al.[30] argue for a progressive rate structure at the level of countries and depending on both their level of wealth measured by the Human Development Index and their level of emissions. For example, according to this logic, the United States as a country that is both wealthy and has one of the highest per capita emission levels worldwide should set a higher carbon tax than India, which scores lower in both of these categories. One strong argument in favour of such an arrangement is based on the distinction between subsistence versus luxury emissions[31]. Subsistence emissions, which stem from economic activities covering basic needs such as food, shelter and necessary transport, tend to be high in relative terms in developing countries, in part due to a lack of low-carbon technologies. It would be unfair to tax these subsistence emissions at the same rate as the luxury emissions of people in richer countries that stem from non-necessary consumption activities.

What this framing of the problem in terms of country-level emissions misses are the intracountry differences in emission levels. As we saw earlier, in both the United States and India, the rich emit considerably more than the poor. From this angle, the drawback of a progressive carbon tax at the country level as proposed by Boroumand et al.[30] is double. It risks being too harsh on the poor in countries such as the United States and too lenient on the rich in countries such as India. Moreover, it is unlikely that progressivity at the country level would be able to meet the effectiveness challenge. Suppose the United States charged \$100 per tCO_2e, whereas India charged \$30 per tCO_2e; the main emitters in both countries would probably not be fazed by these carbon taxes, resulting in insufficient change in consumption patterns.

Second, and more importantly in our context, progressive carbon taxation at the individual level, much like other forms of progressive

Table 1 | Theories of justice at a glance

Comprehensive theories of justice	Theories of justice referring to specific contexts
Liberal egalitarianism (for example, Rawls[45] and Dworkin[46]): income inequalities stemming from factors that are arbitrary from a moral point of view should be eliminated or at least mitigated	Winner-take-all-markets (for example, Frank and Cook[47]): typical of the world of sports and music, a small number of 'stars' owe their high pay to special configurations of demand and supply
Utilitarianism (for example, Mill[48] and Singer[49]): given declining marginal utility of income, maximizing utility plausibly requires a compression of inequalities	Code of capital (for example, Pistor[50]): legal provisions in financial sector serve to protect outsized returns on capital for investors in ways divorced from both functioning of markets and from fairness
Libertarianism (for example, Nozick[51] and Gauthier[52]): any inequalities stemming from unjust acquisition such as conquest, oppression or fraud need to be rectified	Executive pay (for example, Moriarty[53]): most contemporary theories of justice criticize the pay of CEOs and management as excessive
Feminism (for example, Moller Okin[54] and Fraser[55]): income inequalities that flow from the gendered division of labour in society should be eliminated	Inheritance (for example, Halliday[56]): both liberals—on the basis of equality of opportunity—and some libertarians—on the basis that entitlement to wealth weakens across generations—call for inheritance taxation
Limitarianism (for example, Robeyns[57]): a limit should be set for the wealth one individual can hold	Money and credit (for example, Dietsch[58]): the financial infrastructure of modern economies confers unjust advantages to those with collateral
	Natural resoures (for example, Vallentyne[59]): contrary to the status quo, individuals have an equal entitlement to the value of natural resources

taxation, triggers the complaint that it would impose an undue burden on the highest emitters to provide most if not all of the necessary reduction in emissions to meet the world's climate targets. Chancel and Piketty[9] appear sensitive to this line of argument when they see the need to justify the 'tax burden' imposed on high emitters by the potential welfare gains for the rest of the population through reduced emissions (page 37 in ref. 9). This way of framing the distributive justice of climate mitigation assumes two parameters—emission reduction targets and the background distribution of income and wealth—and then asks who should contribute financially, via paying carbon taxes, to meeting the climate targets. In Chancel and Piketty's case[9], they ultimately come to the conclusion that the end (emission reduction) justifies the means—asking the well-to-do to shoulder most, if not all, of the cost. But it is easy to see how someone might disagree with this assessment. There is a trade-off, so an objector to progressive carbon taxes might say, between their effectiveness in terms of reducing emissions on the one hand and a just distribution of the mitigation costs on the other. Progressive carbon taxes score high on effectiveness but ask too much of the wealthy in terms of emission reduction. As we now see, this objection to progressive carbon taxes suffers from a fatal flaw.

Why progressive carbon taxes are just

In this section, I argue that a broader adoption of progressive carbon taxes is unlikely unless their advocates address the concern identified at the end of the previous section more convincingly. Would progressive carbon taxes really ask too much of the rich? Once we establish the connection to the third literature identified in Fig. 1, namely, the theories of justice in terms of income and wealth, we see that, on the contrary, progressive carbon taxes are not merely compatible with justice, they in fact represent a requirement of justice. In one sentence, the debate on progressive carbon taxes so far suffers from a blind spot by assuming that the money the rich spend on carbon-intensive activities is legitimately theirs. This, as we now see, is a mistake.

Intracountry inequalities in income and wealth have been on the rise in many countries over recent decades[32–34] and, consequently, have climbed up the political agenda. From a theoretical perspective, we can distinguish two broad reactions to this inequality. On the one hand, some scholarship focuses on inequality as an instrumental bad. Inequality can be detrimental to economic growth[35], to democratic institutions[36] and to health, for example[37]. On the other hand, and this is the approach we focus on here, contributions to the literature on distributive justice emphasize that inequality is not just bad because of its effects but is intrinsically bad. From this angle, for a variety of reasons, current levels of inequality cannot be justified.

Of course, theories of justice vary both in their scope and in the precise arguments they put forward about what gives an individual a just entitlement to a particular level of income and wealth. Table 1 provides a non-comprehensive overview of both theories of justice with the ambition of addressing the distribution of income and wealth in society as a whole and theories of justice that refer to more limited contexts of inequality.

You might wonder how one could construct a case for a progressive carbon tax on the basis of such a diverse set of theories. Despite their many differences, what all of these theories have in common is the idea that some portion of the inequalities in income and wealth we observe in our actual societies today are unjust. Consider an example from each column. Feminist theories of justice hold that the gendered division of labour results in unjust wage premia for men; Pistor's analysis of the 'code of capital' suggests that part of the wealth of the rich represents an unjustified form of economic rent. It is worth highlighting that even libertarian theories, usually perceived as more tolerant of income and wealth inequality, argue that past injustices undermine the legitimacy of today's wealth distribution. In fact, it is hard to think of a single theoretical position that would yield a justification for the levels of income and wealth inequality that we see in most countries today. In other words, there is a theoretical consensus that, to some extent, income and wealth inequality is not just regrettable or instrumentally bad but unjust. It is important to understand what this means: there is a portion of the income and wealth of the rich in our societies to which they lack a just entitlement. That portion may be legally theirs but it is not morally theirs. The fact that the different theories in Table 1 disagree about the reasons behind this observation is secondary for our purposes here.

Combining this consensus with the observation from the literature on socioenvironmental inequality that the rich cause the lion's share of emissions yields an important insight: when rich Bob uses money that he lacks a just entitlement to in order to purchase and use a private jet, from an ethical perspective Bob is spending money that does not belong to him. Adding insult to injury, Bob spends this money in carbon-intensive ways. This negatively affects everyone but especially the poor who are more vulnerable to the effects of climate change[38]. How could Bob possibly complain of too heavy a burden if what he is being asked to give up by a progressive carbon tax is not actually legitimately his?

With this insight in hand, we are now in a position to formulate the 'baseline challenge' against the idea that progressive carbon taxes ask too much of the wealthy in terms of emission reduction. The current debate on carbon taxes, even the contributions from advocates of progressive carbon taxes[9], tends to take the background distribution of income and wealth as a parameter or as given. Even those who defend an

ability-to-pay principle[39] to finance climate mitigation and adaptation usually accept that a carbon tax asks the rich to make a larger contribution from something that is rightfully theirs.

This is a mistaken assumption because it relies on an unjust baseline. The baseline from which the justice of carbon taxation should be assessed is that of a just distribution of income and wealth, rather than an unjust one[40]. Making this adjustment leads to nothing less than a paradigm shift. The rich are not only statistically the most responsible for climate change due to their emissions but some of their carbon-intensive consumption is only possible due to an underlying economic injustice, letting them use money that is not justly theirs. Incidentally, notice that while the high emissions of the wealthy are likely to stem from the consumption of luxury goods, the present proposal focuses on consumption per individual rather than on the kind of consumption in question, for example, luxury versus subsistence[31,41]. From an ethical perspective, the above suggests that the rich should contribute more to climate mitigation than they do under a flat carbon tax with rebates for low-income households. A strongly progressive carbon tax is not only compatible with justice, it is required by it. Importantly, this does not entail that a progressive carbon tax has redistribution among its goals: it does not. Its progressivity is justified because the wealthy with a large carbon footprint lack a legitimate entitlement to part of their wealth to begin with.

Figure 3 provides a graphical illustration of the central idea here through a stylized example. For simplicity, let us divide society into three socio-economic classes with equal populations. The left side shows the actual distribution of post-tax annual income as well as the payments that a progressive carbon tax would impose on the three different classes given their consumption patterns. Assume a scenario where the wealthy pay 10% of their annual income, that is, $20,000, in the form of carbon tax; and the middle class pay 2%, that is, $2,000. The poor pay zero, not necessarily because there are no carbon taxes at all on the items they consume but because they obtain carbon rebates. From this perspective, it might well seem that society is asking a lot of their wealthy members when it comes to climate mitigation.

However, pivoting to the right side of Fig. 3, suppose that for a variety of reasons (Table 1) a just distribution of income and wealth would be one where the annual income of the wealthy is 20% lower and the annual income of the poor two-thirds higher. Against this background, in the absence of a more progressive taxation of income and wealth (see also the 'Four objections' section below) it seems more than fair to ask the wealthy to contribute 10% of their annual income through the progressive carbon tax. In fact, it would be unjust to let them use this money that is not rightfully theirs in ways that harm all members of society through the emissions and subsequent climate change that their carbon-intensive consumption patterns cause.

We can now see why I described the familiar debate on the regressivity of carbon taxes and the justification of rebates (see 'Carbon taxes and regressivity' section) as limited to justice in a narrow sense. Justice in a broader sense requires us to take the justice of the background distribution of income and wealth into account when assessing the justice of carbon taxation. It requires us to meet the baseline challenge. Specifically, this entails that a carbon tax such as the one in British Columbia, which meets the regressivity challenge through revenue recycling (see 'Carbon taxes and regressivity' section) is not sufficient to deliver justice. Given an unjust distribution of wealth and its implications for carbon emissions, progressivity of the rate structure is also required from the perspective of justice. Notice that this leaves open the question of whether the progressive rate structure should be the same across countries.

The strength of the case for progressive carbon taxes made in this section depends to a certain extent on how unjust the background distribution of income and wealth is considered to be. Beyond pointing to the consensus depicted in Table 1, I do not attempt to quantify this consensus here. That said, it should be noted that there remains a strong case for progressive carbon taxation even in the hypothetical scenario where the background distribution of income and wealth were just. After all, arguments appealing to both the larger contribution of the rich to climate change and their ability to pay for climate mitigation still apply in that scenario[39]. But that is not the world we live in. My primary objective here has been to show that in our world, with its unjust distribution of income and wealth, progressive carbon taxation represents a requirement of justice for a different reason.

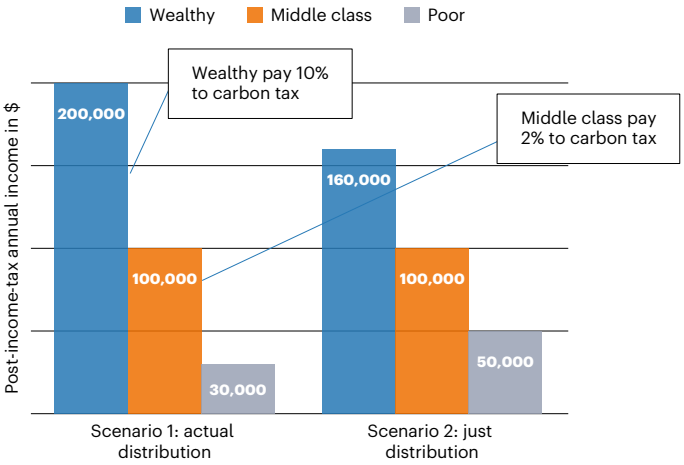

Fig. 3 | The baseline matters. Assessments of just tax burdens should be made with reference to the just distribution, not the actual one.

Progressive carbon taxation in practice

How would one go about implementing progressive carbon taxation at the individual level? Even with modern technology, measuring the carbon intensity of individual consumption patterns is difficult. Fortunately, some useful indicators for carbon-intensive consumption are nonetheless available. Especially when it comes to two of the most carbon-intensive domains of our lives (housing and transport) coming up with emission proxies for certain kinds of consumption seems feasible.

Imagine a system where, in addition to charging a basic, flat carbon tax for fossil fuel consumption as we do now, we measure or impute emissions for the five categories listed in Fig. 4. For the first three categories (construction, building operation and air travel), this will be straightforward because this information is readily available today: construction requires permits; houses heated with gas or oil have consumption meters; and ownership information is available for private aircraft and passenger information for all flights. For the last two categories (private boats and car transport), emissions could be attributed to owners on the basis of the kind of boat or vehicle in question (production emissions; engine type and size) as well as on an average level of consumption. Tracking actual individual consumption in these categories might be possible but would be cumbersome and potentially lead to carbon tax evasion.

The actual and attributed emissions then get summed to calculate a proxy for the overall individual carbon footprint per year. Individuals get taxed according to the progressive carbon tax schedule on the right-hand side of Fig. 4. A marginal tax rate of $1 million per tCO_2e above 50 tCO_2e might seem high and needs to be put into perspective. According to the carbon emissions calculator[42] of the International Civil Aviation Organisation (ICAO), a United Nations agency, the carbon footprint of an economy class return flight from New York to Paris is 0.634 tCO_2e. That means you would have to fly from New York to Paris and back more than 78 times a year before you land in this category. This shows two things. First, not many people would ever pay the highest marginal carbon tax. Second, to effectively disincentivize someone

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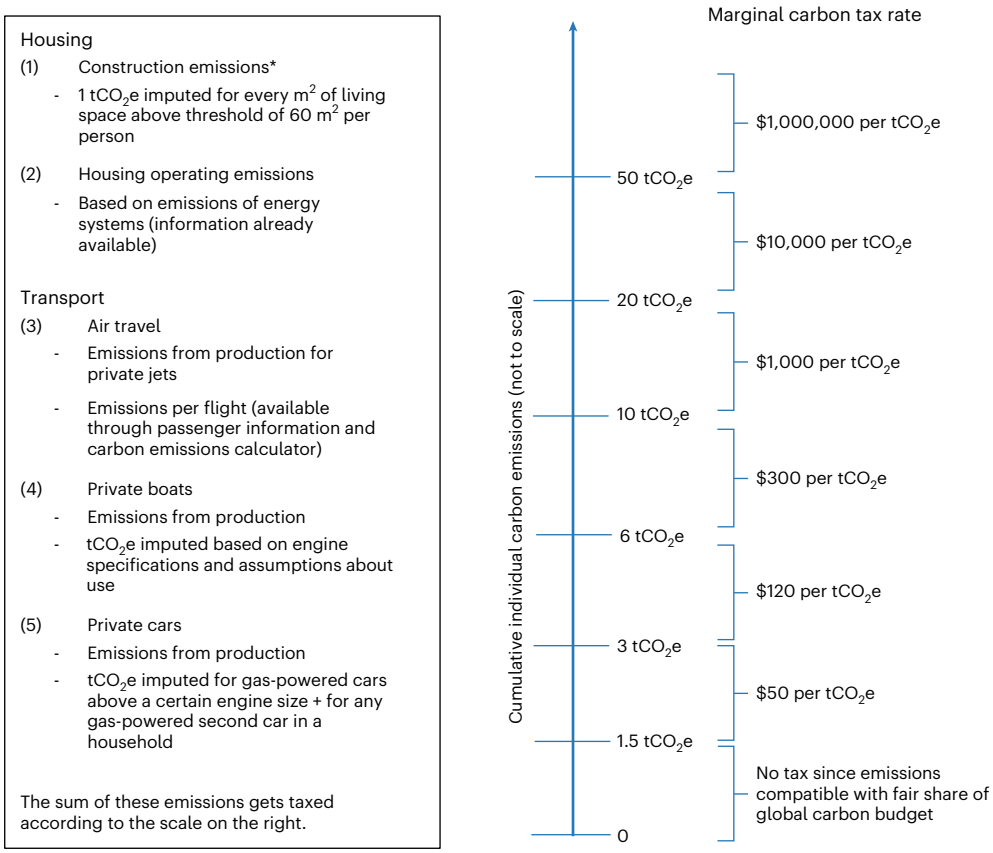

*A system would have to be found for taxing the acquisition of buildings with a living surface above the threshold, too.

Fig. 4 | A proposal for a progressive carbon tax schedule. Categories of emission sources on the left, marginal tax rates for different emission brackets on the right.

who has the kind of money to do this requires a prohibitive tax rate. In fact, there may well be some kinds of consumption categories such as private jets or yachts above a certain size where a ban might be a more reasonable policy approach than a carbon tax but we set this question aside here.

The indicators used above to calculate individual carbon footprints are, of course, incomplete because they do not capture all the carbon-intensive activities an individual might engage in. But recall that the proposal is to combine this progressive carbon tax scheme with a flat carbon tax as we know it today. In addition, I should emphasize that the precise numbers (thresholds; marginal tax rates) are not what is important here; some of them might be implausible. What is important is the demonstration that it could be done.

Four objections

First objection

If the unjust background distribution of income and wealth is part of the problem, would a more progressive taxation of income and wealth not be just as effective or even preferable to a progressive carbon tax? The answer to this question depends on political priorities. Recall from the 'Carbon taxes and regressivity' section that we tax for a variety of reasons, including the promotion of justice as well as the incentivizing or disincentivizing of certain kinds of economic behaviour.

If our political objective is to promote justice, then opting for a more progressive taxation of income and wealth might be preferable. However, if our political objective is to mitigate climate change, then for any given tax revenue a progressive carbon tax promises to be more effective in changing consumption patterns than a progressive income tax. The reason for this lies in the efficacy of carbon taxes as a kind of steering tax to incentivize individuals to shift their consumption from more to less carbon-intensive goods and services. The level of income and wealth taxation that would be necessary to achieve a comparable change in behaviour would be considerably higher.

Second objection

While more effective for reducing emissions, would a progressive carbon tax not result in an inefficient allocation of resources? In other words, would it have a distortionary effect on the economy? If anything, we in fact have reason to think that a progressive carbon tax would be good news from the perspective of economic efficiency. Here is why.

As we saw in the 'Carbon taxes and regressivity' section, GHG emissions represent a textbook example of a negative externality[12]. The data show that the climate mitigation measures taken so far in most countries are not enough to lower emissions to a level that is compatible with the goal of not exceeding a 2 °C temperature rise. As we have seen in the 'The effectiveness of carbon taxes' section, the ineffectiveness of flat carbon taxes is one of the reasons why we are falling short. Adopting a progressive carbon tax would be more effective and thus bring us closer to an efficient consumption level of carbon-intensive goods and services. As acknowledged by economic theory, in real-world markets taxes can be good news from the perspective of efficiency[43].

Third objection

Even if this paper is correct about progressive carbon taxes being both just and effective, what are the chances of such a proposal getting adopted by an establishment which, in most countries, is made up by precisely the kind of people with large carbon footprints whose lifestyle would become much more expensive under such a policy?

On the one hand, it is true that one can expect those with a large carbon footprint to resist progressive carbon taxes. Because members

of this group tend to be well-off (see the 'The effectiveness of carbon taxes' section), because the well-off tend to have a disproportionate political influence in real-world politics, and because the present proposal would certainly lead to a strong corporate lobbying effort as well, it will by no means be straightforward to pass a law implementing progressive carbon taxation.

On the other hand, there is a growing literature on the design features of carbon taxes that are more likely to garner public support[7,20,44]. A well-designed progressive carbon tax would rely on 'feasibility wedges'[44]; that is, design features that limit the outsized influence of vested interests and that underscore the benefits of a progressive carbon tax to a majority of voters. The paradigm shift called for in the 'Why progressive carbon taxes are just' section could be instrumental in meeting this challenge: once I see that Bob is in fact spending money that is not actually his when flying his climate change-inducing (and thus harmful) private jet, I will be more likely to vote for a party that puts progressive carbon taxation in its platform.

Fourth objection

Someone might question the premise in my response to the last objection that a progressive carbon tax is in fact in the interest of a majority of voters. Consider North America where, as depicted in Fig. 2, even consumers in the bottom 50% of emitters have an average carbon footprint of 10.4 tCO_2e, far in excess of the 1.5 tCO_2e compatible with the global carbon budget. Think of the owner of a large pick-up truck who flies to the Caribbean for their holidays. In short, carbon-intensive behaviour has been normalized. According to the carbon tax schedule proposed in the 'Progressive carbon taxation in practice' section, many of these consumers would pay considerable amounts of carbon taxes. Their support seems unlikely. Would a progressive carbon tax not risk a North American yellow vest movement?

This is an important objection. Yet, there exists an answer to it, albeit a partial one. As emphasized in the literature[4,5,7,8,17,20], the combination of a substantial carbon tax with an equally substantial rebate programme or other forms of revenue recycling would mean that most of the population will come out ahead financially. They would have to change their consumption patterns in the process but that is precisely the point.

The reason this only represents a partial answer lies in the fact that in some regions—fossil fuel producing regions (such as Texas in the United States or Alberta in Canada) in particular—a backlash against progressive carbon taxes is likely to be based on considerations of identity as much as on financial interest. Moreover, conservative parties tend to exploit these sentiments for political purposes. I believe this represents perhaps the most formidable challenge to any form of carbon taxation, including of the progressive kind advocated here. But even here, feasibility wedges[44] can be employed to make carbon taxation more politically acceptable[7,20].

In sum, none of the four objections gives us any decisive reason to abandon the idea of progressive carbon taxation.

Future research

In their current form, carbon taxes do not justify the hopes that many place in them for helping to solve the climate crisis. Even in jurisdictions that have met the regressivity challenge, carbon taxes are not effective, nor does the combination with carbon rebates alone guarantee justice in a broader sense. Expressed in terms of the framework laid out at the outset of this paper, they meet neither the effectiveness challenge nor the baseline challenge. As this paper has shown, a progressive carbon tax would be a step forward in terms of both justice and effectiveness.

Many questions remain open and require further research. For example, how much room for manoeuvre do individual states have to adopt a progressive carbon tax unilaterally? As consumption behaviour is less mobile than capital, it would seem that downward pressure on tax rates through tax competition would be less of a factor in this context. But more work is required here. Another fascinating question is whether progressive carbon taxation could and should be extended to cover corporate activity in addition to individual consumption behaviour and, if so, how.

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