Taxation and the environment: an overview of key issues for developing countries

Michael KEEN

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Taxation and the environment: An overview of key issues for developing countries

Author: Michael Keen, Ushioda Fellow in Tokyo College, University of Tokyo and senior fellow at CERDI-CNRS-UCA.

Preface : Aurélien Lechevallier, Director General for Globalisation, Culture, Education and International Development at the French Ministry of Europe and Foreign Affairs.

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Contents

Acronyms

ADF: Advance Disposal Fee

CBAM: Carbon Border Adjustment Mechanism

EPI: Environmental Performance Index

FAO: Food and Agriculture Organization

GDP: Gross Domestic Product

GHG: Greenhouse Gas Emissions

GTED: Global Tax Expenditure Database

HYSACAM: Hygiène et salubrité du Cameroun

IMF: International Monetary Fund

IUUF: Illegal, unreported and unregulated fishing

LDCs: Least Developed Countries

LPG: Liquefied Petroleum Gas

MPB: Marginal Private Benefit

OECD: Organisation for Economic Co-operation and Development

SDG: Sustainable Development Goals

UNCTAD: United Nations Conference on Trade and Development

VAT: Value Added Tax

Foreword

Exposed to global pollution, developing countries are particularly vulnerable to climate change (desertification, coastal erosion, flooding, etc.). They face the dilemma of reconciling economic development with environmental protection.

Implementing policies to preserve the environment and build resilience to climate change requires sufficient domestic resources. To this end, tax and customs policies have a dual role to play: mobilizing new sources of revenue and encouraging more sustainable management of environmental resources.

Encouraging improved taxation of natural resources is one of the top priorities of France's interministerial strategy to support improved domestic resources mobilization in developing economies. Published in 2020, this strategy is accompanied by a strategic investment development plan, through with France has devoted more than €60 million in additional funding to projects in this field over the 2020-2023 period.

Through this investment plan, French development cooperation stakeholders have made strengthening links with the research community a priority. Academic literature, both theoretical and empirical, forms a solid knowledge base that contributes to the French team's thinking, and ultimately helps to identify operational measures in environmental taxation. Within this framework, recognizing that this research field remains relatively unexplored, the French Ministry of Europe and Foreign Affairs supported the writing and publication of this book.

As the tools available to a state for environmental taxation vary from country to country, and practices differ significantly between them, the book addresses the key issues concerning the overarching theoretical framework, challenges of implementation and the political dimension of environmental tax reforms in developing countries, mainly in sub-Saharan Africa. It sheds light on the potential and actual impact of tax and customs policies on the main environmental problems facing developing countries, with the aim of identifying guidelines for the most appropriate approaches. It provides concrete recommendations for public authorities and the international community, particularly on the issue of political acceptance of environmental tax reforms.

I believe that this book will serve as a tool for reflection among all development partners wishing to gain a better understanding of these issues and improve the design of their economic and environmental policies.

Aurélien Lechevallier
Director General for Globalisation, Culture, Education and International Development at the French Ministry of Europe and Foreign Affairs.

Introduction

This short book provides an overview of core issues in thinking about and advising on tax-based approaches to environmental problems in developing countries,[1] with a particular focus on sub-Saharan Africa and a group of 'priority countries[2].

An overarching objective is to place environmental tax issues within the wider context of the need to strengthen domestic revenue mobilization (DRM) in developing countries. This means taking account of their distinct priorities and difficulties in designing and implementing wider tax systems. While the environmental problems that many developing countries face are extremely severe, as will be seen, there are other profound difficulties that their tax systems also need to address, often in circumstances of highly constrained capacity. It is only in this wider context that a realistic approach to their use of environmental taxes can be developed.

The focus throughout is on environmentally-related tax measures that developing countries can undertake themselves. Many of the environmental challenges in low-income countries can be addressed in part, or even only, by action in advanced and more developed emerging market economies. Mitigating climate change is the obvious example, but such measures as timber procurement policies that aim to support sustainable forestry management also have an important role. The focus adopted here is not to downplay the importance of measures in higher income economies, but for the practical purposes of advising on the policies of developing countries themselves—and limiting what is already a wide and diverse agenda. For similar reasons, issues that effectively require global agreement, such as the taxation of international aviation and maritime, are not addressed even though they may have substantial implications for lower income countries[3]. The concern is thus with measures that developing countries acting individually are able, and have an incentive, to undertake themselves[4].

The coverage is selective, and hampered by information gaps. On one hand, the focus on issues that lie within the control of developing countries themselves means that less attention will be paid here than has become commonplace in

1. By 'developing countries' is meant countries in the low- and low-middle income categories of the World Bank, the current classification is at https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups. Each country is different, of course: generalizations about 'developing countries' are inescapable in what follows but should be read with that caution.
2. These are Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Democratic Republic of Congo, Djibouti, Ethiopia, Gambia, Guinea, Haiti, Liberia, Madagascar, Mali, Mauritania, Niger, Senegal, Togo.
3. On which, see for example IMF (2011).
4. This focus also means that the use of external financing to address environment issues, such as climate finance to support mitigation and adaptation to climate change is not considered in what follows—except in so far as those might directly affect domestic actions.

the tax literature to the mitigation of fossil fuel emissions, at least as a response to climate concerns—this has in any case already been extensively and well-studied elsewhere. [5] On the other hand, this focus still leaves a huge range of issues: as will be seen, developing countries face—with differing degrees of intensity—an extraordinarily wide range of severe environmental problems. Not all of these problems can be covered here in the detail that they deserve: issues of sanitation and assuring drinkable water supplies, for example, require more attention than they can be given here. A primary intention, nonetheless, is to broaden the coverage of environmental problems beyond the range usually considered (by tax economists, at least, though not by non-economist sectoral specialists). Such less well-trodden issues include, for instance, problems of waste management and urban congestion. For all of the issues addressed here—but especially the relatively neglected ones—analysis is hampered not only by the almost complete unavailability of systematic, comparable information on a range of developing countries but also by the difficulty of finding sufficiently granular information in specific countries.

While issues of political acceptability arise for all tax increases, they can be especially problematic for environmentally-related taxes. The most critical difference is that environmental taxes are not motivated—at least not wholly—by revenue concerns. While it might be hoped that concern with the environment would actually favor the introduction of such taxes, in practice that rarely seems to be the case—the prime example being widespread failure to adopt aggressive carbon pricing. Moreover, in order to be effective, environmental taxes must often, in themselves, have an adverse impact on some vulnerable groups (though also conferring greater benefit on them) and they are often concentrated on particular sectors (rather than generalized), so that strong opposition is readily assembled. The question of how political resistance to environmental taxation can be overcome recurs throughout the report, taken up not in the abstract—which risks straying far from operationalization—but in the context of specific environmental challenges and country experiences.

The report is in five parts. The first sets out key conceptual issues, placing environmental taxation within the wider contexts of both tax system design and environmental policies more widely. The second part then provides an overview of the developing country setting in relation to tax system design, since much of the literature on taxation and the environment has focused on advanced economies, [6] the aim is to identify what is different about tax system challenges in developing countries—and what is not; in relation to the environment, a brief assessment is provided of the nature and extent of the various problems they face. The third part, which is the heart of the report, reviews in turn specific internally-generated environmental challenges and the scope for deploying domestic tax measures in response, drawing such lessons as experience provides. Part 4 takes

5. See for instance Heine and Black (2018),
6. As for instance Fullerton, Leicester and Smith (2010) and Sandmo (2009).

up three further issues: the use of tax incentives in response to environmental concerns, and possible tax responses to two externally-driven challenges: the need to adapt to current and prospective climate change, and the prospective adoption of a Carbon Border Adjustment Mechanism in the EU, and perhaps elsewhere. The final part draws lessons and provides guidelines, including on enhancing the political acceptability of environmental tax reforms.

Part I : Principle

This part of the report reviews the economics of environmental problems, [7] and in particular of tax-based solutions to them.

The term 'Tax' is used here in a broad sense. The essence of a tax is taken to be governmental price manipulation, [8] and so for present purposes includes, for instance, impositions labelled 'fees' or 'charges' [9] that fiscal accounts may categorize as sources of 'non-tax revenue' but are in other respects analytically equivalent to a tax. It is also taken to include subsides, which are simply negative taxes.

A. Taxation and Other Corrective Instruments

This section sets out the basic economics of environmental problems, and of tax and other approaches to addressing them. The basic ideas are familiar, but some important aspects are often overlooked.

The externality problem—and the role of compensation

Environmental problems are a subset of the general difficulty caused by 'externalities:' the inefficiency that arises when decisions taken by one agent (typically an individual or firm) have effects on others not party to those decisions.[10] Box 1.1 sets out a familiar illustration and possible solutions; it helps too in clarifying precisely what is meant by 'inefficiency,' a term often used too loosely.

Collective ('Pareto') efficiency—maximizing the net social benefits associated with some externality-generating activity—requires equating the associated marginal social costs and benefits[11]… In the figure, this is at emission level q^*, where $MSB(q)=MC(q)$.

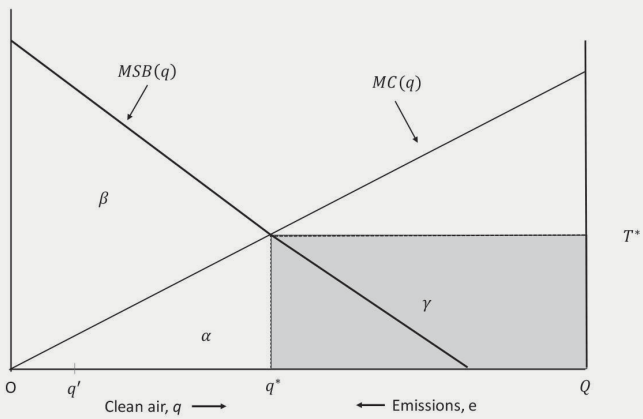
7. We also include under this heading tax issues related to the management of natural resources, the distinct analytical issues raised by which are taken up in Part 3.
8. Pricing policies of publicly owned enterprises can also be seen as meeting this condition. More on the pragmatic grounds of limiting the already wide coverage than on grounds of conceptual consistency, however, this is not considered in any detail below—an important omission in relation, for example, to water-related issues.
9. 'Fees' and 'charges' often have a further connotation that the proceeds may (but need not be) earmarked (or 'hypothecated') to particular uses. This is a distinct issue that is taken up later.
10. Other than effects operating through the price system; such 'pecuniary' externalities do not in themselves create inefficiencies.
11. This assumes that an internal solution is desirable, which may not always be the case: it might be that the private damage eventually becomes so large—at say q' in Figure 1.1—that the damaged party decides to physically remove themselves from harm. Marginal social benefit then falls to zero, and efficiency may no longer call for emissions at q^* but at q'. There are of course other considerations that may come into play in such contexts. It might also be, for instance that the social costs of retreat—the loss of communities, for example—may exceed the private costs. Nonetheless, for some environmental problems—climate change-induced increased vulnerability to natural disasters, for instance—this is a possibility that cannot be entirely neglected.

Box 1.1: The Canonical Externality Problem

Figure 1.1 imagines some attribute, air quality in amount q in this example, which generates social benefit of SB(q). *Air quality may, however, be reduced below the maximum level of* Q *by emission of some pollutant, whose quantity is denoted by e: air quality is thus* q = Q - e. *Limiting emissions, however, requires incurring some abatement cost; the cost of sustaining air quality of* q *is* C(q). *(Private and social costs of abatement are assumed, for simplicity, to coincide). The marginal benefit of an improvement in air quality is lower the higher is initial air quality, so that the marginal social benefit curve,* MSB(q) *is downward sloping. The marginal cost of the additional abatement measures needed to improve air quality, conversely, is greater the higher is initial air quality, so that the marginal cost curve* MC(q) *is upward sloping.*

If the allocation of property rights is such that the polluter may emit as much as they like then, not needing to incur any abatement costs, the outcome will be at point O, *with the lowest possible air quality.*

Figure 1.1: The externality problem



…but ensuring that moving to this Pareto efficient outcome is a Pareto improvement—so that all parties gain—generally requires that compensation be paid. If, for example, the allocation of property rights is such that the emitter can emit, without charge, as much as they like, so that the no-intervention outcome is at *O*, then moving to the collectively efficient level *q** makes the emitter worse off by abatement costs in the amount of the triangular area *α*. But since the social benefit from cleaner air (*α*+*β*) exceeds the private cost incurred by the polluter (by the area *β*), it is possible, in principle, to make a transfer from the pollutees to the polluter (in some amount larger than α but less than *α*+*β*) which ensures that both parties are made better off in limiting emissions to the collectively efficient level. Ensuring that controlling externalities benefits everyone thus requires a package of measures: not just controlling

emissions, but also compensating those who thereby lose[12]. The point, a central theme of the report, is of considerable importance to assessing both the welfare effects and the political feasibility of serious reforms to environmental policies.

Instruments to address environmental problems—Tax and other

There are several instruments by which the canonical environmental problem just described can be addressed, each with different strengths and weaknesses, and different implications for the compensation issue:

- ***Bargaining:*** The party suffering from the damage might agree to pay the emitter some amount, in return for reducing emissions, that at least compensates the latter for the abatement costs they incur.[13] Opportunities for such bargaining are eliminated only by moving to the emissions level at q^*, with both parties then better off than initially.[14] Such bargaining is clearly not a realistic prospect for many of the environmental problems with which we are concerned, in which very many parties are involved. But it is a natural framework for thinking about solving environmental problems in contexts that involve explicit negotiations, as for instance between contractor and government in the extractive industries and in the wider international coordination of environmental policies.

- ***Liability:*** This approach requires emitters to compensate those adversely affected. In practice, this approach is applied ex post in situations where it is not certain ex ante how much (if any) damage will arise: the payment of compensation, for example, for harm from leakage of dangerous chemicals.[15] This may involve the use of insurance and/or some pre-funding, as for instance with the International Oil Pollution Compensation Funds.[16] How this approach leads to a collectively efficient outcome can nonetheless be seen from Figure 1.1: the damage suffered, relative to fully clean air, and hence the compensation that the polluter must pay, is the area under the *MSB(q)* to the right of the relevant level of air quality; maximizing the excess of this over abatement costs avoided (the area under the

12. It might be objected that compensating those whose emissions cause social harm violates the 'polluter pays' principle. But, as the analysis makes clear, there is no efficiency basis for such a principle. If instead it is seen as having a moral basis, care is needed in characterizing who the emitters are: since companies themselves are not people, so cannot pay anything in a meaningful sense, ultimately the emitters include not only shareholders in and workers for emitting firms, but those—potentially among the poor and vulnerable—who purchase at a price that is made lower by excessively high emissions.
13. If, on the other hand, the view was taken that property rights over the atmosphere should be allocated to those harmed by emissions, the same logic would point to transfers from polluters to pollutees. The direction in which transfer run thus depends on how property rights are allocated, but the outcome (q^*) is the same (except to the extent that the transfer itself changes marginal willingness to pay to impose or avoid damage).
14. This is the theorem of Coase (1960): in the absence of any costs to bargaining, an externality will be voluntarily 'internalized.' That is, the collectively efficient outcome will be achieved, and to the benefit of all parties, without any external intervention.
15. A leading example in the wider health context is the 1998 Master Tobacco Settlement agreement in the US, in which tobacco companies settled for USD 206 billion in recognition of smoking-related health costs.
16. Established under the International Maritime Organization and financed by charges on those receiving oil by sea, this provides compensation for damage from oil spills: see iopc.funds.org.

MC(q) to the right of the same point) leads the polluter to choose the efficient level of emissions *q**. [17]

This approach has particular appeal when the determinants of harm are too many and varied for external verification to be feasible—the stability of a building, for instance—and when damage may in any case not arise. Shavell (2010, 2011) makes a forceful argument that these features are so pervasive that liability is generally superior, in particular, to a tax-based approach—except in the textbook case, as above, of a single readily observed pollutant. This does presume, however, a well-functioning judicial system—or at least one that functions better than the tax system—and so may be less compelling in the context of developing countries.

- ***Regulation:*** By this is meant some form of quantitative restriction—in the setting above, for example, regulation might simply impose the legal restriction on the polluter that it emit no more than *q**. In the absence of any accompanying measure, the party suffering the damage benefits, by the area $\alpha+\beta$—but the emitter loses, by the (lesser) amount α.

- ***Taxation:*** This approach achieves the efficient level of emissions *q** by facing the emitter with a tax per unit of emissions at a rate *T** equal to the social marginal benefit of clean air *MSB(q*)* experienced by the damaged party at that efficient level. Such a 'Pigovian' [18] (or 'corrective') tax effectively resolves the externality problem because the emitter, when self-interestedly choosing how much to abate, will do so up to the point at which their marginal cost of doing so, *MC(q)*, exactly equals the tax *T** saved; so setting that tax equal to *MSB(q*)* means that the emitter will choose exactly the efficient level of emissions.[19]

Two issues, potentially related, arise as distinct to this tax-based approach. First, a question arises as to the use made of the revenue raised, given by the rectangular area γ. To see the importance of this, suppose that the revenue is simply wasted. The consequent loss of welfare reduces the net gain from the correction of the externality itself by the amount of the rectangle γ. That loss might even outweigh the environmental gains, so that the final effect is to reduce collective welfare. Only if sufficiently good use is made of the revenue is the Pigovian tax approach even collectively efficiency-enhancing.

The second is that the polluter suffers a double loss from the corrective tax: not just the costs of abating, the area α, but also the loss of resources in the form of tax paid, the area γ. Combining this with the previous point, an obvious option is to use the revenue raised by the Pigovian to compensate the emitter (which needs to be

17. More formally: The emitter's objective is in this case to minimize, by choice of *q*, the sum of damages *SB(Q)−SB(q)* and abatement costs *C(q)*, the necessary condition for which (the prime indicating differentiation) is $-SB'(q)+C'(q)=0$, the unique solution to which is *q**.
18. Named for Arthur Pigou (1920).
19. In this case the emitter chooses e to minimize the sum of tax paid on emissions *T*e* and abatement costs *C(Q-e)*; the necessary condition is $T^*-C'(q)=SB'(q)-C'(q)=0$, the only solution to which, given the assumptions implicit in Figure 1.1, is *q**.

done in some way such that the polluter sees no link with that compensation to the amount of emissions—otherwise the incentive for them to reduce emissions is undone). There is, however, no necessary link between the revenue raised and the compensation needed: it may be that the revenue is enough to compensate, or it may be that additional resources are needed to achieve this.[20]

- ***Auctioning rights to pollute ('cap and trade'):*** The collectively efficient outcome q^* might also be achieved by auctioning rights to emit in that total amount; since the polluter will be willing to buy such a right so long as the price is no greater than their marginal cost of abating, the price at which those q^* permits will sell is exactly T^*. Ensuring that the polluter gains relative to the unrestricted outcome thus raises the same issues regarding the use of the auction proceeds (and perhaps additional resources) to finance their compensation.

The concern in this report is with tax-based approaches, but they are appropriate only when superior to the alternatives—and in practice different approaches often need to be combined. There are large literatures on both the relative strengths and weaknesses of these various instruments, and on the comparison between tax-based and regulatory approaches most specifically. These will not be reviewed here, but Figure 1.1 summarizes key insights on the former issue, drawing in part on the considerations regarding the latter in Box 1.2 It is important to recognize too that in practice the policy choice is usually not which single instrument to use, but rather one as to how best to combine them: dealing with over-fishing for example, may require not only a landing or other tax but also regulatory limits or prohibitions on bottom-dragging methods in order to avoid damage to the stocks that are not related to the immediate catch.

Figure 1.1: Alternative instruments for addressing environmental externalities—A Heat Map

Concern	Regulation	Taxation	Liability
Need for revenue			
Multiple emission sources			
Risk of tipping points			
Limited instruments for compensation			
Damage hard to assess a priori			
Salience			
Political acceptability			

Note: Green (red) indicates greatest (least) suitability given the concern or feature in the first column

20. A sufficient condition for the revenue from the Pigovian tax to provide adequate compensation (the area γ being larger than the area α), it is readily seen (since $\alpha \leq Tq^*$), is that the efficient level of emissions q^* be less than twice the uncontrolled level Q.

Box 1.2: Comparing tax-based correction with regulation

Beyond the evident difference that tax measures collect revenue while regulatory ones do not—and by the same token raise deeper compensation issues—several differences merit highlighting.

On the positive side for tax measures:

- ***With heterogenous emitters, tax measures more readily assure that any given total amount of abatement is achieved in the most cost-effective way.*** *If there are several emitters, achieving any given level of overall abatement at the lowest possible cost requires doing so in such a way that they all have the same marginal abatement costs; otherwise the total cost could be reduced by having emitters with low marginal abatement costs emit a little less, and allow those with higher marginal abatement costs to emit a little more. If emitters have different abatement cost structures, however, this will generally mean that they should emit differing amounts. Accomplishing this by regulation will require knowing all those differing abatement cost schedules. Taxation, in contrast, achieves this effect automatically: each emitter will equate its* MC *to the same tax rate* T*, *so they will all end up with the same marginal abatement costs. Without the need for any knowledge on abatement costs, taxation thus reduces total emissions is in the most efficient—cheapest—way.*
- ***Tax measures have a similar advantage when consumers differ in their valuation of a polluting good.*** *For instance, allowing drivers into cities only on alternate days, depending on whether their number plate is odd or even, prevents some highly valued trips occurring and fails to prevent some low value trips in a way that charging an explicit price would not.*
- ***Tax measures may have a particular salience, invoking intrinsic environmental concerns that may reinforce their behavioral effects,*** *especially if supported for example by labelling and other transparency measures. Against this, there may be risk that by framing environmental improvement as a commodity to be paid for like anything else taxation will crowd out an 'intrinsic' motivation to take environmentally responsible actions—though there seems as yet to be no evidence of this.*

On the positive side for regulatory measures:

- ***The assurance on aggregate quantities provided by regulation is especially valuable when small differences in emissions have a large effect on the marginal social damage that emissions cause.***[1] *When knowledge*

of the relevant MSB *and* MC *curves is imperfect, mistakes will be made in setting either prices or quantities. Setting the tax too low, for instance, will lead to emissions that are too high—and that is especially damaging when the* MSB *curve is particularly steep, since that error will greatly increase social costs relative to fixing quantity at that lower level. The point is especially important when emissions beyond some level risk breaching irreversible tipping points (a particular concern, of course, in the context of climate change).*

- ***The determinants of harm may vary with circumstances that are more easily observed than taxed.*** *The likelihood of passing on COVID-19, for instance, depends on mask wearing and proximity to others—which is easy to see but hard to tax. Likewise, the damage from alcohol consumption, and the costs of passive smoking, are not the same for all units consumed, so cannot be addressed by simple tax measures: drink-driving rules and smoking bans have a useful supporting role.*

1. *More precisely, the quantity-based approach is more likely to be preferred the steeper is the* MSB *curve in the figure in Box 1.1 relative to* MC *curve (Weitzman, 1974). Intuitively, a relatively flat* MC *curve means that a small 'mistake' in setting the emissions tax will have a large effect on the level of emissions; and a steep* MSB *curve means that that implies a large difference in social benefits—or, put differently, a large difference in social harm.*

Local versus global externalities

Border-crossing externality problems raise, in addition to questions of instrument choice, a distinct set of coordination issues. In such cases, countries are likely to cut their emissions only to an extent that reflects the damage they suffer from those emissions, not the damage that they impose on others. Improving efficiency thus calls for some degree of credible coordination of policies. The classic example is of course climate change, since damage depends only on the cumulative stock of GHGs and not on where in the world they were emitted. Externalities that are confined to one jurisdiction, however, are not subject to this additional level of complexity and so are in this sense more straightforward to deal with.

Local environmental problems are likely to provide the most compelling case for action in developing countries—and so are the focus of this report. All countries find it hard to galvanize their citizenry to undertake costly actions in service of the global good, and this difficulty is amplified in developing countries given that, in most contexts, their limited size and prosperity mean that their actions can make little difference to the situation of the world as a whole. For more localized externalities, however, there is no such reason for hesitation. This is not to deny that

all countries have some responsibility to address global challenges: most developing countries have undertaken mitigation commitments under their Nationally Determined Contributions, for example (with the prospect of financial support helping to overcome their hesitation). And of course environmental problems may be 'local'—by which is meant that their impact is geographically confined—but still affect more than one jurisdiction (including at sub-national levels). The point, rather, is that—consistent with the focus mentioned at the outset, on measures that they themselves can take—their local environmental problems are those that developing countries have the clearest self-interest to address.

Also

Two further points of note:

The incidence of a corrective tax—who bears the real burden—does not matter for efficiency, but does for its distributional impact. Much attention is often paid to the question of whether or not corrective taxes are 'passed on' to the purchaser of some externality-generating commodity or 'passed back' to its producer, often with an apparent presumption that it is only in the former case that the corrective objective is achieved. This, however, is not the case. What matters is the reduction in emissions: whether this is achieved by reducing demand through a higher price to the buyer or reducing supply by a lower price to the producer is immaterial for efficiency. Where incidence does matter, of course, is for the separate question of whose real income is reduced by the tax.

Corrective taxation generally calls for taxes in specific form, not *ad valorem*. Because damage is related to the quantity of emissions, not their price, their correction is better targeted by a tax that is a fixed amount per unit ('specific') rather than by one that is proportional to the price (*ad valorem*).The practical implication is that any suggestion to amend the VAT or impose some other ad valorem charge to address an environmental problem is likely misplaced. Use of the VAT is doubly inappropriate when the externality is generated by some input, since any higher into VAT charged on it will be credited to the purchaser, and so ultimately have no effect. [21]

B. Environmental Taxes when Revenue Matters

In the setting above, the purpose of the Pigovian tax was solely to correct the externality: further issues arise when it is viewed in the context of the wider tax system In practice, of course, and perhaps especially in developing countries, raising revenue is a core and pressing objective in itself. Environmental taxation must thus be viewed in that wider context, a perspective that raises significant additional considerations.

21. Unless, that is, the purchaser is exempt.

What level and structure of tax rates?

Tax policy design becomes more complex when the tax system is asked to serve two objectives simultaneously: raising revenue and improving the environment. The preceding section looked at how corrective taxes should be set when revenue is not a concern; so, before turning to the complexities when this motive is combined with a need for revenue, it is helpful to look at the other side of the coin: efficient tax design when the environment is not a concern.

Taxation inherently creates inefficiencies in the form of 'excess burden'. It operates by driving a wedge between the prices that some buyer pays and some seller receives. Income taxation, for instance, means that purchasers of labor pay more than sellers receive, and taxes on commodities mean that those buying pay more than sellers receive. As a consequence of that wedge, some transactions that would have been attractive to both buyer and seller in the absence of tax will not be undertaken in its presence. This means that the private sector experiences a welfare loss from taxation over and above that which is an inescapable consequence of transferring resources, in the form of tax revenue, from the private to the public sector. That additional loss is known as 'excess burden' (or 'deadweight loss'). An efficient tax system minimizes the excess burden associated with revenue-raising, achieving which—still leaving externalities aside for the moment—requires two things:

- ***Setting tax rates on final commodities according to the 'Ramsey rule.'*** This requires, in the simplest case, setting higher ad valorem tax rates on commodities that are in more inelastic demand (that is, for which the quantity demanded is less sensitive to price).[22] In this way, the tax system reduces demand for all commodities in roughly the same proportion.

- ***Not taxing intermediate inputs.*** Taxing inputs leads to inefficient production methods, because it leads producers to choose input mixes other than those they would have chosen in the absence of taxation; in effect, it leads to a reduction in the output available for final consumption. But this cannot be desirable if the government has sufficiently flexibility in the tools available to it, including through the tax rates it sets on final consumption, to find some worthwhile use for the additional output that removing any such inefficiency would generate. This is the Diamond-Mirrlees theorem.[23]

22. The more general form of the Ramsey rule requires that compensated demands (demands, that is, calculated when welfare, not income, is held constant in the face of varying prices) for all commodities be reduced by approximately the same proportion. This reduces to the inverse elasticity rule just described when compensated cross-price effects between taxed goods are all zero. For a formal exposition, see for example Myles (1995).
23. From Diamond and Mirrlees (1971). The proposition, in essence, is that when here are no constraints on the ability to tax final products (and rents can be taxed at up to 100 percent) Pareto efficiency requires that there be no taxation of intermediate inputs (because by distorting input choices this will lead to a reduction in aggregate output which could otherwise be put to good use).

Now combining the environmental and revenue objectives, two archetypal cases help fix ideas on how tax design can best balance the objectives of correcting for external damage and minimizing excess burden in the conventional sense above—and assuming for now no restriction on the tax instruments that can be deployed:

- ***It is only taxes on commodities that generating an environmental harm which need to directly reflect that damage:*** [24] for other commodities, that is, the usual Ramsey rule continues to apply. This result—highly convenient for keeping tax design (relatively} simple—is an instance of a general principle of targeting at work: the best instrument to address a policy problem is that which acts most directly upon it.

- ***When the externality arises from the consumption of some item sold to final consumers the efficient tax rate is not simply the sum of Ramsey and Pigovian components.*** Because a corrective tax has the side effect of increasing excess burden, the efficient add-on to the Ramsey tax is some amount strictly less than the Pigovian component: [25] this is one aspect of the 'additivity principle' of Sandmo (1975). [26] That add-on is smaller the greater is the government's need for revenue. This may seem strange, as one might have thought environmental taxation is made even more attractive by a need for revenue. But the explanation is straightforward: the additional excess burden created by environmentally motivated tax translates into an erosion of the tax base that undermines the potential to raise tax revenue—and the stronger is the government's need for revenue, the more costly that effect is and so the more strongly it weighs in the balance against environmental gain.

- ***When the externality arises from the use of some input, revenue and environmental objectives are more separable:*** the tax on final consumption should be set by the Ramsey rule, and that on the input set at the Pigovian rate (with no adjustment for the need for revenue).[27] The intuition is that this preserves production efficiency along the lines of the Diamond-Mirrlees theorem but in the relevant social rather than the narrower private sense, because it ensures that input prices reflect their true social costs.

24. This is another aspect of the additivity principle Sandmo (1975). There is, however, a subtlety. The result being referred to here is that the tax rates on goods other than that generating the harm can be expressed as if as unaffected by that harm; in terms of the collective impact of those taxes on patterns of compensated demand, however, the efficient tax system does bear less heavily on items that are substitutes for the damaging good.
25. As an exception, Pirtillä and Toumala (1997) establish conditions under which, with an optimal nonlinear income tax—especially implausible in the developing country context—the adjustment is simply the first best Pigovian tax. These are that environment quality have no impact on either commodity demands or the valuation of time spent doing other than earning income.
26. This holds even when cross-price elasticities are not zero.
27. There appears to be no readily available proof of this.

The implications and relevance of these results for developing countries, however, requires particularly careful consideration. The key point here is that the framework just described presumes an unrestricted ability to tax all commodity transactions which is not fully compelling even in advanced economies, and is especially problematic when, as in developing countries—a point taken up further in Parts 2 and 3.A below—large parts of the economy are extremely hard-to-tax, except perhaps on their purchases from large firms or abroad. It presumes too that taxes can be perfectly targeted on the source of environmental harm, which again may not be the case in practice. Both of these limitations, as will be seen, have significant implications for appropriate design of environmentally-motivated taxes in practice.

When are environmental subsidies warranted?

It is a good principle of tax policy to tax bad things rather than subsidize good things. When revenue is not a concern—meaning that revenue can be raised, or spent, in ways that do not create any distortion, there would be nothing to choose between the two policies. In the canonical example of Box 1.1 above, for instance, instead of charging polluters a tax T^* for each unit they emit one could also achieve the efficient outcome q^* by paying them an amount T^* for each unit of emissions reduction below Q. Intuitively, when revenue does not matter the only concern is the price of bad things relative to the price of good things; and that can be increased by either raising the former or reducing the latter.[28] When revenue does matter, however, there is an evident advantage to taxation in the revenue it raises: if there were not such an advantage, the government would have cut taxes already.

That said, pricing schemes—'feebates'—with both tax and subsidy elements may also have a role in some context. Such schemes combine a tax on emissions, from cars, for example, to the extent that they exceed some 'pivot' level with a subsidy (the rebate part) to the extent that they are below that level. This provides much the same incentive to reduce emissions intensity—increasing the fuel efficiency of cars—as would an outright tax. With judicious choice of the pivot level, moreover, such a scheme can be designed to be broadly revenue-neutral and so leave the average price of the final product unchanged. The potential appeal of the feebate, political and perhaps also distributional, is thus in discouraging pollution while limiting the price impact on consumers. By the same token, however, feebates are less effective environmentally than an outright tax: cars may become more fuel efficient, for example, but the environmental gain through a reduced demand for cars that would be generated by a tax is removed.

28. Even then, there is a risk that the subsidy approach can encourage entry into the sector by polluting firms; in principle though, given the assumption that revenue is not in itself a concern, that can be corrected by imposing an appropriate tax on entrants and making some good use of the proceeds.

More fundamentally, there may also be cases in which it is harder to tax the 'bad' thing than to subsidize the 'good' thing. This is likely to be so, for example, when the bad thing is something that has not happened or cannot be reliably observed. It is hard, for instance, to tax companies for not undertaking fundamental research into renewable technologies that will benefit not only them but the wider community;[29] To induce a level of research matching social needs more widely, some form of subsidy may be warranted.

While environmentally-motivated subsides, including tax incentives, may thus be appropriate in some cases, their use is fraught with potentially difficulty. There is extensive experience with such measures in non-environmental areas: the use of tax breaks of various kinds—'tax incentives'—to encourage desirable activities is extensive, especially in developing countries. And it is widely regarded as having been highly unsatisfactory,[30] including not least in terms of:

- ***Limited effectiveness:*** A key risk is redundancy: of subsidizing activities that would have taken place even without the subsidy. In the environmental context, the choice—in encouraging fundamental research on renewables, say—will often be between providing a tax break or financing the desired activity directly. The risk in providing the tax break is that it will have no impact on the activity but simply reduce the revenue collected on an unchanged tax base. An additional $1 dollar spent by the government on providing a more generous tax deduction for some form of favored spending, for instance, will only deliver more than $1 of that spending if its level is highly responsive to the tax reduction.[31]

- ***Governance problems and proliferation:*** Monitoring to ensure that the conditions under which the tax incentive is granted can be lax, and special interest groups can be adept at securing tax breaks for themselves, including by corrupt means.

These dangers should be a particular concern in the environmental area. Providing special environmentally-related tax incentives can be: appealing to politicians as a way to display their environmental credentials; advantageous for special interests; and spare environmental activists from having to take on the unpopularity of becoming advocates for tax increases. The final outcome, however, can be that environmental objectives are pursued in a way that is potentially far more costly to the economy and to well-being, including of the least well-off, than a coherently designed tax-based approach. The point here is not simply one

29. An incentive for them to undertake research into renewables can be provided by taxing the bad of fossil fuel emissions, but even then they will look only to their own interests in deciding how much and what kind of research to undertake,
30. For a detailed treatment of the issues, see Platform for Collaboration on Tax (2016a,b).
31. Allowing firms to deduct some proportion α of their spending on some item, I against tax charged at a rate of τ, reduces the cost to them of acquiring $1 of this item to the net-of-tax price $\$(1-\alpha\tau)$. With their spending then being some function $I(1-\alpha\tau)$, a small increase in α increases private spending by more than it costs in tax revenue, $\alpha\tau I(1-\alpha\tau)$ if and only if the elasticity of I with respect to the net-of-tax rate exceeds unity. We leave aside from this discussion issues around the relative effectiveness of private and public spending.

for developing countries: arguably, many of the advanced economies are taking a fundamentally mis-conceived approach in prioritizing spending measures to deal, for instance, with climate concerns. For developing countries, however, their especially acute need for revenue and the wider governance challenges they face make the dangers of tax incentives especially acute.

What use to make of the revenue?

Although (perhaps because) the primary motivation for environmental taxes is not to raise revenue, the question of how to use they revenue they raise is critical—for reasons of both efficiency and politics. That the use of the revenue raised by environmentally-related taxes is critical for economic efficiency was seen above; but it also potentially has a powerful, even determinative, impact on the political prospects for their adoption: especially where governance and the quality of institutional framework of public spending are weak and trust in government low—common issues in developing countries—clear assurance that the revenue raised by such taxes will be put to good use is likely to be important for their social and political acceptability.

There are broadly four possible uses that can be made of the additional revenue associated with environmental taxes (which may of course be combined):

- ***Reducing other inefficient taxes:*** This is one interpretation of how the revenue is used in the Ramsey-Sandmo analysis above: broadly, with all taxes being set to minimize excess burden, the additional revenue enables all other taxes to be reduced to some degree.

  A more plausible starting point may be one in which taxes are not all set to minimize excess burden. In that case, the most efficient use of the additional revenue is to reduce most those taxes for which the marginal excess burden is highest.[32] There is a sizable literature seeking to rank tax instruments by their inefficiency,[33] with a fairly common presumption being that the most inefficient will typically be the corporate or personal income tax. But inefficiency depends closely on details of design—a well-designed corporate tax, bearing on rents, will be highly efficient, while more common designs may not be, for example. Simplistic presumptions are best avoided. More fundamentally, the ambition of developing countries is generally not to maintain but to increase total revenue.

- ***Direct compensation of those harmed by the tax:*** Securing a Pareto gain from environmental taxes, as seen above, requires compensating those that are adversely

32. This relates to the 'double dividend' idea that environmental taxation can lead to both improved environmental outcomes and reduced excess burden. Much has been written on this, but with ultimately little enlightenment. There is evidently some truth to the idea if the tax system is not initially set, environment aside, to minimize excess burden. But in that case the prior policy step would be to reform that initial system even if there were no environmental concern. On this issue, see for instance Fullerton, Leicester and Smith (2010).
33. For developing countries, see for example Acosta-Ormaechea, Sola and Yoo (2018).

affected—and the same may be true simply in order to amass the needed political support for reform. In practice, though not (as also seen above) as a universal rule, this will often cost less than the revenue raised by the tax, leaving some left over for other uses.

Exactly which instruments are best used for this purpose will be context-specific. In some advanced countries, personal income tax reductions or targeted social benefits have been used; [34] this, however, is likely to be problematic in lower income countries whose personal income taxes do not reach deeply into the most vulnerable populations and whose targeting abilities more generally may be limited. Many developing countries have, however, developed ways of making transfers to such groups, not least in the context of the COVID-19 pandemic, including by innovative digital means: this is taken up in Part 3.[35]

Compensating measures will generally create their own behavioral responses, and hence their own distortions; they may, that is, increase excess burden. While this is essentially the familiar trade-off between distributional and efficiency concerns in another guise, it can nonetheless underly quite sharp differences in policy recommendations. Among proponents of carbon taxation, for instance, there is strong disagreement between those who would use the proceeds to pay a poll subsidy (on distributional and political acceptability grounds) and those who would use them to reduce distorting taxes (on efficiency grounds).

Political economy considerations may also arise. It is not necessarily the most vulnerable who are in the strongest position to resist the adoption of environmental taxes: compensating the poorest decile for an increase in fuel taxes, for instance, may leave the politically decisive (the median voter, to take one stylized example) still opposed. There is thus a potential difference between compensation on fairness grounds and transfers intended to buy acceptability with powerful groups. Also potentially important for the political economy of compensation is recognizing that it may be impossible to reach literally all those adversely affected by the tax. One consequence of the exceptions that remain is a potential avenue for those opposed to the reform for their own reasons to shroud their views by asserting a wider unfairness of the tax.

- ***Earmarked environmental spending:*** [36] Traditional public finance thinking is opposed to earmarking (or 'hypothecation'): the allocation of particular revenue sources to particular items of spending. There are broadly two arguments against its use:

- If earmarking is 'hard,' meaning that revenues from the designated source determines total spending on the specified item—which is rare, but useful conceptually

34. Some provinces of Canada, for example, provide a refundable 'carbon tax rebate.'
35. See in particular Boxes 3.2 and 3.3.
36. The concern here is with the earmarking of explicitly environmental taxes; there can also be earmarking to environmental purposes of non-environmental taxes, as in the case of Fiji taken up later.

as an extreme case—it may impose undesirable constraints on the allocation of public spending. There are certainly many cases, for instance, in which tax measures to reduce the level of some damaging activity are appropriately accompanied by 'clean up' spending measures which reduce the harm that the remaining level of activity causes: a charge to reduce levels of waste generated by households, for example, will generally need to be accompanied by infrastructure development to treat the waste that remains. But (even leaving aside the possibility that the revenue raised by such an environmental tax might be best used for non-environmental purposes—a collection tax financing local health initiatives, say) there is no reason to suppose that the revenue raised by an efficient corrective tax will be exactly the amount required to finance the efficient level of clean up.[37] It may be greater, or it may be less: the point is that a mechanical link between particular items of revenue and spending is almost inevitably inefficient.

- If, on the other hand, earmarking is soft (in the sense of anything other than hard), then the criticism is one of lack of transparency. Taxpayers are then being told that their tax payments are going to a particular use, when, in any meaningful sense, they are not: unless earmarking is hard, allocating revenue from some tax to a particular purpose does not necessarily increase spending on that purpose since, money being fungible, the government may allocate less from other sources.

In practice, nonetheless, earmarking environmental tax revenues to environment-related spending is not uncommon—more common, at least, than in other areas of externality-correcting taxation.[38] Examples include the allocation of Vehicle Excise Duty in the UK to a road fund [39] and of federal gasoline tax in the US to road maintenance; others will be seen in Part 3. The main argument in favor of earmarking is to enhance political support for reform, in two (possibly overlapping) ways:

- ***Easing the impact on affected firms and individuals.*** The clearest instance, which will be argued later to be of special importance, is that which a commitment is made that at least some part of the proceeds of an environmentally-related tax will be used to make compensatory cash transfers—direct compensation of the kind above. But the linked spending may also be on real goods and services. Revenue from a corrective tax might be used, for example, to reduce the private costs of responding to that tax: learning to use organic fertilizer, for instance, as the tax on chemical fertilizer is increased. These considerations apply not just to individuals,

37. Suppose for example that damage is $D(e,K)$, where now K denotes some item of spending, and e again denotes emissions, with (indicating subscripts by derivatives) $D_K<o$, The efficient corrective tax rate is $T^*=D_e$; the efficient level of spending (at price p) maximizes $-pK+D(_e,K)$, so that $-p=D_K$. Net revenue is thus $T^*.e-pK=D_e.e+D_KK$, which is sure to be zero only if damage is homogeneous of degree zero in emissions and spending. That would be the case if, for instance, doubling both emissions and real spending leaves damage unchanged—which is not especially plausible: doubling waste generated might be expected to increase damage even if spending on collection is also doubled. Efficient corrective taxation actually more than finances efficient spending if, as that example suggests, damage is homogeneous of some degree greater than zero.
38. Calls for tobacco tax revenue to be allocated to health care, for instance, have largely been resisted.
39. This prompted perhaps the most eloquent of all critiques of hard earmarking, by Winston Churchill, when Chancellor of the Exchequer in the 1920s: see Keen and Slemrod (2021, pp. 95-96).

but also to firms. In the limit, for example, environmental taxes on business inputs may drive firms out of business even though, once they have had time to adjust their methods, the social value of their production would remain positive. The free allocation of emission permits that has been common under carbon trading schemes, for instance, can be thought of as addressing this by (temporarily) earmarking the revenue from the notional sale of those permits to those that bought them. More direct measures of earmarking to facilitate mitigation would include, for instance, allocating some of the proceeds from an emissions tax to subside the installation of scrubbers, or (as has been proposed in the aviation and maritime sectors) to support R&D into mitigation technologies. In similar spirit, spending the proceeds of an environmental tax on some item that particularly benefits those consumers that it adversely affects can serve as an imperfect but perhaps worthwhile form of compensation.[40]

- ***Overcoming distrust of government.*** Where trust in government is low, and suspicion that public revenues are not put to good use is high, earmarking may serve as a device for governments to commit that they will put to some acceptable use the additional revenue that is being raised from some new tax, or tax increase[41]—and this may be so even if that use conveys some generalized benefit rather than being a form of direct compensation to those most directly affected. How persuasive this is in explaining widespread earmarking of environmental tax revenue to environmental ends is not, however, entirely clear. In principle, distrust alone would allow for revenue from such sources to be allocated to any form of valued spending (on health, say), and not necessarily environmental. The argument thus seems to rely on taxpayers attaching particular importance to environmental issues at such—but the widespread resistance to environmentally-related taxation suggests that not too much reliance should be placed on this,. Moreover, how effective earmarking is as a commitment device can be doubted, as no government can bind its successors. That said, however, in practice earmarking arrangements do seem often to prove remarkably and surprisingly long-lived.

Earmarking remains a contentious issue, and a more complex one than may appear. There is no doubt that in some cases extensive earmarking has caused real problems of budgetary management. But its relative prevalence suggests that fairly loose earmarking has in some cases facilitated meaningful environment tax reform. Some pragmatism may be in order.

- ***Addition to general revenues:*** Given the pressing revenue needs of almost all developing countries, this—in technocratic terms—is likely to be the preferred use, at least of the revenue that remains after such compensation as felt appropriate has been paid for.

40. Pirttilä (1999). The difficulty is in finding some item for public support that is more highly valued by those responsible for the harmful emissions but does not encourage them to emit more.
41. The argument is explored in Brett and Keen (2000).

There are thus several trade-offs to be faced in deciding how to use environmental tax revenues. One is between the breadth of compensating measures and the creation of additional fiscal space to finance other spending. Another is between reducing the most distortionary taxes and enhancing public spending. And one more may be between securing unfettered use of the additional revenue raised and the need to foster trust that those revenues will be well spent.

Part 2: Context

This part looks in turn at key feature of developing countries in terms first of tax policy and administration, and then in the environmental challenges they face.

A. What's (Not) Different about Tax Systems in Developing Countries?

While no two developing countries are the same, they share some common differences from advanced economies that are potentially critical in thinking about the proper role there of environmental taxes.

A more urgent need for tax revenue

At an average of around 17 percent—and 15 percent in low-income countries—tax ratios[42] in developing countries remain stubbornly low. In around half it is below the 15 percent widely taken as a minimal level to have some prospect of meeting urgent needs and launching on sustained growth.[43] Among the priority countries, only three have ratios exceeding 15 percent.[44] Achieving even a subset of the Sustainable Development Goals (SDGs) in low-income countries has been estimated to require, on average, additional revenue of around 15 percent of GDP [45] — and that calculation was before the revenue setback imposed by COVID-19: general government debt in low income countries has risen by about 5 points of GDP since the onset of the pandemic.[46] It also relates only to some essentially non-environmental SDGs (such as health and education), so does not encompass various spending needs that will become evident throughout this report.

This fundamental revenue shortfall has been widely taken as a strong argument for enhanced environmental taxation in developing countries—but the argument needs to be tempered. There is little doubt that environmental taxation can be a particularly efficient and fair form of taxation. But revenue, of course, is not the primary objective: environmental taxes may yield large social benefits but very modest revenue. Moreover, the counterpart to that strong unmet need for revenue is an evidently high marginal cost of raising that revenue—which, for reasons set out in Part 2.B, can argue for environmental taxes being lower than otherwise, to

42. Meaning here total revenue as a proportion of GDP. Figures in this paragraph are calculated from the UN-WIDER data set at https://www.ictd.ac/dataset/grd/ Underlying country data are for 2020 or the most recent year available in later 2022.
43. Gaspar, Jaramillo and Wingender (2016).
44. These are Burkina Faso, Djibouti and Senegal. Data are available for only 17 of the 19 priority countries.
45. Gaspar and others (2019).
46. IMF (2022), Table 1.2.

the extent that by increasing the deadweight loss from the current tax system they actually make raising revenue through traditional instruments harder. Heavier fuel taxation, for instance, raises input costs and so will tend to discourage production and perhaps dampen prospects for growth. This risk of dissipating the wider tax base is not an argument against environmental taxes, but a caution to bear in mind in deciding how far to push them—and a caution that may be especially germane to lower income countries.

Weaker tax administration capacity

One reason for the poor revenue performance of many developing countries is that their tax administrations commonly lack effectiveness in their core functions: registering taxpayers, assessing their liability, collecting taxes due and reporting to the legislature and public on their activities. This in turn reflects weaknesses not only in processes and procedures, including in the use of available technologies, but also in governance arrangements—corruption remains a concern in many—and in the quality and quantity of the resources available. Improving performance in these attributes is a central focus of external support, including in recent years through the development of medium-term revenue strategies. While there is progress, the capacity of tax administrations in developing countries will remain weak for some time yet.

This weakness, coupled with severe revenue needs, implies a need to focus on scarce administrative capacity with revenue potential very much in mind. Areas that are likely to prove especially important in this regard are improving the performance of the VAT, including in relation to delivering refunds speedily and fully—with evident benefits too in removing an impediment to efficient business operations—as well as extending the personal income tax beyond public and large enterprises, and establishing more effective taxation of capital income. At the same time, administrative attention is already being to a degree diverted away from these core issues by the need to conform with international developments in corporate taxation and international information exchange.

For tax administrations operating in such strained circumstances, the implementation of new environmental taxes which might have limited revenue potential may not be a priority. This is not to say that even low-yielding environmental taxes are always undesirable: indeed, if the environmental benefit—or gains along other dimensions of efficiency, as touched on later—are large enough, such taxes may be worthwhile even if the costs of administering them exceed the additional revenue raised (though that can be a hard point to sell to ministers of finance). There is, nonetheless, a clear imperative to focus attention on environmental taxes for which either the revenue yield or the environmental benefit—preferably both—are substantial.

It will be important that environmental concerns not add to the proliferation in many developing countries of 'quasi-taxes' that serve as little more than nuisance taxes. Regulatory agencies in many cases raise fees and charges that feed directly into their own budgets, and this risk potentially attaches to some environmental taxes too. Beyond the potentially disproportionate costs imposed on taxpayers, this risks a fragmentation of policy and, to the extent that the funds raised are off the government's budget, a lack of transparency. [47] They make it hard, indeed, to assess what environmentally-related charges may already be in place.

The limited ability of administrations to implement—and of taxpayers to comply with—even basic tax rules also point to the importance of both parsimony and simplicity in tax design. Taxation inevitably brings a degree of complexity, but in the context of environmental taxes this consideration points to the use of a relatively limited set of charges that may be imperfect or incomplete in principle but which nonetheless have a substantive impact and whose simplicity eases implementation. A tax on gasoline, for example, is not ideally targeted to address congestion and accident externalities—but it may be a reasonable proxy.
In terms of instrument choice, however, it is not the absolute weakness of tax administration that matters but its weakness (or strength) relative to the agencies charged with alternative instruments. Regulators, for instance, may be no less limited in capacity or vulnerability to corruption than tax officials; and the legislative no less prone to capture by vested interest on regulatory matters than on tax affairs. The merits of a liability approach to environmental problems may also be undermined by slow, unreliable judicial processes.

Limited reach of the tax system

Both a symptom and a cause of their weaknesses, the reach of the tax system in many developing countries is seriously limited, in terms of the breadth of individuals and enterprises that participate directly in the tax system. This observation is often expressed as the notion that levels of 'informality' are high, but this confounds two distinct limits of the reach of the tax system. One is that some enterprises are so small, and some individuals so poor or hard to connect with, that the tax rules simply exclude them from any direct liability: focusing on the larger potential taxpayers can make good sense given the scarcity of administrative capacity, The second limit is instead that some individuals and firms—possibly even large and prosperous ones—while formally subject to tax do not comply with their obligations, either deliberately or because of failures on the administrative side.

47. To control and monitor such quasi-taxes, DRC, for example, has established a Direction Générale des Recettes Administratives, Judiciaires, Domaniales et de Participations outside the tax and customs agencies.

Several consequences follow for environmental taxation, in addition to further reinforcement of the advantage of instruments that require compliance by a few, relatively easily identified and monitored businesses:

- ***Taxing inputs may increase efficiency even apart from the any environmental gains.*** A core tax policy prescription—from the Diamond-Mirrlees theorem mentioned above—is that input taxes are generally ill-advised, as they cause production inefficiencies that can be avoided by well-designed taxes on final output. Where the ability to levy such final taxes is limited, however, the taxation of inputs that generate adverse externalities may not only make sense on environmental grounds but also serve to combat inefficiencies by taxing those who would otherwise remain outside the tax system. The leading possible instance of this is in relation to energy taxation, and discussed further below.

- ***An increased risk of unintended consequences,*** as the inability to effectively deploy a full set of instruments may create risk of behavioral responses to environmental taxes, towards untaxed alternatives, which dampen or even reverse the intended environmental benefit. An example, taken up later, is the risk that increased taxation of kerosene and other cooking fuels will lead poorer consumers to shift towards energy sources that create more local air pollution.

Greater direct dependence on environmental assets—and greater vulnerability

Livelihoods in many developing countries, often fragile, are more directly linked to environmental assets and circumstances than they are in advanced economies. Natural capital accounts for nearly half of the national wealth of low-income countries, compared to around 3 percent in high income countries. [48] Most obviously, agriculture, including small holdings, remains a critical sector in most. The extraction of fossil fuels and other exhaustible resources—major national assets in many developing countries—raise local environmental concerns as well as issues around policies towards exploration, development and extraction. Similarly for forestry and, in some countries, fishing. Water supply is already in many cases very stretched: fourteen of the world's mega-cities already experience serious water shortages. Biodiversity too is increasingly recognized as an asset, and tourism activity can be jeopardized by adverse environmental developments.

While many of these challenges also arise in some advanced economies, they will often have a far greater immediacy of impact in lower income countries,

48. Lange, Wodon and Carey (2018). 'Natural capital' here includes energy, minerals, agricultural land, forests and on-land protected areas; its value is estimated as the present value of associated future rents.

creating a distinct vulnerability to adverse environmental shocks and developments. Food supply shocks, for instance, may not be offset by increased imports, but lead to risk of starvation; over-fishing, or damaged water quality and availability, may leave migration as the only option.

The immediacy and profundity of these vulnerabilities is evident in the marked exposure of developing countries to the deepening, increasingly frequent natural disasters linked to climate change. The risk itself, however, is largely outside the control of those countries themselves. What is in principle under their control, however, is how they respond to the increased risk—and to environmental developments more broadly. Tax measures have received little attention in this context, a gap that this report aims to go some way towards filling.

Lower real incomes—Does that make environmental concerns a lesser priority?

The low-income levels of developing countries may also have implications for environmental policies. One relates to 'affordability' issues in relation to addressing global environmental issues, Fully efficient carbon pricing to mitigate global emissions, for example, is often taken to imply that that price be the same in all countries. This is not the case, however, if the social valuation attached to an additional dollar of income differs between them: specifically, if that dollar has more social value in a lower income country, then—even leaving aside arguments around historical responsibility—efficiency requires that the carbon price be lower there than in higher income countries. [49]

More contentious is the argument that lower incomes imply a lower willingness to pay to avoid environmental damage. [50] The idea that the monetary cost of environmental damage is lesser in low income countries is inherent in the common practice of evaluating loss of life and morbidity associated with environmental damage by reference to an individual's foregone earnings. Indeed it has become standard in multi-country studies of environmental issues to assume that the monetary value of life is systematically lower in lower income countries. Such a view is perhaps implicit too in the reluctance of lower income countries to set environmental standards at the same level as do advanced economies [51] (though a role may also be played here by a divergence of interests within developing countries, between the better off and the less influential who suffer the

49. This is discussed further in Part 3.A below.
50. This is closely related to the idea of an 'environmental Kuznets curve:' an inverse-U shaped relationship between environmental degradation and the level of development. A voluminous literature seems, however, to have found little sign of such a relationship generally being at work.
51. And indeed some may become even less inclined to do so as the agreement on a minimum rate of corporate tax creates incentive to find ways to attract business other than through low effective rates of corporate tax.

damage). One implication of a lower valuation of environmental damage is the potential for mutual gain from shifting environmental harm from rich countries to poorer. Repugnant though this argument is generally recognized to be, [52] the efficiency point is a real one: the transfer of trash from one country to another may be efficient, so long as the price fully reflects not only the private but also the social costs to the latter. Distasteful as it is, those with lower real incomes may, all else equal, attach less priority to environmental problems; pretending otherwise risks imposing on developing countries the priorities of those on higher incomes.

A modest contribution to, but greater damage from, climate change

Developing countries emit, and have emitted, only a very small proportion of the current stock of GHGs. This is so in term of both current and cumulative emissions. Excluding India and Indonesia, developing countries accounted for about 14.7 percent of global GHG emissions in 2019; sub-Saharan Africa for about 7.3 percent; and low-income countries for only 3.7 percent. [53] Shares of cumulative emissions, and hence historical responsibility for the current stock of GHGs, are even lower: about 5.7 percent for sub-Saharan Africa. [54]

But they suffer, and will suffer, an especially strong adverse impact. It has long been recognized that "The most vulnerable–the poorest countries and populations – will suffer earliest and most" [55] from climate change. Simply in terms of output, one estimate is that for the median low-income country (with an average annual temperature of 25°C) a temporary temperature increase of 1°C reduces per capita output by an amount that rises to around 1.5 percent seven years later. [56] Beyond the relatively slow-moving effects of climate change, developing countries are also especially vulnerable to natural disasters, including those whose increasing frequency and intensity is associated with climate change: a single drought can lower an African country's medium-term growth potential by 1 percentage point. [57] Output measures, however, may reflect but cannot fully capture the social costs

52. As shown by the reaction to the famous memo of Larry Summers when Chief Economist of the World Bank. (text available at http://academics.semo.edu/hhill/ui429/summers-memo/), Some, nonetheless, see the logic of his intentionally provocative argument as unrebutted: see for example Johnson, Pecquet and Taylor (2007).
53. Figures (and those for CO_2 below) are calculated from CAIT data downloaded from https://www.climatewatchdata.org/data-explorer/historical-emissions?historical-emissions-data-sources=cait&historical-emissions-gases=all-ghg&historical-emissions-regions=All%20Selected&historical-emissions-sectors=total-including-lucf%2Ctotal-including-lucf&page=1 (June 9 2022). Emissions include from land use change and forestry, but exclude those from international aviation and maritime.
54. Calculated (also for CO_2 below) from World Resource Institutes data at: https://www.wri.org/insights/4-charts-explain-greenhouse-gas-emissions-countries-and-sectors#:~:text=China%20is%20the%20biggest%20emitter,the%20European%20Union%20at%207.03%25.&text=Most%20of%20the%20top%2010,tCO2e%20per%20person
55. Stern (2007), p. vii.
56. IMF (2017).
57. Cited in IMF (2021).

of climate change through such channels as increased spread of vector-borne diseases and child mortality, nor the social strains from deteriorating food security and water scarcity that can give rise to migration and even conflict and political turmoil.[58] These effects, moreover, are already becoming evident: both temperature and sea level in Africa have already risen faster than elsewhere.[59]

But some things are much the same

Core principles of tax administration and policy apply in developed countries no less than advanced, including

- ***The practical appeal of taxes that can effectively be levied at just a few points,*** such as at import, or by monitoring and controlling a small number of large taxpayers.
- ***The attractions of taxing rents—that is, amounts in excess of the minimum required by investors.*** Being in excess of the minimum required, these can in principle be taxed at high rates without leading to any change in production decisions. For this reason, they are in perhaps second only to environmental taxes in the list of ways in which governments might meet their revenue requirements. Such taxes have particular appeal in relation to natural resources, which can give rise to substantial rents—and which, since the rents are largely location-specific—can in principle bear particularly heavy tax rates without inducing activity to move abroad in search of lower taxes.
- ***The basics of good tax administration apply.*** For example, since the damage for which environmental taxes are intended to correct generally relate to the quantity of emissions or the amount of some commodity that is used, it is many cases appropriate to specify environmental taxes in specific form (fixed in monetary amount) rather than ad valorem (proportional to the product price). But then it is important to update them regularly to prevent (even at moderate inflation rates) the erosion of their real value: World Bank (2021) cites the example of Indonesia, where 70 percent of the revenue from forestry fees then came from a fee schedule that had been unchanged since 1999; in the US, the federal excise tax on gas has not changed since 1993.

58. Burke, Hsiang and Miguel (2015) find evidence suggesting that climate change has the potential to significantly increase "violent crime, civil conflict, and political instability" (p. 610).
59. IPCC (2021).

B. Environmental Problems and Priorities in Developing Countries

This section provides context for later analysis by providing a broad overview of the extent and nature of environmental problems in developing countries, with a focus on sub-Saharan Africa and the priority countries. It is not directly tax-related but provides a sense of which issues are most important for the countries themselves, and hence (some areas being more susceptible to tax treatment than others) a sense of where the scope for corrective tax policy maybe greatest.

For this we make particular use of the Environmental Performance Index (EPI), which provides quantitative scoring, based on expert assessments, of performance in 40 areas: the worst possible score is zero and the best 100 percent. These are aggregated into scores for each of 11 categories (described in Box 2.1), which are in turn aggregated to provide an overall score. [60] The EPI is not without controversy, and, of course, not too much precision be attached to the scores themselves, or the rankings that imply. And some categories of interest from the tax perspective (such as waiting costs of congestion) are not covered. Nonetheless, the EPI has found widespread acceptance in the academic literature, and the results are suggestive.

Box 2.1: The Eleven EPI 'Issues'

The categories are: [1]

- ***Air quality:*** *Exposure to nitrogen oxides (NOX), sulphur dioxide (SO_2), carbon monoxide (CO), P2.5 and others.*
- ***Sanitation:*** *Diseases and deaths from exposure to unsafe sanitation and drinking water*
- ***Heavy metals:*** *Exposure to pollutants such as lead, arsenic, and mercury (which can result in prolonged/irreversible damage to human health).*
- ***Solid waste:*** *Tracks the percentage of solid waste which is collected, treated, and recycled; also considers the amount of plastic waste released into the ocean.*
- ***Biodiversity:*** *Assesses actions toward retaining natural ecosystems and protecting the full range of biodiversity within their borders*
- ***Ecosystem:*** *Covers grassland loss, wetland loss, and tree cover loss.*
- ***Fisheries:*** *Reflects the percentage of a total catch that comes from overexploited or collapsed fish stocks, and the proportion of fish caught by trawling and dredging.*

60. See Wolf and others (2022) and further information on the EPI at https://epi.yale.edu.

- ***Acidification:*** *Emissions of nitrogen oxides (NOX), sulphur dioxide (SO_2).*
- ***Agrochemicals:*** *Focuses on whether fertilizers and insecticides are used efficiently and sustainably.*
- ***Wastewater:*** *the percentage of wastewater that undergoes at least primary treatment, relative to the proportion of the population connected to a municipal wastewater collection system.*
- ***GHG emissions:*** *Levels and growth of various categories. Since this relates to a global rather than externality, little attention is paid to this in what follows.*

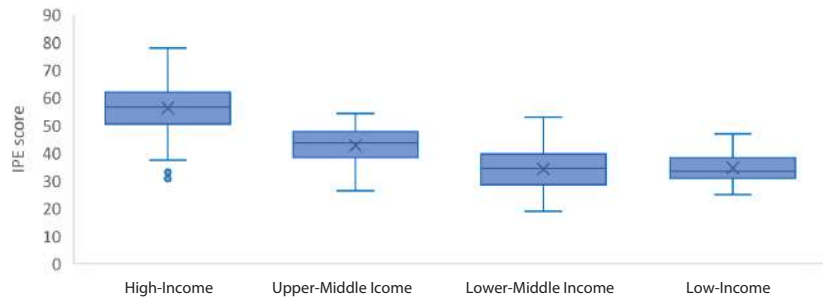
1. Their labelling here differs from that in EPI itself, to link more closely with the framing of later discussion.

The aim here is to describe performance, not to explain it. There is of course work on this; [61] exploratory work with these data suggests that, conditional on income per capita, low government effectiveness and high resource dependency are associated with poor performance. But this remains an unsettled area, with more to do.

Assessment

Environmental problems are especially acute in low-income countries, with markedly lower overall EPI scores (Figure 2.1). This is as one might expect, though it is notable that the low-income group do not obviously perform worse than the lower-middle income group—shades, perhaps of an environmental Kuznets curve [62]—and that the highest performing low-income countries perform better than some high-income countries.

Figure 2.1: EPI scores by income group

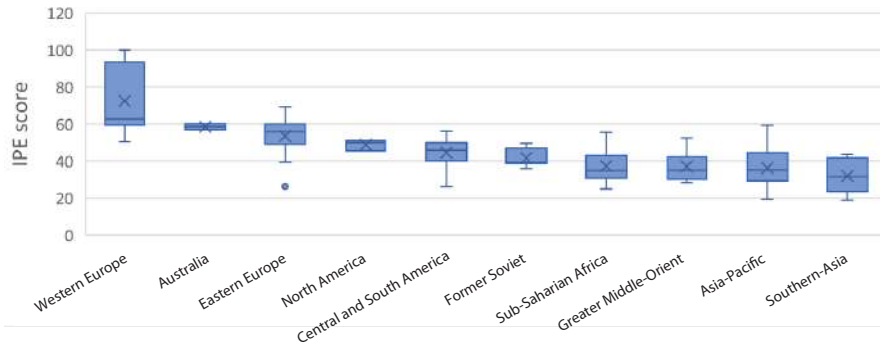


Source: EPI 2022 report and World Bank Country and lending groups. Retrieved August 22, 2022, from https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups. Figures are for most recent year available.

61. As indeed in Wolf and others (2022).
62. This is the idea that as development proceeds environmental quality initially worsens before at some point improving.

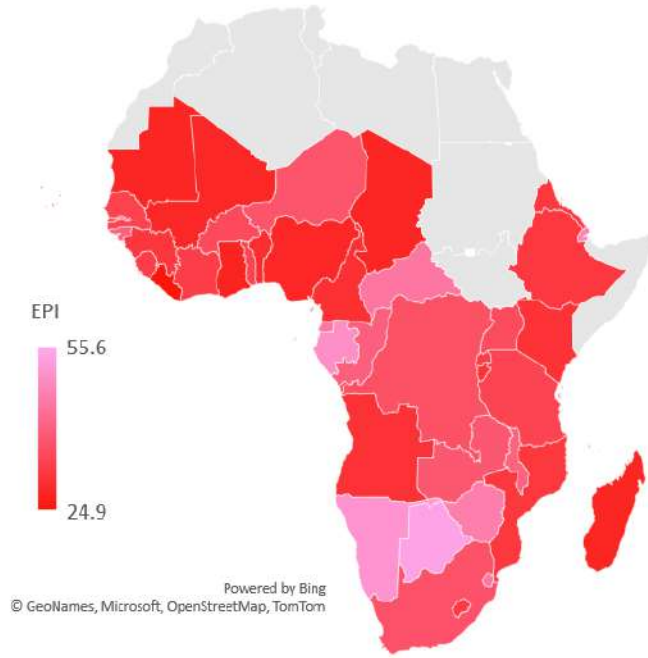
While performance in sub-Saharan Africa is generally low, it is not the lowest and there is sizable cross-country variation in overall performance. Average scores are somewhat lower in Southern Asia, and performance is comparable with that in Asia-Pacific (Figure 2.3). A sense of the diversity across countries in sub-Saharan Africa (and Haiti) is provided by Figure 2.4.

Figure 2.3: EPI scores by region



Source: EPI 2022 report.

Figure 2.4: Overall EPI scores across sub-Sharan Africa and Haiti



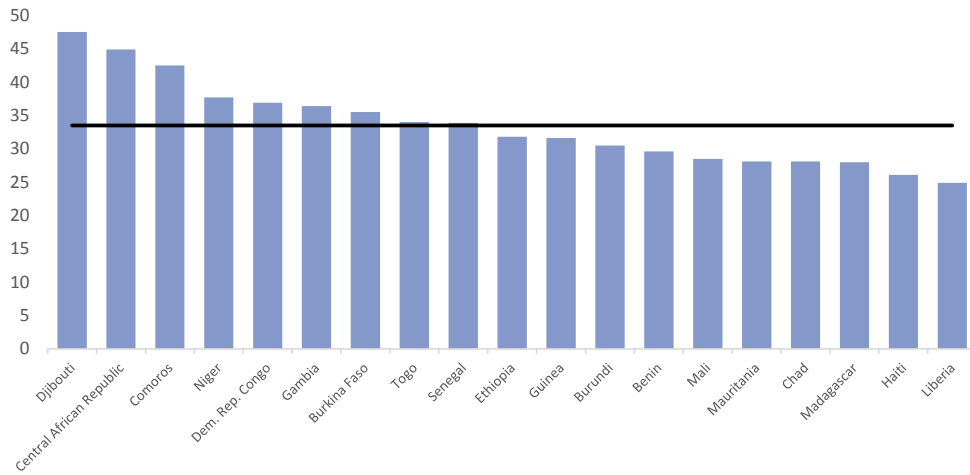
Source: EI 2022 report

Note: Gray indicates data not available.

The average performance in the priority countries is generally worse than in sub-Saharan Africa more widely. The mean EPI score for these countries is 34, compared to 40 in the non-priority sub-Saharan African countries; and a gap of around this magnitude is found in all areas other than air quality and ecosystems, where performance is much the same.

There is, however, considerable variation in performance among them. That there is considerable heterogeneity across priority countries in their overall scores is suggested by Figure 2.4 and detailed in Figure 2.5. Within the wider context of sub-Saharan Africa, the first column of Table 2,1 shows that Djibouti and the Central African Republic, for instance, are both among the highest performers in sub-Saharan Africa; more troublingly, four of the seven lowest performers are priority countries: Ghana, Liberia, Madagascar and Mali.

Figure 2.5: Overall EPI scores in priority countries



Note: Horizontal line indicates average for these countries.

Source: EPI 2022Report

A more granular picture of environmental challenges faced emerges from the assessments under the eleven categories, set out in Table 2.1 below. Some care is needed in inferring from these indicator-specific scores the practical significance of any challenge: bad fishery management may be a relatively minor concern, for example, in a country with little actual potential in fisheries. The results are nonetheless suggestive:

- ***Within performance areas, there is substantial variation across countries:*** on acidification, for example, Burundi scores 74.8 but Benin only 6; on fisheries, Togo scores 7.1 while Cabo Verde scores 100.

- ***Within countries, there is substantial variation in performance across areas:*** Mauritania, for example, scores 81.3 on ecosystem management but zero on water quality/management; and Niger scores 65.4 on acidification, but only 8.4 on solid waste management.

Most striking, however, is considerable commonality in the most pressing concerns. Highlighted in Table 2.1, for each country, are the four areas in which performance is weakest. Notably:

- ***Waste management (solid and water) and sanitation are leading concerns in virtually all countries:*** among priority countries, in only Benin, Djibouti and Mauritania is one of these not among their four worst-performing areas.
- ***Agrochemicals are a leading concern in around one-third of these countries,*** though among priority countries only in Niger.
- ***Fisheries are a concern in around half of the countries*** for which an assessment is available.
- ***Air quality and heavy metals, in contrast, are rarely the weakest areas***—though the extent to which the overall assessment reflects damage that may be localized in large cities is unclear.

Indicators of environmental performance do not necessarily translate into indicators of welfare loss, or of how urgently action is needed. Moderately bad solid waste management, for instance, may have a larger adverse impact than very bad acidification. And it may well be that the best time to act is before problems become extremely severe, rather than when policies generating harmful environmental effects have built up their own supportive interest: better, for instance, to deal with outdoor air pollution, for instance, before urbanization becomes even more intense.

One lesson, nonetheless, is that some of the most important areas are ones in which tax/pricing measures have been relatively little studied. There has been much work from the public finance perspective on, for example, fuel pricing—but very little on waste management or the provision of drinkable water. This, as will become clear, in part reflects the limited availability of information; it is hard not to think that it also reflects a research agenda that has been implicitly driven by the interests of richer countries. This distorted focus of previous work is worth remembering in the discussion that follows, though remedying it will remain a task for the future.

These environmental harms are likely to fall disproportionately on some of the most vulnerable. Within countries, their distributional impact may differ across the various types of damage: poor sanitation, for example, may fall more heavily and pervasively on the relatively poor than does, say, over-fishing. In so far as damage is geographically concentrated, however, it is clear that it will be those without the means to relocate elsewhere that suffer most. This general point—that is the poor that are most at risk from environmental degradation—will recur in the specific contexts explored below. And it poses distinct problems for a tax-based approach to addressing environmental challenges, since these most affected groups also tend to be among the hardest to directly compensate.

Table 2.1: EPI scores by issue (sub-Saharan Africa and Haiti)

Pays	EPI overall	Air quality	Sanitation and drinking water	Heavy metals	Solid waste	Biodiversity
Angola	30.5	23.1	12.8	36.7	9.6	30.1
Burundi	***30.5***	***30.7***	***5.4***	***35.2***	***2.7***	***42.3***
Benin	***29.6***	***22.3***	***13.5***	***36.2***	***29.7***	***63.6***
Burkina Faso	***35.5***	***26.1***	***7.8***	***29.1***	***16.7***	***78.5***
Botswana	54	17.1	20.9	39.2	27.3	89.3
CAR	***44.9***	***19***	***0***	***23.5***	***3.4***	***80.2***
Cote d'Ivoire	32.8	18.2	17.3	44.2	11	58.2
Cameroon	30.2	13.2	7.8	35.6	15.4	42
Dem. Rep. Congo	***36.9***	***25.1***	***13.6***	***35.5***	***4.1***	***68.6***
Republic of Congo	40.1	16.7	14.6	44.4	23.7	67.5
Comoros	***42.5***	***38.4***	***15.2***	***46.4***	***15.5***	***53.9***
Cabo Verde	41.9	28	35.6	58.7	24.1	12.1
Djibouti	***47.5***	***19.6***	***18.3***	***45.6***	***16.9***	***10.8***
Eritrea	31.7	19.3	6.4	37.8	15.3	8.8
Ethiopia	***31.8***	***33.7***	***11***	***35.2***	***5***	***59.2***
Gabon	49.7	25.7	27.7	53.4	30.5	85.1
Ghana	27.7	15.3	20.9	54.6	13.6	52.9
Guinea	***31.6***	***21***	***11.3***	***32.3***	***18.9***	***60.6***
Gambia	***36.4***	***20.7***	***19.2***	***36.5***	***14.5***	***42.2***
Guinea-Bissau	40.2	19.4	6.8	28	14.3	76.2
Equatorial Guinea	44.8	22.9	33.2	39.5	46.5	62.5
Kenya	30.8	30	13.7	49.9	13.3	46.4
Liberia	***24.9***	***28.3***	***9.9***	***36.7***	***11.9***	***26.8***
Lesotho	32.3	11.1	7.3	24.5	5.9	13.7
Madagascar	***28***	***33.6***	***6***	***32.4***	***11.2***	***31***
Mali	***28.5***	***26.7***	***8.3***	***31.9***	***4.5***	***46.9***
Mozambique	31.7	37.9	16.4	23.3	9.8	65.2
Mauritania	***28.1***	***21.1***	***13.6***	***55.1***	***35.5***	***10.7***
Mauritius	44.8	50.7	65.5	66	67.4	18
Malawi	40.6	35.7	12.1	36.8	3.5	82.4
Namibia	50.9	22.2	19.7	43.9	26.5	73.9
Niger	***37.7***	***27.1***	***1.5***	***26.8***	***8.4***	***77.1***
Nigeria	28.3	13.8	5	50.9	12.7	45.7
Rwanda	32.8	24.7	16.9	44.6	4.5	47.6
Senegal	***33.9***	***22.1***	***13.1***	***47***	***11.2***	***65.1***
Sierra Leone	32.7	21.6	11.6	36.8	12.1	51.2
Sao Tome and Principe	52.9	26.8	35.3	44.3	20.4	59.1
Eswatini	44.9	16.9	12.6	39.6	14.6	28.7
Seychelles	55.6	54.8	51.5	67.8	44.4	76.1
Chad	***28.1***	***24.3***	***0***	***28.6***	***5.1***	***62.4***
Togo	***34***	***21***	***5.2***	***43.1***	***10.3***	***59.2***
Tanzania	34.2	33.2	18.5	43	10.4	70.1
Uganda	35.8	27.4	17.6	41.3	13.2	75.8
South Africa	37.2	22.2	24.7	58.1	39.2	54.7
Zambia	38.4	23.6	13.5	41.7	6.9	91
Zimbabwe	46.2	23.9	16.9	32.1	13.3	83.7
Haiti	***26.1***	***28.2***	***14.1***	***11.7***	***9.4***	***35.4***

Note: Bold italics indicates a priority country; highighting indicates the lowest four scores for each country.
Source: EPI 2022 Report.

Ecosystem services	Fisheries	Acidification	Agrochemicals	Wastewater	GHG emissions
29.4	24.3	50.5	24.9	0	37.7
22.2	***NA***	***74.8***	***18.5***	***0***	***29.4***
15.8	***11.3***	***6***	***35.3***	***9.6***	***26.2***
9.7	***NA***	***45.6***	***40.6***	***0***	***27.6***
58.8	NA	37.2	10.7	0.9	63.1
39.7	***NA***	***61.1***	***15.9***	***0***	***49.5***
55.5	29.3	52.5	19.7	1.2	25.1
19.1	10.4	62.5	44.2	0	35.4
17.4	***NA***	***56.4***	***26.4***	***0.1***	***35.1***
26.5	14.9	62.7	34.5	8.8	44.9
35.5	***78.4***	***59.2***	***37.3***	***10.1***	***41.2***
80.8	100	21.4	16.7	24.7	51.4
100	***6.5***	***74.6***	***49***	***0***	***73.7***
90.1	22.7	58.1	14.9	0	40.4
27.6	***NA***	***43.6***	***56.9***	***0.1***	***19.9***
37.7	7	66.1	26.2	0	56.3
10.3	12.8	65.3	22.1	3	23.8
13.9	***22***	***47.6***	***31.2***	***0***	***30***
28.5	***12.5***	***58.2***	***36.4***	***7.9***	***46.5***
28.3	33	62.9	34.1	0	40.5
29.1	21.9	69.8	25.4	1.2	53.6
17.7	16.4	71	27.1	1.1	29
2.4	***20.7***	***45.5***	***22.4***	***0***	***30.5***
28.3	NA	53.1	45.5	0.3	53.3
21.8	***30.2***	***52.6***	***35.9***	***0***	***28.4***
26.5	***NA***	***61.1***	***30.7***	***0***	***21.9***
15.8	57.1	25.6	30.4	20	19.3
81.3	***18.2***	***56.1***	***27.2***	***0***	***27.8***
100	18.5	64.8	20	2.8	46.4
15	NA	62.7	36.7	0	33.1
39.1	26.5	76.7	14.8	5	64.6
82.5	***NA***	***65.4***	***21.6***	***0***	***17.9***
12.2	23.3	62.2	28.6	0.2	29.6
17.8	NA	67.8	31.5	0	32.6
15.5	***23.9***	***28***	***39.9***	***0.5***	***33.6***
15.8	34	44.1	33.2	0	35.5
100	19.7	55.6	18.2	10.9	63.2
20.9	NA	75.5	43.2	70	67.9
71.7	20.3	72.4	8.8	19.5	53.9
9	***NA***	***63.9***	***28.4***	***0***	***18.5***
22.4	***7.1***	***72.6***	***39.2***	***0***	***34.4***
18.8	19.1	64.4	31.1	2.9	25.3
14.6	NA	63.2	21.3	0.4	26.8
14.4	29.9	74.6	61.1	21.7	34.1
19.9	NA	32.2	53.2	4.5	25.6
17.7	NA	87.8	42.8	37.2	41.9
20.4	***33.5***	***19.8***	***15.7***	***7.1***	***27.9***

Part 3: Reducing damage and managing resources

This part of the report provides a broad review of what the analysis above suggests are the most pressing environmental challenges in developing countries, with an eye to the potential role of tax-based response. [63] Many of these problems are inter-related: the rising water temperatures caused by climate change, for example, are also one source of threat to sustainability of fisheries. There are also more problems than can be manageably addressed here. The coverage amounts to a pre-selection of those issues that appear substantive and of widespread importance (in the priority countries and more broadly), which are essentially local in nature, so that developing countries can hope to address them by their own actions, and for which tax-like measures appear, a priori, to merit consideration.

A. Fossil Fuel use

As with GHGs more broadly, developing countries account for only a very modest share of global CO_2 emissions, and an even more modest share of the global stock. Excluding India and Indonesia, they accounted for about 11.9 percent of global CO_2 emissions in 2019; sub-Saharan Africa accounted for about 5.6 percent; and low-income countries for 2.9 percent. In terms of historic responsibility, sub-Saharan Africa accounts for only around 5.7 percent of cumulative CO_2 emissions.

In terms of addressing the global climate challenge, there is in any event a strong equity case for relatively low carbon taxes in low-income countries. Standard 'first-best' considerations would imply that since the global damage caused by emitting any GHG is the same wherever in the world the emission occurs, so too should be the corrective tax applied. Unless, however, one takes the view that the marginal social value of USD1 is the same to citizens all over the world, a uniform price clearly does not maximize collective welfare: doing so requires, essentially on affordability grounds, a lower tax in low-income countries, where that marginal value is highest. More subtly, a uniform price may not even achieve Pareto efficiency: with appropriate adjustment of trade policies, all could be better off by setting lower carbon prices in poorer countries.[64] All this, importantly, is without invoking any argument for a differentially lower rate on the grounds of a lesser historical responsibility.

63. An omission, however, is the issue of sanitation and the supply of drinkable water.
64. For example, starting from a globally unform tax, a high- and low-income country might both gain if the low-income country were to set a lower carbon tax whilst also offering an appropriate trade concession to the high-income country (which might take up more of mitigation burden itself). Keen and Kotsogiannis (2014) show more generally how carbon pricing and trade measures can interact in shaping fully efficient policies. See also Gillingham and Keen (2015).

That said, local co-benefits can provide a powerful case to reduce the burning of fossil fuels substantially in many developing countries. Prominent among these co-benefits are:

- ***Reduced emissions of a range of airborne pollutants,*** generated along with CO_2 in burning fossil fuels, that have seriously adverse local health effects. [65] One study covering 13 developing countries puts the co-benefits in the range of USD 27-196 per tonne; [66] a more recent study suggests they may be higher. [67] These are large numbers relative, for instance, to the carbon price called for to address climate change, which has been put in the region of USD 50-100 per ton of CO_2 by 2030.[68] It remains the case, however, that these issues have been more intensely studied for more advanced economies. It is also the case that these external effects arise most powerfully in densely populated countries, and so are likely a more immediate concern in East Asia than in Africa. Nonetheless, these considerations appear significant, and likely to become more so over time. [69]

- ***Reduced congestion and road accidents.*** Unlike pollutants, these externalities are not inherent in the burning of fossil fuels for transportation, and so in principle might be addressed more effectively by better-targeted instruments, such as the congestion charges discussed in section G below. They are, however, so closely correlated with vehicle fuel use in most countries that a tax on those fuels can serve as an indirect but reasonable corrective tax along these dimensions too. And the effects can be large. Accident externalities, notably, appear to be especially large in developing countries, where fatal accidents are far more common. [70]

While the relative importance of these co-benefits will vary, they seem likely to dwarf climate concerns for many developing countries—and hence provide a potentially powerful call for action. In South Africa, for instance, congestion and accident costs are a greater concern than local pollution, while in Indonesia the opposite is true; in both cases, however, these co-benefits taken together are about four times as large as the climate externality. [71] For developing countries, one could see climate change mitigation as the co-benefit from reducing local pollution, rather than vice versa.

While not the best targeted instrument to address all of these environmental challenges, taxes on fossil fuels will often be a good proxy. Congestion externalities, for instance, are most directly addressed by explicit pricing of road access (discussed in Section G below), while dealing with accident externalities raises

65. These include NOx, PM2.5 (particulates with diameter less than 2.5 micrometers) and SO_2).
66. Nemet, Holloway and Meier (2010).
67. West and others (2013).
68. Carbon Pricing Leadership Coalition (2017).
69. This is suggested by, for example, the heat map in Figure S31 of the Supplementary Material to West and others (2013).
70. About 90 percent of both fatal and non-fatal road accidents occur in low- and lower-middle income countries, though they have less than half the world's motor vehicles: Heine and Black (2018).
71. Heine and Black (2018), p.16.

issues concerning insurance. Nonetheless, both sources of harm are sufficiently closely correlated with fossil fuel use to make it taxation a natural proxy when better targeted measures remain infeasible.

Not the least of the appeals of taxing fossil fuel use is the prospect of substantial additional tax revenue. Going beyond subsidy elimination, a USD 70 per ton of CO_2 might raise, on (GDP-weighted) average, about 1.4 percent of GDP in sub-Saharan Africa. For countries with tax ratios in the order of 15 percent, the revenue potential is thus significant.

Taxation, moreover, has considerable advantages over other instruments for reducing fossil fuel use. [72] The obvious advantage over regulatory measures, such as emission standards or quantitative limits, is in the revenue raised. Moreover, pricing measures—ideally, in terms of climate concerns, a tax on carbon emissions at the same rate across all sources—ensure that overall mitigation is achieved at least cost. [73] As set out in Box 1.2, this is because each entity reduces emissions up to the point at which the abatement cost it incurs in doing so just equals the carbon price it thereby saves; a uniform price across all emitters and sources thus equates the marginal cost of abatement across them, and so implies that the overall abatement occurs at the least overall cost. The choice between cap-and-trade and taxation as ways to establish such a carbon price is less clear-cut. Cap-and-trade may appear to have an advantage in fixing the level of overall emissions, which, given the large social cost of breaching irreversible 'tipping points' in the global climate system; but current emissions have only limited impact on the cumulated stock of GHGs (which is the source of damage), so that taxes can be adjusted over time, if need be, to exercise similar control over total emissions. There are some signs, moreover, that cap-and-trade schemes have been more vulnerable to the inclusion of unnecessary exemptions that erode the revenue gain (including through the allocation of free permits) and to earmarking. [74]

The scale and nature of the challenge

As ever, the first prescription in pricing fossil fuel use it to do no harm—which in this context means eliminating outright fuel subsidies. These have been a long-lasting concern, including in developing countries. In sub-Saharan Africa they amounted to around 1.5 percent of GDP (perhaps 5.5 percent of total government revenue) in 2011, and still around the same amount in 2020. [75]

72. See for instance de Mooij, Keen and Parry (2012) and IMF (2019a).
73. If that uniform carbon price varies across countries—for which, it was argued above, there may good reason, then it is mitigation within that country which is achieved at minimum cost.
74. IMF (2019b, p.6) reports that, globally, the proportion of revenues going into general revenue is far lower for emission trading schemes than for carbon taxes. On this, and a wider assessment of the comparison between taxes and trading systems as instruments for carbon pricing, see also Parry, Black and Zhunussova (2022).
75. IMF (2013) and Figure 7 of Parry, Black and Vernon (2021). At more than 4 percent of GDP in 2011, they were then highest in Mozambique, Zambia and Zimbabwe.

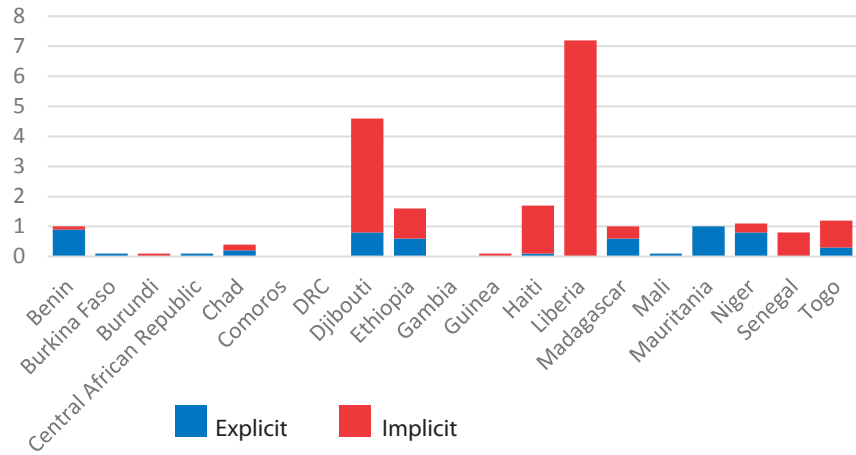
Beyond this, however, there is substantial scope and need for corrective taxation to address environmental harm from fossil fuel use. A broad sense of this is provided by IMF (2021a), which provides country-specific estimates of both explicit and 'implicit' subsidies, with the latter reflecting failure of prices to reflect estimated damage in terms of climate change, air quality, congestion, and externalities from vehicle use as well as application of less than the standard rate of VAT. Over sub-Saharan Africa as a whole, for example, explicit subsidies cost around USD 14.5 billion in 2020; implicit subsidies were more than five times as large, at around USD 77.5 billion. And among the environmental aspects, air quality and vehicle externalities rank about equally with climate damage, in both cases costing around 2.1 percent of GDP. In other parts of the world, it is worth noting, local damage looms even larger: In East Asia and the Pacific, in contrast, the external costs of air quality damage and from vehicle externalities are more than twice those through climate effects.

For the countries of interest, fossil fuel subsidies (in the broad sense) averaged around 1.2 percent of GDP in 2020, with three-quarters of this being 'implicit'—but with wide variation (Figure 3.1). Two outliers stand out, reflecting very different considerations. In Djibouti, vehicle externalities are far larger than in most other countries, at 3.2 percent of GDP. [76] In Liberia, in contrast, the large implicit subsidy reflects underpricing of the climate damage from the use of gas and (especially) coal in power generation. Other among the higher implicit subsidies—in Senegal, Togo [77] and to a lesser extent Ethiopia—also reflect underpricing of coal. For most of these countries, however, explicit subsidies to gasoline and diesel appear quite modest in many countries: [78] only in Ethiopia and Haiti (in both cases for diesel), as well as Djibouti, do they exceed about 0.2 percent of GDP. In several countries, consumer prices for gasoline and diesel more than cover both supply and environmental costs. [79]

The revenue gain from moving to efficiently corrective taxation of fossil fuels would likely be substantially lower than their current cost—because fossil fuel use would decline (that, of course, being the objective). A rough rule of thumb might be that taxation will recover something over half of the subsidy cost. [80] A generous upper bound, however, is provided by the estimates in Figure 3.1: in all but perhaps four cases, the potential revenue gain is well under one percent of GDP.

76. Whether this is from congestion effects or other vehicle externalities is unclear from the data.
77. Under-pricing of LPG is also sizable.
78. For several of these countries, however, information on pricing of gasoline and diesel is not available.
79. For example: In Senegal, the consumer price of gasoline of USD 1.19 per liter exceeds the sum of supply costs (USD 0.42), climate damage (USD 0.14), air pollution (0.01), vehicle externalities (USD 0.08) and foregone VAT (USD 0.12).
80. For instance, Parry, Black and Vernon (2021) find that while global subsidies were around USD 7 trillion in 2020, efficient taxation would raise an additional USD 3.8 trillion.

Figure 3.1: Explicit and Implicit Fossil Fuel Subsidies, 2020



Source: https://www.imf.org/-/media/Files/Topics/Environment/energy-subsidies/fuel-subsidies-template-2021.ashx. Details of construction are in Parry, Black and Vernon (2021).

Fossil fuel tax design in developing countries

Not the least merit of fuel taxation, particularly in the low-capacity context of many developing countries, is its potential administrative simplicity. A tax on carbon is a specific tax: one whose base is defined in physical terms, that is, rather than value,[81] and so is relatively easily observed and verified, making it traditionally one of the simplest forms of tax to administer. Almost all countries are very familiar with excises on gasoline and diesel: a carbon tax is a conceptually straightforward extension of these. Moreover, taxes on fossil fuels have the great convenience for tax administrations that they can in general be readily and effectively levied at just a few points in the production chain: at import, extraction, or as inputs to power generation. Nor is a fully uniform tax on all carbon emission entirely necessary in all cases. It may be that taxing a few key sources achieves a large part of the possible effect: for China and India, for example, setting a tax on coal equivalent to USD 50 per tonne of CO_2 achieves over 90 percent of the emission reduction that a general carbon tax at that rate would achieve. But the pattern varies, depending on the energy sources for power generation and the prevalence of road transport. In Tanzania, for example, a coal tax does almost nothing, while a road fuel tax achieves one-third of the effect of a generalized carbon tax at the same rate. [82] The ease of administering taxes on fossil fuels should not, however, be over-stated: it may be necessary, for example to arrange rebates for power installations that use end-of-pipe abatements, including, potentially, carbon capture. Nonetheless, the challenges would be far from the most daunting that tax administrations in

81. This reflects there being essentially fixed coefficients in the carbon content of the different forms of fossil fuel.
82. The comparisons reported here are from IMF (2019a), p.31.

developing countries are asked to tackle; simpler, for example, than those they are expected to address in implementing an increasingly complicated international corporate tax system.

In some other respects too, raising fossil fuel prices has particular appeal for developing countries:

- ***By reaching 'informal' operators through their inputs, fuel taxes may increase efficiency.*** The exclusion of such businesses from the regular tax system—whether illegally, as a consequence of evasion, or legally, as a consequence of tax design—gives them a competitive edge that distorts production away from more heavily taxed businesses, and by narrowing the tax base erodes the potential tax take. Taxing them on their inputs creates its own distortions (incentivizing them to use less taxed fuels), but—as elaborated in Box 3.1—may on net improve the efficiency of resource allocation. It may, that is, have beneficial effects even leaving aside environmental gains. This would also weaken, if not reverse, the presumption (set out in Part 1.B) that efficiency considerations generally call for corrective tax rates below the marginal social costs of the associated externalities. Several simulation studies suggest that there can indeed be substantial efficiency gains on this score in developing countries, including when account is taken of the possibility (returned to below) of inducing some shift to the use of untaxed but more damaging energy sources. [83]

Box 3.1: Environmental taxation with an informal sector[1]

When all taxpayers are compliant and fully included in the tax system, efficient tax policy when some input generates adverse external effects is straightforward, *as described in Part 1.B. It requires that the input be taxed at the first-best Pigovian rate while the final product is taxed at the Ramsey rate described above. In developing countries, however, many operators are 'informal' in the sense [2] that they are not fully encompassed in the tax system: this may be illegal evasion, or it may simply be that they are below some size threshold for liability to the tax.*

`Informality' of this kind requires a different approach, and provides new opportunities. *Take, for instance, the plausible case in which informal operators do not charge tax on their sales but cannot escape a tax on their purchases of fuel as an input. Then:*

- ***An input tax, applicable to formal and informal firms alike, is desirable even if there is no externality.*** *Such an input tax would not be efficient if there were*

83. See for example Bento, Jacobsen and Liu (2013). Other studies are cited in Heine and Black (2018).

no informal sector: by distorting input choice, it would compromise production efficiency, which the Diamond-Mirrlees theorem implies cannot be desirable. In the presence of an informal sector, however, the broadening of the tax base and reduction in the tax on final output that input taxation enable outweighs—at least for a sufficiently small input tax—the production inefficiency created.

- ***When there is an externality, the optimal input tax may be either higher or lower than the Pigovian charge.*** *The inherent desirability of an input tax even without an externality implies that the efficient input tax may exceed the marginal damage; but it does not mean that when there is such an externality the tax rate should always be set even higher than that marginal damage. This is because the loss of production efficiency from a higher input tax may come to dominate the welfare impact before the point at what that tax equals the marginal damage. Broadly, the efficient emissions tax is less likely to exceed marginal damage the higher that marginal damage is.*
- ***A greater need for revenue may imply a higher input tax****. This may seem obvious, but runs directly counter to the earlier lesson that, when the externality is associated with a final product, the externality correcting component is lower the greater is the need for revenue. With an informal sector, however, a greater need for revenue makes it more important to capture a tax base beyond sales by formal sector firms—one way to do which is through the input tax.*
- ***An additional tax bearing only on informal sector inputs is desirable, again even if there is no externality.*** *when the sales tax and common input tax are optimally set. The exclusion of informal operators from the tax on final sales results in the informal sector being too large (in the sense that marginal costs are lower there than in the formal sector); an input tax applying only to informal operators counters this competitive advantage and so reduces the associated production inefficiency.*

  One way in which such a targeted input tax might be achieved is by ensuring that the input is subject to VAT: the associated input VAT will be recovered by formal firms but not by informal ones.

Notes:

1. This box draws on work in progress.

2. For a sense of controversies around the use of the term 'informal,' see for instance Kanbur and Keen (2015).

- ***The distributional effect may be progressive,*** in the sense that the burden of increased fuel taxes may quite possibly fall disproportionately on the better off—a sharp contrast to developed countries, where possible regressivity has been a major concern. This is to some degree the counterpart of the familiar observation that fuel subsidies (primarily of gasoline and diesel) tend to be

regressive. [84] But the same may also be true of carbon taxes more generally. In India, for example, the evidence is that the burden of carbon taxation, as a proportion of consumption, is greater at higher levels of consumption. [85] The reason for this more benign effect is that the poorest in low-income countries are less likely to be connected to the electricity grid and/or own vehicles.

That would not mean, however, that there are no distributional concerns. Even if the poor bear a proportionately lower burden than the better-off, they are likely still to be adversely affected in absolute terms. As one instance of this, 'informal' operators are often small, low-income businesses—and taxing them through their inputs, even it improves efficiency, is likely to leave them worse off. This may be less of a concern to the extent that such operators were previously evading tax: improvements in tax fairness may weigh against the adverse distributional effect. In many cases, however, it may be that these informal operators are perfectly compliant, but tax thresholds have been set, reasonably, to exclude these small and poor taxpayers from the core tax system partly on equity grounds.

There is some risk of adverse side-effects, calling for accompanying measures. The danger is of inducing some, particularly among the poor and vulnerable, to switch to alternative energy sources, notably biofuels and wood fuels, that have strongly adverse local environmental effects. Indoor air pollution remains a significant problem, causing half of all deaths from air pollution. Rather than compromise pricing policies, one preferred way to address this is by increasing the availability of off-grid renewable sources.

The price increases required to align fossil fuel prices more closely with the associated external damage will be most pronounced in countries making heavy use of coal. Take for instance, a tax of USD 70 per tonne of CO_2 (while recognizing that—for affordability reasons, and given a focus on only on local externalities—this may, for the foreseeable future, be on the high side for most low-emitting developing countries). In sub-Saharan Africa, this might raise the price of coal—the dirtiest and most problematic of fossil fuels—by 200 percent. The proportionate effect of that same carbon price on natural gas and gasoline prices, though far from trivial, would be much lower: for the latter, an increase of about 16 percent. [86]

Making fossil fuel pricing reform happen

Securing political acceptability of the price increases required to address even only local externalities is likely to be hard, raising issues of both tax design and compensatory measures. Experience abounds of spectacular and

84. See for instance Coady, Flamini and Sear (2012) and Sterner (2012).
85. IMF (2019b), p. 14. The estimate includes the indirect effect of energy tax increases on product prices. Within Asia-Pacific, Alonso and Kilpatrick (2022) find similarly progressive effects in Kiribati, Myanmar, and the Philippines.
86. IMF (2019a) Appendix Table 11. These are GDP-weighted averages.

effective opposition to fuel tax increases, especially to highly visible and salient increases in gasoline and diesel taxes: striking instances included the repeated violent protests against fuel price increases in Haiti. There are several possible measures to smooth adoption:

(Over-) Compensation

Measures to compensate—or even over-compensate—the poorest and most vulnerable are generally warranted on fairness grounds, and likely essential for political acceptability. While consumption-based subsidies generally convey a larger benefit to the better off than to the poorer (because they commonly buy the subsidized good in larger amounts), it is important to remember that they do nonetheless convey some benefit on the poorest; indeed where income support systems are ill-developed, they may be one of the few ways in which some relief can be provided to the poorest, and thus warranted on distributional grounds even though very poorly-targeted. Without compensation, subsidy reduction thus has adverse distributional effects. And in terms of sheer politics, the loss of such benefit as subsidies do convey on the poorest creates risk of widespread (and effective) opposition to reform.

Implementing such compensation, however, requires extensive political and technical preparation, Box 3.2 reports on two of the most successful subsidy reduction programs, in India and Iran. Key features underlying their success [87] —likely to be no less informative for tax increases than for subsidy reductions—include:

- ***Extraordinarily intense political commitment…*** Commitment and communication are of course commonly cited as pre-requisites for successful tax reform, [88] to an extent that the point risks being trite. What is worth emphasizing, however, is the profound depth needed on both dimensions. In India and Iran, the Prime Minster and President respectively invested substantial political capital in the success of reform—and took corresponding political risks to their careers.

- ***…and effective communication.*** In each case too, communication was a major undertaking. In India, for example, around one billion text messages were sent in local languages to publicize the scheme; and in Iran mass media issued daily reports on the number of bank accounts credited. In each case too there was an effective message: subsidies were not being removed, but were being switched from products to people.

- ***Credibility:*** There was strong assurance that compensation would indeed be paid, both from the political and institutional investment required and, most tangibly, in the Iranian case from pre-delivery of the compensating payments.

87. See also the examples of successful fuel subsidy reform in Arze del Grenado, Coady and Gillingham (2012), which have many of the same features.
88. As, for example, in the guidelines for energy price reform set out in Clements and others (2013) and in Coady, Parry and Shang (2018).

- ***Extension of financial inclusion:*** In each case, the payment of direct cash transfers was at the heart of reform, implementing which required opening millions of new bank accounts—with benefits beyond those of the immediate reform, including (but not only) for the possibility of further tax/spending initiatives.

- ***Adept use of technology, including biometric identifiers,*** was especially critical in India, where the use of Aadhaar provided a way to link bank accounts to intended recipients comprehensively and in way robust against false claims.

Box 3.2: Two fuel subsidy reforms that succeeded

India (Liquefied Petroleum Gas (LPG)), from 2014: [1]

The intention was not to remove the subsidy but improve its targeting. *The aim of the LPG subsidy is to secure access to cleaner energy for poorer households, reducing damage from indoor air pollution. Prior to reform, however, diversion of LPG from households registered for the subsidy to un-subsidized commercial users* [2] *was believed to be extensive; much of the benefit, moreover, went to the better-off.*

The essence of the reform was to have all transactions at market prices but with direct transfer payments to those entitled to subsidy—which is widely believed to have been largely achieved. *Known as PaHaL, the program now delivers cash benefits to around 140 million consumers—making it the world's largest cash transfer system—disbursing around USD3.7 billion; in the process, around 36 million LPG connections were de-activated. The extent of fiscal savings remains contentious, but one assessment concludes that they were doubtless "very substantial." The project has also evolved over time, with an element of means-testing introduced and a supplementary (Ujjwala) project to encourage registration by women both introduced in 2016.*

Key elements of the reform package included:

- ***Building adequate financial inclusion:*** *around 200 million new bank accounts were opened.*
- ***Deploying modern technology, including biometrics:*** *the cleaning of the register as a first step of reform, for instance, centered around the use of matching techniques to identify questionable registrations. The biometric identifier Aadhaar enabled accurate linkage of bank accounts and registration status (with an alternative identification route, in the early stages, for those not yet covered by/wishing to use Aadhar).*
- ***Strong communication:*** *this ranged from widespread consultation in the development of the project, including through expert committees, to local*

workshops and advertisements publicizing the scheme and how to access it, Key messages included stressing that the intention was not to remove the subsidy, but to target it on those needing it.

- ***Continued, visible and high-level political commitment:*** *the Prime Minister was highly prominent in the process, both publicly and in planning. He led, for example, a 'Give it up' campaign that seems to have successfully nudged many of the better-off into not claiming the benefit.*

Iran (gasoline), 2010:[3]

The primary aim of the reform was to reduce the massive fiscal cost of fuel subsidies while also furthering equity objectives. *With the world price of oil at around USD 2 per liter, a subsidy that reduced the domestic consumer price to 10 cents per liter (albeit subject to some rationing) was evidently unsustainable.*

At the heart of the strategy for reducing the subsidy was payment of a compensatory uniform subsidy to all Iranian citizens of around USD 40,[4] ***accessible only on enactment of the reform*** *(and to recur subsequently). Targeted assistance was also provided to businesses identified as being strongly affected. Ultimately, the poll subsidy was received by nearly 90 percent of the population.*[5] *In the first year after implementation, the saving from subsidy reduction was put at around USD50-60 billion, with compensatory payments of USD40-45 billion.*

There are many similarities with the Indian experience. *Financial inclusion required development in order to deliver the compensatory payments: an additional 16 million bank accounts were created. Communication was highly visible, spelling out the need for reform (including the inequity created by the subsidies) and the government's intention to use the bulk of the revenue for compensation—this was presented as not a revenue-raising device, but as replacing subsidies for products with a subsidy to people—and the ready availability of the poll subsidy. Commitment was made clear not only by the visibility of the funds people could see in their bank accounts, but by the prominence of the President throughout the process—including with an address to the nation on the day before enactment of the reform.*

Notes:

1. *This draws particularly on Mittal, Mukherjee, and Gelb (2017) and Nelz (2016).*
2. *Generally without the consumers' awareness—and hence without their in effect turning the subsidy into a cash transfer.*
3. *This account draws particularly on Guillaume and others (2017).*
4. *800,000 rials multiplied by up to six household members.*
5. *The better-off were discouraged from applying.*

Digitalization offers increasingly realistic—and potentially transformative—opportunities for delivering effective compensation—with lessons learned during the pandemic to draw on, The Indian experience shows the power of biometric identifiers, linked with bank accounts, to deliver cash benefits to a wide population and with strong protection against fraudulent inclusion. More imperfect but still meaningful delivery can be achieved by mobile money (Box 3.3), as has been seen during the pandemic. There remains some way to go: biometric identification and even mobile networks remain incomplete. Even Aadhaar itself—widely taken, as above, as a very positive example—appears to suffer technical problems (such as duplication), [89] while others point out that funds can still be diverted from their intended beneficiaries when collection is made in cash. And there are risks: the ease of making cash transfers around election time may not go unnoticed by politicians. Nonetheless, looking forward—and perhaps not very far forward—an unprecedented capacity to deliver cash support provides a way to alleviate many inefficiencies in tax design that are motivated by distributional concerns, and pave the way, not least, for environmentally-motivated tax increases.

Box 3.3: Using mobile money to make cash transfers to the poor [1]

While details are hard to find, there are encouraging experiences. It is generally hard to gauge, for instance, how much of the target group is reached, and how many non-targeted receive the benefit—but there are positive signs:

- ***Togo** made payments to 500,000 people—six percent of the population—within two weeks of the start of the pandemic, using biometric identification from the electoral register.*[2]

- ***Côte d'Ivoire** launched during the pandemic a system to transfer cash to around 120,000 vulnerable households;* [3] *this appears to build on the experience of a World Bank project that similarly distributed cash amounts to the vulnerable through their mobile phones.*[4]

- ***Bangladesh** is using mobile money to pay USD 30 per month to about 5 million families, as part of its COVID response.*

- ***Nigeria i**ncluded mobile money payments within its wider national Social Safety Net Program Scale-Up (NASSP-SU), with a World Bank project to make mobile delivery more robust now underway.*[5]

***This approach is limited, however, by the reach and quality of the mobile network system.** The potential is evidently high: two-thirds of the world's unbanked have a mobile phone. But coverage varies both across countries—it appears to be high in East Africa, but is only 1 percent in Niger and 20 percent in*

89. Comptroller and Auditor General of India (2021).

Côte d'Ivoire. It may also be weak in rural areas, and the transactions costs of cashing through money agents can be sizable.[6]

Notes:
1. This box draws on IMF (2021b) and Aker (2020).
2. Toesland (2021).
3. See https://reliefweb.int/report/c-te-divoire/c-te-divoire-vulnerable-households-and-small-businesses-find-relief-government
4. World Bank, at: https://www.banquemondiale.org/fr/news/feature/2022/07/07/afw-cote-divoire-a-small-grant-that-changes-lives
5. https://www.worldbank.org/en/news/press-release/2021/12/16/nigeria-to-scale-up-delivery-of-social-assistance-to-10-2-million-households
6. There are also failures to report: little now seems to be heard of the pioneering Ti Manman Cheri scheme introduced in Haiti in 2013, concerns about which were expressed by CGAP-UKAID (2013),

'Poll subsidies'—uniform payments to all—can offer an especially attractive way forward, in both equity and political terms. For implementation, they simply require the ability to identify and make payments to all, which digitalization is making increasingly feasible; by definition, they do not require the complication of means-testing. In political terms too, they can ensure a large number of winners from the reform.

Compensation dilutes the additional tax revenue raised, but to a potentially limited—and in any event largely controllable—extent. Most studies (albeit generally for advanced economies) find that a substantial portion of the revenue gain—commonly half or more—remains even after compensating the lowest (two or three) deciles. Means-testing can reduce the net cost, but is administratively more complex (though such relatively simple measures as 'lifeline' tariffs for electricity can help).

Under a poll subsidy, the typical skew in consumption patterns provides room to compensate, say, half of the population while still increasing net revenue, If median consumption is 70 percent of mean consumption, for instance, then full compensation of the lowest half still leaves 30 percent of the additional revenue free for other uses. [90]

90. To see this: Gross additional revenue, per capita, from increasing a tax on consumption by an amount t is $t\bar{X}$, where $\bar{X}$ denotes average consumption; using a proportion θ of this to finance a poll subsidy, of $\theta t\bar{X}$, leaves all with consumption below the median better off if and only if $\theta t\bar{X} > tX_{median}$ or $\theta > X_{median}/\bar{X}$.
The claim in the text follows on taking $X_{median}/\bar{X} = 0{,}7$.

Other measures

Addressing distributional concerns, however, does not guarantee political acceptability *Resistance, possibly even presented as a concern with the wider welfare of the poor, may come from the uncompensated powerful. Possible measures to address this include:*

- ***Use of feebates to dampen the price impact:*** These, as mentioned earlier, impose a tax that decreases (and, beyond some pivot point, becomes a subsidy) with the cleanliness of the production method used. For example, power generators might be charged a tax for each kilowatt hour generated in ways that imply emissions per KWh above the industry-wide average of emissions, but paid a subsidy on those that emit less. The tax and subsidy components of such a scheme can be calibrated so as to leave the average price to the user unchanged, likely disarming resistance to some extent. This approach does however have downsides. One, of course, is that the revenue gain is eliminated. Another is that the environmental benefit is also less marked, being limited to the change in production methods: with the price unchanged, there is no mitigation from reduced demand for fossil fuel-using products.

- ***Earmarking some portion of the proceeds might also be considered.*** This is a more contentious option for the reasons set out in Part 1.B—reasons whose force is amplified by the potentially sizable amounts involved. Nonetheless, it appears that around one-quarter of global revenues from carbon taxes have been earmarked to environmental spending. [91]

Systematic, context-specific political mappings of the obstacles to beneficial fuel price reforms reform appear to be surprisingly rare. Case studies can provide lessons from the experiences of others, but are ultimately rooted in their own unique circumstances; even within countries, the path to successful reform may vary over time. [92] However persuasive they are, listing the various options to support reform, as above, needs to be supplemented in practice by taking careful stock not only of who gains and loses, but of power relationships and blocking powers, of possible linkages with other issues, and so on. Understanding and manipulating these are the tools of the skilled politician. For those advising on reform, the case for proactively encouraging and supporting more systematic political scoping analyses of these kinds—little done at present—may merit careful consideration.

91. IMF (2019c), p. 6.
92. In the US, for example, the landmark 1986 US tax reform followed extensive negotiation and debate, and was passed on a bipartisan basis; the 2017 reform, in some respects no less of a landmark, did not.

B. Forestry

Forestry presents a complex and inter-related set of tax challenges, not all of which are, in the narrowest sense, environmental:

- ***Efficient management and taxation of a valuable renewable resource:*** Forests provide a potentially permanent stream of private and public revenue, maximizing the value of which—irrespective of any external effects—requires careful attention to the decisions as to when to cut and replant trees. There is an extensive theoretical literature on this, and on the effects of alternative forms of forestry taxation. [93] A related general concern is the design of the tax system to capture a substantial share of any rents (meaning, recall, earnings in excess of the minimum required by the investor) associated with forestry. Taxing rents, as noted in Part 3, is a particularly appealing way to raise revenue as it leaves private decisions unaffected (leaving any external effects or other course of social inefficiency to be addressed by other instruments).

- ***Importance for large numbers of highly vulnerable people:*** around 80 percent of the world's rural poor live in or near forests. [94] This again is not an intrinsically environmental issue: that is, the issue would remain the same even if there were no environmental issues associated with deforestation. Nor, by the same token, is this issue best addressed through forestry-related policies. Of course, the poverty implications of such policies are potentially critical considerations; but those policies themselves may not be the best-targeted way to relieve poverty and support the human capital development ultimately needed to address the more fundamental challenges.

The environmental issues associated with forestry are profound—with both global and more local aspects:

- ***Deforestation is a major contributor to climate change:*** Cutting down living trees first removes a continuing carbon sink, and then, to the extent of their decomposition or burning, releases the carbon they have stored. [95] IPCC (2020) estimates that deforestation accounts for most of the 13 percent of global CO_2 emissions from Agriculture, Forestry and other Land Use Activities over 2006-2017; and that with 'high confidence' reduced deforestation could cut global emissions by around one-third. It is of course this potentially central role in addressing the climate challenge that largely drives the intensified focus on forestry over recent years. Tropical forests, which (being fast-growing) are especially valuable as carbon sinks (and whose cutting is correspondingly damaging) have been, and continue to be, especially exposed.

93. An old but classic treatment of this is Heaps and Helliwell (1985).
94. World Bank (2021), p.1
95. Trees also store water, helping to avoid flash floods. As so often, however, there are nuances to be found in the science: chemical emissions from trees can generate methane, for instance, and trees can have a darkening effect that traps heat. See BBC (2020).

Importantly, however, the climate-related harm from deforestation arises largely globally, so that the local incentive to mitigate on those grounds is very weak; external support or cajoling is likely to be needed to provide appropriate incentives (and perhaps also means) for national action.

- ***Degradation of agricultural productivity,*** through soil erosion and desertification, reduced pollination, flood and storm damage amplification, disruption of water systems and a range of other effects. These are localized damages, though, importantly, they may well span national borders. One estimate is that the marginal value of these eco-services, in terms of air quality and water regulation, is around USD1,500 per acre per year.[96]

- ***Other adverse external effects, particularly hard to value:*** These include increased risk of zoonotic disease, [97] damage to coastal fisheries, and loss of biodiversity.

Addressing these policy challenges is made especially difficult by extensive small-scale logging, non-compliance and other governance problems. Forestry is strongly marked by several features that always make tax administration—and regulatory policies too—difficult. Informal operations (in both senses of the term above: small and noncompliant) loom large, accounting for perhaps 30-90 percent of production. [98] Taxpayers are often in remote areas, which makes monitoring hard. Corruption, facilitated by the difficulty of independent monitoring—and including at the highest levels—is generally believed to be marked. Technological advance, including the use of drones and lidar, [99] has potential to ease the problem of monitoring logging activities and is capable of providing information on carbon absorption and other features upon which taxation might be based. Implementation, however, requires more than monitoring: it requires accurate assessment and enforcement.

The role and design of tax instruments

Tax instruments are one element in a suite of measures needed to address challenges in forestry—but one that may have been underused. Outright spending measures, including those with external financial support, have a role in incentivizing appropriate actions. Perhaps most notably, REDD+ provides support for nationally-developed plans, including results-based payments. [100] Interest has also been shown in supplementing established formulae for transfers to lower-level

96. Ojea and others (2016). This excludes carbon-related benefits.
97. That is, diseases transferred from (or to) animals to (from) humans.
98. Jianbang and others (2016). Figures given for rates of illegal logging in the Congo basin are: Cameroon, 33 percent; Dem. Rep. of Congo, 87 percent; Rep. of the Congo, 72.5 percent.
99. Light Detection and Ranging.
100. REDD ('Reducing Emissions from Deforestation and Forest Degradation')+ is a UNFCCC-created platform that provides results-based and other forms of support for measures promoting emission reduction and carbon sequestration. See https://unfccc.int/topics/land-use/workstreams/redd/what-is-redd

government to include an element rewarding efforts to improve sustainable forest management: 'ecological fiscal transfers.' [101] In many countries, insecure property rights still pose difficulty. And progress may be difficult without actions targeted at corruption—an issue that of course extends far beyond forestry.

Taxation and other measures outside the forestry sector can also have a major impact. Favourable treatment of land in other uses, most notably agricultural subsidies, can amplify deforestation.[102]

A wide variety of tax instruments have been applied to, or proposed for, the forestry sector itself.[103] The most common are:

- ***Recurrent area-based taxes:*** These are fixed, periodic amounts per acre or hectare exploited, typically set (or auctioned) in line with estimated harvest value of the area. The applicable rate may be differentiated according to the operator's certification (as for instance in Gabon).[104] Difficulties with this include the creation of an incentive to shorten forest rotation periods and the risk that this addition to fixed costs makes operators more vulnerable to swings in market conditions. For both reasons, this approach is now quite widely criticized. Against that, however, fixed fees, being invariant to commercial decisions, potentially have features of a rent tax.
- ***Output-based charges ('stumpage' fees):*** Akin to royalties commonly charged on the extraction of non-renewable resources, these are charges related to quantity felled, perhaps varying with the nature of the tree and also with the (third party) certification status of the operator. This will be effective in curbing logging to the extent that, as is generally presumed, the price of timber is fixed on world markets, and the impact of the tax consequently felt as a reduced price to domestic producers.

Rarely commented upon, it is important to recognize that cutting decisions may depend not only (or even mainly) on the current level of stumpage fees but also on their expected future levels. If rates are expected to increase substantially in the future, for example, that provides an incentive to cut now. This effect is exactly analogous to the 'green paradox' that has been widely discussed in relation to carbon pricing: a credible commitment to more aggressive carbon taxation in the future may have the undesired effect of accelerating emissions now.

- ***Export taxes:*** Differing from output taxation in distorting towards domestic sales, and hence domestic processing (which may itself be an object of national policy),

101. As in Brazil, France and Portugal.
102. World Bank (2021 p.20) cites Brazil, for example, as taxing forested land more heavily than agricultural.
103. Adopted less than globally, all carry some risk of leakage, as reduced harvesting in one region puts upward pressure on global timber prices and so encourages increased harvesting elsewhere.
104. The levels of certification might be, for instance: none; certification of legality in the chain of ownership; or certification of acceptable management standards (with third party verification for both the latter).

the appeal of taxing exports is essentially administrative ease and effectiveness in potentially capturing illegal logging. The rates might again be varied with some indicators of sustainability practices.

- ***'Feebate' schemes,*** of the kind discussed above. Such schemes have a lesser impact on the average price of the final product than a uniform output-tax, and so are less focused on reducing output per se than on reducing the associated environmental damage. Feebates have as yet been relatively little applied in any sector, particularly in developing countries, but two variants have come to attract attention in relation to forestry. One would pivot around certification status, the other around changes in carbon storage relative to a baseline. [105]

- ***Auctions and other forms of rent taxation:*** There is a well-developed literature on the design of tax schemes and auction systems as rent-extraction devices, much of it with the extractive industries in mind but no less applicable to renewables, such as forestry. [106] While explicit rent taxation appears relatively rare in forestry, there is some and broadly positive experience with auctions: it has been estimated that the introduction of auctioning in Cameroon tripled revenues.[107]

These instruments address different objectives, so that deploying more than one may be appropriate. Revenue objectives as such are best served by rent taxation; output-based and export-based taxes serve to raise revenue while also reducing the volume of deforestation, and (if differentiated accordingly) may encourage sustainable practices; feebates are targeted more firmly on environmental sustainability rather than simple volume effects; tax incentives can directly encourage new planting and growth. The appropriate instrument choice thus depends on the objectives pursued and the relative weight attached to them. Combining revenue concerns with environmental sustainability, for instance, might point to a combination of rent taxes and feebates.

There is a sense that tax instruments have unexploited potential in forestry, the heaviest reliance having been on regulatory measures. That forestry may be undertaxed is a key theme, for example, of World Bank (2021), with the (now somewhat dated) evidence most commonly cited suggesting possible capture of 3-30 percent of forestry rents. [108] The former figure is certainly very low. The latter is also low, but less outrageously so when compared for instance to comparable achievable rates in mining, which might be around 40-60 percent.[109] Effectiveness in taxing rents, however, is not simply a matter of comparing how much is captured as tax revenue to the underlying rents. It requires structuring the tax so as to have the non-distorting effect that defines a true rent tax. Experience in other sectors provides many

105. See, respectively, Karsenty and Picard (2021) and Parry (2021).
106. See for example Boadway and Keen (2010, 2015), Land (2010) and, on auctions, Cramton (2010).
107. Collomb and Bikié (2000) and Karsenty (2000).
108. Boyd and others (2005) and Gray (2002).
109. IMF (2012).

lessons on how this might be done. More generally, however, there is no shortage of ideas for improving forestry taxation. Experience with more innovative instruments remain limited, however, and World Bank (2021) goes on to note the need for further case studies and piloting.

C. Fisheries

Over-fishing remains a pervasive problem… In 1974, about 90 percent [110] of global fish stocks were within 'biologically sustainable' levels (a term that needs to be interpreted with some care)[111] ; by 2017, this had declined to about 35 percent. Illegal, unreported and unregulated fishing (IUUF) remains extensive. The SDG Target 14.1 of ending over-fishing and IUUF by 2020 was missed, by a wide margin. That said, there have been some improvements in sustainability (in relation to tuna, for example, though concerns remain), and these are seen as indicating the potential gains from careful stewardship.

… and is a particular concern in many developing countries. For them, it seems that oceanic over-fishing is less dramatic—there seem to be no data for inland fishing (which is especially important in in several parts of Africa)[112] —but it still troubling. Levels of fishery stewardship are generally low, with IUUF believed to be particularly high. Aquaculture, in principle less vulnerable to the common pool problem of over-fishing, is seen as having considerable potential and grew rapidly in several African countries during the early part of the century, but remains relatively limited and subject to commercial and managerial difficulties. [113] Climate change (through rising water temperatures and acidification) is amplifying these concerns: in an index constructed by the FAO, [114] it is countries in tropical coastal regions of sub-Saharan Africa that are most vulnerable to climate impacts on marine capture. The issue is a very real one, in terms of both food supply and livelihoods. [115] Consumption of fish, which has been growing rapidly in lower income countries, on average accounts for around 20 percent of animal protein intake in LDCs; in some (including for instance Gambia and Sierra Leone, as well as many

110. The figures in this paragraph and the next are from FAO (2020), variously pages 5, 6, 7, 8, 41, 47, 58 and 168-9.
111. A fish stock is said to be 'biologically sustainable' if it is above the level which gives the maximum sustainable yield (FAO, at https://www.fao.org/sustainable-development-goals/indicators/1441/en/): hence 'unsustainability' does not mean that the stock is doomed. That said, efficient fish management generally requires maintaining biological sustainability thus defined.
112. Lake Chad and the Congo, for example, each account for about one percent of global catch. Fishery issues are thus not only for coastal countries.
113. Aquaculture now accounts for around half of global fisheries production. It has lagged, however, in most of Africa: while it now accounts for about 18 percent of fish production there, a very large proportion of this is in Egypt. On the challenges facing the sector, see Ragasa and others (2022).
114. FAO (2022), Box 22. The index combines elements of food dependence, significance of fisheries in GDP and projected impact on capture.
115. There is also here a sharp reminder here that objectives of poverty relief and food security can conflict with environmental sustainability concerns: the introduction of tilapia into several African lakes has provided an important new food source, but has also had adverse effects on biodiversity.

Small Island Developing States), it accounts for over 50 percent.[116] Nor is this simply a matter for the (relatively) affluent: smoked fish, for example, is a key dietary element in many coastal communities in Africa. It is troubling, in this context, that the FAO projects a decline in food consumption in sub-Saharan Africa to 2030, as growth of population outstrips that of production. [117] Over-fishing (attributed by local fishers to distant-water fleets) has also been seen as one driver of illegal immigration from Senegal.[118]

The need to stem over-fishing points to a potential corrective role for taxation, cap-and-trade or even (temporary) outright bans. In principle, a tax per catch would internalize the impact of each capture on the development of the future stock.[119] Alternatively, the total catch might be fixed and tradable licenses to catch issued in the same amount. As seen in Part 2.A, under conditions of perfect certainty these two instruments can be structured to be precisely equivalent, including in the revenue they raise This may be an instance, however, in which, around the point at which true unsustainability sets in, the marginal social cost of depleting fish stocks becomes so high, and the scope for readjusting tax-based measures in time sufficiently limited, that there is a distinct preference for quantity-based instruments. (It may even be that in some cases an outright ban is appropriate, perhaps as a temporary measure to restore stocks to the sustainable range). Among such instruments, cap-and-trade has the particular strengths, as also seen, of equalizing this element of marginal cost among fishers and so ensuring that the total catch is harvested in the most cost-efficient way. Auction systems thus have much conceptual appeal, including as rent capture devices, and are indeed commonly applied to fishing by advanced countries. Implementation, however, remains challenging in low-income countries, not least in the capacity to enforce their fishing rights.[120]

The dominance of small and artisanal fishing in developing countries poses challenges for all such measures. Fishers, and those in related activities (such as smoking for local consumption) are often small/micro, hard-to-tax business. Levying any form of tax on them—corrective or otherwise—can thus require some compromise relative to the ideal. If, for example, and as may often be the case in developing countries, licensing or levying charges at the point of landing is infeasible, charges per boat (varying by size, motorization and/or perhaps other indicators of catch potential) or on fishing fuels (also warranted on other grounds) might be considered. Again, the first priority is to do no harm: subsidies to fishing fuels, and

116. Patterns differ quite widely across countries: for example, per capita consumption in West Africa is twice that in East Africa.

117. FAO (2020), p.170.

118. See for example Gauriat (2022).

119. The classic account of these issues is in Dasgupta and Heal (1979). They further note that full efficiency may require levying not only a catch-based tax (or cap-and-trade) but also a per-vessel tax, in order to deal with the common pool problem: catches by one trawler make it more costly for others to make catches. Deploying both taxes, however, seems likely to be over-ambitious in the present context, where levying even one is problematic. It may be, however, that, as noted below, a per-vessel tax would be administratively easier than, and have similar effects to, a catch-based tax.

120. External support has a role here: Mauritania, for instance, has benefited from support by French and Spanish coast guards.

favourable treatment of small farmers, are evidently problematic, especially where other instruments for local support and development are available.

One option, in principle, is to ensure that fish products are at least fully captured by the VAT. This of course runs up against the often-heard objection, on distributional grounds, to taxing food—to which there are equally well-trodden responses.[121] One of those responses has particular force in the present context: small fishers, and those who purchase from them, will not be required to charge VAT if their activities fall below the VAT threshold. At the same time, the VAT will bear on those with higher incomes, who may account for much of the trend towards increased fish consumption in developing countries.[122] Weighing against these beneficial distributional effects, of course, is a likely lesser impact on fish capture (as well as a smaller revenue gain); and this will be further muted to the extent that fish production is exported (as much of the fish capture in Africa appears to be) and so not subject to the VAT.[123]

The near-term revenue potential of taxes on fishery appears to be limited—except in countries that can attract distant-water fleets. Surveying five sub-Saharan African countries —and noting the difficulty of obtaining data in this area—Ochialli (2021) finds that revenue from fishing accounts for less than 0.5 percent of total revenue in Guinea and Uganda, and a more sizable 2 percent or so in Senegal. [124] In a few cases, however, substantial revenue can be raised from agreements that allow distant-water fleets from more advanced economies access to national fishing zones. Most notably, in 2019 Mauritania raised about 13 percent of its total revenue from charges related to fishing,[125] a key element being a Sustainable Fisheries Partnership Agreement (SFPA) with the EU (now of around €60 million per year, with additional payments by fleet operators).[126] Such cases, however, remain exceptional: the SFPA with Mauritania is the EU's largest, and, at around one percent of the global total, Mauritania has larger marine capture than any other sub-Saharan African country.[127] A notable development, however, has been China's recent indication that it seeks to expand its distant-water fishing, including off Africa.[128] These agreements, it should also be noted, are not without controversy: critics see them as selling a national resource too cheaply, undermining local fishers and driving migration.[129]

121. See for example the discussion in IMF (2019c).
122. FAO (2020), p.6.
123. Africa is a net exporter of fish and fish products in value terms, but a net importer by volume (FAO (2022) p. 80).
124. These figures include, it seems, both sector-specific and sectoral contributions to general taxes (such as the VAT).
125. Calculated from OECD statistics at https://stats.oecd.org/Index.aspx?DataSetCode=REVMRT.
126. Details are at https://ec.europa.eu/oceans-and-fisheries/fisheries/international-agreements/sustainable-fisheries-partnership-agreements-sfpas/mauritania_en. The EU also has an agreement with Senegal, but in the amount of only around €1.7 million per year (Holland, 2019).
127. FAO (2020), Table 2.
128. Godfrey (2022).
129. See for instance Coalition for Fair Fisheries Agreements (2020).

D. Agriculture

Profound challenges are faced in moving agriculture towards more environmentally friendly methods whilst also securing food security and meeting growing global needs. The promotion of sustainable agriculture, for instance, is a key component of SGD2. Achieving this is made no easier, however, by other profound challenges to the sector: the same SDG also calls for achieving food security concerns and ending hunger. All this, moreover, while meeting what might be a 35-55 percent overall increase in the global demand for food.[130] Addressing these challenges requires close attention to key features of the sector that bear directly on possible tax measures: Box 3.4 elaborates.

Box 3.4: Tax-relevant characteristics of agriculture in developing countries

From the tax perspective, the continued importance of small-scale farming, at or near subsistence levels, is a critical consideration. *Data are scarce, but one study for four Anglophone countries in sub-Saharan Africa finds that one- to two-thirds of all farmland is in holdings of less than 5 hectares;*[1] *and only 10-20 percent is in holdings of over 100 hectares. While the group intermediate to these two categories appears to be growing, the implication is that in order for any measures to be effective they need to reach a substantial number of small farmers. And that can be problematic in tax terms because small farmers are:*

- ***Hard-to-tax:*** *Their relative remoteness and sheer lack of scale makes small farmers a classic example of a group that is 'hard to tax.' (Indeed in sheer revenue terms it often makes sense—given too the administrative and compliance costs that would be incurred—to exclude them from the application of anything more than a simple income tax, and to set a VAT threshold that will likely exclude many of them). This makes it difficult for the tax system to reach them other than by measures imposed at convenient points earlier in the production chain.*
- ***Often amongst the most vulnerable:*** *Two-thirds of the world's poorest households—in the sense of being below the World Bank poverty line of USD1.90 per day—have at least one member employed in agriculture.*[2]

Notes:

1. Jayne and others (2017). The figures are (in per cent): Ghana, 46.4; Kenya 66.1; Tanzania, 54.0; Zambia, 35.8.

2. Aguila and Sumner (2019).

The harmful practices that jeopardize sustainability in agriculture are of broadly two types:

- ***Contribution to GHG emissions***. These in turn can be divided into three:

130. From the meta-analysis of van Dijk and others (2021).

Land use change

The core issue here is the conversion of forested land to farming use (arable or pasture), as discussed above. The wider question this raises is that of what, in particular circumstances, is the appropriate balance between forestry, farming and other uses? On this—where there is a clear tension between, for example, climate and food security concerns—little systematic guidance appears to be available.[131]

Absent more precise guidance, the first role for taxation is to do no harm—meaning the avoidance of subsidies promoting particular types of land use or commodities. Achieving tax-neutrality as between alternative land uses may require attention to other aspects of tax policy too, for example in the income tax treatment of the costs associated with farming or forestry—though the importance of this may be limited in many developed countries by the prevalence of small-scale farmers, outside the tax system (legally or not). It may also require some degree of international coordination of policies, or at least a recognition of cross border effects: removal of a subsidy to, say, wheat in one country may lead to an increase in the world or regional price that leads to land use change toward wheat production elsewhere.

Other sources of GHG emissions from agriculture

Prominent amongst these[132] is the methane[133] emitted by cows and other ruminants. Such 'enteric fermentation' directly accounts for about 6 percent of all Greenhouse Gas Emissions. That is a sizable amount: more, for example, than the aviation and shipping sectors combined. Demand for beef, moreover, is projected to rise substantially.

Taxation has been proposed to help address this issue—and the idea may be gaining momentum. The methane emissions fit very directly into the canonical externality model of Part 2.A, suggesting that a tax response may be appropriate. This logic has been recognized for some time. The FAO (201) highlighted the potential for tax measures in relation to livestock emissions in 2010.[134] Since emissions are not directly monitorable (for now), a tax would have to be based on some proxy. Imposed downstream, that would mean a tax on meat or dairy products as such. Upstream, at farm level, it might be imposed on the number of animals, with adjustment for dietary or other measures taken to reduce the emissions of each. New Zealand tried to introduce such a tax as early as 2003, but stiff (and colorful) opposition by farmers led to its withdrawal,[135] but is now planning introduction

131. IPCC (2020) notes, for instance, that setting aside land for reforestation, afforestation and other measures may compete with agricultural use.
132. Others include emissions of methane and nitrous oxide, both GHGs, from livestock urine and manure.
133. Methane has nearly 25 times the warming potential, over 100 years, of CO_2. It is not toxic (but is flammable).
134. Food and Agriculture Organization (2009).
135. *The Guardian* (2003). This also provides an example of an environmental charge whose proceeds were reportedly earmarked to environment-related spending: on research into reducing this form of emissions. On the 'colorful' aspect, see Keen and Slemrod (2021).

of a farm-level tax in 2025. And a handful of countries (all developed) have introduced differentially higher commodity taxes on meat and dairy.[136] For some time, the idea of a tax-based approach attracted little attention from the public finance community, perhaps seeing it as little more than a nuisance tax. As appreciation of the severity of the problem has grown, however, so the idea may be resurfacing.

The incidence of such a tax would need careful consideration, particularly in terms of the impact on low-income pastoral farmers. If imposed downstream on consumption by countries that are significant in world markets, some part would be passed back to producers—in an amount that would be greater the more responsive is consumer demand and the harder it is for farmers to substitute into alternative activities. The impact on developing countries might be muted, however, since their beef exports are often restricted on health grounds.[137] And Africa, specifically, accounts for only around 6 percent of world meat production.[138] If, however, low-income countries were instead to levy some form of upstream tax on domestic production—perhaps as part of their contribution to mitigation—the impact on farmers could be marked. This remains speculation however: these incidence issues have received less attention than developments of climate policy in the near future may warrant.

• ***Other pollutants.*** Of primary concern here are:

Synthetic fertilizers: Forms of damage from their application[139] include: run off into waterways leading to 'dead zones'[140] in rivers, lakes and coastal waters; leaching[141] into groundwater of nitrates that at high levels can be toxic to humans and animals; soil acidification[142] (harmful to plant growth and microorganisms in the soil).

Pesticides: These are toxic chemicals, whose use generates damage in several forms, largely because their application inadvertently but very commonly reaches non-targeted species.[143] These include: direct health risk to farmers;[144] diminishing populations of pollinators and risks to biodiversity; water pollution through runoff and leaching; damage to soil microorganisms; airborne drift of pesticides reducing air quality.

136. True Animal Protein Price Coalition (2021) cites Spain and Switzerland as having introduced differential consumption taxes on meat, and Germany as considering doing so.
137. Lowe (2021) notes that Vietnam is the only beneficiary under the Generalized System of Preferences that exports beef to the EU.
138. See https://ourworldindata.org/meat-production
139. There is damage too from the production of fertilizers, which makes heavy use of natural gas or coal.
140. Areas in which levels of oxygen are too low to support aquatic life.
141. Leaching is the soaking of water into the ground (whereas runoff is movement of surface water).
142. The last two effects arise for nitrogen-containing fertilizers.
143. The development of pest resistance can amplify these problems by encouraging still more intense use of pesticides.
144. Ninety five percent of the deaths associated with pesticides occur in developing countries, though they account for only 25 percent of their use.

There is a strong efficiency case for taxation to play a central role, alongside regulatory measures, in addressing these challenges. Conceptually, these are classic externalities; and corrective taxation would be relatively easier to administer and to design—as will be spelt further below. Regulation too clearly has a role, in some cases because the social costs of particular components are especially high (as with the move to limit banning nitrate-based fertilizers in Europe), in others because the tax cannot practicably be fine-tuned sufficiently to correct key aspects of harm (as with the mandating of 'windbreaks' limiting the area over which pesticides can be applied).

In practice, however, fertilizers and pesticides have long been, and appear still to be, widely subsidized in developing countries—at a fiscal cost that is hard to assess but likely sizable. Information on the scale of such subsidies, particularly recent, is hard to find, but has commonly exceeded one percent of all public spending (Box 3.5).

Box 3.5: The fiscal cost of fertilizer and pesticide subsidies

Available quantitative information is sketchy, and often dated, but gives a sense of the potential extent of these subsidies:

- ***In Mali,*** *the fertilizer subsidy accounted in 2017 for around 10 percent of the government's agricultural spending, and 1.5 percent of all its spending. Over the period 2008-2017, the averages were around 17 and 2 percent respectively. There was substantial variation over this period, with the share of all spending reaching a high of around 3.5 percent (in 2012) and a low of around one percent (in 2008)* [1]

For an earlier period:

- ***In Burkina Faso*** *and* ***Senegal,*** *the fertilizer subsidy averaged a similar 15 percent of agricultural spending over 2011-2014,* [2] *accounting respectively for about 1.5 and 1.1 percent of all government spending.*[3]
- *Fertilizer subsidies were even higher over this period in* ***Ghana, Malawi*** *and* ***Zambia,*** *at between 37 and 58 percent of agricultural spending,* [2] *with the implied share of all government spending ranging from 1.5 percent (Ghana) to a massive 6 percent (Malawi).* [3]
- *In 2014, agricultural input subsides more broadly—likely to be mainly fertilizer and pesticides* [4]*—were around 26 percent of all agricultural spending in the countries mentioned above plus* ***Ethiopia, Kenya, Nigeria*** *and* ***Tanzania*** [5] *That in turn would correspond to an average of 1.3 of all government spending.*[3]

Import data can provide a rough indication of possible orders of magnitude, *since there is almost no domestic production of chemical fertilizers and pesticides in developing countries. A plausible upper bound, for instance, is obtained by supposing these imports to be distributed free of charge. For the 11 priority countries, for which data are available, this would imply a cost of around 0.4 percent of GDP, equivalent to around 3.2 percent of total revenue. A subsidy of 25 percent—which appears in line with past practice would thus amount to an average of around 0.1 percent of GDP, or 0.8 percent of total revenue. There is, however, wide variation around this average: relative to total revenue, the cost of a 25 percent subsidy ranges from 0.1 percent in Gambia to 1.6 percent in Benin. (More detail, on data and results by country, is in Appendix 1).*

Notes:
1. Koné and others (2019), Table 2.
2. Smale and Theriault (2018), Figures 2 and 3.
3. Using here the figures on agricultural as a share of all public spending in Goyal and Nash (2017), Table 2.5.
4. There may also be subsidies, for instance, for seeds and water.
5. Jayne and others (2018)

A key design issue is whether the objectives of these subsidies can be better achieved in other ways, enabling a transition to appropriately corrective taxation. A variety of rationales are offered for such subsidies, and scheme design varies in reflection of differing priorities. Some reflect a desire to expand agricultural output; here any short term gains need to be weighted directly against potential longer term losses, as well as the potential for alternative productivity-enhancing measures. Others cast subsidies as countering other imperfections, the questions then being how such subsidies are best structured to achieve these objectives, and, more fundamentally, whether they can be achieved by better means. Mitigation of high transport costs, for example, is sometimes cited as a rationale: that raises wider issues of transport infrastructure development, and perhaps of improving distribution arrangements. Poverty relief too is clearly a central concern in many cases. To some degree—and at some efficiency cost—the impact of the tax could be tailored to some indicator of farmers' prosperity: some amount might be tax-free for holdings below some threshold scale for example, though that would create distortion incentives in itself (to resell, and perhaps limit the size of holding); or an implicit tax could be imposed only on larger farmers by levying no explicit excise but instead denying VAT deductions for purchases of these inputs. The question also arises as to whether practicable but effective compensatory mechanisms might be found, perhaps using some of the digital methods increasingly applied in other areas. (One merit of a regulatory approach, as noted in Part 1.A, is that it mitigates (but does not eliminate) the welfare loss suffered by producers), since they do not suffer the rectangle of resource transfer (γ in Figure 2.1).

Sri Lanka's overnight ban on imported agrochemicals in 2021—disastrous both economically and politically—is a powerful lesson of the need for preparation in scaling back subsidies. (Box 3.6). Proudly presented as making Sri Lanka the first country in the world to eliminate chemical fertilizer, but largely motivated by the massive fiscal cost of the subsidy, the result was a substantial decline in agricultural production and an intensification of a growing economic crisis. Sectoral experts warned of this outcome, highlighting the need for informing and educating farmers. The importance of this was clear to the farmers themselves; and work in China supporting farmers in moving to more sustainable practices is reported as having increased yields of maize, wheat, and rice by 11 percent and decreasing nitrogen fertilizer use by 15-18 percent.[145]

A phased elimination of the subsidy, combined with extensive education and training, would likely have proved a wiser approach, even—or especially—in the difficult circumstances of the time. There are cases in which a 'big bang' approach to fiscal reform is appropriate; in their final design of the reform described in Box 3.2, for example, the Iranian authorities very consciously decided on a very large subsidy reduction given the political and technical investment up front. Where expert advice is of a large adverse effect on output and livelihoods, however, the case for a gradual approach, coordinating fiscal and communication/training measures, seems clear.

Box 3.6: Sri Lanka 's ban on pesticides and chemical fertilizers

On April 22, 2021, the Sri Lankan government introduced an immediate ban on imports of fertilizers and agrochemicals—subsidies to which had become a major fiscal burden. *It had previously announced an intention to transition to organic agriculture on environmental grounds, but the urgency of the action reflected desires to ease pressures on foreign reserves and strengthen a dire fiscal position: In 2019, the fertilizer subsidy program—reported to have covered nearly 90 percent of the cost of paddy fertilizer [1]—cost around USD 253 million: about 2 percent of all recurrent government spending.[2]*

The ban led to a large fall in agricultural output, which amplified, but did not cause, an ongoing economic crisis. *Deeper roots had already been planted by extensive tax cuts in 2019, direct monetary financing and the pandemic-induced collapse of tourism. By early 2021, the debt ratio exceeded 100 percent, having increased by more than 16 points over two years,[3] foreign reserves were becoming unsustainable, and investor confidence was faltering. With over 90 percent of farmers using chemical fertilizers,[4] the impact on production was dramatic and rapid: the rice harvest during the 2021 Maha season[5] in 2021, for instance, was 40 percent lower than that in 2020, and rice imports increased*

145. Cui and others (2018).

by a factor of ten. The impact on livelihoods was correspondingly dire—both directly for the two thirds of the population, including many of the poorest, directly dependent on agriculture and indirectly though the corresponding increase in prices. Recognizing this, the ban was removed in November (but now subsidizing only organic fertilizer)[6]. The continuing hardship and discontent became a major element behind the overthrow of the government in July 2022.

Farmers were simply not ready for the change. *In a survey of farmers conducted shortly after the ban,[7] more than half expected their harvest to fall by at least 40 percent. Nearly two-thirds, nonetheless, supported a policy of transitioning out of chemical fertilizers and agrochemicals. Only 23 percent, however, knew of suitable organic alternatives for their crops and even fewer said they knew how to correctly apply a suitable organic fertilizer. Nearly 80 percent asked for a transition of at least a year, and for education on the organic options.*

Notes:

1. Waidyanatha (2022). United States Department of Agriculture puts the subsidy at 48-88 percent, depending on the product.

2. United States Department of Agriculture (2021) https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Sri%20Lanka%20Restricts%20and%20Bans%20the%20Import%20of%20Fertilizers%20and%20Agrochemicals_New%20Delhi_Sri%20Lanka_05-14-2021

3. IMF (2022), Table A15.

4. Sharma and others (2022).

5. This is from sowing in September to harvesting in March.

6. news.lk, at: https://www.news.lk/news/political-current-affairs/item/33320-no-change-in-government-policy-only-green-agriculture-president-emphasizes

7. Abeysinghe and others (2021).

Chemical fertilizers and pesticides are leading candidates for the application of corrective environmental taxation in developing countries—which, in terms of design and implementation, is in principle straightforward. Generally imported or produced by large enterprises (often already subject to significant regulation), administration seems to pose no great difficulty. As to the level of the appropriate charges, GHGs in their use and production would naturally be charged on a CO_2-equivalent basis (ideally, indeed, as part of a generalized carbon pricing scheme). Such work as there is (for advanced countries) suggests, moreover, that marginal abatement costs through this route are relatively low.[146] Less appears to be known, however, on the appropriate calibration of corrective charges for other sources of harm (such as through leaching).

146. Meyer-Aurich and others (2020).

Political resistance, however, will be strong. Farmers are an important and potentially powerful group in all countries: in developing countries, they are often among the poorest, numerous and potentially vociferous. In developed countries too, they form a powerful lobby, adept at attracting attention. The removal of fertilizer taxes adopted by several European countries in the 1970s and 1980s seems to have reflected such opposition. And it is being seen again now as the issue returns to the political agenda. Demonstrations in both Canada and The Netherlands in response to plans to reduce chemical fertilizer and nitrogen emissions more generally[147] —involving blocking motorways, and the judicious dumping of large amounts of manure—were well-targeted to attract public attention and put pressure on politicians. (The Sri Lankan experience, easily misrepresented, provides them with unfortunately powerful ammunition). Nonetheless, the use of chemical fertilizers and pesticides are almost textbook cases in which taxation is an appropriate response, since the source of the damage is closely related to a well-defined final product whose use is relatively easily monitored. Taxation also generates revenue from which compensation can be made: and compensation (even over-compensation) has often proved a key part of agricultural reform. One way to dampen the impact on prices, and so to diminish opposition, might be implementing correction through adopting a feebate scheme rather than outright taxation—but with the disadvantages this approach was seen in Part 1.B to bring.

E. Waste management

Both global and local concerns—and a particular challenge in developing countries

Poor waste management (solid waste and wastewater) contributes substantially to a wide range of health and environmental problems—and was seen in Part 2.B to be a major concern in very many developing countries. The most prominent amongst these, beyond sheer hellishness of daily life for this in proximity to waste sites, are:[148]

- ***A significant contribution to climate change:*** Methane emissions from decomposing organic waste, including human waste—about half of all solid waste in developing countries—produces 'biogas' (or 'landfill gas'), a combination of CO_2 and methane. These emissions can be mitigated by the use of composting methods

147. In the Netherlands, the government confirmed in June 2022 its target of halving nitrogen emissions from agriculture and construction by 2035; in Canada, the intention, also announced in June 2022, is to reduce GHG emissions from fertilizer use by 30 percent by 2030: See, respectively: https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Government%20Presents%20National%20Program%20to%20Reduce%20Nitrogen%20Greenhouse%20Gas%20Emissions%20in%20Rural%20Areas%20_The%20Hague_Netherlands_NL2022-0035.pdf and https://www.canada.ca/en/agriculture-agri-food/news/2022/03/government-seeks-guidance-on-path-towards-reducing-emissions-associated-with-fertilizer.html

148. Like other listings of harm in this paper, there are other forms of damage not mentioned: the transport of waste to landfill sites also of course generally implies some fossil fuel use in itself, and there may be risks to tourism, notably in small islands short of land space.

to produce organic fertilizer, or by using biogas to generate energy (in principle displacing other sources);[149] it can also be reduced by flaring.[150] A distinct source of climate harm is the incineration of waste, which produces 'black carbon,'[151] a powerful GHG. Waste, solid and water, accounted for around 3 percent of global GHG emissions in 2019.[152]

- ***Direct damage to human health:*** Accumulated waste, including human sewage, attracts rodents, other vermin and mosquitos that act as disease vectors (an effect that can be reduced by 'sanitary' landfilling.)[153] The black carbon produced by uncontrolled incineration also causes strong local damage to air quality, and working conditions for scavengers on waste sites are often dangerous.

- ***Damage to soil and water quality:*** Through leaching of toxins, including from untreated human sewage, into ground and surface water (and hence into drinking water). Untreated wastewater carries pollutants into human and animal water supply.

- ***Thin plastic bags cause multiple harms:*** Easily transported by wind, toxic, and non-biodegradable, these can poison animals, with feedback into humans. The drain blockage they cause can also create serious difficulty: this has amplified floods in Accra (Ghana) and Surat (India), which in the latter case were associated with the spread of a 'plague-like' disease.[154] Single-use plastic products are also a particular concern.

- ***Marine litter:*** The 11 million tons of plastic that end up in the ocean every year (also generating microplastics that are impossible to recover) have been estimated to cause damage of at least USD 9-19 billion annually.[155]

From both a global and (even more) a local perspective, waste management problems are especially acute in developing countries. Waste accounted for 2-3 percent of GHG emissions in more advanced countries in 2003, for instance, but over 4 percent elsewhere.[156] And whereas OECD waste has been described as "properly managed" by 2005,[157] in developing countries only about half of organic waste is even collected;[158] what is collected, moreover, goes almost entirely to dumps or poorly controlled landfill sites near slum areas.[159] At least two billion

149. See for instance EPA (2020).
150. Flaring converts methane into less climate-damaging CO_2, greatly reducing emissions in CO_2-equivalent terms.
151. Black carbon is essentially pure carbon in particulate form. It has a far stronger but shorter-lived warming effect than CO_2.
152. Calculated from World Resources Institute (2020).
153. This involves covering the landfill with soil.
154. United Nations Environmental Program and International Solid Waste Association (2015).
155. United Nations Environment Program (2021).
156. IPCC (2007), p. 506. 'Advanced' here means Annex 1 countries and Economies in Transition.
157. United Nations Environmental Program and International Solid Waste Association (2015). p. 7.
158. Matheson (2022).
159. Hoornweg and Bhada-Tata (2012), p.24.

people live in areas with only uncontrolled dumping.[160] And while matters have been improving, in 2017 over two-thirds of the population of sub-Saharan Africa lacked even basic sanitation services, with open defecation for 20 percent. Box 3.7 elaborates further on the state of waste management in sub-Saharan Africa.[161]

Box 3.7: Solid waste management in sub-Saharan Africa

Performance is generally very poor, but appears to vary widely:[1]

- ***Collection rates are low,*** *averaging around 55 percent for the African continent*[2] *as a whole; they are as high as 95 percent in Lagos, 88 percent in Kigali, and 70 percent in Addis Ababa*[3]*, and as low as 25 percent or so in Wa (Ghana) and Jimma (Ethiopia). There can be wide variation, moreover, across cities within a given country and even within cities.*
- ***The proportion of collected waste that is managed appropriately is low:*** *perhaps around 50 percent on average for the Continent. While reliable information by country does not seem to be available, for low-income countries as a whole the proportion of collected waste disposed of in a controlled manner is put at under 35 percent.*[4]
- ***Recycling, which is primarily undertaken by small operators, is low,*** *at an average of around 4 percent of solid waste.*[5] *The proportion of recycle waste collected also varies widely being as high as 85 percent in Bamako, reflecting an active market in organic waste and systemic efforts. In Addis Ababa, it is only 10 percent.*

Notes:

1. *Except as noted, numbers in this box are from UNEP (2018), variously: pages 30, 31; Figure 3.9 and note thereto; and p. 38 and Figure 3.10—see also the qualification there on the Bamako-Addis Ababa comparison. These data are thus somewhat dated.*
2. *Continent-wide comparisons include North Africa, where performance seems to be high relative to sub-Saharan Africa.*
3. *MEFA (undated).*
4. *UNEP (2015).*
5. *The comparable rate in OECD countries is around 30 percent.*

With volumes of waste set to rise substantially in sub-Saharan Africa, the challenges in the region are set to increase. Driven largely by continued rapid urbanization (discussed further in Section G), one projection is that daily municipal solid waste production, which was around 450 million tonnes per day in 2015, will about double by the latter 2030s. For urban Africa alone,[162] they are projected to

160. United Nations Environmental Program and International Solid Waste Association (2015). p. 270.
161. This box, and the analysis in this section more generally, is hampered by the difficulty of obtaining accurate and current information on waste management practices, including financial arrangements: a difficulty stressed for example by UNEP (2018).
162. UNEP (2018), Figure 1.2 and p.153.

about triple over that period.[163] These challenges are widely recognized by municipal and national authorities, and have attracted external support, but realities lag far behind aspirations;[164] and the public finance aspects have received little systematic attention.

A specific but above all a general role for taxation

There are several tax-type instruments that can in principle help improve waste management, but for some at least their prospects in low-income countries are limited. Beyond emissions taxes on specific toxic substances whose production is concentrated among businesses large enough to be readily monitored, several tax instruments can in principle be deployed[165] to reduce the quantity of waste and/or to encourage recycling by setting prices that present decision-makers, firms and individuals, with prices that reflect the full marginal social costs[166] of their actions:

- ***Garbage collection fees*** charge by the weight, volume and/or nature of material collected for disposal, and so are intended to reduce the waste to be processed. Particularly in low-income contexts, however, a collection fee material enough to meaningfully mitigate the externality can be highly problematic:

- Where monitoring and enforcement capacity are low—as is likely to be the case in many developing country contexts—such 'pay as you throw' schemes can lead to illegal dumping.[167]

- Issues of distributional equity, and indeed of affordability, may arise. Where fees are levied,[168] they appear to be both modest and widely evaded (at least by households): in Bahir Dar (Ethiopia), for example, the fee around 2010 was about 60 cents per household, with only around 50 percent compliance.[169] That said, however, there are instances in which communities appear to have been willing to enter into informal arrangements with neighbourhood-based associations and small businesses that involve payment of some small fee in return for garbage collection. These have played an important role in Bamako, for example, since the early 1990s, collecting door-to-door for a fee paid directly by households.[170]

163. MEFA (undated) reports spectacular growth in waste generation between 2016 and 2019 in East Africa, of 28 percent in Kenya and 94 percent in Ethiopia.
164. Current levels of recycling, for instance, are far short of the African Union's target of recycling 50 percent of urban waste by 2023 (UNEP (2018), p.2).
165. A recent review of these instruments is in Matheson (2022).
166. There is an issue as to whether these should reflect local or, more fully, global social costs; it seems likely, though little if any attempt has been made to quantify this, that local damages will be far larger than those arising globally.
167. In Belgium, for instance, to establish an enforcement reputation the authorities searched illegally dumped garbage for evidence identifying the dumper (United Nations Environmental Program and International Solid Waste Association (2015). p. 156).
168. Around 2010, only about half of all residents of African cities paid some form of collection fee (UN-Habitat, 2010).
169. Lohri and others (2014). Among businesses, however, compliance was around 90 percent.
170. See Kéita (2001) and "Waste Collection Dispute in Bamako", https://www.ejatlas.org/print/privatization-of-waste-management-and-displacement-of-informal-recyclers-in-bamako-mali#

This points to recognition of waste management (at least the collection aspect) as a local public good: one, that is, which conveys benefit within a relatively small group of people. Individuals then have a meaningful incentive to contribute, especially when some sense of community identity creates an expectation that others will be contributing similarly. This aspect of waste management as having features of a local public good may create opportunities for constructive use of other tax-type measures to amplify voluntary contributions to the local public good of collection, such as arrangements to match household (or business) payments to local collection operators.

- ***Landfill taxes ('tipping fees')*** also incentivize waste reduction, but also risk increasing illegal dumping or burning (releasing local toxins).
- ***Advance disposal fees*** (AFDs) also aim to act on the volume and composition of waste (and perhaps also encourage recycling if charged only on first sale) by charging commodities, or inputs, some amount intended to reflect the full social cost of their disposal.
- ***The tax on thin plastic bags*** is the best known such fee. While charged at modest rates, has proved extremely effective in reducing their use: a typical finding is of a massive price responsive, with an arc elasticity of demand around 34.[171] In developing countries, however, it seems more common to ban plastic bags rather than tax them. This may be because, even though such a tax could be implemented upstream of hard-to-tax small retailers, the regulatory option is easier to enforce. Whether this is indeed the case, however, remains unclear.
- ***Deposit-refund schemes*** charge a fee upfront that is then refunded on presentation of the used product. This approach is targeted on encouraging recycling rather than reducing the volume of waste, and the revenue potential is also limited (net revenue being positive only to the extent that return does not occur). This, in many ways, would seem to have particular appeal in the developing country context, as both drawing on and providing a source of income to large numbers of scavengers (who may account for 5 percent or so of urban employment)[172] —and may indeed be one of the most promising options for developing countries, Only Zimbabwe, however, seems to have adopted such a scheme, with results that are apparently impressive for beverage containers (though less so for batteries).[173] Quite why such schemes have acquired little momentum outside advanced countries remains unclear.

  A similar effect to deposit-and-refund is achieved by non-price means through ***extended producer responsibility schemes,*** which simply impose an obligation on producers to recover their used product.

171. Matheson (2019).
172. Le Courtois (undated). There are said, for instance, to be 10,000 such scavengers deriving their livelihood from a large waste site in Accra alone (United Nations Environmental Program and International Solid Waste Association (2015). p.16).
173. Kaseke (2015).

One other potential instrument is relevant for low-income countries in particular:

- ***Tariffs on waste imported for disposal*** should cover both direct and external costs, but beyond that can also serve as pure revenue-raising devices, exploiting any market power that the importing country may have. Such power may be limited, however, by competition between alternative countries of disposal. It would be enhanced by some coordination of tariffs between them, which the frameworks for regulatory agreements on trade in waste might facilitate. While this trade remains controversial, and subject to international agreements,[174] so long as it continues a strong case can be made for taxing it appropriately; indeed the notification elements of those agreements may ease the implementation of meaningful tariffs. Information on the current extent of tariffs on imported waste, however, seems hard to obtain.[175]

Revenues from such instruments are often, perhaps usually, earmarked for environmental purposes, often in relation to waste management[176] —which may be problematic. This is an instance of the general issues raised in Part 2.B. There may be some salience or at least political acceptability to be brought by earmarking taxes aimed at improving waste management. In principle, tipping fees and ADFs should at least meet the private costs of disposal. But, beyond their limitations set out above, few developing countries seem to have succeeded in introducing them at close to cost-recovery levels.[177] This difficulty argues that such charges should be seen as, at most, a marginal source of finance for spending on waste management. The critical task of financing much needed improvements in waste management should not be held hostage to the proceeds of taxes whose revenue yield may well be very modest.

The most fundamental challenge in improving waste management, however, is securing adequate financing—one more instance of the wider DRM challenge in developing countries. Landfill construction to serve one million people, for example, can cost around USD 10 million.[178] Even in principle, and leaving aside the desirability or not of explicit earmarking, there is no reason to

174. Such as the Basel and Bamako Conventions, which impose controls and in many case prohibitions on the import of hazardous waste. The coverage of the former, including in requiring prior notification and consent, was extended in 2019 to cover many plastics.
175. Some countries, such as South Africa, levy export taxes on some forms of waste to encourage domestic processing. Leaving aside standard issues of trade policy as to the wisdom of such protection, this amplifies the wider need to ensure that any adverse environmental implications of waste processing are dealt with.
176. See for example figures 13-15 of Matheson (2019) on the use made of Advance Disposal Fees, in mostly advanced countries.
177. Even in OECD countries, revenue from solid waste-related taxes averages under 0.02 percent of GDP (Matheson, 2022).
178. Kaza and others (2018). For sub-Saharan Africa as a whole, one estimate is that investment needs alone will amount to around USD 500 million per year by 2030 (UNEP (2018), Table 8.7). In some respects these costs seem modest: the latter, for instance, would be in the order of an annual 35 cents per capita. But they can be large relative to the budgets of local government, and covering the continuing costs associated with infrastructure investments (such as, in this case, of collection) has often proved problematic in practice.

suppose that the revenue from the instruments above, even if set with full efficiency, would equal the revenue needed to cover the costs of efficient waste management. And the constraints of implementability and affordability noted above evidently reduce their revenue potential considerably. There are some ways in which effective waste management can itself be a source of income, most directly through power generation: as intended, for example, with a waste-to-energy project in Addis Ababa.[179] But the need for significant additional support from tax revenues more widely is clear. In Mauritius, for example, even after they had been doubled waste-related revenues covered only about 20 percent of waste-related spending. In Ethiopia, fees have covered around half of the costs.[180] All that, moreover, is relative to actual rather than desirable levels of spending. For the developing world as a whole, World Bank (2014) put the underfunding of solid waste management at over USD 40 billion per annum.

Private sector involvement does not remove the need for substantial financing from public revenue. Involvement of the private sector in waste management, which is quite extensive, can mitigate the revenue need by encouraging efficient delivery; but, as shown by experience in Cameroon (Box 3.8), it does not remove the fundamental need for some form of publicly-financed subsidy.

The revenue need arises, moreover, at one of the weakest areas of the tax systems in low income countries: local government. Waste management is commonly a function for local government;[181] which is generally marked by severe limitations in both own resources and capacity. Those own revenues often include property taxes,, and are in some cases supplemented by taxes that are labelled as relating to waste management but bear no direct relation to waste generated: this is the case in Cameroon, for instance (Box 3.8), and in Bamako (where a 'local development tax' is charged at fixed amount on (at an annual FCFA 3,000 per adult per month) and businesses.[182] The revenue raised from such local charges, however, is generally extremely modest: in Bamako, for example, they are around USD 6 per capita.

179. UNEP (2018), p.140.
180. Lohri and others (2015).
181. And a significant one: it may account for 20 percent or more of local spending (EPA (2020), p 6). Notable too is that waste management is relatively expensive in developing countries (see for example Matheson (2022)).
182. IMF (2015a). On the weaknesses of local tax systems in Francophone Africa more generally, see Chambas (2010).

Box 3.8: Waste disposal in Yaoundé

Waste disposal in Yaoundé—which, while remaining problematic, seems to be among the more effective arrangements—is through a service contract with a private operator. *In the early 2000s collection rates stood at around 45 percent, toward the higher end of those in Francophone cities.* [1] *After several attempts at other arrangements, these cities subsequently settled on contractual arrangements with Hygiène et Salubrité du Cameroun (HYSACAM), a private enterprise that also provides waste management services in Douala and Baffoussam, as well as elsewhere on the Continent.*

Performance appears to have improved since the first in the current series of service contracts was signed in 1998. *HYSACAM claims to have achieved collection rates of 80-90 percent (though not explicitly for Yaoundé)* [2] *Collection rates appear to be reasonably high, and disposal for Yaoundé is at an apparently well-managed landfill site at Nkolfoulou. Contracts specify performance in some detail: daily collection tonnage, schedules and so on. These contracts, moreover, have been amended to reflect changing priorities and understanding of waste management problems, for example, with the establishment of a central transfer station allowing initial collection from locations that can be hard to reach, including as a result of roads in poorer areas being impassable for large lorries in the rainy season.*[3]

About 85 percent of the financing of HYSACOM is from central government. [4] *Unlike other public-private partnership arrangements in the sector, HYSACOM does not, it seems, charge a fee directly to households or businesses. It is financed in part by a Waste Collection Tax TOUM, collected centrally and reallocated to municipal authorities, that is charged on households and business; detail is again hard to find, but this appears to be levied as a fixed charge unrelated to waste generated. This, however, covers less than 10 percent of waste collection and storage costs. Some is financed by the local authority through other means—leaving the remaining 85 percent to come from the central government.*

Notes:

1. *Paoort et al. (2009), Table 1. The comparable figures in Nouatchott and Njamena, for example, were in the 15-30 percent range; but data are presented for only a few cities.*
2. *Parrot et al (2009)*
3. *Such an arrangement was suggested by Parrot et al. (2009), and positive results claimed in Ngounou (2018).*
4. *This paragraph draws on HYSACAM (2012), and so may be both dated and partisan; more recent and independent information, however, has proved hard to find.*

There is doubtless scope to raise more from local charges, but a role for central governments too. One estimate, for example, is that revenue from the local development tax in Bamako, currently USD 160,000, could be increased to USD 13 million; relative to total (transfer-inclusive) revenue of around USD 50 million, that would be a highly significant amount.[183] Possible creative approaches include attaching such charges to electricity or water bills, which could improve compliance at least among the better-off, as has been tried in Ethiopia.[184] Even so, transfers from central government evidently have a critical role to play, with more needed if real progress is to be made. Beyond the need for strengthened DRM at national level, this raises wider issues concerning the appropriate level of government to which the waste management function should be allocated: there are good reasons to allocate considerable powers to local government, in terms of the need for local knowledge and, ideally accountability. But it may be that a more purposive role for central government is needed. This may encourage greater priority being given to waste management in the allocation of collective national revenues. There may also be tax competition forces at work: lower-level governments may hesitate to impose meaningful waste disposal charges for fear of driving businesses or wealthier individuals to areas with less stringent charging; and/or they may pay inadequate attention to waste management problems that also affect other localities.

While strengthened DRM is ultimately critical for fundamental improvement in waste management, there may be scope to learn more from the variety of financing modes now used. The most immediately relevant concern is that resources adequate to not only operational needs but also the fairly substantial investments that may be needed (for example to recover and use landfill gas) are currently not forthcoming. While public resources are in all cases pivotal, there appears to be wide variation in current approaches, in terms for instance of contracting with private firms, the use of fees, and the involvement of local communities and small businesses. Systematic information on the nature and performance of these arrangements, viewed from a fiscal perspective, could pave the way to better use of what are set to remain very limited resources allocated to this area.

183. World Bank (undated, p.60). The assumptions behind this striking estimate, however, are not entirely clear.
184. UNEP (2018), p.166. We have been unable to find information on the outcome.

F. The Extractive Industries

The extraction of petroleum and minerals can create significant environmental problems—for some of which a tax-like approach may be well-suited. Sources of potential damage include direct harm (local and in some cases global) from pollutants and disruption to local economies and communities. Many of these may be best addressed by regulatory measures built into contracts: the explicit negotiation between government and potential contractors has similarities to a situation of Coasian bargaining (as discussed in Part 2.A). For some key problems, however, tax-type measures, whether within or outside contracts, can be well-targeted to serving efficiency and fairness objectives.[185] Prominent among these are:

- **Flaring and venting:** [186] About 8 percent of the world's production of natural gas is either burned ('flared') or simply enters the atmosphere directly, whether deliberately ('venting') or not ('fugitive emissions'). Flaring produces CO_2 and sulfur dioxide (a cause of acid rain); the former is mainly a global concern,[187] bur the latter has strong regional effects. Venting and leakage—and flaring, to the extent it achieves less than full combustion—are even more harmful, involving the emission of methane. The adverse environmental consequences are severe, and have come to receive increasing attention: together, they account for about 5 percent of global GHG emissions, as well producing particulates and other matter damaging to air quality and health. And much of this takes place in lower income countries: Gabon and the Republic of the Congo are among the top 20 countries by volume of flaring[188] .

  Flaring is relatively easy to monitor, and if an outright ban is felt to be too costly, there is a clear case for taxation, ideally in the form of a carbon tax on the CO_2-equivalent emissions combined with charges for other sources of harm. Adopted most notably in Nigeria, tax-based approaches seem,however, to be the exception rather than the rule. Venting remains harder to observe. One option in that case may be to charge fuel suppliers with a presumed methane leakage rate but with an option to rebut this by providing reliable monitoring evidence.[189]

- **Decommissioning:** Restoring affected areas once extraction is complete—avoiding for instance open-pit mines becoming mosquito breeding grounds—can be a costly exercise, the financing of which requires early attention in order to ensure that the funds are available when needed. There are several options for this,[190] combining elements of the liability approach discussed in Part 2.A and tax-like measures: one, for instance, is to require payments during the life of the project into an escrow fund that will be used to finance cleanup.[191]

185. We do not address here the distinct, and difficult, issues associated with artisanal mining.
186. This discussion draws on Romson and McPhail (2021a,b).
187. Methane is non-toxic, though it can cause moderate harm to humans if inhaled in sufficient quantity.
188. Table 3 in Romson and McPhail (2021a).
189. This is suggested in IMF (2019a).
190. See for instance Chapter 6 of United Nations (2017).
191. There may in some cases be opportunities to build sustainable landfill facilities in disused mines.

- **Compensation/support to affected communities.** While the fiscal and other benefits of extraction generally arise nationally, the external costs are often borne locally. That creates a case for some measure of compensation and development support to affected communities. This might be addressed either by imposing some tax-like obligations on contractors—to develop local infrastructure, for example—or through transfers from national government, whether as some explicit form of sharing revenues from the extractive activities or as an outright grant.

The tax issues at stake in these contexts are well-known, and appropriate policy responses are fairly clear, though for the last of these are likely to be particularly country-specific as they touch on quite widely divergent practices in fiscal federalism. Much less widely studied, however, are two new and quite fundamental challenges for tax design in these sectors.

New tax challenges in the extractives

These arise from two distinct sets of prospective global developments. One is the likely impact of what one can hope will be increasingly ambitious climate action on demand for the products of the extractives—which are quite different for oil and gas on the one hand (offering too in this case some opportunities for innovative approaches) and several key minerals on the other. The second, affecting both sectors in similar ways, come from a profound change in the wider international tax system now in prospect: the adoption of a global minimum corporate tax. The tax policy challenges these developments pose are substantial and complex.

The consequences of, and dealing with, ambitious global mitigation

Taking the two sectors in turn:

Oil and gas

Responding to the prospect of lower oil and gas prices

The potential implications of more aggressive mitigation for oil and gas production—and for the tax revenue raised from the sector—are sizable. The expectation is that mitigation, if it is to achieve climate objectives, must lead over time,[192] to significant reductions in both the selling price faced by oil and gas producers and their output. In this way, much of the real burden of achieving global climate objectives may be borne by low-income oil and gas producers. This, in broad terms, is the 'stranded asset' problem. The impact on oil producers' tax revenues could be substantial:[193] at a price pathway consistent with a 2oC target, they might fall on average, by 2040, by a little under 10 percent of GDP. In Congo

192. There are shorter-term issues that arise in the present from the expectation of lower hydrocarbon prices in the future: this creates an incentive to bring forward extraction. This 'green paradox' might in principle call for some dynamic adjustment of tax rates in the extractives, but such dynamic manipulation would likely raise practical difficulty, including an adverse effect on investors' certainty as to their tax treatment; it is not explored here.

193. The figures that follow are from IMF (2019b).

they might fall even more, by around 15 percent. And even when the amounts are less than the average, the effects may still be substantial, as in Gabon, for instance, where the reduction might be 5 percent or so of GDP. Some developing countries with newly identified fields might find that they are simply not developed. Beyond the revenue considerations, the impact on developing country late-comers to oil extraction may thus amplify concerns that developing countries will bear an unfair burden in solving a problem they did not create.

This new problem warrants rethinking the current tax treatment of fossil fuel producers in developing countries. A central issue in the taxation[194] of the extractive industries is the appropriate balance between royalties (charges based only on the value or volume of sales)[195] and profit-based taxes, including not only the corporate income tax but a variety of schemes—widely recommended for the extractives—that are intended to tax only profits in excess of the investor's minimum required returns.[196] Royalties have the merits of being relatively easy to collect and of generating revenue earlier in the production cycle than do profit-based taxes. Rent taxes have the merit of yielding potentially substantial revenue without distorting commercial decisions.[197] A long-standing question in the taxation of the extractives has been the appropriate balance to strike between royalties on the one hand and profit-based taxes, especially rent taxes, on the other. And the issue posed by the prospect of more aggressive mitigation is how that balance between royalties and rent taxes—and indeed the levels of each—should respond to a prospective medium- long-term decline in hydrocarbon prices. A consequent reduction in tax revenue may be largely unavoidable—but it may be that a judicious reconfiguration of tax systems can limit that loss.

Characterizing the best tax response is complex, but it is plausible to suppose that revenue-maximizing royalty rates fall; the implications for rates of rent taxation, however, are unclear. The analytical difficulty here is that understanding the appropriate response requires understanding the considerations that guide the setting of the two forms of tax, which are not entirely clear—why it is, for instance, that countries do not rely almost entirely, or at least much more heavily, on rent taxes? There has been considerable discussion of this, but one reasonably appealing approach is to suppose that policy design needs to weigh against the merits of each tax instruments, describe above, their key disadvantages: royalties discourage production and rent taxes may be vulnerable to profit shifting. In such a setting:

194. The term 'tax' is used here to include the full suite of fiscal instruments applied in the extractives: royalties, for example, are often labeled 'non-tax,' though that makes little if any difference to their impact.
195. There are forms of 'royalty' that make some allowance for costs; for clarity, the term is used here in the narrower sense.
196. The standard corporate income tax, in contrast, does not exclude from taxation the cost of equity finance.
197. Assessments of this wider issue include Boadway and Keen (2010), IMF (2012) and, for a different perspective, Conrad (2015).

- Lower producer prices likely make royalties less attractive: they reduce the revenue loss from cutting royalties (because the base, sales, is smaller) and increase the indirect revenue gain that lower royalties generate by encouraging production. [198]
- The implications for income-based and rent taxation are more complex, as they can effectively combine two elements: a tax on sales and a subsidy (at the same rate) to costs. For the first element, exactly the same considerations apply as for royalties, so pointing to a lower rate of rent taxation. But the effect through the subsidy component might point in the opposite direction: the reduction in rents consequent on the lower producer prices may weaken the incentive to limit profit shifting by maintaining a relatively low rent tax rate.

Royalties are like carbon taxes

More innovatively, there may be scope for new approaches that build on the observation that royalties on fossil fuels are, in effect, carbon taxes (Box 3.9). A royalty of 10 percent on a barrel of oil that sells for USD 100 is equivalent for instance, to a carbon tax on its content of about USD 20, tonne.[199] A higher royalty where the oil is extracted thus reduces the need for a carbon tax where it is used. Indeed, purely on administrative grounds—consistent with the principle of applying taxation at points in the production process that are readily controlled—there is a strong case for levying carbon taxes at the point at which fossil fuels are extracted. The question then is whether there are means by which countries that consume oil—especially oil produced by developing countries—might be able to accept 'carbon royalties' levied by producers as meeting, at least in part, their own carbon pricing objectives; and, beyond the technicalities,[200] whether they might have the will to do so.

Box 3.9: Royalties as Carbon Taxes

Royalties—charges related to the volume of value of production—are a commonplace feature of fiscal regimes for oil and gas exploration. Viewed as instruments for sectoral taxation, they are commonly assessed in terms of trading off, on one hand, the benefit of securing some revenue for the government early in the production process (before exploration and capital costs have been fully recovered) and of being relatively easy to administer (being less vulnerable than profit based taxes to tax avoidance activities) against, on the other hand, the risk of discouraging extraction that would be only marginally profitable in the absence of taxation.[1]

198. For royalties levied in specific form (that is, on volume rather than sales) the first effect in this bullet is absent, but the second remains.
199. Very roughly, burning one barrel of oil emits a little under 0.5 tonnes of CO_2. Note too that, when they bite, cost recovery limits in the taxation of oil producers act like royalties.
200. There is, for example, an important different between revenue-based royalties and carbon taxes that would ideally be levied, as noted earlier, by reference to quantities rather than value. But it would clearly be feasible to move royalties to a specific basis.

Viewed from another perspective, however, royalties have another important feature: since the carbon content of a given volume of oil is essentially a (known) constant, they are implicit taxes on that content. That is, they are, in effect, carbon taxes.

In the Republic of Congo, for instance, liquid hydrocarbons are subject to a royalty of 15 percent on the value of production[2]—a rate that seems fairly typical for sub-Saharan Africa.[4] At an oil price of, for example, USD 90 per barrel, that amounts to a tax of USD 13.5 per barrel. Burning the fuel in one barrel of oil releases about 0.43 metric tomes of CO_2.[3] The royalty thus amounts to a charge of USD 31.4 per ton of CO_2. That is a considerable amount, relative for instance to an aspirational price of USD 70 per ton of CO_2 by 2030.[4]

The principal difference between this implicit tax and a carbon tax of the kind required for mitigation is that the royalty is specified relative to the value of output (that is, in 'ad valorem' form) whereas corrective carbon tax would be independent of the oil price (because that price does not affect the harm that burning oil causes). Converting an ad valorem royalty to one specified in terms of the physical quantity of oil (that is, 'specific' form), however, raises no technical difficulty; indeed a specific royalty may well be easier to administer.

Exactly the same analogy to carbon taxes applies, of course, to excise taxes on coal (though these now seem relatively rare) and—at least to the extent that the wood will subsequently be burnt or decay—to stumpage fees in forestry.

Notes :

1. See for instance the discussion in Boadway and Keen (2010).

2. Article 159 Hydrocarbon law of Code of 2016, Article 159. A lower rate may apply for operations in "difficult zones."

3. Conversion factor from Environmental Protection Agency, at https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

4. Carbon Pricing Leadership Coalition (2017), for example, see an explicit price of USD 50-100 per ton of CO_2 by 2030 (with accompanying measures) as aligned with the temperature objectives of the Paris agreement.

Minerals

For several minerals, on the other hand, climate action points to a strong increase in demand.[201] Renewable and low carbon technologies, it turns out, are highly material-intensive, largely through the use of batteries for propulsion and storage to overcome intermittency. Electric vehicles and the infrastructure they require, for example, are heavily reliant on cobalt, lithium, nickel, manganese, aluminum and copper; and wind power uses copper, iron ore and neodymium. The growing importance of such minerals has already been seen in price developments.

201. On this, see in particular Addison (2018) and Jones (2020).

From the tax perspective, realizing the potential benefits requires attention to issues of both rent capture and the external effects of mining. Conceptually, the key issue is as above—the appropriate balance between rent taxes and royalties—but cast in the context of increasing rather than falling prices. The same arguments in this case suggest an important role for royalties; and indeed the DRC, for example, has levied an additional 6.5 percent royalty on cobalt. That said, however, explicit rent taxes have traditionally played less of a role in minerals than in oil and gas; this may be a good time to upgrade their role. To the extent that the expectation of strong demand leads to further exploration and the development of new fields, there is an opportunity to establish strong design early in the process—and a chance to avoid making mistakes that can be hard to correct once major investments have been made and contracts signed. While there will inevitably be pressure to offer attractive tax deals to encourage exploration and development, experience points to the danger of becoming locked into excessively generous arrangements. And of course the more familiar problems of establishing arrangements to deal with the local pollution and damage that extraction may involve, discussed above, will also arise.

The Global Minimum Tax

The prospective widespread adoption, from 2024, of a minimum effective corporate tax has potentially sizable implications for tax design in the extractives—and may be broadly beneficial for low-income producers. In October 2021, nearly 140 countries agreed on a package of reforms to the international tax system that includes (as 'Pillar Two') ensuring that all entities within large multinationals would face an effective tax rate on their 'excess profits' of at least 15 percent.[202] The details are involved, and not directly related to environmental concerns, and so relegated to Appendix 2. But the implications may be major, and will start to be felt soon: many countries are now committed to implementation from 2024. The upshot is that, with sufficiently widespread adoption, the global minimum tax should enable hydrocarbon and mineral producing countries to assure at least that 15 percent effective rate through the use of profit-based taxes. As explained in Appendix 2, however, the details of the minimum, may create pressure to reduce royalties that are based simply on the volume or value of sales.

An uncertain and complex outlook

Prescriptions for dealing with the two challenges faced in oil and gas are potentially conflicting. Responding to the global minimum tax requires setting sufficiently high profit-based taxes, and even to partly replacing royalties by rent taxes; on the other hand, lower world hydrocarbon prices may point to reducing rates of rent taxation. And those lower prices strongly suggest lower royalty rates than otherwise; but to the extent that those can be accepted by others as effectively being carbon taxes, that would point to maintaining or even increasing them.

202. Extractives are excluded from the other main element (Pillar One), which in any case now seems less likely to be implemented.

For now, the balance of considerations for petroleums points towards ensuring sufficiently moderate royalty rates and sufficiently high rates of income or rent taxation. How to balance the conflicting considerations, depends on views as to likely developments over the coming years in both international corporate taxation and global mitigation efforts. At present, one can perhaps have more confidence that there will be widespread adoption of measures along the lines of the global minimum corporate tax than one can have in the likelihood of generalized aggressive carbon pricing or, even less immediately likely, an acceptance by others of carbon pricing at source. The balance of arguments then tilts towards ensuring sufficiently moderate royalty rates and sufficiently high effective rates of income or rent taxation. Caution is in any event called for, not least as frequent changes in tax policy can run counter to investors' desire for certainty in their tax treatment—which is an especially paramount concern in the extractives, where very high sunk costs make confidence in future tax treatment a critical concern.

Prospects, however, can change—and there remains a strong case for recognizing and deepening royalty-like charges on oil and gas as carbon taxes. Not least, doing so may go some way towards addressing the concern that low-income countries are being asked to bear an inequitably large burden in the pursuit of global climate objectives.

For many minerals, in contrast, the brighter price outlook allows a more confident focus on ensuring adequate rent capture. This may point to more extensive use of explicit rent taxes that has been traditional in this sector, especially as simple royalties may become less attractive if the host country wishes to attract investors by providing, within the changed international tax rules, a modest overall tax take.

G. Urban congestion

Urbanization, set to continue especially rapidly in Africa, is bringing major social, economic and environmental challenges. The population of Africa living in cities has been rising at around 3 percent each year, the fastest rate in the world and one that is expected to continue: by 2050, it is projected that the urbanization rate will reach about 60 percent,[203] and that the number of megacities[204] in Africa will have increased from three to nine. Among the priority countries, the number of megacities increases from one (Kinshasa) to two (the addition being Addis Ababa); but 11 cities in these countries are projected to have populations in excess of 5 million.[205] The challenges this poses are daunting, and past experience is not encouraging: it is widely recognized that in many parts of Africa "the process of urbanization has not been well-managed."[206] Large cities in Africa are commonly

203. African Development Bank (2014).
204. 'Megacity' here means a population of over 10 million. The two other current megacities in Africa are Lagos and Johannesburg.
205. These are (in order of projected population) Dakar, Bamako, Antananarivo, Ouagadougou, Niamey, Lubumbashi, Conakry, Mbuji-Mayi, N'Djamena, Doula and Lome: see Hoornweg and Pope (2014).
206. World Bank (2013b, p.3).

marked by pervasive slum conditions, inadequate public services (including access to drinkable water),[207] illness (including from local air pollution), insecurities and crime.

Not the least problem, and aggravating others, is congestion. Systematic and comparable data on the extent of congestion in such cities do not appear to be available, but, for example:

- In ***Kinshasa***, the average time spent in traffic is reportedly around three hours per day; and the average speed by road travel between municipalities is about 14 kilometers per hour.[208]
- In ***Lagos***, on some estimates the most congested city in the world, the average (two way) commute time is over two hours and the average in-city speed is around 17 km/hr.[209]
- In ***Nairobi***, ranked the ninth most congested, commuting times are also around two hours.
- In ***Abidjan***, the poorest traveling by public transportation spend 200 minutes per day using or waiting for transport.[210]
- In ***Douala***, the time spent on formal transport is around 88 minutes per day.

The COVID-19 pandemic does seem to have had a marked initial impact on the number of trips taken in urban Africa, falling by 20 percent or more in Abidjan, Dar es Salaam, Lusaka and Port au Prince; this though now seems to be back to pre-pandemic levels.

Congestion generates a range of adverse externalities, which it seems may be substantial in large cities in Africa. Detailed assessments of damage outside the advanced world are difficult to find, but a thorough World Bank study for Cairo, while dated, is suggestive of the likely nature and extent of these external in cities of this kind: see Box 3.10.

Some of these external costs are 'indirect,' in the sense that they arise from the amplification of problems whose fundamental roots lie elsewhere:

- ***Local air pollution*** and ***carbon emissions*** associated with the use of fossil fuels are worsened by congestion: this is because emissions are higher from slow moving

207. In Lagos, for instance, it is reported that only 30 percent of the population has access to clean water, and only 10 percent through household connections (Oboye, undated).
208. World Bank (2018, p.48).
209. Ranking and travel times (also for Nairobi) from Numbeo traffic index, at Traffic Index by City 2022 Mid-Year (numbeo.com); accessed July 30, 2022. This dataset, however, covers few cities in sub-Saharan Africa.
210. Morisset (2019).

vehicles and upon acceleration.[211] The climate costs associated with carbon emissions are of course borne globally.

Box 3.10: External congestion costs in Cairo

World Bank (2013a) reports on an ambitious project to detail congestion problems in Cairo and suggest remedial action. Summarizing, the central estimates of the key (total and average) external costs are: [1]

	In USD per capita [2]	In percent of Egypt's GDP	In percent of grand total
Direct:			
Waiting time	125	1,05	39
Productivity loss	45	0,37	14
Reliability	78	0,66	24
Safety	-5	-0,04	-1
Total direct	***243***	***2,04***	***66***
Indirect:			
CO_2 [3]	3	0,03	1
Other emissions	75	0,63	23
Total indirect	***78***	***0,66***	***24***
Grand Total	***321***	***2,70***	

Several features stand out:

- ***The total cost of congestion is very large:*** *even allowing for more conservative estimates (for example in relation to productivity loss and reliability effects, both of which seem particularly speculative [4]), it exceeds 2 percent of GDP. Per capita, within Greater Cairo, it is around USD 300, at a time when GDP per capita was around USD 3,000.* [4]
- ***Costs of delay are by far the largest single item;*** *wasted time alone amounts to around one percent of GDP*
- ***Emissions other than of CO_2 are a major cost:*** *in this case, they account for around one-quarter of the total (which appears to have been around USD1 per tonne of CO_2), and might well be second only to waiting time.*
- ***Climate-related costs are modest:*** *even at a far higher carbon price than used in these estimates, they are clearly an order of magnitude lower than, for example, those associated with other emissions.*

211. See for example Pollution Solutions Online (2018) and Begg and Haigh (2017); the latter show, for instance, that in London halving urban traffic speeds increases NOx emissions from diesel buses and trucks by 50 percent.

While it is dangerous to generalize from one case, these broad features are consistent with other impressionistic evidence and studies for some emerging economies, and may reasonably serve, for now, as plausible stylized facts for cities at a similar stage of development.

Notes:

1. From World Bank (2013a) Tables 4.12 and 5.15. The classification into direct and indirect costs here differs from the original. Some costs reported there are excluded here as being either largely private (such as additional vehicle wear and tear) or as operating though the price system (as with impact on housing prices) and so, while raising equity concerns, not obviously being a source of inefficiency. World Bank (2013a) also reports estimates of additional fuel costs, but it is hard to disentangle the fiscal cost (operating through fuel subsidies) from the private cost.

2. Over the Greater Cairo Metropolitan Area

3. At a carbon price of around USD 10 per ton of CO_2.

4. From https://www.macrotrends.net/countries/EGY/egypt/gni-per-capita , accessed August 2, 2022.

As in the case of Cairo, it is the morbidity and premature mortality from local pollution that is commonly the more immediate concern in low-income countries, falling partly on passengers but having a markedly regressive impact in being concentrated largely in poorer areas.[212]

- ***Fiscal costs*** arising from fuel subsidies are directly increased by the implied increase in fuel use per trip.

On the other hand:

- ***Accident costs*** may be reduced by congestion, though this is not certain: accidents can also occur when encountering congested traffic. In the Cairo study, there was assessed to be a social gain on this account, but the effect is small.

More fundamentally, congestion in itself directly generates what are likely to be even larger externalities in the form of delay, uncertainty and reduced productivity. In choosing to travel, each driver is likely to ignore the slower travel time that their trip imposes on others. For individuals, this uses up time better spent in production or genuine leisure; for businesses, it increases production costs and (since congestion tends to be associated with more variation in travel times) creates additional commercial uncertainties. As found in the Cairo study, congestion may also directly reduce productivity, including by dampening beneficial agglomeration externalities. (These reductions in production efficiency, of course, in turn have indirect adverse effects on government revenue). Importantly, these costs, unlike

212. For ambient air pollution, for example, this is well-established for North America; hard evidence for low income countries is limited, but appears in line with that experience: see Hajat, Hsia and O'Neill (2015) and https://www.tandfonline.com/doi/abs/10.1080/00139157.1976.9930739?journalCode=venv20

those mentioned above, are inherent in congestion itself: they would be exactly the same, for instance, if emissions from road travel were zero. And, as in Box 3.10, these costs can clearly be very large.

(Very) rough calculations suggest that the marginal external costs of congestion delay—which is what matters for policy—are substantial in many cities of the developing world. Figures such as those in Box 3.10 relate to the total external costs of congestion. For policy, however, it is the marginal external cost that matters: the proper objective is not to eliminate congestion, but to balance the marginal social costs associated with it to the marginal benefit of travel. In terms of the urgency of reducing congestion, for example, it is the marginal external cost at observed levels of congestion that matters.[213] There appear to be few clearly documented estimates of this marginal external cost for cities in developing countries. It seems to be a reasonable presumption, however, that in highly congested situations the marginal external cost of an additional trip—that is, the cost of the additional delay it creates—is at least as large as the private cost.[214] It might thus be approximated by the average wage (as a proxy for the opportunity cost of being stuck in traffic) multiplied by the actual trip time. At the average hourly wage rate in Kinshasa of around USD 1.5, for example, the external congestion cost of an additional trip of three hours is around USD 4.5[215] —an estimate that may well verge on the side of caution.

Addressing the challenges posed by congestion externalities calls for a suite of integrated measures, including in relation to public transport, with a pivotal role for pricing instruments. Improvements in the quality and design of urban transport design (one-way systems, bus lanes, relief of choke points) and of transport options (notably, affordable rapid bus and rail transit), both public and private are clearly key. In Jakarta, for instance, a decades-long effort to ease congestion through an integrated strategy of this kind continues. Deeper issues of urban planning also arise, a common concern with many African cities being the long distances between business centers and workers' homes. Proper pricing, however, has a key complementary role in incentivizing socially efficient transport choices and, consequently, in guiding appropriate infrastructure and planning decisions. Pricing issues arise along various dimensions related to congestion. In many contexts, the most direct of these is likely to be reinforcement of the case for reducing fuel subsidies, which effectively subsidize driving when the efficient

213. This will typically be higher than the optimal congestion charge, since that reflects the reduction in marginal external costs from lowering congestion to the efficient level.

214. Suppose that trip time is $c(n)$, with n being the number of travelers, so that total trip costs at a wage of w are $wnc(n)$. Differentiating with respect to n, the marginal social cost of an additional trip is $wc(n)+wnc'(n)$; the first term here is the private cost while the second is the marginal external cost and can be written as $wcE(n)$, where $E(n)$ is the elasticity of trip time with respect to the number of travelers. The result follows if that elasticity is at least unity—which, in very congested situations, it seems plausible to suppose might be the case.

215. This may sound high. But if, for example, an additional driver causes a 2 second delay to 7,000 drivers, the time lost amounts to around 4.5 hours.

response (even in terms of delay alone, leaving aside local pollution concerns) is to tax it. Such higher charges on road fuels are naturally coupled with the development and proper pricing of mass transit systems, both to reinforce the beneficial effect on congestion and as a form of compensation to low-income road users adversely affected by more aggressive fuel pricing. On a lesser scale, but with a potentially meaningful effect, is the pricing of in-city parking.[216]

The best targeted way to address urban congestion as such is by pricing it explicitly. Implicit pricing sometimes takes place in the form of bans or other regulatory measures, such as allowing only cars with odd or even number plates on alternate days. As noted in Box 12, however, that leads to some trips not taking place even though willingness to pay would be high while failing to discourage others for which willingness to pay is low. The result is that whatever reduction in emissions is achieved does not come at the lowest possible cost, which would require equalizing the willingness to pay across all drivers. The logic of congestion pricing, along the lines set out in Part 1, is to do exactly that, by charging on each vehicle an amount equal to the value of the additional delay that its presence on the road imposes on all other vehicles, that value being calculated at the level of traffic at which the marginal social cost of travel equals the Marginal Private Benefit. Such pricing not only generates short-term social efficiency in the volume of traffic on roads of a given capacity, but in doing so supports long-term decisions as to the appropriate capacity to build: when congestion is socially excessive, for instance, the social benefits from expanding capacity to alleviate congestion are less than they may seem.[217]

Such pricing has proven merit, is technically feasible and should be a medium-term target for many congested cities in the developing world. As yet, congestion pricing has been adopted only in a few cities in high income countries.[218] Their experiences, however, are generally seen as encouraging: in broad terms, delays have fallen by the order of 10-30 percent; where monitored, emissions of NOx have commonly fallen by around 10 percent, and those of PM2.5 and PM10 by even more.[219] Doubtless largely as a result, interest in congestion pricing seems to be growing, certainly in advanced cities, such as New York and Sydney, but also, albeit more tentatively and slowly, in parts of the developing world, as for instance in Delhi, Jakarta and Mumbai.[220] Much critical detail arises, of course, in assessing the potential scope and merits of congestion pricing in such settings:[221]

216. The need to supplement congestion pricing by other measures is stressed, for instance, by Arnott, Rave and Schöb (2005).
217. To see the point somewhat differently: One risk in expanding capacity on a congested road is of simply diverting traffic from uncongested roads, with no effects on travel time. Arnott and Small (1994) show that this possibility (which they call the Pigou-Knight-Downs paradox), and other similarly counter-productive outcomes, cannot arise if travel on congested roads is appropriately priced.
218. Notably London, Milan, Gothenburg, Rome, Singapore and Stockholm; road tolls, which use similar technologies, are of course more widespread.
219. Van Amelsfort and Swedish (undated), Tables 1 and 2.
220. Indonesia Expat (2017), Institute for Transportation and Development Policy (2019). There is already significant use of toll roads in Indonesia, including on key access routes into Jakarta.
221. Fuller accounts of many of these are in van Amelsfort and Swedish (undated) (which also provides a careful account of the practical steps towards the introduction of carbon pricing) and Parry (2008).

- ***Technology*** as such, is rapidly ceasing to be an obstacle. Well-established systems to identify and charge vehicles, with whatever sophistication (of time- or vehicle-varying charges, for example, to reflect variations in external costs) are available, and the costs, while significant, are increasingly manageable[222] (particularly, perhaps with some form of private sector involvement.)[223] It is this that opens up the possibility of congestion far beyond advanced economies.

- ***Design issues*** arise—in, for instance, selecting the charged zone, and as between cordon and area pricing,[224] and in deciding exemptions/reduced rates.

- ***Governance and institutional issues*** may be a more serious obstacle in developing country contexts, for instance in the need for reliable and readily accessible registers of license plates; that at least, however, should not be an insuperable problem.

- ***Revenue potential***—in the sense of additional funds freely available for unconstrained use—is likely to be limited. Such schemes generally more than cover their operational costs, but (both technically and for acceptance) congestion pricing is likely to be part of a package of urban transport reforms that involves spending to which it is naturally linked (directly through municipal budgets and as a form of earmarking to foster acceptability),[225] such as the development of potentially subsidized mass transit. In this wider sense, the revenue from congestion pricing can enable meaningful increases in public spending by often cash-strapped municipal governments.

The greatest difficulty in establishing congestion pricing, however, is likely to be in securing political acceptance.[226] Compensating measures have an obvious role to play, bearing in mind that some of those to be compensated, with politics if not equity in mind, are likely to be better-off drivers. For the less well-off whose total trip costs might increase, the development of low-cost alternatives can, as noted, provide compensation while also directly addressing congestion. There may also be some risk that charges might be seen as implicit restrictions on the mobility of the poorest, and an unacceptable form of discrimination. More generally, and as is often the case with corrective taxes, credible assurances that the revenue raised will be put to valued use can be critical. In the case of congestion, as just noted, the need to combine pricing and spending measures makes some form of linkage between receipts and related spending measures especially natural. Encouragingly,

222. In the European cases reported by van Amelsforst and Swedish (undated, Table 4), investment costs are generally in the range USD 100-200 million.
223. Such involvement does not, however, appear to be a feature of schemes in place, and can bring its own issues of management and politics.
224. The difference is that the former does not charge trips wholly within zone.
225. In Indonesia, toll road receipts have in some cases been securitized in order to finance infrastructure development (Global Infrastructure Hub, 2021).
226. For ambient air pollution, for example, this is well-established for North America; hard evidence for low income countries is limited, but appears in line with that experience: see Hajat, Hsia and O'Neill (2015),

the experience has been that while congestion pricing schemes are often opposed at the outset—the appearance of charging for something that was previously 'free' is always problematic—they do gain acceptance, or at least toleration, once they are in place and evidently succeeding in their aims.[227]

With congestion set to become increasingly dire in much of the developing world—not least in the priority countries—pricing measures need to be elevated as a key element of the response. Developing strategies to deal with congestion is time-consuming and technically challenging, requiring expertise in a range of areas; delay in elevating analysis and consideration of pricing schemes not only prolongs the damage suffered but risks making it still harder to overcome opposition.[228]

227. Van Amelsfort and Swedish (undated), Table 5.
228. In some cities, notably New York, reduced travel during COVID-19 and ongoing changes in work practices have been seen as likely to reduce opposition to congestion pricing. As noted, however, travel in urban Africa appears to be back to pre-pandemic levels.

Part 4: Further issues

This part takes up three further issues. It first considers the use of a class of instruments whose potential application spans a range of environment issues: tax incentives. It then turns to two areas in which, rather than addressing problems over which they exercise some direct control, as in the previous part, developing countries must react to challenges whose source is beyond their control. The first is adapting to climate change: that is, limiting the damage they will otherwise suffer. The second is responding to the coming adoption by the EU and perhaps others, of a Carbon Border Adjustment Mechanism.

A. Tax incentives

The general principle of taxing bads rather than subsidizing goods warrants inherent caution in the use of tax incentives—more favorable tax treatment than standard—in pursuit of environmental objectives. This is especially so where, as in developing countries, the need for revenue is dire. Experience with tax incentives has not been happy, including in developing countries: not only do they undermine the overarching revenue imperative, they have all too often been ineffective (including in offering support for activities that would have been undertaken without them) and prone to governance problems. There may, nonetheless, be cases in which this is an appropriate policy: perhaps because the distributional consequences of a tax-based approach would be unacceptable given the tools for compensation available, or because the activity to be discouraged (failure to innovate, say) is unobservable.

Such evidence as there is suggests that the use of environmentally-motivated tax incentives remains relatively modest in sub-Sharan Africa. The Global Tax Expenditures Database (GTED), which provides comprehensive and detailed information on tax incentives in a large number of countries, reports only five countries in sub-Saharan Africa—out of the 27 that it reports on—as providing incentives whose aim is to "promote environmental sustainability"[229] (Table 4.1). In only Benin and Burkina Faso do these account for more than 10 percent of the revenue foregone through all tax expenditures.

229. For two of those not covered, Côte d'Ivoire and Senegal, there are no signs of such tax incentives in the data.

Table 4.1: Environmentally-motivated tax incentives, in percent of total revenue foregone through tax expenditures

	2015	2016	2017	2018	2019
Benin	-	5.72	8.31	13.41	9.86
Burkina Faso	4.82	10.31	10.56	10.30	-
Cameroon	-	-	0.78	0.01	-
Madagascar	-	2.07	1.66	-	-
South Africa	0.08	0.54	0.53	0.27	0.72

Source: GTED database.

Note: "-" indicates not available.

Many of these provisions aim to promote the use of relatively clean fuels, including solar and wind power. Their nature (and number) vary quite widely, and in some cases the environmental motive is hard to detect,[230] or somewhat peripheral.[231] A recurrent objective, nonetheless, is the promotion of solar and wind power. This is pursued very systemically in Cameroon, which stands out as having an apparently comprehensive suite of measures to this end: a whole range of items associated with the use of solar and wind power are excluded from VAT.

Strikingly, the great majority of incentives operate through the VAT—which may be problematic. Some take the form of customs exemptions (and could be argued to bring the tax system closer to a preferred state irrespective of any environmental concern); only one—a corporate tax deduction for energy-savings in South Africa—operates through the income tax. There is logic in the reliance of the rest on VAT reductions to the extent that the intention is to encourage purchase by final consumers or traders below the VAT threshold as, for instance, with solar powered water heaters in Madagascar. In most cases, however, the tax break applies to items that seem likely rather to be inputs into further production—wind turbine blades, for example. In this case, with a well-functioning VAT, rate reductions have no effect, since the purchaser in any case receives a credit for any VAT they are charged. VAT exemptions, moreover—which is how the source describes these measures—actually discourage the domestic production of such items, since they imply that while no VAT is charged on sales, no input VAT charged to the producer is recovered: tax paid on the final product is thus higher than it would have been had normal VAT been charged.[232] In either case, in a well-functioning VAT system,

230. It is not clear, for example, what environmental purpose is served by the exemption of color TV receivers in Burkina Faso.

231. Benin, for example, is reported as exempting from VAT motorbikes with four stroke engines—favoring them over two stroke engines, which emit more hydrocarbons, carbon monoxide and particulates. (Another example, incidentally, of reliance on subsidy-like measures when tax measures (higher taxation of two stroke vehicles) would be the more efficient policy, though perhaps seen as less attractive distributionally).

232. Indeed domestic production may be disfavored relative to imports, which benefit from zero-rating—meaning full recovery of input VAT—abroad.

favorable VAT treatment of inputs into solar and wind power generation, and other environmentally sound items, is either ineffective or harmful. The only rationale for such treatment can then only derive from the VAT not in fact functioning well, so that reduced taxation of inputs does reduce input costs at subsequent production stages. Effort might be better focused on strengthening the VAT—once again emphasizing the importance to achieving environmental objectives in an efficient way of pursuing the wider DRM reform agenda.

While not yet extensive, there is thus some cause for concern in the use of environmentally-motivated tax incentives—standard guidance on the use of incentives is relevant, with some particular aspects to stress. Pressures to offer such incentives seems likely to grow, and guidance on the use of tax incentives in general. as provided perhaps most fully in Platform for Collaboration on Tax (2016a,b), applies. This guidance stresses, for example the greater effectiveness of cost- rather than profit-based incentives (a criterion that most of the measures above satisfy) and the need for transparency in the award, monitoring and assessment of incentives. Some elements of advice, however, stand out especially forcefully in the environmental context:

- ***Consider whether non-tax measures may be more effective:*** For example, the use of the VAT to encourage solar and wind energy, just seen to be highly problematic, may be less effective than judicious use of generous feed-in tariff rates.

- ***Require that all tax incentives be approved by the ministry of finance:*** With environment-related responsibilities shared across many line ministries, it is important to guard against the risk—which has been a very real one-in other contexts—that line ministries are in a position to grant tax breaks.

- ***Monitor effectiveness:*** Rigorous assessment of the costs and, so far as possible, benefits of incentives need to be assessed, both before their adoption and during their implementation.

- ***Include sunset provisions:*** Especially in the use of renewable energies, the objective is to support movement to a new structure that will ultimately prove self-sustaining, Tax measures, accordingly, should be thought of as transitional. Including a terminal date, though with the possibility of continuation, provides a mechanism both for continued assessment of the effectiveness of and need for support through the tax system.

- ***Consider the implications of the global minimum tax now entering into effect.*** Unless they are carefully structured,[233] any incentive that brings the effective corporate tax rate on entities within scope of the minimum below 15 percent will be negated by these new rules.

233. In the form of a 'Qualified Refundable Tax Credit,' as described for instance Devereux, Vella and Wardell-Burrus (2022).

B. Adaptation to Climate Change

While much adaptation will occur—is occurring—spontaneously, public intervention will have a key role. Especially for slow-moving effects, adjustment can be expected to take place gradually in much the same way as it does to other transformations in the wider economic environment: farmers will try different crops, people and businesses will move to where water supply is more assured, hotels will close in unmanageably hot locations and open where temperature are milder. These changes can be disruptive and painful—migration especially so—but the natural role for public policy is to ease such 'autonomous' adaptation through measures of social support, just as for other sources of economic change. Only a few years back, it was possible to argue that the consequent role for government was very limited.[234] But few now argue this. The failure to launch on aggressive mitigation, increased understanding of the generality and depth of the effects (especially for publicly-provided infrastructure and social support measures, and including in relation to rapid-onset disasters) along with recognition of the market failures and imperfections that may impede adaptation—all mean that the need for government to take a proactive role in delivering and promoting adaptation is now generally accepted. Accepted, that is, in principle, though action in practice has fallen far short of rhetoric.

The need for additional public expenditure on items with elements of publicness, and on social support, is clear.[235] Coping with climate change calls for upgrading or reinforcing items with public-good like characteristics, perhaps within some locality. This means that while some private initiatives may emerge,[236] it is likely to be inadequate: examples include improved weather projection services, strengthened sea defences and research into crop resilience. Coping also means reinforcing measures of social support whose provision is a central function of government: protecting those most vulnerable to local weather changes, coping with increased health care costs, and support to deal with potentially higher water prices, for instance.

Estimates of the amounts needed vary widely, but—relative to GDP—they are likely to be quite substantial in many developing countries and Small Island Developing States (SIDS), and extremely high in a few. Quantitative assessment is difficult: many items (such as strengthening health systems to cope with increased risk of vector-borne disease) are hard to distinguish from development-oriented

234. To Tol (2005), p. 577) for example: "National governments and international organizations have little to do with adaptation, and should not try."
235. In some contexts, climate change may reduce elements of public spending: fewer winter deaths in now colder countries. Any such effects seem likely to be very minor, however, in developing countries.
236. As, for example, with the building of the dikes in the Netherlands, undertaken privately and leading to the emergence, which continues, of water boards with quasi-governmental revenue-raising powers.

spending more generally;[237] needs vary considerably across countries and even localities; they depend on projected climate developments; and 'need' depends on the targeted degree of protection.[238] Estimates, correspondingly, vary widely. In terms of average effects, for 2050 they range from negligible to annual spending of about 0.3 percent of global GDP. For developing countries, however, they are higher: for 50 or so they exceed one percent of GDP annually, and for some SIDS may be 20 percent.[239] For sub-Saharan Africa, the need has been put at 2-3 percent of regional GDP for the next decade. [240]

Domestic tax revenues will likely have to play a key role in financing this additional spending. From a global perspective, the amounts at stake are not unmanageable—given enough cooperation and goodwill. There has indeed been much focus on delivering support in the form of climate finance, from both public and private sources. The results so far, however, have not been impressive: the target of USD 100 billion[241] by 2020 was missed, and incentivizing private finance to address public-good type needs (including through public-private partnerships and other forms of blended financing) has evidently proved difficult. Realistically, much of the finance for adaptation will have to come from domestic revenue sources.

Adaptation needs thus amplify the general imperative of strengthening domestic tax systems. Even a one percent increase in the tax ratio is a substantial matter for many developing countries. These additional spending needs are just part, moreover, of those needed to meet the SDGs; and, for disaster prone countries, the need for some pre-financing of recovery measures. Rising even some way towards these challenges requires further progress on the basic improvements to tax policy and administration encompassed in the broad DRM agenda.

The scope for specific tax policy initiatives to guide adaptation, in contrast, appears limited. In principle, there might be scope for tax measures to ease autonomous adaptation where price signals are not conveying adequate incentives.[242] Tax might be levied, for instance, on seeds for crops known but not generally recognized to have more resilient alternatives, or on firms and individuals establishing in areas increasingly prone to storm surges. In many contexts, however, the provision of information and regulatory measures may be more targeted and adept in moving private choices than tax measures which must, for practical purposes, take relatively crude form:[243] Box 4.1 illustrates and amplifies on this for adaptation in agriculture.

237. There is also some overlap between measures supporting mitigation and those strengthening adaptation: reforestation, for instance, can help preserve air and soil quality (a program in Niger is credited with having improved crop yield, for example) and, in cities, ease urban heat islands.
238. Full 'climate-proofing', for example, may well be inefficient. Cost may also depend on when remedial action is taken, which is itself an important decision (there being a potential value in the option to wait until the extent of climate change to be managed is clearer).
239. This estimate is from Aligishiev, Bellon and Massetti (2020), whose Figure 2 is the source of the previous sentence.
240. Chapter 2 of International Monetary Fund (2022b).
241. For both mitigation and adaptation: the former, so far, has received much more resourcing than the latter.
242. In some cases, however, it might be that retreat is the best response, as noted in Part 2.A.
243. The action-focused report of the Global Commission on Adaptation (2019), for example, contains no recommendation for specific tax measures.

That said, however, the economics of adaptation remains a largely undeveloped field, lagging far behind work on mitigation.[244] This is just as true—possibly more true—of tax aspects as it is of any other. It may be premature to write off a purposive role for tax policy just yet.

One area perhaps warranting more attention, for example, is in relation to the pricing of water. This is likely to become an increasingly problematic issue: the number of people without adequate water access for at least one month per year has been projected to increase by around 50 percent to 2050. Price (in effect, tax) measures are likely to be both critical and contentious in addressing this challenge, but have received relatively little analytical attention.[245]

Box. 4.1: Adaptation in agriculture: What role for taxation?

Adaptation can greatly dampen the adverse impact of climate change on agricultural activity, but the measures required are highly context-specific and highly detailed… *One study finds, for example, that adaptation of wheat cropping systems can increase yield by 10-30 percent (depending on climate outcomes.)*[246] *What efficient adaptation requires, however, is highly context-specific. It may involve, for instance, using more drought-resistant plant species and/or more intense irrigation and/or different forms of irrigation, with the choice differing across even geographically close areas. It may involve changing planting times, a different mix of hard and softwood trees in forestry. And so on: "The immense diversity of agricultural practices…means there is a correspondingly large array of possible adaptation options."*[247]

…so that the scope for purposive corrective taxation is limited. *Varying tax rates across actions and even localities to ensure that the private costs of each of this immense variety of options is broadly corrected for any imperfection in private sector responses is problematic—to say the least—both intellectually and practically. Intellectually, uncertainty as to the benefits of alternative actions in relation to likely climate developments appears to remain high. Practically, while it may be technically feasible to vary tax rates on seed type by drought-resistance, for instance, or to use remote imaging to detect planting times and tax farmers accordingly, the potential administrative and compliance burdens (which would need to be assessed relative to the additional benefits to the environment and to public revenue), would clearly be a major obstacle. There may at some point emerge well-defined items of input or of practice for which there is a well-developed case for corrective taxation to encourage appropriate directions of adaptation in agriculture. For now, however, there appear to be none.*

244. Global Commission on Adaptation (2019, p.60) notes plaintively that: "The growing body of economic research on adaptation…has not generally been translated into practical tools to inform decision-makers." In the tax area, there is not even yet such a body of research.
245. There are of course exceptions, as for instance IMF (2015b).
246. See Table 1 of Howden et al. (2007).
247. Howden and others (2007).

The best-established and primary role for taxation in relation to adaptation is thus to help meet the macro-fiscal challenges it poses. As a source of revenue to this end, environmental taxes have no particular significance. In presentational terms, however, even non-environmental taxes can be labelled and perhaps to some extent earmarked to serve environmental purposes. In Fiji, for example, an 'Environment and Climate Adaptation Levy' is charged not only (at 10 percent) on the turnover on selected services but also on income over a threshold level. Several elements of the former might be seen as having a corrective element,[248] and this accounts for the bulk of the revenue. The levy on income,[249] however, has no evident corrective element. In any event, almost all the proceeds have been spent on environmental projects, overwhelmingly on adaptation rather than mitigation.[250] The question, however, is not only whether such spending is higher than it would have been without the labelling/earmarking—it seems unlikely to be lower—but whether it has improved, or, to the contrary overly constrained, the overall composition of public spending.

Within this overarching imperative, some general principles of tax policy can help attune tax systems to adaptation needs. These include:

- ***Avoiding tax impediments to private sector adjustment.*** Adaptation may require farmers to undertake more borrowing, for instance, supporting which may require ensuring adequate deductions for interest payments by those large enough to be appropriately included in the formal income tax. For small farmers below the threshold for inclusion in the regular tax system, it may mean moderating the burden of any presumptive tax that is applied to them instead. Adaptation may also require enhanced risk-taking, which calls for adequate loss-carry forward provision, perhaps limiting the progressivity of the income tax, as well as basic income support.[251] Tariff policies may also require review.

- ***Caution in the use of tax incentives.*** Pressure to grant tax breaks for adaptation-promoting actions can be expected to become increasingly intense. All the remarks on incentives above thus apply, including the need for considerable circumspection in their use. A first test should be to ask whether the better policy is not instead to tax activities that run counter to adaptation priorities: rather than subsidize new construction in areas less prone to storm damage, for instance, tax the construction in areas that are prone. In other cases, direct spending may be more efficient: allocating research and development support to specific projects with clear spillover benefits may allow better targeting than does providing deductions for projects whose objectives may more easily be tipped towards private rather than social gain. This is not to say that tax incentives can never have a

248. The tax is levied, for instance, on hotels and tourism-related services, so might be seen as correcting for associated adverse environmental effect these may have, as well as on plastic bags.
249. And, similarly, the application of the levy to luxury yachts.
250. Part is formally allocated to a Climate Change Relocation Trust Fund intended to mobilize donor support for climate-related spending.
251. This is because the increasing marginal tax rates generally associated with more progressive systems mean that the additional income in good outcomes is taxed more heavily than liability is reduced in bad outcomes.

constructive role: in some cases, for instance, governance problems may be even greater on the spending side. It suggests, however, setting a high and well-defined bar for creating such incentives, and, at a minimum, establishing clearer procedures for their award and systematic monitoring than has often been the case.

C. Responding to Carbon Border Adjustment Elsewhere

The EU's commitment to introduce the world's first Carbon Border Adjustment Mechanism (CBAM) is a major development for carbon pricing policies. The essence of a CBAM is the imposition of a tariff on imports at a rate equal to the excess of the domestic carbon price rate over the effective price that has been charged on the carbon embedded in those imports.[252] Adoption of such a scheme by the EU represents a marked and unprecedented development in international environmental tax policy, and others may soon move in the same direction: both the Canada and the UK, for example, have held consultations on the topic. Trading partners now need to consider the implications, and how best to respond.[253]

The nature of CBAMs in prospect

There are three main rationales for adopting some form of CBAM, which reflect both national concerns and some concern with the wider global environment. One argument for CBAM is that it negates the adverse competitive impact of carbon pricing on domestic enterprises by ensuring equality of treatment with international competitors; that limits the disruption to domestic economic activity, and may also help garner political support for more ambitious carbon pricing. The second is that it limits the risk that increased production abroad ('leakage') will reduce or even reverse the reduction in global emissions that would otherwise arise. There is conceptual merit to these two arguments: if, for some reason, carbon prices in some countries are constrained away from levels that are ideal from the global perspective, then collective efficiency requires that those countries which are not constrained adopt something akin to a CBAM.[254] The third argument for CBAM—albeit seen by some as veering too close to infringing others' sovereignty—is that it will induce the countries whose exports will attract the carbon-based tariff to instead adopt more aggressive carbon pricing themselves. The concern in the discussion here is not to provide a detailed assessment of these arguments, or of the question as to whether other instruments might better serve these aims, but with how their adoption elsewhere might affect developing countries and how they, in turn, should respond.

252. In principle, a CBAM might (one could argue 'should') also remit a similar 'excess' carbon charge on exports. In practice, however, most proposals, and the EU scheme, do not do this, and we therefore presume in what follows that there is no export rebate.
253. For a relatively brief overview of key issues in the design and implementation of CBAMs is in Keen, Parry and Roaf (2022) and online appendices. Topics covered there that are set aside here include the important question of how non-price measures that have mitigation effects similar to carbon pricing will/should be treated and the WTO-consistency of CBAM schemes (which remain speculative until the issue is litigated). The latter are addressed in more detail by Parry and others (2021)).
254. Keen and Kotsogiannis (2014).

The EU CBAM will come into full effect in 2026. The initial proposal by the European Commission in July 2021[255] was agreed by the Council in March 2022[256] and the regulation became effective in May 2023. Importers will be required to report on carbon content from late 2023, with full transition, including financial payments, by 2026. Some detail remains to be addressed, but the core design features of the scheme, relevant for the impact on low-income countries, appear reasonably settled. These include:

- The import charge will apply only to cement, aluminum, fertilizers, electric energy production, iron and steel, and hydrogen;
- It will apply only to emissions directly associated with production in these sectors; that is, carbon embodied in the inputs of these sectors will not be included;
- There will be no export rebate/exemption; and
- There are no exclusions for developing countries or LDCs.

The wisdom of these features is debatable, but their importance here is in how they will shape the likely impact on developing countries.

Assessing the magnitude of the impact on developing countries

Developing countries are typically exporters of embedded carbon…. One estimate is that of the carbon embedded in goods produced in low-income countries, more than half is embedded in exports to the rest of the world; for Africa, the figure is around 25 percent.[257] This suggests that low-income countries could be quite heavily exposed to the application of a CBAM elsewhere, though that will depend on other factors too: for example, even if a large proportion of domestic emissions are exported, those exported emissions may be low relative to the total value of exports (in the case, for instance, that emissions intensity of GDP is low and/or exports are large relative to GDP).

…but not in all cases. Indeed all the countries of interest for which data are available are substantial net importers of carbon, except (very modestly) Senegal.[258]

Design features of the EU scheme limit its likely impact on developing country exports, The scheme will apply to only the six sectors listed above, and only in relation to their direct emissions; a good part of the exported carbon from low-income countries may well be excluded from application of the EU CBAM. Less noted, there may also be effects through developing countries' imports; these are taken up below.

255. European Commission (2021a).
256. https://www.consilium.europa.eu/en/press/press-releases/2022/03/15/carbon-border-adjustment-mechanism-cbam-council-agrees-its-negotiating-mandate/
257. See World in Data at https://ourworldindata.org/grapher/share-co2-embedded-in-trade. This appears to have greater coverage of low-income countries than other data on embodied carbon (such as Yamano and Guilhoto (2020)), which has no coverage for sub-Saharan Africa (other than South Africa), but that coverage is nonetheless limited.
258. Imported emissions relative to domestic emissions (in percent) are: Benin, 27.4; Burkina Faso, 25.5; Côte d'Ivoire, 46,9; Ethiopia, 31.8; Madagascar, 31.0; Senegal, -0.6; Togo, 211.7. That Africa nonetheless emerges as a net exporter must, it seems, reflect the weight attached to net exports from South Africa and Tunisia.

The limited empirical work on the issue suggests that the aggregate effects may indeed be modest (for now). Simulating the impact through a computable general equilibrium model, UNCTAD (2021)[259] find that adding a sectoral CBAM, much in line with the EU scheme, to a carbon tax of USD 88 per tonne of CO_2[260] reduces real incomes in developing countries by around USD 10.2 billion, more than offsetting a gain of USD 2.6 billion from the adoption of an EU carbon tax alone. (For LDCs and SIDSs, the CBAM converts a tiny gain into one of USD 0.6 billion—but the assumption in this calculation, counter to the current proposal, is that these would be excluded from application of the CBAM).

In some countries, in some sectors, the impact may nonetheless be significant. European Commission (2021b)[261] identifies a number of sectors in particular developing countries likely to be both powerfully impacted by the proposed CBAM and significant to the broader economy. The most marked of these[262] is the steel and aluminum sector[263] in Mozambique. More than half of its production is exported to the EU, with those exports amounting to 7 percent of GDP; the impact of the CBAM is put (without explanation) at a loss of 1.6 percent of GDP. European Commission (2021b) also mentions two priority countries: Mauritania (iron ore, 10-20 percent of GDP) and Senegal (2-5 percent of GDP in phosphate mining and fertilizer production).[264] While the effects in these cases are evidently sizable, there appear to be relatively few such examples. As the ambition of pricing measures within the EU increases, however, so the effects will become more widespread and more sizable.

Welfare implications and policy choices

The question then arises as to how an exporting country (developing or other) might best respond to the adoption of a CBAM by the importing country. Of course, there is in any event an incentive to adopt some form of carbon pricing to address local pollution and contribute to global mitigation efforts. This environmental incentive, however, is broadly unchanged by the implementation of a CBAM elsewhere, so can be set aside in considering the best response: Does the adoption of a CBAM abroad, for example, strengthen the case for carbon taxation at home? Key considerations here are that:

- ***There is a case for imposing an export tax on embodied carbon to offset the carbon charge that the CBAM-imposing country levies at import.*** An offsetting export tax always makes conceptual sense because it has no effect on the exporting businesses—they care about the total tax they pay, not to which government they pay it—and simply transfers tax revenue from the CBAM-imposing country to the exporting country.

259. Table 6.
260. As at May 31, 2022, the EU-ETS price is around USD 90 per tonne.
261. Tables 3.1 and 3.2.
262. Also highlighted by Pleek, Denton and Mitchell (2002).
263. Aluminum has a wider significance in this context: it is the sector covered by the proposed CBAM for which the share of imports from LDCS in total EU imports is highest, though still less than 5 percent (Lowe, 2021).
264. The other case highlighted by European Commission (2021b) is Sierra Leone (iron ore, 3-15 percent of GDP). Pleek, Denton and Mitchell (2022) also mention Mozambique, Ghana, Cameroon, Zimbabwe, Zambia and Nigeria as particularly exposed, but with no detail.

- ***Going further and applying that same offsetting tax to all domestic production—a true carbon tax—will be more attractive than it was in the absence of the CBAM.*** This, intuitively, is because part of the loss from unilateral adoption of a carbon tax—a reduction in domestic production and consequent loss of surplus—becomes irrecoverable once a CBAM is imposed. The (non-environmental) benefits of the carbon tax in terms of revenue consequently loom larger. (A more precise account of the various considerations at work, which become quite complex, is in Appendix 3).

- ***Nonetheless, responding to a CBAM abroad by moving to a full carbon tax may not be warranted.*** Assessing the case for doing so requires gauging a trade-off: between the additional tax revenue generated and the (greater) loss of welfare to consumers from the consequently higher domestic price.[265] Two quantities are critical here. One is the social valuation of that additional revenue: only if it is sufficiently high will it be desirable for the exporting country to establish a general carbon tax for that sector. The other is the proportion of domestic carbon emissions embodied in exports: the higher this is (and hence the lower the portion embodied in domestic sales), the lower is the welfare loss on the demand side. Evidence on this proportion for many developing countries as noted above, is scarce; but there are signs that in many cases it may actually be low, and the incentive for broader carbon pricing correspondingly weak: only about 3 percent of the domestic carbon emissions of China and India, for example are embedded in their exports to the EU and US.[266]

On the import side too, non-CBAM-adopting countries may also be affected by an EU-style CBAM if it leads to higher carbon pricing by adopters. If—as under the EU scheme—adopters do not remit the carbon price on their exports, the effect would be akin to their levying an export tax: harmful to consumers in the importing country but providing an element of protection to import-competing producers.

There are also choices to be made by CBAM-imposing countries in the treatment of developing countries—though whole or partial exclusion seems unlikely. Noting that embodied emissions from low-income countries are a very small share of all implicit carbon imports into the EU,[267] some have argued that application of the CBAM to low-income countries would violate the principle of common but differentiated responsibility, and notions of 'climate fairness' based on historical responsibility for the accumulation of the stock of greenhouse gases. One suggestion, for instance, is that LDCs be entirely excluded while a more contingent approach is taken for lower middle-income countries (since some are major emitters). There seems, however, to be little appetite for this. This may in part be because of the additional complexities that would need to be added to rules of origin

265. Recall that we set aside here the rationale for carbon taxation on environmental grounds, since that is broadly unchanged by the adoption of a CBAM abroad.
266. Keen, Parry and Roaf (2022).
267. Implicit carbon imports from India, for instance are less than one per cent of those embodied in EU final demand (Lowe, 2021).

requirements, already an administrative challenge in many contexts; perhaps too because of the possibility of relocation of production, or legal risks under WTO rules.

The use to be made of the revenue collected by the EU CBAM remains contentious, particularly in relation to developing countries. The revenue at stake is modest: the Commission estimates it at around € 2.1 billion per year by 2030.[268] Nonetheless, the issue arises with all environment taxation, as discussed above, and the options in relation to CBAMs parallel those raised there:

- ***Absorption in general revenues,*** as with the Commission's proposal that 75 percent be allocated as an own resource for the Union.
- ***Earmarking to environment-related spending,*** one suggestion being that the funds support technology transfer to and climate related spending in low-income countries.[269]
- ***Compensating payments to low-income countries,*** corresponding to a direct form of compensation for the income effect of the revenue raised.

For the compensation option, there are possible lessons from the agreement to establish a common minimum rate of corporation tax discussed above. The initial proposals for that minimum gave priority to the parent company (analogous to that imposing the CBAM) in collecting any 'top up' tax that might be needed to bring the effective tax rate up to the minimum. But it was quickly realized that the host country (analogous to the non-CBAM country) would have an incentive to pre-empt this by topping up itself—just as exporting country faced with a CBAM has an incentive to pre-empt by imposing an export tax. Recognizing this, the final proposal contains a provision to facilitate the imposition of such a top up tax by the host.[270] One could imagine similar measures that would establish a clear and accepted legal basis for low-income exporting countries themselves to cleanly and simply impose and collect the revenue from, the CBAM themselves.

There may be simpler ways of serving core purposes of the CBAM while respecting the particular circumstances of low-income countries—such as agreement on a minimum carbon price. As proposed by Parry, Black and Roaf (2021), for instance, rather than subject low-income countries (and LDCs in particular) to either full CBAM on the one hand or partly/wholly excluding them on the other, application of the CBAM might be waived so long as the applied carbon price exceeded some consensually agreed minimum level.

268. European Commission (2021a) p. 47.
269. As for instance in Pleek, Denton and Mitchell (2022).
270. This is the 'Qualified Domestic Minimum Top-up Tax'.

Part 5: Lessons and guidelines

This final part brings together key conclusions from the discussion above.

General considerations

Several 'global' environmental problems can be eased by action in developing countries—but 'local' problems provide them with a far stronger imperative to act

Notably, even apart from any global benefit, local co-benefits (reduced air pollution) make a strong case for tax-based measures to mitigate CO_2 emissions. With some exceptions, moreover—such as perhaps in relation to forestry—developing countries' contribution to global environment problems are relatively modest; even though they suffer from climate change, they can do little to mitigate it. From their own perspective the most pressing problems over which they can have some influence—such as the over-use of chemical fertilizers and pesticide and in waste management—are primarily local in nature.

Many of the most intense environmental problems faced by developing countries have received little attention from the tax perspective—in part, perhaps, because information is scant

Waste management, sanitation and the provision of drinkable water, for example, emerge as among the most major environmental problems in all virtually of sub-Saharan Africa. This has been widely recognized from a project development perspective, but these topics have received very little attention in terms of developing supportive tax and pricing policies. Systematic comparative information of policies that have been adopted, and their impact, is extremely hard to find, which hampers work in the area. This neglect may partly reflect a lack of interest relative to topics that are of more policy and academic interest from an advanced economy perspective.

Taxation is not necessarily the best response to environmental problems, and on its own, is rarely enough

In some cases, regulation may be the superior instrument, whether in terms of ease of implementation (in relation to the use of plastic bags for instance) or because risk of exceeding catastrophic tipping points under price-based measures is unacceptably high (as for example in respect of some fishing methods). Regulation may also imply a lesser need for compensatory payments, and the additional practical and political complications that can create. Even when taxation does have a key role, moreover, regulatory measures are often a useful complement (limiting effects from excessive use of pesticides, for example, or as an adjunct to rules on waste

disposal). In other cases, tort law may have an important role. Moreover, charging a price to polluters still leaves potential scope for investment to limit the damage that the pollution causes: spending measures (other than cash transfers) also have an important role (investment in urban transport infrastructure, for instance, as part of a package includes congestion pricing).

Environmental tax reform must often start with subsidy reform

This is true not only in the much-studied area of fossil fuel subsidies, but also, for instance, in relation to fertilizers and pesticides. The latter is another area that has received too little attention, and on which information on fiscal aspects is scant—but whose scale and social importance has been highlighted by the huge political and economic damage from the ban on chemical fertilizers and agrochemicals in Sri Lanka in 2021. Other forms of agricultural subsidy raise similar concerns.

Taxation is most likely appropriate when environmental problems come from readily observed 'pollutants' generated by products that are used by many and/or can be taxed 'upstream'

These are the circumstances in which establishing a uniform charge on users is important to achieve abatement in the least-cost way, the tax base is readily defined, and—consistent with standard tax administration advice—revenue collection can be concentrated at a few easily monitored points: at import/export or in the hands of a relatively small number of sizable entities. Leading candidates meeting these conditions include not only fossil fuels but also chemical fertilizers and pesticides, export charges on forest products, and waste disposal.

The additional net revenue is unlikely to be transformative…

The biggest ticket items are in the taxation of fuel—perhaps 1.5 percent of GDP in sub-Saharan Africa—and (to an unknown degree) fertilizers, pesticides, and perhaps forestry. Much though not all of this additional revenue will likely be needed for compensating measures (see below). And in some cases the objectives that a tax might serve also call for some public spending: parallel to the case for some charge on waste disposal, for instance, is the need to support spending on collection and responsible processing. Relative to needs (which, in terms of achieving even a subset of the SDGs, are in the order of 10-15 percent of GDP for some low-income countries), the amounts made newly available for other government spending, while significant, do not diminish the urgency of the broader and difficult tasks of tax system improvement more generally. In some areas of environmental interest, moreover—notably in the hydrocarbons sector—there may be downward pressures on revenue to face.

…so that the primary case for environmental taxation remains an environmental one

The principal benefits of environmental tax reform are likely to be for individual well-being—especially for the poorest and most vulnerable—rather than for public finances. Environmental taxation should not be thought of as an easy way to sidestep wider DRM challenges.

Political considerations

The compensation of losers is key not only to the intellectual and moral case for environmental tax reform but also, experience suggests, for its political acceptability

Often forgotten, the fundamental welfare rationale for corrective taxation is not simply that it reduces adverse external effects to efficient levels: it is that, when combined with judicious transfers, it can be a source of gain for all—including, not least, those adversely affected by the tax. And this point becomes a moral imperative when, as is typically the case in developing countries in particular, leading candidates for reform—increased prices of fuels and some agricultural inputs, for example—are likely to bear especially heavily, both directly and indirectly, on some of the poorest and most vulnerable. The fact that they may in some cases also stand to gain the most from limiting environmental harm (through improved air quality, for example) does not detract from the sheer impact that such reforms will have on the affordability to them of key commodities. Importantly, while subsidies (and under-taxation) may be regressive in the sense that the benefits go disproportionately to the better off, they typically do convey some benefits to the least well-off—so their removal implies some harm. And the fate of all too many reform efforts has been to trigger intense hardship and discontent—especially, perhaps, when there is discontent with government more widely[271] —that find expression in street protests which lead to rapid policy reversal; which in turn makes it less likely that future governments will have the courage to try again.

Successful reform strategies, such as the subsidy reforms in India and Iran, require carefully-prepared, credible and effectively-communicated measures to compensate the most vulnerable losers.

Technology and broadening financial inclusion are making compensation increasingly practicable

When individuals have access to bank accounts and can be comprehensively and accurately identified, and appropriate technology is in place, direct cash transfers can be made as direct compensation for environmental (and many other

271. Keen and Slemrod (2021) argue that when major tax revolts occur they are typically bringing to a crisis wider social and political tensions.

efficiency-improving) tax increases. The successful and large fuel subsidy reforms in India and Iran were preceded by major efforts to open tens of millions of bank accounts—with wider benefits even beyond the reform itself. In India, the biometric identifier Aadhaar provided confidence that coverage was essentially universal, and with little risk of duplicate payments. Even without such a complete infrastructure for direct cash payments, recent experience, not least during the pandemic, has shown the potential to use mobile money as a way to make payments that reach deep into the population (as for instance in Togo). With the increased use of digital techniques, and spread of biometric identifiers, there is here real cause for optimism.

Uniform 'poll subsidies' may have particular appeal for delivering compensation

The attractions in this context of uniform poll subsidies—the same cash amount for all—are that they avoid the additional informational requirements needed for means-testing, and (given the likely strong skew in the distribution of the benefit of the subsidy) can ensure that a majority of the population benefits from the reform package while still leaving substantial additional revenue to be spent for other purposes. Moving forward, means-testing can allow more targeted compensation (hence reducing the fiscal cost of compensation), which may also be needed to deal with environmental tax measures that have local rather than national consequences (as, for instance, with charges for waste management).

Commitment, communication and planning are often said to be key—but what needs to be stressed is how extraordinarily intense the efforts (and risks) need to be

Recognizing these three requirements is easy. What is not easy is delivering them with the required force:

- Major reforms require not only some presence from high political figures, but the involvement at presidential or prime minister level to a degree that risks political careers—which can be ruined by unsuccessful reforms (as, most recently, in Sri Lanka) and, in some cases, even by successful ones.

- Effective communication is not just a matter of a few advertisements but of ongoing and intense campaigns across a range of media and in a variety of forms: the billion text messages in local languages sent in India, for instance, or the daily newspaper reports of progress on registration in Iran.

- Planning requires more than a clear vision of the reform. It may need: potentially sizable investments in accompanying infrastructure (such as opening bank accounts and strengthening information systems); enhancing cooperation across multiple agencies that may not be used to working together (the ministries of agriculture and finance, for example) and with the private sector (on banking

issues, for instance); and accompanying non-tax measures (such as the training of farmers needed to secure effective movement away from chemical fertilizers). The demand on scarce skills in low-capacity governments remains a significant impediment to effective planning and implementation.

Messaging to the effect that reform is not (primarily) a revenue raiser—and concrete steps lending credibility to that—have played an important role in successful reform

The natural resistance to tax increases, especially where trust in government is low, can be even more powerful when they are levied on services (such as waste management) which, even if barely provided at all were previously not charged for. Compensation provides a firm basis for persuasive messaging in this context: the headline message of subsidies being shifted from things to people has proved notably effective and media advisors could doubtless repurpose it for outright tax increases. Credibility that compensation will be paid also matters: providing cash transfers in advance of reform, but only activating them when reform takes place, is a logical approach.

Contrary to conventional public finance wisdom, revenue from environmental taxes is often earmarked to environmental spending—which may call for a more nuanced view

Such spending, particularly when oriented to business, may serve as a form of compensation, along the same lines as the compensatory payments just discussed. There may be other cases too in which earmarking revenues from an environmental charge to related spending—using waste collection fees to finance recycling plants, for example—may help overcome distrust in government. Even general tax increases may in some cases have enhanced appeal if the proceeds are allocated to environmental ends, as for instance in Fiji. The open (and difficult) question is whether any increase in the prospects of fiscal reform outweigh the powerful objections to earmarking; that (a) if 'hard,' it potentially distorts spending patterns (with risk of either over-spending, when the revenue would be better spent elsewhere, or under-spending, if the earmarked receipts are inadequate); or (b) if 'soft,' the earmarking has no real effect and so simply misleads taxpayers. As the capacity to make direct compensatory cash transfers described above increases, so the dangers of earmarking may be more easily avoided.

Tax System Considerations

The most powerful argument for stronger fuel taxation in developing countries is to mitigate local pollution

Even aside from the question of what responsibility low-income countries should take in the reduction of global emissions, the mortality and morbidity costs of

fossil fuel use through local air pollution are likely an order of magnitude greater than the impact on climate change. On that count alone, significantly higher fuel taxes are commonly warranted.

Where tax implementation is weak, taxation of inputs—fossil fuels being a leading example—may have distinct efficiency benefits beyond any environmental gain

With a substantial informal sector—meaning operators outside the formal system, whether illegally or not—some degree of input taxation may be beneficial in itself. This is because the gain for broadening the tax base offsets the production inefficiency caused by taxing input use. The gain is of course amplified when input use causes environmental harm: in terms of fossil fuel taxation, most notably (but also in relation to fertilizers and pesticides) this consideration amplifies the case for taxation to mitigate local pollution problems. It does not follow however, that the tax should be set even higher than the marginal damage itself, since at some point the loss of production efficiency comes to dominate.

The weakness of tax administration in many developing countries cautions against amplifying established problems of 'nuisance' taxes

However environmentally beneficial their effects might be, any new tax creates additional challenges both for the tax administration in implementing them and for businesses in complying with them. The proliferation of such charges already being a concern in many developing countries, adding to them may carry significant additional costs. It may be, for instance, that savings in administration and compliance costs mean that banning the use of plastic bags is preferable to taxing them, even though the latter may be more efficient and generate at least some modest revenue gain. In this, however, it is not only the absolute but the relative weakness of tax administration that matters. Governance issues may be no less, for example, in relation to approaches to environmental challenges based on public spending, and regulatory agencies may be vulnerable to lobbying that erodes the effectiveness and fairness of environmental measures.

For some environmental problems the weakness of lower-level tax administrations and of local governments own revenues is a significant constraint

This is most obviously so in relation to waste management, where the capacity to implement charges is problematic, and revenues any case unlikely to meet associated spending needs. Restructuring vertical transfers from the central government to help meet these needs, incentivize charging, and perhaps coordinate across localities in dealing with shared problems may be appropriate.

Ultimately, attention is required to granular issues and opportunities in sectoral tax system design.

Key points in relation to those considered in this report (other than fossil fuel use, above) are:

- ***Limiting the adverse impact on fossil fuel producers of more aggressive global carbon pricing may require rebalancing away from royalties and towards rent taxation…*** The adverse effects of royalties on production will become stronger, the risk they pose to marginal production rise, and their revenue yield fall. Some medium-term adverse effect on revenues from a long-term decline in fossil fuel prices and sales would be unavoidable, though the upcoming adoption of the global minimum corporate might cushion the effect. Absent compensation from other countries, the risk of stranded hydrocarbon assets in some developing countries is a real concern.

  …but there may also be a real and innovative opportunity for oil producers to exploit the nature of royalties as de facto carbon taxes. In principle, there is no reason why royalties might not be recast as carbon taxes that could reasonably be recognized as such in countries purchasing the fossil fuels, Though now far from current policy dialogue, the possibility may deserve further elaboration and airing.

- ***For many mineral producers, on the other hand, climate action provides significant revenue opportunities that appropriate tax design can help to realize,*** with a strong case in particular for considering more extensive use of explicit rent taxes. New developments provide a need and opportunity to put in place robust arrangements that balance the desire to encourage exploration and development with revenue needs.

- ***Appropriate tax structures in forestry include both a royalty and rent-tax component—but practice lags behind theory.*** There is a strong literature on designing the royalty-type component, and significant support has been provided in this area; why practice remains so poor is not entirely clear.

- ***Fertilizer and pesticide use are prime candidates for corrective taxation.*** The first step is the removal of subsidies—with a clear need, as seen in Sri Lanka, for this to be preceded by extensive training, and attention paid to compensatory measures also needed.

- ***The scope for more purposive tax/pricing measures in addressing waste management problems warrants closer attention.*** The area is a difficult one: practically, given the affordability concerns that pricing may cause and the importance in this area of local administrations, often extremely weak; and conceptually, because of the limited information on this aspect of waste management policies. While the primary need is simply for finance, which might come from general revenues or external sources, the problems are too great for the role of tax/pricing to be ignored.

- ***Beyond potential scope for more rent-extraction in a few countries attracting distant-water fleets, scope to use tax measures to enhance revenue/sustainability in fishing is limited.*** The extent of any such scope, moreover, is more asserted than proven.

- ***With rapid urbanization set to continue, urban congestion pricing will require increasingly serious consideration within wider transport and urban strategies:*** Congestion already causes serious problems of local pollution and simply in terms of waiting time. Pricing congestion, meanwhile, is becoming increasingly feasible; and failure to do so risks distorting infrastructure decisions. Congestion pricing is only part of the solution to transport problem that are set to become only more intense; but may be easier to introduce onto the policy agenda before rather than after damage becomes even more severe.

Environmentally-motivated tax incentives pose much the same risk as any other—perhaps even amplified

The well-known risks posed by tax incentives—of ineffectiveness, and for governance—apply just as forcefully in environmental contexts as in others. Indeed an apparent tendency for the political process to favor subsidizing good things rather than (as is generally more efficient) taxing bad ones, and maybe too the wide range of agencies involved in some aspect of the environment, may make standard guidance (on transparency, assessment, monitoring and control) especially important.

There are few simple tax prescriptions to support adaptation to climate change

Required adjustments are too specific (related to particular crops or regions, for example) to be readily amenable to corrective taxation. The clearest tax implication of the need to adapt to climate change is reinforcement of the need to enhance DRM in general.

The adoption of Carbon Border Carbon Adjustment Mechanism in the EU, and perhaps also elsewhere, raises new issues—which may become more pressing over time

It would likely:

- *Have adverse effects in only a few cases, and do correspondingly little to strengthen incentives to adopt a carbon tax—for now…* A few cases in which substantial damage to economic activity may arise in developing countries have been identified, but adverse effects seem relatively limited—at least with the scope and likely sectoral coverage carbon adjustment envisaged by the EU. Adoption of a CBAM would provide some incentive to introduce domestic carbon pricing elsewhere (by reducing the efficiency loss it creates)—that, indeed, is one of its purposes. But this too will be correspondingly limited.

- *Create an incentive for developing countries to pre-empt a CBAM abroad by imposing their own carbon-related export tax—which advanced CBAM-imposing countries might perhaps facilitate.* Not imposing such an export tax in response to a CBAM effectively transfers revenue to the importing country. There is a strong analogy here with the incentive under the global minimum tax for developing countries to levy a 'top-up' tax themselves, rather than leave this to the some other country. In that context, topping up by the source has been facilitated by the agreement on special provisions. As CBAMs come to be adopted, the possibility of a similar provision in relation to carbon taxation would bear further thought.

Future increases in the aggressiveness of carbon pricing, needed to achieve climate objectives, which countries adopting them may be under increasing pressure to accompany with a CBAM, could evidently make both these issues more germane.

Even from an environmental perspective, wider DRM progress remains key

Even if fully efficient and equitable tax measures were adopted, the profound environmental challenges in developing countries—waste management, securing clean water supplies, unsustainable management of forestry and fisheries—would require substantial revenue beyond that which such measures would raise. Environmental taxation, in that sense, is not a solution to the wider DRM challenges faced by developing countries. And environmental problems add to them.

Appendices

Appendix 1 : Imports of fertilizer and pesticide, selected countries

	Tax Revenue in per cent of GDP [1]	Fertilizer imports in percent of GDP [2]	Pesticide imports in per cent of GDP [2]	Fertilizer + pesticide imports, in percent of GDP	Fertilizer + pesticide imports, in percent of revenue
	Col, A)	(Col, B)	(Col, C)	(= A+B)	(=D/A)
Benin	11,4	0,41	0,32	0,73	6,4
Burkina Faso	19,5	0,45	0,12	0,57	2,9
Burundi		1,01	0,26	1,27	
CAR	8,9				
Chad	10				
Comoros	9,5		0,02		
DRC	8,7	0,14	0,02	0,16	1,8
Djibouti	16,9				
Ethiopia		0,52	0,13	0,65	
Gambia	13,3	0,03	0,04	0,07	0,5
Guinea	12,6	0,12			
Haiti	6,6		0,04	0,04	0,6
Liberia	14,4				
Madagascar	11,2	0,21	0,12	0,33	2,9
Mali	18,6				
Mauritania	10,4		0,03	0,03	0,3
Niger	10,5	0,11	0,02	0,13	1,2
Senegal	17,9				
Togo	14,8	0,48	0,09	0,57	3,9
Averages	**12,74**	**0,35**	**0,1**	**0,41** [3]	**3,2** [3]

Notes:

1. From IMF WoRLD revenue data set.
2. From Food and Agriculture Organization database at https://www.fao.org/faostat/en/#home; consulted 09/04/2022.
3. Over only countries for which data are available for both fertilizers and pesticides.

Appendix 2: Implications of the Pillar Two; The global minimum tax

The headline feature of 'Pillar 2' of the G20-OECD led October 2021 agreement on international tax reform[272] is an effective global minimum tax rate of 15 percent. Behind this, however, is important detail. Key features are that the minimum will apply to each entity of multinationals with global sales of at least EUR 750 million—which will include many extractive companies—and take the form of a 'top-up tax' that is charged, at a rate equal to the excess of 15 percent over the ratio of 'covered' taxes to accounting profit, on a base that is equal to 'excess profit', defined as the amount by which the entity's financial profit exceeds a 'carve-out'[273] that is mechanically related to its tangible assets and payroll. The meaning of 'covered taxes' is particularly important for the extractive industries. It is primarily intended to encompass standard corporate income taxes; it seems too that it also includes rent taxes.[274] Importantly, however, royalties based only on sales or volume are explicitly not covered: that is, no account is taken of such taxes in topping up tax to 15 percent of excess profits.

The implications for hydrocarbon producers, whether directly affected by the minimum or not, could well be positive:

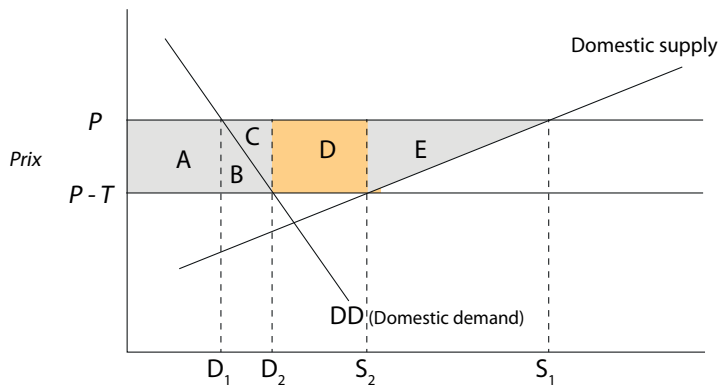
- ***For those not affected:*** Where covered taxes are high enough to avoid application of the top up, there will still be an effect through the reduced incentives for multinationals to shift profits to lower tax jurisdictions, since rates in those lower tax jurisdictions will increase. There is evidence (albeit not specifically for the extractives) that the consequent revenue gain can be significant.[275]
- ***For those that are affected:*** Both an opportunity and an incentive to raise rates of profit-based taxation are created. The opportunity arises because generalized application of the minimum enables effective rates to be raised to at least the minimum without fear that producers will be able to rearrange their activities so as to take advantage of lower rates elsewhere. And there is an incentive to do so because, assuming effectively global implementation, if rates are not increased domestically the top up may well instead be applied by some other country.[276] Moreover, the model rules provide a direct route—the 'Qualified Domestic Minimum Top-up Tax (QDMTT)'—that makes it easy for them to do so. A strong case can then be made for developing countries to adopt such a QDMTT, since failing to do so simply cedes revenue to the parent country without making investing in the country concerned any more attractive (because the investor then simply pays the same amount of tax to another government).

272. A summary is in OECD (2021). There is a Pillar 1, from which extractives are explicitly excluded.
273. Formally, the 'substance-based income exclusion.'
274. This appears to be the implication of paragraph 28 in Chapter 24 of OECD (2022).
275. UNCTAD (2022).
276. This would be a country in which some parent of the concerned entity is located (under the 'Income Inclusion Rule') or, failing that, one in which a sister company in located (under the 'Undertaxed Profits Rule').

Within this broadly positive outlook, there may be pressures to reduce royalty rates, and complications from fiscal stability agreements. Since they are not covered, adoption of common, minimum profit tax rates may make royalties a more prominent focus in countries' attempts to enhance the attractions of their fiscal regimes to investors—and hence potentially more prone to downward pressures from tax competition. As a separate matter, it is fairly commonplace for countries, especially in the developing world, to enter into contractual agreements not to raise their tax rates on particular projects. As a result, they may face legal difficulties in now aiming to pre-empt the topup tax being applied by the parent country. Investors, in principle, are indifferent as to which government levies the topup, so may be willing to enter into renegotiation: in practice, however, their willingness to do so remains unclear.

Appendix 3: How should a small exporter respond to a CBAM abroad?

The figure below considers an exporting country that is small in world markets (setting aside environmental considerations, as explained in the text). Initially, the world price it faces is P, leading it to consume amount D_1, supply amount S_1, and export the difference $S_1–D_1$. Now the importing country—the whole world, as far as the exporter is concerned—imposes a carbon-related tariff, equivalent to a tariff on the good itself of T. The price available to the exporter thus falls to $P–T$, domestic consumption rises to D_2, supply falls to S_2, and exports fall to $S_2–D_2$. In terms of welfare, the loss of producer surplus, the area $A+B+C+D+E$, more than offsets the gain of consumer surplus of $A+B$, leaving a net loss of $C+D+E$



Suppose, however, that this country now imposes an export tax of T structured as one on embodied carbon. This has no effect on either the domestic consumer price (domestic sales being untaxed) or the price received on exports (it is only who collects the tax, not its amount, that changes)—but it raises revenue in amount D. The welfare loss from the application of the CBAM by the importers is not eliminated, but is reduced to the sum of the two triangles, $C+E$.

Next, consider instead responding to the CBAM by levying the same tax *T* on all domestic production, whether exported or consumed at home: moving, that is, to a full-blown carbon tax in this sector. This has no effect on the producer price, which, because of the CBAM, remains equated to the world price less the amount of the carbon charge it faces. So the domestic consumer price (being that producer price plus the charge now also payable on consumption, rises to *P*. This reduces consumer surplus by *A*+*B*. But revenue is now collected on all domestic production, in amount *A*+*B*+*C*+*D*. There is thus a net gain—relative to passively accepting the CBAM—of *C*+*D*.

That is, in this simple setting adopting an export tax is a sensible response to the CBAM and moving to a sectoral carbon tax an even better one. And this is so even though adopting the carbon tax in the absence of the CBAM would have been unwise. That would have implied a loss of *E*: the amount by which the loss of producer surplus exceeded the revenue raised. Intuitively, once the CBA is in place that loss of *E* becomes in effect irrecoverable and irrelevant to policy decisions. What can be recovered through the carbon tax is the export tax revenue initially conceded to the CBAM-imposing country, *D*, and the amount by which the additional domestic consumption induced by the CBAM is valued more highly by foreigners than at home, *C*.

This example is, of course, highly stylized, and relates only to a single sector. Extending the carbon tax beyond that sector would generate losses of surplus elsewhere; the more extensive is carbon use is the rest of the economy, the larger those losses—and the weaker the case for adoption of a generalized carbon tax—can be expected to be.

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Taxation and the environment: an overview of key issues for developing countries

This book is a lightly revised version of a report prepared for the Ministry of Foreign Affairs, France, under the platform Mobilisation des Ressources Intérieures Publiques (MRIP). It provides an overview of core issues in thinking about and advising on tax-based approaches to environmental problems in developing countries. The aim is to bring a rigorous and practicable public finance perspective to the environmental challenges faced by developing countries, with a focus on those over which they have some control. Special attention is paid to nineteen 'priority countries,' mainly Francophone and all but one in sub-Sharan Africa. The hope and intent, of course, is that the discussion and analysis have wider application and interest beyond these countries.

Michael Keen is Ushioda Fellow in Tokyo College, University of Tokyo and senior fellow at CERDI-CNRS-UCA. He was formerly Deputy Director of the Fiscal Affairs Department of the IMF.

A preface is provided by Aurélien Lechevallier, Director General for Globalisation, Culture, Education and International Development at the French Ministry of Europe and Foreign Affairs.

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FERDI

63, boulevard François Mitterrand
CS 50320
63009 Clermont-Ferrand Cedex (France)
www.ferdi.fr
+33 (0)4 43 97 64 60