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CARBON PRICING AND CLIMATE JUSTICE

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Many economists believe that the best way to curb the use of fossil fuels for climate change mitigation is to put a price on carbon emissions. If our use of the biosphere's limited capacity to absorb emissions carries a price tag, rather than being free of charge, consumers, firms, and governments alike would have an incentive to use it less and to invest more in energy efficiency and renewable energy.

Carbon pricing proposals have encountered opposition, however, from some climate justice advocates. These opponents have leveled three major criticisms at the strategy: first, that carbon pricing is a 'false solution' that will not really arrest climate change; second, that it is a regressive policy, hitting the poor harder than the rich; and third, that it does not adequately protect vulnerable communities that suffer the greatest environmental harms from the extraction, processing, and burning of fossil fuels.

None of these criticisms can be dismissed lightly. But none of them is insurmountable.

To promote climate justice, carbon pricing must be effective in curbing emissions; it must be equitable; and it must address the needs of vulnerable communities. The key to effectiveness is to anchor the carbon price firmly to an ambitious emissions reduction trajectory. The price then emerges as a consequence of keeping the fossil fuels in the ground.

The key to equitable carbon pricing is to recycle the revenue to the people, based on the principle that the limited ability of the biosphere to absorb emissions safely belongs equally to all. Equal per capita dividends transform carbon pricing from a regressive policy to a progressive one.

The key to protecting vulnerable communities overburdened with pollution is to embed carbon pricing within a broader policy mix that ensures emissions reductions and environmental health improvements at the locations that need them most. This chapter discusses how these requirements can be met.

Effectiveness

Merely instituting a carbon price does not guarantee that climate policy goals will be met: the price must be adequate to ensure that emissions reduction goals are met. Actually existing carbon prices have largely failed to achieve this, leading some to conclude that carbon pricing is a

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false solution. The remedy, however, is not to make emissions free, but to implement a carbon price that is up to the job.

The climate policy litmus test

The litmus test for effective climate policy is whether it keeps enough fossil fuel in the ground to prevent global temperatures from rising more than 1.5–2 °C above their pre-industrial level, the target set forth in the 2016 Paris Agreement. Many policies can contribute to this, but there is only one way to be absolutely certain that we achieve emission reductions commensurate with this target: put a hard ceiling on the amount of fossil carbon we allow to enter the economy and ratchet the ceiling steadily down over time.

The most straightforward way to do this is to issue carbon permits up to the level set by the ceiling. If the target is to cut emissions by 85% in 30 years, for example, this means cutting the number of permits by about 6% each year. At every tanker port, pipeline terminal, and coal mine head, fossil fuel corporations would be required to surrender one permit for each ton of carbon they bring into the economy. When these permits are auctioned, the firms will bid what they expect to recoup from higher prices paid by consumers. The carbon price is a direct result of this limit on supply.

If other climate mitigation policies dramatically reduce demand for fossil fuels, the price will be lower than would otherwise be the case. Indeed, if other policies are so successful that they achieve the targeted emissions reduction on their own, the supply limit would turn out to be redundant and the permit price would fall to zero. Like fire insurance, in an optimistic scenario the carbon price would turn out to be unnecessary – but optimism is not a good reason to forgo insurance.

To guarantee that we meet the target, it is not enough to set a carbon price and hope it will do the job: the price must be anchored to the emissions trajectory. Likewise, just investing in mass transit and hoping for the best, or passing fuel economy standards and hoping for the best, is not enough. We know these measures will help, but we cannot know exactly how much.

Today the world is past the stage where just hoping for the best is good enough. We need to make absolutely certain that we cut emissions decisively in the coming years. And we need to face up to the reality that is almost certain to come with this objective: higher prices on fossil fuels.

Existing carbon prices

Today, carbon pricing systems cover approximately 11 gigatons of carbon dioxide emissions worldwide, equivalent to roughly 20% of total greenhouse gas emissions. In 2019 the prices ranged from US$1 to $127 per metric ton of carbon dioxide (mt CO_2). In more than half the cases, emissions were priced at less than $10, equivalent to less than 10 US cents on a gallon of gasoline or 3 euro cents on a liter of petrol (World Bank 2019, p. 12).

Indeed, many countries actively subsidize the use of fossil fuels. Direct subsidies by governments amounted to $333 billion/year worldwide in 2015 (Coady et al. 2017).[1] The average subsidy worldwide was roughly five times larger than the average carbon price. In effect, therefore, the average net carbon price was *negative*.

Even those jurisdictions with the most robust carbon pricing policies implemented so far have failed to cut their emissions along anything close to the 6% per year trajectory that would be needed globally to meet the target established by the Paris Agreement. Sweden, the country with the world's highest carbon price ($127/mt CO_2), barely changed its greenhouse gas emissions from 2014 to 2019, not only because its price arguably remains too low but also because it applies to less than half of the country's total emissions.[2] British Columbia, with the highest carbon tax in Canada (\$26/mt CO_2), applying to more than 70% of its greenhouse gas emissions, registered an overall decline of only 0.5% between 2007 and 2017.[3] The lesson is not that carbon prices 'don't work.' It is that carbon prices not securely anchored to hard emissions targets don't work.

Carbon prices based on neoclassical efficiency: the 'social cost of carbon'

Prescriptions for the 'right' carbon price necessarily rest on an ethical foundation. One candidate for such a foundation is the efficiency criterion of neoclassical economics, where the optimal price – termed the 'social cost of carbon' (SCC) – maximizes the net present value of the benefits of emission reductions minus their cost.

Measuring the benefits of emission reductions and translating them into monetary terms is notoriously difficult.[4] The equations used in integrated assessment models (IAMs) to estimate GDP losses as a function of increases in global temperature are, as Pindyck (2013, p. 870) observes, 'completely made up, with no theoretical or empirical foundation.' The treatment of uncertainty in IAMs is deeply problematic in the presence of catastrophic risks of unknown and unknowable probability and magnitude (Weitzman 2011; Ackerman 2017). The use of discount rates, based on the dubious premise that the time-preference logic that individual mortals use in thinking about their own futures ought to tell us how to think about the well-being of future generations, causes the monetary value assigned to future damages to melt away, much as polar ice today is melting with climate change.[5] The benefits of reducing emissions of hazardous co-pollutants emitted by fossil fuel combustion, such as sulfur dioxide and nitrogen oxides, are excluded from SCC calculations, despite evidence that their monetized value often is comparable to or even greater than conventional estimates of climate damages.[6] For these among other reasons, a review on the *Journal of Economic Literature* concludes that the models used to compute the SCC are 'so deeply flawed as to be close to useless as tools for policy analysis' (Pindyck 2013, pp. 861–862).

Further difficulties arise in the measurement of marginal abatement costs, which are compared to marginal damages in order to arrive at the ostensibly 'optimal' carbon price and emissions trajectory. Future abatement costs, in particular, are uncertain: the cost curves shift downward over time, and public policies, including carbon pricing, can accelerate this shift. For both damage functions and abatement costs, extrapolations outside the range of past experience are especially problematic.

Carbon prices based on science: target-consistent prices

An alternative way to prescribe the carbon price is to anchor it to emission targets based on climate science, such as the objective of holding the rise in global mean surface temperature to 1.5 °C above its pre-industrial level. Here the normative criterion is safety rather than neoclassical efficiency.[7]

The safety criterion is the foundation of much environmental law. The U.S. Clean Air Act, for example, directs the U.S. Environmental Protection Agency to set air quality standards for 'the protection of public health and welfare' while 'allowing an adequate margin of safety' – not to determine clean air standards by weighing marginal benefits of protecting public health against its marginal costs.[8]

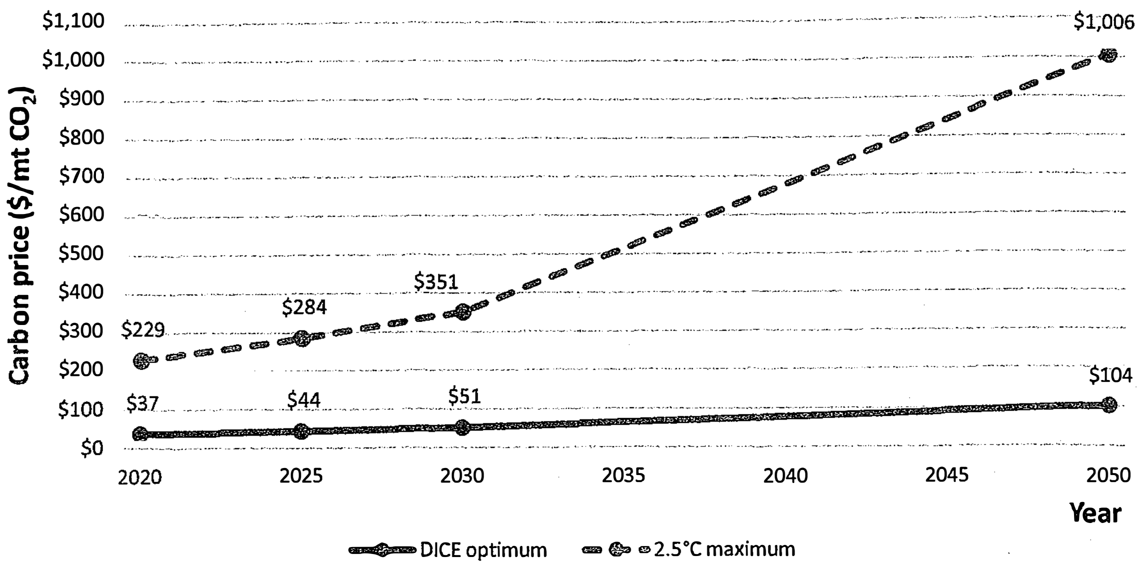

Figure 17.1 Carbon price paths

Note: Global CO_2 price in 2010 US dollars.

Source: Boyce (2018), based on data from Nordhaus (2017a, Table 17.1).

To be sure, there is always some degree of arbitrariness in delineating what qualifies as 'safe,' but scientists are better placed than economists to address this question. Unlike neoclassical efficiency, the safety criterion does not require the estimation of marginal damages and marginal abatement costs across the range of potential outcomes. Economists who accept this approach frame their policy advice more modestly, in terms of choosing the most cost-effective means for reaching the climate policy goal rather than choosing the goal itself.[9]

Figure 17.1 illustrates the potentially huge differences between prices prescribed on the bases of neoclassical efficiency and safety. The estimates shown here are drawn from a paper by William Nordhaus (2017a), who compared the SCC derived from an IAM called DICE (the dynamic integrated model of climate and the economy) to the price that the model estimates would be needed to hold the global mean temperature increase to 2.5 °C.[10] The 'welfare-optimizing' SCC prescribed by the neoclassical efficiency criterion rises from $37/mt CO_2 in 2020 to about $100 in 2050. The temperature increase accompanying this trajectory would be 3.5 °C by the turn of the century, rising further thereafter.[11] The price required to meet the 2.5 °C maximum starts more than six times higher at about $230/mt CO_2 in 2020, and rises to about $1,000 in 2050. The gap between the two trajectories would be even wider if the safety constraint were taken to be the 1.5–2 °C target set out in the Paris Agreement.

Mechanics of effective carbon pricing

The cost of meeting emissions targets cannot be known with much precision in advance, since it will depend on how abatement costs shift over time. If there are certain carbon price thresholds beyond which fossil fuels will be replaced quickly by alternative energy, the cost will be lower than one might conclude by merely extrapolating from past experience. On the other hand, it is plausible that marginal costs will rise more sharply as emissions are cut more deeply. This is one reason to set the quantity of emissions and the let the carbon price adjust accordingly, rather than merely setting a price and hoping it turns out to be right.

Carbon taxes vs carbon caps

A carbon price can be instituted via a tax or an emissions cap. A tax sets the price and lets the quantity of emissions vary; a cap sets the quantity of emissions and lets the price vary. A third option is to combine the two, via a hybrid system in which the tax serves as a floor price in permit auctions.

Although the future relationship between carbon prices and emission quantities cannot be known in advance, past experience may offer a first approximation as to what to expect. A meta-analysis of estimates of the price elasticity of energy demand, based on hundreds of empirical studies published between 1990 and 2016, found that a 10% increase in energy prices results on average in a 2.1% decline in the quantity consumed in the short run and in a 6.1% decline in the long run (Labandeira et al. 2017). The inelastic response, with the fall in quantity being less than the rise in price, stems from the fact that energy to a large extent is a necessity rather than a luxury.

Different studies reported a wide range of estimates, however, reflecting variations across energy products, locations, time, and estimation techniques as well as differences in public policies. The central importance of meeting emissions targets, coupled with considerable uncertainty as to the relationship between quantity and price, provides a strong argument for setting the trajectory for reducing carbon emissions and letting the price adjust, rather than vice versa.

One way to anchor the carbon prices to the emissions targets is to place a cap on total emissions. The annual quantity declines over time; each year the number of permits is set by the cap. During a recession, when energy demand is weak, the permit price will be lower than during an economic boom. If energy-saving technological change proceeds rapidly, the permit price will be lower than if technological change proves to be slow. Regardless of these uncertainties, the cap guarantees that the target is met.

A second option is a carbon tax with a rate that automatically adjusts in response to the distance between present emissions and targets. Switzerland has done this in its CO_2 levy on power plants. Hafstead et al. (2017) recommend adjusting the tax rate annually or biennially, with the extent of adjustment depending on the difference between actual emissions and targets. Metcalf (2018) proposes a carbon price that rises at an annual real rate of 5% when emissions targets are met and 10% when they are not, but if the base is too low, the percentage adjustments may prove inadequate for meeting the targets.[12]

A third option is a tax-and-cap combination, in which the tax serves as the floor price in permit auctions. The cap sets the ceiling on the total number of available permits. If the tax turns out to be high enough to keep demand within this limit, it is the carbon price. But if the tax alone proves too low to meet the target for reductions in emissions, then the cap kicks in, and permit auctions let the carbon price rise accordingly. Compared to a cap alone, this policy has the merit of providing price certainty on the downside, which could be helpful in guiding investment decisions.

Where to implement the carbon price?

Carbon pricing is most easily implemented upstream – at the ports, pipeline terminals, and mine heads where fossil fuels enter the economy. For each ton of CO_2 that eventually will be emitted when the fuel is burned, the supplier must surrender one permit or pay the tax. In the U.S., an upstream system would involve roughly 2,000 collection points nationwide (U.S. Congressional Budget Office 2001). If, instead, the compliance entities were the consumers of fossil fuels, the administrative costs would be much larger.

CO_2 emissions can be calculated simply from the carbon content of fossil fuels prior to their combustion, eliminating any need for end-of-pipe monitoring. In this respect, CO_2 differs from conventional pollutants like sulfur dioxide, where emissions per ton of fuel vary depending on fuel quality and pollution-control equipment. The predictability of CO_2 emissions makes a low-cost upstream pricing system feasible.

Existing carbon pricing systems often have midstream compliance entities – power plants, large industrial facilities, or fuel distributors – who are located between the firms that first bring fossil fuels into the economy and to the final consumer. When these entities are few in number, the administrative costs are tractable. But midstream systems typically are less comprehensive than an upstream system, since they do not cover all sectors of the economy.

Wherever implemented, the carbon price in the end will be passed through to final consumers. When the cost of coal goes up, for example, so does the cost of electricity. In other words, it is not the upstream or midstream compliance entities who ultimately pay the carbon price. This is a feature of any carbon pricing system, not a bug: it is the cost pass-through that transmits price signals to consumers, firms, and governments to curtail their carbon footprints.

To trade or not to trade?

A cap-and-permit system is not necessarily a cap-and-trade system. Most permits in society, such as parking permits and driving permits, are not tradeable. There is no intrinsic reason that carbon permits should be different. 'Cap-and-trade' became a part of the climate policy lexicon – so much so that sometimes it is incorrectly assumed to be synonymous with a cap-and-permit system – only because early pollution permit systems, like the U.S. sulfur dioxide program for power plants and the European Union's emissions trading system for CO_2, gave away free permits to firms by means of formulae based on historic emissions. These permits were tradeable so that firms with higher abatement costs could purchase them from firms with lower abatement costs.

If permits are auctioned rather than given away, there is no need whatsoever for them to be tradeable. Each firm simply buys as many permits as it wants at the auctions, which are held quarterly or annually. If a firm buys more permits than it needs, it can save the extra ones to use in a subsequent compliance period.

Permit trading has several drawbacks. First, it introduces possibilities for market manipulation and speculation. Second, it multiplies administrative costs, since permit trades must be tracked. Third, it diverts part of the money that consumers pay in higher fuel prices into trader profits, at the opportunity cost of putting these funds to other uses. Finally, permit giveaways confer windfall profits on the recipients, effectively rewarding them for past pollution.

'Offsets' are a variant of permit trading whereby firms can pay for emissions reduction (or carbon sequestration) elsewhere as a substitute for buying a permit. Although appealing to economists on cost-effectiveness grounds, offsets are beset by the formidable practical difficulties of verification and additionality.[13] Moreover, they can create perverse incentives for polluters to increase baseline emissions in order to garner more payments.[14] In effect, offsets risk turning the emissions cap into a sieve. A better strategy is to pursue emissions reduction elsewhere and carbon sequestration separately, so that their benefits come in addition to, rather than instead of, the emissions reductions mandated by the cap.

A uniform international price?

An international agreement on a uniform world carbon price is unlikely, and perhaps undesirable. Experience suggests that it is far more likely that individual nations (or subnational units) will continue to establish carbon pricing policies independently, with prices that vary across jurisdictions.

Apart from the practical and political impediments to international agreement on a carbon price, different countries may have sound reasons to want different prices. In effect, a uniform international price would allocate the earth's remaining carbon space based on ability to pay: high-income countries would be able to afford more emissions than would low-income countries. Yet the United Nations Framework Convention on Climate Change provides that countries will reduce emissions according to their 'common but differentiated responsibilities and respective capacities,' a formulation that implies that higher-income countries should do more, not less, to curb their emissions.

Cross-country differences in the air quality benefits of reduced fossil fuel use may provide a further motive for price differentiation (Boyce 2020). Insofar as the public health impacts of fossil fuel combustion are more severe in some low- and middle-income countries, they ultimately may prefer higher carbon prices.

In any case, the prospects for effective carbon pricing do not hinge on international action. Air quality co-benefits alone may be sufficient for countries to decide to adopt the policy. The economic and employment benefits brought by the clean energy transition may provide a further motive. And, as discussed in the next section, if revenues from carbon pricing are recycled to the public as dividends, the net financial impact can be positive for the majority of each country's residents. Together, these attractions may well be sufficiently compelling for countries to adopt carbon pricing policies without awaiting an international accord.

Distributional equity

The revenue generated through carbon pricing is likely to be substantial, especially if the price is robust enough to be effective in curbing emissions. A simple calculation will illustrate the potential order of magnitude. CO_2 emissions from fossil fuel combustion in the U.S. currently amount to about 5.2 billion mt/yr. At \$230/mt CO_2 (the initial carbon price in the safety-based trajectory depicted in Figure 17.1), total carbon revenue would amount to about \$1 trillion/year, the exact amount depending on the extent of the associated change in quantity. If the demand for fossil fuels remains price-inelastic, total revenue will rise as the cap tightens in future years. Who pays and who receives the carbon revenue will pose critical distributional questions.

Carbon rent

When the supply of fossil fuels entering an economy is curtailed, their price goes up. This can be expected to occur regardless of the means and motive for the supply restriction (see Table 17.1). When OPEC cuts oil production, for example, the world prices go up. In this case, the extra money that consumers pay ultimately flows back to the producer cartel. Similarly, if a country were to simply 'keep the oil in the soil,' a slogan popular among climate justice activists, prices at the pump would rise. In this case, the extra money would flow to those producers who continue to extract oil. Carbon pricing differs in that it opens other possibilities for allocating the extra money that is paid by consumers.

The higher cost of fossil fuels as a result of carbon pricing – here termed 'carbon rent' – is a transfer, not a resource cost. This money is not spent to abate emissions; rather, it is paid for fossil fuel use that is not abated. It is not used to produce more fossil fuels. Nor does it magically disappear. Instead, it is transferred to the recipients of the carbon rent, whoever these may be.

Table 17.1 Three ways to cut the supply of fossil fuels

Strategy	*Motive*	*Effect*
Supply restriction by cartel	Market manipulation	Higher profits for producers
Just say no	Climate stabilization	Higher profits for producers
Carbon pricing	Climate stabilization	Decided by policy design

Source: Boyce (2019b, p. 64).

Who are these recipients? Broadly, there are three options. One is to give free permits to firms in the policy called cap-and-trade (or, more precisely, cap-and-giveaway-and-trade). In this option, the transfer leads to windfall profits.[15] The second is to auction the carbon permits (or, equivalently, levy a carbon tax) and let the government retain the revenue. In this option, the final distributional impact depends on how the government uses the revenue. The third is to auction the permits (or levy the tax) and return the money to the people as equal per-person dividends. In this option, the result is a net transfer from those with bigger-than-average carbon footprints to those with smaller-than-average carbon footprints.

Incidence of carbon pricing

The amount that any given household pays in higher fuel bills (and higher costs for other goods and services that use fossil fuels in their production and distribution) as a result of carbon pricing depends upon the size of its carbon footprint. Those who consume more, pay more; those who consume less, pay less. Local, state, and federal governments likewise pay in proportion to their use of fossil fuels.[16] Firms, on the other hand, behave as intermediaries, passing on the costs on to these final consumers.

In general, households at the upper end of the income distribution have the biggest carbon footprints, for the simple reason that they consume more of just about everything, including fossil fuels. They heat and cool bigger homes, they travel more often in airplanes, and so on. So in absolute amounts, they will pay more as a result of carbon pricing than low- and middle-income households.

Relative to their incomes, however, upper-income households often pay less.[17] Figure 17.2 shows the distributional incidence of a \$50/mt CO_2 tax in the U.S. In the lowest expenditure quintile, the tax claims 2.8% of household expenditure; in the top quintile, 1.9%. The impact is thus regressive.[18] It also would be quite evident to the public, as fuel prices are among the most visible in the economy.[19]

Sharp increases in the prices of fossil fuels could generate a backlash from consumers in general, and from low- and middle-income consumers in particular, jeopardizing the policy's political sustainability. Whether this happens, however, may depend crucially on where the money goes.

Carbon dividends

Returning carbon revenue to the people as equal per-person dividends would transform the policy into one with a progressive effect on income distribution (Boyce 2019b). Upper-income households generally would pay more in higher prices than they receive back as dividends. Lower-income households generally would receive more than they pay. Middle-income

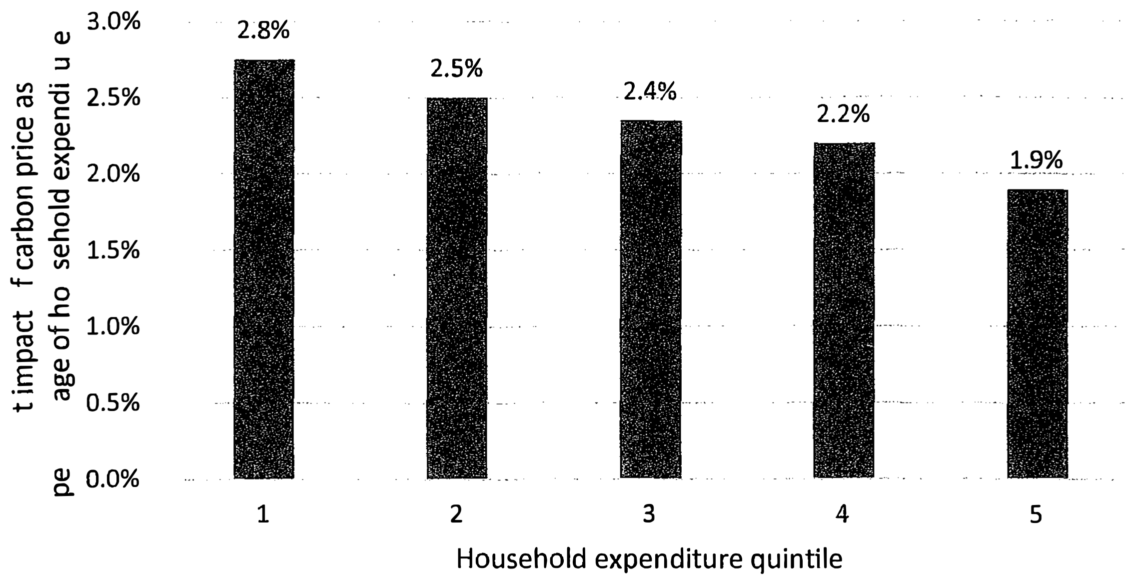

Figure 17.2 Incidence of \$50/ton CO_2 tax in U.S.

Note: Based on consumer expenditure survey data for 2012–2014.

Source: Calculated from data in Fremstad and Paul (2019, Table 17.2).

households generally would more or less break even, thus being protected from negative impacts on their net incomes. The result would be a decrease in income inequality.

Carbon dividends are an example of a 'feebate': individuals pay fees in proportion to their use of a commonly owned resource, and the money collected in fees is returned in equal rebates to all co-owners. The idea can be illustrated with an analogy. Imagine that 1,000 people work in an office building whose parking lot has only 300 spaces. If everyone could park for free, the result would be chronic congestion and excess demand. To avoid this outcome, a parking fee is charged that limits demand to fit the lot's capacity. Every month the proceeds from the fee are distributed in equal payments to everyone who works in the building. Those who take public transportation or bicycle to work come out well ahead: they pay nothing and get their share of the revenue. Those who carpool to work roughly break even. And those who commute every day in a single-occupancy vehicle pay more into the revenue pot than they get back.

Carbon dividends apply the same idea to the atmospheric parking lot. The incentive for a household to reduce its use of fossil fuels is not diminished by the rebate, since its individual use only affects what it pays, not what it receives.

Net impact of a carbon price-and-dividend policy

If a substantial share of the carbon rent is returned to the public in equal per-person dividends, the net distributional impact of carbon pricing becomes sharply progressive. This is illustrated in Figure 17.3, which shows the net impact of the \$50/mt CO_2 price with dividends. The bottom quintile receives a positive transfer, net of what they spend as a result of the carbon price, that is equivalent to 3.9% of their household expenditure. The top quintile sees a negative net impact equivalent to 0.8% of theirs.

Although the net impact of a carbon dividend policy on the vertical distribution of income is progressive, there will be variations within any given income stratum. Fremstad and Paul (2019), from whose data Figures 17.2 and 17.3 are derived, calculate that 95% of households in the

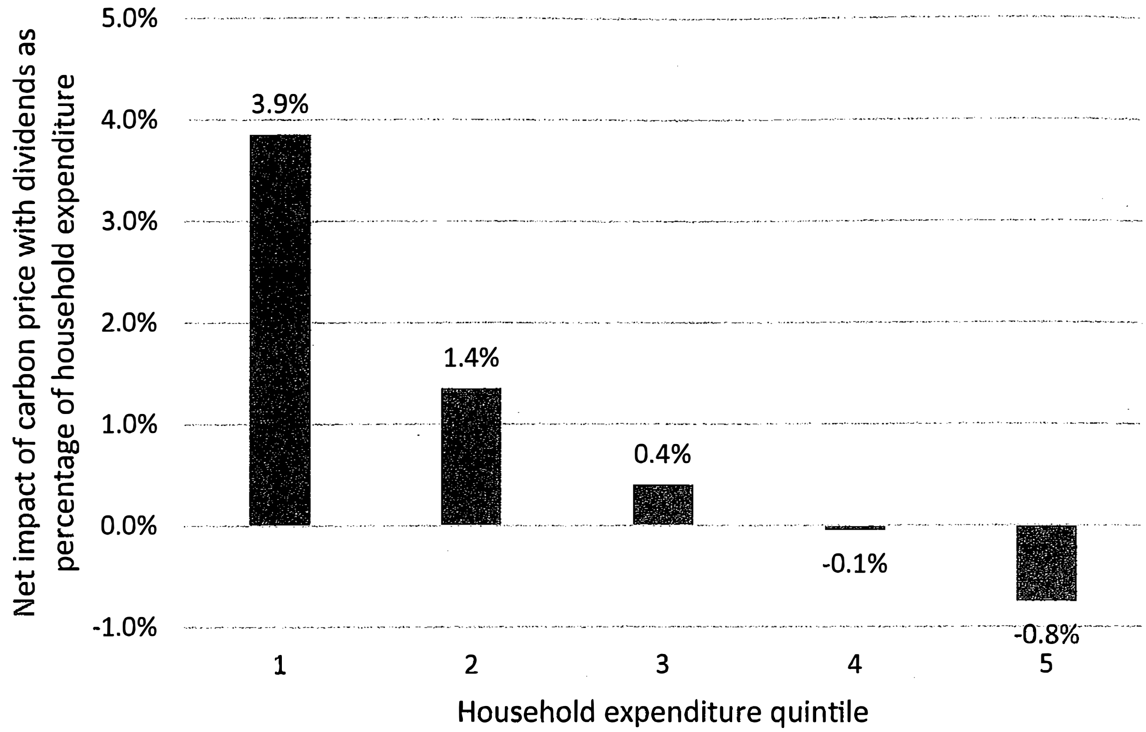

Figure 17.3 Net incidence of $50/ton CO_2 tax coupled with dividends in U.S.

Source: Boyce (2018), calculated from data in Fremstad and Paul (2019, Table 17.2).

bottom quintile come out ahead – their dividends exceeding what they pay as the result of carbon pricing – and that in the top quintile, 93% pay more than they get back, while in the middle quintiles the results are more mixed. Some of the reasons for horizontal variations within the same income stratum include circumstances that are largely beyond the control of individual households, such as rural-urban differences in vehicle miles driven and regional differences in home heating and air conditioning needs. On grounds of horizontal equity, policymakers may want to take such factors into account in allocating part of the carbon rent (Boyce and Riddle 2011; Cronin et al. 2017).

Dividends and political sustainability

Distributional considerations are important in climate policy in general, and carbon pricing in particular, not only for reasons of equity but also for reasons of political sustainability. While most people are distressed by the possibility (and, increasingly, the reality) of climate destabilization, this prospect often is overshadowed by the more immediate demands of day-to-day survival. Significantly higher fuel prices, unless counterbalanced by carbon dividends or comparably visible return flows of money, would cut into living standards and would not be accepted with equanimity.

This may be the main reason why existing carbon prices to date have been too low, and too incomplete in their coverage, to make a bigger dent in total emissions. Many politicians are prepared to support weak measures to address climate change, accompanied by a great deal of handwaving, but their appetite for strict policies to curb the use of fossil fuels is suppressed by their fear of a backlash from the public.

The political perils of carbon pricing were illustrated vividly in France in November 2018, when the 'yellow vest' protests erupted in response to President Macron's announcement of an increase in taxes on gasoline and diesel as a step to address climate change. Macron 'talks about the end of the world,' demonstrators complained, 'while we are talking about the end of the month' (Rubin 2018). Understandable worries about paying bills at the end of the month are shared by many workers across the world.

Carbon pricing in the broader policy mix

If the carbon price is securely anchored to the emissions reduction trajectory, the policy can be effective. If the carbon revenue is returned to the public as equal per-person dividends, it can be equitable. But carbon pricing is by no means the only desirable climate policy in the toolkit. Smart regulations, too, can help to 'bend the cost curve,' accelerating technological changes and reducing the costs of energy efficiency and clean energy. Smart public investment likewise can save money and spark key innovations.[20] And while carbon emissions from fossil fuels is the proverbial elephant in the climate change room, this is not the only important task: we also need to reduce emissions of other greenhouse gases, develop smart land management practices for carbon sequestration, and invest in adaptation to deal with the climate changes we have failed to prevent.

For climate justice, important complements to effective and equitable carbon pricing include 'hot spot' remediation measures, public investment to ensure a just transition, and adaptation grounded on the bedrock principle that access to a clean and safe environment is a human right shared by everyone.

Hot spot remediation

As already mentioned, carbon pollution accompanies a number of hazardous co-pollutants, including sulfur dioxide, nitrogen oxides, particulate matter, and air toxics. Far from being distributed uniformly across the population, co-pollutant impacts often are concentrated in communities that are at a disadvantage by virtue of their relative lack of purchasing power, political power, or both. In the United States, for example, there is abundant evidence that low-income and predominantly African-American and Latino communities are disproportionately exposed to these and other air pollutants (Boyce and Pastor 2013; Zwickl et al. 2014).

Carbon pricing on its own cannot ensure that disparities in co-pollutant exposure are reduced. Indeed, in the absence of safeguards in the policy mix, environmental disparities could be exacerbated. This concern led many environmental justice advocates in California to oppose the state's cap-and-trade program. Initial evidence suggests that these worries were not misplaced. A study of the program's first three years revealed that even as overall emissions went down, emissions actually went up in some socioeconomically disadvantaged neighborhoods (Cushing et al. 2018). To ensure emissions reductions in the places where they matter most, carbon pricing policies must be accompanied by mandates to (i) identify vulnerable communities that are disproportionately burdened by pollution from the production or combustion of fossil fuels; (ii) monitor emission trends in these communities; and (iii) take whatever regulatory or other measures are needed to guarantee that emissions reductions in these communities at least match those mandated by the policy's overall trajectory (Boyce and Pastor 2013).

Public investment in a just transition

Some revenue from carbon pricing may be dedicated to public investment as well as dividends.[21] Because spending by local, state, and federal governments accounts for a substantial fraction of total carbon emissions and hence of the carbon rent, devoting a commensurate share to public investment would not reverse the progressive net impact of dividends. It would be regrettable from an equity standpoint, however, if public investment in clean energy were financed primarily by regressive taxation.

The phrase 'just transition' is often used to refer to policies designed to safeguard the well-being of workers and communities that currently depend on employment in the fossil fuel industry during the clean energy transition. More broadly, it can be used to refer to policies that channel a fair share of public investment toward communities that have suffered disproportionate environmental harms from fossil fuels. These include urban neighborhoods overburdened with pollution as well as rural communities saddled with the toxic legacies of fossil fuel extraction.

California law today mandates that a substantial share of carbon auction revenues goes to investments in disadvantaged communities that have borne disproportionate environmental burdens.[22] Similar provisions are warranted for all public investments in ecological restoration and environmental health, whether funded from carbon revenues or otherwise.

Adaptation for all

Because it is too late to prevent climate change altogether, investments in adaptation will be an important item on the climate policy agenda in the decades ahead. Funds for this purpose are likely to be scarce relative to needs, raising the question of how adaptation resources should be allocated. Neoclassical economics prescribes that investments ought to be guided by cost-benefit analysis. But conventional measures of costs and benefits rest on willingness to pay, which in turn reflects ability to pay. The implications of this approach were spelled out with brutal clarity more than two decades ago in a World Bank memorandum signed by then-chief economist Lawrence Summers, in which he asked whether the Bank should encourage more migration of dirty industries to developing countries, and concluded that 'the economic logic of dumping a load of toxic waste in the lowest-wage country is impeccable and we should face up to that.'[23] Climate change can be understood as a new kind of toxic waste.

A radically different criterion for the allocation of adaptation resources would be to count each human being equally, rather than each dollar. The ethical basis for this alternative approach is the principle that a clean and safe environment is a human right, rather than a commodity to be distributed based on purchasing power, or a privilege to be distributed based on political power.

For example, in evaluating where and how best to safeguard coastal populations against sea-level rise and storm surges, the wealth-based approach would prioritize construction of sea walls to protect expensive real estate while flooding less valuable adjoining properties. The rights-based approach would prioritize protecting human lives, regardless of whether the people in question happen to be rich or poor. Again, the normative criteria of neoclassical efficiency and safety generate contrasting prescriptions. The implications of this difference for climate justice are evident.

Conclusions

To recap succinctly, carbon pricing can advance the transition to a clean energy economy in a manner that is both effective and equitable.

The key to effectiveness is to anchor the price to an emissions-reduction trajectory that is consistent with the goal of climate stabilization. This can be done by means of a cap that tightens along the emissions-reduction trajectory, a tax with a rate indexed to this trajectory, or a combination in which the tax serves as the floor price and permits are auctioned when the demand for permits at the price set by the tax exceeds the supply of permits set by the cap.

The key to equity is to recycle most or all of the carbon revenue to the public in the form of equal per-person dividends. This converts what would otherwise be a regressive policy into a progressive one, and may help to safeguard the political durability of the policy. At the same time, carbon pricing can and should be coupled with complementary policies to advance the goal of climate justice, including measures to protect environmental quality and public health in those communities that suffered the greatest harm from the fossil-fueled economy of the past.

Notes

1 For more on fossil fuel subsidies, see Sovacool (2017).

2 Price and coverage from (World Bank 2019, p. 28); emission trends from Statistics Sweden (2019).

3 Price and coverage from (World Bank 2019, p. 28); emission trends Environmental Reporting BC (2019).

4 For discussion, see for example, Azar 1998; Ackerman et al. 2009; Pindyck 2013, 2017; van den Bergh and Botzen 2014; Howard and Sterner 2017.

5 For discussion, see National Academies of Sciences, Engineering, and Medicine (2017), chapter 6.

6 See, for example, Shindell et al. 2016.

7 For discussion of safety versus neoclassical efficiency as a criterion for policy making, see chapter 1 in this handbook.

8 42 U.S. Code § 7409 – National primary and secondary ambient air quality standards, section (b)(1).

9 See, for example, Stiglitz and Stern 2017.

10 Nordhaus dismisses a more ambitious target as 'infeasible.' However, the Intergovernmental Panel on Climate Change reported in 2018 that exceeding 1.5 °C would entail serious risks of heightened damages. The IPCC concluded that meeting the 1.5 °C target will 'require rapid and far-reaching transitions in energy, land and infrastructure (including transport and buildings), and industrial systems' that are 'unprecedented in terms of scale, but not necessarily in terms of speed' (IPCC 2018, p. 17).

11 Nordhaus (2017b, Figure 4 and Table A-5). To put this number in perspective, the last time the earth experienced mean temperatures 3.5 °C above pre-industrial levels was about 125,000 years ago, long before the advent of cave painting (about 40,000 years ago) or agriculture (about 10,000 years ago). Global sea levels were about 6 meters higher than at present.

12 For example, with an initial price set at $40 and a maximum annual increase of 10%, the carbon price in 15 years could be no higher than $167.

13 For example, an analysis of the Clean Development Mechanism, an international offset program established under the Kyoto Protocol, found that 85% of the projects analyzed had 'a low likelihood that emissions reductions are additional and are not over-estimated' (Cames et al. 2016, p. 11).

14 For discussion and proposals for potential remedies, see Bushnell (2012) and Bento et al. (2016).

15 Countervailing policies could limit or eliminate windfall profits to the firms. For example, government regulators may prevent electric utilities from raising prices to consumers, albeit with the side effect of weakening or eliminating the price signal to end users of electricity. Alternatively, governments can tax the windfall profits.

16 In the U.S., for example, federal, state, and local governments account for roughly one-fourth of total fossil fuel use. An important issue in carbon pricing is whether, and if so, how, some of the carbon rent will be recycled to 'keep government whole' (Boyce 2019a, ch. 25).

17 The picture may differ in low-income countries where fossil fuels are more a luxury than a necessity. In such settings, the incidence of carbon pricing may be progressive. For examples, see Brenner et al. (2007) on China in the 1990s, and Datta (2010) on India in the early 2000s.

18 The measured extent of regressivity depends, among other things, on whether household income or expenditure is taken as the base for calculations (Hassett et al. 2009). It also may depend on whether inflation-indexed changes in government transfer payments are taken into account (Cronin et al. 2017).

19 For evidence on the keen awareness of fuel prices among the U.S. public, for example, see Ansolabehere et al. (2013).

20 On the role of regulatory standards in innovation, see Ashford and Hall (2011). On the role of public investment in innovation, see Mazzucato (2013).

21 A 2009 U.S. Senate bill proposed, for example, that 75% of carbon permit auction revenue be allocated to dividends and 25% to a clean energy trust fund for public investment. For discussion, see Boyce and Riddle (2011).

22 For an analysis of the California policy, see Callahan and DeShazo (2014).

23 The memorandum was leaked to *The Economist,* which published the relevant excerpt on 8 February 1992 under the headline, 'Let Them Eat Pollution.'

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