Challenges and Solutions to Environmental Tax Reforms

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Dirk Heine

Dedicated to Philippine, for all her support.

Contents

Nomenclature

BTA	Border Tax Adjustment
CBD	Convention on Biological Diversity
CBDR	Common But Differentiated Responsibilities (under the UNFCCC)
CCS	Carbon Dioxide Capture and Storage
CGE	Computable General Equilibrium (class of macroeconomic models)
CO2	Carbon dioxide
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation (of the ICAO)
CP	Conference of the Parties (to the UNFCCC)
CPF	Carbon Price Floor
CS	Consumer Surplus
EKC	Ecological Kuznets Curve
ETR	Environmental Tax Reform
ETS	Emissions Trading Scheme
FCPF	Forest Carbon Partnership Facility
FLEGT	Forest Law Enforcement, Governance and Trade
FSC	Forest Stewardship Council

G20	Group of Twenty
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GHG	Greenhouse gas
GSMA	Groupe Speciale Mobile (international mobile phone coordinating body)
ICAO	International Civil Aviation Organisation
IEA	International Energy Agency
IMF	International Monetary Fund
IMO	International Maritime Organisation
IPCC	Intergovernmental Panel on Climate Change
IRR	Iranian Rial (currency)
ISEAL	International Social and Environmental Accreditation and Labelling Alliance
LPG	Liquefied petroleum gas
MARPOL	International Convention for the Prevention of Marine Pollution from Ships
MRN	Movement Reference Number (in customs processes)
MRV	Veasuring, Reporting and Verification (of emissions)
NCTS	New Computerised Transit System (of the EU Customs Union)
NDC	Nationally Determined Contribution
NMPC	Nonlinear Model Predictive Control (macroeconomic modeling technique)
NOx	Nitrogen oxides
ODI	Overseas Development Institute
OECD	Organisation for Economic Co-operation and Development

PEFC	Programme for the Endorsement of Forest Certification Schemes
PES	Payments for Ecosystem Services
PIT	Personal Income Tax
PM2.5	Ultrafine particulate matter with a diameter below 2.5 μm
PPP	Polluter Pays Principle
PS	Producer Surplus
R&D	Research & Development
Ramsar	Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat
REDD+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
SO2	Sulphur dioxide
TFEU	Treaty on the Functioning of the European Union
UNFCCC	United Nations Framework Convention on Climate Change
US-IAWG	United States Inter-Agency Working Group on Social Cost of Carbon
USD	US Dollar
VAT	Value-added Tax
VOCs	Volatile Organic Compounds
VPA	Voluntary Partnership Agreement
WHO	World Health Organisation
WTO	World Trade Organisation

Part I

Introduction

Chapter 1

The need for Finance Ministries to engage in environmental law

1.1 Institutional responsibilities for environmental damage

Law categorises societal issues into spheres of responsibility for different institutions, such as the division between issues that fall under the responsibility of the courts as opposed to government. Once an issue has been determined to be the government's responsibility, one still has to determine which administration within the government is in charge of the issue. Within governments, responsibilities are not only defined by hard public law, but also by soft law, such as the administrative schedule of responsibilities through which cabinet allocates societal issues to different line ministries. Each of these institutions, in turn, has legal competence for different types of policy instruments.

Economics, meanwhile, has tended to disregard the association of policy instruments and institutional responsibilities and compare the relative efficiency of different policy instruments, as if policymakers could freely choose between them. For example, many economists have found that taxes are more efficient at reducing environmental problems than regulations. Such purely economic analyses can have limited political applicability if a country has given the administrative responsibility for all environmental issues to an Environment Ministry, but the responsibility for all decisions of tax policy to a Finance Ministry. In this case, the Environment Ministry may not actually be in a position to act on the policy recommendation. Such mismatches could imply that environmental policy is undertaken with the wrong policy instruments, even when the efficiency advantages of other instruments are known, just because those are outside the scope of responsibility for the ministry in charge of the topic.

Once the scopes of responsibility for societal issues and policy instruments are set up, they can become entrenched. Law and Economics scholars should, therefore, periodically reconsider if the institutional setup is adequate, or if there could be substantial efficiency gains from change. A good indicator to establish if such changes would be desirable is whether the nature of the societal problem in question has changed in significant ways since the areas of responsibility have been allocated.

Governments are routinely organised in "line ministries" that deal with sectoral issues, and "central ministries" that deal with cross-sectoral problems. The latter includes the Executive Office of the Head of State, in some countries a Planning Commission, and in all countries a Finance Ministry. Finance Ministries are responsible for tax policy and for non-monetary economic problems that affect the stability of the economy as a whole. Line ministries, by contrast, are allocated to topics that can have broad societal impacts but that are not perceived as a core macroeconomic risk. Usually, these ministries are in charge of regulation and sectoral expenditures, but not of tax policy.

At the time in which environmental policy emerged, environmental problems were seen as such a sectoral issue, and were therefore allocated to a new line ministry. Subsequently, two discoveries occurred. New environmental problems that do impact the macroeconomy evolved – in particular climate change – and economists have increasingly pointed out the cost advantages of tax policy as an instrument for controlling environmental damage. Both discoveries call for scholars of Law and Economics to re-investigate if the allocation of competences should not be reconsidered so that also the Finance Ministry assumes a co-responsibility for this societal issue. This chapter, therefore, collects the evidence that climate change is indeed a macroeconomic risk, so that it requires the attention of the central ministry responsible for the cross-sectoral stability of the economy as a whole.

1.2 Environmental problems pose macro-size economic risks

Climate change is happening, and it is progressing significantly faster than previously expected. Over the earth's history, the climate has always varied, but based on data records reaching back 800,000 years, we know that atmospheric greenhouse gas concentrations have never before risen as fast as in the last 150 years. Within that geological time span, the year 2016 has seen the fastest increase in those concentrations (World Meteorological Organization, 2017). Since modern precision temperature recordings started in 1880, the year 2017 has been the hottest years on record, with the 10 warmest years ever recorded all occurring after 1998 (Blunden *et al.*, 2017). "*It is extremely likely [95-100 %] that human influence has been the dominant cause of the observed warming since the mid-20th century. For the warming over the last century, there is no convincing alternative explanation supported by the extent of the observational evidence*" (U.S. Government Inter-Agency Global Change Research Program, 2017, p. 12). "*Geological records show that the current levels of CO_2 correspond to an 'equilibrium' climate last observed in the mid-Pliocene (3–5 million years ago)*" (World Meteorological Organization, 2017, p. 1), meaning that humans have no experience of adapting their economic systems to changes of this scale; it is an experiment without precedent, with everyone in the test tube.

The damage from climate change is rising and may spiral out of control. To see that we are dealing with macroeconomic risks, it is critical to understand that climate damage may come in both a smooth, gradual type, as well as an abrupt, discontinuous type. Scientifically, there is "*very high confidence in the potential for state shifts*" (U.S. Government Inter-Agency Global Change Research Program, 2017, p. 33) in which the climate system passes tipping points to unleash positive feedback mechanisms of escalating damage, meaning that beyond certain threshold warming levels, the costs of climate change may accelerate abruptly. If human action increases temperature levels beyond certain levels, these increases may trigger positive feedback mechanisms in the climate system which would cause additional, autonomous warming. This additional warming may then spiral out of control, implying that these tipping points could be points-of-no-return. "*The further the Earth system departs from historical climate forcings, and the more the climate changes, the greater the potential for these surprises*" (U.S. Government Inter-Agency Global Change Research Program, 2017, p. 34). "*Their consequences could be high, potentially exceeding anything anticipated by climate model projections for the coming century*" (id., p. 412). "*Therefore, there is significant potential for humanity's effect on the planet to result in unanticipated surprises and a broad consensus that the further and faster the Earth system is pushed towards warming, the greater the risk of such surprises*" (id., p. 34). If these bifurcations are assumed away, "*society may be lulled into a false sense of security by smooth projections of global change*" (Lenton *et al.*, 2008, p. 1792).

Avoiding the crossing of climate tipping points is critical from the point of view of macroprudential policy. It is not certain at which levels of temperature increases these tipping points lie. Based on the scientific consensus (IPCC, 2014), the international community has agreed to translate its legal objective to "*avoid dangerous anthropogenic interference with the climate system*" (UNFCCC, 1992, Art. 2) into the commitment to contain global warming to "*well below 2 degrees Celsius*" (2015 Paris Agreement, Art. 2). For Finance Ministries, the concept of a tipping point is, of course, familiar. Through macroprudential policies, they seek to contain the risk of unleashing crises, knowing that, once triggered, a crisis can be much more expensive to stabilize than the costs of policies to prevent it. For climate change, stabilization might even be impossible (IPCC, 2014) leading to a fat-tailed probability density function for disastrous outcomes (Weitzman, 2011), so there is a clear macroprudential logic to stay on the safe side of tipping points.

Even before any tipping points are hit, climate shocks impose severe macroeconomic damage. Besides the future risk of abrupt increases in cost shocks, climate change also causes more gradual costs. Also these gradual costs are expected to rise over time, partly because greater warming causes disproportionately greater damage and partly because "*the physical and socioeconomic impacts of compound extreme events (such as simultaneous heat and drought, wildfires associated with hot and dry conditions, or flooding associated with high precipitation on top of snow or waterlogged ground) can be greater than the sum of the parts (very high confid-*

ence)" (U.S. Government Inter-Agency Global Change Research Program, 2017, p. 33). The external cost of carbon is therefore commonly modelled as increasing exponentially over time (US-IAWG, 2013), informing the target to contain global warming to 2°C. Also based on these smooth cost increases, it is widely agreed that the benefits of mitigating and adapting to climate change several times exceed the economic costs of such policies (e.g. Stern, 2006).

It is impossible to achieve climate macro-stability without implementing mitigation policy in almost all countries. Quantitatively, it is impossible to stabilize the climate without substantial mitigation efforts in all large countries, even poor ones where other economic concerns are most pressing. "*Staying below a 2°C temperature increase implies that the global carbon budget has to be limited to 800* $GtCO_2$*. This means that by 2050 almost 90 % of coal, half of gas, and two-thirds of oil reserves have to remain unburnt*" (Edenhofer *et al.*, 2017, p. 463), which is impossible without significant climate action including in developing countries where most of the current coal-intensive development is occurring. However, the world is quickly running out of time, as even current and planned coal power plants alone will exhaust half of the remaining carbon budget by 2030 (Edenhofer *et al.*, 2017), in particular in countries where a lack of environmental taxation makes such investments lucrative.

In the Paris Agreement, almost all countries have therefore committed to climate change mitigation. This is a massive structural change in emerging climate law, because – before the Agreement – only developed countries faced binding obligations to reduce emissions. Given their historic responsibility for past emissions, their greater economic ability to shoulder the abatement costs, and their higher per-capita emissions, developed countries are expected to cut emissions more deeply than developing countries (UNFCCC Art. 3), but all countries party to the Paris Agreement have now made a binding commitment to contribute to this mitigation effort through their Nationally Determined Contributions (NDCs).

Failing to implement these climate commitments, in developed and developing countries alike, would almost certainly push global warming above 2 °C, and towards potential tipping points. "*Achieving global greenhouse gas emissions reductions before 2030 consistent with targets and actions announced by governments in the lead up to the 2015 Paris climate conference would hold open the possibility of meeting the long-term temperature goal of limiting global warming to 3.6 °F (2 °C) above pre-industrial levels, whereas there would be virtually no chance if net global* *emissions followed a pathway well above those implied by country announcements*" (U.S. Government Inter-Agency Global Change Research Program, 2017, p. 32). Countries' climate plans (NDCs) must, therefore, be implemented.

Implementation, in turn, will require Finance Ministries to take a central role, for several reasons. The NDCs are inherently cross-sectoral, which requires co-ordination across line ministries. Finance Ministries will invariably play some of that coordination role through their function as managers of the budget allocation process. In many countries, Finance Ministries are also responsible for long-term Public Investment Management, and NDCs often contain long-term public investments. The implementation of NDCs is furthermore expected to be very costly, thus affecting Finance Ministries in their core mandate of ensuring sustainable financing. Lastly, the transition to low-carbon climate-resilient development implies a substantive structural shift in economies, so the macroeconomic consequences need to be managed, again pointing to Finance Ministries. And more mundanely, implementing deep economic transitions requires political power, which Finance Ministries clearly wield unlike Environment Ministries, particularly of developing countries.[1] This perspective that Finance Ministries have a large co-responsibility for the implementing the NDCs is increasingly being shared by these ministries themselves.[2]

1.3 The choice of policy instrument

If Finance Ministries accept a co-responsibility for climate change mitigation, the question poses itself which policy instrument they will use.

Since Finance Ministries are responsible for the state of the economy as a whole, there will always be many other concerns for them besides environmental issues.

[1] The last point is based on interviews of the author with the administrators of long-standing country assistance programs for environmental reforms which the World Bank provides to developing countries. Experience with such programs over the last 10 years suggests that the involvement and support of Finance Ministries is critical for ensuring the successful implementation of large environmental programs in poor countries.

[2] For example, at the World Bank in 2017, 30 Finance Ministries supported a call for fiscal reforms to implement the Paris Agreement (World Bank, 2017a). At the European Council, EU Finance Ministries recognized that the implementation of the Paris Agreement requires reforms to price carbon (European Council, 2017).

Clearly, there can be trade-offs between the implementation of the climate commitments and other economic issues. Any such trade-offs can motivate political delay, with the aforementioned financial implication that the total cost of implementing the Paris Agreement increases dramatically. Politically, it is therefore essential to find policy instruments that minimise such trade-offs between the environment and the economy. Minimizing those trade-offs requires using the least-cost mitigation policies and designing mitigation policies such that they contribute to achieving other (non-environmental) economic objectives like equitable and stable growth. In a recent study for the World Bank, Heine & Black (2019) review 30 years of research on the economic effects of a particular mitigation instrument – environmental taxation – to find that this instrument does enable Finance Ministries to jointly reduce emissions while enhancing economic development, and that this instrument should thus form the core of Finance Ministries' role in climate change mitigation. That study,[3] which draws on this thesis, elaborates that there are over 30 channels through which environmental tax reforms can create a "double dividend".

Choosing environmental taxation as the main mitigation instrument is also well in line with climate law. Scholars in the economic analysis of law have long emphasised the need for lawmakers to use economically efficient policy instruments. For climate policy, lawmakers appear to have listened and enshrined cost-effectiveness as a legal principle in the founding text of emerging climate law. UNFCCC Art. 3 explicitly requires that "*policies and measures to deal with climate change should be cost-*effective *so as to ensure global benefits at the lowest possible cost*". However, climate lawmakers refrained from a definition of cost-effective instruments. Instead, the Paris Agreement sets quantity objectives for the amount of mitigation that must be achieved, and lets each country decide individually what it considers to be the nationally appropriate mitigation instrument.

Many economists have suggested that environmental taxation features amongst the most efficient mitigation policies (e.g. Acemoglu *et al.*, 2012; Fullerton, 2001). "*Revenue-neutral shifts toward environmental taxes can have extremely low or negative costs, even when carbon taxes are implemented unilaterally*" (Liu, 2013, p. 668). In the next chapter, we will, therefore, review to what extent environmental taxation is an efficient policy that Finance Ministries can use individually to achieve their national mitigation objectives.

[3] 2019 Award of the World Bank Vice Presidency for Economics, Finance and Institutions.

1.4 The need for policy mixes

The importance of environmental taxation does not mean that other policy instruments do not have central roles to play for the sustainability transition. Even when a government uses environmental taxation and other market-based instruments optimally, there are remaining market failures inhibiting the sustainability transition (Seto *et al.*, 2016), and some of these market failures are best addressed using sectoral regulations or expenditure policies (Grubb *et al.*, 2014b). At the most basic level: environmental taxation should not be used in cases where the optimal quantity of the harmful activity is zero, which instead call for bans. More generally, a government which seeks to minimize the cost and maximize the effectiveness of the sustainability transition should integrate environmental taxes within a wider policy package.

For example, to decarbonize the transport sector, the effectiveness and equity of a tax on motor fuels at reducing pollution are improved if it is combined with public investments to expand public transport systems, and vice versa (Avner *et al.*, 2014; Gillingham & Munk-Nielsen, 2019). In this case, the joint impact of pursuing both policies is greater than the sum of their parts. The same is often true for combining environmental taxation with public support for green innovation (Acemoglu *et al.*, 2012). Conversely, policies can also undermine each other. For example, a country that uses green bonds, feed-in-tariffs or regulations to raise the share of renewable energies in the electricity market and that simultaneously covers competing fossil fuel energy sources with an ETS, needs to beware of potential negative interaction effects. The policy measures pushing renewables into the market may reduce the scarcity of emissions permits under the ETS, thereby reducing the market carbon price, which in turn raises emissions (Fischer *et al.*, 2016). In such a situation, the joint impact of several interventions can be less than the sum of their parts. It is then critical for governments to investigate and manage interaction effects and carefully embed fiscal policies into the wider sustainability governance framework.

An important first step to improve the capacity of governments to manage these interactions is transparency. A tested reform to build this transparency is "climate budgeting". The idea here is that Ministries of Finance aggregate and track all the expenditure programs of sectoral ministries related to climate change and tag these expenditure lines in the central budget. As climate change affects so many sectors, it is presently difficult for many governments to identify overlaps or contradictions of expenditure programmes and track the efficient use of funds (Fozzard *et al.*, 2014; Jorgensen *et al.*, 2014). Transparently including this information in the central government budget supports cross-sectoral coordination. Climate budgeting is also useful to break the path-dependency that often surrounds ministerial budget allocations, because it provides a more informed shared reference point for negotiations between finance and sectoral ministries on whether the budgets allocated to climate-related expenditures are adequate for the policy objectives sought.

Climate budgeting can be further improved by incorporating information on tax expenditures. In many countries, there are large tax expenditures supporting production techniques which contradict sustainable development objectives. More recently, tax expenditures are also growing for supporting green goals. The two types of special rules can contradict each other without anyone realising and increase the complexity of the fiscal system. Since the relative prices determine incentives for private markets to invest in the sustainability transition, the simultaneous provision of tax expenditures for both high- and low-carbon technologies also increases the overall transition cost. Tax expenditures can also weaken the institutional capacity of governments and the democratic process for achieving sustainability transitions. This is because tax expenditures are often excluded from government budgets (OECD, 2010a), and thereby escape the scrutiny of the budget review process in Parliaments and public debate. Public surveys indicate that many people believe renewable energies are heavily subsidised whereas certain fossil fuels like lignite are not, when the playing field is instead tilted towards the latter, just through support systems that the public has greater difficulty understanding. Such misconceptions of fiscal support systems undermine public support for sustainability transitions. Fiscal authorities can enable informed public debate and consistent policymaking by transparently including tax expenditures that act for or against sustainability objectives in the budget. Such accounting practices do not need to upset standard budgeting mechanisms such as overall expenditure estimates where changes might have repercussions elsewhere in the fiscal system (e.g. in budget deficit calculations). Legally, this information can be included in a separate budget annexe while still fulfilling its transparency function.

The regulatory framework on the inclusion of tax expenditures in budgets hence has an important role for environmental mitigation objectives. But budgets also matter for adaptation. Here it is the annexes to the budget that governments standardly use for tracking fiscal risks which have a role to play in the sustainability transition. As climate change impacts all sectors, it is difficult for a central government to have a consistent aggregate view of climate impacts for the economy as a whole. Since Finance Ministries are tasked with macroeconomic policymaking and as the guardian of public finances, they have a role to play in assembling this information from line ministries, and tracking the adequacy of adaptation investments and policies to respond to these challenges. The central budgeting mechanism is a powerful instrument for such cross-sectoral coordination, and fiscal risks are an action-oriented way to go from quantifying and classifying to managing contingent climate damages.

Whereas such fiscal reforms can accelerate sustainability transitions and reduce their costs, successful implementation is a large governance challenge. Environmental fiscal policy is data-intensive and requires technical capacity in an area that is still foreign to most finance ministries. The solution often involves closer collaboration with line ministries. For example: In tax policy, the environmental effectiveness of excise duties can be improved by letting rates vary according to the sustainability of production methods. But doing so requires a lot of data and enforcement capacity that only line ministries, and in some cases non-state actors, have. In expenditure policy, public investments can be made more sustainable by incorporating environmental and social "shadow costs" (as the European Commission has long recommended),[4] and in several EU Member States individual ministries have calculated such shadow costs, but their use – and even knowledge of their existence – tends to vary a lot across ministries.

Sometimes Finance Ministries have taken shortcuts to reduce the need for complex coordination, capacity building or appraisals. These shortcuts can come at a cost to the efficiency and effectiveness of sustainability transitions. For example, to support green innovation, a standard policy has been to extend one-size-fits-all tax expenditures which provide the same deductibility for broad types of R&D investments. These policies reduce administrative cost and the problem of "picking winners" but have often led to the leakage of funding to unintended uses and sometimes worsened corporate tax base erosion. Recently, the European Commission floated a strategy calling for a fundamentally different approach, in

[4]E.g. in European Commission (2014a, p. 56ff.).

which public investments take a much more active role in pursuing innovation "missions" (Mazzucato, 2019, 2018a). Such a "green entrepreneurial state"[5] might yield great benefits for growth and value creation,[6] but requires significant governance capacity, and not only great collaboration between ministries but new governing frameworks for collaboration with the private sector, too. The lesson might then be that advanced approaches to governing sustainability transitions can improve outcomes but must be backed up by sufficient capacity. If the capacity is not available, a simpler but robust framework might be preferable, and an assessment framework might help governments determine their situation: to choose approaches or determine capacity gaps for handling the approach that was chosen.

An example for such choices is the decision between implementing environmental fuel tax policies "upstream" (where fuels enter the economy – e.g. mines, wells, ports, pipeline border crossings), "midstream" (at fuel processing units – e.g. refineries) or "downstream" (at the point of fuel combustion – e.g. chimneys). Traditionally, Europe has used upstream approaches for standard fuel taxes but downstream approaches for carbon pricing and environmental regulations. As environmental considerations are integrated more deeply into standard tax policy, the question arises which of these two approaches should be used. The downstream approach can create superior environmental incentives but involves higher administrative and compliance cost. For countries with constrained governance capacity, shifting upstream can help reduce these costs as well as evasion (Liu, 2013) and leakage to the informal sector (Bento *et al.*, 2018; Markandya *et al.*, 2013). The improvement of evasion and informality issues can drastically reduce the cost of environmental policy - this thesis will shed light on how practically this can be done.

1.5 Focus

We have highlighted the need for Finance Ministries to engage in certain macro-scale environmental problems. We then described the need for fiscal policies to be embedded in policy packages, with roles for complementary regulations, public

[5] Mazzucato (2018b)
[6] Mazzucato (2018c, 2013)

investment, and other frameworks – below we will often refer to liability system. These complementary policies are important, but that is also widely recognised in the literature. Furthermore, there is, of course, no doubt about the importance of Environment Ministries for environmental policy of course. This thesis recognises the importance of those other policy instruments and institutions, but sets a focus on Finance Ministries because there is much less guidance on their environmental role, which – notwithstanding the continued relevance of Environment Ministries – is currently becoming acutely important. Most of the 51 Finance Ministries that last year committed to deep environmental fiscal reforms through the Coalition of Finance Ministers for Climate Action are completely new to this policy field.

Simultaneous to the recent movement of Finance Ministers, also the economics community made a big shift. A recent statement of 27 Nobel laureates called for tax policy to take the main role in the global fight on climate change, instead of other regulatory approaches. Akerlof *et al.* (2019) point out that "*A carbon tax offers the most cost-effective lever to reduce carbon emissions at the scale and speed that is necessary.*" "*A sufficiently robust and gradually rising carbon tax will replace the need for various carbon regulations that are less efficient. Substituting a price signal for cumbersome regulations will promote economic growth and provide the regulatory certainty companies need for long-term investment in clean-energy alternatives.*" Finance Ministries are hearing these calls on their tax policy, but many questions abound. This thesis seeks to use the author's involvement in these policy dialogues to identify relevant barriers and potential solutions to this greater use of environmental taxation, while respecting – as emphasized above – the need for policy packages and environmental policy through other institutions.

Chapter 2

The efficiency case for environmental taxation*

This chapter investigates in more detail whether tax policy really is an efficient environmental policy instrument, and focuses in particular on the efficiency of using fuel taxes to mitigate climate change and air pollution.

2.1 Internalisation of externalities

The fundamental purpose of environmental taxation and emissions trading systems (which are jointly known as "carbon pricing" in their applications to climate change) is to make consumers and producers of polluting goods take into account the costs imposed by this pollution on society as a whole.

*Contents from this chapter have been published in the journal article Heine, Dirk, Semmer, Willi, Mazzucato, Mariana, Gevorkyan, Arkady, Radpour, Siavash, & Hayde, Erin. 2019. Financing Low-Carbon Transitions through Carbon Pricing and Green Bonds, *Vierteljahreshefte zur Wirtschaftsforschung*, **88**(2), p. 29-50, and the book chapter Heine, Dirk, & Black, Simon. 2019. Benefits beyond Climate: Environmental Tax Reform. in Pigato, Miria (ed.), *Fiscal Policies for Development and Climate Action.* Washington DC: World Bank Publications, as well as coverage related to the 2019 Award of the World Bank Vice President for Economics, Finance and Institutions for that book.

2.1.1 Foundation of free markets

Although the roots of this "cost internalisation" are commonly attributed to Pigou (1932), the need for free markets to internalise social costs has been agreed upon for much longer. Already Adam Smith pointed out that the very idea of forcing third parties to bear the cost of a private exchange contradicts the idea of a free market.[1] He also pointed to the efficiency of taxation as a policy response, suggesting that carriages in England should be taxed in proportion to the damage they cause to roads and therefore to other road users (Smith, 1776, p. 481). More formally, the First Fundamental Theorem of Welfare Economics showed that in order for a free market to generate a Pareto-efficient competitive equilibrium, external costs must be internalised (Arrow, 1951; Lange, 1942; Lerner, 1934).

A root motivation for cost internalisation is thus that free economic markets require all exchanges in the economy to be voluntary, between freely consenting trade partners. Third parties must not be forced to pay for external costs arising from transactions. Market economies are meant to reward those who create net value, rather than those who merely redistribute value in zero-sum or negative-sum games. When the production of a good causes pollution, the costs of that pollution must, therefore, be paid by those taking the decision to produce and consume the product, rather than by unrelated third parties. Otherwise, producers and consumers can forcibly redistribute welfare from those third parties to themselves. Without bearing the full costs of their actions, such producers and consumers have an incentive to carry out transactions even when those transactions cause net harm to society because of the external costs borne by their victims. To safeguard the core principles of liberty and net value creation, economic agents must, therefore, bear the full costs of their own actions. Pricing environmental damage contributes to this cost internalisation.

[1] "*It is unjust that the whole of society should contribute towards an expense of which the benefit is confined to a part of the society*" (Smith, 1776, section 1.4). "*In the race for wealth, and honours, and preferments, [man] may run as hard as he can, and strain every nerve and every muscle, in order to outstrip all his competitors. But if he should justle, or throw down any of them, the indulgence of the spectators is entirely at an end. It is a violation of fair play, which they [society] cannot admit of*" (Smith, 1759, section 2.2.2)

2.1.2 Internalisation through liability

The internalisation of environmental damages can be achieved through different means than taxes, such as through emissions trading systems (ETS) and the private enforcement of property rights in courts. The latter option looks appealing, as it avoids direct government intervention. When the production of a good creates pollution that harms a third party, this person might in principle take the producer or consumer of the good to court to seek compensation for that harm.

Unfortunately, even in the most developed economies with well-defined property rights, the transaction costs of legal proceedings would be prohibitively high in many pollution cases, in particular for greenhouse gases. CO_2 has a vast number of emitters, whose scentless effluences mix invisibly and spread globally. The location of most damage caused by a given source of emissions is outside the jurisdiction where this source of emissions is located, and the global warming caused by a molecule of CO_2 persists for about 100 years after it is emitted (Stocker *et al.*, 2013). This implies that the polluters and their victims do not know each other, mostly live under different judicial systems, and may live in different time periods. For practical purposes, it is often impossible for victims of climate change to take those harming them to court.

Coase, therefore, gives air pollution as an example where government intervention can improve efficiency. "*This would seem particularly likely when, as is normally the case with the smoke nuisance, a large number of people are involved and in which therefore the costs of handling the problem through the market or the firm may be high*" (Coase, 1960, p. 18).

2.1.3 Normative Coase Theorem

Even when the private property rights solution does not offer a viable solution, it can nevertheless greatly inform public policy. Following the Normative Coase Theorem (Parisi, 2007), the government should set a carbon price that coincides with the price that freely negotiating emitters and victims of climate change would have reached if they were able to meet in an ideal court setting. Rational private parties, bargaining on a level playing field, would set the carbon price at the level of the marginal damage that the carbon emissions cause the victim.

This rate, which would be reached through the first-best bargaining process (Coase, 1960), coincides with the definition of an optimal environmental tax (Pigou, 1932). Let us elaborate this point further.

Coase explains which price would be reached in a bargain between a person suffering from an activity that imposes a harmful effect and the person emitting that effect. If the victim holds the right to the absence of this harmful effect, the maximum price that the victim can ask is bound by the counterparty's profit from continuing the activity, and the minimum price that the victim will accept is the value of the damage itself.[2] Initially, the price can vary within that range, but for bargains undertaken in perfect competition, Coase points out that the bargaining price for the right to continue the harmful effect would converge to the opportunity cost of using that right in its next best use.[3] For example, if the harmful activity is pollution, the opportunity cost of selling the right to emit the pollution would be the victim's otherwise avoidable health costs. Pigou, similarly, defines the optimal tax on an activity that generates external costs as the difference between the marginal social net product of the activity ("*the aggregate contribution made to the national dividend")* and the marginal private net product. Like Coase, Pigou specifies that the opportunity cost of any uncompensated resources has to be subtracted from the value which the activity in question adds to total production *("the aggregate contribution made to the national dividend*"). In this way, both Coase and Pigou make very strong computative demands, as they both refer not only to the cost that the parties impose on each other, but also on the economy overall. Note that this commonality is not how Coase interpreted Pigou in his article, which substantially deviated from Pigou's actual writing,[4] but reflects where both au-

[2] Coase makes this point using the example of a bilateral externality between a cattle-raiser whose steers impose damages on the produce of a neighbouring farmer. If the farmer negotiates the price for which he would grant the cattle-raiser the right to continue to let his steers stray, "*the farmer would not be able to obtain a payment greater than the cost of fencing off this piece of land nor so high as to lead the cattle-raiser to abandon the use of the neighbouring property. What payment would in fact be made would depend on the shrewdness of the farmer and the cattle-raiser as bargainers. But as the payment would not be so high as to cause the cattle-raiser to abandon this location and as it would not vary with the size of the herd, such an agreement would not affect the allocation of resources but would merely alter the distribution of income and wealth as between the cattle-raiser and the farmer*" (Coase, 1960, p. 5).

[3] "*In conditions of perfect competition, the amount which the farmer would pay for the use of the land is equal to the difference between the value of the total production when the factors are employed on this land and the value of the additional product yielded in their next best use (which would be what the farmer would have to pay for the factors)*" (Coase, 1960, p. 6).

[4] "*Pigou as Straw Man: Since Pigou did not express or apparently hold the view attributed to him, the*

thors' actual writings agree.

Outside of perfect competition, the parties in a Coasean bargain could diverge from the above price-setting mechanism; a "victim" who sells its right to be free from a damage could demand more compensation than the value of the damage incurred.[5] A Pigouvian tax, however, would continue to be set according to the damage imposed. In this way, the Pigouvian tax rate is either equal or less interventionist than the price achieved in a Coasean bargain because the tax rate only covers the damage, whereas under a Coasean bargain, the victim may be able to (under non-competitive circumstances) make a gain from trade.[5]

The Pigouvian approach to set the compensation at the lower bound is, in fact, an incentive for victims from social costs to first seek an agreement with the persons creating these external costs before seeking recourse in a tax solution. Another incentive comes from the fact that in the case of a Coasean bargain, the compensation payment is being transferred between the bargaining parties (so the victim can be personally compensated) whereas in the case of a Pigouvian tax, the money goes to the general public, represented by the taxman. From a neoclassical efficiency-standpoint, these outcomes are equivalent, but they provide an incentive to individuals to use Coasean bargaining when possible and to resort to Pigouvian taxation only as a solution of public policy when the bargaining over rights does not function.[6]

question arises as to what he is doing in the [Coase 1960] *article at all"* (Simpson, 1996, p. 74). "*When several or numerous third parties are concerned, the Coasean and Pigouvian approaches are neither totally different nor opposite to one another, but rather are complementary*" (Slaev, 2017, p. 952).

[5] "*What payment would in fact be made would depend on the shrewdness of the farmer and the cattle-raiser as bargainers*" (Coase, 1960, p. 5).

[6] The reason why the efficiency consequences of compensating victims directly (Coasean bargain) and compensating the general public (Pigouvian tax) are equal, is that the standard social welfare function used in Law and Economics treats the welfare of the victim and the welfare of another person in society as perfectly substitutable. Posner (1985), for example, suggests that the economic objective of law should be the maximisation of wealth, which assumes a social welfare function which adds up the wealth (or utility) of individuals without social weighting. Coase makes the same assumption in his definitions of efficiency and his normative suggestions for the objectives of law. In the same vein, Pigou assumes that damages caused to an individual victim can be compensated through transfers made to the taxman as a representative of the public at large. In this way, he assumes that the victim does not need to be treated differently from the standard taxpayer. This approach again uses the same social welfare function as the one implied by Posner and Coase.

That said, it is possible to adapt Pigouvian taxation to treat the welfare of the victim differently from the welfare of the general taxpayer. Pigou suggests attributing a greater change in social welfare to money losses of the poor compared to money losses of the rich. In most countries, the average taxpayer is richer than the average person in society, and environmental damages are borne more by the

Summarising, the Pigouvian tax rate would be set equal to or below the rate that freely bargaining individuals would achieve if they were able to negotiate about the social cost in question. Therefore, carbon prices at the Pigouvian level cannot be labelled as "interventionist". They are rather the consequence of taking property rights seriously in cases where bargains on social cost are not always possible so that fall-back policy options are needed.

2.2 Cost-efficiency relative to regulations

In addition to carbon pricing, the internalisation of environmental costs can also be achieved through regulatory instruments. Price-based instruments do, however, have lower costs.

2.2.1 Equalisation of marginal abatement costs

One reason for this cost advantage is that environmental taxes and emissions trading systems (ETS) allow firms with different abatement costs to vary in the intensity of their emissions cuts. A profit-maximising firm will reduce its carbon emissions to the level at which its private marginal cost for achieving these emissions reductions equals the carbon price. A firm that can abate at a low cost will undertake greater emissions reductions than a firm that finds reducing emissions expensive. As a result, firms equalise their marginal abatement costs rather than their abatement quantity. The emissions reductions occur where they are least expensive, minimising the economy-wide cost of climate change mitigation (e.g. Ackerman & Stewart, 1985; Buchanan & Tullock, 1975). Compare this outcome in carbon pricing with the counterfactual outcome under a regulation in which each firm is mandated to achieve the same quantity of carbon mitigation. In the latter case, some of the cost advantages of firms with cheaper carbon mitigation opportunities remain unused, and the overall climate target is reached at a higher cost.

poor than by the rich (see chapter 12.3.2). These concerns can be incorporated into Pigouvian taxation by adjusting the tax rate accordingly, as well as through the use of the revenue (chapter 12.4.2).

2.2.2 Scope of emissions reduction opportunities

A related cost advantage of carbon pricing policies – such as environmental taxation or ETS – over regulations is the scope of emissions reduction opportunities (e.g. Aldy *et al.*, 2010; Krupnick *et al.*, 2010). For example, a carbon price provides electric power stations with an incentive to switch to cleaner generation fuels ("input substitution effect") and reduce exhaust ("abatement effect"), while simultaneously providing an incentive to consumers to purchase goods using less electricity ("output substitution effect"; e.g. Sterner & Coria, 2012). By contrast, a regulation mandating that power stations install emissions treatment equipment (e.g. carbon-capture-and-storage or scrubbers for sulphur dioxide) forgoes most of these wide-ranging incentives. Achieving the same overall emissions reduction target with a higher number of mitigation opportunities lowers overall costs. Furthermore, the state becomes less intrusive, since a carbon price leaves private agents the freedom of choice of how to achieve emissions reductions, rather than mandating a particular way of doing so.

2.2.3 Dynamic efficiency

These cost advantages also hold over time. Consider a regulation that requires power plants to reduce their carbon emissions below a certain benchmark value. After a power plant achieves this standard, it has no incentive to keep improving. If the regulation is replaced by carbon pricing, the power plant faces a dynamic incentive to continue exploiting cost-efficient opportunities for further emissions reductions (Sterner & Coria, 2012).

2.2.4 Revenue recycling

As a by-product of their environmental purpose, environmental taxes generate public revenues. These revenues can be used to lower other taxes, either directly – for example, by reducing personal or corporate income taxes, reducing labour overhead costs, compensating losers – or indirectly – by financing a budget consolidation that would have otherwise required other taxes. In either case, this revenue-recycling effect of environmental taxes produces another efficiency gain that is unavailable with regulations.

The size of these efficiency advantages from revenue recycling depends on how the revenues are used. Heine & Black (2019) provide an in-depth analysis of the different policy options to maximise these gains under different country circumstances.

2.3 Vulnerability to government failure

2.3.1 Misunderstanding between Coase and Pigou

Correcting market failures such as climate-change risks may not work well if there are also government failures (Tullock *et al.*, 2002). This problem was at the forefront of Coase's concerns with Pigouvian taxation, although the two authors appear to have had much the same position about the need to balance risks of market and government failure.[7] Three safeguards for protecting environmental taxation against government failure have been suggested.

Firstly, Pigou suggests scrutinising whether the government has the administrative capacity to efficiently enforce environmental taxes before introducing them.[8] We will return to the steps required for implementing this safeguard in chapter 11 where we set out how environmental taxes can be adapted to situations of low government capacity.

[7] Above we pointed out features that make Pigouvian taxes comparatively non-interventionist. However, Coase's interpretation of Pigou was that "*economists, under the influence of Pigou and others, thought of the government as waiting beneficently to put things right whenever the hidden hand pointed in the wrong direction*" (Coase, 1995, p. 30). Coase strongly opposed such interventions on the ground that "*governmental administrative machine is not itself costless. It can, in fact, on occasion be extremely costly*" (Coase, 1960, p. 18), so that interventions such as through Pigouvian taxation would lead to "*results which are not necessarily, or even usually, desirable*" (id., p. 2). Pigou did, however, share these views and argued that it was essential to be prudent in using taxation to address social costs. "*It is not sufficient to contrast the imperfect adjustments of unfettered private enterprise with the best adjustment that economists in their studies can imagine. For we cannot expect that any public authority will attain, or will even whole-heartedly seek, that ideal. Such authorities are liable alike to ignorance, to sectional pressure and to personal corruption by private interest*" (Pigou, 1932, pt. II, ch. XX, para. 4). As a result, "*Pigou's view was thus much the same as that of Coase, though he was marginally less skeptical about the merits of state action*" (Simpson, 1996, p. 73).

[8] "*In any industry, where there is reason to believe that the free play of self-interest will cause an amount of resources to be invested different from the amount that is required in the best interest of the national dividend, there is a* PRIMA FACIE *case for public intervention. The case, however, cannot become more than a* PRIMA FACIE *one, until we have considered the qualifications, which governmental agencies may be expected to possess for intervening advantageously*" (Pigou, 1932, pt. II, ch. XX, para. 4).

Secondly, Pigouvian taxes should only be imposed on externalities for which the size of damages has been quantified with sufficient certainty. Studies that calculate Pigouvian taxes for real-world policy advice therefore routinely exclude entire categories of damages which are known to exist but for which data is scarce (e.g. NRC, 2009; Parry *et al.*, 2014; Stern, 2016), to purposefully rather err on the side of "non-interventionism" than vice-versa. As a result, the risks of inefficiently intervening through taxes are kept in check, although there is an increased risk of type-II errors.[9]

2.3.2 Risk of governance failure under environmental taxes relative to alternative policy instruments

The third safeguard against government failure is the choice of the policy instrument itself. This section extends the analysis in Posner (1992, p. 378f.).

The approach here is to find which policy instruments can correct market failures at the least risk of causing government failure. Consider first regulations and then carbon pricing. When the government decides for businesses whether a new clean technology should be introduced, both the costs of introducing the technology and the benefits of reducing emissions require analysis. With carbon pricing, by contrast, the government only requires information about the marginal damage caused by carbon emissions and not about the marginal costs of abating these emissions (Posner, 1992, p. 378f.). The government leaves it to businesses to compare the benefits of emissions reductions (as expressed by the carbon price) and their costs. Policy can then be efficient even if the government lacks half of the information required for a cost-benefit analysis.

The last argument – that carbon pricing policies such as environmental taxes require only the quantification of costs whereas regulations require the quantification of costs and benefits – corrects an error of Coase. Coase (1960, p. 43f) had suggested that governments should undertake full analyses of costs and benefits before any policy intervention on social costs. He intended this advice to reduce the risk of government failure. However, his recommendation would imply that

[9] A type-II error is defined as failing to reject a false null hypothesis. It is also known as a "false negative" finding. In this application, the policymaker needs to decide whether the evidence base is strong enough for including a given social damage in the calculation of a Pigouvian tax. The null hypothesis is that an activity or substance does not cause an external damage.

the state (either through government or courts) undertakes wide-ranging investigations into both the costs and benefits of various private sector activities. Such a dominant role for the state effectively amounts to a public plan selecting which private activities the state finds useful and which not, which is the opposite of Coase's intention to avoid a planned economy. The finding of Posner (1992, p. 378f) – that environmental taxes only require the evaluation of the social costs from activities while leaving it to private decision-makers to determine the private benefits of these activities – then implies that the use of environmental taxes, as opposed to Coase's approach, reduces the amount of information that governments need to raise and leaves more decisions to private market participants.[10] The risk of government failure is reduced accordingly.

2.3.3 Corruption and evasion

Two other risks of government failure are corruption and evasion. It is, however, possible to design environmental taxes in a way that enables those taxes to perform better than classic environmental regulations towards each of these types of government failure. Here we briefly explain how this tax design works, and in chapter 11 we provide details on how this tax design can be implemented in various country circumstances even when the government has a low administrative capacity.

Most greenhouse gases and air pollution are associated with the combustion of fuels, and fuels are generally easy to tax because they enter the economy at only a small number of points such as refineries, the entry points of pipeline systems at ports or border crossings. At this 'upstream' stage of the supply chain, the fuels are typically handled by a few, huge, formal-sector entities. Each of these features implies that the revenue collection for upstream environmental taxes is much easier to supervise, audit and protect against evasion than it is for most traditional taxes which attach to physically smaller or invisible monetary tax bases and charge a much greater number of small taxpayers who are spread out across the economy. The fact that fuels are also dangerous and strategically essential

[10] For air pollution cases, Coase explicitly favoured regulations over taxes and justified this based on taxes requiring the government to collect more information Coase (1960, p. 41). However, it is precisely the information requirement that favours taxation over regulation since regulations require a full cost-benefit analysis instead of only an analysis of the costs.

means that their flows are already closely tracked by governments in most countries. It is also easier to supervise fuel taxes compared to other tax bases like income flows for the simple reason that fuels as a tax base are physical, voluminous, and therefore harder to conceal and shift to other jurisdictions than money streams.

The enforcement of regulations on emissions standards has almost the opposite characteristics. The number of chimneys to regulate is much greater than the entry points of fuels to the economy. So the amount of (technically trained) government personnel required to supervise a pollution regulation can be enormous. Furthermore, the government may need to send auditors across the country to check compliance with regulations, including to remote regions where many less developed countries can have a scarcity of technically qualified controllers. By contrast, upstream fuel taxation can be executed in just a few central points. The need for a person-to-person interaction between an auditor and a person who is being controlled can thus be much smaller with this type of taxation than with regulations. When the government uses environmental fuel taxes instead of regulations it can accordingly concentrate its supervision over a small number of officials who impose a carbon price at a few fuel entry points to the economy, and the climate policy covers all subsequent activities using these fuels. It is then private trade partners who pass the environmental tax price signal through the market, to the remote regions, to the informal activities, to all industries. Each private agent has an incentive to enforce the price signal with his transaction partners fully, given the private incentive to pass on a tax incident, so the public policy benefits from voluntary private enforcers where it lacks public ones.

In chapter 11, we consider some additional complexities when countries use other types of environmental taxation. However, the bottom line here is that upstream environmental taxes are more robust against corruption and evasion than regulations. Upstream environmental taxes are furthermore more robust against evasion than other taxes, such as personal income taxes. Liu (2013) estimates the size of these benefits in a macro model in which countries use the revenues from environmental taxes to reduce their pre-existing taxes. The model is calibrated using cross-country data on evasion for the different tax types. Liu (2013, p. 656) finds that "*In countries with high levels of pre-existing tax evasion, a carbon tax will pay for itself through improvements in the efficiency of the tax system*".

2.3.4 Informality

Government failure is also associated with the informal sector (or "underground economy"), and again environmental taxes can reduce this problem, creating efficiency gains.

The existence of an informal sector is a major legal problem, for example when people illegally engage in business activities and then cannot enforce a contract or labour rights in courts. Informality is an example of government failure in the sense that government taxes are a significant incentive for workers and firms to become informal (La Porta & Shleifer, 2014). This avoidance reaction, in turn, raises the costs which most taxes pose to the economy (Piggott & Whalley, 2001).[11] However, when environmental fuel taxes are implemented upstream, they impose the tax at a choke-point in the supply chain where the economy is almost entirely formal.[12] From this choke-point, the tax incidence is passed through the entire economy, charging both the informal and the formal sector. A shift from traditional to environmental taxes can, therefore, broaden the tax base for raising revenue, and it can also reduce the fiscal system's disincentive to join the formal sector for efficiency gains.

Designing an environmental tax so that it covers the informal sector alongside the rest of the economy drastically reduces the cost of policy. In the United States, the informal market only accounts for 9 % of GDP, but even then, the cost of mitigation efforts to formal sector output is reduced by 62 % when the environmental tax

[11]Informality adds another margin through which taxed entities can avoid taxes. Whereas in classical computations, for example of the optimal personal income tax, individuals can react by reducing their labour supply, they can now also shift their labour supply to the informal sector. The optimal personal income tax rate is accordingly lower. Raising more public revenues is a more substantial challenge then, because raising the rates of traditional broad-based taxes may push additional people into the informal sector (Duncan & Peter, 2014). These distortions from today's tax systems are well documented in many countries (e.g. Bruhn & Loeprick, 2016; Gatti *et al.*, 2014; Benhassine *et al.*, 2016; Mele, 2017).

On a higher level, informality prevents the economy from allocating resources optimally because in the presence of informality, "*allocation is determined not by productivity but by 'fiscally* effective*' productivity*" (Markandya *et al.*, 2013, p. 109). Each of these factors mean that there could be large gains from reducing the bias of traditional taxes favouring the informal sector. To reach this objective of better covering the informal sector, various other, (non-environmental) tax strategies have been tried, but with limited success (Benhassine *et al.*, 2016; Dube & Casale, 2016)

[12]Unless a country uses significant amounts of fuelwood or informal waste incineration (which is the case in some developing countries) or where a country has a lot of cross-border fuel smuggling. For the cases, see Heine & Black (2019).

covers the informal sector compared to when it does not (or compared to macro models which assume that no informal sector exists) (Bento *et al.*, 2018). In Spain, which has an informal sector share of around 20 % of GDP, introducing a carbon tax equivalent to a 15 % emissions reduction would cause official GDP to rise by 7 % and official unemployment to fall by 3 % (Markandya *et al.*, 2013). Country studies for China, India, and Iran suggest that accounting for the existence of informal markets is sufficient to make environmental tax reforms a policy that increases GDP (Bento *et al.*, 2018; Carson *et al.*, 2019; Mirhosseini *et al.*, 2017).

2.3.5 Conclusion on government failure

Coase (1960) had suggested that environmental taxation may pose too substantial risks of government failure and instead favoured private bargaining solutions, "doing nothing", or regulations. Here we suggest that environmental taxation is more robust than regulations against government failure and more robust than some core non-environmental taxes against evasion and informality. The implication is that environmental taxation is a more, not less, efficient environmental policy instrument for countries with greater risk of government failure.

This finding does not mean that government failure is not a critical concern. It remains true that countries must balance efforts to correct market failure with the risk of government failure. However, if countries do act on environmental problems, the risk of governance failure is an argument for choosing environmental taxes over regulations. Furthermore, when countries contemplate "to do nothing" about environmental problems, they need to consider that they already have other, non-environmental taxes and that a tax shift from these other taxes to environmental taxes can help them reduce evasion problems of their fiscal systems. These additional efficiency gains provide a non-environmental reason to introduce environmental law, and to do so through Pigouvian taxes.

While environmental taxes then do not have a major vulnerability to the risk of government failure, it is still important to implement these taxes in a least-risk manner. Chapter 11 sets out how this can be done in high-risk countries.

2.4 Interaction effects with green bonds[13]

2.4.1 Efficiency of instruments in policy packages

Despite all these efficiency advantages of environmental taxes, other policy instruments will generally be used as well. Environmental policy is therefore typically implemented alongside other policy instruments in "policy packages". The efficiency of each policy instrument then depends also on its performance in combination with the other instruments. Here we illustrate this point by considering interaction effects of carbon taxation with green bonds, and what the advantages are relative to other carbon pricing instruments. In chapter 9 we will describe more of these interaction effects of environmental taxes (with subsidies and sustainability certificates).

A "green bond" is a bond whose proceeds are earmarked for financing investments that support environmental objectives. First created by the European Investment Bank and the World Bank together with the Swedish SEB in 2007/2008, green bonds are today issued by government agencies, multilateral institutions, and private businesses. The interaction effects that we study in this section apply both to publicly and privately issued bonds.

This section focuses on the interaction effects of green bonds and environmental taxes: for other issues on green bonds such as the difference in yields between green and conventional bonds and the certification of bonds, see the extended version of this section in Heine *et al.* (2019).

2.4.2 The case for combining carbon pricing with bonds

Environmental taxation contributes to a green transition in production technology, but because of remaining technology market failures beyond those internalised by the taxes, the most efficient technology transitions require combining environmental taxes with public investments (e.g. Acemoglu *et al.*, 2012; Grubb

[13]This subsection is based on the journal article Heine, Dirk, Semmler, Willi, Mazzucato, Mariana, Braga, Joao, Flaherty, Michael, Gevorkyan, Arkady, Hayde, Erin & Radpour, Siavash. 2019. Financing Low-Carbon Transitions through Carbon Pricing and Green Bonds. *Vierteljahrshefte zur Wirtschaftsforschung*, **88**(2), 1-22.

et al., 2014b; Newell, 2015). Environmental taxation can help fund these investments but they may equally be financed through green bonds. Given the size of financing challenges for green transitions, both financing instruments might best be used jointly.

Another argument for combining green bonds with environmental taxation is that the instruments perform differently politically. A core problem of climate policy is to convince policymakers who are focused on short election cycles to implement policies that can imply short-term losses for long-term gains. Many policymakers doubt the short-term gains from carbon taxation even when they do agree that the policy will be beneficial in the long-run. Green bonds have the opposite profile: they allow policymakers to mitigate today and pay for this mitigation action tomorrow (or make their successors pay). Therefore, the two policy instruments have different inter-temporal cost profiles. The first-best policy may be to only use environmental taxation. But even if environmental taxation is the most efficient climate policy, if policymakers are not currently willing to roll out this policy at the scale needed, it is likely more cost-efficient to top-up whatever level of environmental taxation is achievable today with some second-best policy instruments than to delay climate policy. Green bonds appear politically more achievable. Precisely in situations in which policymakers shy away from incurring short-term costs for long-term gains, bonds could make climate policy incentive-compatible, because they shift some of the cost for repaying the bond to the next period (Sachs, 2015).

Another motivation for green bonds is intergenerational equity. Climate policy invariably involves intergenerational transfers, because the mitigation of emissions today causes benefits for future generations. The current generation may then wish to let future generations share in the cost of today's efforts. Green bonds are an instrument for achieving such burden sharing when they are used to finance today's mitigation actions and the bonds are repaid by the future generations. Such burden sharing is Pareto-superior to a business-as-usual scenario with insufficient mitigation today (Orlov, 2017; Sachs, 2015).

2.4.3 Relative efficiency of environmental taxes to ETS in interactions with green bonds

In this section, we compare how environmental taxes would perform in combination with green bonds relative to how emissions trading systems (ETS) would perform in such a policy package. The analysis in this section is an addition to the literature on the relative efficiency of environmental taxes and ETS.

2.4.3.1 Effect of carbon prices on green bonds

It is known that green bonds perform better (in the sense of increasing demand in financial markets) when climate change mitigation projects have higher private returns (Flaherty *et al.*, 2016). It is also known that the returns from climate change mitigation projects improve when countries implement carbon pricing as households and firms substitute away from fossil fuels. These findings imply that a sufficiently high CO_2 price in ETS or taxes supports the successful market introduction of green bonds as well. Climate bonds are only partly an alternative to carbon pricing if they require carbon pricing for their market success. However, if carbon pricing takes off, we can expect green bonds to thrive as well.

Both carbon taxes and ETS would thus be expected to raise demand for green bonds, but that does not mean that their contribution would be equal. We know that ETS have much higher carbon price volatilities than carbon taxes. We also know that green investment projects can more easily attract green bond financing if their returns on investment are less volatile (Flaherty *et al.*, 2016). Therefore, as the returns on investment for green investment projects depend on carbon prices, a more stable carbon price also creates a more stable return on investment and accordingly increases the demand for green bonds. As a result, emissions trading systems do not maximise the potential of green bonds to the same extent as carbon taxes of the same carbon price level.

2.4.3.2 Effect of green bonds on carbon prices

There is another negative interaction effect between ETS and green bonds which does not exist with carbon taxation. An ETS puts a cap on emissions, and emissions leakage can occur when green bonds finance climate change mitigation projects for industries that are covered by the same emissions cap. The mitigation achieved through the bonds can reduce the scarcity of emissions permits under the cap, reducing the price of those permits and thereby allowing the displacement of emissions rather than their net reduction.[14]

To prevent this unwanted feedback loop, governments would need to tighten ETS caps when they introduce green bonds. However, those adjustments may be politically impossible precisely in the situations where green bonds are sought. If green bonds are introduced as a second-best policy to fill the policy gap left by the political opposition to serious carbon pricing, the same political opposition would probably also prevent an adjustment in emissions caps.

Against this argument, optimists may point out that the introduction of green bonds might break the political gridlock because it creates new vested interests: The holders of green bonds have an interest in the tightening of ETS caps.[15] Current lobbying by industries to loosen emissions caps could then be counterbalanced by new lobbying from investors who seek to tighten those caps. By that reading, the creation of green bonds could both weaken and strengthen ETS. However, with a carbon tax, these outcomes are clearer. The aforementioned adverse feedback effects of green bonds for ETS prices do not occur for carbon taxes for which the rates are fixed by Parliament. With carbon taxes there is only the positive effect that a carbon price (whether ETS or tax-based) has on the demand for green bonds. So the risk that green bonds and carbon pricing will undermine each other is smaller with carbon taxes than with ETS.

[14] This finding is original, but there have been related findings in the literature on how ETS interacts with other policies. Fischer & Preonas (2010) show a similar interaction effect between demand-side subsidies for the deployment of renewable energies and ETS prices. In Europe, many governments provide feed-in tariff and other demand-side subsidies to renewable electricity. At the same time, the electricity market is covered under an Emissions Trading Scheme, and the cap on the total amount of emissions is not tightened along with the expansion of renewable energies. As a result, a displacement of thermal energy by renewables reduces the scarcity of emissions permits under the cap. The ETS price falls accordingly, which reduces the ETS's abatement incentive to the remaining (base-load) thermal energy suppliers. A similar adverse interaction effect exists when green consumerism shifts demand away from goods that are covered by an ETS to goods that are not covered, thereby lowering the ETS price (Perino, 2015). Our addition to this literature is that such an interaction also occurs between bonds and ETS, and its implications for the choice of carbon pricing in countries that seek to access growing green bond markets for financing their ecological transitions.

[15] To our best knowledge, this argument has not yet been made in the literature on the effect of green bonds on ETS. However, there is a related, wide-spread argument that the distribution of emisson permits creates a new lobby for the continuation of emissions trading because the entities which receive the permits have new economic interest in the maintenance of the ETS from which their permits derive value.

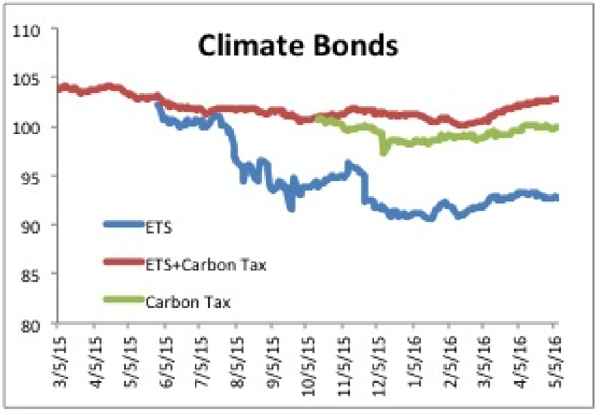


Figure 2.1: Evolution of green bonds prices under different carbon pricing regimes

2.4.3.3 Empirics

The interaction effects described above are new additions to the literature, and so there are no empirical tests of these theoretical findings yet. However, a first analysis of the raw data from financial markets does confirm these results. As shown in Figure 2.1, green bonds are performing better in countries that employ carbon taxation than in countries with ETS.[16]

2.5 Interaction with value-added taxation

Another source of efficiency of environmental taxation, which has never been considered in the literature before, is that environmental taxes improve a central feature of the value-added taxes (VAT). Before analysing this interaction effect, we briefly remind ourselves what “specific-rate taxes” and “ad-valorem taxes” are.

[16]The theoretical analysis in this section is original and single-authored, but has been included in the co-authored journal article Heine *et al.* (2019) from which this data analysis is taken. The paper also confirms the above analytics using Nonlinear Modelling Predictive Control (NMPC).

2.5.1 Ad-valorem and specific-rate taxes

Countries are broadly using two types of consumption rates. “Ad-valorem taxes” increase the price of a good by a set percentage amount, whereas “specific-rate taxes” increase the price of a unit of fuel by a set monetary amount. The ad-valorem consumption tax used in most countries is the “value-added tax” (VAT) which is typically the second-most important source of revenue for a government after the personal income tax. A core reason for the VAT’s popularity is that it raises revenue in a more growth-friendly manner than other taxes. By raising the price of all products by the same proportion, the VAT seeks to minimise the distortions which taxes have on consumption choices. This objective is called “fiscal neutrality” and aims to allow the market to achieve allocative efficiency while financing the state.

Environmental taxes have the opposite objective. Whereas the VAT strives for being neutral to consumer choices, environmental taxes seek to change behaviour. To change this behaviour efficiently, environmental taxes must always be specific-rate taxes. Because the environmental cost of any product is given by the physical effects per unit of that product, the tax rate must equally be defined per physical unit of the product, not per price of the product. If the price of a barrel of oil in international markets doubles tomorrow, the social cost per amount of CO_2 contained in a barrel is still the same. Hence, the efficient environmental tax does not fluctuate with the price of a polluting good but is fixed per unit of the physical good. An environmental tax should therefore always be applied as a specific-rate tax. Moreover, whereas the fiscal-neutrality principle underlying the VAT is to apply the same percentage tax rate for all products,[17] the Pigouvian principle underlying the environmental tax is to apply different unit tax rates for different products, to adjust each product price according to its product-specific marginal social damage. For example, a litre of gasoline and a litre of alcohol will both be taxed for their social costs with specific-rate taxes; these taxes will vary per unit while facing the same VAT rate.

A last important feature before we can consider the interaction effects is that tax

[17] Countries should thus not use the VAT to deal with environmental problems. The VAT on polluting products should be neither higher nor lower than the standard rate for products that pose environmental damages or benefits. The law in some countries does diverge from these principles by granting reduced VAT rates for fuels or renewable energies. In these cases, the VAT system can destroy the Pigou efficiency of an environmental excise tax system. But those interaction effects are known.

law in most countries applies the VAT to the sum of the product price and the specific-rate tax.[18] The above is just standard tax principles, but the following implication is new.

2.5.2 Effect of environmental taxation on the fiscal neutrality of the VAT

If a polluting product is sold at lower prices because it can externalise part of its production cost, the absolute amount of VAT collected per unit of this product is artificially low, distorts competition and thereby removes the VAT neutrality. To see this effect, consider two competing products, one of which is polluting and the other one is not. Assume the production and sales price of the polluting product is lower than for the clean product for the sole reason that it can externalise costs. Then the absolute amount of VAT paid per unit of the polluting product will be lower than for the clean product, further increasing the cost difference between the two products. The VAT will then aggravate the distorted competition between the two products. Environmental taxation is needed to rectify this problem. For the VAT system to achieve its neutrality objectives, the environmental tax needs to be applied on a specific-rate basis, at the Pigouvian rate, and be subject to value-added taxation itself.

Over the last thirty years, governments have relied ever more on the VAT as a source of revenue. The higher a VAT rate is, the greater is its scalar effect at amplifying the price difference of competing products. If those price differences are due to cheap products externalising social costs, increasing the VAT rate raises this allocative inefficiency. Therefore, the increasing use of VAT systems around the world increases the need for Finance Ministries to apply environmental taxation as well. Otherwise, Finance Ministries would fail their objective of using the VAT to raise revenue in a fiscally neutral manner.

[18] The post-tax price after the levying of the VAT and environmental taxation is equal to (1+VAT rate)*(pretax price of one unit of the good + environmental tax per unit of the good), where the VAT rate is a percentage, and the environmental tax is a set amount of currency per physical unit of the good.

2.5.3 Coase's second-best argument

Coase expressed concerns that environmental taxation would have adverse system-level effects on the efficiency of economies. *"The Pigovian analysis shows us that it is possible to conceive of better worlds than the one in which we live. But the problem is to devise practical arrangements which will correct defects in one part of the system without causing more serious harm in other parts"* (Coase, 1960, p. 34). He rejected *"a comparison between a state of laissez faire and some kind of ideal world"* (id., p. 43). *"A better approach would seem to be to start our analysis with a situation approximating that which actually exists, to examine the effects of a proposed policy change and to attempt to decide whether the new situation would be, in total, better or worse than the original one. In this way, conclusions for policy would have some relevance to the actual situation"* (ibid.).

The actual situation of fiscal policy in most countries today is that the VAT is the core of public financial systems. This VAT is presently distorting allocative efficiency through the mechanism that we described. A Pigouvian tax would, instead, decrease that system-level distortion. In this way, the Pigouvian solution is supporting rather than contradicting what Coase argues for.

Coase was concerned that "*there is a real danger that extensive government intervention in the economic system may lead to the protection of those responsible for harmful effects being carried too far*" (id., p. 28). But the starting point is that there is already extensive government intervention in the economic system, through systems like the VAT. And given that starting point, environmental taxation helps to reduce inefficiency.

Environmental taxation has many other system-level effects beyond this one example. Here we move on, but Heine & Black (2019) provide an extensive review of the literature showing that environmental taxation also has many other efficiency-enhancing system-level effects. Environmental tax reforms can reduce unemployment in labour markets with involuntary unemployment, in particular of unskilled workers. They also reduce distortions of pre-existing income tax systems, generally broaden the tax base which allows reducing tax rates, and better align the tax system with "Ramsey efficiency".[19] Environmental taxes also

[19]Ramsey (1927, p. 56) showed that the optimal rate of a consumption tax is "*proportional to the sum of the reciprocals of its supply and demand elasticities*". If a good that inelastically demanded is taxed more than a good which is elastically demanded, that variation minimizes the overall deadweight

move fiscal burdens from the taxation of profits to the taxation of Ricardian rents and from the taxation of labour to the taxation of leisure. Environmental tax reforms can equally reduce the overall compliance and administrative costs of tax systems, induce green technological change, and raise growth through energy efficiency. There is similar causal evidence that environmental taxes reduce public health costs, traffic congestion and traffic fatalities. The reader is referred to Heine & Black (2019) for the details on each of these effects, but the general point here is that environmental taxation creates system-level efficiency gains. So the efficiency-enhancing effect of environmental taxation on the VAT system is only one example. Coase can feel comforted that Pigouvian taxation does enhance system-level efficiency.

loss caused by the tax system. Therefore, the fact that the price elasticity of fuels is generally low price makes them a good tax base. When the revenue of fuel taxes is used to reduce general consumption taxes on goods that are demanded more elastically, the "Ramsey efficiency" of the overall tax system improves.

Chapter 3

Challenges to environmental taxation analysed in the remainder of this dissertation

Chapter 1 has shown that some types of environmental damage[1] are now of a size that impacts the stability of the macroeconomy as a whole. As a result, it should be in the core interest of Finance Ministries to contribute to environmental protection. In particular, Finance Ministries should no longer stand in the way of using tax policy for climate change mitigation. Chapter 2 has underscored this point by showing that taxation can reduce environmental damages in a cost-efficient manner. However, Finance Ministries have been slow to change their approach to environmental taxation. In this chapter, we consider what the barriers to action might be before the subsequent chapters investigate potential solutions.

[1]From climate change.

3.1 The tax gap

To what extent are Finance Ministries already implementing fuel taxes in line with environmental damage? In Parry, Heine, Lis & Li (2014), the IMF provided the first calculation of Pigouvian tax rates for fossil fuels in 150 countries. The IMF subsequently compared these optimal tax rates to the rates of fuel taxes and fuel subsidies that countries have in reality. In 2015 that gap amounted to 5.3 trillion USD per year, which is equivalent to 6.5 % of global GDP (Coady *et al.*, 2017). To put this figure into perspective, consider that the international community's aspirational (and unmet) target for mobilising finance to assist climate action in developing countries is 100 billion.

Coady *et al.* (2017) suggest that Finance Ministries are effectively encouraging actions that cause environmental and other climate damage, and they find that these figures are worsening over time, despite the increased environmental commitments that countries have made over the last decade. This lack of progress has been confirmed by subsequent quantifications of the tax gap by other authors. The OECD evaluates fuel taxes in 42 developed and emerging economies that jointly account for 80 % of global energy use, and finds that "*apart from some modest steps forward in a couple of countries, there is little evidence of better use of taxes on energy use to address the mounting global environmental and climate challenges. Instead, real tax rates are gradually eroded by inflation in most countries, suggesting indifference to the environmental efficacy of taxes*" (OECD, 2018, p. 51). Ross *et al.* (2017) confirm this finding in the area transport policy, which is shocking given that transport had been the policy area where environmental tax policy had the biggest uptake. Nevertheless, they find that the global mean gasoline tax has fallen by approximately 10 % over the last decade.

This overview has shown that countries around the world are not taxing fuels in line with their carbon and environmental costs. Given our findings of chapters 1 and 2, we hence ask: what barriers are preventing policy action?

3.2 Output and employment

One explanation for the lack of policy action is that Finance Ministries believe that environmental taxation would cause severe damages to their economies. This concern might be particularly relevant for poor countries given their pressing development needs besides environmental objectives. Heine & Black (2019) provide an in-depth literature review of 30 years of economic research on this question and find that environmental taxation instead improves non-environmental macroeconomic progress indicators when the revenues are used for reducing distortive pre-existing taxes, such as labour taxes on low-earning households and corporate taxes on small and medium-sized enterprises.

3.3 Competitiveness

Another explanation for inaction is the competitiveness of emissions-intensive industries. This issue has been analysed in depth in developed countries, with the majority of studies finding that environmental taxes are firstly not a significant problem for industrial competitiveness and secondly that policy designs are available to handle any remaining competitiveness issues.[2] However, only a few such studies exist for developing countries, and those generally have more emissions-intensive export industries, so competitiveness effects of environmental taxes may remain a principal concern for Finance Ministries in the developing world. To fill this research gap, Coste, Calì & Heine (2019), analyse the competitiveness effects of environmental fuel taxes using firm-level data. For robustness, three datasets were used: a global one that is limited to rather large companies and two more detailed dataset of firms in Mexico and Indonesia. In each case, an increase in environmental taxes is not associated with a competitiveness loss. Instead, the results suggest that firm-level productivity and profitability increases as firms respond to the price signal by improving energy efficiency to more than compensate the fuel price increase. The analysis thus supports the strong version of the Porter Hypothesis (Porter & van der Linde, 1995) that environmental policy can improve instead of harm competitiveness.

In these co-authored works, we have hence addressed some of the main potential barriers to environmental tax reforms. However, there is a range of further potential additional barriers which we address in the following chapters.

[2]See Coste, Calì & Heine (2019) for a review of these policy options.

3.4 Causation

The continued resistance of Finance Ministries towards environmental taxation could reflect more profound concerns that tax policy is the right instrument for environmental problems. After all, many scholars of Law and Economics have raised fundamental concerns with the Pigouvian objective of internalising social costs through the tax system. In chapter 2, we have already addressed some of these concerns, but Coase (1960) put forward another fundamental critique, claiming that Pigouvian taxes failed to address the causation of social damages adequately. And also beyond Coase, causation has been been a recurring concern in Law and Economics over environmental taxation. Therefore, chapter 4 investigates these critiques. We will see that causation of social damages is indeed seen very differently by different schools of thought, which leads to some major misunderstandings. To be able to untie the entangled debates on this issue, we will need to develop a framework from first principles, starting from disagreements about even the fundamental objectives of environmental law.

3.5 Business cycle

A primary objective of Finance Ministries is the fiscal management of the macroeconomic business cycle. Perhaps environmental taxation hinders this objective in some way. After all, during economic recessions, one often hears calls for relaxing environmental taxation. Such calls are also made by academics (e.g. Fischer & Heutel, 2013) who argued that emissions trading systems would rightly relax carbon price signals during downturns (because of lower demand for emission permits) whereas environmental taxes would always be fixed. We will address these concerns in chapter 5 by drawing on our causation framework developed in chapter 4.

3.6 Responsibility for global damages

Another potential reason why Finance Ministries do not act on environmental taxes is that they do not accept their respective country's responsibility for some of the emissions. In today's interconnected global economy, a significant share of greenhouse gas emissions can be attributed to traded goods. Emerging climate law attributes the responsibility for these emissions to the country where the good was produced, but many researchers have questioned that definition of national responsibilities. They argue that instead the country consuming the good should be seen as the one causing the damage. Accordingly, Finance Ministries might not be clear about who should be the one taxing these "embodied emissions". Chapter 6.1 provides a surprising answer.

Another set of emissions for which Finance Ministries may not feel responsible is emissions released while transporting goods through the high seas or international airspace. International law does not attribute these emissions to any state, and OECD research even suggests that "*it would be impossible to apportion shipping emissions to countries*" (Merk, 2013, p. 4). However, chapter 6.2 attempts precisely that: developing a theory how the emissions in international space can be attributed to individual countries and what follows for the question which Finance Ministry should tax these emissions.

3.7 Feasibility and governance failure

Yet another potential reason why environmental taxation is not implemented could be that it is infeasible. Perhaps countries lack the administrative capacity. For example, Coase finds that environmental taxes have such strong requirements for data that they are "*the stuff that dreams are made of*" (Coase, 1988, p. 185) so "*carrying them out means heading towards regulatory failure*" (Schmidtchen *et al.*, 2009, p. 5).

This thesis therefore attempts to prove the feasibility of environmental taxation in the following way. We take two worst-case scenarios of industry sectors for which many authors in the literature have argued that it would be very difficult or impossible for any individual Finance Ministry to implement efficient environmental taxation. For both industries, we develop a mechanism that overcomes the various constraints without raising major complexity and while maintaining low administrative and compliance costs. The argument is that if environmental taxation works under these worst-case scenarios, it should certainly work in other industries.

These two case studies are the taxation of emissions from international maritime transport and of the taxation of environmentally destructive overseas production of imported forestry products. Taxation in these sectors is complicated by the following impediments:

The activity in which the environmental damage occurs takes place outside the jurisdiction of the state which would like to impose an environmental tax. Accordingly, the state needs to find a way of implementing policies overseas despite legal restrictions for “extraterritorial regulation”. The limitation for extraterritorial relation also prevents the taxing state from requiring overseas entities to release data through which the environmental tax could be calculated, as well as preventing on-site enforcement or audits. This data limitation is particularly severe in forestry, where the cost of environmental degradation can vary dramatically depending on type (or lack) of local forest management and harvesting, and the prevalence of illegal timber logging. A further complication is that policy action in both industries is restricted by trade law. The international maritime industry is furthermore notoriously difficult to capture by taxes of any type due to its mobility and the fact that 70 % of container ships globally are registered in tax havens. In forestry, interaction effects with a multitude of coexisting policy measures need to be taken into account.

Chapter 7 presents our scheme for the maritime sector, proposing solutions for each of these concerns. Chapter 9 presents the suggested forestry solution.

The approach taken in these chapters is to analyse what can be done in a challenging industry by an entity with the level of administrative capacity of the European Union. Chapter 11 instead considers the opposite possibility: what environmental taxation can achieve in a more straightforward sector within a country that has much a lower administrative capacity, such as Finance Ministries in low-income countries. There we describe a menu of second-best and third-best options for environmental taxation in countries which need to strike a balance between environmental sophistication and administrative cost. By illustrating the possible choices, we show that in a wide range of country circumstances there are sensible forms of environmental taxation which can realistically be implemented.

3.8 Conflicts with international negotiations

Many environmental problems are the subject of protracted international negotiations. Another potential barrier to national environmental taxation may then be countries' fear that unilateral taxation could negatively impact those negotiations. Chapter 8 investigates this concern using the unilateral maritime tax scheme from chapter 7 as a test case. The chapter shows under which conditions a unilateral environmental tax could instead help the international negotiations succeed rather than harm them. We also analyse how the legal principle of Common but Differentiated Responsibility, which importantly shapes global climate negotiations, would impact national tax policy design and what repercussions such adjustments could, in turn, have on the international negotiations.

3.9 Smart mixes

Environmental taxation works best when it is combined in packages with other policy instruments (e.g. Grubb *et al.*, 2014b). However, such combinations of instruments can give rise to unwanted interaction effects. Fear of such adverse dynamics might again prevent Finance Ministries from entering environmental policy which has so many pre-existing non-fiscal instruments. Several of these interaction effects have not yet been studied before. To help fill these gaps, this thesis makes the following contributions.

Chapter 2.4 investigated the interaction effects between green bonds and two alternative forms of carbon pricing. We showed that the risk of adverse interaction effects is smaller with environmental taxes than with emissions trading schemes.

Chapter 2.5 discovered an interaction effect through which environmental taxation improves the effects that value-added taxes have on allocative efficiency.

Chapter 4.3 adds to the slim literature on interaction effects from combining Coasean bargaining with Pigouvian taxes.

Chapter 7 describes a particular combination of taxes and subsidies that can overcome information problems for Pigouvian taxes on transborder externalities. The chapter describes this combination in the context of the maritime sector, but it is a more general contribution that extends the Pigouvian literature on combinations of taxes and subsidies, taxes and rebates, fees and rebates ("Feebates").[3] It also extends the literature on consumption-based carbon pricing by providing a new way how excise taxes can be adjusted for carbon contents without violating Article III(2) of the GATT.

Chapter 9 shows how private sustainability certificates can be used for adjusting environmental tax rates, as another way of overcoming information problems for Pigouvian taxes on transborder externalities. The chapter also shows how some long-standing problems with sustainability certificates can be overcome when these are combined with taxes: free-riding, limits to competition among certificates, the resulting lack of dynamic incentives and threshold transaction cost problems for land smallholders. Again, the analysis is provided with a particular industry sector example, but the solutions developed there are contributions to the literature on social costs more generally.

3.10 Equity and poverty

Another constraint that could hold back Finance Ministries' adoption of environmental taxation is that, even if the policy is economically efficient, it might not be equitable. Such a critique might not worry some leading scholars of Law and Economics who argue that lawmakers should focus on efficiency (e.g. Posner, 1979)[4] but others have criticised that lack of concern for equity and called on the discipline to better balance "equity-efficiency trade-offs" (e.g. Sanchirico, 2001). Chapter 12 therefore investigates whether such an efficiency-equity trade-off exists for environmental taxation, and what could be done about it.

Equity issues of environmental taxation have been studied many times for the USA and Europe. Therefore, chapter 12 reviews that literature but then adds to it through a focus on developing countries.

[3] Such as the "two-part instrument for a second-best world" from Fullerton & Wolverton (2003) or "upstream taxation with downstream rebates" from Parry, Heine, Lis & Li (2014), and the legal analysis of combining excise taxes with tax credits in Trachtman (2017).

[4] The objective of wealth maximisation that Posner suggested assumes a social welfare function in which no weight is given to distributional equity, and the routine use of the Kaldor-Hicks criterion in Law and Economics embraces that choice.

3.11 Political economy

Of course, political economy will always be determinative of whether Finance Ministries implement environmental taxation. However, political economy must not only be a concern to elected lawmakers but equally to this dissertation in Law and Economics. Law and Economics strives to improve the efficiency of the law. But we know that in the legislative process, efficient reform proposals are routinely sacrificed if they pose too high a political risk. Therefore, Law and Economics scholars should study strategies of introducing the changes that they recommend in ways that reduce the political costs of reform. Chapter 13 develops such strategies.

There have been many studies on the political economy of environmental taxation in the past, but this thesis extends the literature by providing such an analysis based on Behavioural Law and Economics.

3.12 Conclusion

Chapters 1 and 2 have shown the rationale for Finance Ministries to take a more active role in environmental policy by implementing environmental taxation. However, this is clearly not happening – quantifications of the economic costs of environmental damages point to a vast tax gap. Even though countries have agreed on increasingly ambitious mitigation objectives in emerging international environmental law, they have even regressed in their environmental taxation.

This situation must alarm scholars who are concerned about the efficiency of environmental law, for two reasons. Firstly, it appears as if all the results on the efficiency of environmental taxation carried no weight for actual legal change: thus calling into question the sense of our enterprise. Secondly, the overall costs of meeting a given climate change mitigation objective under Paris Agreement will escalate the longer policymakers wait. The cost of waiting could bring down any efficiency gains to be had from choosing the right mitigation instrument. We have hence looked at ten barriers that could explain the lack of implementation. Two major barriers have been addressed before in Heine & Black (2019) and Coste, Calì & Heine (2019), but in the following, we proceed to address the other eight barriers.

Part II

Causation principles underlying environmental taxation

Problems treated in this part

If it is known to all parties involved in the production and consumption of a product that the production of this product causes environmental costs to third parties, who should be regarded as the cause of the environmental costs and who should then pay the external cost – producers or consumers? For air pollution with diffuse, long-travelling particles, domestic environmental law and international climate treaties tended to have a simple answer: producers. Yet, this attribution of causality and costs has been criticised. In chapter 4, we analyse these problems in the general case of producers and consumers, before chapter 6 applies our framework to current controversies in emerging climate law.

Restrictions of the analysis

Where policy applications are considered, we restrict the analysis throughout to environmental taxation, given the focus of this thesis. Furthermore, the analysis assumes competitive markets. For environmental harms, we only consider CO_2 and diffuse, long-travelling air pollutants. Through this focus on multilateral complex pollution problems, the text avoids replicating analyses of dual causation in bilateral pollution problems that have already been treated at length in the Law and Economics literature (e.g. Coase 1960 and its many applications), and instead focuses on causation of pollution in a setting with high transaction costs and great information problems that prevent efficient bargaining. Where lawmaking bodies are analysed, we do not consider judges directly, as their decisions of causal attribution have already been analysed at length in the literature. Instead, we apply principles developed in that literature to institutions of fiscal policy and climate treaties, asking what the causation principles that the literature derived for judges imply for these other lawmaking bodies. The objective here is to use principles that have been developed in the context of courts and compare them to principles that we derive here to be in place in these other lawmaking bodies, rather than to contribute to the existing large literature on efficient court decisions.

Structure

In chapter 4, section 4.1 reviews the literature's attribution of causation of environmental harms to producers and consumers. Section 4.2 presents a model of the relation of causation to the pass-through of taxes. From the results of section 4.2, we derive a generalisation about the relation of Coase and Pigou, attempting to build a general theory of causation that satisfies the frameworks of both. Section 4.4 tests our causation principles by relating them to some other causation frameworks in tort law.

Chapter 6 applies our results to suggest solutions for two problems of emerging climate law for which current conceptions of causation appear to be failing. These issues are the shared causation of emissions embodied in tradeable products (chapter 6.1) and the causation of emissions released in international space (6.2). We also apply our causation framework to tackle the recurring question of whether pollution pricing should be weaker during economic downturns (chapter 5).

Chapter 4

Does Pigou make the true polluter pay? A framework for prospective multilateral causation of emissions in high-frequency market interactions*

4.1 Problem overview

There have been several types of critique on the relation between the causation of environmental harms and the burden that environmental taxation imposes on the person who is identified to be causing the harm. Here, we consider first where the

*Contents from this chapter are included in the forthcoming journal article Heine, Dirk, Faure, Michael, & Dominioni, Goran. 2020. The Polluter-Pays Principle in Climate Change Law: An Economic Appraisal. *Climate Law*, **9**.

wider schools of thought shaping environmental law stand concerning the general attribution of causation and responsibility for environmental harms. Next, we consider critiques inquiring whether it is the producer or the consumer who caused the harm, and then move to critiques suggesting that both caused the harm but that government should "do nothing about the problem at all". That analysis is followed by a consideration of authors suggesting that both producers and consumers cause the harm and that government, therefore, must do a lot to vary the burden put onto each agent efficiently. Lastly, we consider proposals that all fiscal policy towards environmental law would be flawed because the agent who caused the harm does not pay for it anyway.

4.1.1 Relation to economic objective of environmental law

The causation of environmental harms and the appropriate attribution of responsibilities to polluters is perceived differently by classical lawyers, Ecological Economists and Environmental Economists. To understand these differences, it is informative to consider how these traditions differ in their view of the overall objective of environmental law.

The objective of environmental law from both a classical legal perspective (e.g. TFEU Art. 191) and from the perspective of "Strong Sustainability" favoured by Ecological Economics (Neumayer, 2013, p. 25, 28; van den Bergh, 2001, p. 17), is to reduce environmental harms. This is an objective that hinges upon physical units of pollutants (Daly, 1978; Ekins, 2003; Hueting & Reijnders, 1998; Huffman, 2000; van den Bergh, 2001) and their effects for maintaining ecosystem functions (Goodland, 1995), inter alia because "*the essence of Strong Sustainability is that it regards natural capital as fundamentally non-substitutable through other forms of capital*" (Neumayer, 2013, p. 27). With this focus on the physical problem, it seems natural to also consider physical control when attributing responsibility for emissions to actors who are physically capable of reducing the pollution. So if a lawmaker applies this framework to decide whether a producer or a consumer of a polluting product is responsible for reducing the physical amount of pollution, it appears natural to allocate that responsibility to the producer, since the producer certainly has the greatest physical ability to reduce the pollution. For example, unlike the consumer, the producer does have the physical and legal ability to fit pollution control equipment in his factory's chimney.

Attributing the responsibility to abate a social cost to private actors appears to necessitate attributing to them equally the causation of the damage itself. Accordingly, classical environmental law attributes both the causation and the responsibility for abatement to those agents who physically cause the damage, e.g. by undertaking the act of combusting a fuel in the production of a product. The consumer of the product – in whose creation that pollution was released – is not normally seen as having caused the pollution.

As a result, current environmental law is firmly based on producer responsibility and the producer being regarded as causing harm. The law rests on technology regulation directed to producers, on an Emissions Trading System directed to producers, and generally on policy intervention at the point of releasing the emissions, which is in most cases where the producer is, not where the consumer is.

Neoclassical Environmental Economics tended to favour the same route, but for slightly different reasons, which are rooted in a different view of the overall objective of environmental law. In the theoretical framework of "Weak Sustainability", which is "*deeply rooted within neoclassical economic thinking*" (Neumayer, 2013, p. 24, 28), the environment has no intrinsic value;[1] it is one of several substitutable forms of capital,"natural capital", which can provide goods and services such as clean water and visual amenity.[2] Therefore, what happens to physical pollution is considered pertinent only insofar as it raises the overall cost of providing goods and services by lowering the quality or quantity of natural capital. In this framework, the economic objective of environmental law is the same as the economic objective in other areas of the law. Law provides decision-makers with incentives to decide in a way that maximises the total payoff of society (Bovenberg & Goulder, 2002; van den Bergh, 2001).[3] Decision makers shall engage in activities that increase the total amount of goods and services in society,[4] but refrain from activities that merely redistribute values between themselves and other individuals whenever such redistribution does not create a net added-value. Under the framework of Weak Sustainability, there is a prima facie case for potential

[1] In the sense that, "*Nature has value if and only if humans value nature*" Neumayer (2013, p. 8). Note however that, while this approach is common in neoclassical Environmental Economics, there are exceptions in the literature where concepts of "existence value" are used.

[2] For ensuring Weak Sustainability, "*natural capital can be safely run down as long as enough man-made and human capital is built up in exchange*" (Neumayer, 2013, p. 23).

[3] Alternatively, that maximises the total wealth in society (Posner, 1983, 1985).

[4] Usually referred to as "social welfare" in neoclassical Welfare Economics.

legal action in cases when, in the absence of the law, decision makers can engage in activities that externalise costs to other agents (Cropper & Oates, 1992). [5] These are cases where, in the absence of the law, decisions can be socially detrimental but privately optimal for the decision maker, because the decision maker can extract rents at the expense of others, while not generating a net added-value. Environmental law here steps in to provide the incentives to create and innovate instead of seeking rents. Once all social costs are internalised, agents pursuing their own interests will undertake net-value-creating activities. The ability of a rule to achieve this internalisation is often called the "Pigouvian efficiency", after Pigou (1932) whose name is most closely associated with the conception that the economic objective of environmental law is the internalisation of marginal externalities. This position might also be summarised as saying that the objective of environmental policy is efficiency (generally expressed in utility or monetary terms) rather than efficacy (in physical terms).

4.1.2 Reception of the Polluter Pays Principle in environmental law

This neoclassical perception that the objective of environmental law is to internalise social costs has been adopted in environmental lawmaking under the popular expression of the Polluter Pays Principle (Cropper & Oates, 1992; Kettlewell, 1992). The Polluter Pays Principle has been officially endorsed by OECD countries (OECD, 1994), by the European Union (TFEU Art. 191, para 2), and by the United Nations (Rio Declaration, Principle 16). While lawyers have controversially debated the meaning of the Polluter Pays Principle (de Sadeleer, 2005; Sands & Peel, 2012), economists have commonly defined it as just another wording of the principle that external damages should be internalised (Cropper & Oates, 1992) – so just a restatement of the Weak Sustainability objective in environmental law. The adoption of the Polluter Pays Principle by lawmakers may then create the impression that the Weak Sustainability perspective on the objective of environmental law would have come to dominate the classical legal perspective.[6] This does not

[5] Or as Kuhn & Tivig (1996, p. 10) expressed it: "*as long as production externalities are internalized in the exporting* [producing] *country, no economic environmental problem exists – independent of the level of* [physical pollution] *standards; whereas as long as the Pigouvian efficiency condition – marginal pollution equals marginal abatement cost – is not fulfilled, an economic environmental problem exists*".

[6] "*The PPP is essentially an economic principle translated into law*" (Bleeker, 2009, p. 291). Reflecting back to our earlier observation that neoclassical economics and classical environmental law do

appear to be the case, however, because of the way in which the Polluter Pays Principle seems to have been interpreted in practice in environmental lawmaking and policy. An implicit assumption in many discussions of the Polluter Pays Principle is that the person who physically causes the pollution – for example by burning fuel during the production of a good – is also the one who causes that pollution and to whom the responsibility for that pollution should be attributed. In the legal reception of the Polluter Pays Principle, the polluter tends to be identified as the producer of a product, the operator of the production process, or the person controlling the process that physically generates the pollution.[7] This at-

not necessarily share the same perspective on the basic objective of environmental policy, the legal scholar de Sadeleer (2012) exemplifies this conflict for the Polluter Pays Principle. "*The principle contains neo-liberal overtones that appear to countenance the idea that the right to pollute can be purchased for the monetary equivalent of the environmental cost sustained*" (de Sadeleer, 2012, p. 418), arguing that the PPP is not necessarily consistent with the objective of reducing physical pollution.

[7] For example, the EU's Environmental Liability Directive which "*lays down rules based on the polluter-pays principle*" (European Commission, 2016, para. 1) attaches the responsibility for environmental harms to the "*legal, private or public person who operates or controls the damaging occupational activity*" (Lawrence, 2006, p. 1). "*The fundamental principle of this Directive should therefore be that an* OPERATOR *whose activity has* CAUSED *the environmental damage or the imminent threat of such damage is to be held financially liable* (European Union, 2004, para. 2, my emphasis)". In some member states, secondary law implementing this directive has made the owner rather than the operator liable (or applied several liability to both) (Fogleman, 2013, p. 25), but also in that case the Polluter Pays Principle is being applied by holding the producer side, not consumers, responsible.

For transboundary pollution, Kettlewell (1992) describes how the Polluter Pays Principle is held to mean that either the company producing a polluting product or the state where this company is based should pay. Schrijver (2010, 2008, 1997) shows that this association between the physical origin of an environmental harm and responsibility for its occurrence is deeply ingrained in international environmental law.

For pollution caused in accidents, OECD member states agreed that "*the Polluter-Pays Principle implies that the* OPERATOR *of a hazardous installation should bear the cost*" (OECD Council, 1989, appx. para. 4, my emphasis). In case law for accidents, there is a "*tendency to shift the risk of causal uncertainty to enterprises*" (Faure & Hartlief, 1998, p. 690).

In the case of waste regulation, the entity held to be the polluter is the one "*holding*" the waste when it generates the pollution, which can be different from the company originating the good that has come to waste or the operator of a dump (de Sadeleer, 2012). Nevertheless, also in the case of waste regulation, it is true that the entity with the physical control is in general considered as the causal polluter (ibid). The same special situation holds for motor fuels, where – although end-consumers are considered responsible for some of that particular pollution – this attribution is again based on the their control the physical generation process of the pollution during fuel combustion.

For summaries of the theoretical legal literature applying the Polluter Pays Principle to associate responsibility for and causation of damages to producers or physical operators, see Mossoux (2010). For a Law and Economics approach equating the Polluter Pays Principle with the binary attribution over the causation of damages to producers (and harshly criticising the principle on the basis of that tribution of responsibility to firms is made most explicit in waste regulation in the form of "Extended Producer Responsibility".[8] If the producer is also the one taking all the decisions whether or not to pollute, then it is efficient to always treat the Polluter Pays Principle as if it was a Producer Pays Principle (Schmidtchen *et al.*, 2009). If instead, the producer is not the one who is economically causing the pollution in the sense of deciding whether the pollution occurs or not, then the Polluter Pays Principle should be understood differently. Efficiency requires that all decision-makers internalise the cost of their decision. It is thus important to avoid an interpretation of the Polluter Pays Principle that attributes all costs to producers, since then there would be no extenral costs left for the consumer to bear.

4.1.3 Coasean dual causality view

According to Coase (1960), social costs are generally caused jointly by two or more parties, so he would see a problem with identifying producers as the sole source of environmental harm. We return to his theorem and its relation to Pigou (1932) below, but here note that Coase would regard pollution costs to be mutually caused, so that potentially also consumers could be seen as having contributed to the damage.

4.1.4 Attribution of causation in Ecological Footprinting

4.1.4.1 Early Environmental Footprinting

Such a shift, to regard consumers as contributing to the causation of environmental harms, comes from the rise of Ecological Footprinting. Unlike Coase's conjecture, the view inherent in traditional Ecological Footprinting has not, however, been that producers and consumers share causation. Instead, proponents of

conception) see Schmidtchen *et al.* (2009). Lidgren & Skogh (1996, p. 178) recommend this association on the basis that it is "*simpler to control a few producers*" than "*a large number of consumers or suppliers*" and that it is easier to identify owners of facilities than consumers.

[8] "*The implementation of the EPR principle, within the Polluter Pays Principle framework, implies that producers are considered responsible for the environmental impacts of their products along their whole life cycle*" (Monier *et al.*, 2014, p. 124).

Ecological Footprints traditionally suggested locating the full responsibility for emissions released with the end-consumer of any product (Rees, 1992).[9]

The causation by the consumer is seen to extend so far as to cover all the damages arising from the supply chain of the product that the consumer buys. To find all those damages, Ecological Footprints apply Life-Cycle Analysis to quantify the damages created along a product's supply chain, and then traditionally present the sum total as the Ecological Footprint caused by the respective consumer.

4.1.4.2 Current Footprinting

Although Footprinting started by assigning all the causation of pollution to consumers, subsequently producers also started computing their Ecological Footprint. This move made Ecological Footprinting part of the objectives to implement the Polluter Pays Principle through Extended Producer Responsibility. The mix of approaches did not help in clarifying the question as to who really causes the pollution and who must hence pay how much, if the true polluter is to pay. Instead, the joint usage of these different frameworks leads to double-counting of emissions. The same unit of emissions could now be part of the Footprint of a consumer and part of the Footprint and Extended Producer Responsibility of a producer, with the degree of causation (or responsibility)[10] being regarded as 100 % for both producers and consumers. In his treatment of Coase, de Meza (1998, p. 273) comes to the same conclusion that "*Everyone involved is fully responsible for all the damage done*", but double-counting does not seem right intuitively.

4.1.5 Relation to tort law

Despite these problems of double-counting, the intuitive base of the current form of Footprinting seemed right, that both consumers and producers might be tak-

[9] This form of accounting also transfers from consumers to countries. *"The Ecological Footprint is based on the actual consumption of goods by a country's inhabitants, so if something is produced in country X and used in country Y, the land requirement is registered totally within country Y. Thus, if the consumer of a final product is responsible for the entire ecological impact of the process which has generated that product, the consumer should be charged for the total emissions related to the process"*(Bastianoni *et al.*, 2004, p. 255).

[10] In general, mainstream economic texts do not distinguish between causation and responsibility. Below we describe why it is often also impossible to distinguish causation, responsibility and liability when using fiscal approaches.

ing some of the decisions that lead to pollution and that both might hence be perceived as causing parts of the pollution. This intuition is in line with Coase's starting point that causation is shared, and "(...) *it is intuitively clear that responsibility is somehow shared between the supplier and the recipient of a commodity, because the supplier has caused the impacts directly, but the recipient has demanded that the supplier do so*" (Lenzen *et al.*, 2007, p. 32). If "*all parties with a role in designing, producing, selling or using a product are responsible for minimising the environmental impact of the product over its life*" (McKerlie *et al.*, 2006, p. 620), then "*an acceptable consensus probably lies somewhere between producer and consumer responsibility*" (Lenzen *et al.*, 2007, p. 32). But if we accept that causation and/or responsibility is shared, we may need to know exactly how much of it rests with which actor. Here environmental law can learn from many similar situations of shared causation that exist in tort law where frequently two agents are held to have jointly caused a tort. Different methods of attributing legal causation have arisen for partitioning the amount of losses that each of the agents causing a tort should individually pay for.

One such rule is liability based on negligence, where a producer bears all the losses that were caused if she[11] does not abide by a standard of care that the law prescribes, and where the other party bears the losses that still occur when she did take the prescribed level of care (Shavell, 2008). The strength of the negligence rule is that it recognises a cross-causation of torts, by providing both parties with incentives to optimise their contribution to the size of overall expected accident costs (Kahan, 1989; Landes & Posner, 1983). This liability rule has been criticised, however, as implementing a sharing of responsibilities that would not be in line with the Polluter Pays Principle in cases where harm is not foreseeable or avoidable for the victim (International Law Commission of the UN General Assembly, 2006). Instead of the standard negligence rule, that UN Commission suggested that strict liability, another tort law principle where all losses are borne by the tortfeasor independent of his care levels, would be more in line with the Polluter Pays Principle. That recommendation to use strict liability does not, however, solve our problems of attributing causation; it just shifts the responsibility for that causation to one of the two agents. This shift, in itself, may appear not to be in line

[11] I excuse for the gender bias that an omission of writing "s/he" or the alternating use of "he" and "she" may cause. To avoid confusion when switching genders in examples or repetitive use of "the agent", I from hereupon use the pronoun "he" throughout the text and mean it just as a shorthand to indicate both genders.

with the Polluter Pays Principle if the producer is not factually causing the damage alone. It then looks as if the suggestion by the International Law Commission of the UN General Assembly (2006) returns us the problem that the negligence rule tried to avoid, namely, assigning legal causation of torts as a binary choice: either one person is strictly liable or the other is. Strict liability can be designed to assign causation without the binary choice, however, if the principle is supplemented by the tort principle of proportionate causation. Here, each agent that shared in the legal causation of a tort is held strictly liable for the damages that he caused himself, but only for his part in the overall damage. The proportionate causation principle is coherent with the Polluter Pays Principle in that every agent pays the proportion of the damage that he causes. Unfortunately, however, the principle does not in itself find out who is causing the tort. Courts are needed to engage in extensive fact searching on the merits of every particular case, investigating whose actions increased the probability that the tort occurred by what percentage (e.g. Young *et al.*, 2004). For environmental law, such fact searching is needed in many settings (e.g. Faure & Nollkaemper, 2007; Faure, 2009b), but for diffuse air pollutants that travel long distances or global pollutants with countless sources, such fact searching appears too costly if it needs to be done for every individual case. Granted, there are cases where causation of environmental damages can be dealt with on an aggregate level. In many cases, however, where efficiency requires incentives for each individual decision-maker, and for some wide-spread pollutants, the case-by-case determination of proportionate causation through courts or government may be too costly, since the number of agents concerned is so large. For such pollutants, we then need a way to apply tort law principles, such as strict liability with proportionate causation, without the large transaction costs that come from determining on a case-by-case basis the proportion by which each agent caused the damage. Fiscal policy can provide a way of collecting damage payments with low transaction cost, but to apply it, the causation principles that have been developed for tort law may need to be adapted. Particularly, the question remains as to on whom the tax should be imposed such that it reflects who caused the damage. And if courts are not available to determine this question on a case-by-case basis, how can this causal attribution be done?

4.1.6 Economic rules proposed for apportioning causation

Several proposals have been made for rules that attribute a degree of causation to agents who jointly caused environmental damage. Returning to our example of a producer and a consumer of a polluting product, these rules attempt to assign shares by which each of the two entities caused the pollution without a need to inquire into the details of every transaction. The objective of these rules is hence not to be correct in every case but to make the true polluter pay in the majority of cases.[12]

Ferng (2003) puts forward an early proposal that attributes shares to both consumers and producers, but unfortunately, his shares add up to more than 1, thereby returning our inquiry to the problem of over-counting that we saw in the example of Ecological Footprints.

Gallego & Lenzen (2005) suggest resolving the problem by simply considering producer and consumer to each have caused 50 % of the damage. Unfortunately, such a rigid split, with a fixed proportion, is arbitrary if not all producer-consumer relations are the same. More problematically yet, the fixed 50 % shares do not solve the over-counting problem. This is because, where supply chains for a polluting good contain more than one producer and one consumer, each level of the supply chain would be attributed 50 % of the total damage, thus over-counting. If such a rule was used in – say – environmental fiscal policy, the incentives that each agent would face would not be efficient but instead deter also socially efficient pollution. Solving the problem of inefficiently varying incentives with the length of the supply chain is hard though, because policymakers would not be practically able to adapt the shares to any other fixed number if goods are in free circulation and the number of persons in a supply chain can vary at any time.

Lenzen *et al.* (2007, p. 29) concur that *"there exists a ubiquitous need for a consistent and robust, quantitative concept of producer and consumer responsibility"*

[12] This limitation reflects a general institutional difference between fiscal policy institutions which have the declared aim to be correct in the majority of cases but not in every case, which is called the principle of typification. According to this principle, fiscal policy aims to be correct for general types of situations but not for the circumstances of all cases. Fiscal policy always applies general rules across persons in different circumstances. Courts, instead, work in the other direction, from considerations of specific cases, taking into account how the decision in a specific case changes the wider system. In German law, there is an explicit right of fiscal policy institutions to be wrong in individual cases if it is for the purpose of typification [Typisierung] that helps at getting the average case right (von Bornhaupt, 1998).

and that the needed calculations of each agent's individual share in the overall shared responsibility of agents needs to be done through government or other agents that are outside of the transaction concerned. Lenzen *et al.* (2007) want to overcome this problem by attributing different shares of responsibility to the different sellers and buyers of a polluting product, attributing to each stage of the supply chain the share of responsibility that corresponds to the value added at that specific production or consumption stage. In section 4.10, we will derive why this proposal makes economic sense as an indicator of the degree of shared responsibility. However, in the way that Lenzen *et al.* propose it, the assignment of liabilities for each person sharing in the causation of the damage requires data that is too costly or even impossible to obtain for policymakers, as it varies across supply chains and time.

Steenge (1997) develops an Input-Output model which suggests that, economically, the causation of damages should not be attributed to the industry sector where they were physically caused, since the inputs from that sector are used in other sectors and by end-users. Given this interconnectedness, Steenge argues that, instead, the causation of environmental damages should be attributed to sectors according to how many parts of the polluting good are used in each sector. Unfortunately, his analysis does not reduce to a simple rule that policymakers could use, also because he does not distinguish actors inside sectors. His principle relies on data that is available in aggregated fashion for sectors, but lawmakers need to set incentives for individual actors, and there the data that his Input-Output requires is not available to lawmakers. And as with the other authors' suggestions, the transaction costs for determining individual responsibilities according to his method seem considerable. Similar problems apply to the Input-Output treatment of causation in Andrew & Forgie (2008).

None of these rules conclusively solves the problem of apportioning causation. As a result "*the literature on shared-responsibility options is still in its infancy*" (Afionis *et al.*, 2017, p. 15).

4.1.7 Passing on responsibility

4.1.7.1 Problem of pass-through

All of the rules that we considered relied on the ability of the state to measure the degree to which individual agents contributed to jointly-caused damage. We expressed doubts that the state is actually in a position to do that.[13] But even if we assumed for a moment that the state did have some method or rule that allowed it to find out individual contributions to jointly-caused damages, that ability would still not be enough to satisfy the Polluter Pays Principle. The state would additionally need to have the enforcement capability to make each of the agents pay the amount of the damage that they caused. And whether the state has this second ability – to make individual agents pay the tax burden of an environmental tax that it wants them to pay – is equally doubtful.

This enforcement problem arises independently from the information problem because an agent from whom the government requires a payment may pass on the real incidence of that payment to transaction partners. Consider, for example, a situation where an agent is held to have caused a certain percentage of a damage, but where he is in a negotiation position to extract from others, with whom he is in a transaction relationship, the funds required to make that payment. Such an agent is effectively in a position to make others pay on his behalf, which could be seen as enabling him to shirk the responsibility for damages that he caused.

Even worse, if some, but not all agents, are able to pass on the costs for their damage payments to transaction partners, or if the proportions of such passing-on vary between agents, the government would not be able to offset that variation by itself varying the amount of the payment it requires. The real amount that an agent who caused a damage has to pay after deducting the proportion of the payment that he can pass on to others then appears not to be determinable by the government, even if the government knows the cost of the environmental damage and how much of it the agent in question caused.

It can appear hence as if even a perfectly identified environmental tax, where the government requires from each agent the payment of a tax equal to the proportion

[13] In tort law, judges do find out the individual contribution to the causation of jointly caused damages, but for long-travelling air pollutants or greenhouse gases, the transaction costs for such fact-finding may be too large.

of an environmental damage that the taxed person caused, would not implement the Polluter Pays Principle, because some of the responsibility for the harms could be passed on to other agents. If this were true, it would be a concern for all the schools of thought that we have identified. Those who regard producers as having caused environmental damages and who hence want to make them pay for the damage would be concerned that some such producers may be able to pass on these burdens to consumers. Those who regard consumers as the ones ultimately causing the damage would be concerned that they could pass on their responsibility to the producers, or to any of their other transaction partners. And those who regard the causation of environmental damages as being shared between producers and consumers and who therefore want government to make each agent pay their share of the damage, would be concerned that after government did call for these individualised payments according to some apportionment rule, the real sharing of the burdens could be done in a way that bears no relation to the actual proportion of the causation of that damage.

Fullerton (1996) provides an empirical example of this issue. For Pigouvian taxes which aim to set the tax rate equal to the damage caused in order to satisfy the Polluter Pays Principle, the government has an objective for the tax burden that agents causing that damage must bear. Fullerton investigates pass-through for taxes with such a Pigouvian intention and finds that "*(...) U.S. environmental tax burdens are passed from taxed industries to all other industries.*" He concludes that, due to this pass-through, the targeted tax burdens are not achieved.

4.1.7.2 Relation to tort law

As for Pigouvian taxation, tort law that applies strict liability with proportionate causation, also aims for courts to set the size of the payments that wrongdoers need to pay according to the expected damages[14] inflicted by their actions (e.g. Young *et al.*, 2004). Since in many tort cases, the parties involved in the joint causation of the tort meet only once (e.g. in an unforeseen accident), the degree of pass-through is smaller than with environmental taxes, where the parties

[14]Expected damages are standardly used in Pigouvian theory of optimal taxes, but they have also long been recommended in the economic analysis of tort law. *"For parties to be led to reduce accident risks appropriately, they should generally face probability-discounted or 'expected' liability equal to the increase in the expected losses that they create"* (Shavell, 1985, p. 587). In both fields of study, a version of the Polluter Pays Principle is the aim, and expected damages are used because the role of the law is seen to prospectively provide deterrence incentives to the agent taking the decision.

involved often engage in repeated transactions (producers and consumers who jointly cause pollution through one transaction meet and negotiate over prices again in subsequent transactions).[15]

Consider a tort case where a damage was jointly caused by two agents and where the judge applies damages equal to the expected costs[16] of the tort. Assume it is an accident between a car driver and a pedestrian where both failed to exercise a reasonable standard of care, such that both contributed to the causation of the damage, which was to break the leg of the pedestrian. Assume the judge applies strict liability with proportionate causation and finds that, on the merits of the case, the car driver's contribution to causing the accident was the proportion ρ and that, before the accident occurred, the car driver should have expected the cost C^e of an accident A, if it occurred ($C^e = E\left[C|A\right]$). The judge hence charges the car driver his contribution to the expected damage $\rho \times C^e$. By not being fully compensated, the pedestrian is implicitly made to pay the difference between $\rho \times C^e$ and the actual cost C that he had as a result of the broken leg. This splitting of the damage costs is likely to be final if, after the court case, the car driver and the pedestrian never interact again.

If, instead, the two are in repeated transactions, for example because they are neighbours and the car driver later goes and asks for some favour from the pedestrian, and the pedestrian feels that the splitting of the damages in court was not fair, then the pedestrian might ask the car driver for an additional payment before he is willing to do the favour. Repeated interaction after an accident occurs may, therefore, change the allocation of the damage payments compared to the causal attribution of damages that the judge identified.

In environmental fiscal law, repeated interactions are omnipresent. There are ongoing streams of pollution that arise from the ongoing production of mass products, which can be regarded as being jointly caused by the repeated interaction between producers and consumers. Hence, a producer (or a consumer) on whom the state imposes a damage payment due to his participation in the causation of some pollution is in a much better position than in normal tort cases to push part of the real incident of the damage payment onto his transaction partner.

[15]For example for CO_2, most emissions are released in a few industries (Grubb *et al.*, 2014a) which – in economic geography terms – happen to be mostly low-order goods (Mayhew, 2009) that are demanded at high frequency in global industry supply chains.

[16]In line with the Polluter Pays Principle.

This means that the ability of a court, or of a fiscal policymaker, to decide who should bear what proportion of the cost of a damage for a given proportion of the damage causation is then generally smaller in environmental tax law compared to a court's ability to take this decision in tort law.

Not all of tort law is concerned with one-time interactions though. In product liability law, for example, it is equally possible for one party to shift part of the expected damages onto another party. There, the producer of a good may expect to pay certain costs from accidents caused to consumers, who will then bring court cases against it. The judge may then decide that the producer caused the damage and charge it accordingly, but the producer may pass on some of these costs onto its consumers. The expected damage cost will be part of the price, in a way that the real burden of who pays for the damage may again be split in a different way to how courts identified the relative proportions of that causation. The state is then equally not able to directly make the producer pay for the damage that it identifies the producer to have caused. This problem for the state, that effective payments may vary wildly, independent of whom the state identifies as the causal source of the damage, seems to undermine the internalisation of damages in product liability law just as it seems to undermine the Polluter Pays Principle in environmental fiscal law.

However, this problem appears even larger for environmental fiscal law than for product liability law. This is because Behavioural Law and Economics tells us that agents do not perfectly foresee the expected damage caused by their actions.[17] As a result, it matters whether the producer's payment for damage is made before or after the damage occurred. In product liability law, the producer pays after the damage occurs, even if courts will later charge him the amount of expected damage costs that the court finds that the producer should have expected. In environmental tax law, by contrast, the producer can be made to pay for the damage before it occurs (upstream taxation), for example through a fuel tax that equals the amount of damage that the state expects to occur as a result of the later combustion of that fuel. The two regimes set different behavioural incentives. Under environmental tax law, we can be more confident that even a producer with bounded rationality is aware of the expected damage cost of his product if the fiscal authority already charges him before production. Under this condition,

[17] Generally (e.g. Jolls, 1998; Lichtenstein *et al.*, 1978), but in particular for environmental damage (Baddeley, 2011).

when the producer fixes the price for the consumer, the producer will know the tax and try to include it (and thereby the expected accident cost) in the price. If, by contrast, the producer faces no Pigouvian tax but instead a product liability, he must himself calculate the expected damage from potential harm that consumers may derive from his products. If he underestimates the likelihood of that damage, then he will not try to include the full expected damage cost in the price when the product is sold. When the damage now occurs, and the consumer takes the producer to court and is awarded the damages payments according to the court's view on who caused that damage, the producer may no longer be able to pass on those costs to the consumer. If the producer tried to do so ex-post, the consumer might just stop buying the product in the future.

These examples suggest that, even though the Polluter Pays Principle can be applied in tort and environmental tax law, the greater occurrence of pass-through makes it harder for the state to make a polluter pay a particular amount in environmental tax law. Unlike in tort law, with green taxes, the state is not able to determine who ultimately pays for a given amount of social harm. The state might thus be unable to implement its views on who caused the pollution and who is hence the Polluter who should Pay. If the economic objective of environmental law is to achieve an efficient internalisation of damage costs, then the pass-through of environmental taxes might undermine its economic purpose.

If these concerns were to be true (we show below how they can be resolved), then the hurdles for realising environmental taxation in line with the Polluter Pays Principle could be insurmountable. It appears relevant to show why these concerns are not true, because if they followed through, that would cast doubt on the feasibility of the neoclassical efficiency objective for environmental policy. If it is true that the internationalisation of damage costs cannot really be achieved because Pigouvian taxes are passed through irrespective of who caused the damage, would it be better to return to the classical legal objective of environmental law to just effectively reduce pollution? And if environmental taxes are particularly susceptible to this apparent problem of passing through responsibility for one's own causation of environmental harms, is then maybe the classical legal approach to environmental law to use command-and-control regulations and liability regimes more robust than Pigou's approach to environmental law? Should we then maybe even embrace the regulation, instead of relying on market-based measures such as taxes?

In the remainder of this chapter, we defend the economic-efficiency approach and try to show how all these problems are solvable.

4.1.8 Outlook

Until this point, the chapter discussed the relation between three fundamental questions for environmental law: objective, instrument and causation. We have shown that there is continued controversy about the very objective of environmental law and the causal attribution of damages, and how one impacts the other. These two concerns importantly impact the question whether taxes are an appropriate policy instrument for environmental problems.

Classical environmental law tended to suggest the objective of environmental law to be the reduction of physical environmental harm, and that the appropriate policy instrument to achieve that objective would be regulations. These two positions seemed to be consistent as long as regulations would be able to change the behaviour of those agents with physical control over the environmental damage.

Neoclassical economists have sometimes challenged the objective of physical efficacy, and instead suggested to focus on efficiency. They equally posited that instead of regulation, the appropriate policy instrument is taxation.[18] But to make a powerful case for change, the neoclassical economists needed to show that their two positions (the changed objective and the changed instrument) are consistently linked through a theory of causation as well. Until now, we have recounted various challenges to this consistency by authors who suggest that taxation might not make the true polluter pay, which might in turn cast doubt on taxation or the objective of efficiency. In the following, we aim to resolve these concerns.

We will build a theory that, in cases where environmental damage was caused by several agents who are transaction partners, such as producer and consumer, the sharing of the burden of that damage can be achieved in a manner that respects the different proportions by which the agents caused the damage. This approach works when the government imposes an environmental tax at the Pigouvian level – at the level of the damage caused by the agents jointly. The government does not normally need to determine which proportion of a damage was caused by which of the transaction partners. The amount of causation will covary with

[18]See for example the consensus view of 27 Nobel economists in Akerlof *et al.* (2019).

the amount of the tax incidence that agents bear after the tax was introduced, which resembles a Coasean bargain in a setting where such Coasean bargaining would not have been possible without the Pigouvian tax. The Coasean bargaining will achieve a burden sharing in line with the proportions by which agents individually contributed to the joint causation of the damage, because the factors that determine the bargaining position of these transaction partners also express their contribution to causing the damage. As a result, the debate on whether producers or consumers should be regarded as the cause of environmental harms would be rendered unnecessary. Even in the face of these problems, environmental taxation can be used to make the agent who truly caused the pollution pay.

4.2 Relation of causation to tax incidences

4.2.1 Thought experiment # 1

Consider the following thought experiment. There is a competitive market with a large number of producers manufacturing an identical product at zero profit. All producers apart from one share the same technology which produces no pollution. The remaining producer uses another technology which produces a fixed amount of pollution per unit of output. This pollution is harming a third party which has no means to avoid it. Apart from the pollution, the production technology used by the majority of producers operates at the same marginal and fixed costs as the technology used by the polluting producer, and there is no environmental tax, so the extra costs to society that come from the pollution are fully externalised. As a result, the producers all have the same production costs and prices, and all face the same residual demand by customers. The customers cannot tell which producer is the polluter.

In this setting, let us consider the question if the polluting producer is causing the pollution or if, instead, its customers are causing it. In the economic analysis of tort law, a basic test for such questions of causation is the "but-for"-test.[19] The

[19]In this analysis, we are skipping one other test which judges apply in tort law before considering the causation of damages. This other test relates to determining whether there has been any "wrongful behaviour", which is a pre-condition for the existence of a tort. Since the consumer's purchase was legal, there was no such wrongful behaviour, so tort law would not apply any sanctions. However, there was an external cost and damage caused to a third party, which is why we apply the but-for

test attributes causation to an agent if damage would not have occurred, but for the action that the agent undertook. Let us apply this test to our problem.

We could argue that the pollution would not have occurred had consumers not demanded products supplied by the polluting producer, given that the producer is only in business because consumers demand his products. Equally, we could argue that the pollution would not have occurred had the producer not adopted the polluting technology. Both suggestions seem to work, so both sides may be seen as having caused the damage.

We may get further with another version of the but-for test that uses the information that we have about the demand function. As the market is in perfect competition, all producers individually face a flat demand function. Hence consumers of the polluting producer would also be perfectly willing to change their supplier of the product away from the polluting producer to one of the clean producers. Social welfare would be increased if such a shift in demand occurred, since social welfare here is the sum of consumer surplus, no producer surplus (as none exists under perfect competition), and the loss to the pollution victim. We have another but-for condition: Social welfare would be higher, but for the producer's unwillingness to use the non-polluting technology. But again, social welfare would also be higher, but for the consumer's insistence on using this supplier. It appears as if the two parties were sharing causation evenly.

From the but-for test, it seems as if both parties cause the damage. Now consider the impact of a tax that is imposed on the pollution to internalise the damage accruing to the third party victim. The tax only affects the polluting producer's products; his marginal costs rise. If the producer passes them on in prices, all consumers shift away to other producers. So as, in a competitive market with zero profit, the producer cannot absorb the cost – he goes out of business. Neither the polluting producer nor his customers then end up paying the tax; which also means that they are sharing the tax burden evenly. Hence, the amount of tax borne by the polluting producer and the amount of causation that each contributed to the environmental harm is even.

test to infer how the causation – independent from the existence of any wrongful behaviour – could be apportioned.

4.2.2 Thought experiment # 2

Consider now a slight modification to our example. The polluting producer is not a perfectly competitive firm anymore but makes a small margin of profit. This situation could, for example, exist because the polluting producer's production technology is some infinitesimally small amount cheaper than the clean production technology of the other producers, and for some fixed costs of switching technology, the clean producers are not adopting the polluting technology. Despite the small cost difference, the producers still sell their products at the same price, with the polluting producer being able to sell at a slight markup. The consumers still consider the goods of all producers perfectly substitutable and behave as in perfect competition, with each producer facing a flat residual demand function. I furthermore assume that the polluting firm is not able to scale up production and take the market, so the above market is in equilibrium. What does this different set-up imply for our but-for test?

The situation before the introduction of the tax is otherwise identical to the previous example. Social welfare could be higher, but for the consumers' choice to buy the product, some of which comes from the polluting producer; and social welfare could be increased, but for the polluting producer's choice to use the given technology.

When now the tax is introduced, the polluting producer may not immediately go out of business because he can afford a slight rise in his marginal cost, but he would not be able to pass on the tax in prices. If he does increase the price, the consumers will shift to other producers, and it is not possible to say that "Social welfare could be higher, but for the consumers' maintained choice to buy from the polluting producer"; instead the consumer's action to shift away all their demand would cause that social welfare increase. By that argument, the consumers would no longer be causing the social loss. The producer, if he wants to continue producing, must absorb the tax change in his costs. Then he must continue paying the tax, which – if the tax is set at the Pigouvian tax rate that equals the damage to the third party victim – will exactly equalise the social loss from the pollution. Therefore, after paying the tax, the producer is also no longer causing a social welfare loss. It is the payment of the tax, and its full absorption by the producer, that equalises the degree to which producer and consumers are causing changes in social welfare.

As with the first thought experiment, the proportion of the tax paid by the polluting producer and the consumers equals the proportion by which the two groups cause the damage.

4.2.3 Intuition

What do these thought experiments teach us intuitively? We considered a notion of causality that depends on conditions of supply and demand for a product that caused damages.

The agent who insisted the most on continuing the pollution after the onset of taxation was regarded as having caused that pollution to a greater extent. In the boundary case that we considered, the decision that the pollution continued was completely due to the insistence of the producer himself to continue its production as such, as consumers were perfectly willing to give up these products (and buy others). This share of the causation matched the relative shares of the tax burden borne by the producer and the consumers. From a popular intuition, the degree to which an agent insists on an outcome also raises that person's causation or responsibility for that outcome. The notion of causation that we considered is in line with that popular view, and so was the share how the tax burden ended up being divided.

Besides the popular notion that relative causation is associated with the relative insistence on an action, we also see in our thought experiment another popular notion of causation: that relative causation is associated with relative benefits from an action. In the second thought experiment, the producer was the only one benefiting from the pollution, as for the consumers there was no benefit from buying the product manufactured with the polluting technology compared to buying the products manufactured with the clean technology. The sharing of the tax bill for the pollution was also proportionate to the sharing of the benefits from pollution. From popular intuition, the extent to which somebody benefits from an outcome is often linked to notions of responsibility for that outcome. The notion of causation that we described is again in line with that popular view, and equally are the shares of the tax incidences.

4.2.4 Formal derivation

Here we illustrate how the tax incidence and pass-through relate to the above notions of causation.

4.2.4.1 Relation of causation to tax incidences when causation is defined as the notion of unwillingness to reduce pollution

Consider this time a large number of price-taking producers who sell to consumers a product whose industry output Q causes pollution Ω at a fixed marginal emissions factor e.

$$\Omega \equiv e \times Q$$

In the absence of policy, the industry is in equilibrium, so the quantity demanded of the polluting product equals the quantity supplied; $Q_S = Q_D = Q_*$.

Now suppose the government introduces a pollution tax t per unit of emissions. As a result, the equilibrium output and price is going to change. However, here we want to analyse the relationship of pass-through to the willingness to reduce output and pollution, and for this analysis, we will consider the initial disequilibrium after the tax was introduced and in which market prices have not yet adjusted. In this way, we can first consider the reaction functions of producers and consumers and afterwards the pass-through of the tax. Therefore, consider first the initial disequilibrium that occurs after a tax is introduced due to the creation of excess supply or demand before market prices adjust to the new after-tax equilibrium. To consider these initial responses, let us ask the hypothetical question of how output and pollution would be impacted if market prices were fixed. In this case, if the tax was imposed on suppliers and market prices are fixed, suppliers would have to bear that full tax increase as a reduction in the producer price. Accordingly, the reduction in pollution would be given by

$$\frac{d\Omega}{dQ_S}\frac{dQ_S}{dt}\Big|_{\Delta Q_D=0} = e \times \frac{\partial Q_S}{\partial P} \times (-1) \times dt \tag{4.1}$$

If, instead, the tax was imposed on demand and prices were fixed, buyers would bear the whole burden of the adjustment and pollution would decrease by the following amount

$$\frac{d\Omega}{dQ_D}\frac{Q_D}{dt}\bigg|_{\Delta Q_S=0} = e \times \frac{\partial Q_D}{\partial P} \times 1 \times dt \tag{4.2}$$

The formulae differ in the negative sign. This is because, also when there is no pass-through, the tax would decrease the price that producers receive if the tax is imposed on them (in equation 4.1) whereas if, instead, consumers face the tax liability, it would increase the price that they pay (in equation 4.2).

Dividing these equations 4.1 and 4.2 gives an expression of the relative willingness of suppliers and buyers to reduce output and pollution if they need to pay a pollution tax.

$$\frac{\frac{d\Omega}{dQ_S}\frac{dQ_S}{dt}\Big|_{\Delta Q_D=0}}{\frac{d\Omega}{dQ_D}\frac{dQ_D}{dt}\Big|_{\Delta Q_S=0}} = -\frac{\frac{\partial Q_S}{\partial P}}{\frac{\partial Q_D}{\partial P}} \tag{4.3}$$

The relative willingness to reduce pollution given the tax is here represented by the ratio of the slopes of supply and demand functions. Using the fact that at the point of departure before the tax the market is in equilibrium, we can multiply the numerator and denominator of equation 4.3 by $\frac{P}{Q}$ to express this relative willingness in terms of elasticities.

$$\frac{\frac{d\Omega}{dQ_S}\frac{dQ_S}{dt}\Big|_{\Delta Q_D=0}}{\frac{d\Omega}{dQ_D}\frac{dQ_D}{dt}\Big|_{\Delta Q_S=0}} = -\frac{\frac{\partial Q_S}{\partial P}\frac{Q}{P}}{\frac{\partial Q_D}{\partial P}\frac{Q}{P}} = \frac{\epsilon_S}{|\epsilon_D|} \tag{4.4}$$

The relative willingness of buyers and sellers to reduce pollution when faced with the full tax burden is then given by the ratio of the absolute values of their respective price elasticities.

Before moving on, let us illustrate this notion of relative willingness to reduce pollution with a numeric example. Suppose the demand and supply functions are $Q_S = 2 + 4P$ and $Q_D = 50 - 2p$; the tax is $t = 3$ and $e = 1$. In this case, if now a tax is imposed on producers and they cannot pass it on, the decrease in pollution ($\frac{d\Omega}{dQ_S}\frac{dQ_S}{dt}\Big|_{\Delta Q_D=0}$) would be 12 units, whereas if the tax is imposed on buyers and they need to pay it in full, the decrease in pollution ($\frac{d\Omega}{dQ_D}\frac{Q_D}{dt}\Big|_{\Delta Q_S=0}$) would be only 6.[20] In this case, the willingness of suppliers to reduce output and hence pollution given this tax burden would be twice as large as the corresponding willingness of buyers.

To arrive at this conception of relative willingness to reduce pollution, we assumed that after-tax prices are fixed. Let us now consider how prices adjust and how this adjustment compares to relative willingness. If the tax is imposed on producers, consumers will bear a tax incidence which expresses the share of the total tax burden that they bear as a result of sellers adjusting prices. In a competitive market, the tax incidence faced by buyers is given by the standard formula

$$I_D = \frac{\rho_D}{1-\rho_D} \tag{4.5}$$

The incidence I_D expresses the relative tax burden that consumers bear after prices adjust compared to the burden borne by producers. ρ_D is the proportion of the tax that producers pass through to consumers in taxes. For a competitive market, we know the classic result that $\rho_D = e \times \frac{\epsilon_S}{\epsilon_{S+|\epsilon_D|}}$.[21] Using this result, we can express the incidence of the tax borne by consumers as

[20] In the pre-tax equilibrium for this numerical example, $Q_S^* = 2 + 4P = Q_D^* = 50 - 2P$, so $P^* = 8$, and $Q^* = 34$. After the tax is imposed on producers and before market prices adjust, there is initial an excess demand of $E_D = \frac{\partial Q_S}{\partial P} \times dt = 4 \times 3 = 12$ units of the product. So for $e = 1$, 12 would also be the reduction in pollution. If instead the tax is imposed on consumers, there is initially excess supply of $E_S = \frac{\partial Q_D}{\partial P} \times dt = -2 \times 3 = -6$. So in this case, pollution would decrease by 6 units.

[21] To derive this standard result, consider the impact of a change in the tax on the equilibrium output. Here we assume the tax is levied on producers, so the producer price P_S for a tax imposed per unit of emissions e is $P_S = P_D(t) - et$, so the larger is the emissions rate, the larger is the tax wedge to the consumer price P_D. In the pre-tax equilibrium, $Q_S = Q_D = Q_*$

Using implicit differentiation, $\frac{dQ_S}{dP_S} \times \frac{dP_S}{dt} = \frac{dQ_D}{P_D} \times \frac{dP_D}{dt} \implies \frac{dQ_S}{dP_S} \times \left(\frac{dP_D}{dt} - e\right) = \frac{dQ_D}{dP_D} \times \frac{dP_D}{dt}$.

Solving for the pass-through coefficient, $\frac{dP_D}{dt} \equiv \rho_D = e \times \frac{\frac{dQ_S}{dP_S}}{\frac{dQ_S}{dP_S} - \frac{dQ_D}{dP_D}}$.

For a change away from the original pre-tax equilibrium, where $P_S = P_D$, we can multiply nominator and denominator with $\frac{P}{Q}$ to express ρ_D in terms of elasticities. Accordingly, $\rho_D = e \times \frac{\varepsilon_S}{\varepsilon_S - \epsilon_D} = e \times \frac{\varepsilon_S}{\varepsilon_S + |\varepsilon_D|}$.

$$I_D = \frac{\epsilon_S}{|\epsilon_D|} \tag{4.6}$$

and equivalently for the incidence payable by producers

$$I_S = \frac{|\epsilon_D|}{\epsilon_S} \tag{4.7}$$

Comparing equations 4.6 to 4.4 and 4.7, we see that the relative willingness of trade partners to reduce pollution is the inverse of the share of the tax burden that they end up paying. A party's relative resistance to reducing pollution proportionately increases the tax payable for that pollution to continue. Using our numerical example, suppliers were willing to reduce pollution by 12 units whereas buyers were prepared to reduce pollution by 6 units; accordingly, after the tax has been reflected in prices, buyers pay double as much for the continuation of pollution than sellers. Even holding the amount of pollution fixed, as a party shows more willingness to reduce that pollution, its environmental tax burden decreases.

4.2.4.2 Relation of causation to pass-through when causation is defined through a but-for test

Since people's definitions of causation vary, we take another perspective to gauge the robustness of the above result.

After the tax is imposed, there is a new market equilibrium, brought about by the reaction functions from both buyers and sellers. We can compare the pollution reduction achieved under that market equilibrium with the pollution reduction that would have been achieved by buyers and sellers acting alone. This comparison allows us to assess how much pollution would have been reduced *but for* the actions of the other party.

The equilibrium pollution reductions are given by

$$\frac{d\Omega}{dQ_*}\frac{dQ_*}{dt}$$

To find $\frac{dQ_*}{dt}$, we can use the price elasticities of either Q_D or Q_S as long as we take into account on which party the tax was nominally imposed and that in the after-tax equilibrium, producer and consumer prices are not equal. Considering a tax imposed on sellers, the equilibrium reduction of pollution is given by

$$\frac{d\Omega}{dQ_*}\frac{dQ_*}{dt} = e\frac{\partial Q_S}{\partial(P-t)} \times \frac{\partial(P-t)}{\partial t} \times dt$$

Using our previous numerical example with $Q_S = 2 + 4P$ and $Q_D = 50 - 2p$, the tax set at $t = 3$ and $e = 1$, the tax-induced reduction in the equilibrium output and pollution is 4.

We divide this equilibrium reduction in pollution with the reduction that would have been achieved with supply alone bearing the tax and prices fixed (equation 4.1, for which the numerical example had a reduction of pollution of 12). This gives us the proportion of emissions reductions that would have been achieved but for the respective other party, in this case buyers.

$$\frac{\frac{d\Omega}{dQ_*}\frac{dQ_*}{dt}}{\left.\frac{d\Omega}{dQ_S}\frac{dQ_S}{dt}\right|_{\Delta Q_D=0}} = \frac{e \times \frac{\partial Q_S}{\partial(P-t)} \times \frac{\partial(P-t)}{\partial t} \times dt}{-e \times \frac{\partial Q_S}{\partial P} \times dt} \tag{4.8}$$

In our numerical example, the result of equation 4.8 is $\frac{\frac{d\Omega}{dQ_*}\frac{dQ_*}{dt}}{\left.\frac{d\Omega}{dQ_S}\frac{dQ_S}{dt}\right|_{\Delta Q_D=0}} = \frac{4}{12}$, suggesting that because of buyers, only one third of the pollution reduction was achieved; or *but for* buyers, the reduction could have been three times as large.

How does this conception of causation compare to the tax burden borne by buyers and sellers? Equation 4.8 reduces to[22]

$$\frac{\frac{d\Omega}{dQ_*}\frac{dQ_*}{dt}}{\left.\frac{d\Omega}{dQ_S}\frac{dQ_S}{dt}\right|_{\Delta Q_D=0}} = 1 - \frac{\partial P}{\partial t} = 1 - \rho \tag{4.9}$$

$\frac{\partial P}{\partial t}$ is the proportion ρ by which producers are able to pass-on the tax burden to consumers through higher market prices. Equation 4.9 suggests that producers

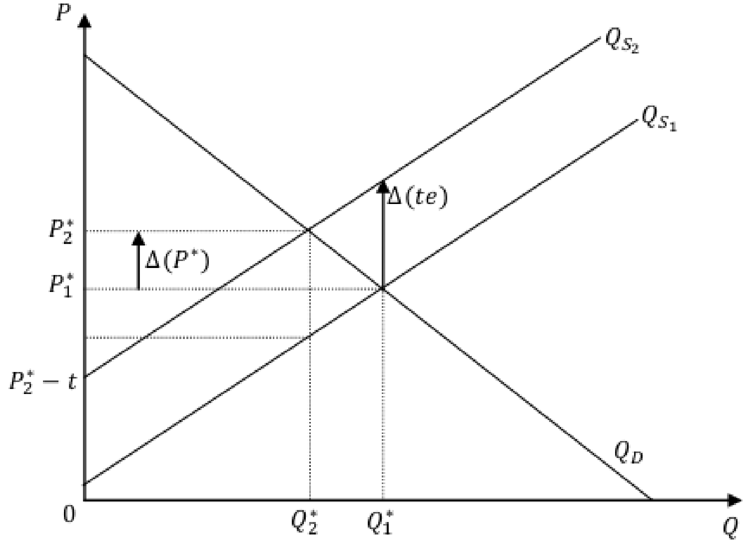
[22] In the numerator, the producer price is given by $(P - t)$, in the denominator the price is fixed and hence given by P. In both cases, the price elasticity of demand for the producer price is assumed to be the same, so dividing through the elasticity of supply for changes in the producer price gives 1.

are able to pass on to consumers exactly the same proportion of the tax burden that consumers have caused. In our numerical example this means that as only one third ($\frac{4}{12}$) of the pollution reduction was achieved due to buyers, the proportion of the tax passed on to consumers is also $\rho = 1 - \frac{\frac{d\Omega}{dQ_*}\frac{dQ_*}{dt}}{\frac{d\Omega}{dQ_S}\frac{dQ_S}{dt}\Big|_{\Delta Q_D=0}} = 1 - \frac{4}{12} = \frac{2}{3}$. Again this suggests that the proportion for which consumers and producers pay taxes for the continuation of polluting activities coincides with their share in the causation of the continuation of these activities.

4.2.4.3 Relation of responsibility to pass-through when causation of damages is defined by who benefits from these harms

Closely associated with the concept of causation is the concept of responsibility. In section 4.2.3, we discussed another popular view on causation, that those who benefit most from an activity which causes damage to others should also bear a greater responsibility for that activity. Lenzen *et al.* (2007) equally argued that the causation over environmental harms should be attributed according to the shares of added-value that agents derive from a polluting activity. Under certain conditions, also this alternative definition of causation is matched by the burden sharing that the pass-through coefficient imposes.

To see this coincidence, consider the proportion by which each of the parties causing the pollution benefit from a further increase of it. The benefits that the consumer and producer derive from the production of the polluting product are given by their respective consumer and producer surpluses.



Consider the pictured example in which the pass-through coefficient equals the ratio of the price change (small left arrow) to the tax change (large right arrow). This ratio $\left(\rho = \frac{p_2^* - p_1^*}{p_2^* - p_2^* - te}\right)$ is the same as the ratio of the consumer surplus to the sum of consumer and producer surplus. The burden of the tax is hence borne in proportion to the benefits that consumers and producers obtain from their exchange. Also the deadweight loss from taxation is shared in this proportion. Hence, in this example, after an environmental tax is imposed on a polluting product, the proportions by producers and consumers end up paying for this tax equal to the proportions by which they benefit from continuing to produce and consume that polluting product. This finding carries over to several functional forms which all share the property that the tax passthrough coefficient does not vary in the tax rate. These include: constant-elasticity demand combined with constant average cost or power-law cost, linear demand combined with constant marginal cost or linearly increasing marginal cost, and exponential demand combined with constant marginal cost (Fabinger & Weyl, 2014, p. 14).

Next, consider a carbon tax which achieves full decarbonization, as is the objective of the European Commission under the new Green European Plan. Full decarbonization requires almost eliminating the market for certain high-carbon products like coal. In this case, the incidence for such a carbon tax is to take away the consumer and producer benefits of the market for that high-carbon product. The passthrough coefficient would then be

$$\lim_{t \to \infty} \rho = \frac{CS}{PS + CS} \tag{4.10}$$

Again, consumers and producers share the burden of the environmental tax according to how much they benefited from that pollution. For this full-decarbonization case, that burden sharing holds for all functional forms.

Weyl and Fabinger explain what we can learn from this extreme tax for less extreme taxes. The factors that make a consumer or producer bear a larger tax burden are the same which drive their consumer and producer benefit of the polluting product. *The global incidence of the market, the ratio of consumer to producer surplus, is the quantity-weighted average pass-through rate between zero tax and the smallest (perhaps infinite) tax that chokes off all trade. This implies that the same factors that affect local incidence, relative elasticities of supply and demand, determine the global division of surplus. If demand is more elastic than supply globally, the surplus of the market's existence will accrue primarily to suppliers and conversely mutatis mutandis. Intuitively, to the extent that pass-through does not vary much as tax rates change, taxing a market hurts most that side of the market which benefits most from its existence*" (Weyl & Fabinger, 2013, p. 536). Therefore, for a pollution tax, the tax incidence falls on those parties who are most responsible for the pollution in the sense of benefiting most from the polluting good.

Next consider this thought experiment: After an environmental tax has been introduced, consumers/producers of a polluting product get the opportunity to purchase/sell one additional unit of the polluting product untaxed. How do consumers and producers respectively benefit from that additional unit of the good and the associated pollution? As a proportion of the total surplus generated by this untaxed unit, the consumers' share equals the passthrough coefficient of the environmental tax, and vice-versa for producers. For all the goods produced after the environmental tax has been introduced, the tax burden is split according to how much consumers and producers would benefit from an additional unit of the good. Another way of looking at this: After an environmental tax has been introduced, the marginal consumer pays the pass-through coefficient that equals the share of the total surplus which that consumer used to derive from this good prior to the tax. All consumers thus pay the tax burden according to the previous consumer surplus of this marginal consumer.

As a caveat, it is possible, with demand and supply functions of non-standard shapes such as functions with dramatic kinks, that the price elasticities of the marginal consumer and producer vary significantly from the rest of the market. In this case, it is possible for Pigouvian taxes to impose a burden sharing which does not well reflect the contributions of the average consumer or average producer to the causation of the pollution. In this case, the average producer (consumer) pays for the way the marginal producer (consumer) contributes to causing the damage. But this exception requires the above-mentioned peculiar functional forms. And in such exceptions, if the peculiar combination of elasticities in the taxed markt contributes to a social problem, the Pigouvian tax would also generate revenues that the state could use to address that problem.[23] But again, for many combinations of standard demand and supply functions, that correction using the revenues is not required as the tax itself already imposes the correct burden sharing.

For any functional form, it is true that Pigouvian taxation causes the costs of eliminating the socially inefficient share of pollution to be born according to the shares by which producers and consumers benefited from that inefficient pollution. Recall that, out of all pollution emited in the production of a good, Pigouvian taxation eliminates only the socially inefficient part, i.e. pollution whose social cost per unit of the good exceeds the consumer and producer surplus. The cost of reducing this pollution is thus the deadweight loss induced by the Pigouvian tax, which is split according to the previous consumer and producer surplus, which in turn equals the passthrough coefficient.[24] This division of costs is like the Hand rule in tort law, which suggests that the share of liability that tortfeasors should

[23]For example, suppose there is a structural break in the demand for a polluting good. The marginal consumer is very elastic but the average consumer is not. In between them is a dramatic change of slope in the demand function. No such nonlinearity exists for supply. In this case, it is possible that consumers bear a small proportion of the tax burden even though the average consumer derives a large surplus. If this disconnect is seen as a social problem, the state could consider using the tax revenues for lump-sum transfers to the side of the market that is seen to be paying in excess of its causation of the damage.

[24]If the demand and supply functions are of non-standard form, this finding holds with a slight variation. Consider a series of infinitesimal tax rises starting from the pre-tax market equilibrium up to the new market equilibrium with the Pigouvian tax rate. The some functional forms, the passthrough coefficient may vary along this series of small tax changes. The ratio of surpluses lost due to the overall tax change ($\frac{CS}{PS+CS}$) equals the quantity-weighted average of the passthrough coefficients for this series of small tax changes. For more details, see Weyl & Fabinger (2013, p. 535f).

face depends on the surplus they obtained from the exchange that caused the inefficient pollution.[25] The important difference to the Hand rule is that Pigouvian taxation also charges for the pollution that remains after the socially inefficient share has been eliminated, i.e. for the pollution for which agents were not negligent but which nevertheless cause costs to victims. And it charges consumers and producers for the causation of that statically efficient share of the pollution by the same proportions as it charges them for the causation of the inefficient share.

Underlying these approaches lie the different approaches to revenue use and centralized or decentralized fact-finding for the socially efficient level of pollution. The Hand rule requires state representatives to determine what the efficient level of pollution is at the moment of the trial – considering both the benefits and costs of any option for reducing the causation of damages by all parties concerned. If the state has all this information, it then requires no payment for pollution below the threshold value of abatement that was determined. With Pigouvian taxation, the state does not require information on the efficient level of pollution (Posner, 1992, p. 378f.) and how that threshold changes over time with autonomous technical progress and the incentive effect of the policy itself. The state just considers external costs, leaving the private market to determine the type and benefits of abatement actions. The state then cannot use a threshold value for the efficiency of pollution as a determinant for switching on or off the payment obligations. Instead, the same payment obligation is extended to all agents on the basis of observables - the revealed preferences of the marginal consumers and producers.

The revenue that is collected for the socially efficient pollution normally goes into the Finance Ministry's general budget.[26] Since the revenue substitutes for

[25] According to the Hand rule, if an agent could have prevented a damage but did not, he should be considered negligent and pay for a damage if the expected cost of the damage exceeds the cost of preventing it. For a consumer, the cost of preventing a proportional externality is the consumer surplus forgone from consuming that product. The Hand rule thus suggests varying liability for social costs in line with the surplus that the consumer obtains from the socially harmful activity. Likewise, with a Pigouvian tax, consumers and producers will jointly reduce the output of a polluting good down to the level where the marginal private surplus from the remaining output equals the tax rate which is set at the marginal social cost.

[26] Some countries use revenue earmarking rules for fuel taxes and ETS revenues that are specifically labeled as carbon pricing (World Bank *et al.*, 2019). However, the vast majority of carbon pricing measures are general fuel taxes without such labeling (OECD, 2018). And general fuel taxes do typically accrue to the general budget. Furthermore, most Pigouvian economists and fiscal policymakers also recommend allocating all explicit carbon taxation revenues to the general budget – see for example IMF (2019) which was endorsed by representatives of about 90% of Finance Ministries and Central Banks globally.

revenue otherwise raised from the average taxpayer through any other taxes, we can simplify that the tax burden for the statically efficient share of pollution goes to the average taxpayer. If the average consumers and producers of the polluting good are the same as the average taxpayer for all other taxes, they are collectively paying to themselves. However, the collection of the revenues still ensures that each consumer and producer pays for contributing to the causation of the social cost, according to the burden on society that consumers and producers as separate groups cause at the margin.

4.2.5 Efficient burden sharing without government micro-management

Before moving on, we here summarise the results of this section. For two different understandings of causation, we have shown that the tax burdens that consumers and producers each bear reflect their relative contribution to the causation of the damage. This always holds on the margin for the causation of statically inefficient pollution, but with many demand and supply systems also for the average consumer and producer, for the causation of statically efficient pollution. This usually efficient sharing occurs without the need for the government to identify who caused what proportion of the damage; instead the government can just impose onto the transaction partners the total sum of damages that they jointly caused, and the transaction partners will implicitly and efficiently sort out who caused what damage and who should pay what proportion.

In section 4.1, we considered critiques in the literature by one group of writers who argued that the true causation of environmental damages comes from producers, and another group who argued that the true causation of environmental damages comes from consumers. Yet, other writers regarded the damages as being caused jointly. We also considered proposals for rules how the government should vary the burden that is imposed onto agents to make sure that the true Polluter Pays. Here we have seen that it does not matter whether an environmental tax is imposed on a person who did not actually cause the damage. As long as this person is the transaction partner of the one who genuinely caused the damage, the tax burden will efficiently shift to the other side.

4.3 Relation of causation to Coase's bargaining over Pigou's taxes

4.3.1 Relation to Coase's dual causation argument

The view that both the producer and the consumer of a good share in the causation of the problem is an idea close to Coase's theory of causation. In Coase's view, the buyer's and seller's reciprocity in a transaction implies dual causation of damages that arise as a byproduct of that transaction.

4.3.2 Relation to Coase's and Jenkins's Invariance Propositions

In the model of causation and effective liability that we have described, it does not matter on whom the tax liability is imposed: the price is paid by the one causing the environmental harm because the tax incidences are shared in either case, and degrees of causation coincide with the pass-through coefficient. Much of this is an application of two invariance propositions: that of Coase (1960) and that of Jenkin (1871).

Jenkin (1871) showed that, with price-taking agents, the distribution of the tax incidence does not depend on the attribution of the legal tax liability. We used this standard result and showed how it compares to the relative causation of damages.

Coase (1960) showed that, in the absence of transaction costs and with price-taking agents, efficient final allocations of entitlements are reached regardless of the initial allocation of entitlements. In section 4.2 we showed that two agents who jointly cause a damage will share the effective liability for a pollution tax on that damage according to the shares by which they each contributed to the causation of the damage, and that this efficient outcome will be reached independently of how the state perceives and attributes relative causation and tax liabilities between transaction partners. We hence showed that Pigouvian taxes – similar to the Coase Theorem – impose the efficient tax incidence that matches the amount of causation for the damage irrespective of the legal assignment of the tax liability. As with other Coasean solutions, the burden of the tax is split through private bargaining instead of through further state intervention.

Much can be said about the relation of Coase's invariance proposition and the literature on the Tax Remittance Invariance Proposition that developed out of Jenkin (1871). For non-Pigouvian taxes, these interrelations have been covered by Logue & Slemrod (2010); here we advance on the implications for Pigouvian taxes and causation.

4.3.3 Coasean bargaining over Pigouvian taxes

Coase meant his invariance proposition to apply to cases where transaction costs are low, such as neighbourhood issues, or conflicting uses of broadcasting spectra within one area. For those broadcasting spectra, the conflict happens between agents who have low transaction costs for negotiating with each other, because they are few and well informed, so getting all relevant interests and facts together at a negotiation table is not too costly. Costs of negotiating are also low in the neighbourhood issues that Coase considered. Neighbours have low transaction costs because they are already in the same place, know each other's costs and other relevant factors as a byproduct of carrying out the economic activities that they were doing already before the neighbourhood issue arose. Our case of the determination of tax incidences between producers and consumers is similar. There, the social damage is jointly caused by two agents who are in a sales contract. The fact that they are in a contract already means that the division of the tax incidence is not the only negotiation going on. Instead, producer and consumer are already in a transaction that requires the determination of market-clearing prices. If an environmental tax is introduced, producers and consumers do not need to set up a separate transaction between themselves to distribute the tax burden; they do not even need to negotiate separately. Instead, the sharing of the tax will be determined just as a by-product of the transaction partners' previous activity of determining the market-clearing price, with the sole difference that now the two agents need to determine an after-tax market price. So the transaction costs are low, exactly fulfilling the main pre-condition for Coasean bargaining.[27]

So there is Coasean bargaining on the economic incidences of such a tax. If this is an environmental tax set at the optimum rate, it is Coasean bargaining on sharing the burden of a Pigouvian tax. This deduction may sound obscure to some

[27] Simultaneously, also the criterion of Demsetz (1967) is fulfilled that the legal system should only intervene if the costs of the policy intervention itself do not outsize the efficiency gains of the intervention.

Law and Economics scholars, who think of Coasean and Pigouvian solutions as alternative approaches to internalising social costs. Here we suggest instead that in environmental taxation, Coase and Pigou rather reach efficiency together. The reason why the two thinkers have been understood differently appears to arise from different conceptions of causation over environmental harm. With our conception of causation, we aim to bring the two viewpoints together and show how a Pigouvian view on causation, in fact, enables the use of Coasean bargaining for a class of social costs where Coasean bargaining could not be used alone.

4.3.4 "Social costs" as costs borne by society at large

Coase focuses on social costs for which there is a reciprocal causation of the harmful effect: both the person originating the damage and the person suffering from the damage jointly cause it. He does not explicitly exclude the possibility that other types of social costs might exist but did not clearly cover such cases either. However, he restricts his analysis of bargaining solutions to two-person cases where the reciprocal causation exists. "*In all examples, Coase focuses on the relationship between a single producer of an externality and a single consumer*" (Slaev, 2017, p. 954).[28] Accordingly, Coase's followers understand his position to be quite clear-cut: "*Harm is not caused unilaterally by the polluter but is always jointly caused*" (Schmidtchen *et al.*, 2009, p. 28), so that "*everyone involved is fully responsible for all the damage done*" (de Meza, 1998, p. 273), which implies that "*there are no 'victims' or 'offenders'*" (Schmidtchen *et al.*, 2009, p. 5). And because this finding is held to apply to all social costs, "*from a Coasean perspective, the terms 'externality' and 'external costs' are therefore misleading*" (Schmidtchen *et al.*, 2009, p. 4).

In the Pigouvian tradition, by contrast, a usual conception of social costs is that these costs are generated by the transaction between a producer and a consumer and imposed on a third-party pure victim.[29] In the Pigouvian understanding,

[28]See also Major *et al.* (2016, p. 245): "*His important observation was that the relationship is reciprocal, for any beneficial reduction in smoke emission equally entails harms to the factory. Interestingly, Coase immediately shifts from the plural to the singular. In the second paragraph of the paper, he formulates the problem as between two actors, A and B. Subsequent examples (*e.g. *between the farmer and the cattle rancher, or between the confectioner and the neighbouring doctor) continue the re-formulation in which the ostensible 'offending principal' and the ostensible 'subjected victim' are each cast as unified actors. No longer are the effects spread among multiple others.*"

[29]"*Indeed, most expositions of the Coase theorem as a critique on externalities in the planning and law*

therefore, an externality is *"a third-party effect,* [which] *is the uncompensated effect suffered by an innocent victim (the third party) that is generated by parties to a contract. It is 'external' to that contractual arrangement*" (Lai, 2007, p. 344).

The two schools of thought, therefore, appear to have different conceptions of "social cost", and that dichotomy leads to certain misunderstandings. Coase himself criticised Pigou for, in his view, not considering the contribution of the victim to the damages at all. Coaseans hence suggest that "*according to the Pigouvian view there is only one agent who causes the external cost*" (Schmidtchen *et al.*, 2009, p. 4). However, this critique is actually based on a misconception of how Pigouvian taxes are calculated in practice today. The misunderstanding about causation hinges upon different understandings of what a "social cost" is. Coase's and Pigou's views on causation are not contradicting each other at all. Coase and Pigou are merely analysing different types of cost. "*The authors have more in common than is widely recognised, with some of their key differences being due to the nature of the problems they tended to focus on*" (Ancev & Harris, 2006, p. 7).

4.3.4.1 Pigouvian definition of environmental taxes as applied in empirical quantitative fiscal economics

If a neighbour in a train listens to loud music and that causes damage to me, then I might be seen as partially causing that damage if I have a chance to avoid the damage by moving to another train carriage. Fiscal economists who compute external damage would therefore not count all of the damage that accrues to me as genuinely external damage. When optimal environmental taxes are computed by fiscal economists, the Pigouvian tax rate is defined as that external damage that affect agents who cannot avoid the damage. External costs are not those that accrue to persons who voluntarily absorb damage. This difference is essential, for example, in computations of optimal environmental taxes for gasoline (as the most significant environmental taxes observed in present-day law). These computations commonly include a proportion of expected accident costs as one of their largest components. But to compute the Pigouvian tax rate, the expected damage of an accident that car drivers face is not completely counted, because

fields use bilateral examples" (Lai, 2007, p. 343) whereas *"in Pigou's terminology, an externality is present when there is a divergence between private and social cost. In this Pigouvian sense, the discussion is usually conducted fro a three-person world in terms of 'third-party effects', although a two-person world can also witness such a divergence*" (ibid).

not all of it is regarded as external damage. Since the drivers know that there is a potential accident cost and they nevertheless engage in the activity, a proportion of the losses are considered "internal" (Parry & Small, 2005).

Another example: The occasional death of miners in coal mines is, for example, not commonly taken into account when computing the external costs of coal production,[30] because the miners choose to participate in the activity. What is considered "external", by contrast, are the deaths from the fine particulates released in the combustion of the coal at power stations, because these particulates travel so far that those persons inhaling them cannot realistically avoid them. Accordingly, computations of Pigouvian tax rates on coal take into account the second type of cost, not the first. This consideration in calculating Pigouvian taxes is similar to the "defence of coming to a nuisance" in tort law.

Distinguishing between internal and external costs is often difficult. These separations involve similar causal inquiries to the ones made by courts in tort cases, who equally need to set out which proportion of each damage was caused by the victim. Does this mean that the apportionment of "internal" and "external" costs for fiscal purposes would involve the same information costs as the apportionment of causation in courts? No, because with Pigouvian taxes, we have reduced complexity by restricting the number of persons to consider in the causation: only the victim is relevant; how later the proportionate causation of polluters is split does not need to be judged by any state actors. With the tax computations, we have a reduced number of cases that need to be considered,[31] because the relative causation of producers and consumers does not need to be considered through a state agency anymore.[32] Using the fact that the agents are in a transaction hence cuts down on the number of agents whose contribution to the social harm has to be considered. Accordingly, also transaction costs (for compliance and administration) are cut.

[30] These costs have therefore been classified as "internal" in leading policy studies, such as the European Commission's project "ExternE" (Eyre *et al.*, 1999; Rabl *et al.*, 2005), the US Government's project "Hidden Cost of Energy" (NRC, 2009) and the IMF's "Getting Energy Prices Right" (Parry *et al.*, 2014). In each case, these "internal costs" are counted as zero for the purpose of determining optimal government intervention.

[31] Generally, the greater the number of persons involved in a bargain, the lower the chance of the Coase theorem applying (Hoffman & Spitzer, 1982; Mailath & Postlewaite, 1990). We try to solve this general problem here considering how the Coase theorem can work again if we supplement it with a Pigouvian tax which crushes the number of agents who need to be considered in the bargain.

[32] And this apportionment of damage payments cannot be set by a state agency because the agents are in a transaction and can hence diverge from the agency's decision.

But the contribution of those agents outside the transaction – the third-party victims – still does need to be considered. Tax agencies ease the data requirements for this task by assuming general cases (typification), but the objective of the inquiry remains similar to courts who need to determine the victim's contribution to the damage. The proportion of the damage that was caused by those who participated in the transaction gives the tax rate imposed on that transaction. After this computation, the Pigouvian tax rate is, by construction, the amount of damage that accrues to persons who have not already internalised the damage.

The examples that Coase uses are examples of persons who internalised the harm because they had a way to avoid it. This internalisation must be the case because Coase says that the causation is dual and that therefore there are never true victims. Coase's examples of social costs are hence not actually external costs in Pigou's definition. Pigou considers the external costs after the costs that the victim caused have already been deducted; so the costs for which true victims exist. Coase considers that category to be empty. Coase suggests that taxes should not be used because the victim also contributes to the causation of the costs. Pigouvian economists would say that if any costs are due to the victim, they are internal, and of course, no tax is then needed anymore to make the person causing them internalise them. Pigouvian taxes consider only the harm that agents cannot avoid. Coase's critique that Pigou did not consider dual causation in the sense that the victim of pollution contributed to the causation is therefore based on a misconception because Pigouvian taxes are already net of the victim's contribution to the damage.

4.3.4.2 Coincidence of genuinely social costs and problems of Coasean bargaining

Pigou suggests a solution for a type of social cost for which Coase's suggestion of dual causation fails. This solution incidentally coincides with many situations where Coasean bargaining does not work. Let us see in this section where that coincidence comes from.

According to Coase, problems of social costs can be solved through bargaining if transaction costs are low. The examples that he considered are problems between neighbours where these low transaction costs arise, and we equally have low transaction costs for bargaining over tax incidences between agents who are already in a purchase transaction. Outside of these simple cases, environmental problems are often so complex that resolving them through Coasean bargaining would cause substantial transaction costs.

Take the example of air pollution from $PM_{2.5}$, so the most relevant environmental problem if we go by current death tolls (WHO, 2014). Chains of causation are indirect,[33] and the time and geographical gaps between the causation of the harm and the manifestation of its effects are so large that the transaction costs for direct bargaining over harms from $PM_{2.5}$ pollution would be very high. Without interception by Pigouvian taxation, Coasean bargaining then appears impracticable.

For another example consider greenhouse gas emissions, where radiative forcing of a molecule released from any one emitter in the world has global ramifications, with a long time lag, and depends on an existing stock of greenhouse gases that were released by other emitters but who are nevertheless sharing in the causation of the marginal damage of the particular emitter because the dose-response function is nonlinear. All these are genuinely complex issues, where a bargaining solution alone is almost impossible, even if one just considers the number of persons involved. Bargaining may be possible between states, but to set effective incentives for polluters, who are individuals, the incentives need to be individual; so to reach the decision-makers, the internalisation problem persists much as before.

Both the case of air pollution with fine particulate matter and climate change are examples where true victims exist who cannot avoid the environmental harm at any reasonable cost. If $PM_{2.5}$ travels such long distances that even persons moving away from the pollution source by 2000 km are still inhaling a meaningful fraction of the pathogens (Zhou *et al.*, 2006), then the physical presence of these victims in the pollution plume cannot reasonably be regarded as a contribution to the causation of the damage. For climate change, the fact that CO_2-molecules are stock pollutants that cause harm by remaining in the atmosphere for around 100 years (IPCC, 2014) implies that future generations are affected by today's emis-

[33] The relative risk of dying from $PM_{2.5}$ rises in the concentration of particulates inhaled, but not all particulates that are emitted are inhaled, and death occurs not from one particulate from one source but from the mass absorption of particulates originating from many different sources. Furthermore, the relation between the concentration of particulates and the relative risk of dying is not linear in the concentration (Lim *et al.*, 2014), so the amount of damage that a pollution victim suffers from one particular emitter is uncertain and the damage that one polluter causes to a victim depends on the damage that other polluters cause to the same victim.

sion decisions. These future victims then, of course, cannot bargain with current generations, and they cannot be seen to cause the emissions that will harm them.

We see from these examples that there exists some proportion of the damages accruing to victims that the victims cannot reasonably be seen to have caused. By dealing with this and only this subset of costs, Pigouvian taxes deal with problems that cannot be solved through Coasean bargaining – and exempt those that can, by treating those costs as 'internal'. Coase's and Pigou's solutions for internalising costs then do not overlap. That is not to say that policymakers may not wrongly try to apply both solutions at the same time, but in optimum, they are treating problems with different types of causation.

The choice of instrument is determined by whether the problem is, in fact, a social cost or merely a private issue. Coase's famous article is called "The Problem of Social Cost", but, in earnest, it deals with neighbourhood problems between private agents who are capable of resolving these issues by themselves.[34] Not all problems are like that, and some problems represent a genuine social cost. In our view, a cost becomes a *social* cost when it reaches out from neighbourhood issues or community issues to affect the *society at large*. These are also the cases when transactions costs become invariably large. If transaction costs are small, so that private agents can solve them on their own, the problem is not a concern for society at large, and there is no reason for the tax system to get involved. Instead, Coasean bargaining will be enough in small cases. If instead the problem cannot be solved by private agents on their own and affects wider society, then it is a genuinely social cost, and many of its components will be true external costs which the individual private agents cannot redress. In between these two extremes lies the applicability of Ostrom's type of local peer-based institutions for medium-sized problems that go beyond a neighbourhood to affect a whole community but not society at large (Ostrom, 1990).

[34]And although Pigou died just before the publication of Coase (1960) it seems that he would have agreed with Coase's solution for precisely those neighbourhood issues as he wrote "*The deficiency of the private, as compared with the social, net product* (...) *can be mitigated in various degrees by compensation schemes*" (Pigou, 1932, pt. II, ch. IX, para. 7). His book discusses 31 times the use of "*practicable bargains*" to avoid different types of social conflicts. He discusses private solutions and distinguishes them from a "*second class of divergence between social and private net product*" which are "*of such a sort that payment cannot be exacted from the benefited parties or compensation enforced on behalf of the injured parties*" (id., para. 10). He thereby does seem to suggest that taxes should only apply to that subset of social costs where the parties involved are not able to resolve their problem through direct bargaining. It, therefore, seems that Pigou would have agreed with Coase in exactly those sorts of neighbourhood problems that Coase (1960) focused on.

4.3.5 Pigou's taxes bring social costs into Coase's bargains

With this background, let us consider what happens in a transaction between a producer and a consumer when a Pigouvian tax is introduced.

The producer and the consumer are jointly causing a damage from which a third party suffers. The third party might equally share in the causation of the damage, but a Pigouvian tax is set at the proportion of the damage that the victim was not able to avoid. The size of the damage is hence only the amount that the producer and the consumer are jointly causing, and not including whatever the third-party victim is contributing.

Before the introduction of the Pigouvian tax, we assume that the victim was not in a position to bargain with the producer and the consumer. This is of course not always the case, but it is the case for the social problems that we considered. We hence assume here that the victim was not able to make the producer and the consumer internalise its harm. After the tax is introduced, the producer and the consumer are internalising the harm. And differently from before, the producer and the consumer will now engage in a Coasean bargaining over the tax incidence. Hence the imposition of a Pigouvian tax has made a Coasean bargaining over at least part of this problem possible.

As a result of the calculation of the Pigouvian tax, which filters out all costs that the victim could have efficiently avoided, and of the Coasean bargaining, which occurs between the producer and the consumer after the imposition of the tax, all agents – producers, consumers, and third-party victims – are bearing an effective liability in line with their joint causation of the damage.

The only significant conflict between Coase and Pigou is then on the factual question whether damages exist that the victim does not cause and that it cannot claim back through liability; what we have called "genuinely social costs". If those exist, Coase alone would not have a solution. Pigou has one, but it involves Coase downstream when those who jointly caused the victim's harm share the burden between themselves through a bargaining over prices.

4.3.6 Pigou enabling Coase

Why does this mean that Pigou enables Coase? If Coase is right, and social costs are generally reciprocally caused because they do not represent situations in the category of what we labelled as "genuinely social costs", then the conditions for Coase's bargaining solution applies. In that case, Pigouvian taxes would be zero because they only consider such costs. Even in this world, there is no real conflict between the instruments suggested by Coase and Pigou per se. Pigou would just be dealing with an empty set.

If the genuinely social costs do exist, Coasean bargaining will not come about on its own, irrespective of who has what entitlements, because the transaction costs for genuinely social costs prevent bargaining between true victims and polluters. After a Pigouvian tax is established though, the state is building a channel through which the transaction between victims and polluters becomes possible, with the tax fixed at the level that would have been reached had Coasean bargaining be possible. After the state has thereby represented the victim at the negotiation table that the victim could not participate in, the splitting of the tax burdens between the transaction partners now works through another Coasean bargaining process.

Coase (1960, p. 18) had called for economists to do "*the work of the broker in bringing parties together*" so they could bargain solutions for social costs. And this is what the Pigouvian tax does: It brings the producer and the consumer of a polluting good to confront the cost that they are jointly causing towards third-party victims, so that these two parties bargain how they will share the tax bill which equals the social cost. The tax acts to enable that bargain for this type of social cost.

4.3.7 Instrument choice

A critic may argue that, while the preceding argument shows that there is a need for the state to play a Pigouvian role, this finding does not mean that the intervention should be fiscal when it can also come from a liability-based system.

Calabresi & Melamed (1972) recommended that in cases where transaction costs are too large for efficient bargaining over efficient prices, an independent actor such as a court should step in and take the role of setting an appropriate price. Through such liability rules, the person violating another person's right then only needs to pay the price determined by the independent actor. In tort cases, that independent actor is a court, and in many environmental settings outside high-frequency market transactions (e.g. accidents), liability can more easily be used to compensate victims than fiscal approaches (Faure, 2001; Faure & Nollkaemper, 2007; Faure, 2009a; Faure & Liu, 2011).

Nevertheless, some cases remain when the administrative and compliance costs of court proceedings exceed the claims that victims have against each of their opponents, which may be very many, as in the situation of the great number of air pollution sources (Faure, 2009a). There can then be cases where liability-based systems are simply too expensive. Other cases abound where the victim is unable to prove who exactly caused the damage – as in cases of air pollution where it is the concentration of pollutants which kills – and not the individual particulate – and where these particulates originate from a vast number of sources – but where it is known that each source does cause damages to someone. The complexity in understanding and proving environmental damages furthermore puts large costs on those claiming the damages – the state here has the resources to do the necessary research on expected damages, while the fixed costs are high for victims, particularly as they will almost always be liquidity constrained. Additionally, the victim of a stock pollutant might be born after the person causing the damage already died. For these reasons of system costs and feasibility, pollution problems that affect a great number of actors at any time, the independent actor in Calabresi's setting may be a government agency setting taxes rather than a liability-based system.

This is not to say that there would not be room for liability systems, or that some pollution victims would not contribute to the causation of their damages. The point instead is that after the state exploits all measures that victims can efficiently take to avoid damages, and after it exploits all cost-efficient rooms for liability systems allowing victims to recoup damages that they did not cause, there will be non-internalised costs remaining, and these costs may be large.[35]

[35]Using a conservative estimation approach that considers entire cost categories as "internal", Parry *et al.* (2014) estimate the external costs of the combustion of energy sources in 150 IMF member countries. This damage is unlikely to be caused by the victims, since the calculations already involved large deductions for internal costs, such as all the costs for in-house air pollution (assuming that all of the around 3 million annual deaths from in-house air pollution (WHO, 2014) are voluntary as the persons inhaling the damage also ignite the fire), all the costs of deaths in single-driver vehicle collisions (assuming that because drivers themselves chose to be in a vehicle, the potential of death in traffic is completely an internal cost). The cost of carbon is equally conservatively set at the rate estimated by US-IAWG (2013), which makes no adjustment to concave utility functions and – in this context – the concentration of climate damage on the world's poorest citizens. Furthermore, all effects of air pollution that are not outright killing humans are assumed to cause zero social cost. Despite all these conservative assumptions on the costs already internalised by pollution victims,

This, in turn, means that the victim itself cannot recoup the losses it incurred without fault and that these losses hence remain external costs, unless the state does assume its Pigouvian role. When the government does take on this Pigouvian role, it sets the Calabresian-style price for the liability directly through a tax rate or indirectly by determining the cap for a cap-and-trade system. Taxes set at Pigouvian levels imitate the outcome that private parties would have reached had they been able to negotiate because the tax rate is set at the efficient rate that a Coasean bargain – had it been possible – would have reached equally. We can see this coincidence of the outcomes by considering that Coase assumes price-taking agents. In a competitive setting, where prices equal marginal costs, agents accept the price that equals their damage. By setting the tax rate at the Pigouvian rate, so at the rate of the truly external damage, the public purse – acting on behalf of the victim – receives a price (the tax) that mimics what the victim would have settled for in a competitive bargain, thus implementing the Normative Coase Theorem (Parisi, 2007).

4.3.8 Extension to bounded rationality and imperfect information

Another way how Pigou and Coase solve problems together in the causation of environmental damages can be seen by considering insights from Behavioural Economics and Information Economics.

the remaining external costs per year add up to around 5.3 trillion USD per annum.

Some of these costs could be recouped through liability, for example Faure & Nollkaemper (2007) suggest liability solutions to climate change, but for many of the costs such approaches would be costly due to the number of pollution sources and receptors involved, the difficulty of proving the source of the harm for a particular case, the cross-border distribution of pollutants, their lifetime and the resulting intergenerational problem. The lesson is then not that the entire 5.3 trillion USD of external costs should necessarily be addressed through Pigouvian taxes, but that the amount of the truly external cost is certainly not zero as implied by Coase (1960). Coase did claim that after taking into account dual causation and liability solutions the problem of "social costs" would be solved. Here instead we argue that genuinely "social" costs remain to be dealt with after Coasean bargaining has played its role. Pigou here does offer a solution, and, in fact, Pigou's solution applies only here. Coase and Pigou are hence writing about solutions for different problems; instead of contradicting each other as Coase had claimed.

4.3.8.1 Causation of damages to others

Behavioural Economics suggests that agents can have bounded self-interest (Bicchieri & Xiao, 2009; Falk & Fischbacher, 2006; Fehr & Schmidt, 1999; Rabin, 1993), and that there is commonly asymmetric information about relevant product characteristics between producers and consumers (Bar-Gill & Stone, 2009; Grubb, 2009; Kennedy *et al.*, 1994).

The presence of asymmetric information is standard in many polluting industries (de T'Serclaes *et al.*, 2007; Donat, 2003; Kennedy *et al.*, 1994). The producer was there during the production process when the pollution was generated. And since the producer deals with the product at a higher frequency than the consumer, the fixed costs of obtaining information about the product features are more easily covered. Hence it is standard to assume that asymmetric information on pollution is to the disadvantage of the consumer.

For the bounded self-interest, that feature may also arise for producers; but in a competitive environment, the more caring producers may not survive (Bicchieri & Xiao, 2009; Fehr & Schmidt, 1999), for instance, if their bounded self-interest causes them to minimise their costs less than their competitors. The good types can then be driven out of the market (Akerlof, 1970; Friedman, 2007).[36] On the consumer side, competition and reciprocity can equally reduce the prevalence of bounded self-interest (Bicchieri & Xiao, 2009; Falk & Fischbacher, 2006; Fehr & Schmidt, 1999).

With that background, let us consider now the consumer of a polluting product who does not know about the pollution. Assume also that the consumer has bounded self-interest so that he does not want to harm victims and would internalise some of the harm done to the victim through his preferences if he did know about the pollution.

We further assume that, had he known about the pollution, the consumer would have wanted the polluting production process to be changed. This remedy could have worked in the Coasean fashion, through the consumer bargaining with the producer for a change of the mode of production. This bargaining could be through

[36]Ethical producers also have a chance to stay in the market with higher prices if they can obtain higher prices. But if only some producers care for ethical and expensive production standards, and consumers do not care so that their willingness to pay for the ethically produced products is not higher than for the other products, then the ethical producers are not able to survive the competition.

the consumer explicitly negotiating with the producer, or the bargaining could have been implicit, through some of these ethical consumers stopping purchase-ing the good until the producer changes the production method. In both cases, the bargaining might have achieved an efficient Coasean solution, whose degree of social efficiency would be determined by the extent that the consumer cares for the victim. With the information problem, however, the bargain does not take place, as the consumer does not know there is a problem to bargain about.

Now assume that the government does introduce a Pigouvian tax. The tax makes visible the information about the harm done to the victim. The consumer can now learn about the existence and the size of the damage in whose causation he inadvertently participated because that information is made transparent to him by the Pigouvian tax. Now the consumer is in a position to decide whether to avoid participation in the causation of this social cost or not. The Coasean bargaining to reduce the damage can now happen.

4.3.8.2 Causation of damage to oneself

Consider now a case where the pollution or some other product feature harms the consumer himself. As before, the consumer does not know about the harm. This set-up could describe, for instance, insecticides used in agriculture where farmers who purchase insecticides from their suppliers often do not know about the risks that these chemicals pose (Lekei *et al.*, 2014; Rahman, 2003), even when those chemicals affect the farmers' own health while using the product.

So we have a product that causes damage to the consumer (the farmer), but the consumer does not see all of those costs. Who is then causing the damage to the consumer? By our conception of causation, the consumer is causing some of the harm jointly with the producer, and the shares of the causation depend on the price elasticities of demand and supply for the product. The fact that the consumer does not know about the existence of the costs that he is imposing onto himself does not change the fact that he is contributing to the causation of those costs through his demand. After all, if he did not purchase the product, the harm would disappear.

So far, so uncontroversial from a neoclassical viewpoint. The trouble comes with the relation of causation to the responsibility and the effective liability. For an efficient outcome, the proportion by which an agent caused a cost should be reflected in the effective liability that this agent faces. Legally, the agent should furthermore be responsible for the damage over which the liability is imposed.

But the lack of the agent's knowledge may cast doubt over his responsibility. Some argue that, philosophically, knowledge of harm may even be a pre-condition for responsibility (Cane, 2002). This is a radical position, but most legal systems accept that lack of knowledge over damage may reduce the responsibility ascribed to tortfeasors (ibid). And in most legal cases, responsibility is a precondition of liability.

Calabresi (1975) furthermore argues that, in settings where the Coase Theorem cannot be applied directly due to high transaction cost, and where he, therefore, seeks to attribute causation to the cheapest cost avoider, causation should never be attributed to an agent who cannot foresee the damage. Also, *"under the doctrine of unforeseeability, accidents whose probabilities are likely to be underestimated by injurers should be excluded from the scope of liability"* (Ben-Shahar, 2009, p. 100). For our example, these positions of Calabresi and Ben-Shahar suggest that the consumer who causes damage to himself because he lacks the knowledge should either not be seen to have caused the damage or at least not be held fully liable for the damage. Being held liable here means paying for the damage, so Ben-Shahar's point might imply that the consumer here should not have to pay, at least not fully.

Instead, it may be appropriate to make the producer pay given the producer's knowledge of the damage involved with his product. Ben-Shahar (2009) provides an extreme example that illustrates the logic of holding the producer responsible. An adult hands a gun to a child; the child factually causes damage – who then caused the damage? In this case, most people would regard the adult as the causal agent. But treating producers of harmful products like the adults and their consumers like innocent children may not be efficient either. The world may not be as clear-cut, and the consumers should face incentives to learn (Ben-Shahar, 1999).

Without intervention, in our example of the farmer consuming an insecticide, responsibility and liability are assigned in the opposite way to their assignment in the gun example. Responsibility and effective liability are not lowered just because the farmer is not aware of harm. And the elasticities of demand and supply attribute causation to an agent whether or not he is aware of a damage. The consumer bears effective liability for the damage, irrespective of responsibility.

This is because the costs of the damage are borne by himself, not by his transaction partner. Whether the consumer is responsible does not change the sharing of the damage.

Besides this mismatch of responsibility and effective liability, there is a potential mismatch between the proportionate causation and effective liability. This is because the degree of the causation is determined by the elasticities of supply and demand for the product, but the effective liability for the damage is set separately because the consumer has not realised the existence of some of the damage. If the consumer does not realise those costs, they will not affect his demand, and hence he will not be passing on these costs onto the producer; instead, the costs will stick with the consumer, the producer does not receive an incidence of the cost through a reduced product price.

What is failing here is not our usual determination of causation, but the Coasean style bargaining process through which effective liability is determined. Such asymmetric information is a standard problem for Coase (Ausubel *et al.*, 2002; Illing, 1992).

A simple economic answer to such problems is that the state should do nothing. By the "Victim Pays Principle", the consumer should bear the harm, so that he has an incentive to find out the information about his product. Assume, however, that it may be inefficient to require from consumers to always learn full information about products given the fixed costs of information gathering. Then the state could intervene, for example through product regulation. A market-based alternative would be Pigouvian taxes, and those taxes would also bring back our efficient match between the shares of causation and the shares of effective liability.

The Pigouvian tax makes sense if the Pigouvian assumption is satisfied that the cost of the pollution is not "internal". Above, we said that the normal criterion whether or not a cost is classified as "internal" is that the victim should not have caused the harm or that there was no cost-efficient way for the victim to avoid the harm. Here the victim did contribute to the causation of the harm, so the Pigouvian tax is only justified if it is not cost-efficient for the victim to just learn about the harm.

If that assumption is justified, and the tax is imposed on the harming product, then the tax removes the information problem. The existence of the damage is made explicit to the consumer, through the price mechanism. Now the problem of responsibility is reduced because the consumer is informed through the price that the product contains an extra harm cost. And the problem of efficiently splitting the effective liability is solved because the Coasean bargaining is made possible through the inclusion of the damage cost in the price. In the way how consumers and producers normally negotiate prices, they now just negotiate also the effective liability as part of the price.

The tax makes the information about the damage explicit. The consumer participates in causing the damage just as he did before, but now he knows about it. The bargaining is then made with all cards on the table, and the Pigouvian tax establishes one of the conditions for the Coasean bargaining to be efficient. After the Pigouvian tax, the proportion of the burden borne by the consumer equals his share in the causation of the harm to himself.

4.4 Relation to further causation principles

Here we stay close to the principles of causation underlying Coase but consider some of the related causation principles developed in the tort law literature and compare them to our causation principles from section 4.2 to test these for consistency.

4.4.1 Cheapest cost avoider

4.4.1.1 Introduction to CCAP

The Cheapest Cost Avoider Principle (CCAP) holds that the state should resolve problems of conflicting claims on resources by holding accountable the party who has the comparative advantage in reducing pollution. For example, if a factory emits air pollution from which residents living in the area of the pollution plume suffer, the state should investigate who could resolve this conflict cheaply: the factory, by reducing its pollution, or the residents, by moving elsewhere. The state should not prescribe policy prior to a cost-benefit analysis of the case, and then take a regulatory decision attributing responsibility on the cheapest cost-avoider, which could be the residents. The CCAP seeks to provide a solution based on Coase (1960) for cases where transaction costs of the affected parties are too high to permit a bargaining solution. *"It is the existence of transaction costs which makes it imperative that initial liability be placed on the party or combination of parties that can avoid accident costs most cheaply"* (Calabresi & Bass, 1970, p. 77).

Like the Coase theorem, the CCAP has been used to condemn Pigouvian taxation as well as the Polluter Pays Principle. Above, we have shown that there is much less conflict between Coase and Pigou than commonly assumed; that their bargaining and tax solutions are instead useful for different types of social costs, and that Coasean bargaining over Pigouvian taxes can help address cost types that individually both instruments could not address. Here we want to equally show that many critiques of the PPP/taxes using the CCAP are based on misunderstandings, and that there is actually much less contradiction than is often assumed in Law and Economics. In making these explanations, we draw on our results above, as well as those in chapter 2, which we hence do not restate.

In the exposé of critiques of the PPP/taxes, we make frequent references to articles by Calabresi as he first proposed the CCAP, as well as to the recent book "Transport, Welfare and Externalities: Replacing the Polluter Pays Principle with the Cheapest Cost Avoider Principle" by Schmidtchen *et al.* (2009). The latter base themselves on a wide Law and Economics literature to argue that the PPP is fundamentally wrong; that Pigouvian taxation is a "traditional view" disproved by the "modern view" of Coase, and that replacing both with the CCAP is a matter of urgency for European environmental policy.

4.4.1.2 Shared causation

The main reason that Schmidtchen *et al.* (2009) give why the CCAP would be superior to the PPP is that the latter would not take into account the shared causation of damages. *"It is important to note that according to the Pigovian view there is only one agent who causes the external cost – the provider"*[37] (ibid, p. 4). However, in section 4.2, we showed that a Pigouvian tax makes the producers and a consumers of a polluting product bear the environmental tax burden in proportion of their shared causation of the harm. In section 4.3.4.1, we explained that calculations of Pigouvian tax rates in empirical fiscal economics deduct potential contributions of the victim to the causation of the damage as "internal costs".

[37] The citation continues "*of the transport services.*", as the book takes its examples from the transport sector. In this association of the PPP with "the provider", we see again the association made between the PPP and responsibilities of producers that we criticised in section 4.1.2.

Recall the exclusion of miner deaths from calculations of the optimal coal tax or the downward adjustment of accident deaths of car drivers in calculating optimal gasoline taxes.

Missing this part of the calculation of Pigouvian taxes leads Schmidtchen *et al.* (2009) to overstating not only problems with Pigouvian taxation but also one advantage. They state that *"Whereas the CCAP requires some form of a cost-benefit analysis to be undertaken in order to identify the cheapest-cost avoider, the PPP simply requires information about the polluter"* Schmidtchen *et al.* (2009, p. 72). However, identifying "the polluter" requires an assessment by the fiscal authorities whether a particular damage type is genuinely an externality rather than an internal cost. And that is an inquiry also into the victims, to arrive at a net estimate of "genuinely social costs" and hence of the polluter.

So two allegations are false. There is no need to abandon taxation using the PPP in favour of regulatory decisions using the CCAP due to shared causation – shared causation should and is taken into account by correctly calculated Pigouvian taxes. And because it is taken into account, Pigouvian taxes do not have the simplicity advantage of not needing to deal with this issue.

4.4.1.3 True victims

After deducting internal costs from the total losses of victims, and summing up all those costs per unit of the polluting good, only genuinely social costs remain. The victims of these social costs can never be the cheapest cost avoiders of the pollution stemming from the good, since they have – by construction – no handle on this cost type. Imposing a Pigouvian tax to internalise these types of social costs is, therefore, compliant with the objectives of the CCAP.

4.4.1.4 Consumer versus producer

Let us now move from victims to the least-cost distribution of burdens between producers and consumers harming those victims, and use our results from sections 4.1.7.1 and 4.1.7.2.

Calabresi & Bass (1970) discuss situations in which the state should use the CCAP to assign liability for losses to producers or consumers. They specify that, strictly under conditions where transaction costs are too high to enable Coasean bargaining between the affected parties, the state should directly intervene, and hold the party liable who has the lowest cost in avoiding the damage. We completely agree this this policy prescription under that condition. However, Pigouvian taxes are commonly used in situations where an externality arises from a mass product which producers and consumer trade frequently. In this situation, transaction costs for bargaining can be removed by including the externality cost directly into the price over which producers and consumers are bargaining anyway. Afterwards, the party on whom the tax is imposed may pass on a share of this cost to their transaction partner. Three take-aways are important:

Firstly, it is impossible for the state to affect what share of the environmental tax burden consumers or producers pay. As a result, it is fruitless for the state to inquire if producers or consumers are the cheapest cost avoiders. For example, suppose the state is concerned about social costs from coal-fired electricity and finds out that coal power stations have a comparative advantage relative to their consumers in reducing those costs. The state thus imposes a pollution tax onto the coal power stations. However, the coal power stations pass an incidence of this tax to consumers, and the outcome would have been the same had the state found that consumers are the cheapest cost avoiders and put the tax on the consumers instead. For the sharing of cost between these transaction partners, it is, therefore, irrelevant who the state thinks is the cheapest cost avoider: it will be overruled by the market anyway.

Secondly, the Pigouvian tax enables a type of Coasean bargain, and thereby removes the condition under which Calabresi & Bass (1970) called for the state to use the CCAP.

Thirdly, we know that, in a situation where high transaction costs prevent Coasean bargaining, the state can undertake reforms to stimulate that bargaining, for example through the creation of property rights over emissions and as market maker for trading these rights. But Pigouvian taxes are equally a way to get there. And if both of these options fail, the state has the back-up option to use direct regulatory decisions for implementing the CCAP. And this can only be a back-up option because, if trading becomes possible, transaction parties will overrule the regulatory decisions regarding who should pay how much.

The above chapter has shown what happens when consumers and producers carry out this bargaining. The tax burden is borne by the side of the market that is most insistent on the continuation of the polluting activity and that is benefiting most from it. That also means the tax burden is not borne by the cheapest cost avoider. Instead, the bargaining distributes the tax burden such that the person who finds it most costly to reduce the polluting activity bears the cost. In this way, the market outcome, not the state's assignment of the tax bill, contradicts the CCAP.

4.4.1.5 Consumer versus consumer, producer versus producer

But this apparent contradiction of the CCAP does not mean that Pigouvian taxation would stand in the way of an overall reduction in the cost for achieving an environmental objective. This can best be seen when considering the distribution of tax burden and of abatement among consumers and among producers.

Between consumers and between producers, the tax burden is again borne by those who find it most costly to prevent the harm. For example, if two producers of electricity are taxed for their emissions, the one with the higher marginal abatement cost bears the greater tax bill. The other one undertakes the greater abatement effort. So the tax burden is on the higher-cost avoider, the abatement burden is on the lower-cost avoider. And it is this ability of taxes (or ETS) to distribute costs and abatement efforts in this way which enables the economy to overall reach an abatement objective at the least cost. It ensures maximum use of the abatement cost advantage of the cheapest-cost avoider until that producer's marginal abatement cost matches the one of the higher-cost peer and (through the tax rate) the marginal benefit of abatement to the true victim. The same classic result holds for the allocation of tax burdens and abatement efforts between consumers.

4.4.1.6 Parties involved versus general public

The victims themselves are not directly compensated by the taxation, which adds to the deduction of internal cost to ensure that their incentives are not distorted by the tax. Instead, the revenues typically go to the general budget, i.e. the wider public. That again is consistent with the CCAP, because the wider public presumably faces much higher costs to prevent the harmful activity than the parties involved in the harmful activity.

4.4.1.7 Information costs

Pigouvian taxation uses general rules which a Finance Ministry then rolls out across an economy. It is not a system for dealing with categories of harm which vary in case-specific manner such as the details involved in a particular accident. Those categories of harm fall clearly outside its scope. But the fault line when an issue can be sufficiently generalized to fall under a macro policy like taxation and when case-by-case review is needed is contested. Schmidtchen *et al.* (2009) propose a much greater role for case-by-case cost-benefit analysis using the CCAP, to replace the PPP completely and to give taxation a smaller role with a much greater role for direct regulatory decision making. Calabresi had cautioned, however, that the system costs of applying the CCAP must be taken into account. Schmidtchen *et al.* (2009) thus engage in an enquiry on the system costs of making this switch to the CCAP and find that, although the PPP and Pigouvian taxation would have a cost advantage, that advantage would not be sufficient to justify their use. Their analysis of system costs is problematic, and as a result, a too great use of the CCAP could itself raise the costs of environmental policy.

Schmidtchen *et al.* (2009) first describe the information needs of the CCAP. *"The CCAP also requires undertaking some form of cost-benefit analysis in order to identify the cheapest cost avoider as well as the measures the latter should apply in order to maximize the welfare of society"* (p.3). *"Such a cost-benefit analysis is concerned both with the determination of the optimal goal of the regulatory proposal and with the means of realizing it at the lowest cost"* (p.6). Next they compare the information needs of the PPP/taxation: "*having identified this polluter, the question arises how to determine what he should pay. In order to solve this problem* [for implementing Pigouvian taxes], *policy makers need information on the external costs and on the abatement (or avoidance) costs. But if policy makers have all this information, they know all that is necessary to identify the cheapest cost avoider*" (p. 72). As a result, Pigouvian taxes would not have much of an information cost advantage.

However, it is not generally true that the state needs information on abatement costs in order to implement Pigouvian taxation. Here we use the extension of Posner (1992, p. 378f.) in section 2.3.2. To take regulatory decisions, the state indeed needs to compare both social benefits and private abatement costs. Environmental taxes instead only require the evaluation of the social costs from activities while leaving it to private decision-makers to determine the private benefits of these activities, and decide whether or not to abate. This difference is important, because private agents are likely to be the least-cost information gatherers, since they already engage in the business. Substituting Pigouvian taxation with direct regulatory decisions using the CCAP would give up this private-sector information cost advantage. It would imply that the state undertakes wide-ranging investigations into both the costs and benefits of various private sector activities. Such a dominant role for the state effectively amounts to a public plan selecting which private activities the state finds useful and which not, which is the opposite of Coase's intention to avoid a planned economy.

That said, Pigouvian taxation is still very data-intensive in its calculation of external costs and the deduction of internal costs of alleged victims. Nevertheless, there is an information cost advantage because the tax policy enlists the private sector to reveal the abatement cost information.

4.4.1.8 Best briber

But if the state does not undertake detailed analyses of abatement costs prior to introducing Pigouvian taxes, how can it ensure that the cheapest-cost avoider has an incentive to abate? One might be concerned about cases where a Pigouvian tax is introduced on either the producer or consumer of a polluting product but where the cheapest cost avoider is actually a fourth party whom the government never considered. Such a problem can correct itself through the private market if the government follows certain design principles for Pigouvian taxation.

As (Calabresi & Bass, 1970, p. 81) reminds us: *"If we are unable to make a sound decision as to who is the cheapest cost avoider (...), we should allocate accident losses to the best briber, that is, that party who is in the best position to find the cheapest cost avoider and pay him to adopt the optimal mix of avoidance and accident costs. In essence we look for the party who can enter into transactions most cheaply."* In the case of environmental taxation, Calabresi's recommendation mostly means that countries need to frequently update their tax rates and allow offsets. Consider the following examples where the taxed entity engages the cheapest cost avoider as an agent and then itself (as the principal) is taxed less by the sovereign.

1. A country introduces a Pigouvian tax on coal power stations in order to meet a national CO_2 emissions target. However, besides the coal power

station, CO_2 also comes from agriculture and some farmers have a lower cost of abatement than the coal power station, so they are the cheapest cost avoider. The government was either not aware or did not have the administrative capacity to tax the farmers, but is allowing the coal power station to reduce its tax liability if the power station pays the farmers for reducing their emissions instead of itself. In this case, the taxation of the power station still leads to the efficient allocation of the pollution reduction, even though the government failed to target the cheapest cost avoider. This scheme, called "carbon taxation with offset markets" provides a self-correction mechanism whereby the private sector can overrule the public selection of the pollution abater if that helps reduce social cost. Again, the tax creates a Coasean bargain. A real-world example of such a policy is the 2019 carbon tax of South Africa, with similar schemes being discussed in Senegal's carbon tax plans and global policy discourses for linking carbon taxes to offset markets (ITMO). Similarly, the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) charges airlines a type of carbon tax unless they purchase offset credits for another entity to reduce emissions in their space.

2. In the second example, a country introduces a Pigouvian tax on coal power stations in order to meet a national SO2 target. Furthermore, it provides certainty to the coal power station that the tax rate will be re-evaluated regularly, by reviewing the amount of SO_2 emissions per unit of the taxed coal. Assume the government thought that the coal power station could most cheaply reduce its SO_2 emissions by installing an emissions scrubber, but the coal power station instead finds that SO_2 emissions can be reduced more cheaply by a third party: a fuel processing firm which washes a large proportion of the sulphur content out of the coal before it goes to the power station for combustion. The coal power station thus pays the fuel processing unit to act as its agent. Lastly, the government reduces its tax rate accordingly during the regular re-evaluation of the SO_2 emissions per unit of coal combustion. The burden to reduce emissions is now with the cheapest cost avoider even though the tax remains allocated differently. A real-world example for this policy is the statutory updating mechanism of carbon tax rates in Mexico and Switzerland. The OECD is trying to convene policy action on such updating in its member states (OECD 2018), and the IMF is advising its members to use a similar scheme of tax refunds which

are provided when the pollution was lower than what was assumed (Parry, Heine, Lis and Li 2014). Work from this thesis was used in that publication and is expanded in chapters 7 and 9.

3. Now assume that over time, the cost profiles change in both examples. The marginal cost of the farmers in the first example rise with their quantity of abatement, and the costs of scrubbers in international markets continues to fall. As a result, the cheapest cost avoiders change, but the government might have no information to know that, or be slow to adjust. Nevertheless, the Pigouvian tax remains efficient because both schemes build in a self-correction mechanism through which the private sector can shift the burden of adjustment over time even if the policymakers are slow to update environmental policy. This dynamic efficiency of the tax policy would not exist in the case of the regulatory decision making using the CCAP that Schmidtchen *et al.* (2009) recommend because they rely on the policymaker, rather than the market, to determine the cheapest-cost avoider.

These examples show that it is not necessary for the state to assign abatement obligations to the cheapest cost avoider as long as the Pigouvian tax has built-in market-building mechanism that allow a self-correction mechanism.

If the right correction mechanisms are in place, it can even be detrimental for the state to attribute the tax liability to the cheapest cost avoider. Let us illustrate this point using example 2 from above. If it is cheapest to abate SO2 emissions at the fuel processing stage, but there are many more fuel processing units then coal power stations, the overall cost of environmental policy could still be lower if the state assigned the tax to the few coal power stations and relied on the above correction mechanism than if it tried to supervise many small processing units. The same if the processing units were in the informal market or had other enforcement issues. This means that the identification of "choke points" in the supply chain could be more important than the identification of the cheapest cost avoider. In chapter 11 we will therefore provide advice on the right point to tax based on such choke points and other strategies for reducing governance failure than misidentification of cheapest cost avoiders.

Given the above, we reject the claim of Schmidtchen *et al.* (2009, p. 26) that "*in order to minimize the magnitude of the (inevitable) welfare losses one has to ensure that the party with the lowest costs of reducing the amount of harm has an incentive* *to do so*". What the state instead needs to ensure is that Pigouvian policies are defined so that the taxpayer can engage the least-cost avoider as an agent. The state does not need to identify the cheapest cost avoider as long as it identifies a true externality and charges either the consumer or the producer for it. If these two are not the cheapest cost avoiders, they can contract the cheapest cost avoider as an agent, have the damage reduced, and pay less taxes. What the state needs to do is regularly update tax rates.

4.4.1.9 Valuing claims

Schmidtchen *et al.* (2009) also argue to reject taxes/PPP in favour of regulatory decisions/CCAP on the grounds that "*attempting to internalize external costs on the basis of the Pigovian view of cost causation outlined above will in all likelihood lead to welfare losses relative to what could be achieved if one took into account the fact that some harm is unavoidable*" (p. 26). They base this argument on Ogus (2006, p. 167) who rightly pointed out that "*There is no a priori reason for assuming that, because the polluter's activity involves a physical interference, her claim on the environment is less valuable than that of the pollutees*". Schmidtchen *et al.* (2009) are concerned that the state might force a reduction in pollution in cases where the polluting activity creates a net benefit to society.

For Pigouvian economists, this concern will be difficult to understand. If the polluting activity creates more value than harm, the private marginal benefit will exceed the tax which is set at the marginal social cost. So the pollution will continue. The tax would not stop this socially beneficial activity. It would nevertheless provide an incentive for private parties to keep evaluating this benefit and for innovation to occur to potentially resolve the conflict in the future.

Perhaps the basis for the misunderstanding here is the conflicting interpretations of the PPP and of the objective of environmental law itself that we analysed in section 4.1.1. The problem stressed by Schmidtchen *et al.* (2009) exists if the objective of environmental policy is always to reduce pollution. But we described the other view by which Pigouvian taxation seeks to internalize cost as an objective in itself, grounded in the Second Fundamental Theorem of Welfare Economics. We explained that a great confusion exists between different strands of the literature with camps who seemingly write about the same issue but who disagree even on the very objective of environmental policy. Seeing these different starting points can help us understand why both Schmidtchen *et al.* (2009) and Pigou might be right here but for different understandings of what the objective of environmental taxation actually is.

Unaware cost avoiders

Here we use section 4.3.8 to describe how Pigouvian taxation can help overcome a problem that Calabresi & Bass (1970, p. 88) identify for the CCAP: "*Assuming that the consumer does in fact have a comparative safety advantage, that advantage is meaningless unless he adequately appreciates the risk he faces.*" "*The first condition for this awareness is adequate information and this may be very costly.*" "*The second condition is that consumers adequately evaluate the risks when they are informed of the dangers.*" The authors follow on to describe that ensuring the consumer's awareness is difficult given the technical nature of risk factors, information costs, asymmetric information. We might add credence goods and behavioural heuristics. As we explained using the example of farmers hurting themselves with pesticides, tax policy is a potent solution. This is because Pigouvian taxes translate complex information into prices. Because consumers of course already pay close attention to the product price, it is an efficient channel to communicate such costs. After an environmental tax has been introduced, the consumer does not even need to know that the price rose because of externalities being internalized: the consumer can remain rationally ignorant to such information and still contribute to lowering the social cost.

Conclusion of this subsection

The CCAP has been used to call for abolishing the PPP and for reducing the importance of Pigouvian taxation. In this section, we have reviewed reasons why this juxtaposition is unfortunate. By uncovering certain misunderstands, we showed that the two principles and the instrument of Pigouvian taxation actually work together more smoothly than stern critics like Schmidtchen *et al.* (2009) suggest. Much of the harsh critique by these authors was based on the conception that Pigouvian taxes lack a framework of shared causation – which we showed to be wrong.

In the end, environmental taxation remains an instrument for categories of harm that occur with great frequency from the mass production and consumption of polluting products. The CCAP instead provides good guidance to policymakers and judges for reducing categories of environmental harm that are highly case-specific. Overusing the CCAP would imply that policymakers or judges would require a great deal of information, decide for society what trade-offs to make, and directly determine outcomes, like in a planned economy. The PPP can and Pigouvian taxation can in many cases enlist the private market in this effort and decentralise the cost-benefit analyses for decisions on social costs. The two approaches could thus usefully coexist.

4.4.2 Scope of liability

Here we analyse our causation principles some more by finding out what scope of liability it imposes. Shavell's (1980) concept of the scope of liability describes to what extent the damage that an agent causes leads to liability. Where it is possible that damage is caused by an agent but he is not held liable for it, the scope of liability is said to be "restricted". This is the case, for example, with a negligence rule. With a strict liability rule, the scope of liability may instead be unrestricted.

The principles of causation underlying Pigouvian taxation that we described in section 4.2 and 4.3 allow the policymaker to choose the degree by which he restricts the scope of liability.

4.4.2.1 Full restriction of liability for unexpected harms

The rates and bases of Pigouvian taxes are fixed on an ex-ante basis.[38] The scope of liability is, therefore, restricted to the damages that the lawmaker foresaw. Where the emissions of a substance cause unforeseen damages, Pigouvian taxes apply no liability to the emitter at all. That is a clear lack and shows the need for combining environmental taxes with (ex-post) tort law or (ex-ante) regulations based on the precautionary principle.

[38] To calculate that tax base, fiscal economists value all those categories of damage that are expected to occur from the emission of a substance and that are not assumed to be "internal" due to the victim's expected role in the damage causation.

The likelihood for restriction of the liability under Pigouvian taxation is a policy choice which depends on the scope of damages that the cost-benefit analyst who estimates the Pigouvian tax rate decides upon. There is hence no conservative or interventionist leaning in the causation principles underlying Pigouvian tax rates itself (despite suggestions by Demsetz 1996 that Pigouvian taxes would necessarily embrace interventions). The cost-benefit analyst can assume a small scope of expected harms or a large scope. After this scope has been set, however, Pigouvian taxes are enforcing a full restriction of liabilities on unexpected harm, and ex-post thereby embrace a non-interventionist policy stance.

4.4.2.2 No restriction of liability for expected harm

Unlike for unexpected harm, Pigouvian taxes feature no restriction of effective liability for expected harm. This is firstly because the charging of an ex-ante tax on damages cannot be avoided through judgement-proof tortfeasors (cf. Faure & Weishaar, 2012; Polinsky & Shavell, 2010; Shavell, 1986). Secondly, our analysis above implies that an agent can pass onto his transaction partners only the effective liability that also reflects those transaction partners' contributions to the joint causation of the damage.

Chapter 5

Environmental taxation in bad times and the causation of social costs along the business cycle

In this chapter, we consider whether countries should impose less stringent carbon pricing during economic downturns and whether this is an argument against environmental taxation.

5.1 First comes a full stomach, then comes ethics*

During economic downturns, it is common to hear political demands by industrial lobbies to weaken environmental policies such as pollution pricing. The argument goes that since more firms in downturns are under financial pressure, the state should during those times generally ease its cost pressure for companies to intern-

*Bertold Brecht (Dreigroschenoper, 1928: "*Erst kommt das Fressen, dann kommt die Moral.*")

alise environmental costs. It is a fiscal variant of the wide-spread[1] view that environmentalism is something for the good times. These calls have been subject to intense debate in environmental macroeconomics.[2] The Law and Economics movement has indirectly opposed such calls because macroeconomic factors do not traditionally feature in the literature's search for efficient rules. Law and Economics scholars commonly optimise legal rules through microeconomic analysis, and the solutions that they describe usually are held to apply in a stable manner, regardless of the ups and downs of the business cycle. Equally, most judge-made law consists of rules which have general applicability that holds irrespective of macroeconomic factors. Only because a judge made a decision during an economic boom does not typically mean that this decision does not hold later during a recession. For example, when a court takes a decision on a new type of liability and that decision carries precedent for future cases, courts do not state that their decision would only apply during good times; it applies generally whatever the business cycle. If the industrial lobbyists are right that it is economically efficient for the state to put less environmental pressure on firms during downturns, maybe Law and Economics would need to make its efficient liability rules vary with the business cycle as well. Here we apply our framework of causation to this question. We start by considering if causation varies with the business cycle; then turn to recent arguments on the optimal variation of pollution pricing in the environmental macroeconomics literature, and then investigate how the two relate. We show that even with constant pollution pricing the demands of easing the producer's burden of pollution pricing (the traditional industry positions) are actually already fulfilled. This coincidence supports the traditional position of judges and the Law and Economics movement to strive for efficient rules that can stand regardless of temporary macroeconomic fluctuations. There is a case for stable rules; no constant fine-tuning is necessary.

[1] See, for example, the analyses of cyclical environmental preferences in Kahn & Kotchen (2011) and Kenny (2018).

[2] Two previous related debates include the "Ecological Kuznets Curve" (EKC) and the "Porter Hypothesis". There first concept refers to the statistical hypothesis that ecological pressures might first rise and then fall as countries develop their economy. For example, water pollution problems in Europe may today be less severe than during the 1970s and 1980s, fueling an argument that countries can grow their way out of pollution. Unfortunately, the EKC does not hold when countries' resource use is accounted for under a "consumption principle" as we will review in section 6.1. The Porter Hypothesis instead suggested that environmental regulation can help countries' external competitiveness (Porter & van der Linde, 1995), which can be seen as an argument that they should not "develop first, clean up later".

5.2 Cyclical variation of causation

In the tort law literature, causation commonly depends on the actions of individuals and not on the circumstances of the overall market. For the conception of causation developed in this chapter, however, we do need to take into account macroeconomic factors, because we use elasticities of demand and supply to define causation and these elasticities can vary with the business cycle. At first sight, this variation of the elasticities along the business cycle seems to be a problem as it suggests that, in different macroeconomic settings, an agent is causing different proportions of invariant damages arising from a product. At second sight, however, this view on the causation of environmental damages appears intuitive and reduces a macroeconomic problem that other writers find with the Polluter Pays Principle.

5.3 Optimal variation of pollution taxes along the business cycle

From a literature survey of neoclassical environmental macroeconomics, Fischer & Heutel (2013, p. 207) derive that *"in an optimal framework, both emissions and emissions prices respond in procyclical fashion to macroeconomic shocks*". Heutel (2012, p. 245) explains that "*a policy that pegs emissions to GDP is a good approximation of optimal policy*". Even with stable nominal environmental tax rates, emissions rise in booms and fall in recessions. These authors recommend, however, that not only emissions but also emissions prices should vary with the business cycle. Emissions prices do vary in this way under cap-and-trade schemes like the EU-ETS, but there are no examples of countries pegging nominal environmental taxes to the business cycle. According to Fischer & Heutel (2013, p. 208), this lack of cyclicity in tax rates is inefficient. Accordingly, they find that "*Given the current economic situation of well-below full employment, as well as the growing economic scale of environmental challenges like climate change, environmental policymakers are arguably facing more complex tradeoffs than ever before.*"

Here we want to point out that, given our view on causation and effective liability, there is – in fact – a variation of price signals along the business cycle, already without a modification of nominal environmental tax rates. And for producers, this variation of the price signal does take the procyclical shape that Fischer & Heutel (2013) recommend. For consumers, however, the price signal is counter-cyclical, but this should not disturb tax policy but, if at all, expenditure policy.

The variation of price signals that exists without an explicit modification of nominal tax rates arises because the price elasticities of demand and supply are endogenous in macroeconomic shocks. Therefore, the degree to which an economy in a recession causes environmental damages and the effective liability that it faces do already respond to the macro shocks.

As demand and supply curves shift outwards and inwards with the business cycle, elasticities of demand and supply change unless the functions also change slope while shifting. For the price elasticity of demand, $\varepsilon_D = \frac{\partial q}{\partial p} \times \frac{p}{q}$, to remain constant when demand shifts outwards such that $\frac{p}{q}$ changes, the slope $\frac{\partial q}{\partial p}$ must offset the change. Where these offsetting changes do not occur, we expect that the relative elasticities of supply and demand will change with business cycles, thus impacting the shares by which producers and consumers cause environmental damages and pay for them.

5.4 Supply side

Consider that in neoclassical macroeconomics, Aggregate Supply Functions are commonly assumed to be upward sloping in the short-run, whereas in the long-run, the Aggregate Supply Function is assumed to be vertical. This assumption accommodates New Keynesian concerns for the potential of an output gap in the short-run while upholding the Classical assumption that the market returns to competitive equilibrium in the long-run. The long-run is here assumed to be the good times, while output deficiencies are assumed to be short-run features (e.g. Hillier, 1991).

Following the logic of our model, the suppliers of products are hence causing a greater proportion of damages occurring during times when the economy is in a boom, and they are causing a smaller proportion of damages that occur at times when the economy is in a recession.

5.5 Demand side

The price elasticity of demand is commonly regarded as pro-cyclical. This finding is partly explained by the fact that "*If sellers reduce prices in recessions, they attract few additional buyers*" (Edmond & Veldkamp, 2009, p. 791). Another explanation comes from studies that estimate the elasticity of demand itself as well as studies that estimate markups. We can use the results from both strands of the literature since the optimal markup of a product is the inverse of the absolute value of price elasticity of demand for that product (e.g. Samuelson & Marks, 2013).

Empirically, Field & Pagoulatos (1997) provide evidence of the procyclicality of elasticities of demand; Oliveira Martins & Scarpetta (1999) provide corresponding evidence that markups are countercyclical. The theoretical literature largely concurs with these empirical findings, though explanations vary in type. Edmond & Veldkamp (2009) start off with the observation that inequality tends to be larger during downturns as compared to during booms.[3] And when income inequality is greater, the price elasticity of demand is lower because the distribution of the probability density of willingness to pay is then less concentrated, and therefore the number of additional buyers that can be attracted through a small price decrease is smaller (Edmond & Veldkamp, 2009). An alternative explanation of procyclical price elasticities of demand and countercyclical markups is that, during booms, more new firms invest the fixed costs needed to enter the market, so the degree of competition in the market increases (Bilbiie *et al.*, 2012). Our own intuition is that, in recessions, consumers cut down on their consumption of goods that they do not genuinely need, starting with luxury goods. Luxury goods also have the highest price-elasticities of demand. The remaining consumption bundles then contain a higher proportion of necessity products, which have a low elasticity of demand. As the consumption bundle of the representative consumer hence changes along the business cycle, the price-elasticity of demand for the average product bought during booms is higher than the price-elasticity for the average good bought during recessions.

In our framework of causation, a greater price elasticity of demand during booms

[3]This logic only holds for certain types of recessions though because, during the Great Depression, inequality fell (Palma, 2009). In the recent Great Recession, however, the logic of Edmond & Veldkamp (2009) seems to hold well, because income inequality decreased only in the immediate aftermath of the stock-market bust in 2008 and then rose again immediately after stock markets stabilised despite the continuance of the macroeconomic slump (Piketty, 2014).

suggests that, in good times, consumers are causing a smaller proportion of the damage linked to the products that they purchase. In bad times, it is instead the consumers' relatively inelastic demand that causes the persistence of the environmental damage.

5.6 Joint effect

The elasticities of supply and demand co-vary with the business cycle in opposite directions, reinforcing each other's suggestion about who is causing the damage. In a boom, supply is less price-sensitive, and demand is more price-sensitive. Hence producers are causing a greater proportion of the damage and rightly bear a greater proportion of the tax burden. In a recession, it is instead consumers who account for a greater share in the causation, and the increased tax incidence accordingly makes them bear a greater proportion of the effective liability for damage caused by the remaining output.

5.7 Endogenous variation of price signals with stable tax rates

5.7.1 Producers

For producers, the price signal to cut pollution is hence procyclical, just as Heutel and Fischer recommended. It is procyclical already without any variation of the nominal tax rates. So the finding that the degree of causation over the same damage varies along with the business cycle is not a problem for our causation concept. Instead, that variation is contributing to efficiency.

During a recession, firms carry a smaller relative burden from environmental taxes compared to the relative burden they bear during booms. Assuming that a tax policymaker focuses on the production side of the economy, the introduction of environmental taxes does then not necessarily pose greater trade-offs during downturns compared to during boom times. Instead, the Coasean-type bargaining over Pigouvian taxes solves this adjustment need, by varying the burden on firms in a decentralised manner even without the state's involvement.

From an Institutional Economics point of view, this is excellent news. We know that rules once implemented tend to persist (Acemoglu *et al.*, 2000; Acemoglu & Johnson, 2005). Acting against this path dependence, loss aversion and the tendency of environmental taxes to produce more concentrated losses than gains implies that it is easier to coordinate lobby efforts for reducing environmental taxes than to adjust them upwards (Baldwin & Robert-Nicoud, 2007; Kahneman & Tversky, 1979; Olson, 1978). So there can be ratchet effects where tax rates that the state adjusts downwards during a downturn are not adjusted back upwards after the recession passes. This would be a problem: it is already tough to implement optimal corrective tax rates at any time; if those tax rates would then need to be constantly adjusted with the business cycle, even a successful environmental tax reform that once sets these tax rates at the efficient levels might quickly be washed out with the next adjustment during a recession. It is then good news that tax policy does not need to go down this slippery slope during downturns to protect producers.

5.7.2 Consumers

For consumers, however, the burden of the environmental tax is countercyclical, so it is felt hard in times that are already hard. This pattern might immediately appear inefficient, but it is only a problem in some instances.

Consider first an environmental problem such as short-lived flows of air pollutants such as $PM_{2.5}$, which is a relevant example because it currently carries the highest death-toll of all air pollutants (WHO, 2014). Some consumers die from $PM_{2.5}$, and some consumers buy products that release $PM_{2.5}$. The health effects per unit of $PM_{2.5}$ do not decrease with the business cycle,[4] so reducing the tax rate would just mean that during the recession, some consumers bear

[4]Conversely, the health impacts per unit of pollution generally increase in downturns because fuel combustion falls, so the concentration of the pollutant decreases, and that raises the marginal damage because the dose-response function for $PM_{2.5}$ is concave (Lim *et al.*, 2014). So the marginal burden that consumers of polluting products impose on their neighbours suffering from these damages is increasing, not decreasing. The Pigouvian tax rate should then be increasing, not decreasing. Here we are concerned with papers by Heutel and Fischer that suggest that, instead, the tax rate should be decreasing. We want to show that their point may be questionable due to a separate argument. In this text, we are concerned just with the variation of causation and its relation to the variation of effective liability, not with the dose-response relationship, so even though both arguments go against their suggestion, here we assume constant maginal damage to reduce the complexity of our counter-argument.

non-internalised net damages from other consumers causing $PM_{2.5}$ emissions. Between consumers, the effect of a tax rate reduction is then a distributional change, but no social welfare gain.

The increased financial stress of consumers during a recession can nevertheless justify policy action. However, it would be more efficient for the state to provide direct poverty alleviation through means-tested benefits than to distort environmental tax rates. Lowering the tax rates would distort consumption choices, and the absolute amount of economic benefit provided by reduced environmental tax rates would accrue mostly to higher-income households as long as the taxed products are normal goods (see chapter 12).[5] While underpricing externalities then does not efficiently reach the poor,[6] expenditure policies such as means-tested benefits can reach the poor much more efficiently. Accordingly, if the

Some further implications of the dose-response function (for the need for policy action when pollution is already decaying) are covered in Heine *et al.* (2017).

[5]If the consumption of a good causes an environmental externality that is not being taxed, there is an implicit subsidy in the definition of Stiglitz (2006) and the IMF (Coady *et al.*, 2017). This implicit subsidy is paid on a specific rate basis through artificially reduced consumer prices. For normal goods, consumption rises with income, so a rich person receives these implicit subsidies more often than a poor person. Any pre-existing level of inequality is thereby amplified through the non-internalisation of external costs. However, there is a counter-argument to this endogenous inequality creation. While the poor have a lower total expenditure on most polluting products such as energy and hence do not benefit from the mentioned implicit subsidies as often, the lower middle class spends a more substantial proportion of their income on energy. This proportion-based counter-argument overlooks, however, that compensation payments to households for phasing out the subsidy (e.g. lump-sum transfers) would equally account for a larger proportion of poor people's income. Unless a state internalises externalities (i.e. removes the implicit subsidies) without the use of such compensation policies, the maintenance of fuel subsidisation (or non-taxation of environmentally damaging fuels) therefore reinforces inequality.

Inequality outcomes of optimal environmental tax reforms are better than the inequality outcomes of keeping fuels subsidised (or equivalently keeping externalities underpriced) which themselves have better inequality effects than removing the subsidies without any compensation payments. For a well-designed environmental fiscal reform, which must involve simultaneous changes the tax and the expenditure side, inequality hence falls, not only statically but also over time. A simpler way to put this argument is that since the poor consume less fuel than the rich (energy being a normal good), poverty and inequality can be reduced by replacing low-priced fuels with targeted money payments to poor households or financing targeted support measures to break poverty traps, such as improved public education and vocational training. An illuminating case study is Iran. From 2010-2012, Iran replaced its fuel subsidies with a minimum income, using 50 % of the saved revenue. This proportion was enough to reduce inequality dramatically, from a Gini coefficient of 0.42 to 0.34 (Guillaume *et al.*, 2011). The absence of Pigouvian taxation accordingly increases inequality significantly.

[6]This effect has been most strongly shown for fuel subsidies (e.g. Arze del Granado *et al.*, 2012) but the underlying economic principle applies to underpriced externalities more generally, as there is economically no significant difference between the effects of directly subsidising a polluting fuel and implicitly subsidising it through unpriced externalities (Coady *et al.*, 2017).

increased financial burden of environmental taxes during downturns needs to be accommodated, that suggests varying expenditure policy, not tax policy. Alternatively, direct taxes can be reduced to compensate the effects of the environmental tax – again this is more efficient than distorting the environmental tax rate (Chiroleu-Assouline & Fodha, 2010, 2011, 2014).

5.8 Conclusion

We considered evidence that the elasticities of supply and demand vary depending on the business cycle. Our formulae on the determinants of the causation of emissions then suggest that the degree to which consumers and producers cause emissions also changes over the business cycle. We compared the direction in which the causation changes according to our formulae with the direction in which effective liability should optimally change according to results in the environmental macroeconomics literature. We saw that these directions match, suggesting that it is not a problem that our formulae suggest a cyclical variation of causation. There is a cyclical variation of price signals of environmental tax burdens, even without the variation of tax rates recommended by the literature discussed in Fischer & Heutel (2013). This implicit and automatic adjustment supports the traditional approach in Law and Economics not to vary liability rules along the business cycle.

Chapter 6

Who is responsible for emissions from international trade?

This chapter uses our concepts of causation from chapter 4 to suggest solutions for two controversial problems in emerging climate law: embodied emissions[1] and emissions in international space.

[1] "Embodied emissions" are those greenhouse gas emissions that arise in the production of a good which is subsequently exported. This concept describes only the emissions from the production process itself and not from the emissions that arise in international transport of the good. For this reason, international climate law attributes embodied emissions to the producing (exporting) country, whereas emissions released in international space are not attributed to any particular country.

6.1 Causation of embodied emissions in international climate law

6.1.1 Critiques of the current attribution of causation

Under the current climate regime, emissions released in the production of goods that are subsequently exported count towards the carbon budget of the exporting nation (e.g. UNFCCC, 2015).

6.1.1.1 Critique in the law-making fora themselves

Developing countries have long criticised this legal accounting practice, arguing that the emissions were caused by those countries to whom the goods were exported, since the emissions would not have been released had the importing countries not demanded the underlying products. "*This raises the issue of who should be responsible for this portion of emissions and bearing the carbon cost of exports. China certainly wants importers to cover some, if not all, of that cost.*" (Zhang, 2011, p. 104).

6.1.1.2 Academic critique

Also scholars called for revising carbon accounting, since "*Whilst the nation-state is at the heart of most international negotiations and treaties, global trade means that a country's carbon footprint is international*" (Wang & Watson, 2007, p. 7). "*The geographical separation of production and consumption complicates the fundamental questions of who is responsible for emissions and how the burden of mitigation ought to be shared. Yet, national inventories such as those conducted annually by parties to the United Nations Framework Convention on Climate Change account for only those emissions produced within sovereign territories, ignoring the benefit conveyed to consumers through international trade*" (Davis & Caldeira, 2010, p. 5687). "*To increase the likelihood of a future climate agreement, carbon accounting must shift from production-based inventories to consumption-based ones*" (Grasso & Roberts, 2013, p. 2).

The system is seen as unjust, including for some developed countries. Luxembourg, for example, is considered to have the highest per-capita emissions in Europe, but a large share of these emissions stem from the transport sector due to the country's location on one of the primary motorways linking France and Germany. "*A country which is crossed by trucks, for example, 'pays' for GHG emissions associated with goods it has not produced and will not use.*" (Bastianoni *et al.*, 2004, p. 254). Under the EU's "Effort Sharing Decision", these motorway emissions are nevertheless counted as having been caused by Luxembourg, making the Effort Sharing Decision appear arbitrary, which is a major problem because it is the only EU climate law instrument that limits emissions across all sectors.

6.1.2 Worsening of the problem over time

6.1.2.1 Outsourcing responsibilities to fulfilling treaty obligations

The emissions accounting problem already existed under the Kyoto Protocol, where only developed countries were under legal obligations to mitigate their emissions to certain country targets (UNFCCC, 1998). Under that regime, this accounting practice meant that the developed countries could meet their allocated total quantity of carbon emissions at a lower cost to themselves.

6.1.2.2 Europe's climate success: a statistical artefact?

Counting only emissions released from their territories, many developed countries stabilised their greenhouse gas emissions, while "*the global emissions associated with consumption in many developed countries have increased with a large share of the emissions originating in developing countries*" (Peters *et al.*, 2011, p. 8907). The total carbon emitted by developing countries increased accordingly, but that did not immediately increase their mitigation costs, as the Kyoto Protocol did not impose legally binding obligations on developing countries to stay below a set level of emissions. Overall, the practice of attributing emissions for exported products exclusively to the exporting country reduced the proportion of global emissions covered by legally binding targets, so the common objective of climate change mitigation suffered. This problem affects about 23 % of global emissions (Davis *et al.*, 2011) and 23-38 % of Chinese emissions (Davis *et al.*, 2011;

Liu *et al.*, 2013). The entire question of whether developed country emissions altogether are currently in- or decreasing hinges upon this selection of accounting principles (Kanemoto *et al.*, 2014) and their underlying views of causation. But despite the relevance for overall emissions, the issue never received enough pressure to change the accounting practice.

Over time, however, the problem has become more acute. The difference between the amount of carbon that developed countries import and the amount that they export is widening (Xu & Dietzenbacher, 2014). Developing countries increased their share of exports to countries covered under the Kyoto Protocol (Annex 1). As products produced in developing countries are on average more emissions-intensive[2] than comparable products produced in developed countries, there was an increase in the proportion of global emissions for which there is controversy.

6.1.2.3 Carbon leakage increasing this trend

The severity of this problem is further augmented by carbon leakage. With climate policy being phased in for jurisdictions under stricter carbon limits, some producers moved to developing countries where these limits were lacking under the Kyoto Protocol. This situation has improved under the Paris Agreement given its near-global scope of binding caps, but since countries continue to vary dramatically in the stringency of these caps,[3] the risk of merely redistributing emissions rather than abating them persists. Without a solution for accounting for embodied emissions, this problem may even increase since "*emissions in trade constitute a large and growing share of global emissions*" (Sato, 2014, p. 831). The potential for "carbon leakage" for a unilateral carbon price is in the range of 5-30 % of the covered emissions (Böhringer *et al.*, 2017), and the relocation risk is concentrated in a few emission-intensive sectors (Grubb *et al.*, 2014b). When these sectors leave the policy-implementing country, they may re-export some of their emissions-intensive products. This re-exporting of particularly emissions-intensive products again poses again the guilt question: is it correct to attribute such emissions to developing countries? Is this treatment of causation justified in

[2]For example, the emissions-intensity of US imports of energy-intensive products is 100-300 % higher than the emissions intensity of the US production of such products (Fischer & Fox, 2011).
[3]On the variation of the Nationally Determined Contributions, see the databases in World Bank (2017b) and UNFCCC (2017).

particular under a treaty which is based on the legal principle of mitigating climate change in accordance with "Common But Differentiated Responsibility and Respective Capabilities" (UNFCCC Art. 3)?

6.1.2.4 Impacts on negotiations on legally binding emission targets

Effect on developing countries

It is not only the rise of such emissions that brings back the question as to if it is right to attribute their causation entirely to exporting countries. The topic is becoming more pressing also as a result of changes in international climate negotiations. After the Kyoto Protocol, climate negotiations have aimed to establish legally binding emissions targets for all countries. Achieving this extension of binding targets has met severe opposition from developing countries, even risking bringing down the whole international climate law-making process. One proposition that developing countries have voiced, is, again, to change the way in which the emissions for exported goods are classified, putting the entire burden on importing countries. If they achieved this aim, some hope that meeting a given carbon target would be easier for emerging markets in particular. Listening to this demand might help the negotiations themselves, because "*Sharing responsibility for emissions among producers and consumers could facilitate an international agreement on global climate policy that is now hindered by concerns over the regional and historical inequity of emissions*" (Davis & Caldeira, 2010, p. 5687). Negotiations perceived as equitable have greater chance of succeeding (Bosello *et al.*, 2003; Lange & Vogt, 2003; Lange *et al.*, 2007) also since "*Equity and justice concerns have been of paramount significance in international negotiations on climate change ever since the adoption of the 1992 United Nations Framework Convention on Climate Change*" (Afionis *et al.*, 2017, p. 1).

Since most of these papers were written, the world did adopt the Paris Agreement (UNFCCC, 2015), but as climate negotiations continue, the need for increasingly deep agreements between developed and developing countries on this matter persists.[4]

[4]Under the Paris Agreement, developing countries did accept legally binding Nationally Determined Contributions (UNFCCC, 2015). That does not mean, however, that the debate on accounting principles is over (Croft & Trimmer, 2017). The Agreement did not change the accounting principle, and the negotiations on quantities continue. We can expect this debate to also remain relevant in the

Effect on developed countries

Besides potentially affecting the negotiation positions of developing countries, a change in carbon accounting might also change the negotiation positions of some major developed countries. Which country is emitting the most may have an impact on the expectations in negotiations for action from that country. During the George W. Bush Administration, and in particular in the first term, the American failure to act on climate change has been particularly criticised since the USA was the biggest emitter. The United States tried to shift the focus, pointing at China which became the biggest emitter in 2012. Since then, China has frequently been singled out in analyses as the "biggest emitter", stepping up pressure on that country to act, and diverting attention from American responsibilities over emissions in the US public discourse. Whether China really is the biggest gross emitter in the world depends on the carbon accounting: under the production-based accounting, China does emit the most, but not under the consumption-based accounting, where its emissions are up to 38 % lower (Liu *et al.*, 2013), thereby returning the United States to the position of the biggest emitter.[5] If negotiation parties do expect whoever is the biggest emitter to play a special role in mitigation efforts, the accounting does matter, even though – from a physical perspective – it is just about shifting around emissions.

6.1.3 Economic causation of embodied emissions

From the perspective on causation that we laid out above, embodied emissions are jointly caused by the persons selling and buying the goods. The exporter plays a role similar to the producer in our previous analysis, and the importer behaves like the consumer.[6] The exporter then causes the proportion of emissions

upcoming negotiations of the Global Stocktake of Nationally Determined Contributions (UNFCCC, 2015, Art. 14). In this Stocktake, countries are going to review their progress on mitigation, and the size of this progress in each country will vary depending on whether causation for these emissions is accounted for under the production or the consumption principle.

[5]Equally, "*with GHG accounting based on consumption, the EU's emissions would be about a quarter higher*" (Erbach, 2015, p. 7).

[6]Equating producers and exporters in this way appears to be the legally correct way of pursuing our analysis. In both domestic law and international law, causation and responsibility for the emissions are typically assigned to the agent engaged in the activity that factually caused the emissions; e.g. at the point of combustion of fuels. Where for domestic law this is the producer, in international law it is the exporter. So we can here use our results for producers from chapter 4 to analyse exporters.

that corresponds to his price elasticity of supply relative to the price elasticity of demand of the importer. This way the causation is shared and quantifiable.

Suppose for a moment that international climate law established globally enforced carbon taxes (a "carbon price floor").[7] Those taxes would solve the problem of causal attribution between state actors. Each country would pay a tax incidence corresponding to its share in the causation of the emissions.

6.1.4 Fixing quantities or prices?

There is a growing movement of economists calling for a change in the target of climate law from an international set of emission quotas to an international carbon price (Weitzman, 2017; Cramton *et al.*, 2017; Farid *et al.*, 2016; MacKay *et al.*, 2015; Nordhaus, 2007, 2009). We have added one additional reason to make this conversion: the problem of attributing responsibility for international emissions to individual countries would go away if there was an international carbon tax.

This is an application of the debate about objectives of environmental law that we described in chapter 4.1.1, where we identified that classical environmental law and Ecological Economics tend to focus on targeting effectiveness in physical terms (measured, for example, in quantities of emissions per country), whereas neoclassical Environmental Economics tends to focus on efficiency in monetary or utility terms. Here we see the practical importance of this debate for climate law. Transitioning from a quantity focus to a price-based focus would enable a solution to the currently debilitating conflict on apportioning causation between countries.

[7] Politically, the implementation of international carbon taxes may currently be unlikely. To this concern, we have three responses. Firstly, such a tax could be made more likely if we also considered an integrated view of fiscal policy where expenditure policy can help solve problems that the tax alone causes. The tax revenue from a carbon tax can, for example, be used to compensate developing countries. This compensation could work through direct lump-sum payments to countries (e.g. using a quantification methodology such as in Keen *et al.*, 2011) or indirectly by contributing tax revenues to the Green Climate Fund.

Another way to achieve an international carbon price that some authors consider politically more feasible is through linking emissions trading schemes. In principle, efficient sharing of causation and liability can also be achieved through emissions trading schemes if those are designed much like taxes (e.g. Parry *et al.*, 2014; Parry, 2017). Several countries are in a process of linking their carbon markets, so that a uniform carbon price seems to become more likely in a subset of countries (World Bank & Ecofys, 2015).

6.1.5 Causation principles support neither climate law's current production-based accounting nor the consumption-based alternative

But our causation model is not only useful with carbon tax agreements; it can also inform the continued use of quantity-based climate law. As we saw in the literature review, there are significant fights over which state causes what quantity of emissions. The current accounting practice was criticised for failing to account for the contribution of producers/exporters to causing the emissions. Our analysis confirms that critique but defies the call for a full swing to consumption-based carbon accounting. Instead, the quantity of emissions caused by individual countries could be counted as the emissions from products produced and consumed domestically, plus a share of the emissions from exported and imported products. The shares could be calculated according to the average elasticities of supply and demand in trade streams for carbon-intensive products. This perspective would present a balanced view on causation that falls in between the two extremes to associate causation of embodied emissions entirely with exporter or importers.

6.1.6 Role of the state as a causal entity

Now, one may argue against this perspective that, if we follow through interpreting the causation of embodied emissions as we did with the producer-consumer cases above, then we understand causation as an effect of supply and demand. And if we then afterwards portray the causation of the individual agents on state bodies, then we are holding state bodies responsible for the elasticities of supply and demand of their citizens. Is this justified? Can we interpret causation this way if the actor is the state? We based our view on causation in the but-for model of causation used in tort law. And a but-for argument can be made about the demand and supply functions of citizens in states. A state can shape demand and supply of its citizens. It is but for the lack of action of the state[8] that its consumers and producers do have these demands and supplies of polluting products. Hence it appears appropriate to regard the state as an agent causing the emissions and calculate the causation through its citizens' demand and supply functions, as a

[8]Due to the lack of intervening fiscal policy.

second-best solution since the citizens are not themselves accountable actors in international law.

6.1.7 Consumption- versus production-based carbon taxes

Previous literature on embodied emissions found that it matters greatly whether carbon taxation is implemented on a production basis or a consumption basis. Traditionally, proposals for carbon taxes were production-based, but then the equity arguments that led to the concern about embodied emissions being caused in destination countries contributed to calls for carbon taxes to be implemented at the point of consumption (Munnings *et al.*, 2016). From our discussion of pass-throughs we see that, if carbon taxes were implemented internationally, the choice between consumption and production-based carbon taxes does not matter from a distributional point of view. The distribution of the tax burdens is the same in both cases, and does correspond to the contribution to causing current emissions. The choice between these taxes can then be made completely on the basis of where the compliance and administrative costs are lower, where the imposition is legally feasible, and (in a world without global carbon pricing) where competitiveness effects are less concerning. Furthermore, the distribution of the revenues would vary - efficiently accruing to the government which is taking on the political cost of imposing the tax.

6.2 Causation of emissions in international space

Here we go one step further in the climate law debate, showing how our approach to causation would deal with emissions in international space, for which current international climate law does not have a functioning solution.

6.2.1 Status quo

Following the attribution of embodied emissions on export products, here we analyse which countries should be accountable for emissions that were released in international waters and international airspace. Currently, the climate regime treats international emissions as if they were not caused by the countries undertaking the trade. When a good is transported from one country to another by – say – an oceanliner, the emissions of that oceanliner in international waters are not counted as part of the carbon emissions of either the exporting or the importing nation. These emissions completely fall out of the UNFCCC regime for whose functioning the nation-based definition of emission targets is so important.

6.2.2 Rise of sectoral emissions under a fixed cap for economy-wide emissions

Economically and environmentally, that omission poses a big problem. Whereas the total quantity of world CO_2-emissions needs to fall by 80 % until 2050 (IPCC, 2014) to reach the 1.5-2 °C target that emerging climate law subscribes to, the emissions in international air and waters are projected to increase by 380-460 % and by 50-250 % respectively (ICAO, 2009; Smith *et al.*, 2014). This increase occurs despite the technical possibility to reduce sea-born emissions from 2009 to 2050 by 60 % (Sims *et al.*, 2014).

Inefficiency of shifting responsibility

With a fixed climate budget, letting emissions in international space increase this much would imply that other industry sectors on land need to abate emissions even more. Economically, however, marginal abatement costs are assumed to rise in the quantity abated. So if the international transport sectors do not abate emissions and instead other sectors need to do more, the overall economy-wide costs of mitigating climate change would increase.

Wider economic damages from carbon mitigation policies also increase if the responsibility to mitigate is put on just a few sectors. Consider an example where, in order to spare international transport sectors from mitigation responsibilities, a high carbon tax was implemented for emissions on land. We know from standard Public Economics that the distortion that a tax creates in the economy rises in the tax rate by more than in proportion.[9] Accordingly, if the responsibility to abate is narrowly concentrated on industry sectors on land, then a carbon tax there would

[9]The deadweight loss of a tax rises approximately with the square of the tax rate (e.g. Varian, 2010).

need to be much higher, and the distortions to the economy would rise by more than proportionately to that higher tax rate.

The costs for overall emissions abatement would instead be minimised if the marginal abatement costs in all sectors are equalised. So if the maritime and aviation sector undertook abatement up to the point where the marginal costs of reducing emissions by another tonne equalled the costs of such mitigation in the average of other sectors.

6.2.3 Missing state-level attribution impacts lawmaking fora, fracturing emerging climate law

It is hence important to bring international emissions into a climate change mitigation regime. Legally, however, that has proven to be a severe problem, since the UNFCCC climate regime is built on the responsibilities of individual countries for the emissions that they caused. Outside UNFCCC, the International Maritime Organisation (IMO) and the International Civil Aviation Organisation (ICAO) have been attempting to find solutions for their respective industry sectors without determining individual states' responsibilities for emissions in international space. However, both negotiations streams appear stuck.[10] One potential reaction would be to bring emissions in international commons back into the main climate regime, but to do so, the question to which countries these emissions should be attributed again has to be solved.

6.2.4 Solution proposed by our causation framework

As before, we would ascribe the causation of the emissions in international space to the transaction partners, which, in the case of goods transport, are the consignees and the consignors of the cargo. In the case of passenger transport, the

[10] ICAO agreed to implement a carbon pricing regime (CORSIA) but it has only sub-global coverage and exempts most emissions by only applying the carbon price to marginal emissions beyond a 2020 benchmark. The sector is hence not nearly mitigating emissions in line with the cross-sectoral mitigation objective reached in the Paris Agreement. Most recently, China has also declared plans of exiting CORSIA, thus further shrinking its effectiveness.

IMO agreed to reduce emissions in a landmark decision in April 2018 but has not agreed on a policy measure for reaching this objective. This lack of agreement on policy instruments is despite more than a decade of negotiations over a market-based policy measure.

consignee is the cargo. If an international tax were used, the real incidence of the tax would again match the relative contributions of the transaction partners to jointly causing the damage. The problem of apportioning responsibility would accordingly be solved.

6.3 Conclusion

Problem

In emerging climate law, there is a lot of disagreement about the right attribution of responsibilities for those emissions that were released in the production and transport of traded goods. Many hold that the current practice of account all emissions to the producer country is not fair, and in the case of emissions in transport, the current practice even means that nobody is held accountable.

Solutions

We provided the following solutions.

A first-best solution would be for climate law to transition from country-level quotas to an agreement of globally taxing greenhouse gases. In this case, our causation framework suggests that each country would pay the incidence of the global carbon tax according to the share of emissions that it caused.

A second-best solution is to continue with the quantity-based system but to calculate the country-level emission quotas differently. Previous authors have suggested two extremes: full production-based accounting or full consumption-based accounting. Our causation framework suggests that the truth lies in the middle as consumer and producer countries both contribute to the causation of the damages, and the shares can be calculated using average elasticities of demand and supply.

Implications

Implementing even the second-best solution would have large repercussions for emerging climate law.

Developing countries would see their responsibility for global emissions fall, which may help in facilitating climate agreements, but also bring developed countries more in line with reality as they would need to live up to the fact that their current environmental progress is partly built on advantageous accounting – an accounting which actually goes against the climate law principle of favouring developing countries (Common but Differentiated Responsibility, UNFCCC Art. 3).

Using these causation principles would also help reduce the fracturing of climate law. Even though the Paris Agreement sets climate targets for the whole world, it is not currently able to cover all emissions through its main instrument: the Nationally Determined Contributions (NDCs). Emissions that are released in the international transport of goods fall out of the NDCs, because of a disagreement over the national apportionment of such emissions. Current international law does not attribute these emissions to any state, and OECD research even suggests that "*it would be impossible to apportion shipping emissions to countries*" (Merk, 2013, p. 4). As a result, emissions from the shipping and aviation sectors needed to be regulated in a negotiation stream separate from the main climate negotiations, with questionable success. Here we have provided a solution for apportioning these emissions to countries, so that they could be included in the NDCs. We have also shown a way how consumer countries could identify a responsibility for emissions that were released in producing their goods overseas.

Our current system of international law is still very much build on the nation-state, and acting through international agreements is fraught with difficulties. It can be that nobody feels responsible for the emissions from international transport of goods, and exporting countries can feel they are not responsible for the emissions of their export sectors. Here we have described a way to apportion responsibilities and situate the causation with the nation-state. Furthermore, the fact that the proposed system would shift more responsibility to consumer countries may spur environmental efforts if countries' valuation of environmental protection rises in their income levels.

This chapter has therefore shown a way to attribute causation of emissions to countries which may not have the physical control over these emissions. For example, consider a case where Germany imports products from China by ship. The emissions which the ship releases in the high seas would, under our new conception of causation, be jointly caused by Germany and China. So Germany and China could then both have a responsibility of acting on a share of these emissions, even when it does not have physical control over emissions occurring in the high seas outside its jurisdiction. Chapter 7 will describe how countries can tax such emissions outside their borders given legal limitations on extraterritorial regulation and economic limitations on tax competition. Chapter 9 makes the same case for taxing embodied emissions.

Creating these possibilities for attributing national responsibilities and enabling national action does not mean that it must be nation-states who act on these emissions – ideally the world could act as one through an international agreement on such emissions – but here we show backup a solution in case the world does not act as one and we continue to need individual nation-states to act. In chapter 8 we then show how bottom-up national action on emissions can contribute to making successful international climate agreements more likely.

Part III

National environmental tax policy for global environmental problems

Chapter 7

Taxing emissions in international space: The maritime case*

Many academics and policymakers agree that taxing maritime fuels – which are currently tax-exempt around the world – would be efficient, but that any such reform requires a unanimous international agreement. Such an agreement is deemed indispensable because any unilateral action would be impossible due to massive tax competition in this industry, competitiveness effects and the legal limits on regulating an industry operating mostly in international waters, thus

*Contents from this chapter are included in several publications. Most has been published in the journal article Heine, Dirk, & Gäde, Susanne. 2018. Unilaterally Removing Implicit Subsidies for Maritime Fuel: A mechanism to unilaterally tax maritime emissions while satisfying extraterritoriality, tax competition and political constraints. *International Economics and Economic Policy*, **15**(2), 523–545. The legal analysis surrounding this chapter has been published in Dominioni, Goran, Heine, Dirk, & Martínez Romera, Beatriz. 2018. Regional Carbon Pricing for International Maritime Transport: Challenges and Opportunities for Global Geographical Coverage, *Carbon and Climate Law Review* **12**(2), 140–158. Contents of the chapter relating to international negotiations have been published in Parry, Ian, Heine, Dirk, Kizzier, Kelly, and Tristan Smith. 2018. Carbon Taxation for International Maritime Fuels: Assessing the Options, IMF Working Paper 18203. The mechanism developed in this chapter has also been published through the MIT Climate Co-Lab which awarded its 2015 Judge Award for the best submission in the transport sector.

outside of any state's jurisdiction. However, an international agreement to solve these problems has proven impossible to reach, thus resulting in the conservation of the status quo. To break this deadlock, this chapter proposes a mechanism whereby a small coalition of countries, to start with, can introduce environmental taxes even in the absence of an international agreement. This incentive-compatible scheme solves the above-mentioned issues. The mechanism is furthermore designed to avoid locking in a sub-global scheme. Instead, it has the potential to contribute to unlocking the gridlock in negotiations over a global agreement on this matter.

7.1 Overcoming economic constraints

To mitigate climate change, large reductions in global greenhouse gas (GHG) emissions are required. Emissions from the maritime sector, however, are rising fast. International maritime transport accounted for just 2.2 % of global CO_2 emissions in 2012, but as trade volumes grow, these emissions are projected to rise by 50-250 % by 2050, depending on future economic and energy market developments (Smith *et al.*, 2014). In a business-as-usual scenario, maritime transport is expected to account for as much as 17 % of global CO_2 emissions by 2050 (Cames *et al.*, 2015). There is an enormous potential for maritime emissions reduction that has not yet been exploited, though. Compared to the baseline scenario, combined technical and operational measures could reduce CO_2 emissions by 60-75 % per tonne-kilometre by 2050 (European Commission, 2013b; Sims *et al.*, 2014).

Yet, to date, despite agreement among global governance institutions about the need to tackle the issue,[1] there is little market-based policy incentive to improve fuel efficiency. Unlike other transport fuels (except for international aviation), maritime fuels are not subject to fuel excise duties. In the absence of appropriate incentives, producers and consumers of maritime fuels impose an external cost on third parties. Using official accounting costs per tonne of CO_2 endorsed by the governments of the United States, Great Britain and Germany, the external cost of

[1]See the register of proposals made in negotiations at the International Maritime Organisation at http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Market-Based-Measures.aspx as well as the reports that IEA *et al.* (2011), as well as the International Monetary Fund and the World Bank (Keen *et al.*, 2011) provided at the request of G20 Finance Ministers.

carbon[2] emitted by this sector in 2012 amounts to between USD 33.7 bn - 82.6 bn.[3] The current lack of environmental fuel taxation in the sector is thus creating a significant social cost.

In this chapter, we suggest an economically and legally viable solution for how to remove tax subsidies for carbon emissions released by maritime transport in the absence of an international agreement on this issue. In doing so, we focus on a coalition formed by the member states of the European Union (EU), although the mechanism is applicable more widely.[4] The mechanism is designed such that it imposes only a small additional administrative burden on tax subjects and authorities by drawing on existing institutions and databases. This chapter is also a contribution to find a way of extending the Paris Agreement's focus on bottom-up national and regional action to a sector where this approach has proven particularly difficult to implement given the international nature of maritime emissions. Lastly, this chapter is a practical policy contribution to the literature on negotiation strategy. Oberthür (2003) defends unilateral action (or the threat of unilateral action) as one of the ways to move beyond political stalemate with regards to maritime emissions. In this chapter, we provide a sector example of how regional action may enable global cooperation, instead of harming it.

The chapter is structured as follows: Section 2 reviews the previous literature on unilateral schemes for pricing emissions in the maritime sector. Section 3 introduces the emissions tax regime. It first elaborates on what the appropriate tax bases should be for international and intra-EU shipping, by whom the tax should be paid, and how the tax base could be computed. Subsequently, it expands on why using two different tax bases is unproblematic, and how the tax rate should be set. Section 4 concludes.

[2]In this chapter, the term "carbon" refers to both CO_2itself and the carbon equivalent of other GHGs.

[3]These estimates follow from multiplying the total amount of maritime emissions from Smith *et al.* (2014) with the US Cost of Carbon (US-IAWG, 2013), the UK Treasury's Shadow Price of Carbon (Price *et al.*, 2007) and the German mid-level short-term estimate of the external cost of carbon (Burger, 2014; Friedrich *et al.*, 2007; Schwermer, 2012). The German estimate for long-term damage is significantly higher. 33.7 bn is the amount when using the US Social Cost of Carbon, the German mid-level short-term estimate for the cost of carbon suggests this figure is 77.8 bn. With the UK Shadow Price of Carbon, this figure further rises to 82.6 bn.

[4]In particular, it would work even more effectively in Australia and Japan, given their lack of land connections to other jurisdictions.

7.2 Barriers to unilateral emissions taxes

To increase social welfare, Pigou (1932) suggests that the external social costs inflicted by the private sector can be internalised by levying a corrective tax on the activities that cause environmental damage. However, when applied to emissions released in the international maritime industry, the Pigouvian theory encounters various obstacles. Many authors have agreed on the need to tax maritime emissions but at the same time have expressed several feasibility concerns:

7.2.1 Extraterritoriality

Since most maritime emissions occur in international waters, taxation by single states may be legally infeasible. Due to legal prohibitions of extraterritoriality – i.e. the legal limit on a country's ability to impose obligations (such as a tax) outside its own jurisdiction (Scott, 2014) – each country might only be allowed to charge for emissions arising in its internal waters. However, such a narrow tax base would leave almost all of the maritime sector emissions uncovered (Bäuerle *et al.*, 2010; Faber *et al.*, 2009), and thus severely limit the environmental effectiveness of the tax.

7.2.2 Tax competition

Due to the mobility of sea trade, taxation might furthermore also be economically infeasible. There is already severe competition in taxes on shipping activities, and concerns are that maritime emissions taxes could be avoided by moving to tax havens (e.g. Keen *et al.*, 2013). The success of introducing a tax exclusively in one region depends on the cross-price elasticity of demand for maritime fuels in that region relative to the maritime fuel price in regions outside the tax regime. This elasticity is high because, to avoid the tax, vessels navigating in several jurisdictions can refuel en route, in a port not included in the tax scheme or in international waters from tank ships or floating platforms (Keen *et al.*, 2013). Many economists argue that these avoidance opportunities render regional taxation of emissions released by international shipping infeasible (e.g. Heitmann & Khalilian, 2011; Keen *et al.*, 2013, 2011; Miola *et al.*, 2011; Mishra & Yeh, 2011). Empirically, an attempt to unilaterally introduce a maritime fuel tax in Port of

Long Beach / California has failed (Mishra & Yeh, 2011) and ever since served as a striking counter-argument against unilateral taxation of maritime fuels.

7.2.3 Free trade

A unilateral maritime emissions tax might equally be a concern for international free trade, as a regional emissions tax could distort trade patterns (Keen *et al.*, 2011).

7.2.4 Current gridlock

7.2.4.1 Conclusion in the previous literature

All these concerns have led to the conclusion that taxation of maritime emissions may only be feasible through a unanimous international agreement (e.g. Keen *et al.*, 2011).

7.2.4.2 Hold-up problem

Yet, whilst taxation by individual jurisdictions has been deemed *legally* and *economically* infeasible, taxation through a unanimous international agreement appears *politically* unattainable! Due to the difficulty of bridging polar negotiation positions, for instance between certain island states and oil-producing countries, the task of attaining unanimity for such a global agreement is utopian.

Consequently, with some important exceptions,[5] years of negotiations within the IMO and the G20 on carbon pricing in maritime transport have not produced any tangible progress. This gridlock is symptomatic for negotiations on climate change mitigation in general where any reluctant party can bring the whole process to a halt because unanimity is required for a global agreement.

[5] At the beginning of 2013, amendments to the International Convention for the Prevention of Pollution from Ships (1973) and Protocol (1978) (hereafter MARPOL) Annex VI Regulations to improve the energy efficiency of vessels came into force. This was an important step by the International Maritime Organization (IMO) in order to target emissions released by maritime transport, though on their own, these policies do not set dynamic incentives to reduce emissions. These regulations tackle network externality problems and foster R&D in the sector. However, they do not affect marginal incentives to optimize fuel consumption.

Economic contract theory suggests that parties negotiating a global climate agreement will block the introduction of an emissions tax in case it reduces their payoff relative to their reference point, i.e. the non-cooperative alternative. For negotiations requiring unanimous agreement, the reference point equals the status quo, as parties know that without their consent no deviation from the status quo is possible. This gridlock may be unsettled if at least one party is able to credibly threaten to set up a unilateral tax scheme – which requires such a tax scheme to be effective and its implementation to be feasible. If such a unilateral scheme were introduced, those parties that are currently blocking a global agreement would need to re-evaluate their stance towards a global tax regime; but this time vis-à-vis the payoff they realise as outsiders faced with the effects of a policy unilaterally implemented by another negotiation party. Ironically, it is the introduction of a unilateral tax regime that could then render a unanimous agreement possible. This is because the existence of a feasible unilateral tax scheme improves the outside option of those in favour of a global emissions tax, whilst simultaneously changing the reference point for those blocking it: If its negative effects on the non-cooperative payoffs are large enough, unilateral action will make the outsider willing to engage in a global agreement, thus overcoming the current stalemate. More details on the potential impact on negotiations are provided in chapter 8.

7.3 Previous reform proposals

To overcome the stalemate in negotiations over a global carbon pricing scheme, the literature has discussed various unilateral mechanisms.

Kollamthodi *et al.* (2013) find that a unilateral market-based mechanism, such as emissions trading, can be used to successfully reduce emissions from maritime transport – without recommending any specific instrument, though. Furthermore, they suggest that any precise tracking of released GHG emissions and other relevant data would carry a high administrative burden.

Faber *et al.* (2009) analyse an emissions tax that covers shipping in EU waters. According to this proposal, the scope of emissions covered by the tax varies by whether the incoming vessel carries a single Bill of Lading[6] (i.e. all cargo shipped

[6] A Bill of Lading contains information on the port of lading and discharging, the vessel and the carrier.

shares both the same port of origin and the same port of destination) or multiple Bills of Lading (i.e. the vessel carries cargo with different ports of origin and/or ports of destination). The authors recommend that the tax bill be determined per vessel. This implies that the vessel owner is taxed only for the emissions released on the last leg of the cargo transport into the EU, as emissions of other ships prior to transshipment[7] taking place outside EU waters cannot be considered under this scheme. As a result of this geographical restriction, Faber *et al.* (2009) find that this scheme provides opportunities for tax avoidance, although to a limited extent. The emissions coverage is further reduced by the proposed introduction of size thresholds: The authors recommend that the tax be based on data from emissions measurements executed by individual vessels. As this monitoring is considered costly for small ships, those would need to be exempted from the tax.

Both Hemmings (2011) and Kågeson (2011) recommend taxing maritime emissions through a fuel tax, but recognise that, for international shipping, unilateral fuel taxation causes too much base erosion as vessels could refuel easily outside the geographical coverage. Therefore, they hold that international shipping should be exempted, at least temporarily, from the tax. Like Faber *et al.* (2009) and Kollamthodi *et al.* (2013), they recommend that the tax bill be determined per vessel. In the medium-term, Kågeson (2011) envisions a gradual increase of the regional coverage of the emissions tax, extending it to the last leg of incoming voyages and the first leg of outgoing voyages, similar to the proposal in Faber *et al.* (2009). In the case of multiple Bills of Lading where the cargo composition varies during the voyage, Kågeson (2011) suggests calculating the emissions for the route over which the majority of the goods destined for the EU was transported. Shipping lines, therefore, would be able to reduce their tax liability somewhat through varying the location of transshipments and the composition of their cargo.

Bäuerle *et al.* (2010) analyse the calculation of maritime emissions based on the total distance over which cargo has been transported to (from) the EU as one of three options to integrate maritime emissions into the EU ETS. The necessary data can be retrieved, amongst others, from customs databases. Total emissions, however, are not calculated from actual data but based on vessel and trade lane specific average values. The authors highlight that the suggested tax regime does not establish a link between cargo consignees (consignors) and vessel owners, which puts a question mark on the environmental effectiveness of the tax. Overall,

[7] Transshipment is the act of shipping cargo to a hub port for onward shipment to a destination port.

Bäuerle *et al.* (2010) conclude that this option may not be sufficiently exact to serve as carbon pricing method.

7.4 Policy design

This section will present a regional Pigouvian tax scheme on emissions from maritime shipping, i.e. a price-based mechanism internalising the present value of marginal future climate damages caused by these emissions. We will discuss the main features of the tax scheme by expanding on the appropriate tax base, the definition of the legal tax liability and the recommended tax rate. In doing so, we build upon the strengths of the above-discussed strand of literature while sketching a tax regime that both reduces the opportunities for tax avoidance and solves extra-territoriality issues usually occurring with unilateral taxation. Furthermore, we present new arguments on the effects of the schemes established in the literature referred to above. The tax scheme presented below consists of two different regimes for emissions released in both international shipping (Section 7.4.3) and intra-EU shipping (Section 7.4.4). To be effective, both regimes should be put in place jointly and by the EU as a whole.

7.4.1 Choosing the right tax base for international shipping

Determining the tax base requires defining both the taxable activity and the geographical coverage of the emissions tax. We will also elucidate the treatment of transshipment and transit under the tax.

7.4.1.1 Taxable activity

The choice of the taxable activity should be made considering which option allows the internalisation of the greatest share of the external social cost of the emissions at the lowest policy cost.[8] The literature suggests, strictly under the condition that the policy is applied globally, that a tax on maritime fuel consumption would be the first-best option for internalising climate damage from carbon emissions. The own-price elasticity of maritime fuels is rather low (Keen *et al.*,

[8] Applying Demsetz (1967).

2011, 2013; Mazraati, 2011). Thus, demand for maritime fuels can be expected to only slightly decrease as a reaction to the introduction of a global tax on maritime fuels. In addition, because of the low elasticity of cargo demand, the increase in the fuel price triggered by the tax will have a high pass-through to the purchaser of the freight services (Keen *et al.*, 2013), thus limiting the commercial impact of the tax on shipping companies. As a result, introducing a tax on maritime fuel consumption is an effective policy to price carbon emissions if – and only if – the policy is implemented via an international agreement with global coverage.

The success of introducing a tax exclusively in one region, however, depends on the cross-price elasticity of demand for maritime fuels in that region relative to maritime fuel prices in regions outside the tax regime. This elasticity is much higher because, to avoid the tax, vessels navigating in several jurisdictions can refuel en route in a port not included in the tax scheme or in international waters (e.g. from tank ships or floating platforms). Consequently, in the absence of a global agreement unilateral fuel taxation would cause too much tax base erosion. Large vessels could move easily outside the geographical coverage, which results in carbon leakage.[9]

Therefore, if a unilateral EU tax on maritime transport emissions was introduced, internationally mobile deep-sea vessels should not be charged based on their fuel uplifts within the EU. Instead, the appropriate tax base still covers the total emissions but circumvents the issue of tax avoidance. Whilst the cross-price elasticity of demand for refuelling internationally mobile vessels within the EU is too high for fuel consumption to serve as a sound tax base in the case of unilateral action, the elasticity of demand for the service of lading and unlading cargo[10] in the EU is much lower. In this case, an EU port authority could hence charge for the emissions released during inbound and outbound transport. Exploiting the low elasticity of port demand, the arrival and departure of cargo at and from EU ports could thus be defined as the taxable act that incurs the legal tax liability.[11]

Defining the taxable activity in this way greatly limits tax avoidance issues but does not eliminate them. A potential first way to avoid the tax is to ship cargo

[9]Carbon leakage describes a situation in which reducing emissions in one region is (partially) offset by an increase in emissions in another region. See Kollamthodi *et al.* (2013) for an in-depth analysis of this issue in the maritime sector.

[10]In the remainder of the chapter, we use the term "cargo" as a collective term for both containers and bulk cargo.

[11]Notice that, if EU ports all levied the tax alike, there would be no intra-EU shifts in the port choice.

to a non-EU port close to EU borders (e.g. in St Petersburg or Ambarli / Istanbul) and cover the remaining distance via land or water transport. However, such a strategy is not lucrative under this scheme. EU customs authorities have access to data for the transshipment of cargo even when that transshipment occurs outside the EU, and therefore the tax could be imposed for the emissions released by maritime shipping throughout the whole international supply chain. In addition, land transport is not, in most cases, a commercially viable solution. Because the cost advantage of maritime transport over road and rail transport is so large,[12] the maritime tax burden would be minor compared to the extra cost of time, rent, scheduling, trucking and railway costs needed for avoiding that tax.

Another possible vehicle for tax avoidance would be to ship intermediate products to a port close to the EU for final assembly and then ship the final products to the EU (with regard to imports) or the foreign destination (with regard to exports), replacing the direct shipment of final products. Then, the emissions tax would be charged only for the short distance between the EU port and the close-by non-EU port, thus massively reducing the tax burden. However, this tax avoidance method would require shifting production location, which could entail substantial additional costs relative to the comparatively minor cost of the emissions tax per value of goods transported.[13] Moreover, shifting the production location could make both the intermediate and the final product subject to import and export duties (when applicable). For these reasons, this avoidance strategy is unlikely to be commercially viable for most products. Thus, having considered these avoidance opportunities, we find that defining the taxable activity as the arrival and departure of cargo at/from EU ports substantially decreases the chances of tax avoidance relative to the risk of tax avoidance from a regional fuel tax.

7.4.1.2 Treatment of transshipment and transit

Taxing emissions without risking base erosion and a decline in the competitiveness of EU ports mandates an exemption for transshipment – the act of shipping cargo to a hub port for onward shipment to a destination port – and for

[12] Once ports in the St Petersburg area will have been enlarged and modernised they could attract more trade destined to Baltic states, which would likely increase avoidance behaviour but not to the extent that would question the feasibility of regional action as such.

[13] Keen *et al.* (2011) estimated the tax-induced cost increase per value of goods transported would be small.

transit – the act of transporting cargo via the EU to third countries without releasing the cargo into free circulation in the EU. One reason for mandating these exemptions is that the implementation of an EU emissions tax must not discourage other countries from for their part putting in place an emissions tax. If emissions taxes were levied on several legs of a transportation chain, taxation would likely become complex, hence increasing transaction costs markedly. Second, in contrast to the elasticity of demand for loading (discharging) cargo at source (destination) ports, the elasticity of demand for transshipment and transit services is high. Thus, while in most cases, it is commercially unviable to substitute EU destination ports with non-EU destination ports, this may not hold for transshipment and transit services. For global shipping companies, there is more flexibility in the location of transshipment as opposed to destination ports. Hence without an exemption of transshipment and transit in place, an EU emissions tax could both distort transshipment and transit patterns and constitute a comparative disadvantage for EU ports.

Exempting transshipped cargo is administratively simple. Transshipped cargo does not clear customs, so if the emissions tax is levied at the point of customs clearance, a transshipped cargo will be excluded from the process anyway. Furthermore, the transshipment status of products is already documented in the existing customs systems. Exempting cargo in transit is similarly straightforward. Cargo designated for transit is treated separately by customs already, with automated tracking and control in place (in the form of the EU's electronic transit system NCTS). Exempting cargo designated for transit from the emissions tax would hence be highly automatable and not require extensive new tax administration or rule compliance monitoring processes, thus limiting the transaction costs of the proposed measure.

7.4.1.3 Geographical coverage

Faber *et al.* (2009), Kågeson (2011) and Kollamthodi *et al.* (2013) argue that, due to data unavailability, any unilateral emissions tax should only cover emissions released on the last inbound or first outbound leg of a voyage. We instead argue that emissions released during the whole voyage should be subject to the tax in order to avoid a series of other problems.

First, it is not rare that ships change their port of destination after having left port. En route shifts in the port destination can occur, for instance, because of changes in cargo purchasers. For this reason, limiting the taxation coverage to the first outbound voyage could be problematic, as it allows tax avoidance behaviour via artificial en-route destination shifts. Second, taxing emissions from the last inbound or first outbound leg of a global voyage would provide an incentive for shipping companies to have cargo transshipped at a port outside of EU waters, causing the loss of tax revenue Faber *et al.* (2007).[14] The costs of transshipment might not outweigh the tax savings in all cases, but on the margin trade lanes would be distorted, environmental effectiveness compromised and tax revenues reduced. Third, transshipment would come at a cost to shipping companies, thus raising the cost of trade. The overall cost of maritime transport would therefore rise by more than the emissions tax itself suggests. A fourth argument in favour of including the emissions released on the whole voyage is that the positive impact of the tax regime on international climate negotiations would be much stronger. If the emissions tax is levied on the last inbound and first outbound leg only, non-EU transshipment ports in general and non-EU transshipment ports located close to the EU, in particular, could raise their market shares. As a result, the countries hosting these ports would likely prefer the unilateral EU scheme over an international or global one and thus block negotiations on international alternatives. The same arguments hold against the option of limiting the scope of taxation to ship movements within territorial waters of the EU. The above-mentioned issues would even be aggravated under such a scheme. For all these reasons, it is important that the geographical coverage of the tax is not restricted to the last inbound or first outbound segment or to intra-EU voyages. In the following, we explain how the regional tax regime can have a global coverage.

7.4.2 Defining the tax liability for international shipping

Authors favouring the restriction of the geographical scope of the tax to the last inbound leg of a voyage (Faber *et al.*, 2009; Kågeson, 2011; Kollamthodi *et al.*, 2013), or even a restriction to cover only to voyages within EU waters (short-run

[14]For example, if a previously non-stop shipment from Tokyo to Rotterdam now included transshipment in Singapore, the tax liability could be reduced by 26 % (comparing the respective distances along the standard trade lanes using data from www.sea-distances.org). The costs of transshipment might not outweigh the tax savings in many cases, but on the margin, trade lanes would be distorted, environmental effectiveness compromised and tax revenues reduced.

policy favoured by Kågeson 2011), also recommend identifying the shipowner as the taxable entity and the vessel as the accounting unit for the determination of the tax liability. We argue that these recommendations are interdependent: the first policy choice dictates the following two. The shipowner being the taxable entity implies necessarily that the vessel has to be the corresponding accounting unit. Identifying the vessel as the accounting unit implies that only the emissions released by the very vessel calling at the first EU port can be considered for the computation of the outstanding tax. Compromising the efficient use of this method, many cargo items are transshipped en route. Consequently, the vessel that transports cargo from the last transshipment port to the first EU port accounts for just part of the emissions that were released en route to the EU. The impact of this fact is relatively insignificant in bulk transport where transshipment is rare, but large in container transport.

If, however, total emissions are to be covered under the tax regime, the emissions released by the previous vessels in the transport chain also need to be included. But this requires refraining from treating the vessel as the accounting unit and its owner as the taxable entity. Otherwise, tax authorities would need to charge the owner of the last vessel for emissions that were released by vessels owned by other entities. Such a tax appears to lack a legitimate basis.

Instead, the tax subject should be an agent who remains involved throughout the whole transport chain, irrespective of transshipment. The consignee of the cargo for imports and the consignor of the cargo for exports meet this requirement. The accounting unit that matches the consignee (consignor) is the unit of cargo. This arrangement solves the problem of how to tax total emissions in cases where vessels carry cargo from various ports of origin (destination) – i.e. the problem of multiple Bills of Lading that are considered potential sources of tax avoidance by Faber *et al.* (2009) and Kågeson (2011). Within this framework, the effective tax rate would not vary in the composition of the cargo origins or destinations, as every consignee (consignor) would pay for the emissions released on the whole route from the source port to the destination port of the cargo.

Defining the consignee (consignor) as the taxable entity has both legal and political advantages, too. In most EU member states, the consignee, or the person acting on behalf of the consignee as importer, must be incorporated or resident in the EU (Flexport, 2018), which is a route to establish the EU's jurisdiction to impose the tax. Similarly for exports, the EU Customs Code requires that the consignor or the person acting on behalf of the cosignor as exporter must either be physically present in the EU or resident in the EU (European Commission, 2018). There is another another basis for establishing jurisdiction if the tax is structured as a consumption-based excise tax (i.e. a tax that is collectible on products that are consumed in the taxing state). It would be simple to distinguish which goods imported are for domestic consumption given that the alternatives (goods in transit or transhipment) are explicitly flagged in customs procedures. And GATT Article III(2) allows the collection of internal consumption-based excise taxes at the border, so they could be collected from the consignee alongside other customs procedures. What are then the advantages in establishing juridistion and avoiding extraterritoriality in comparison to a situation where the tax is alternatively imposed on the shipowner? Ship owners can be incorporated anywhere in the world. If shipowners were the taxable entity, the tax liability would hence often fall on foreigners, causing political and potentially also legal concerns related to the state jurisdiction over foreign vessels in international waters (Dominioni, Heine, Martinez Romera, 2018). Given that most emissions are released in international waters, states need a solution to efficiently price the emissions at their source, whilst at the same time complying with their jurisdictional limits.

The legal limit of extraterritoriality arises only if a state is directly involved in imposing obligations outside its own jurisdiction. But unlike public law, cost sharing through contract law does not end at national borders. Private parties negotiating their prices will take into account the tax-induced cost increase. Therefore, when domestic consignees (consignors) are charged an emissions tax, they will generally pass on a proportion of the tax burden to their transaction partners, irrespective of where the latter are incorporated. The portion of the tax burden being passed on depends on the relative elasticities of demand and supply. From this, it follows that the share of the economic tax burden borne by each transaction partner is independent of the allocation of the legal tax liability (Jenkin, 1871; Logue & Slemrod, 2010). Instead, as we have seen in chapter 4, the distribution of the economic incidence of the environmental tax reflects the relative shares of the transaction partner's contribution to the causation of the environmental damage. Situating the legal tax liability for imported (exported) products with the domestic consignee (consignor) hence avoids extraterritoriality constraints and results in a distribution of the economic tax burden according to the Polluter Pays Principle. Simultaneously, the political resistance from non-EU jurisdictions against a unilateral EU carbon pricing scheme that could arise if the taxation was imposed on non-EU residents – which also hampered the introduction of the EU-ETS in the aviation sector – could be overcome since the legal tax liability would only be imposed on EU residents.

7.4.3 Determining the tax base for international shipping

The computation of the tax base requires detailed knowledge of the levels of emissions released,[15] which is a general concern regarding the implementation of environmental taxes. In their own jurisdiction, governments are free to impose regulations that force polluters to provide the data, for example by mandating the installation of monitoring equipment. But in the case of maritime emissions taxes, jurisdictional restrictions apply (Wilensky, 2014). These restrictions prevent tax authorities from imposing control systems on foreign ships. A national law stipulating that ships entering a jurisdiction's internal waters need to have special monitoring equipment installed seems to solve the problem (Faber *et al.*, 2009). But even such port access standards could only extend to the last leg of an international itinerary. Thus, we suggest an alternative system which raises the needed data on overseas emissions without the need for jurisdiction over international ships: combining taxation on default values with a system of subsidies that are provided if emissions remain below these default values.

7.4.3.1 Typification

Taxation on default values, also known as typification, is the systematic adaptation of default values for different stylised types of taxpayers. It is frequently used in other fields of tax policy that exhibit severe data constraints (e.g. income taxation). These regimes facilitate organisational learning. Taxpayers are incentivised to provide data on a voluntary basis which is then used by the tax authorities to iteratively refine the default values and make them as realistic as possible. These regimes are justified if the alternative – tax authorities calculating the exact tax liability for every single case and bearing the burden of proof – is too costly.

[15] This data-intensiveness holds particularly for local pollutants because, unlike the situation for CO_2, different processes of fuel combustion (for SO_2, NO_x, $PM_{2.5}$ and VOCs) and different technologies for emissions capture (for SO_2, NO_x, $PM_{2.5}$) vary the amount of pollution that is emitted per unit of fuel that is combusted.

Instead, taxation based on default values helps cutting compliance and administrative costs. These cost savings, however, are partially offset by a reduction in tax revenue. This loss of tax revenue arises because only those taxpayers who believe that they have been overcharged have an incentive to opt for a favourable tax assessment and provide the required data. However, there are also those who will not challenge their tax bills because, in reality, they have emitted more than was assumed or because they do not want to provide any data. As a result, the tax revenues will be lower compared to regimes where the tax liabilities of all taxpayers are determined on a case-by-case basis.

The optimal default values thus have to be determined by weighing the reductions in compliance and administrative costs against the loss of tax revenue. This is also a trade-off between the environmental effectiveness and the costs of the policy. A policymaker who cares most for the maximum environmental effectiveness can set the default value higher, as a greater portion of maritime transport is then affected by dynamic incentives. A policymaker who is willing to reduce the environmental effectiveness of the tax in favour of lower administrative and compliance costs will instead set a lower default value. And a policymaker who most wants to implement a mechanism without causing major disruptions – for example, to be able to gradually build up the institutional capacity to manage the scheme – would start with a lower default value and then increase it gradually. The scheme could hence accommodate different political priorities. We favour setting the default values so as to provide incentives such that the environmental effectiveness is high and efficient ships are not discriminated against.

7.4.3.2 Computation of the tax bill

The emissions can be calculated from fuel consumption per type of fuel $(w_{fuel})_i$ (in tonnes of fuel). Multiplication with the carbon content of fuels used $(f_{carbon})_i$ (in tonnes of CO_2 per tonne of fuel) yields the CO_2 emissions e (in tonnes of CO_2) released whilst burning the fuels.

$$e = \sum_{i=1}^{n} (w_{fuel})_i \, (f_{carbon})_i = w_{total} \sum_{i=1}^{n} (\theta_{fuel})_i \, (f_{carbon})_i \tag{7.1}$$

where

$$(\theta_{fuel})_i = \frac{(w_{fuel})_i}{w_{total}} \tag{7.2}$$

is the share of fuel type i in the total fuel consumption $w_{total} = \sum_{j=1}^{n} (w_{fuel})_j$ and $\sum_{i=1}^{n} (\theta_{fuel})_i (f_{carbon})_i$ is the average carbon conversion factor for a given vessel. Fuel consumption can be approximated by multiplying the transport work performance by the vessel with its assumed energy efficiency η^e (in tonnes of fuel per tonne-kilometre of cargo transported):

$$w_{total} \approx \eta^e d^e w_{cargo} \tag{7.3}$$

Transport work is defined as the weight of cargo transported w_{cargo} (t) multiplied by the estimated distance d^e from the cargo's port of origin to the port of destination (km). Here it is crucial to assume that the most direct one of the major trade lanes between the two ports have been taken. The provisional tax bill T can then be determined by multiplying the estimated emissions e with the carbon tax rate t_{carbon} using equations 7.1, 7.2 and 7.3:

$$T = \frac{1}{2} t_{carbon} \eta^e d^e w_{cargo} \sum_{i=1}^{n} (\theta_{fuel})_i (f_{carbon})_i \tag{7.4}$$

That is, the provisional tax bill is calculated by multiplying the hypothetical direct distance travelled by the weight of the cargo, the assumed vessel efficiency, the assumed emissions factor, and the carbon price. The assumed vessel efficiency includes assumptions on average capacity usage, speed, engine types and other factors. We will expand on the calculation of the default values in the next section. Notice that only half of the incurred climate damage would be taxed because the EU only has a legitimate claim on half of the tax base, whilst for imports (exports) the country of origin (destination) has the right to claim the other half. Thereby no multiple carbon pricing would occur even if other jurisdictions introduced a similar carbon pricing scheme.

If the tax authorities estimate the tax base correctly, the tax will provide the consignee (consignor) with the Pigouvian price signal. If however, the calculation of the tax base was too high because one or more default values did not match the actual values, setting the right Pigouvian price signal requires one further step.

To see this, assume that the emissions caused by transporting cargo that either was delivered to an EU-destination or originated in the EU were actually lower than was estimated by the tax authorities. This case is dealt with by allowing the shipping company to optionally provide the tax authorities with data proving that the transport of the cargo actually caused fewer emissions than initially assumed by the tax authorities. On the provision of such proof, the tax authorities will disburse the excess amount of tax. As already argued, to overcome extraterritoriality constraints it is crucial that the tax subjects are the cargo consignee (for imports) or consignor (for exports). Still, any excess amount of tax should be disbursed to the shipping company. This is because the shipping company has the most detailed information about how the cargo was transported and what amount of emissions was released. Hence the shipping company is able, if applicable, to provide the proof necessary to claim the payout of the excess amount of tax more cheaply than the cargo consignee (consignor).

For the distribution of the net cost of the tax, it is irrelevant that the state offers shipping companies a subsidy and charges cargo consignors (consignees) a tax – the economic incidence of the fiscal payments is not affected by the question to whom a tax or subsidy is remitted. This is because the cargo consignee (consignor) negotiates freight rates with the shipping company, and hence a shipping company that receives a subsidy will have to agree to a lower freight rate. The tax incidence would have been the same had the consignor (consignee) been both charged the tax and refunded the excess amount of tax. The advantage of providing the subsidy to shipping companies is that it overcomes the extraterritoriality problem whilst also making the party with the most detailed information about the emissions released cooperate with the tax authorities.[16]

The amount of the subsidy[17] S that the shipping company receives is determined as follow:

[16]This mechanism design differs from the more standard use of two-part environmental fiscal instruments in the Environmental Economics literature where the recipient of the tax rebates is the same entity as the taxpayer (see Parry *et al.*, 2014; Fullerton & Wolverton, 2003). In taxing maritime emissions it is economically efficient and legally important to separate taxpayer and recipient of the subsidy or rebate. This can also be beneficial for tax-and-rebate mechanism outside this sector since the tax liability is shared in the same way in both cases but the legal complications, as well as the transaction costs, can be reduced through this apportionment.

[17]Technically, the payout of the excess amount of tax is not a refund, but a subsidy. A tax refund would demand the excess amount of tax to be refunded to the tax subject, i.e. the cargo consignee (consignor).

$$S = T - \frac{1}{2} t_{carbon} \eta d w_{cargo} \sum_{i=1}^{n} (\theta_{fuel})_i \, (f_{carbon})_i \tag{7.5}$$

Whereas in the calculation of the tax bill (equation 7.4), we used the assumed direct distance (d^e) between the cargo's port of origin and its port of destination, the calculation of the subsidy is based on the actual distance d that the ship sails after loading the cargo until offloading it. Equally, η in the subsidy refers to the actual fuel efficiency per tonne-kilometre, which is impacted by the actual capacity usage of the ship, speed, engine type, weather and other factors, whilst the conversion factor $\sum_{i=1}^{n} (\theta_{fuel})_i \, (f_{carbon})_i$ depends on the carbon content of the fuel and potential future uses of pollution control equipment such as carbon capture and storage (CCS).

Submitting the data to prove the entitlement to a subsidy is rather straightforward for shipping companies as it is already common industry practice to retain fuel delivery notes to calculate CO_2 emissions and disclose this information to customers (BSR, 2017). The definition of distance underlying the tax formula is defined such that several shipping companies can claim subsidies on the same piece of cargo while each receives only the portion of the excess amount of tax that each ship should rightly claim given its share in transporting the cargo from its port of origin to its port of destination. That is, to be eligible to a subsidy, a shipping company does not need to be the last (first) carrier in the maritime transport chain to the EU port of destination (from the EU port of origin). Instead, it is sufficient for the shipping company to establish that cargo which it has carried for some of the distance has afterwards been imported into the EU (initially been exported from the EU). This way, carriers along the whole maritime transport chain are provided with the incentive to reduce their emissions and submit the relevant emission data to EU tax authorities. Since subsidies are determined based on cargo that has been imported into (exported from) the EU, the calculation of the subsidies is not distorted by the composition of the cargo on board, i.e. no subsidies can be claimed in cases where the cargo has not been imported into (exported from) the EU.

Due to the prospect of obtaining subsidies, shipping companies have an incentive to emit less than the default amount of emissions determined by the tax authorities. Because of the subsidies a shipping company receives, it can offer more competitive freight rates (and as argued above, also has to). Through this process, shipping companies have an incentive to supply the tax authorities with an increasing amount of data. This then enables tax authorities to continuously improve the estimation of the provisional tax base. Thus, the tax authorities receive the required data without having mandated its provision. In this way, the tax authorities are in a position to levy taxes on precisely quantified emissions even when they lack the legal ability to mandate all taxpayers to report their emissions. They only need to demand that the taxpayers who are providing the data also grant rights to verify the accuracy of the submissions through random checks – either by the tax authorities or by authorised independent verification companies.[18] The tax-and-subsidy mechanism solves the limited right of tax authorities' to access data is solved, as the tax authority receives the required data without having to mandate its provision. Furthermore, the random checks also incur much less administrative costs compared to the case where tax authorities have to bear the burden of proof.

7.4.3.3 Computation of the default values

In maritime policy debates, it is often claimed that data on maritime emissions is currently too scarce for policy action. Accordingly, both the EU policymaking process and the International Maritime Organisation's Marine Environment Protection Committee seek to first establish regulations for Measurement, Reporting and Verification (MRV) and mitigation objectives before moving on to the design of policy measures for attaining those objectives (European Commission, 2013c; IMO, 2015). The mechanism described here could help to speed up this process because it would be able to provide efficient mitigation incentives even without mandatory MRV. Instead, the MRV would be voluntarily adopted by shipping companies with an interest in receiving the subsidy payment. It is, therefore, unnecessary to wait with the introduction of policy measures until the faraway date when today's maritime MRV systems have been harmonised and extended to global coverage. With this policy design, carbon pricing does not require mandatory MRV to function efficiently.

In the following, we will show that the datasets required to estimate a sound provisional tax base are or soon will become available to the competent authorities via European electronic data management systems, and without incurring

[18] See chapter 9 for the suggested verification mechanism and its economic effects.

substantial administrative costs. Moreover, the tax regime provides incentives for shipping companies to voluntarily provide additional data, which will result in a comprehensive and concise database over time. This date will then be raised despite the legal and administrative constraints for obtaining data about the emissions of ships on a per-voyage basis in international waters.

In the case of ships calling at EU ports, it will become possible to estimate rather precise default values from 2019. Since January 2018, the regulation on the monitoring, reporting and verification (MRV) of carbon dioxide emissions from maritime transport (European Union, 2016) mandates shipping companies to record (on a per-voyage and annual basis) and report (on an annual basis) data on fuel consumption, distance travelled, ship efficiency, and carbon emissions for each ship. Hence detailed data on carbon emissions are becoming available to the European Commission and the EU member states' competent authorities. The MRV system covers about 90 % of the relevant emissions, as vessels below 5,000 gross tonnage are excluded to reduce the administrative burden.

Besides the EU-MRV system, further databases are available to calculate the default values. As for other cargo import and export notifications also have to be submitted, the required information can be retrieved from customs databases, including the weight of cargo, the consignor's and consignee's identities and addresses, the port of origin and the port of destination, as well as stop-overs / transshipments en route. The direct sea lane distance between the port of origin and the port of destination is hence available.[19] Another data source for computing the default values is AIS positioning data.

This data will be complemented by MRV data of the previous year on the annual average energy efficiency of the given vessel and the annual average carbon conversion factor for this vessel. The customs and MRV datasets can be merged using the IMO Ship Number which is a unique identifier for ships contained in both datasets. This estimation method will incur only low administrative or compliance costs, as each of these data is or will be shared electronically amongst EU competent authorities via joint data management systems.

Regulatory MRV will, however, only cover emissions from vessels calling at EU ports. For the emissions released further upstream and for ships with less than 5,000 GT the competent authority will have to use alternative, albeit initially less

[19]Such calculations are performed, for instance, by data providers such as www.dataloy.com.

precise, default values.[20] With more and more actual data on the energy efficiency of ships which are not covered by the MRV system being provided by shipping companies that claim subsidies, the energy efficiency database can be enriched by this data. This could overcome the possible difference between the distribution of the energy efficiency of ships covered by the MRV and those that are not. As ships outside the scope of MRV are not legally bound to provide the data regularly on an annual basis, they should be assigned the default energy efficiency if no actual value from the previous year is available. The lower the efficiency that the policymaker assumes in setting this default value, the greater is the incentive of the shipping company to voluntarily provide the missing data.

From this, it follows that the tax authorities will be provided with precise and mostly verifiable data to determine the tax liability. Established and trusted data exchange mechanisms exist for the shipping companies to make claims for subsidies in an easily automatable form. Moreover, out of all competent authorities, customs authorities are probably the ones who are most familiar with cross-country collaboration, having in place data transmission systems (and in the case of the Schengen area also integrated databases), which is not the case in most other fields of tax policy. By making customs authorities the body responsible for the implementation of the tax regime, the calculation of the provisional tax base using pre-existing systems comes at a comparatively low additional cost and will be less likely held back by political games over data access rights.

7.4.4 Determining the tax base for intra-EU shipping

When taxing emissions from *international* shipping, it is important to tax emissions from *internal* maritime shipping in the same way. Excluding the latter from an emissions tax would not compromise the environmental effectiveness of the tax, but it would raise concerns under WTO law. If the emissions tax regime

[20]This applies to both the carbon conversion factors and ship efficiency. For instance, the British Department for Environment, Food & Environmental Affairs (Defra) annually publishes international averages of carbon conversion factors per ship type (see http://www.ukconversionfactorscarbonsmart.co.uk) which can be used as default values. In cases where the ship type is unknown, it can be assumed to be the ship type typically used for transporting the respective cargo type (Bäuerle *et al.*, 2010). To determine the default energy efficiency, the average energy efficiency data of each ship from the MRV database can be enriched with information on its ship type which is recorded in shipping registers.

described above is put in place without pricing also emissions released by vessels operating within EU waters, the compliance of the scheme with Art. III(2) GATT could be questioned (See Dominioni, Heine, Martinez Romera, 2018, for a detailed discussion of compliance with Art. III(2) GATT). In particular, discrimination could take place if the products transported by these (untaxed) vessels compete with products transported in international shipping. We hence describe in the following how emissions from domestic shipping could equally be taxed at the same rate as emissions from international shipping.

The main reason why we suggest using a different mechanism for intra-EU shipping is that an alternative, probably less administratively complex, solution is available. Also using customs data for the taxation of emissions from intra-EU shipments is possible but not optimal. In certain cases, customs authorities do also raise data on intra-EU shipments – even if domestic goods do not need to clear customs – since the status of the cargo as "community goods" needs to be demonstrated in various circumstances. But there are also situations in which this data is not collected by customs authorities, i.e. when vessels never leave EU waters and exclusively transport community goods. Then the tax base could not be determined. Furthermore, even where the data is raised to establish the status of cargo as community goods, there is no customs bill to which the emissions tax could be added. The intuition of the tax regime that we suggest for international shipping, however, is that established transactions and systems should be re-used to the greatest extent possible to keep system costs down. Accordingly, using the customs system to tax emissions for intra-EU trade seems less appealing than it is for emissions caused by the trade of EU member states with the rest of the world.

By introducing a fuel tax on emissions from intra-EU shipping as suggested, e.g. by Hemmings (2011) and Kågeson (2011), these issues could be circumvented. Under such a regime, the emissions are taxed upstream, meaning that they are taxed indirectly by taxing the fuels based on their carbon content. A fuel tax is simple to administer and to comply with (see chapter 11). However, unlike with the mechanism which we have outlined for international shipping, under a fuel tax the consignee (consignor) of the cargo cannot be the taxable entity. Instead, the vessel owner should be defined as the taxable entity. This, however, is unproblematic since, for intra-EU shipping unlike international shipping, there are no problems with extraterritoriality (as the emissions are released within EU territorial waters) and multiple Bills of Lading (as the tax base is independent of the cargo origin). As for road motor fuels, making the vessel owner the taxable entity does not preclude organising the collection of the tax through withholding taxes at the level of the fuel supplier. Since marginal compliance and administrative costs typically fall in the size of a tax base, the tax should be levied as far upstream as possible, such as at refuelling companies. Charging upstream is not a problem for the mitigation incentives as the price signal gets passed on to the ship.

The weak point of a fuel tax for intra-EU shipping, however, is that it offers loopholes for tax avoidance – the very argument that has led us to disfavour such a tax in the case of international shipping. Yet, this Achilles heel would not nearly be as vulnerable in the case of intra-EU shipping as it is for international shipping. If the tax were levied throughout the EU, the opportunities for tax avoidance for vessels transporting goods within the EU would be limited. The only opportunity for avoiding the tax would be by leaving EU waters in order to refuel outside the geographical coverage of the fuel tax. Even then, accessing the high seas would not suffice for a domestic ship to completely avoid tax liability since, if a vessel left EU waters for refuelling, it would automatically be covered by the above-described emissions tax on international shipping. This is because, under existing EU customs laws, a domestic vessel leaving and re-entering the EU must register its cargo in the EU customs system, even if it transports EU cargo only, to have the EU status of the cargo re-determined.[21] As a result, a domestic vessel leaving the EU in order to refuel elsewhere and thus avoiding the fuel tax would be covered under the custom-based tax on emissions arising from international transport.

Opportunities for tax avoidance by refuelling outside EU waters could also be limited by prohibiting the installation of refuelling platforms within the EU member state's Exclusive Economic Zone. The sea area covered by the Exclusive Economic Zone is so large that any remaining incentives for tax avoidance should be effectively reduced. The Netherlands, Belgium and Germany are already using maritime spatial planning, and the prohibition of floating refuelling platforms would only be an extension to this existing system.

Where two systems for computing a tax base co-exist, they can overlap. Thus, these systems would need to be safeguarded against double-taxation. For this

[21]Under the European Custom Code Article 136, the status of the shipment as "community goods" must be reestablished when a ship exits the customs territory, stops somewhere (e.g. for refueling) and then re-enters the customs territory.

purpose, deep-sea vessels that refuel in EU ports should be exempted from the fuel tax. This is because emissions from deep-sea vessels are already covered by the emissions tax. Hence they should not be taxed twice through a tax on their fuel consumption. Furthermore, vessels departing from the EU for international destinations are equally covered by the emissions tax and should thus be exempt from the fuel tax, too. The amount of tax-free refuelling by vessels leaving the EU should not be limited to the estimated quantity of fuel to be consumed on the remainder of the voyage outside EU waters. Any such limitations would compromise the EU share in the international bunkering business because refuelling quantities sufficient for more than one voyage is common practice, not just a potential tax-avoidance strategy.

However, whereas the bunkering of tax-free fuel per eligible vessel should not be rationed, an emphasis has to be placed on which vessels are eligible to bunker tax-free. Clearly, vessels which are not leaving EU waters after refuelling should not be entitled to tax-free bunkering. But leaving EU waters for a short distance only should not qualify vessels either in order to discourage tax avoidance through disguised round-trips. To be entitled to tax-free bunkering, vessels should have to leave EU waters for a voyage long enough to disincentivise fuel tourism. Ex-ante, the eligibility for tax-free bunkering could be proven by producing the relevant customs documents which indicate the next port of call, and ex-post, this assertion could be verified through the AIS positioning system.

Another form of overlap could occur when domestic vessels which have already paid the fuel tax leave the EU for a nearby port, load cargo there, and subsequently re-enter the EU. The consignee of these goods would then be liable to pay the emissions tax, passing some of the economic incidence of the emissions tax onto the vessel owner. As the latter, however, would already have paid for its emissions through the fuel tax, he would have to bear more than the intended tax burden. To correct for this over-taxation, the vessel owner would have to be allowed to demand a rebate on its previous fuel tax bill, accounting for the amount of emissions that were covered under the emissions tax.

7.4.5 Defining different taxpayers in international and intra-EU shipping

Above we have argued that, for the emissions tax applied to international shipping, the taxable entity should be the consignee or consignor, whereas, for the fuel tax applied to domestic shipping, the taxable entity should be the vessel owner. At first glance, an observer might find this variation in the taxable entity discriminative. Economically, such discrimination does not exist, however. Instead, this arrangement minimises the overall system costs.

By the standard theory of Tax Remittance Invariance (Jenkin, 1871; Logue & Slemrod, 2010), the costs that vessel owners, consignees, consignors and fuel suppliers bear as a result of the taxes proposed would be the same independently of whom is the taxable entity. This is because the agent on whom the tax burden is imposed will pass some of it onto his transaction partners. For example, the shipping company will pass some of their fuel tax burden upon the consignees and consignors of the cargo. The same applies to the custom-based emissions tax in international shipping. If, for instance, the consignee of the cargo foresees being charged additional costs associated with the cargo, he will pass it partially onto the shipping companies when negotiating freight rates. Again, the shipping company, which is thereby indirectly burdened by an emissions tax, will pass some of that cost onto its fuel suppliers. The extent to which each agent is able to pass the economic incidence of the tax onto other agents is determined by the market structure and the elasticities of demand and supply along the supply chain (Keen *et al.*, 2011). Thus, the fact that shipowners have to remit the fuel tax, while consignees (consignors) have to remit the emissions tax, does not change the distribution of the tax incidence.

7.4.6 Minimizing the cost burden of the tax regimes

The tax regimes we propose do not only render taxation of maritime emissions economically, legally and politically feasible. They also achieve this by imposing comparatively low compliance and administrative costs on the involved entities.

7.4.6.1 Compliance costs

Defining the consignor (consignee) for international shipping and the shipowner for internal shipping, respectively, as the taxable entity, minimises the overall cost burden. Paying a tax is associated with compliance costs (filling out forms, providing documents, etc.). These costs are not the same for all possible taxable entities. Thus, the taxable entity should always be the agent facing the least compliance costs. Through this least-cost attribution, all agents will benefit because the agent who bears the legal tax liability will pass on not just part of the tax itself, but also part of the compliance costs. So if the agent with the lowest compliance costs is the taxable entity, also the economic incidence borne by all agents participating in the transaction will be reduced. This means that the legal tax liability is actually relevant for the economic incidence of the tax, but only in terms of the amount, not in terms of the proportion of the total cost.

For the customs-based emissions tax in international shipping, we have shown why the compliance costs are low for the consignee. The consignee (consignor) is already the taxable entity for other custom-based charges on the same cargo. Adding one more item to the list of existing custom charges appears to cause lower compliance costs than establishing a completely new type of transaction between tax authorities and shipping companies. For domestic shipping, the custom-based transaction does not exist and hence defining the consignee (consignor) as the taxable entity would establish a whole new transaction and thus increase compliance costs. Adding a fuel tax to an existing fuel bill, however, causes only low compliance costs.

7.4.6.2 Administrative cost

The second way in which the definition of the taxable entity could change the economic burden arising from the tax, is through administrative costs. The costs for the tax authorities to administer tax payments vary with the taxpayer. The lower the administrative costs, the higher the net revenue. As a result, the government needs lower taxes (or lower borrowing) to raise the same public revenues. The parties involved could benefit therefrom directly through a lower tax rate, or indirectly as participants in economic life. In the case of a Pigouvian tax, the tax rate is set reflecting the external damage and should therefore not be varied in administrative costs. Both effects would, however, reduce the net economic burden of the tax.

Again, as regards international shipping, administrative costs should be lower by re-using the existing customs system – which already refers to consignees (consignors) – than by setting up an entirely new system. However, for domestic shipping, setting up a system similar to the custom-based system for international shipping would be costly for tax administrations. As fuel taxes are established already in other areas of energy policy with meagre administrative costs, they appear to be the best option.

7.4.7 Setting the tax rate

The tax rate can be determined in two different ways. One option is that the EU sets a tax rate reflecting the damage inflicted on the EU only. Such a tax rate would imply a price of GHG emission much lower than the accounting prices for CO_2^e usually used by governments, since the latter are generally calculated as to mirror damages accruing to the whole world. Legally, a tax rate set along these lines might be easier to maintain as it would allow the government to argue that it is acting to protect its own citizens rather than intervening to protect the rights of other countries' citizens or the global commons (Heine *et al.*, 2017). Alternatively, the EU could set the tax rate according to the estimates of global damage caused, thereby achieving greater climate change mitigation effects. However, in this case, accommodating expenditure policy, i.e. earmarking of tax revenues, might be necessary to ensure compliance with the United Nations Law of the Sea (UNCLOS) (Dominioni, Heine, Martinez Romera, 2018).

The nominal tax rate levied on emissions in international shipping should be equivalent to the implicit tax rate levied on fuels in internal shipping. I.e. if a tonne of GHG is taxed at a certain rate in the custom-based system, the fuel tax should be set based on its carbon content such that the implicit tax per tonne of CO_2^e released at the point of combustion will be the same. Keeping the nominal tax rate the same for the emissions from international and internal shipping is important both for Pigouvian considerations and WTO compliance (Dominioni, Heine, Martinez Romera, 2018).

7.5 Conclusion

Despite the availability of technical and operational measures to reduce greenhouse gas emissions from international maritime transport, these emissions are amongst the fastest-growing of any global industry. A key impediment to mitigation in this sector is the lack of taxation of maritime fuels. To provide the needed mitigation incentives, maritime emissions would need to be priced, but the introduction of such emissions pricing is plagued by problems of tax competition, legal constraints on extraterritorial policy action, data unavailability over emissions, and concerns for competitiveness and distortions of trade patterns. Given these constraints, the predominant view in the literature is that the introduction of emissions taxation in the maritime sector would require a unanimous international agreement. Such an international agreement has, however, not been forthcoming despite decades of negotiations. Since there does not appear to be a functional outside option that a coalition of early movers could embark upon even without a global agreement, climate action in this sector can be easily blocked. This gridlock in negotiations might be broken, however, if there does – counter the common wisdom – exist a credible mechanism for an individual Finance Ministry or a coalition-of-the-willing to tax maritime emissions even in the absence of an international agreement. This chapter develops such a mechanism, proposing a feasible and cost-effective unilateral tax regime which takes account of the above-mentioned constraints.

Chapter 8

Taxing unilaterally to enable global agreement? The maritime case*

8.1 Impact of unilateral options on the chances for a global agreement

This chapter investigates in more depth how the availability of a mechanism for *unilateral* maritime emissions taxation could impact the ability of countries to, instead, reach a *global* agreement on pricing these emissions. The question that we ask is hence: Supposing that a unilateral tax option becomes available in maritime climate negotiations, how does the mere availability of this policy option impact the chances of reaching an international agreement – which would itself substitute the unilateral tax option and instead introduce an international maritime emissions tax with global coverage?

The general expectation in maritime climate negotiations is that the only way to introduce emissions pricing is through an international accord which has un-

*This chapter is based on a working paper co-authored with Arne Pieters.

animous support.[1] This preference for unanimity gives a great number of individual players the power to block an agreement. It is important to note that the obstacles in the way of reaching a global solution and those impeding unilateral action should not be viewed separately. Not being able to take unilateral action can create, or at least entrench, the negotiation gridlock for joint action.

The measure proposed in chapter 7 provides a way around the infeasibility of an EU unilateral measure. Heine *et al.* (2017) and Dominioni *et al.* (2018) furthermore suggested that the mechanism does not require a change in international law, which legally circumvents the need for other ("non-coalition") countries to approve. This viability of a regional policy option could, in turn, affect the international negotiations for a global measure, as it will change the counterfactual scenario. In the terminology of economic contract theory, the possibility of the unilateral action changes the outside option, both for those in favour of a global mechanism and for those blocking it. One might say that reducing the need for global agreement can help realising it. Conversely, the gridlock in current negotiations for an international maritime market-based measure can be taken as an indication of how deeply these negotiations currently rely on unanimous agreement.

This chapter aims to describe through which channels the addition of the proposed mechanism to the EU's policy toolbox might affect the gridlock in the negotiations for a global solution. Three types of motives are identified that countries might have for blocking a global fuel tax/levy, followed by a discussion of the extent to which this resistance can be reduced. The impact on the EU position will then be discussed, as well as some strategic approaches which the EU might take towards realising a global agreement.

8.2 Motives for blocking a global agreement

Three types of motives for avoiding an international agreement on a global maritime fuel tax can be identified, of which more than one could apply to one country.

[1] For example, the IMF and World Bank argued that "*Extensive cooperation in designing and implementing international transportation fuel charges would be needed – especially for shipping – to avoid revenue erosion and distortions*" (Keen *et al.*, 2011, p. 6)

Oil sales

Firstly, oil-selling countries have a commercial interest in preventing any tax on oil-generated emissions. Although a global tax on maritime fuels can be expected to reduce their revenues, it is not exactly clear by how much. This will depend on how elastic their demand is, which in turn will depend on, among other factors, the availability of low-cost fuel saving methods, and can, therefore, change over time.

Oil producers are not necessarily concerned about having to impose a fuel tax themselves. Their interest lies in the global demand effects. A requirement for international maritime fuel taxes to be agreed upon unanimously gives oil-producing states the power to prevent this reduction in revenues, and if this outweighs the advantage of justly pricing the externality fuel consumption produces, they have an interest to veto a global tax.

Hold-up

Given the need for unanimity, every actor has the disproportionate power to single-handedly block any deviation from the status quo. Even if certain actors have no reason not to want to have a global fuel tax, they might still want to exploit this power. Knowing that a shift towards a global measure generates value for the EU, these actors have the opportunity to hold up the EU and demand something in return for their support. These countries know that, under unanimity, the last veto to be given up is of great marginal value, which they can exploit to extract rent.

An analogy can be drawn with the known example of a hold-up in a development project such as of a railway line. A landowner knows that his agreement is required in order for the railway line to build. He values his land at some amount but might ask for a much greater amount from the railway company. Knowing that the project's realisation depends on his compliance, he could be able to extract an amount up to the total net value of the railway line if all other necessary parties comply before he does (e.g. Cooter & Ulen, 2007). Given the expectation of such opportunistic behaviour from one or more landowners, the railway company never builds the railway line, even though the various landowners and the railway company might all have benefited from the project.

Tax haven strategies

As a third motive, countries that do not sell oil can have an incentive to block an international mechanism if, firstly, they expect that the European Union will then act unilaterally and, secondly, that they may derive payoffs from the EU doing so. Such payoffs include gains from employing tax haven strategies.

When the alternative to a global fuel tax is a unilateral fuel tax, outside countries can gain from offering ships a way to avoid these taxes. Countries employing such strategies would not gain in terms of tax revenue, given that it would involve a zero-tax on fuel, but could gain refuelling business. The flexibility which ships have in terms of their refuelling location thus not only reduces the effectiveness of a unilateral fuel tax severely, it also generates a group of potential tax haven-countries that have a strategic incentive to block a global agreement. Moreover, this group is potentially vast, because any country located favourably relative to busy shipping routes could qualify.

8.3 The unilateral bargaining chip

The availability of the proposed second-best unilateral option of a cargo-based tax has several relevant effects for the likelihood of reaching a unanimous global agreement introducing the first-best international fuel levy. Firstly, it changes the so-called threat point, or default option, that is relevant to the negotiations. The proposed mechanism shifts that point from the current situation, where international maritime transport emissions are not taxed at all, to a situation where a share of those emissions is properly taxed. Figure 8.1 illustrates this shift for two sides of the negotiation table. The vertical axis measures the value of an outcome for a "green player", such as the EU, while the horizontal axis measures value for oil-producing countries. The fact that the EU would prefer agreement point a over the current status quo, threat point d, while oil producers have reversed preferences, is reflected by $V_{EU}(a) > V_{EU}(d)$ and $V_{OIL}(a) < V_{OIL}(d)$. The availability of a unilateral measure shifts the threat point from d to d', the location of which will be determined by several factors. If at d' a share of maritime emissions is taxed at an efficient tax rate, thereby achieving a reduction in emissions and a reduction in oil demand that are a proportion of what a global fuel tax would achieve, we know that $V_{OIL}(a) \leq V_{OIL}(d') \leq V_{OIL}(d)$. Also, as long as the effectiveness of the unilateral measure outweighs the cost of its implementation, we have $V_{EU}(a) \geq V_{EU}(d') \geq V_{EU}(d)$. Combined, these inequalities tell us that d' cannot lie to the right or below d.

Where d' lies is determined by the relative weight which the EU ports, and those of any coalition partners, have in global sea trade. The larger this weight, the closer the tax coverage achieved by unilateral action comes to that which would be achieved by a global fuel tax.

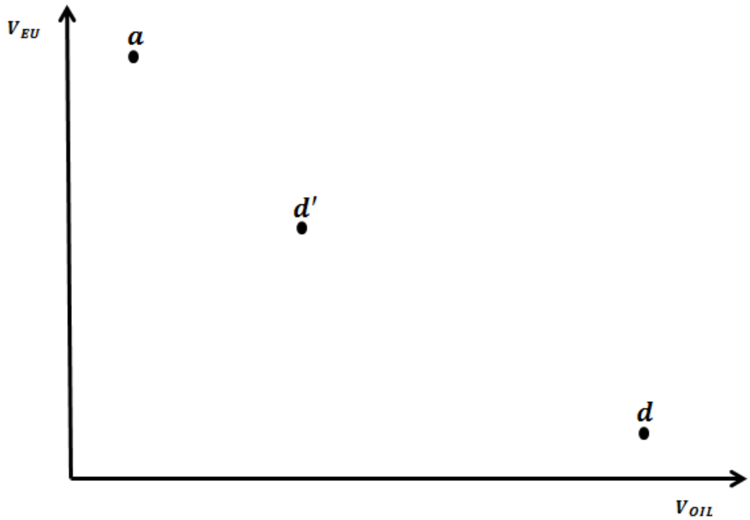


Figure 8.1: A unilateral option shifts the threat point.

The location of d' largely determines to what extent global agreement becomes feasible as a result of a new unilateral option. Relevant to the first motive is the horizontal distance between d' and d, given by $V_{OIL}(d) - V_{OIL}(d')$, which shows how much the outside option of oil-producing countries will deteriorate, the extent of which depends on the tax coverage that can be realised, as well as on the resulting effect on fuel demand. A small coverage will, however, result in oil revenue streams that are still higher than would be the case under a global fuel tax. In the absence of any other factors, the introduction of a unilateral tax on emissions would therefore only make oil producers give up their opposition if enough major oil-demanding countries were to implement it, thereby reducing oil revenues by at least as much as a global fuel tax would do. The threat point would then have shifted so far left that $V_{OIL}(a) \geq V_{OIL}(d')$, making the global agreement a sufficiently attractive option.

A second effect of the mechanism is to reduce the opportunity for countries to extract rent by holding up the EU. The ability to apply this strategy depends on two elements. First, there needs to be a value generated for the EU. Second, the EU has to disproportionally need this party in order to be able to generate this value. The first element will be reduced by the vertical distance between d' and d, or $V_{EU}(d') - V_{EU}(d)$, which represents the increase in value which the EU can now achieve without the need for unanimity. The more coalition partners the EU manages to attract to equally introduce the sub-global action, the narrower becomes the gap between outside payoff and agreement payoff, $V_{EU}(a) - V_{EU}(d')$. It is exactly this difference that strategic blockers try to exploit. As for the second element, this disproportionate power will be severely reduced, since, in theory, only important trading countries would need to agree to a cargo-based tax to approach full coverage. Therefore, the marginal value of adding a country to a coalition would be proportionate to its trading volume, and would not increase as others join. The last country to give up its veto would then still be crucial towards achieving a global fuel tax, but would only be able to exploit the difference in value between a full-coverage cargo-based tax and a global fuel tax.

Previous proposals for unilateral taxation created an opportunistic business option for transshipment countries. Such countries could, therefore, enjoy benefits from the maintenance of an EU regional emissions tax instead of transitioning to a global fuel tax. Under the mechanism proposed in this chapter, there is no such rent-seeking opportunity from distorted transshipment patterns. Accordingly, countries with important transshipment ports would not have any increased incentives to prevent a global measure.

Thirdly, under the proposed mechanism, the benefits from tax haven strategies would be much smaller, if still existent at all, than under previously proposed unilateral options such as a unilateral fuel tax for international shipping. The cargo-based tax renders the fuel tax haven strategy ineffective for most states in the world, mostly because being located on major shipping route yields no tax haven advantage anymore. One would need to have a land connection to the EU in order to still offer an avoidance service, and transport over land is very expensive, such that only countries that are very close to the EU could offer such an avoidance strategy. Even then, one could only offer tax avoidance strategies for ships bound for a port close by, on the EU's periphery. For example, in the case of Turkey, it could be the case that the land connection between the port of Attali and the port of Piraeus is good enough to deliver cargo to Attali by ship and then by truck to Piraeus. That option is only available for the small proportion of EU-destined cargo that has its final destination near Piraeus and not for cargo that needs to be transported via long land transport to recipients elsewhere in the EU. So even in this case, the opportunities to run a successful tax haven are limited, and for the EU as a whole such tax haven strategies will be much smaller with a cargo tax than with a fuel tax. For the negotiations of a global fuel tax this means that – if the EU's alternative unilateral move is to adopt a cargo-based tax instead of a regional fuel tax – fewer countries will have an interest in blocking the global fuel tax in order to trigger the EU to set up a unilateral tax which non-participants could then undermine as tax havens.

However, besides the cargo-based tax, our mechanism equally contains a fuel tax for domestic transport. This domestic fuel tax cannot be undermined by non-EU countries as long as domestic ships never leave the EU's territorial waters. This is the case for most domestic ships, thus limiting the size of the market for offering tax avoidance services. Nevertheless, there are some domestic ships that are technically able to leave territorial waters and go into international waters. This could, therefore, result in some extra refuelling business for adjacent countries. In the case that a unilateral EU-tax has been established, this could cause such countries to protect this extra business and block a global fuel tax.

Although the tax haven motive might not be entirely eliminated, it will play a much smaller role if the EU's unilateral scheme takes the form suggested above relative to a unilateral fuel tax. The potential gains from the strategy will shrink immensely, and additionally, the tax haven strategy can be played by a far smaller number of countries that are determined by proximity to the EU and thereby posing an opposition that is easier to control, as the EU interacts with them more frequently than with more distant countries on a range of non-maritime political issues which can be used as leverage. With the gains to be had as tax havens under the unilateral measure being much smaller, the incentives for non-EU countries to oppose transitioning to a global agreement are effectively reduced.

8.4 Complimentary strategies to transition from a unilateral emissions taxes to a global fuel tax agreement

The previous subsection explained how the option of a unilateral cargo-based tax will eliminate certain obstacles towards achieving international agreement. However, while the chances for a global agreement are then increased, that agreement may nevertheless not yet be achieved. To further increase that likelihood, one could imagine that further measures towards reducing the payoff difference between the outside option and the cooperative option of a global fuel tax, whilst not eliminating it completely, might still be enough to bring about an international agreement.

As for using the mechanism as a credible threat, several factors have to be taken in to account. Firstly, it requires the EU's negotiation partners to believe that the EU is genuinely committed to taking such unilateral action in case of disagreement. In order for the EU's intention to act to be credible, the benefits of unilateral action of the tax need to outweigh the costs. This may not be the case for some of the schemes suggested in the literature, so chapter 7 has sought to create a measure for which this condition holds true. In figure 8.1, the credibility of a threat to act unilaterally is achieved as long as all relevant actors believe $V_{EU}(d') \geq V_{EU}(d)$.

The benefits are not merely a combination of tax revenues and emission reduction, but in the context of the negotiations also include, say, political benefits. Public pressure in the EU to take climate action is what brings about its attempt to take a leading role in the first place, and taking unilateral initiative, when international negotiation partners are not willing to do so, could satisfy this desire more than would be described by its quantifiable effect. In this sense, increased public pressure, as well as the political commitment by those representing the EU will help make the threat more credible.

Besides credibility, the second factor which a credible threat needs is it truly being a threat. The oil producers might believe the EU will take action, but if the effects are very limited, the threat of unilateral action will still not have much of an effect. To truly make a difference, the unilateral action, therefore, needs to significantly damage the disagreement payoffs of the opponents. Relating to figure 8.1, good incentives for oil producers to cooperate would require a substantial vertical shift from d to d'. As has been argued, the more countries the EU can get to join their coalition, the larger this shift would be.

It could be the case that there is some uncertainty among those at the negotiation table about the costs and effectiveness of the proposed mechanism. In that case, it could be important that an actor like the EU assumes the leading role and implements the unilateral mechanism. This would realise the threat for the EU itself (costs will be sunk), thereby overcoming the problem of non-credibility, while at the same time reducing uncertainty for potential coalition members that are tempted to take the same action. By showing the feasibility and effectiveness of the mechanism, the pioneering party implementing it could thereby tilt the negotiations towards a "greener" outcome.

To have a serious chance of bringing about a global fuel tax, the above analysis shows that credibility requires an increase in the EU's disagreement payoff, while threat effectiveness requires a decrease in the opponent's disagreement payoff. These two might not be one-to-one inversely related. The size of the coalition that takes unilateral action will certainly help both ways, however.

8.5 Revenues as a bargaining chip

If an international mechanism such as a fuel tax were reached, the use of revenues would be have to be internationally decided upon, and for this case, Keen *et al.* (2011) have put forward proposals in which many developing countries would realise net gains. With the unilateral mechanism, the European Union would likely still be required to share some of its revenue,[2] but generally, the revenue use will be more on EU terms. The availability of a unilateral tax mechanism

[2]Since most of the emissions from international shipping occur in international waters, the international public at large has a certain claim on some of the revenues. Keen *et al.* (2011) therefore recommend that a share of the revenues should be earmarked for international climate finance, but that the remainder should not be earmarked. The main danger for an efficient use of environmental tax revenues is earmarking for special domestic interests.

Sharing revenue is not the only way to achieve such differential treatment. Another route would be to differentiate the tax rates for cargo from developing countries. However, in a first-best world, differentiating the tax rate would be less efficient than sharing revenue. The inefficiency arises because differentiating the tax rates would distort trade patterns, cause emissions leakage, transfer less utility than a comparable money transfer by mandating an earmarked use of the revenue (for shipping instead of any other budget item that might be more pressing). Furthermore, differentiating the tax rates would also conflict with the intention of UNFCCC Article 3, which aims to compensate the would, therefore, raise the potential for global action because the non-coalition countries have a greater incentive to support the international tax. Knowing that the taxation of maritime emissions will come anyway, countries may want to at least be able to co-decide the use of the revenues.

If the EU implemented its own mechanism, it might still share part of the revenue with neighbouring countries. To protect against tax haven strategies, the EU might pay compensation to bordering countries for getting them to agree to apply EU taxes to EU ships that come to their territory to refuel. Once the EU has set up compensation schemes such as this one, these bordering countries have an incentive to see the unilateral scheme ongoing, since with an international scheme the EU would not need to pay compensation to keep its domestic ships from avoiding the domestic fuel tax. These neighbouring countries might, therefore, be against an international scheme in order to keep the unilateral scheme, particularly after the unilateral scheme is established and has hence become credible. However, as has been argued above, the magnitude of this problem would be small, and the high level of interaction with these countries facilitates the bundling of negotiations with other regional issues to achieve a compromise.

8.6 Sharing revenue or differentiating tax rates?

Even in the case of a unilateral EU-scheme, developing countries may have or make a claim on a share of the tax revenues since Article 3 of the UNFCCC guarantees them a differential treatment. An important question is then also whether any compensation for developing countries would come in the form of differentiated tax rates or through an agreement to share tax revenues. Here we analyse the political economy that may drive either of these outcomes, considering who may have an interest in advocating for which type of compensation. Having argued above that sharing revenues would be more efficient than differentiating tax rates, this analysis of the negotiation positions shall help us derive whether that efficient outcome is politically feasible.

poor. Any reduction in the tax rate for shipping from poor countries would be shared, according to the elasticities of demand and supply for those countries products, with their trade partners; so money aimed at the poor would leak to unintended recipients. Both the efficiency and equity concerns are therefore better served with direct transfers of revenue, instead of differentiation of the tax rates.

Trade businesses in the EU have an interest that compensation of developing countries under UNFCCC Article 3 would take the form of differentiated tax rates rather than lump-sum transfers of revenues. Since in most market situations the economic incidence of the tax rate would be shared between the trade partners in developing countries and their counter-parties in Europe, also the gains from a reduction in the tax rate would be shared. Any compensation granted through differentiated tax rates would hence also partly leak to the European trade-partners. This leakage could be large, particularly for those developing countries whose exports Europeans demand with a high price elasticity of demand. These will tend to be developing countries whose products are less differentiated and thus more easily replaceable with products from other countries. European businesses could hence benefit significantly from a largely failed attempt to compensate the poorest. If European businesses know their strong negotiation position regarding the sharing of tax incidences, then they have an interest to lobby for a tax reduction for emissions released in ship trade with developing countries. In the political debate, it may appear easier to sell a reduction of tax rates if it appears to be granted to the poorest nations than directly to European firms.

But why would such an alliance between European businesses and developing countries be possible then, given that developing countries will equally perceive the real tax incidence and not be myopic about their lot in such a deal? Rational foresighted negotiators of developing countries may agree to such a deal if the alternative – that Europe pays compensation through sharing some of the revenue as climate finance – is even worse. It cannot be worse due to leakage, as sharing revenues lump-sum between states would not affect the economic incidences of private trade parties. It can, however, be worse if Europe's offer to share revenues lump-sum is especially penurious. If Europe's offer of direct climate finance were extremely small, developing countries might prefer a tax reduction even if that option would entail large leakage. But because of that leakage, European states would always find it cheaper to raise the amount of direct climate finance that they provide to developing countries relative to paying the same amount as a tax reduction. Either Europe or developing countries would need to be short-sighted for the lobbying coalition between developing countries and European businesses to arise. This risk of such a coalition forming could, therefore, act as a protection against Europe becoming too selfish about its revenue. If the European Union only considers its personal interests but does not want to grant lobbying groups a platform in the political debate over the introduction of its emissions tax, the EU has an interest in promising some reasonable amount of revenue sharing (e.g. as climate finance) to developing countries so they do not support business groups' call for exemptions and reductions to the tax rate. If all actors negotiate in their own self-interest, the politically feasible outcome would then also be the efficient one – to provide compensation by fairly sharing revenues rather than by distorting the tax rate structure.

8.7 Conclusion

International environmental negotiations have been notoriously slow, prompting individual countries and in particular the EU to occasionally consider implementing policies unilaterally. An important question is then whether the unilateralism can hinder the continued multilateral efforts for global environmental agreements.

A particularly complex test case for this question is the maritime sector, which is perhaps the sector in which climate policy has progressed least across all industries.[3] In this chapter, we have shown that the availability of a unilateral outside option for taxing maritime emissions makes the achievement of a global agreement for taxing these emissions more likely. The availability of an alternative mechanism can help overcome hold-up problems which exist as long as a global unanimous agreement is the only way to tax maritime emissions.

This insight carries lessons that apply more widely than to the maritime sector. Current international environment negotiations have a strong preference for unanimity. However, not all countries value environmental protection equally. In such circumstances, a requirement for consensus can be used strategically to extract concessions for agreement. If, however, scholars can create economically and legally feasible unilateral mechanisms, the risks of hold-ups can be reduced, thus helping to speed up our long-delayed efforts of global climate change mitigation.

[3] Given that all other industries are covered by NDCs under the Paris Agreement or CORSIA in the case of the aviation industry.

Chapter 9

Taxing embodied emissions of imported goods: The forestry case*

Several countries with large end-consumer markets for timber have the declared objective of supporting forest sustainability around the globe, but the world's most important forests are, in fact, outside their jurisdictions. Actions to protect these forests are therefore constrained by the territorial boundaries of jurisdictions. To legally act outside their borders, these countries support voluntary certificates on production practices and price-based instruments, but, unfortunately, neither of those instruments reaches beyond niche market shares, administrative and compliance costs are high, the environmental gains are variable, and the two types of instruments work alongside each other without much synergy.

This chapter designs a mechanism that integrates forestry certificates with price-based instruments, in a way that exploits synergies, and provides dynamic incent-

*This chapter is based on Heine, Dirk, Faure, Michael., & Lan, Chih-Ching. 2017. Augmenting forest sustainability certificates with fiscal instruments, Rotterdam Institute of Law and Economics Working Paper 2015/7. However, to ease evaluation of the author's contribution, the content from co-authors has completely been taken out apart from Box 1. All remaining content is thus single-authored but it benefited from significant advice by Michael Faure. Contents from this chapter will be published in the forthcoming joint book "Fiscal Policies for Sustainable Forests" by the World Bank and the International Tropical Timber Organization.

ives for the sustainable use of forests while keeping down the costs of compliance and administration. It is a mechanism that satisfies legal constraints on extra-territorial regulation while nevertheless allowing countries to act outside their borders.

The mechanism consists of a tax imposed by a timber-importing country on a default assumption regarding the sustainability of the timber, combined with a tax discount that is provided on the receipt of proof that the sustainability was higher than assumed. The proof is established by showing a sustainability certificate to the customs authority when the timber is imported.

This 'Feebate' mechanism reduces standard problems in the literature on the certification and taxation of overseas forestry, such as the problems of threshold costs, free-riding and consumer recognition in markets with competing sustainability certificates, and the problem of how to compute efficient Pigouvian tax rates in a sector plagued by a lack of available data. We show that a combination of price-based instruments with certificates can lead to better incentives for sustainable timber production than each of the instruments alone, without infringing the sovereignty of forest nations.

9.1 Introduction

Despite a plenitude of policy initiatives for forest protection,[1] deforestation and forest degradation remain key sources of global carbon emissions and biodiversity losses. In the continued absence of an effective international forestry treaty, other means of protecting dwindling global forests need to be explored, including unilateral action by individual countries with greater ambitions. Such unilateral action can come from countries with large forests, as well as from countries which have few forests of their own but large end-consumer markets for imported timber. The first group of countries has comparatively straightforward policy options for improving global forest sustainability through domestic action(e.g. Busch &

[1] These instruments include the Forest Principles, Chapter 11 of Agenda 21, the Non-Legally Binding Instrument on All Types of Forests by the UN General Assembly, the Convention on Biological Diversity, the United Nations Convention on Combating Desertification, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the United Nations Framework Convention on Climate Change, the Convention on Wetlands of International Importance (Ramsar), the World Heritage Convention, and others.

Ferretti-Gallon, 2014), whereas the policy options for the second group of countries are more constrained. In this chapter, we investigate whether a Smart Mix of policy instruments[2] may also enable this second group of countries to contribute effectively to global forest sustainability, even in the absence of a global forestry treaty.

Several countries with large end-consumer markets for timber products have voiced their intention to spur efforts toward forest protection internationally,[3] but the effectiveness of unilateral action by most of these countries may be small unless those unilateral actions have a global reach. This is because most of the remaining great forests in the world, as well as most of the deforestation, lie outside their borders. All countries have interests in the protection of the world's forests (see Box 1) but when these forests are outside a country's jurisdictions, it is unable to effectively enforce their protection. This legal restriction on the ability of countries to protect forests overseas furthermore undermines their ability to protect their own forests, due to problems of carbon leakage. It is, therefore, essential to find an effective solution for how countries wanting to act for global forest protection can effectively do that also in the continued absence of effective international treaties.

Two mechanisms used towards this end are voluntary forest certification systems and price-based instruments. Regrettably, none of these instruments had sufficient uptake, so deforestation continues at unsustainable rates (McDermott *et al.*, 2007). This chapter describes a way in which sustainability certificates and price-based instruments could be combined to be more effective than each of these instruments alone, and enable individual countries to raise forest protection globally even in the continued absence of an effective international treaty.

The chapter is organised as follows. Section 9.2 explains why early movers in forestry policy must apply their policy instruments across borders – why it is not sufficient to merely protect forests domestically – and recounts the policy

[2]The concept of a Smart Mix (Gunningham & Grabovsky, 1998) is based on the recognition that all policy instruments on their own can produce suboptimal results, and that a policy objective may be reached more efficiently and effectively by "*harnessing the strengths of individual mechanisms while compensating for their weaknesses through the use of additional and complementary instruments*" (Gunningham & Sinclair, 1999, p. 49). Besides these opportunities, such mixes of policy instruments carry the risk of negative interaction effects and thus require careful analysis.

[3]EU countries, for instance, have continuously set targets since the 1990s to "*promote sustainable forest management (...) globally*" (European Commission 2013a, p. 13; similarly European Commission 2003, p. 1)

measures used for this cross-border purpose up to now. Section 9.3 analyses the problems which are faced by each of the policy instruments when they are used in isolation, before section 9.4 suggests a way of combining them. Section 9.5 analyses whether this combination of instruments enables more efficient forestry protection than the sum of policy instruments alone, followed by the conclusion.

Global externalities from forest ecosystem services

Also countries that do not have significant forests themselves have an interest in supporting the protection of global forests because the benefits of these forests are globally shared. Global forest services can be classified as *resources* (industrial wood, fuelwood, non-wood forest products), *amenities* (spiritual, cultural, historical), *biospheric reservoirs* (biodiversity, climate stabilisation), *social* (sports fishing/hunting, recreation, ecotourism) and *ecological services* (water, health and soil protection) (Shvidenko *et al.*, 2005). As a result of these non-market services, "*forest degradation through over-exploitation generally implies an economic cost far beyond the loss of timber production potentia*l" (Leruth *et al.*, 2001). Part of these forest services are global externalities which accrue to countries other than those hosting the forest, thereby justifying a sharing of costs for the maintenance of the forests. Here we list the two most important sources of these external benefits.

Climate Globally, forest biomass stores over one trillion tonnes of CO_2 (Nabuurs *et al.*, 2007), so there is a large stock even compared to the current total flow of greenhouse gas emissions of about 40 billion tonnes CO_2 annually (IPCC, 2014). All countries have an interest in avoiding the release of this stock of carbon into the atmosphere, which is however currently happening at a rate of 6 billion tonnes per year (Mendelsohn *et al.*, 2012).

Besides forests as sources of emissions, their cross-border importance arises from their role as emission sinks. Forests currently sequestrate one quarter of anthropogenic carbon emissions, and do so much more cheaply than other mitigation technologies (Eliasch, 2008; Golub *et al.*, 2009; Kartha & Dooley, 2015; Nabuurs *et al.*, 2007; Rose *et al.*, 2012; Stern, 2006).

Biodiversity Forests are the world's largest repository of terrestrial biodiversity; tropical rainforests account for between 50 % and 90 % of land species (CBD, 2010; World Resources Institute, 1992). Contingent valuation studies suggest that these species have a large intrinsic and non-use values to humans in general (OECD, 2001), including in developed countries for far-away forests (Navrud & Strand, 2013). Besides these non-pecuniary externalities, all countries share in the consumer benefit from commercial uses of forests, which include biotechnology (Alho, 2008). For example, 25-50 % of new medical products and pharmaceuticals are derived from genetic resources which are largely dependent on biodiversity (Barthlott *et al.*, 2005, p. 276).

Box 1: Benefits from forest protection are shared across countries, justifying an interest of countries in protecting forests outside their borders.

9.2 Status quo

9.2.1 Need for cross-border measures

9.2.1.1 Carbon leakage

The natural starting point for a country eager to raise global forest protection is its own forests. Nevertheless, since timber products are traded internationally, protecting only the forests within a given open economy may give rise to carbon leakage. As the price of domestic timber products rises with increased requirements for their sustainable production, consumers may substitute those domestic products with cheaper imports from unsustainable forestry overseas. A proportion of the country's efforts at raising the overall sustainability of forestry products is then lost. This loss may be large. For greenhouse gas mitigation from the forestry sector, estimates range from 23 % (Meyfroidt & Lambin, 2009, p. 16143), 20-40 % (Murray *et al.*, 2004), 71-85 % (Nepal *et al.*, 2013), 45-92 % (Gan & McCarl, 2007) to above 100 % in particular regions (Boer *et al.*, 2007; Haim *et al.*, 2015). To overcome this problem, a country that raises the sustainability of its own forests must simultaneously also deal with the forestry sector in other countries, either directly or through its imports from those foreign producers.

9.2.1.2 Coverage

Imports are of further importance for many developed countries, whose own forests tend to be small relative to their significant domestic market demand for forest products. Due to the importance of imports in these countries, to make a difference in global forest protection, these countries must supplement any measures protecting their own forests with a trade policy that influences the state of forests overseas.

9.2.2 Barriers to action

The fundamental problem in dealing with foreign production standards is "extraterritoriality". "Extraterritoriality" is the legal limitation of countries wishing to enforce policy outside their own borders, such as the limitation of countries importing timber to directly enforce forest protection standards in timber-exporting countries.

A related problem is the lack of available data. To provide efficient incentives to overseas producers of forestry products, as well as to enforce most policies, data on the sustainability of those products would be required. However, that data is not available to governments in the destination markets, given their legal inability to access the overseas production sites. Even if raising this data was legal, for example due to bilateral agreements with the overseas government, it may come at significant administrative cost.

9.2.3 Arsenal of instruments

Given these constraints, countries with large end-consumer markets for timber have tried four main classes of policy instruments: expenditure policies, taxes, sustainability certificates, and bans.

Expenditure policies have been used to directly change the market of origin of overseas forestry products, by providing overseas forest owners with financial rewards for changing production standards. This expenditure can come either directly from the governments of the timber-importing countries or from corporations in those countries. In both cases the payment may be provided in return for emissions credits, potentially reducing the importing country's or the corporation's climate change mitigation duties under an emissions cap. The Kyoto Protocol's Clean Development Mechanism (CDM) and the post-2005 UN mechanism for "Reducing emissions from deforestation and forest degradation" (REDD+) are the leading examples for this first category of instruments.

Bans and taxes do not directly change the overseas production standards. Instead, they provide indirect incentives by regulating the terms under which overseas forest products can be sold in the acting country's market. A country might ban or tax the production and import of illegally or unsustainably logged timber. An example is the EU's system FLEGT, which bans illegally logged timber from its common market.

Sustainability certificates are labels that private agencies issue to participating forest owners which agree to abide by a set list of standards and prove their compliance in audits by these agencies or their accredited certification bodies. The label is displayed on the timber product, in the hope that consumers with preferences for sustainable production practices pay a higher price for the certified products.[4] Sustainability certificates – like bans and taxes – modify the terms of market access, thereby providing indirect incentives for domestic and overseas timber producers to improve their standards. The leading examples for sustainability certificates are the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC) which issue one forest management label each.

These four instruments circumvent some of the barriers to cross-border forestry policy, but – on their own – each instrument also has limitations. In section 9.3, we will analyse the problems of each instrument in isolation, before section 9.4 considers the joint properties of a combination of instruments.

9.3 Problems of existing policy instruments acting in isolation

9.3.1 Expenditure policies

The policy instrument for cross-border forest protection that is most firmly anchored in UNFCCC climate change negotiations is expenditure policy. Under the 1997 Kyoto Protocol's instrument CDM and the REDD(+) mechanism introduced to climate negotiations in 2005 (Papua New Guinea & Costa Rica, 2005), governments or corporations in developed countries pay money to state or corporate partners in developing countries, and those recipients, in turn, expend funds for lowering the emissions from their domestic forestry sectors (UNFCCC 1998; 2016, Art. 12). Although these mechanisms mark a breakthrough after decades of international negotiation for price-based forestry policy (Angelsen *et al.*, 2012; Kuik, 2013), they are troubled by challenges. These challenges feature in the REDD+ literature;[5] here we focus on a subset of these challenges for which section 9.4 will

[4] Timber products are credence goods – empirically, many consumers consider the sustainability of the production process as a relevant product characteristic (Aguilar & Vlosky, 2007), but they cannot discover this characteristic by themselves even after purchase. Without labelling, the absence of the valued characteristic depresses the purchasing price (Akerlof, 1970).

[5] Summarised, for example, in Angelsen *et al.* (2014); Gupta *et al.* (2013); Voigt (2016).

identify potential remedies that become available when combining expenditure policy with other policy instruments.

9.3.1.1 Cost

"*Exploiting the full potential of REDD requires funding at unprecedented levels*" (Dutschke *et al.*, 2008, p. 52) from developed countries. While these costs are economically well-justified,[6] their funding faces political challenges. REDD+ raises a need for additional public expenditure at a time when many developed countries are struggling with a public debt crisis, and coincides with other multilateral agreements for developed countries to provide climate-related funds to developing countries. Developed countries are to provide USD 100 bn per year for climate change mitigation and adaptation to the Green Climate Fund (UNFCCC, 2009) and USD 10 bn by 2020 to support, for example, the Africa Renewable Energy Initiative for technology development (UNFCCC, 2015). These funding pledges are already in doubt,[7] even without adding forestry to the list of expenditure. This situation creates a risk for the long-term political sustainability of the additional REDD+.

Supporters of a "market-based" REDD+ suggest lowering this need for public expenditure by funding the programme through the sale of "offsets" in emissions trading schemes (Angelsen 2006; Angelsen *et al.* 2014, p.33; Neeff & Ascui 2009; California Air Resources Board 2015). Similar to the CDM programme previously, forest owners in developing countries or their governments would market their emissions reductions in the form of tradeable certificates which companies in developed countries could buy as substitutes for complying with their domestic climate change obligations. Although the policy debate on "market-based REDD+" is focused on the carbon market as a source of funding (Anger *et al.*, 2012; Nimz

[6] Meta-studies on the cost-benefit relation of REDD+ are largely positive. "*Even high end estimates* [for the cost of mitigating climate change through lowering emissions from the forestry sector] *compare favourably with the cost of most other mitigation options*" (Angelsen, 2008, p. 4), although these cost advantages vanish if the mechanism is not well designed (Lubowski & Rose, 2013). The cost effectiveness is further improved if REDD+ also realises gains in non-carbon forestry services.

[7] Whereas developed countries claim to be on track in fulfilling their financing pledges for the Green Climate Fund (Group of 19 Bilateral Climate Finance Providers, 2015; OECD & CPI, 2015), developing countries and NGOs have claimed that the existing contributions fall far short of the amounts promised (CAN 2015; Dasgupta 2015; Deng 2015; Upton 2015; Pons-Deladriere 2015; Vidal *et al.* 2015; Network of 112 NGOs 2014; 2015). Which view prevails depends strongly on the attribution of private climate finance to countries of origin (Westphal *et al.*, 2015).

et al., 2013; Peters-Stanley *et al.*, 2013), these offsets could also work without emissions trading schemes, as corporations could equally be allowed to deduct their payments for overseas mitigation activities from domestic carbon taxes or from renewable portfolio standards (Metcalf & Weisbach, 2012). At first sight, the use of offsets then provides a flexible way for developed countries to raise the sustainability of forestry in developing countries, which they could integrate into all of the main classes of domestic climate policies, without exerting pressure on public funds. The funds would simply come from private markets, seemingly alleviating the public funding problem.

On a closer look, however, REDD+ requires public funding even when offsets are used at full potential, and the policy remains costly. If a developed country funds REDD+ by allowing its corporations to deduct the overseas emissions reductions from their liability to pay for domestic emissions under a carbon tax, the offsets directly cost forgone tax revenue. Equally with a well-designed ETS that auctions emissions permits: the offset costs the same[8] forgone revenue from permit auctions. And if the offsets are deductible from a renewable energy portfolio standard, the government will need to strengthen its climate policy if it seeks to maintain its energy transition targets for which it set up the portfolio standard in the first place. In each case, the use of offsets as a funding source does not remove the maintained need for public funds.

These are concerns for the medium-term options to fund REDD+. The short-term outlook is yet more pessimistic. Available funding is falling far short of the expected cost of REDD+ (Birdsall *et al.*, 2015; Norman & Nakhooda, 2015) and almost all the existing financing comes directly from public revenues (ibid).

9.3.1.2 Coverage

The absence of sufficient funding may limit the supply of REDD+ in developing countries while their demand for REDD+ assistance is being systematically built up through REDD+ capacity development (readiness and demonstration) programmes (e.g., FCPF, 2013; UN-REDD, 2011). Meeting the excess demand for REDD+ assistance may then require rationing, reducing the coverage of global forestry to which the policy instrument can be applied. Without rationing, the rate of payment for emissions reduction under REDD+ may need to be reduced.

[8] If the tax and the cap are optimally set.

This limited coverage, and payments that are lower than the external benefits generated through emission reductions, thus creates a gap. There is thus room for alternative policy instruments to fill that gap.

9.3.1.3 Leakage

If REDD+ had complete coverage and emissions reductions were quantified uniformly and priced according to the marginal benefits of emissions reductions, the problem of cross-border leakage in the forestry sector could be greatly reduced (Kuik, 2013; Wunder, 2008). A global roll-out would establish a cap for emissions from land-use changes; so a country that raises the sustainability of its own forestry sector would not need to fear an offsetting degradation of forestry standards in another country.

As none of these desired outcomes for global forestry negotiations is in reach yet, carbon leakage is nevertheless still possible. For a developing country, non-participation in funding international REDD+ rules out using this instrument to reduce emissions leakage towards another developing country. And also a developed country that decides to increase its funding of REDD+ would have no assurance that the funding will reduce the amount of leakage for improvements in its own forestry sector. The recipients of the REDD+ will not be the causes of leakage, but leakage could still come from any of the remaining forestry plots worldwide that are not under a binding, verified emissions cap, backed-up by functioning domestic forestry policy. Given how far REDD+ is from its ideal end state, and given the funding problems that we have identified for ever reaching that state, leakage remains a risk.

The persistence of this risk even in the presence of REDD+ returns us to the questions we started with: what can a country willing to act in the absence of major progress in international forestry policy do today to reduce cross-border leakage from improvement in its own forestry sectors, and how can an individual timber-importing country undertake cross-border forestry policy? REDD+ appears to provide some of the answers, but not all, requiring other policy instruments to fill the gaps.

9.3.1.4 Sustainable forestry beyond climate change

These gaps also arise because REDD+ tackles only carbon emissions, whereas other dimensions of sustainable forestry – such as biodiversity losses – equally cause cross-border external costs. Again the question arises about what instruments an individual country can use to force overseas timber producers to internalise those costs. REDD+ aims to contain these external costs through "safeguards" (UNFCCC, 2011, Decision 1/CP.16). The meaning of safeguards in the REDD+ negotiations is still emerging (McDermott *et al.*, 2012), but if they are implemented in the form of minimum standards that a REDD+ project or policy must satisfy in order to receive approval,[9] then REDD+ at best provides truncated incentives for conserving forest co-benefits. As standards, in general, do not incentivise agents to do better than the minimum required (e.g. Requate, 2005), forest owners would not face dynamic incentives to keep improving once they have attained the standard. Consistently applying minimum standards would prevent the worst outcomes, and already represents a vast improvement over current policies, but leaves room for further improvement through additional policy instruments[10] which could add those dynamic incentives.

9.3.2 Taxes

9.3.2.1 Pigouvian efficiency

In principle, environmental taxation could be an alternative to expenditure policy, but using this measure is complicated by the extraterritoriality problem. The principles of Pigouvian taxation suggest that unsustainable timber should be taxed according to the damage caused towards wider society. Since unsustainable timber production in one country also causes damage to citizens in other countries (see Box 1), a tax for unsustainable forestry would internalise cross-border external costs.

[9] An example for safeguards as minimum standards are the REDD+ Social and Environmental Standards (SES, 2012). Similarly for previous uses of safeguards in development policy (e.g. World Bank Group, 2005).

[10] Such as combinations of REDD+ with additional Payments for Ecosystem Services (Gardner *et al.*, 2012; Karousakis, 2009) or through exploiting the potential synergy effects of existing policy instruments, which we proceed to analyse in section 9.4.

9.3.2.2 Extraterritoriality

In practice, such efficiency-inspired forest taxes do exist, but these policies are restricted to the domestic forestry sector inside the respective country and do not apply to imported timber. This is due to the legal restrictions on extraterritoriality which prevent a state from assessing the sustainability of foreign timber. Information from the countries of origin of forest products is needed to determine whether a product was sustainably sourced. This determination requires precisely the boots on the ground which timber-importing countries do not have due to the prohibition of extraterritorial law enforcement. Basic checks on a forest's existence and a few of its properties can be obtained without access to the territory, through satellite-based forest surveillance technology, but even the most modern surveillance systems, such as LIDAR,[11] require some data from closer distances for precision (GOFC-GOLD, 2014; McRoberts *et al.*, 2014). Generally, the large diversity of forests requires the determination of various space-specific characteristics that involve extensive surveillance plot-by-plot (Merry & Amacher, 2005, p. 23f.). Without that information, efficient tax rates could not be computed, and would thus not efficiently change the production incentives of overseas forest owners.

The information needed for calculating the external costs cannot be replaced by simple taxes on the mass of timber cut or the value of timber. One might think that, if the importing country has no data on the sustainability of timber, it might opt to instead tax the tonnage of timber imported. But while such a policy may provide an incentive to cut fewer trees, it provides no incentive for sustainable production techniques (Barbier & Burgess, 1994; Leruth *et al.*, 2001). Another alternative to tax timber in the absence of better data is through a charge on the timber's value. This policy would mimic the use of yield taxes which are popular for taxing domestic forest sectors (Amacher, 1997), including to reduce externalities (Amacher & Brazee, 1997; Englin & Klan, 1990; Koskela & Ollikainen, 1997). By decreasing profitability, a tax on timber value provides an incentive to reduce logging. However, on the external margin such a tax also "*has the perverse effect of encouraging the outright conversion of still viable (but degraded) natural forests into monocrop plantations*" (Leruth *et al.*, 2001, p. 416; equally Paris & Ruzicka, 1993). These unintended consequences may become even worse when timber is taxed

[11] Light Detection and Ranging technology, which uses airborne laser scanning to obtain data and to estimate the height, volume, biomass, and stand crown closure of the tree stand.

at progressive rates (Barbier & Burgess, 1994; Lippman & McCall, 1981; Mendelsohn, 1993). To be more efficient, a forest tax must take the sustainability of the timber itself as its tax base. Taxing proxies of the externality, such as timber mass or value, comes at a welfare loss (Sandmo, 1978). The tax rate must therefore directly vary with the sustainability of timber production. Unfortunately, this is not done. There are "*virtually none* [existing tax policies] *directly targeting non-timber benefits production from forest land*" (Amacher, 1997, p. 105). This failure arises because countries do not even have the required data on externalities for timber produced in their own jurisdictions, let alone for timber produced in other countries.

9.3.2.3 Sovereignty, property rights and state obligations

Besides these practical problems, the use of taxation for traded forestry products is contested by some legal philosophers who argue that wood-importing countries would generally have no justification for interfering with the production decisions in overseas forestry sectors. This "eco-imperialism" literature takes up the legitimate concern of developing countries contesting the continued intervention of past colonisers.

One strand of this literature argues that the sovereignty of timber-producing countries means that other nations have no legal right to interfere with domestic decisions over forestry management (Anderson & Grewell, 2000; McCleary, 1991). This is legally correct to the extent that timber-importing countries are not allowed to intervene in the internal affairs of other countries. States have *"the sovereign right to exploit their own resources pursuant to their own environmental policies*".[12] However, while safeguarding the sovereignty of timber-exporting countries, the sovereignty of timber-importing countries must also be respected. The sovereignty of the importing states means that they have the right to govern their own domestic markets, including the right to pass taxes and to apply them evenly in the domestic forestry sector as well as at the customs gate.

Economically, the use of taxes can even be required to maintain the sovereignty of nations in forestry policy. One reason is the existence of transboundary harms.

[12]This rule is upheld all across environmental treaties, from Principle 21 of the Stockholm Declaration 1972 to Principle 2 of the Rio Declaration 1992 and derivative treaties (preamble of the Desertification Convention 1994; Principle 1a of the Forestry Principles 1992; Article 3 of the Biodiversity Convention 1992; preamble of the Climate Change Convention 1992).

Unsustainable forestry in one state creates external costs for other states (see Box 1), undermining the sovereignty of other states in the sense of taking away their ability to control their borders ("interdependence sovereignty")[13] and their markets ("domestic sovereignty").[14] By internalising those external costs through Pigouvian taxes, the importing state regains these powers. The second case requiring taxes for the maintenance of sovereignty is emissions leakage. The systematic occurrence of leakage implies that timber-importing countries are not free from foreign interference in the governance of their forestry sectors (cf. Dietsch, 2015, p. 121; Ronzoni 2009, p. 248, p. 250). They face a pressure to keep the sustainability of their own forestry sector lower than they may otherwise prefer. The downward pressure on environmental standards caused by the leakage removes a people's self-determination of the sustainability of their domestic timber production. By reducing leakage, the taxation of the importation of unsustainable forest products restores the ability of each state to manage its own forests. Such a restoration of sovereignty has efficiency benefits described by the concepts of Tragedies of the Commons and Races to the Bottom: As states regain the ability to manage their forests without leakage, their power to exclude access to rivalrous forestry resources increases. Isolating domestic forests from leakage turns an open-access resource into a national club good, reducing pressures for over-exploitation. And as the use of taxes internalising environmental costs at the border reduces leakage effects, nation-states are enabled to compete on prices instead of on mutually harmful unsustainable production methods. This is a particular benefit to small countries who could otherwise not improve the terms of competition between nations.

Critics have also claimed that the property rights of timber producers forbid foreign interference with production standards. The argument goes that, because the property right over a forest includes the right to destroy, other countries must not penalise unsustainable forestry practices (McCleary, 1991). Only domestic regulators in the timber-producing state could intervene, as they define the extent of domestic property rights. Overseas governments would have to accept the consequences of production decisions taken by domestic timber producers exercising their domestically defined property rights. This argument overlooks, however, that for traded timber, the property right for the wood product is passed on to consumers. The state where these consumers are located can tax its citizens for

[13]Krasner (2001)
[14]ibid

unsustainable consumption. There is no conflict with property rights; the taxation just follows the same principles as for other domestic products with externalities, such as gasoline. A consumer is free to purchase gasoline and has full property rights over it, but the state may nevertheless tax the consumer to internalise the costs of pollution. Such a Pigouvian tax restores – not contradicts – the protection of property (of others), as it internalises external costs.[15]

The imposition of environmental taxes on unsustainable forestry products has also been criticised as a violation of free competition (Anderson & Grewell, 2000; McCleary, 1991). These critiques ignore that the very foundations of free-market economics require that all exchanges are voluntary, between freely consenting trade partners, without forcing third parties to pay for external costs arising from the transaction.[16] As unsustainable forestry causes these external costs, Pigouvian taxes restore free competition rather than inhibiting it.

Another critique has been that timber-consuming states may lack the ethical legitimacy to interfere with the production techniques used by timber-producing states (McCleary, 1991). Principles for the ethical legitimacy of state action are notoriously controversial between different schools of thought, but it is widely agreed upon that a state may legitimately act on a problem if it either suffers from[17] or contributes to[18] the problem itself. A country has a legitimate interest

[15]Economically, a non-pecuniary externality (of the type for which the victim does not contribute to causation; see chapter 4) is a forced transfer like an expropriation.

[16]The First Fundamental Theorem of Welfare Economics, which shows that a free market generates a Pareto-efficient competitive equilibrium, requires that external costs are internalised (e.g. Arrow, 1951; Lerner, 1934; Lange, 1942). The very idea of forcing third parties to bear the cost of an exchange contradicts the idea of a free market. Besides, "*It is unjust that the whole of society should contribute towards an expense of which the benefit is confined to a part of the society.*" (Smith 1776, section 1.4) "*In the race for wealth, and honours, and preferments, [man] may run as hard as he can, and strain every nerve and every muscle, in order to outstrip all his competitors. But if he should justle, or throw down any of them, the indulgence of the spectators is entirely at an end. It is a violation of fair play, which they [society] cannot admit of.*" (Smith 1759, section 2.2.2).

[17]Based on the Right to Protect.

[18]Every state has "responsibilities to protect its own people and avoid harming its neighbours" (UN Secretary General's High-level Commission on Threats, Challenges and Change, 2004, p. 17), constituting "sovereignty as responsibility in both internal functions and external duties" (International Commission on Intervention and State Sovereignty, 2001, p. 13). The responsibility on states to take action to prevent the imposition of harm on other states includes environmental obligations, such as "eliminating unsustainable patterns of production and consumption" (Rio Declaration, principle 8) under the general agreement of states to pursue sustainable development (UN General Assembly, 2015, para. 54; Rio Declaration, para 1-27). Whereas the legal force of these environmental duties of states towards mankind is only emerging (e.g., Schrijver, 1997, p. 239ff.; 2002; 2008, p. 208ff.), they do provide legitimacy for states acting upon them.

in minimising harm to its own population as well as harm originating from its own population. Legally, states are under the obligation to "*ensure that activities within their control do not cause damage to the environment of other states*".[19] Economically, activities in one's control may occur overseas. A timber-importing country financially supports overseas timber productions, and thereby shares in the causation of the overseas timber production, including its production standards. Unsustainable timber production as a commercial activity occurs because there is a demand for it; the state from which this demand originates, therefore, holds an economically defined control. Third-states, as opposed to those states which are importing and exporting the timber, are suffering from the importing state's financing of unsustainable timber production. If the importing state does not act, it does "*cause damage to the environment of other states*" (ibid). The importing state accordingly has a legitimate interest that its own consumption should not contribute to the causation of damages to humanity. Consequently, it can legitimately take action, not by directly intervening overseas but by altering its own participation in the causation of overseas harms by changing its consumption patterns through domestic tax policy.

9.3.2.4 Balancing current and historical responsibilities

Taxes do, however, have the downside of embracing an ahistorical view of global forestry problems. Today's deforestation is concentrated in developing countries because many developed countries cleared their forests long ago (Mather, 1992). Both current and past deforestation contribute to today's precarious state of climate change and biodiversity losses. A first-best Pigouvian solution would have required taxing deforestation both then and now. Given that we cannot change past policy, the remaining second-best policy should at least be to mitigate current deforestation. The optimal choice of policy instruments for this second-best mitigation action can be understood through two worldviews. One worldview is that countries deforesting today impose an external cost on the world; so they should face a Pigouvian tax to internalise the incentive to protect these forests. The alternative view is that countries which still have significant forests today are providing an external benefit to the world; on which other countries that

[19]Legally, see Stockholm Declaration 1972, principle 21; Rio Declaration 1992, principle 2; Desertification Convention 1994, preamble; Forestry Principles 1992, principle 1a; Biodiversity Convention 1992, Art. 3; Climate Change Convention 1992, preamble. Philosophically, see Perrez (1996).

cleared their forests in the past are free-riding (McCleary, 1991; Whalley & Zissimos, 2001). The free-riders should then provide subsidies for protecting the remaining forests overseas. At first sight, these two worldviews contradict each other; on a closer look they are both simultaneously true if one considers that deforestation today would still cause external costs even if past deforestation had not taken place. Past deforestation adversely affected the marginal cost of current deforestation, since the marginal cost of deforestation rises with the scarcity of forests[20] – but even in the absence of past deforestation, cutting forests still releases greenhouse gases and reduces ecosystem services, so marginal external costs still exist. Accordingly, Pigouvian taxes on current deforestation are justified despite their absence during past deforestation. Additional to taxation, however, countries which deforested their land in the past must compensate those that preserved their forests. The optimal policy mix then uses both tax and expenditure policies jointly. Using both instruments together can provide efficient incentives containing current deforestation and a fair share of the burden reflecting the differentiated responsibility of countries for past deforestation.

9.3.3 Certificates

Sustainability certificates are comparable to taxes in that they may modify the prices that forestry products can command in the end-consumer market. Sustainability certificates, by contrast, do not face the same information problems as taxes, because the agencies issuing the certificates do have access to the overseas production sites of their participating forest owners, unlike the taxman of timber-importing countries. These advantages of sustainability certificates, unfortunately, come with downsides as well.

9.3.3.1 Free-riding

Consumers are free to ignore sustainability labels. Those who do can free-ride on the efforts of other, caring consumers. Free-riding itself can have knock-on effects: Experimental evidence demonstrates that people who would, in principle,

[20] For deforestation, as for any activity emitting greenhouse gases, the marginal Social Cost of Carbon rises in the concentration of greenhouse gases already present in the atmosphere (US-IAWG, 2013). Similarly for biodiversity, the marginal cost of destroying a species' habitat rises when previous habitats of the same species have already been destroyed so that they risk extinction.

be willing to behave ethically choose not to do so when others free-ride on their efforts (Bicchieri & Xiao, 2009; Fehr *et al.*, 2002; Raihani & Hart, 2010). As for labels in other markets (Carlsson *et al.*, 2010; Noblet *et al.*, 2006), consumers of timber products may choose not to purchase a certified wood product because they dislike other consumers free-riding on their efforts (Lippert, 2009).

9.3.3.2 Divergence of price premia from external benefits

The willingness of consumers to pay higher prices for a product with a sustainability certificate may stand in no relation to the external benefits of that product. A product may create large or small benefits to society, but the price premium that consumers collectively choose to pay could be lower or higher than those external benefits; there is no arbitrage mechanism for the two to coincide.

9.3.3.3 Fixed costs, coverage problems, and entry foreclosure

Forest owners face fixed costs when they join certification schemes (e.g. Nussbaum & Simula, 2005, p. 200f.). These fixed costs come from the need to make upfront adjustments to their production standards and from the transaction costs of having to prove to certification agencies that their timber production meets the certificate's criteria. Production practices on many forest plots in timber-exporting developing countries can be far below the minimum sustainability practices required from certification agencies like FSC to enter into sustainability certificates (Auld *et al.* 2008; McDermott *et al.* 2007; Pattberg 2005, p.366, Nussbaum & Simula, 2005, p. 182; Gullison, 2003). Within each region, "*FSC has chosen the approach of a single, high threshold standard*" (Bass, 2002, p.5). The adjustments needed for sub-standard timber producers to access certification schemes can then require a Big Push – a large one-off adjustment to the minimum required sustainability level. For small timber producers, these fixed costs can be substantial relative to the commercial gain from selling certified produce (Gullison, 2003), which strongly depends on the size of output (de Camino & Alfaro, 1998, p. 9). This barrier can be exacerbated by credit constraints (Lee *et al.*, 2011, p. 2514), particularly in the remote regions of developing countries where forests are concentrated and where capital markets are particularly thin. As a result, small timber producers in developing countries can be disincentivised from joining sustainability certification systems. Accordingly, small forest owners are left out of almost all forest certification arrangements (Linforth, 2013; Nussbaum *et al.*, 2000). This problem lowers the share of the timber market that sustainability certificates can cover in developing countries. Presently, only 17 % of FSC-certified forests and 7 % of PEFC-certified forests are located outside Europe and North America (FSC, 2014; PEFC, 2014) despite the fact that these agencies do offer their services globally.[21] FSC is addressing this problem by allowing qualifying smallholders to adopt certification over a transition period (Linforth, 2013), which can reduce the entry barriers (Simula *et al.*, 2002), but does not remove them. Since there remains only one FSC management certificate constituting "sustainable forestry", this phased approach only allows giving some forest owners extensions for reaching this single, high threshold. The fixed costs attached to attaining that threshold can then be spread over a few years. The threshold itself remains. Fundamentally, with a single certificate known to consumers, the threshold cannot be reduced for individual producers without lowering "*the incentive to move up to the top level of performanc*e" (ISEAL, 2011, p. 28). The entry barriers for joining these certification schemes then raise doubts over the extent to which sustainability certification in its current form can address cross-border environmental problems.

9.3.3.4 Dynamic incentives

There is consequently a market failure in the low-end of forest sustainability certification because small and less-developed forest owners would need to make adjustments with such large fixed costs that they have incentives to, instead, just abstain from certification altogether. Additionally, there is a market failure in the top-end of forest sustainability certification. Certification agencies such as FSC need to weigh the costs of further increasing their standards with the damages from losing even more of the low-quality market. Environmental organisations point out the need to progressively raise sustainability standards to support continuous improvement,[22] but if the certification agency does evenly increase its requirements for all producers, it further raises the entry thresholds. Without a regular increase in standards, however, those forest owners who have already raised their standards up to the FSC level face no dynamic incentives to keep improving.[23]

[21]FSC in 80 countries, PEFC in 30 (FSC, 2014; PEFC, 2014).
[22]Debate on increasing FSC Principles & Criteria (e.g., Greenpeace, 2014b; Feilberg, 2008)
[23]As for certificates in other markets (cf. Wüstenhagen, 2000, p. 264f.).

9.3.3.5 Competition among certificates

Some authors suggest that the improvement of forest sustainability requires the introduction of low-quality sustainability certificates with lower entry standards to co-exist with high-quality certificates. The end-consumer would then be presented with timber products carrying a range of certificates of different stringencies. The problem of threshold costs could diminish as even timber producers starting off from low sustainability standards would have a low-level certificate in reach. Moreover, the problem of dynamic incentives could equally improve: timber producers that have already attained a sustainability standard would face an incentive to keep improving to reach a more advanced certificate. This system of competing sustainability certificates could provide efficient incentives if consumers did have a finely differentiated willingness to pay for products carrying certificates of different stringencies.

Empirical evidence points out, however, that consumers react to multiple labels by ignoring labels altogether (Martínez, 2013; Spenner & Freeman, 2012). Ben Youssef & Abderrazak (2009) confirm this finding theoretically for cases where incomplete information persists after the introduction of sustainability certification, which is generally the more realistic setting (Bonroy & Constantatos, 2014). Even with just two labels in a market, sustainability may already be reduced unless the labels are so different as to, effectively, compete in separate markets (Fischer & Lyon, 2014). With unlabelled products and two labels of varying quality, resulting consumer confusion benefits the producers with the lesser quality label as consumers do not differentiate between products of different sustainability standards but just consider whether a product bears some form of a label at all (Brécard, 2014). Therefore, as the commercial power of any existing forest sustainability certification depends on its consumer recognition, and as consumers are not able to adequately differentiate between the different sustainability standards, their demand is not sufficiently differentiated to provide efficient price signals to timber producers. A differentiation of certificates would undermine the value of having a certificate at all because only a niche section of consumers would be willing to invest the time to find out the differences between the competing certificates.

With the current form of sustainability certificates, the market of certification agencies then does not work more efficiently with greater competition. Without competition, however, the oligopolists dominating this market – FSC and PEFC – face limited commercial pressure to offer low-priced certification services.

9.3.4 Bans

We have seen that expenditure policies, taxes and certificates are each highly complex policies. By contrast, a seemingly simpler and cheap option to influence overseas forestry practices is to ban the production and imports of timber falling below a specified sustainability standard, such as illegally logged timber.[24] The clout of a market foreclosure on overseas producers hinges on the size of that market, so countries with large timber imports could leverage their position as end-consumers markets for political influence; aggregate consumer demand then yields state power for cross-border forestry policy.

9.3.4.1 Extraterritoriality and WTO compliance

The scope for applying regulatory policy to foreign forestry practices is, however, limited by international law. Unless they are integrated into complex multilateral policy regimes, simple bans for importing illegal timber are hard to enforce due to the restrictions of extraterritoriality, and violations of trade law. The problem of enforcement arises because, even where countries have jurisdiction for banning the import of illegally logged timber, they do not have jurisdiction for verifying the legality of the harvesting in the countries of origin. The burden of proof for banning the import of timber is on the customs authority that asserts the timber's illegality (Lawson & MacFaul, 2010), and the customs authority simply does not have the necessary information. Besides this practical problem, simple bans would violate trade law. Even if domestic forestry products were generally "sustainable" with foreign forestry products being generally "unsustainable", GATT/WTO rules of non-discrimination would treat them as "like products", disallowing discriminatory treatments based on process and production methods. Even simple trade restrictions on illegally logged wood violate GATT / WTO rules (Jinji, 2007).

[24]In the major timber producing tropical countries, illegal logging accounts for 50 to 90 % of total harvested forest volume (Magrath *et al.*, 2009), 15 to 30 % of global forest production (ibid). This problem is not unique to particular countries of origin. For the Brazilian Amazon, 35-72 % of timber is harvested illegally, compared to 22-35 % in Cameroon, 59-65 % in Ghana, 40-61 % in Indonesia and 14-25 % in Malaysia (Lawson & MacFaul, 2010). In the Democratic Republic of the Congo, almost 90 % of logging is illegal (Lawson, 2014). This is a large business – estimated between USD 30 - 100 billion (Luttrell *et al.*, 2011), supported by the ability of loggers to export the illegal products to international markets, particularly China and developed countries (Nellemann, 2012).

Both of these problems can, however, be circumvented when bans are integrated into more complex policy frameworks, although bans then lose some of their cost and simplicity advantages. Legally, it is possible for the government of a destination market to ban the import of illegally logged timber through bilateral agreements, under the condition that the regulations are applied equally domestically (Brack, 2008, 2013; Hudson & Paul, 2011). The European Union, the United States and Australia were able to effectively[25] establish bans on the production and import of illegal timber through regulatory law applicable in their internal markets (internal in the sense of Art. III GATT) requiring companies placing the timber onto these internal markets (through domestic production or import) to exercise "due diligence" that the timber was not illegally sourced. This arrangement makes use of the fact that the restriction of extraterritoriality is part of public law, not contract law. Companies, unlike states, are not bound by extraterritoriality restrictions on their overseas fact-finding regarding production standards. Applying the same bans on illegal timber for domestic production and imports further ensures non-discrimination of overseas producers, which is required for WTO compatibility (Barbier, 1996), even if for some developed countries which do not actually have a problem of illegal domestic timber production the internal application of such a policy may just increase costs without creating extra environmental benefits.

Besides the requirement of due diligence, the European Union reduces the enforcement problems of extraterritoriality and WTO compatibility through a network of bilateral treaties, the Voluntary Partnership Agreements (VPA), in which timber-producing countries explicitly allow these measures.[26] Through bilateral agreements on Legal Assurance Systems with the timber-producing countries, the EU gains the ability to verify the legality of overseas production,[27] greatly reducing the data problem of extraterritoriality. To provide overseas partners with incentives to adopt these measures, the EU grants timber products checked and licensed by these Legal Assurance Systems (with so-called FLEGT licenses) direct access to the EU market. European companies may import this timber without the usual requirement for exercising due diligence. This exemption is meant to

[25] "*For the first time there are potentially real consequences for not demonstrating legality when trading in timber*" (Othman *et al.*, 2012, p. 110; see also European Commission, 2016).

[26] Conferring protection against WTO complaints since "*it is inconceivable that a country would mount a WTO challenge, on the basis of impairment of trade, to a voluntary measure to which it had itself agreed*" (Brack, 2013, p. 8).

[27] Albeit mediated through domestic private monitoring agencies.

provide this licensed timber with a competitive advantage over timber from other countries that do not introduce these Legal Assurance Systems and whose timber can then only be bought by EU companies if those companies ensure the legality through Due Diligence Systems.

9.3.4.2 Due Diligence as a backstop default penalty

The two elements of the EU's ban – due diligence and VPAs with Legal Assurance Systems – are therefore interdependent. VPAs are the preferred instrument for implementing the ban, since they directly improve overseas production standards, directly remedy the problem of unavailable data and provide an added layer of certainty for trade law compliance. However, for VPAs to be attractive for overseas governments, the alternative system of due diligence may not be too attractive for European companies (Overdevest & Zeitlin, 2013). If exercising due diligence is cheap – for example due to weak enforcement of this requirement or low penalties in the case of detections of negligence – this reduces the incentive for companies in Europe to pay a premium for wood licensed under a Legal Assurance System (cf. Overdevest & Zeitlin, 2013).

Unfortunately, precisely this problem exists. In many EU member states, the requirement for due diligence is weakly and unevenly enforced (European Commission, 2016; Gavrilut *et al.*, 2016), the minimum requirements for the systems that corporations need to create for carrying out these due diligence checks are unclearly defined, and there are low penalties for violations (ibid). Accordingly,[28] none of the countries with which the EU agreed VPAs has as yet an operating Legal Assurance System (European Commission, 2016); such systems are developing only very slowly (Overdevest & Zeitlin, 2013). As a result, no timber arrives in the EU with legality (FLEGT) licenses that would remove the importing corporation's requirement for due diligence. To remedy these perverse incentives, EU member states would need better enforcement of their due diligence requirements (European Commission, 2016), which raises the question of whether there are policy instruments that are presently under-used which could help enforce these rules.

[28]But not as the only reason. See below.

9.3.4.3 Compliance cost and competition between large and small timber importers

A naive method for raising the expected demand for FLEGT-licensed wood would be to raise compliance costs of due diligence requirements. This would not be an efficient policy, however. On the contrary, even though due diligence appears to be cheap for some actors, small and medium-sized companies are reporting significant compliance costs (European Commission, 2016).[29] This raises the question again of whether the implementation of bans should make use of additional policy instruments to spare companies the costs of Due Diligence Systems.

9.3.4.4 Governance issues

Besides price incentives, the development of Legal Assurance Systems in VPA countries is also upheld by governance problems. As these problems continue, the default policy that the EU adopts in the absence of FLEGT licenses is the due diligence requirement. But it is difficult for EU companies to ensure that their wood is not from illegal sources in precisely the same countries where the governance problems have prevented the setup of a Legal Assurance System. For a policy instrument to function as the default backstop in case another policy instrument fails, the two should not struggle in the same places.

9.3.4.5 Monopoly power of licensing systems

Even when Legal Assurance Systems become available, there is no guarantee that they will function optimally. In a marketplace, the usual mechanism to guarantee the efficient functioning of a service provider is competition. But under the current system, there is no direct competition for Legal Assurance Systems providing FLEGT licenses.

9.3.4.6 Licensing in non-VPA countries

The EU recognises that some timber-producing countries will abstain from VPAs (European Commission, 2016). Forest owners in those countries may, however,

[29] And similarly for due diligence policies in related markets (cf. European Commission, 2014b).

disagree with their government and seek to adopt the EU's legality standards (the same standards that would be expected for receiving a FLEGT license from the Legal Assurance System of a VPA country). There should then be a route for those overseas producers to have the legality of their timber FLEGT-licensed through some other mechanism than a VPA Legal Assurance System. Otherwise, foreign producers in countries lacking a VPA would have no option to provide accepted legal timber without the burden of due diligence requirements for their produce. Allowing a private route towards FLEGT licenses for such overseas producers would level the playing field between like producers, potentially improving WTO compatibility under the Most-Favoured-Nation rule, and, in any case, freeing up competition.

9.3.4.7 Resulting gaps

Each of these shortcomings points to a potential role for other policy instruments to fill gaps in the implementation of the existing ban on illegal timber, in the EU as in other timber-importing countries.

9.4 Suggested combination of policy instruments

Section 9.3 identified shortcomings in the main instruments for cross-border forestry policy – expenditure policies, taxes, sustainability certificates, and bans – when those instruments act in isolation. In this section, we will analyse whether the instruments can be fitted together in a way that overcomes their individual weaknesses, and combines their strengths.

9.4.1 Combining certificates with bans for illegal timber

9.4.1.1 Applicable countries

To show how the suggestions compare to current legal frameworks of large timber importers, we focus on the EU's system. The suggested mechanism is, however, applicable more widely for countries with sufficient administrative capacity and large consumer markets, in particular for the United States, Australia, Switzerland and China, given their existing or planned bans on illegal timber.

9.4.1.2 Mechanism

Under the current EU policy, timber may only enter the EU common market directly if it holds a FLEGT license from a public Legal Assurance System. For all other timber, importing companies in the EU must maintain due diligence systems. We recommend that the direct market admission should be extended to include private certificates, such as FSC and PEFC, on the condition that those private certificates undertake legality checks that go beyond the stringency of legality checks expected from public Legal Assurance Systems. If this condition is fulfilled, timber with this private legality-certification should be granted direct market access, substituting requirements for Due Diligence Systems. This policy should be applied to all imported wood, including from VPA countries, but in particular also from non-VPA countries. The private certificates should be allowed to take the form of sustainability certificates which include eligible legality checks for forest management and chain-of-custody control, as well as private certificates that only check the legality without testing for sustainability. Both public FLEGT licenses and private certificates confirming legality should be contained in Bills of Lading but not be openly visible as labels to end-consumers.

9.4.1.3 Effects

Granting this direct market access to timber carrying these private certificates avoids double work. Timber importing companies would be able to avoid unnecessarily incurring costs for due diligence when private certificates such as FSC already include due diligence. Timber producers who have already invested in having the legality of their wood checked through private certification companies would not be required to undertake yet another investment into public FLEGT licensing of the same wood. Those timber producers who wish to go beyond the verification of legality to also have their sustainability checked would be able to receive both services in a one-stop-shop, rather than being required to interact with multiple bureaucracies.[30]

The public Legal Assurance Systems of VPA countries would receive competition

[30] This proposition would expand the existing practice of recognising FSC Forest Management certificates as "FLEGT-compliant" in Cameroon, which is also being considered for Indonesia (FSC, 2016). With this recognition, sustainability certification and FLEGT-VPAs would be mutually reinforcing (cf. Hinrichs & van Helden, 2012).

for their services, to provide checks and balances on the delivery quality of their bureaucracies and the cost of their FLEGT licences. There would also be consequences if Legal Assurance Systems continue to be delayed. This competition with private certification agencies would occur on fair terms due to the requirement for the private agencies to provide more stringent tests on legality than those expected from the public system. These requirements prevent potential adverse selection problems that could drive up the costs of the public system, which is required to audit all qualifying forest owners whereas private agencies could choose their contract partners (for example by only certifying timber in the most accessible regions). The requirement would furthermore maintain public systems as the default, to sustain the overseas governments' support for the VPA. Only private parties which can operate more efficiently than the overseas government's Legal Assurance System would enter this market, keeping down the number of such companies to exploit economies of scale in certification services.

Unlike today, there would be a FLEGT-compliant route for overseas timber producers in countries without a VPA to access the EU market directly. The EU thereby vests these timber producers with an interest in the continuation of FLEGT-compliant legality checks also in countries that are currently hostile to them. Creating such private supporters overseas could gradually build a political constituency for entering VPAs.

Granting direct market access to these non-VPA timber producers also has advantages for competition policy. It reduces the concentration of the market for legal timber in the EU and removes a non-tariff trade barrier (requirements for Due Diligence Systems for goods from select countries), thus levelling the playing field between private timber producers in countries with and without VPAs.

Lastly, there are public benefits to granting private agencies undertaking sustainability certification the power to grant private legality certificates on the same level as FLEGT licences. As legality certificates do not reward greater sustainability, there is a public interest in sustainability certificates continuing to be provided. Yet, to increase the market for sustainability certificates, the certification companies need to cover overheads such as the fixed costs of their presence in remote regions. By granting these agencies the power to provide FLEGT-compliant legality checks as part of their services, these overhead costs can be spread, thus helping to drive down the fixed costs of sustainability certification.

9.4.1.4 Limitation

Ensuring that bans on illegal timber are effective removes the worst incentives for overseas producers of exported timber. These are not dynamic incentives to keep improving the sustainability of timber, however. To provide timber producers with dynamically efficient incentives, either taxes or expenditure policy need to be added to the policy mix.

9.4.2 Combining certificates with fiscal instruments

Environmental taxes can provide these dynamic incentives, with the condition that the tax rate is set equal to the marginal external damage caused by unsustainable forestry. Equally, the dynamic incentives could be provided using expenditure policy, if the subsidies are set equal to the marginal benefits of more sustainable forestry. In both cases, however, the prohibition of extraterritoriality prevents the customs authority from accessing data on overseas timber production standards to compute the appropriate tax or subsidy rate. In addition, in the case of taxation, the customs authority does not have jurisdiction for imposing the tax overseas itself. Here we describe ways around the information problem affecting both instruments and the implementation problem affecting taxes. Since the problems for implementing taxes are harder to solve than for expenditure policy, and because expenditure policy faces the funding and efficiency problems mentioned in section 9.3.1, we focus our analysis on taxes.

9.4.2.1 Default tax on timber without sustainability certificates

When a timber product arrives at the customs gate without a sustainability certificate, it will be taxed on the assumption that the wood production was not sustainable. When a timber product arrives with its sustainability certified, the tax rate is reduced. The more stringent the sustainability certificate carried by the timber, the greater would be the tax discount.

$$\begin{gathered}\textit{Tax payment} = \textit{(Tonnes of wood imported)} \times \\ \textit{[(Default value of external damage per tonne of wood)} - \\ \textit{(Deduction for showing of sustainability certificate)]}\end{gathered}$$

For example, if the certification agency was the Forest Stewardship Council, it may provide the customs authority with the information that a given timber product was not only legally harvested (and thus qualifies for direct market entry) but that the product furthermore corresponds to the FSC sustainability standards. Through using the certification agencies, the customs authorities then gain detailed knowledge about the relative sustainability of a wood product, despite their legal and also financial inability to raise this data for all the timber imports themselves.

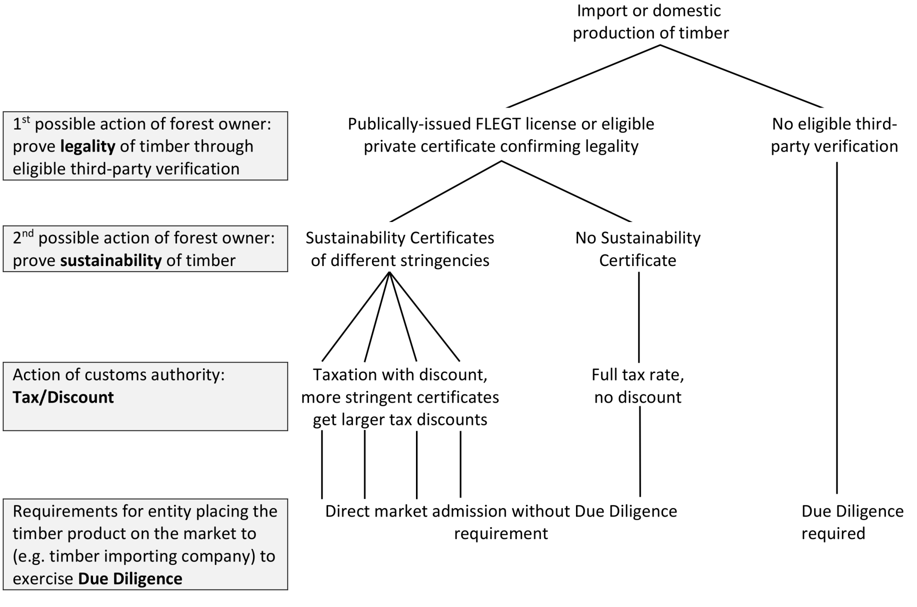


Figure 9.1: Proposed combination of policy instruments

A similar mechanism is possible using expenditure policy.[31]

[31] In this case, the wood-importing state grants the producers of sustainable timber a subsidy instead of a tax discount. As before, the fiscal policy could be combined with certification systems to solve the importing state's information problem regarding overseas production standards.

There would be no subsidy to a timber product that carries only a legality certificate, again on the assumption that the timber was not sustainably produced and accordingly did not generate external

9.4.2.2 Competition among sustainability certification agencies

The FSC would not be the only agency with the right to issue certificates documenting its verification that a forestry product was created in a more sustainable manner than the government's default value for the external damage per tonne of wood. Instead, there would be a competition among certification agencies for making such verifications. A competing agency could issue its own certification. The main remaining data problem for the customs authority is then to have a list ranking how the different certification standards of registered sustainability certification agencies compare to each other in the depth to which their mandated production practices internalise external damages. For example, the customs authority still needs to determine how the level of sustainability guaranteed by an FSC-certificate compares to the level of sustainability of a forest plot with a PEFC-certificate. So the customs authority still needs to take difficult decisions as to how different forest sustainability certificates available on the market should be graded, and how much tax discount should, therefore, be given for each forest sustainability certificate. However, this valuation needs to be done only once for each type of certificate and is hence a much more manageable task than the rating of the sustainability of each individual timber product. The forest sustainability certification agencies existent today have produced extensive descriptions of their standards, and there exist ample third-party verifications of these agencies,[32] so the data for the customs authorities' assessment of their relative stringency would be obtainable.

benefits. When timber products verifiably depart from that assumption, proving their sustainability through a sustainability certificate, the importing state provides a subsidy. The more stringent the certified sustainability standard, the greater the subsidy.

Subsidy payment = (Tonnes of wood imported) $\times$ *(Average external benefit per tonne of wood corresponding to the sustainability certificate presented)*

We return to the analysis of the mechanism using taxes, but unless otherwise indicated, each of the results of the analysis below also holds if the importing state prefers to use this expenditure policy instead of taxation.

[32] E.g. Greenpeace (2013a,b, 2014a,d,c); SRU (2012). Further examples of these third-party verification agencies can be found on the web list of FSC's certification bodies under the Accreditation Services International at http://www.accreditation-services.com/archives/standards/fsc

9.4.2.3 Overcoming limits on the tax authorities' ability to raise data on overseas production standards

In the procedure sketched, the customs authorities do not legally force anyone to reveal data on overseas production standards. Overseas timber producers have the free choice not to provide that information, and have their produce taxed at the default values. Economically, however, foreign timber producers face an incentive to reveal those production standards to certification agencies and hence to the taxing state. To fetch a good price when selling the timber to the importer, the producer has a strong incentive to provide the necessary certificates, particularly if the default rate of the tax without sustainability certificates is set sufficiently high. If commercial competitors of the timber producer do reveal their data and obtain the certificates, the timber producer can even be economically forced to follow suit. The customs authority is hence applying an economic pressure for timber producers to reveal data on their production standards where it does not have the jurisdiction to apply legal force for getting this data.

9.4.2.4 Jurisdiction to tax

To grant the customs authority the jurisdiction to impose the tax despite the restrictions on extraterritorial taxation, the legal tax liability would need to be imposed on the domestic timber importer, not on the foreign timber producer. Legally, this arrangement works because the timber importer is a domestic entity[33] and hence falls under the taxing state's jurisdiction. The importer would thus be taxable in lieu of the foreign producer of the timber.

9.4.2.5 Overcoming limits on the tax authorities' ability to provide a tax incentive to overseas timber producers

Attributing the tax liability to the domestic importer of the timber solves the legal extraterritoriality problem without distorting the incentives for overseas timber producers to raise the sustainability of their production up to a certified standard. This solution exists because, economically, it does not matter whether the tax liability is attributed to the overseas timber exporter or to the domestic timber importer. The tax incidence, in other words the proportion of the tax that an agent

[33] As is the case under the EU Customs Code (see chapter 7.4.3).

ends up paying after deducting the share of the tax bill that he manages to pass onto his transaction partners, is the same in both cases. The economic incidence of a tax that falls onto the transaction partner who faces the obligation to transmit the money is not changed by the legal attribution of the tax liability (Logue & Slemrod, 2010; Jenkin, 1871). If the tax were on the foreign timber exporter, that person would impose a proportion of the tax bill on his domestic transaction partner in price negotiations. Equally, if the tax is on the domestic importer, that person will negotiate a different timber price with his supplier and thereby pass on the same proportion of the tax. This is an application of the Coase Theorem (Coase, 1960) to Pigouvian taxes. Whereas economically the effects are the same, legally the change of liability makes all the difference and prevents the extraterritoriality problem. That problem is solved because, when the domestic importer imposes some of his tax costs onto the foreign timber supplier, that transaction is part of private contract law, for which there are no extraterritoriality constraints. This is unlike the counter-factual situation where the government directly imposes the same payment onto the foreign timber supplier, in which case the same payment falls into the domain of public international law and is prohibited. So changing the attribution of the legal tax liability solves a legal problem, without causing an economic cost.

9.4.2.6 Complimentary domestic policy

Both the policies on legality and sustainability would be applied to imported and domestically produced timber.[34]

[34] We started this chapter with the observation that for any country, the natural starting point for raising forest sustainability globally is its own forestry sector. We then identified the need to flank domestic policies with a mechanism to raise the sustainability of overseas timber, firstly to prevent leakage effects for the sustainability of internationally traded timber products and secondly to have the necessary clout to make a real difference if most deforestation happens overseas. Our focus in this chapter remains with the overseas timber, as domestic policy is legally and administratively a comparatively minor problem.

9.5 Synergies

9.5.1 Competition among multiple certificates enabled

We have suggested an extended role for sustainability certificates, as information sources on overseas production standards not only for consumers but also for customs authorities. It is worth recalling that with the previous role of certificates, the market for certification services could not be made more efficient by increasing competition. Since consumers are not able to adequately differentiate between multiple sustainability certificates, increasing the proliferation of competing certificates would erode the present function of certificates in informing ethical consumers, instead of confusing them. With the currently existing role of sustainability certificates, we had to accept an uncompetitive, concentrated market for sustainability certification services. Accepting this situation was hard because that lack of competing certificates itself came at a great cost as well.[35] Now, however, we have suggested an additional role for sustainability certificates in informing not just consumers but also tax authorities, and this new role does enable competition among an unlimited number of certificates.

With a greater number of certificates, the customs authority would just award different amounts of the tax discount for timber with these different sustainability certificates, given its ranking of the certificates' relative worth. Confusion over too many certificates is a consumer-specific problem; it does not arise for customs authorities. This is because assessing the relative worth of competing certificates requires sinking a fixed cost to acquire the necessary information. For a customs authority, that fixed cost is small given the high frequency of using the acquired information, whereas a consumer uses this information much more rarely and thus has an incentive to avoid the fixed cost and remain rationally ignorant about details of certificates. Consumers are presently the only users of the information

[35] In a duopoly market for certification services, timber producers can benefit from raising their sustainability only if they reach the sustainability required for one of these two certificates. Accordingly, timber producers starting off from sub-standard production practices face a large threshold cost to enter any certification and timber producers that already attained the higher certificate face no dynamic incentives to keep improving. Adding to this inefficiency, certification agencies face little competitive pressure to drive down their costs of service. Summing up, in the present market setting, competition would be costly for consumer recognition, while no competition is costly for incentives.

provided by sustainability certificates – when we enlarge this audience to customs authorities, we create a user group that can handle multiple certificates, and thus enable a more competitive market for certification services. Intensified competition creates incentives for certification agencies to reduce administrative and compliance costs.

Unlike before, each certification agency is now also able to issue more than one sustainable forest management certificate to cater for timber producers at varying levels of sustainability. Consequentially, as the market starts offering a greater diversity of certificates for different stringencies of sustainable production, a larger proportion of forest owners face a dynamic incentive to improve their sustainability because there exists a certificate in sufficiently close reach to make even a small improvement already bear some fruit. Previously, the discrete distribution of forest management certificates (a duopoly market consisting of two predominant certificates with one sustainability level each) made it necessary for producers to make big leaps in the sustainability of their production to acquire a certificate. As the range of competing certificates increases, approaching a continuous distribution over different sustainability stringencies, these big upfront changes to production techniques are not required any more. Producers starting off from low sustainability practices then face fewer problems with fixed costs for attaining their first sustainability certificate, while producers who have already attained higher sustainability levels receive an incentive to keep improving.

With the previous role of sustainability certificates, the price signal for timber producers was muted, since consumers were free to ignore the label. Those who did ignore labels and purchased unsustainable timber products were able to free-ride on the efforts of caring consumers for financing the public good of forest sustainability. The net Pigouvian tax, which the customs authority levies on timber products, reduces that ability to free-ride. The tax – and its certificate-driven system of discounts – internalise the external costs for all products; consumers have no ability to opt out. The previous incentive for opportunism terminates.

9.5.2 Complementing, not substituting, the previous role of certificates

The previous system of consumer labels was a private market solution to information problems. We now introduced a role for government, which may raise the common concern whether the new fiscal role of sustainability certificates may crowd-out the existing role of sustainability certificates as guides to consumers. The fact that also customs authorities would now use sustainability certificates should not inhibit their continued usage by consumers. Efficient joint usage is possible with the following precautionary measures.

The potential problem arises because of the different abilities of customs authorities and consumers to make use of multiple certificates. We want to use the ability of customs authorities to handle competing certificates for various sustainability levels, without that proliferation of certificates causing consumer confusion. One option to make this possible is to allow any number of certificates for the process of claiming the tax discount but to simultaneously restrict the number of certificates which are allowed to be displayed to consumers on products. In this case, the certificates would be treated just like other information that today is already communicated to customs authorities without being visible to end-consumers. This information includes documents such as Bills of Lading, which today accompany all imported cargo from their port of origin to their port of destination without becoming visible to the end-consumers. Bills of Lading contain a series of standardised information; and customs authorities could extend those contents by requiring that legality certificates and sustainability certificates are included in the Bill of Lading, not elsewhere, to be granted direct market access and the tax discount. The entry could take the same form as the existing MRN numbers of customs documents.[36] If the certification agency's legality and sustainability certificates were added to the Bill of Lading, the customs authorities and companies importing the timber would be clearly informed, without any need for that information to be displayed to end-consumers as a label on the product.

All certificates would be included in the Bill of Lading, but only the most high-ranking sustainability certificates would additionally be allowed to be included as consumer labels on timber products. This restriction has three justifications.

As the ban enforces the requirement for all timber imports to be legal, consumers would not get any added information from all products displaying their legality as consumer labels. The alternative of displaying FLEGT licenses and private legality certificates to consumers through labels would have negative consequences. Beck (1992) investigated the relationship between ethics and the law and found that consumers interpret the message that a corporate action is "legal" as a signal

[36]See Heine *et al.* (2017).

that it is ethically acceptable to purchase the corporation's products. A flooding of the market with legality labels on forestry products may – through this channel – shift consumption patterns away from genuinely sustainable forestry products towards those that only just meet the minimum of requirements (cf. Bartley, 2014). Restricting certificates of legality to be included only in the documents submitted to customs, instead of on the products themselves, then allows an effective enforcement of the bans for illegal timber through customs authorities without causing consumer confusion about the relative sustainability of products.

The same benefits pertain equally to restricting the consumer market visibility of low-level sustainability certificates.

Consumers would experience a welfare gain, however, if products with high-level sustainability certificates were labelled. Whereas labelling all products according to their sustainability levels would confuse consumers without providing useful new information, the labelling of highly sustainable products does add useful new information. Such labels enable those consumers who care particularly about the sustainability of timber products to disagree with the customs authority over the extent of external costs caused by unsustainable timber. The customs authority's taxation of unsustainable timber internalises those external costs only up to a certain level.[37] Consumers may wish to go further. And as the most caring consumers who want sustainability beyond the degree that the fiscal system already enforces will tend to demand high-sustainability products, only the certificates documenting the highest sustainability standards need to be displayed on consumer products.[38] For society, enabling this voluntary, additional level of cost internalisation is a Pareto gain.

With the implementation described, the new government's use of sustainability certificates then does not crowd out their continued private use.

[37] The calculation of external costs for computing Pigouvian tax rates always requires making assumptions. As a general practice, these assumptions are chosen to rather err on the side of internalising too little, rather than too much, of the external costs (see discussion in Parry *et al.*, 2014; also Howard, 2014a,b). Accordingly, environmentally concerned citizens may disagree with the Pigouvian cost estimate of the customs authority.

[38] For example, if FSC certificates correspond to a significantly higher sustainability level than PEFC certificates (SRU, 2012) the former would be displayed to consumers, the latter not, while both would qualify for (different) tax discounts.

9.5.3 Devolution of government functions to private agencies without the usual costs

The co-existence of public and private uses of the information raised by private certification agencies relates to the larger debate on the use of private governance in public policy. This debate concerns the question whether central government should devolve regulatory powers to executive agencies and private contractors. Proponents of private governance stress the perceived gains in operational efficiency from executing government tasks through private bodies instead of through slow bureaucracies (e.g. HM Treasury, 2002). Defendants of public governance object that the delegation of government tasks to unelected private bodies may sacrifice the democratic legitimacy of policymaking (Cafaggi, 2010; Dawn & Oliver, 2010; Freeman & Minow, 2009; Lipschutz & Fogel, 2002; Mulgan, 2006; Prager, 1994; Verkuil, 2007). This debate is raised again by the proposed policy since its execution relies on both private certification agencies and public customs authorities.[39] We think, however, that the mechanism proposed here delivers the gains in operational efficiency from private governance without sacrificing democratic legitimacy. This win-win situation becomes possible because the key policy decision, of how to translate the different sustainability certificates into tax discounts (and thereby the determination of the Pigouvian tax rates), rests in the hands of elected governments. The fact-finding, enforcement on the ground, collection and transmission of the information needed about the sustainability of different forest product suppliers is outsourced to private agents. These private agents, in turn, are subjected to competition, disciplining them in operational efficiency, and such competition would not be possible if those same operational tasks were performed by a bureaucracy.

And whereas the current role of forest sustainability certification agencies has been criticised as illegitimate, on the ground that these agencies effectively govern a market without a public mandate (Bernstein & Cashore, 2003), our mechanism would provide that public mandate, extend it and provide checks by elected policymakers.

[39]There are votes in organisations like the Forest Stewardship Council, which actually has very strict rules for the representation of a great number of stakeholders in forestry management, but the actors represented there are not the general voters.

9.5.4 Protection against fraud

Besides operational efficiency, another gain from the mechanism's integration of private and public governance is its resilience to fraud, a concern in the literature on the current use of labels (e.g. Hamilton & Zilberman, 2006; Lippert, 2009). Consider a theoretical situation in which the timber-importing country's customs authority directly interacted with the forest owners in timber-exporting countries, without that interaction being mediated by certification agencies. Forest owners have an incentive to cheat by claiming to produce timber at a higher level of sustainability, so that their products qualify for a greater tax discount. As the customs authority cannot impose legal sanctions overseas, its only ability to punish overseas forest owners for cheating is to deny continued interaction with detected cheaters.[40] The marginal incentive of an overseas forest owner to comply then inversely depends on the detection rate and the relative gain from each case of cheating compared to the long-term gains from continuing to be allowed to export timber to the customs authority's market. This is an application of the Folk Theorem: the incentive to cheat on an agreement depends inversely on the frequency of interaction between transaction partners (Friedman, 1971).[41] Both the detection rate and the interaction frequency increase if the customs authority involves the certification agency in the transaction. Since the certification agency has access to the overseas timber production, the detection rate for fraud by overseas timber producers rises. And trade-oriented overseas timber producers are likely to interact more frequently with sustainability certification agencies (which operate globally) than with the customs authority of an individual export market. Both factors reduce the incentive for an overseas timber producer to cheat on his production standards when the customs authority uses the intermediation of certification agencies. This principle carries over from the literature on other types of cross-border taxation. The literature on Financial Transaction Taxes, for example, equally finds that incentives for fraud decrease if the government imposes its tax not on the original holders of the financial instrument (who are analogous to the timber producers) but on the clearinghouses handling transactions (which are analogous to the certification agencies).[42]

[40] Playing "grim" in game theory terms (Friedman, 1971).

[41] By the Folk Theorem, an equilibrium of compliance can be stabilised through repeated interaction, where the stream of continued collaboration between two players – such as between the certification agencies and the market authorities – exceeds the one-term gains available through a defection.

[42] See, for instance, Brondolo (2011).

These considerations relate to the incentives for fraud by overseas timber producers – so how does the mechanism contain the incentives of certification agencies to cheat themselves? The taxing state can set conditions for certification agencies when they apply to have their certificates accepted for direct market access and the customs authorities' tax discounts. These conditions should include a requirement for the certification agency to be incorporated in the taxing state and a prescribed minimum size and diversification of its local client base. These requirements deter fraud through the following mechanisms. Incorporation in the taxing state enables the imposition of fines. A minimum diversification of the client base ensures that potential gains that a certification agency could make from facilitating the cheating of any one of its client timber producers would be small relative to the potential losses from having its business terminated in the taxing state. Adding to this deterrence, a minimum size ensures that each agency is in a sufficiently frequent interaction with the taxing state, so that the Folk Theorem applies. Requiring a minimum business size also ensures that establishing a certification agency requires incurring a sunk cost. These sunk costs act like a security deposit that the owners of the certification agency can lose if a fraud scandal destroys their accreditation with the customs authority. The one-term gain from fraud is then eclipsed by the contingent loss of this implicit security deposit, providing a further deterrent to fraud.[43]

[43]The greater the required business size in order to obtain a registration as a certification agency, the greater is the required sunk cost to start such a certification agency and the greater is hence the implicit security deposit and the protection it yields against fraud. A higher requirement for sunk costs can, however, also prevent entry into the market for certification services. The tax authority, therefore, needs to balance its objectives of disciplining certification agencies against engaging in fraud (through requiring a high implicit security deposit) and its objective of pressuring these agencies to price their services at low cost (through confronting them with fierce competition which requires low market entry barriers and hence low-security deposits). Where the tax authority strikes the balance depends on how lucrative fraud is, and how much competition among certification agencies is needed. The smaller and the more credit-constrained forest owners are, the lower the optimal minimum size for certification agencies might need to be. This is because, the smaller forest owners are, the more important it is that competition among certification agencies holds down the fixed costs of certification in order not to price these forest owners out of the market. At the same time, certification agencies can presumably gain less from fraud on any single trade deal if the forest owners are smaller, so less costly policing against fraud would be needed than if single deals were much larger. Both aspects point to a lower optimal requirement of business size for certification agencies when forest owners are small. To take account of this optimisation endogenously, the tax authority could vary its requirement for the business size of certification agencies, demanding from those that work with large forest owners and make large transactions that they have a larger business size than those who serve the smaller forest owners and facilitate small deals.

Hamilton & Zilberman (2006) describe a similar trade-off for producers but do not consider the

9.5.5 Reducing trade-offs by simplifying the dimensions of each organisation's optimisation problem

With the present market design, the tasks of sustainability certification agencies are multidimensional, complex and self-defeating. A single certification agency like FSC can only use a single forest management certificate to optimise production incentives for the full range of timber producers. This multidimensional optimisation problem is not just complex. It is impossible to provide the right incentives for each of the different producers with just one forest management certificate because improving the marginal incentives for timber producers at low sustainability levels worsens the dynamic incentives faced by producers with more sustainable productions. A certification agency's business becomes much simpler with the mechanism that we have suggested. Each certification agency can now offer as many certificates of different sustainability levels as it wants. And each certificate just needs to cater for timber producers at one particular level of sustainability. The mechanism's role for the customs authority is also rather unidimensional. The customs authority's role is just to maintain and enforce its fiscal role according to a list of the relative external benefits to be attributed to different sustainability certificates. No organisation faces the complexity of having to optimise the whole of forestry policy; instead, we divide the overall problem into manageable, aligned sub-tasks and root each in a specific organisation.

9.5.6 Orchestration

Separating the larger problems of forestry into individual tasks of separate organisations may raise a red flag with readers who are concerned about the literature on "orchestration". Hale & Roger (2014) and van Asselt *et al.* (2015) observe that the forestry sector boasts plentiful private initiatives that are poorly aligned and that remain below their potential due to the lack of a coordinating agent who could "orchestrate" these initiatives to act in concert. Does our suggested architecture of organisations and mix of different policy instruments contribute to or

role of certification agencies. These authors recognise that fraud with sustainability certificates rises when there are many actors. To keep fraud in check they consider restricting the number of product suppliers, such as the producers of forestry products. We instead recommend to impose no restrictions on the suppliers of timber products, because it is important to encourage rather than deter the legal market participation of forest smallholders. Where fraud is a concern, we rather recommend restricting the number of certification agencies than the number of timber suppliers.

mitigate the existing chaos? The challenge for policy design is to attribute to each organisation a clear role to improve simplicity, and to encourage competition among these organisations to avoid monopoly powers, while preventing chaos. A coordinating agent may be needed, but the orchestration of different forest policies should nevertheless not provide a rigid corset in the old style of "red tape" command-and-control regulation, but instead enable fluid private initiatives. Our mechanism offers a way in which many private initiatives can exist, in the form of certification agencies, without creating chaos, because there is one central coordination through a public body, the customs authority. The customs authority maintains a list classifying how the sustainability certificates issued by the different certification agencies compare to each other, and rewards them accordingly. The tax competition literature calls this type of coordination "yardstick competition" (Shleifer, 1985). The customs office determines the rules, preventing chaos, but within these rules, there is free competition. This yardstick competition provides orchestration without rigidity.

9.5.7 Administrative and compliance cost

New policies tend to raise business fears of increased costs for administration and compliance. The suggested mechanism keeps both costs down by reusing already existing systems and organisations. Rather than establishing a new mechanism for tax authorities to acquire data for overseas production standards, the mechanism reuses the existing system of sustainability certificates. Rather than establishing a new tax transaction, the mechanism reuses the already existing transaction of cargo consignees in customs clearance procedures. Rather than establishing multilateral public agencies to audit international production standards, the mechanism reuses the existing private certification agencies.

9.5.8 Structure of marginal incentives

Each aspect of the mechanism above could in principle also work with an expenditure policy, in which the timber-importing state grants the producers of sustainable timber a subsidy instead of a tax discount. The efficiency characteristics of both variants vary, however, in the following ways.

To face the right marginal incentives, a forest owner should receive different price signals for every level of sustainability he adopts. This price differentiation not only requires that timber producers with more sustainable production methods should receive higher rewards than their less sustainable peers. It also means that forest owners who conserve their forests and let them grow instead of harvesting should receive even larger rewards than those who cut their forests. In general, the most sustainable forestry policy is conservation. Hence, even though the sustainable harvesting of forests should be encouraged, the conservation of forests should at least receive equally favourable treatment. Implementing such a structure of marginal incentives for imported timber is, however, more difficult with expenditure policies than with tax policies. Consider the situation at the customs gate in the suggested mechanism. The timber-importing state only interacts with timber producers who actually cut their forests; those foreign timber producers who completely conserve their forests do not enter into the scheme. If the timber-importing state used subsidies to reward the import of sustainably produced timber, it would impose an opportunity cost on foreign timber producers who did not cut and trade their forests. The implicit reward provided by the subsidy would rise from illegal to slightly sustainable to more sustainable production but then arbitrarily fall once a forest owner seizes to cut the forest for conservation. With a tax policy, such an arbitrary structure of incentives is avoided. A forest owner who does not cut his forest is not taxed; a forest owner who cuts his forest but produces sustainably receives a large tax discount, producers with lower sustainability a lower discount; producers without sustainability certificate face the whole default tax; producers who additionally do not hold a third-party verification of their timber's legality must undergo due diligence; producers with illegal production are refused market entry. For decreasing production standards the strength of the signal is continuously increased. By using taxes instead of expenditures, no forest owner then receives arbitrary marginal incentives.

9.5.9 Limitations of the mechanism

After implementation of the suggested mechanism, there are remaining problems for forest sustainability. The suggested mechanism could combat current deforestation and forest degradation linked to the production of traded timber products. Additional policy instruments are needed to reduce all sources of deforestation that are not associated with traded timber. When the importing state uses taxes instead of expenditure policy, the need to address historical responsibilities for past deforestation remains. Expenditure policies such as REDD+ can fill both of these gaps.[44] And our suggested mechanism for taxing and certifying traded timber would make two contributions to making these expenditure policies more realistic.

Section 9.3.2 identified that, in the absence of expenditure policies, developed countries which cleared their forests in the past are free-riding on the past preservation of forests in many developing countries. Section 9.3.1 showed, however, that existing expenditure policies like REDD+ suffer serious funding problems. REDD+ will require much additional public revenue – our suggested tax scheme could raise some of these funds. Moreover, besides providing funds, the mechanism could also help to set a clearer focus for REDD+ schemes. These schemes would not need to solve all international forestry problems on their own, thereby reducing some of the funding needs. By efficiently addressing a subset of the forestry problems, the suggested mechanism then makes the remaining role of REDD+ slightly smaller and more realistic, again alleviating the large scarcity of funding.

9.6 Conclusion

Several countries with large consumer markets for timber, particularly the EU, have repeatedly stated their aim to raise the sustainability of forests globally, but most of these forests are outside their jurisdictions; their protection efforts are therefore severely limited by legal constraints of extraterritoriality. Private organisations like the Forest Stewardship Council offer a method to circumvent the extraterritoriality constraints through contract law, where overseas forest owners grant access to their territory for verification of their sustainability practices in exchange for a certificate that raises the commercial value of their products in the timber-importing countries' end-consumer markets. Alongside these certificates, and not using potential synergies, price-based instruments arose whereby developed countries subsidise sustainable forestry in developing countries.

This chapter sets out a mechanism for these different tools to be optimally combined. The sustainability certificates are used as the basis of a Pigouvian tax on

[44]With appropriate choices of REDD+ emissions accounting benchmarks.

unsustainable forestry practices. When timber is imported, customs authorities apply a "tax for unsustainable production" which starts from the assumption that the timber is not sustainable. The burden of proof to prove the sustainability is on the taxpayer . The taxpayer establishes this proof by showing a sustainability certificate, and the customs authority of the importing state responds by issuing a tax discount. The customs authority keeps a record of the relative standards of different sustainability certificates and varies the size of the discount according to how strict these different sustainability certificates are. The tax then affects overseas forest owners without violating extraterritoriality constraints because overseas entities are only affected through contract law. Economically, this mechanism allows the timber-importing country to impose a tax incidence outside its jurisdiction. In public law, it would be extraterritorial to apply the tax directly on the overseas entity. However, with the proposed scheme, the tax is not directly applied to the overseas entity. Instead, only a fiscal incidence is applied overseas, when the tax is passed through by the entity which is legally liable to pay the tax – and which is resident in the taxing state – to that entity's contract party which resides overseas. Therefore, the direct imposition of the tax would be extraterritorial whereas the interception of the tax pass-through by contract law makes it legal. It is then legally possible to apply Pigouvian pricing overseas. An international agreement is not required to provide dynamic incentives to overseas forest owners to adopt sustainable timber production.

Due to the diversity of forests, the literature finds that much data would be needed to efficiently vary the pricing of forestry products in destination markets according to the sustainability of production in the countries of origin. Legally, however, there are binding restrictions for collecting this data, since overseas forests again fall outside the jurisdiction of the destination market's state, such that the release of the necessary data cannot be mandated. By setting a tax rate based on default values, the tax can be set without such legal problems and with minimum administrative cost, and by providing a tax discount for proof of being better than the default value, the required data is raised even without jurisdictional power.

Two fundamental problems with certification agencies today are that many forest smallholders in developing countries cannot afford them, and that those forest owners who do participate face insufficiently dynamic incentives to keep improving. Our mechanism tackles these problems by enabling the efficient supply of a greater diversity of sustainability certificates. As this diversity of certificates becomes possible, each forest owner faces a dynamic incentive to improve its sustainability because there is a certificate that is sufficiently close in reach to make even a small improvement promptly bear some fruit.

The present role of sustainability certificates makes it impossible to move beyond oligopoly, but the combination of forest sustainability certificates with fiscal instruments enables the expansion of competition among certification agencies. Enabling this competitive pressure could drive down the costs of certification and make these services affordable for a greater number of forest owners.

Whereas other price-based forestry policies such as REDD+ suffer from unfulfilled funding needs, this proposal raises funds. The mechanism could both co-finance REDD+ and partly substitute it.

The suggested mechanism has low compliance and administrative costs, making it sufficiently inexpensive to justify cost-efficient internalisation of a greater amount of external damage from unsustainable forestry. Customs charges are inexpensive to operate relative to other environmental taxes, and potent customs bureaucracies to oversee a scheme such as this one exist even in countries with otherwise low administrative capacity. While countries with large end-consumers markets might benefit the most, others would gain from acting too.

Decades have passed without meaningful progress towards an effective international forestry treaty. Negotiations have been vulnerable to blockade by individual countries with low ambitions whose agreement was indispensable as long as there was no credible unilateral policy that countries with greater ambition could pursue in the continued absence of an international treaty. In particular for timber-importing countries, there was no credible unilateral policy that would satisfy international legal restrictions and safeguard against carbon leakage. This chapter suggests a mechanism that makes such unilateral action possible without these problems.

Paradoxically, the motivation to develop a unilateral mechanism arises not in order to use it but in order to enable its alternative: an international cooperative agreement. To achieve an international agreement, the outcome of "Business-as-Usual" must be removed from the international negotiation tables, so countries which previously blocked an international treaty have an incentive to re-evaluate their positions. To make this happen, countries with greater ambition for protecting forests must be able to credibly signal their willingness to act even in the absence of an international agreement. And to make this signal credible, countries willing to act today must be able to credibly pursue a unilateral policy as a functioning backup option if international negotiations continue to be blocked. This chapter presents such a policy.

Chapter 10

Lessons for WTO-compatible Border Tax Adjustments

Chapters 7 and 9 provided solutions to the taxation of overseas emissions in two complex sectors. Additionally, these chapters provide lessons for the literature on the trade-law consistent application of “border tax adjustments” (BTA) and “consumption-based carbon pricing”. In this chapter, we make these derivations.

In Coste, Calì & Heine (2019) we showed empirically why countries should generally not fear the competitiveness effects of environmental taxation. However, competitiveness continues to rank high in the concerns of policymakers, which led many countries to carve out large exemptions from environmental taxation for trade-exposed energy-intensive industries. It is then not enough to suggest that these exemptions are not needed; clearly, the political concerns over competitiveness effects are serious and ignoring them will only perpetuate the use of the tax exemptions or prevent the introduction of environmental taxation in the first place.

There is a long-standing literature that seeks to provide these second-best policy instruments. Broadly, this literature has found that one of the most efficient instruments for overcoming competitiveness problems is “border tax adjustment”.[1]

[1] For a review of this literature, see, for example, Fischer & Fox (2012).

Through BTA, a country that has a carbon tax would rebate the tax bill to its exporters ("export BTA") so these do not suffer losses in their international competitiveness from the fact that other countries do not yet apply carbon taxation. Equally, the country would tax imported goods for their embodied emissions ("import BTA"). Simulation models suggest that this policy is highly effective at reducing carbon leakage. However, there has been a controversial legal debate on whether BTA is consistent with trade law.[2] In particular, GATT Article III(2) prohibits the variation of tariffs according to the production methods of "like products". Article III(2) does allow countries to apply taxes at the border when those taxes are merely adjustments for taxes which exist within the domestic market of a country, and those types of tax adjustments are standard practice for VAT and excise tax systems. However, such adjustments do not let the tax rates vary according to production standards, whereas the use of BTA for climate purposes explicitly seeks to adjust the price of goods according to the carbon emissions in their production. Hence many authors have suggested that BTA is inconsistent with Article III(2). The policy might then still be applied, but only through the exemptions that environmentally motivated trade law restrictions can, under strict conditions, enjoy under GATT Article XX. The legal uncertainty has so-far prevented the use of BTA for climate purposes despite those encouraging economic-efficiency results.

Recently, there have, however, been breakthroughs in the BTA literature and our results from chapters 7 and 9 can help substantiate these. When this thesis was started, chapter 7 was intended as a solution to these wider problems, and the core results were presented by as BTA solutions in conferences from 2011 onwards.[3] However, since 2011 other authors have come out with publications that develop similar solutions to the ones in chapter 7. There are nevertheless some additional insights for the BTA literature that chapters 7 and 9 provide and that have not been considered by those aforementioned publications of other authors. Therefore, this chapter will add those additional insights. But first, we review the recent breakthrough in the BTA literature.

Trachtman (2017) and Böhringer *et al.* (2017) point out that the legal concerns

[2] See, for instance, Cosbey *et al.* (2012); Howse (2015); Mavroidis & de Melo (2015).

[3] An earlier version of chapter 7 was presented at the IMF in the winter of 2011, and sent from there to the French G20 Presidency. It was again presented in September 2012 at the Law School of University of California, Berkeley and from then onwards at various conferences. I am not implying in any way that the authors who have proposed similar solutions to the BTA problem since 2011 have taken any of my content. I am only writing this as proof that the results in chapter 7 are original.

over GATT Article III(2) can be overcome when countries apply BTA through consumption-based excise taxes. For example, suppose a country had a carbon tax which was charged per tonne of steel, according to an assumption of the government as to how much carbon is emitted in producing a tonne of steel and multiplication of that emissions factor with the social cost of carbon. Then this excise tax could be imposed on steel at the point where the steel is placed onto the domestic market for consumption. The tax would not be applied when the product is directly exported, but it would be applied when overseas steel is imported for domestic consumption. Through this design, domestic and foreign producers are able to compete on the same carbon taxes without distorting competition.

This tax design can be further improved by rewarding firms that have produced the taxed product with a technology that is less emissions-intensive than what was assumed in setting the excise tax. For example, suppose the excise tax on steel was set assuming that each tonne of steel is produced with a blast furnace, which is a high-emissions technology, but some firms then produce steel using an electric arc, which emits much less. The latter group could then be rewarded. Trachtman (2017) suggests rewarding these firms with a tax credit which can be claimed by showing that a firm used the best-available technology. He shows that this form of rebate ensures consistency with WTO law. Whereas GATT Article III(2) does not allow the variation of the tax according to embodied carbon emissions, the rules are much less strict for subsidies. The WTO Subsidies and Countervailing Measures Agreement does allow the provision of subsidies that differentially reward firms for greener production methods, as long as these subsidies are provided in a non-discriminative way to domestic and overseas producers alike.

Note that chapters 7 and 9 develop a similar solution (which verifiably was finished before the first publication of a working paper by Trachtman, 2017). Our contribution then now is that this part of the results in chapters 7 and 9 confirms Trachtman's, thus adding more weight to his results. Furthermore, both the results in Trachtman (2017) and Böhringer *et al.* (2017) are theoretical in nature, and chapters 7 and 9 show that such schemes can work in practice by analysing the problem in two sector settings. Lastly, Trachtman (2017) and Böhringer *et al.* (2017) only consider embodied emissions and not emissions released in transporting the product, and chapter 7 shows how these can be efficiently covered by such tax schemes as well.

Part IV

Addressing further challenges to the implementation of environmental tax reforms

Chapter 11

Feasibility: Implementing environmental taxation in countries with institutional capacity constraints*

11.1 Risks of governance failure

In this chapter, we will investigate whether environmental taxation is feasible in countries with limited administrative capacity, such as many governments in low-income countries.

Recall that both Coase and Pigou emphasised the need to provide a careful evaluation (before the introduction of any tax solution for social costs) of the costs of additional government intervention. Pigou (1932, part II, chapter XX, para. 4) pointed out that "*In any industry, where there is reason to believe that the free play*

*Contents from this chapter have been published in the book chapter Heine, Dirk, & Black, Simon. 2019. Benefits beyond Climate: Environmental Tax Reform. in Pigato, Miria (ed.), *Fiscal Policies for Development and Climate Action.* Washington DC: World Bank Publications.

of self-interest will cause an amount of resources to be invested different from the amount that is required in the best interest of the national dividend, there is a PRIMA FACIE *case for public intervention. The case, however, cannot become more than a* PRIMA FACIE *one, until we have considered the qualifications, which governmental agencies may be expected to possess for intervening advantageously. It is not sufficient to contrast the imperfect adjustments of unfettered private enterprise with the best adjustment that economists in their studies can imagine. For we cannot expect that any public authority will attain, or will even whole-heartedly seek, that ideal.*" Pigou went on to suggest that the greater the ability of government, the greater is the case for implementing the suggested taxes. Coase was even more worried about the ability of governments to use taxes or regulations to improve on social costs and instead recommended that countries might best refrain from any action. "*There is, of course, a further alternative which is to do nothing about the problem at all. And given that the costs involved in solving the problem by regulations issued by the governmental administrative machine will often be heavy (particularly if the costs are interpreted to include all the consequences which follow from the government engaging in this kind of activity), it will no doubt be commonly the case that the gain which would come from regulating the actions which give rise to the harmful effects will be less than the costs involved in government regulation*" Coase (1960, p. 18).

There are many dimensions of governance failure and many potential costs of government interventions in free markets. However, we have dealt with many dimensions of such potential damages from environmental taxation in the preceding chapters, and in Heine & Black (2019) as well as Coste, Calì & Heine (2019). In particular Heine & Black (2019) have shown that environmental tax reforms create net macroeconomic benefits, which alleviates Coase's (1960) concern that environmental taxes could be improving one social cost while worsening economic well-being overall. However, there is a critical potential source of government failure remaining to be covered and that is administrative feasibility. For example, should we not be worried if a country with large corruption problems and poorly trained civil servants implements complex environmental taxation? Maybe here the concern is justified that Pigouvian taxes are "*the stuff that dreams are made of*" (Coase, 1988, p. 185) so that "*carrying them out means heading towards regulatory failure*" (Schmidtchen *et al.*, 2009, p. 5). If not, we need to provide concrete policy options that can make environmental taxation work reliably even in these conditions of high government failure risk.

The objective in this chapter is therefore to describe designs of environmental taxation that have greater opportunities to function in situations of severely constrained government capacity. This is a delicate exercise because the simplification of a Pigouvian tax scheme normally also implies that the taxes become less efficient at internalising social costs. Most of the environmental economics literature has focused on identifying the most efficient tax designs, whereas here we will consciously give up on some efficiency features for improved feasibility. As government capacity varies among countries in a broad spectrum, we will start off with the simplest design with the lowest requirements and then move up to more complex, and more efficient designs. Our focus will, however, always stay with third-best and second-best schemes for developing countries since the first-best types of policy designs for advanced economies have already been analysed at length in the literature.

11.2 Tax base

11.2.1 Choice among environmental damages to tax

Environmental taxation can apply to many different tax bases, covering a multiplicity of environmental problems. For countries which are not yet using this instrument, the question may then be where to start. Two natural answers are: where policy action is most urgent and where it is the easiest to get started. Fortunately, these answers may coincide.

For most countries, it is simultaneously in line with urgency and feasibility to start environmental tax policies by first taxing fossil fuels. Fossil fuels are generally easier to tax than other environmental tax bases, like forests or water. At the same time, they are a highly relevant place to start. It is the same fuels that simultaneously generate climate change and local air pollutants which account for two thirds in the nine million deaths from pollution per year (Landrigan *et al.*, 2017). By starting environmental taxation off with fuels, it is therefore possible to start environmental taxation in a way that is administratively simpler than with other environmental problems, while still being of the utmost relevance.

When countries tax emissions from fuels, they can choose between taxing the emissions themselves or the fuels. Taxing fuels is generally easier, but the simplicity comes at the expense of slightly diminished environmental incentives. This seems to be a concession worth making for countries with limited administrative capacity which may prioritize feasibility. Furthermore, there exist strategies to further improve the environmental incentives of a fuel tax with limited additional administrative cost. This section first lays out the simplest policy design, then moves to a more advanced approach and a hybrid option that seeks to combine the best of both worlds.

11.2.2 Point of imposition

The most easily implementable environmental taxes are fuel taxes which are imposed "upstream" where the fuels enter the economy. Where "*actual emissions may be difficult or impossible to measure*" (...), "*the best available tax may apply to a measurable activity that is closely correlated with emissions*" (Fullerton *et al.*, 2001, p. 14). CO_2 has a vast number of emitters, whose scentless effluences mix invisibly and spread globally. Monitoring equipment can be used to measure emissions of greenhouse gases and local pollutants at source, but instead one can also tax fuels on the assumption that they will be burned and infer the emissions that will be released during the combustion. Fuels are visible, easily measurable and enter the economy at a small number of points which tax administrations can more easily control than the much larger number of points-of-combustion. "*The beauty of the fuel tax is its administrative simplicity*" (Eskeland & Devarajan, 1996, p. 16). "*To make an emissions fee work, the government has to monitor the plant's emissions. For many pollution problems, especially those caused by a large number of polluters, this is virtually impossible*" (id., p. 1). In those cases, "*taxes can also be levied on polluting goods and services, in presumption of emissions associated with their use*" (id., p. 10).

Taxing environmental damages through the fuels is referred to as "upstream taxation", whereas "downstream taxation" charges the emissions at the point-of-combustion. Administering an environmental tax upstream works in much the same way as countries' existing fuel taxation systems. The key difference is to let the tax rate of different fuels vary according to their pollutant content.

11.2.3 Reusing existing administrative capacity

Countries existing fuel pricing policies show they have the administrative ability for this type of environmental taxation. “*All countries interfere in fuel markets (some with a tax, others with a subsidy), so their ability to manipulate this price is proven*” (id., p. 16), including because “*the collection of a pollution-motivated charge in fuel markets requires little or no new monitoring*” (ibid.).

11.2.4 Controlling administrative cost

Upstream environmental taxation can drastically reduce the number of taxable units, reducing administrative costs. “*To illustrate, there are approximately 146 petroleum refineries in the United States, but there are 247 million registered motor vehicles as well as millions of users of other petroleum distillates. As a result, imposing the tax at the refinery level on petroleum products will be far less expensive than, say, trying to monitor emissions at the tailpipe*” (Metcalf & Weisbach, 2009, p. 523). Compared to most other taxes, like sales or income taxes, the number of taxpayers for fuel taxes levied upstream would be small relative to the size of revenues that can be collected. Therefore, “*for many developing economies, administering carbon taxes, which basically just requires monitoring fossil fuel supply, may be much easier than administering broader taxes*” (Parry *et al.*, 2012b, p. 38).

11.2.5 Selecting among the range of upstream options

But depending on the country’s circumstances and policy priorities, there are important choices to be made regarding how far upstream in the fuel supply chains these environmental fuel taxes should best be imposed. For example, an upstream environmental tax on petroleum could be imposed at the wellhead of an oil field, at the point where the oil enters a central pipeline system, at a refinery gate, or (for imported fuel) at a port or pipeline border crossing. Here we shed light on these choices.

11.2.5.1 Taxing at the mine mouth or wellhead

In some fuel-producing countries, “*operators already pay state severance taxes, which means that they have the administrative capacity to pay the tax and that* *states are already collecting the necessary data*" (Metcalf & Weisbach, 2009, p. 525). Alternatively, the tax can also be collected on the level of fuel extraction companies, which are normally fewer than the number of wells or mines.

For gas, the feeding of gas into the pipeline system can be taxed. Almost all gas is fed into central pipeline systems, apart from some pipelines that go directly from processing sites to large end-users but those are few and could efficiently be taxed separately given their carriage volume.

Coal mines often also release natural gas (coal-bed methane emissions). Therefore, an upstream carbon tax on natural gas should also be collected from coal mines. The easiest way of doing so would be to adjust the coal tax using an emissions factor for the amount of natural gas normally associated with coal production.

11.2.5.2 Taxing at the fuel processing plant

While these choices may be best for reusing already existing tax transactions, environmental incentives can be improved when the fuel tax is implemented at the level of a fuel processing plant. This is because the emissions from the same basic type of fuel (e.g. petroleum) vary depending on the type of distillate derived from it (e.g. diesel, gasoline, etc.). "*Likely CO_2 output can generally be more accurately measured from processed fuel outputs than from unprocessed outputs, which may contain varied amounts of impurities (which lower the carbon content per unit of the fuel)*" (Calder, 2015, p. 46). "*The advantage of taxing refineries is that they could pay a separate tax on each distillate depending on the carbon content. Distillates, such as tar, that would not be burned would not be subject to tax*" (Metcalf & Weisbach, 2009, p. 527).

11.2.5.3 Hybrid case

Consider a situation where some fuel is sent for processing which alters its pollutant content, while another fuel is burned without such processing. In this case, upstream taxation becomes harder to implement because the government needs to make an assumption about the pollution that will be released when the fuel is burned downstream. For example, after coal is extracted, it contains significant amounts of sulphur which oxidises to sulphur dioxide when the fuel is burned in power plants, causing acid rain and local air pollution. Several ways exist for reducing the sulphur dioxide emissions released from the combustion of a given amount of coal. Washing the coal, for example, can reduce its sulphur content by more than 30 %. Given such variation, it can be hard to infer the quantity of emissions downstream on the basis of the volume of fuel upstream. This uncertainty, in turn, complicates the calculation of an efficient upstream fuel tax. There are three main ways of managing this problem. Here we discuss the two simple ones, returning to this problem in section 11.5 which deals with advanced options available to countries with lower risks of governance failure.

Firstly, countries can use regulatory policy to mandate efficient fuel processing. The washing of coal, for example, is a cheap technology which reduces pollution effectively. When countries mandate this practice, it becomes again predictable how much pollution will arise from a given amount of coal, so the efficient tax base is unambiguous.

Without such regulation, countries can deal with partial mid-stream fuel processing by varying the point of tax imposition. A coal mine can be taxed on all its coal extraction apart from those sales which it delivers to an accredited coal processing facility which is then taxed instead. Similarly, for petroleum, the upstream fuel "*producers could be required to pay carbon tax only on sales but not sales to approved processing or refining companies, who would then pay carbon tax on their sales instead*" (Calder, 2015, p. 44).

These types of variation may be difficult to administer in low-income countries, but it is also not necessarily required there, since fuel processing is more common for mid- and high-income countries – so in countries where the required administrative capacity can be assumed. Low-income countries could then practically use upstream environmental taxation without these types of variations, whereas mid-income countries can strive for the more complex system for environmental efficiency gains.

11.2.6 Second-best incentives

11.2.6.1 Efficiency under the simple tax design

Despite their simplicity, these "upstream" fuel taxes can provide reasonable environmental incentives. For example, in the power sector, upstream fuel taxes increase incentives to (1) improve the fuel efficiency of power stations, (2) shift to renewable energies, (3) reduce electricity demand. Alternative policies for reducing emissions typically provide a much narrower set of incentives. For example, a fuel efficiency standard for power plants uses only channel (1), a subsidy for renewable energies uses only channel (2). Using a smaller set of possible behavioural adjustment increases the overall cost of abatement. This finding holds in other sectors, too. For transport, upstream fuel taxes provide incentives for (1) purchasing lighter, smaller cars with more efficient engines, (2) shift to other forms of transport, and (3) curb the intensity with which vehicles are used. By contrast, regulatory policy for car engine efficiency or subsidies for electric vehicles improves only a subset of (1), whereas a subsidy for public transport improves only (2). As discussed above, these other policies nevertheless have complementary roles to play, but a simple upstream fuel tax already gets countries a long way towards efficient environmental incentives.

11.2.6.2 Efficiency losses due to the simplification

The simplicity of upstream environmental fuel taxation also has its drawbacks. Not all types of pollution can be covered in this manner: for example, it is harder to capture CO_2 emissions from industrial processes or land use changes in this way than emissions from transport and electricity generation. Upstream taxation also does not improve the incentive to install technology for capturing pollution, like chimney filters. We will later describe design options for adding these further environmental incentives, but here we first stick with the simple upstream design to show a policy option which is feasible also in countries lacking the administrative capacity for the more advanced options.

11.2.7 Evasion and corruption

11.2.7.1 Empirics

The only way of avoiding an environmental tax should be through the reduction of emissions. Upstream environmental taxes get reasonably close to that ideal. They are much less susceptible to evasion than other taxes. In the UK, for example, there is 2 % tax evasion for the diesel tax, compared to 11 % for the value-added tax and 17 % for the personal income tax. Evasion of environmental taxation in Sweden is less than 1 % (Swedish National Tax Agency 2008) and less than 2 % in the UK (Fay *et al.*, 2015).

11.2.7.2 Relation of the point of imposition to the vulnerability towards corruption

The small number of units to enforce upstream environmental taxes helps in controlling evasion and corruption. Taxing upstream uses the fact that the number of pipelines, mine mouths, and ports at which fuels enter the economy is much lower than the number of chimneys releasing the emissions derived from burning those fuels. This makes it possible to tax emissions of the entire economy from just a few points. Such a concentration makes it easier to protect the tax against evasion and corruption compared to a counterfactual case where individual tax auditors need to be sent to factories to check the compliance with environmental regulations. With the upstream design, the government can thus concentrate its supervision over a small number of officials who impose an environmental tax at a few fuel entry points to the economy, and all subsequent activities using these fuels are covered by the climate policy. It is then private trade partners who pass the environmental tax signal through the market, to the remote regions, to the informal activities, to all industries. Each private agent has an incentive to fully enforce the price signal with his transaction partners, given the private incentive to pass on a tax incident, so the public policy benefits from voluntary private enforcers where it lacks public ones.

11.2.7.3 Industry features protecting against evasion

Fuels are more difficult to conceal than other tax bases. "*The energy industry generally has larger, more well-organized firms than sectors representing other goods*" (Liu, 2013, p. 662). The fact that fuels are dangerous means that the handling of fuels is heavily regulated in most countries, which helps in keeping track of it.

Fuels are easier to account for than other tax bases, and these statistics are available to countries already. "*It is easy to measure and monitor physical units of energy at the supplier level: megawatt hours of electricity, barrels of oil, gallons of gasoline, and tons of coal. Compared to other tax bases, such as hours worked, profits earned,* *or personal income, energy consumed and carbon emitted are easy to monitor*" (id., p. 661). "*Second, it is easy to check how much energy is consumed through existing infrastructure: meters, bills, and storage tanks*" (ibid).

11.2.7.4 Mechanism to enable cross-checks

Pollution measurements can provide a check on the correctness of the fuel tax bill. The combustion of fossil fuels emits "*a variety of air pollutants that have a known relationship to the quantity of primary energy consumed. This provides an independent way to verify how much oil or coal is being consumed. Each of these has a particular fingerprint. Indeed, coal or oil from different sources leave air pollution signatures which can be traced*" (Liu, 2013, p. 661).

Each of these features contributes to controlling the risk of evasion and corruption for environmental taxation when it is implemented through upstream fuel taxation.

11.2.8 Tackling multiple social costs with one tax instrument

Burning fuel causes many different types of environmental problems, including CO_2 but also local pollutants like SO_2, NOx, VOCs, and $PM_{2.5}$. A carbon tax alone would then not be sufficient as these other problems are equally substantial. Fortunately, however, addressing these other environmental damages taxes does not require setting up additional taxes. Instead, these other pollutants can be included in calculating the same overall fuel tax. Jointly charging for a basket of separate externalities through one fuel tax serves to reduce administrative costs (Fullerton, 1996). Instead of needing to comply with a bundle of different environmental policies, a fuel tax can charge for the social cost stemming from various types of pollutants that are all released from burning the same fuel.

11.3 Tax rate

11.3.1 Efficient rate

An environmental fuel tax is economically efficient when the tax rate is set to equal the damage which society-at-large incurs when another unit of the fuel is burned. At this rate, an environmental tax strikes precisely the right balance between the interests of polluters/consumers of the polluting product and the interests of third parties that bear the costs of the pollution.

11.3.2 Roles of specific and ad-valorem tax structures

Recall from chapter 2.5 that countries are broadly using two types of tax rate structures to charge for the consumption of fuels: “ad-valorem taxes”, like the “Value-Added Tax” (VAT) increase the price of a fuel by a set percentage amount, and “specific-rate taxes” such as “fuel excise taxes” increase the price of a unit of fuel by a set monetary amount. To reach the efficient environmental incentives, both tax rate structures have a clearly specified role to play and cannot substitute each other.

Recall that per physical unit of fuel there is a certain environmental damage, like a given physical amount of CO_2 per physical tonne of coal. When the price of the tonne of coal changes in market fluctuations, the pollution per tonne of coal stays the same. The efficient environmental tax of the tonne of coal has then not changed. Accordingly, an environmental tax should be set at a specific rate (Euro / tonne of coal) rather than at an ad-valorem rate. Fortunately, for countries with limited administrative capacity, it is easier to administer a specific-rate excise tax than an ad-valorem tax where prices must be known.

Many countries with low administrative capacity do, however, have ad-valorem Value Added Taxes (VAT). In this case, it is critical for the VAT to be applied to fuels at the same rate as to any other standard product. In some countries, fuels enjoy a preferential VAT treatment. In this case, there is a distortive incentive to consume fuels and pollute – and the size of this incentive varies in an arbitrary way with the fuel price cycle, even though the pollution released per physical unit of the fuel is constant through the cycle. Therefore, even when the fuel excise tax is correctly set, if the VAT is not (e.g. because fuels have been exempted from the excise tax), pollution will be inefficiently high.

Post-tax fuel price = (Pre-tax fuel price + Fuel excise tax) × (1 + Standard VAT rate)

The environmental role for the ad-valorem VAT is, therefore, to ensure the neutral taxation of fuels, just like for any other good, whereas the role of the specific-rate excise tax is to adjust the fuel price for the social cost of pollution caused per physical unit of the fuel.

11.3.3 Calculating the specific rate component

The efficient fuel excise tax, in turn, sums up the social cost of all the types of pollution released when a given fuel is burned.

Different types of fuel contain different pollution quantities. For example, different types of coal vary significantly in their carbon content. Therefore, an efficient fuel excise tax structure has different tax rates for the four main classes of coal (anthracite, bituminous, subbituminous, lignite). Small countries often do not have all coal types, so in those countries the tax rate schedule would be simpler.

Some fuels release significantly more emissions than others, and an efficient environmental tax charges these fuels proportionately. Generally, the combustion of coal releases significantly more greenhouse gases and local pollution than natural gas, and the same for diesel relative to gasoline, or heating gas relative to heating oil. In order to provide the right incentives to market participants, it is essential to set the tax rates on these different fuels in accordance with their pollution contents. This means that a country should price CO_2 released from different fuels the same. If one fuel contains double the amount of CO_2 per unit of energy than another fuel, that fuel should be taxed proportionately higher. This tax rate difference across fuels is exacerbated when CO_2 and local pollutants are considered jointly, given that dirtier fuels perform worse on both criteria.

11.3.4 Information requirements

11.3.4.1 Information on social costs

For almost all countries, estimates for the efficient environmental excise tax are readily available. Whereas research in applied environmental economics used to focus on a few developed countries, policymakers in developing countries can now draw on a set of increasingly detailed estimates for their own countries. To be precise such estimates should at the minimum take into account domestic fuel qualities, the prevalence of pollution control technology, the distance between population centres and power stations, the existing stock of pollution concentration, and local incomes. The first global database providing this level of detail is (Parry, Heine, Lis & Li, 2014), which is a spreadsheet model aiming for simple modifications, allowing policymakers to input their own assumptions. More complex models have taken into account air quality dynamics and, generally, require deeper consultations of the government with expert modeller teams.

All modelling of social costs is based on assumptions, and expert dialogues are generally recommended before transposing any particular set of social cost estimates into tax rate structures. That said, internationally peer-reviewed estimates for developing countries are now available, reducing the administrative burden on governments to come up with their own calculations.

11.3.4.2 Information on abatement costs

Besides the need to derive estimates on the cost of emissions to society, the determination of environmental tax rates does not pose large requirements on the ability of government to execute cost-benefit analyses. For a country with limited administrative capacity, this is a major advantage of environmental taxation compared to command-and-control regulations. When the government uses a regulation to reduce pollution, for example by deciding for businesses whether a new clean technology should be introduced, the government needs to know both the costs of introducing the technology and its benefits from reducing emissions. With environmental taxation, by contrast, the government only requires information about the marginal damage caused by carbon emissions and not about the marginal costs of abating these emissions Posner (1992, p. 378f.). The government leaves it to businesses to compare the benefits of emissions reductions (as expressed by the environmental tax) and their costs. Policy can then be efficient even if the government lacks part of the information required for a cost-benefit analysis.

11.3.4.3 Updating tax rates

Compared to ad-valorem taxes like the VAT, specific-rate excise taxes have the disadvantage that they get washed out by inflation. The tax rates need to be regularly updated. An efficient environmental tax seeks to communicate a price signal of scarcity, but inflation and growth diminish that price signal over time. To maintain the environmental efficiency, governments should annually increase the tax rate, so its value at discouraging pollution stays the same. Some countries, such as Mexico, entrench this updating of tax rates by setting an nondiscretionary requirement directly in the law establishing the environmental tax. Doing so insulates the tax-updating process from the political cycle. An alternative is to task an independent agency with regularly reviewing the tax rate and its fit with the policy objectives. "*An agency might be relatively free from political pressure and would have the advantages of being able to revisit the rate at regular intervals and of employing experts who are able to distill the complex information needed to determine the correct rate. Agencies commonly set prices for significant items when they set electricity, airfare, and railroad rates. Agencies have also been used to set tariffs. Although many of these pricing decisions are now made in the private market, the government must set the tax rate, and these examples illustrate the feasibility of delegation of similar decisions*" (Metcalf & Weisbach, 2009, p. 520).

11.3.5 Tax exemptions

11.3.5.1 Implication of the point of imposition for the feasibility of exemptions

With an upstream environmental fuel tax, it is difficult to exempt particular industries. But such exemptions might not be warranted anyway. In the past, many countries have exempted selected industries from their environmental taxes. Such exemptions are hard to implement when countries use the simple upstream design of environmental taxes suggested here. Indeed, once the fuels are taxed at the state where they enter the economy, the price signal is passed through the supply chain to industries downstream, and normally without exemption. Countries that wanted to exempt a particular industry have either exempted the entire fuel associated with that industry (e.g. coal in Colombia) or have given up the simplicity of the upstream tax in favour of an environmental tax collected at the level of individual emitters (downstream taxation, considered below). These diversions from the clean, broad-based upstream taxation would allow favouring particular sectors but give up the administrative simplicity that we outlined here.

11.3.5.2 Efficiency costs of exemptions

Besides increasing administrative complexity, granting exemptions would cause at least three more costs. Firstly, exemptions undermine the environmental efficiency. Environmentally, all potential CO_2 emissions across different fuel types and fuel users should be taxed at the same rate, as they all cause the same environmental damage regardless of how they are generated or in which location, so when a particular industry is exempted, efficiency decreases (Parry *et al.*, 2012a). Secondly, the economy-wide costs of emissions abatement rise when there are exemptions. When an emissions tax covers the whole economy rather than only a few sectors, only those sectors that can reduce emissions at the cheapest cost will choose to do so – others who find it costlier to adapt will keep polluting. That division of abatement effort is an efficient outcome that uses every industry's comparative advantage to minimise the economy-wide costs of adjustment.[1] However, when individual industries are exempted, the policymaker gives up on some of these opportunities for reducing costs. A third disadvantage of exemption is dynamic inefficiency. The exempted industries do not face an incentive to optimize their environmental performance, so the environmental problems they cause persist, and these industries fall back further in their environmental efficiency, both relative to other industries and to their own industry's global technology frontier.

[1]In a functioning market, only the least-cost abatement options will be chosen. Therefore, by definition, the greater is the coverage, the lower is the abatement cost of those options that are chosen and the lower is the total cost of reaching any abatement target.

11.4 Complementary policies

11.4.1 Output-based subsidies

We listed three cost reasons why countries should be careful with granting exemptions to their environmental taxes for specific industries. At the same time, policymakers may want to shield specific emissions-intensive industries from impacts to their international competitiveness. In this case, complementary policies can be used (for more details see Coste, Calì & Heine, 2019). Here we only note one relatively simple way how upstream environmental taxation can be implemented in a fashion that safeguards competitiveness concerns for sensitive industries. That strategy is to combine the upstream environmental tax with a subsidy for the product of the industry which the policymaker seeks to protect. For example: A country may implement an upstream coal tax but be concerned about the competitiveness of its steel sector. In this case, the government could use proceeds from the upstream coal tax to pay a subsidy for the production of steel. With this setup, the steel sector continues to pay the upstream environmental tax and thus continues to face the incentive to reduce its emissions. At the same time, the steel sector gets the incentive to produce as much steel in the country as possible. Coste, Calì & Heine (2019) describe this strategy in more detail. The key takeaway message is that in addressing any competitiveness concerns, "*providing compensation for the cost increases from energy taxes, where deemed necessary, should not be provided through reduced rates or exemptions, but instead through targeted transfers that maintain the environmental integrity of market-based instruments*" (OECD, 2018, p. 51).

11.4.2 Liberalising energy markets

Upstream environmental taxation works best in combination with the liberalisation of energy markets. Countries that fix the electricity or motor fuel prices in consumer markets, should adjust those price ceilings when they impose an upstream environmental fuel tax. Otherwise, the environmental effectiveness of the tax will be held back because consumers won't reduce their consumption of the polluting good if the price signal is not passed through to them. Producers can, however, face a strong incentive to reduce pollution, for example when the emission tax cuts into the return which a power station would otherwise have been able to make. So, an upstream environmental tax is not ineffective if the energy market has fixed prices, but environmental taxation does provide stronger abatement incentives when it is accompanied by energy market liberalization.

11.4.3 Regulation of pollution control technology

In addition to environmental taxation, there is a case for mandating the adoption of cost-efficient pollution control technologies. As we described above, when countries mandate the adoption of specific pollution control technologies, it becomes easier to carry out upstream fuel taxation because it is clearer how much pollution there will be per unit of fuel burned. Countries may, for example, mandate the introduction of basic technologies like factory chimneys (which help disperse local pollutants), or car catalysts (given that the amount of local pollution from cars importantly depends on the car characteristics rather than only the fuel). Such complementary regulation can importantly simplify tax administration while improving environmental outcomes. That said, there are alternatives that do not rely on regulation and are more efficient, but they are more complex to administer. We cover them next in our section on implementing environmental taxes in countries with greater government capacity.

11.5 Alternative designs that further improve environmental incentives at the cost of a more complex tax administration

11.5.1 Downstream taxation

So far, we have considered the upstream taxation of fuels. A common alternative is to tax the emissions directly at the point where the fuels are burned. This "downstream taxation" is implemented at the chimneys of individual factories.

11.5.1.1 First-best incentives

Downstream taxation can achieve further improved environmental incentives. An upstream environmental tax on motor fuels "*does collect from those who drive vehicles and are thus responsible for the pollution*", but in addition, a downstream environmental tax also provides "*provide incentives to fix pollution control equipment or otherwise reduce emissions per mile driven*" (Fullerton, 1996, p. 34). "*In brief, the incentives provided by presumptive taxes* [upstream] *will inherit any weakness in the association between the tax base (such as fuel consumption) and damages*" (Eskeland & Devarajan, 1996, p. 10).

The difference in environmental efficiency between upstream and downstream taxation is larger for local pollutants than for CO_2. Until now, there is no commercial method for capturing the amount of CO_2 from fuel combustion. As a result, the amount of CO_2 that will be released from a given amount of fuel is clear, and there are no gains in environmental efficiency from taxing downstream (at the chimney) instead of upstream. But the same is not true for local pollutants: when an environmental tax on sulphur emissions is charged at the chimney of a coal power plant, the plant faces an incentive to adopt pollution control equipment like sulphur dioxide scrubbers, even without a regulation mandating such equipment. Such equipment is available for many local air pollutants. A first takeaway message is therefore that if a country's policy objective is mostly to reduce CO_2, then it can more safely go for a simple upstream tax design. But if the objective is also to provide optimal incentives for reducing local air pollution, downstream taxation deserves consideration.

Downstream taxation comes at a higher transaction cost, which leads countries to restrict its application to the largest emissions sources. "*Since the targeted good in the case of an emission tax is not traded, the tax can be more difficult to administer*" (Boyd *et al.*, 2005, p. 22). Fuel extraction and processing are recognized business activities on which data is already available; emissions instead are by-products of business activities on which data is often not collected unless one sets up new Measurement, Verification and Reporting (MRV) systems. Hence upstream taxation can reuse existing data systems whereas downstream taxation would require new data systems.

A downstream tax typically requires operating technology to monitor the amount of pollution passed up a chimney. Over the three decades of their use in developed countries, the cost and reliability of pollution monitoring technology have improved dramatically. Currently, a series of developing countries are following suit. Some cost remains, however, and it accrues per emitter. For small emitters, the cost of the technology itself, its measurement, verification and reporting, may be excessive. Therefore, small emitters are typically exempted. Even in the European Union, more than half of the emitters of CO_2 are exempted from the EU's downstream system of charging carbon emissions, to balance the cost of the policy with the gains from controlling emissions. If the way to keep down the system costs of pollution control is to exempt a large share of the emitters from the policy, then there are important environmental trade-offs. Downstream taxation enables a gain in the environmental incentives for the big emitters which are covered by the policy, but for the many small emitters which cannot be covered, there is no incentive to do their bit. This situation compares to upstream taxation where the fuel-related emissions from an entire economy can be covered, albeit with an imperfect price signal that does not exploit all the incentive margins for encouraging pollution abatement.

11.5.1.2 Different country circumstances suggest different trade-offs

In a country where pollution is highly concentrated in a few power plants, downstream taxation can likely provide better incentives than upstream taxation, and vice-versa. The two can also be combined: many countries have opted for downstream taxation of their power generation sector with upstream taxation of motor fuels. Such a division works well when the different user types are cleanly delineated by different fuels (such as in Europe where almost all the coal is burned by large companies whereas almost all the gasoline is burned by small units). Efficiency losses arise, by contrast, when the same fuel is used by large and small agents, such as in countries in which there a residential use of coal, and generally for natural gas.

Downstream taxation only makes sense when the use of pollution control equipment is actually within reach. Few of those countries with the most significant governance problems presently have advanced pollution control equipment such as scrubbers in their power stations. India, as a more advanced developing country, is now installing its first few SO_2-scrubbers. Depending on the level of technology development in the power station landscape, countries face different trade-offs between the simplicity of upstream taxes and the added incentives for pollution capture with the downstream design.

Countries with very localised air pollution problems and power stations in city centres have a stronger interest to use downstream taxes. When the pollution in a country is particularly concentrated in a given city, a downstream tax can allow the government to selectively raise the tax on pollution in that area. Such a policy can encourage power generation and polluting industries to move outside of cities. It is not clear though how effective such policies are. Evidence from across China indicates that pollution particulates travel up to 2000 km from their source (Zhou *et al.*, 2006). The population centres breathing the pollution can live at vast distances from the pollution's origin. If the pollution is so far-reaching, the gain from being able to vary an emissions tax city-by-city is limited.

Countries need to carefully consider implications for tax evasion. We discussed the relative resistance of upstream environmental taxation to evasion – for downstream taxation the opposite applies. "*Policy makers considering pollution taxes on smokestack emissions or wastewater emissions must consider the extent to which such measures will provoke costly and wasteful responses. Taxes on disperse, mobile point sources such as automobiles must consider not only economic efficiency, in terms of directly targeting the appropriate negative externality, but also tax evasion*" (Liu, 2013, p. 668f).

11.5.2 Upstream taxation with downstream rebates

Hybrid approaches exist which balance administrative feasibility and environmental efficiency.

There exists a way of combining some of the simplicity of upstream environmental fuel taxation with the improved incentives for installing pollution capture technology which a downstream tax offers. In this case, the entity which burns the fuel is eligible for a refund/subsidy when it proves that it has installed pollution capture technology which reduces its emissions below the pollution content of the fuel that it purchased.

For example, consider a coal mine which sells a tonne of coal to a power plant. The state taxes the coal mine for the pollution content of the coal, making an assumption on the standard amount of CO_2 and sulphur dioxide which the combustion of a tonne of coal will typically causes. The power station, however, proves to the government that it has installed a filter which scrubs the SO_2 out of its emissions and therefore receives a subsidy from the government compensating it for the excess tax that has been collected upstream. With this setup, power stations face the optimal incentives from the downstream tax system to adopt pollution control technology.

For a developing country in which pollution capture technology is currently rare, this tax-and-rebate scheme can significantly cut the administrative costs relative to a downstream taxation system. To see this, consider first the boundary case where none of the power stations in the country currently employs pollution capture technology. In this case, the state can accurately tax the emissions upstream – it just needs to know the average pollution content per amount of fuel. The rebate is never claimed, and the government does not need to monitor emissions of power stations. At the same time, all power stations face an incentive to start adopting pollution control technology.

When the first power station does install such technology, it has a monetary incentive to indicate this change to the government and will be eager to furnish verifiable information on the pollution capture so it can start receiving the tax rebate. For all other power stations in the country, the government continues not to need to engage in the monitoring of downstream emissions. The cost of administering downstream pollution monitoring is, therefore, kept to a minimum. The government only needs to interact with the downstream polluters when there is a diversion from the standard case. Administrative cost is also kept down because the burden of proof is on the polluter, who needs to show evidence of the pollution capture to receive the subsidy. Generally, firms can be assumed to have a better knowledge of their technology than the government, so the burden of proof is efficiently allocated to the "least-cost information provider", reducing overall system costs.

The administrative costs of environmental taxation with this system are the lowest in those countries with the least pre-existing pollution control technology and then moderately increases as the country becomes greener. The countries which currently have the least pollution control technology are also the poorest ones, so this system is the cheapest for the poorest countries.

A more advanced country has more pollution control equipment, so the government will need to engage much more often with the monitoring of emissions at power stations. But even in this case, the administrative costs with this system can be kept in check if the most standard pollution control technologies become mandated through regulations, so that the existence of these technologies can be assumed for the upstream tax. In this case, the rebate is again only given for green deviations from the average, and the government again does not need to engage with pollution monitoring in most cases.

11.6 Extending the tax base beyond fuels

As justified in the introduction of this chapter, our focus in this study is on the environmental taxation of fuels, which for most countries appears to be the best place to start environmental fiscal reforms. Here, however, we provide a quick overview of potential next steps for countries which seek to go further than fuel taxation.

A guiding principle for deciding on extensions to environmental taxation is that "*the tax base should be set so that the benefit of a small expansion in the base is equal to the increase in administrative or compliance costs*" (Metcalf & Weisbach, 2009, p. 521). To be able to address a more comprehensive set of environmental problems, we should thus aim for tax designs with the lowest system costs.

11.6.1 Environmental taxation of concentrated emitters

The administrative costs are generally low when emissions are concentrated on just a small number of emitters.

An example is the production of construction materials, such as cement, glass and steel. In fast-growing developing countries with large construction industries, these materials often account for a large share of total greenhouse gas emissions. The productions of cement, glass and steel normally involve the heating of limestone, which releases CO_2, and often the burning of coal. The emissions from the coal would be addressed by the upstream fuel tax system described above. In addition, the emissions from the limestone can be addressed as well. To this end, cement, steel and glass producers can be taxed for their limestone inputs. The tax can either be charged on the limestone itself or the product for which it is used, depending on where the number of taxable units is fewer so administrative cost can be reduced. For cement production, for example, limestone is mostly used to produce the intermediate product clinker, so the CO_2 can be taxed through a tax on the clinker.

The tax rate would be set by taking readily available emissions factors for the average amount of CO_2 emitted per tonne of the taxed product. The environmental incentives can be improved further by offering tax discounts to companies which adopt a low-carbon method of production.

Another concentrated source of emissions are landfills which emit methane, a more powerful greenhouse gas than CO_2. These can be taxed per amount of waste stored, with a tax discount offered to those landfills which burn the methane and thereby transform it into CO_2. Care must be taken in countries in which public littering is a major problem so that discouraging landfills via taxes could set the wrong incentives: in this case regulations or subsidies for the transformation of methane into CO_2 at landfills might be better instruments.

11.6.2 Forestry

The scheme that I described in chapter 9 was centred on the taxation of imported forest products in the European Union. However, a similar scheme can be applied in countries with low administrative capacity which often rather tend to be exporters of such commodities. Many developing countries have export taxes on deforestation-related commodities; for example in Côte d'Ivoire for cocoa, in Indonesia for palm oil, and in Ghana for timber. These existing export taxes do not vary according to the sustainability of production and as such have low environmental efficiency. Just as with the scheme in chapter 9, the rate of these taxes can be varied by granting (different) discounts for those exported commodities that are certified as "legal" or "legal and sustainable".

Outside of export taxes, it is however administratively rather complex to institute environmental taxation in countries with low administrative capacity. The main reason is that emissions are much more thinly spread and difficult to observe. This is very unlike fuels where the upstream points at which the fuels enter into the economy provide "choke points" that facilitate the taxation of large tax bases with few personnel. The customs gate for exported commodities is such a rare "choke point", making export taxes a good starting point for environmental taxation. But in many of the countries with the greatest governance problems, deforestation is driven by internal demand rather than by exported commodities. For example, Trefon (2016) estimates that 90 % of deforestation in the Democratic Republic of Congo is associated with internal demand (mostly for charcoal) rather than exported goods. In such situations, environmental taxation has a much smaller role to play. We cannot go into this field in more depth here, but refer to the forthcoming book Heine *et al.* (2020) by the World Bank and the International Tropical Timber Organization which covers these issues in detail.

11.6.3 Agriculture

Most emissions in agriculture are hard to tackle through tax policy, but it is somewhat more feasible for the subset of emissions that stems from the use of fertilizers. In many countries, chemical fertilizers are subsidized and by reducing these subsidies the price incentives for environmental protection can be improved. The concentration of fertilizer production in the chemical industry would also facilitate their taxation; equally for pesticides. For the price incentives, it is immaterial whether the environmental fiscal reform reduces subsidies or raises taxes, and as environmental tax policy is not on the immediate horizon for the agricultural sector in many countries, subsidy reform generally deserves greater focus. As an illustration, ODI estimates that Brazil and Indonesia provide approximately 100 times as much in agricultural subsidies as in domestic spending on forest protection (McFarland *et al.*, 2015). As a result, the existing fiscal system may provide price incentives for converting forest land to agricultural uses. Even before a potential environmental tax reform, addressing the balance of these subsidies could importantly contribute to improving fiscal incentives for sustainable land use practices.

Emissions from livestock[2] are rising particularly in developing countries. Dramatic changes in food patterns are underway in particular in China – and once entrenched in culture, these emissions sources are difficult to change. This is a case when policy action now would have long-term benefits in the future. The meat boom gives rise not only to environmental but also public health problems. Since this boom driven by increased greater affordability of meat, price-based instruments may be an appropriate policy instrument. One suggestion has been

[2]Mostly methane from feedstock and manure, and nitrous oxide from enteric fermentation.

to tax livestock per head (Metcalf & Weisbach, 2009), and to focus this tax on industrial meat production, exempting small farmers.

The administrative of such a "head tax" would be eased by the concentration of greenhouse gas emissions on a subset of meat types. The production of a kilo of beef meat produces approximately 5 times as much ${CO_2}^e$ as the production of a kilo of poultry meat, and 3.5 times as much as the production of a kilo of pork. A potential environmental tax of greenhouse gas emissions from the livestock sector could hence efficiently focus on cattle.

The tax rate for a head tax would be based on assumed emissions using widely available average emissions factors. "*The tax rate can only be correct on average. Actual emissions from any particular activity cannot be measured*" (Metcalf & Weisbach, 2009, p. 533). However, there does exist a way to further fine-tune the environmental incentives by using some of the tax revenue to subsidize good practices for climate-smart livestock, such as the adoption of certain feedstuffs which can significantly reduce the emissions of greenhouse gases by cattle.

11.6.4 Vehicles

The taxation of cars is important because once a person owns a car, it is difficult to discourage use through fuel taxes. In particular in countries with a fast-rising middle class, car taxes help determine if private car ownership or public transport grow.

Most countries already tax vehicles, often for non-environmental reasons such as to tax luxury goods. However, with relatively simple tweaks, these taxes can contribute to environmental objectives.

Most countries' vehicle taxes currently take as their bases variables that are not directly related to environmental issues such as the number of volume of cylinders, the vehicle weight, the number of axles, or the vehicle's value. To provide better incentives, countries should instead use a tax base that directly relates to the emissions. For example, the number or volume of cylinders is no efficient proxy of emissions, and a car owner does not impose any cost on society by having a car with more cylinder capacity – so this is not an environmentally efficient tax base. Efficiency improves when the country bases its tax directly on the car's emissions profile. Some countries have therefore converted to letting their vehicle tax vary in proportion of the CO_2 emissions per vehicle-kilometre (ECMA, 2018).

In principle, an efficient vehicle tax does not need to be based on CO_2, it could also be based on the emission of local pollutants, and that can be preferable. The optimal choice depends on country circumstances as follows.

In the case where a country already uses efficient motor fuel taxes, the CO_2 problem is already appropriately addressed. Completely unlike the situation for local pollutants, cars do not vary much in their emissions of CO_2 per litre of fuel (neither between models, not within a model over time). So when the fuel tax is set correctly, there is no significant need to fine-tune the fiscal incentive by also imposing a tax on the vehicles. However, cars do vary significantly in the amount of local pollution per unit of fuel. Therefore, public policy can appropriately set incentives for specific car types, even after the fuel tax already set good price incentives for the average vehicle. Countries typically use regulatory policy to set these incentives for specific car types, but under certain situations, vehicle taxes can be easier to administer.

Countries regulate the allowable exhaust of air pollutants and mandate pollution control technology such as catalytic converters against carbon monoxide or hydrocarbons. With a lag, many developing countries follow the regulatory tightening of these car regulations. In the case of countries where these regulatory policies are already stringent and sufficiently enforced, the role of vehicle taxes is small. In countries where these regulations are lax or weakly enforced, vehicle taxes offer an alternative instrument to incentivise the adoption and improvement of pollution control equipment.

A big problem with pollution control equipment for cars is that for many models, the efficacy of the pollution control decays strongly over time. As a result, older cars even of the same model can pollute significantly more with age. One policy response is to enforce annual check-ups but in many developing countries these are under-enforced. The incentives for fraud in vehicle exhaust checks are large. Enforcement requires that an individual car mechanic undertakes a check of the vehicle exhausts and certifies that the exhausts exceed the allowable level, instead of understating the test reporting in return for a higher fee from the vehicle owner. An alternative approach, which is hard to falsify, is to tax the age of vehicles. The age of vehicles is standard information in states' ownership registries, it is physically embossed in every car's chassis, and additionally available through the serial identification number. These independent data sources allow cross-checks. Since age correlates well with a car's pollution profile, states can use it as a proxy of emission which is not open to corruption. Car owners could be required to pay this tax for their annual vehicle circulation permit. The tax should also be collected at the point of imports. The incentives are not perfect – it is preferable for countries to enforce reliable vehicle emissions tests, but if those are not available, this tax solution is a second-best from an environmental and evasion point of view.

Despite these advantages, vehicle taxes that increase with the age of a car may perform poorly on equity grounds, given that lower-income groups own older cars. This concern should be addressed – but perhaps best with expenditure rather than tax policy, such as by improving public transport, making mobility for all rather than personal car ownership the policy objective. But the concern can also be addressed by taxing imported cars with a tax that strikes a balance between an equity- and an environmental component: the value and the age of a car.

Besides increasing the use of public transport, an increase in vehicle taxes may also increase the use of taxis. Increased taxi use has two positive effects on pollution control. Firstly, taxis are used much more intensively,[3] and therefore wear down more quickly than private vehicles. As a result, the rate of turnover for taxis is larger than for private vehicles. A faster turnover of the vehicle stock, in turn, reduces pollution. Secondly, the operation of taxis requires special licences in most countries which makes it possible for governments to require greater pollution control from them. "*Since taxis have to have licences issued by the city, making special requirements for them is usually simple*" (ibid).

The tax does not resolve all issues – particularly for the oldest cars that pose the greatest hazard to the environment and public safety. If today, regulatory policy in many countries does not manage to take the worst cars out of public circulation, tax policy is unlikely to catch them either. Instead, policymakers would need an instrument that has "self-selection", i.e. an incentive for the owners of the worst cars to cooperate with authorities and voluntarily report and hand in their mobile public safety hazard. Such an instrument is a scrappage subsidy: a monetary reward for handing in a car to a car crusher / steel furnace. To save public funds and to provide the best incentives, the rate of such a scrappage subsidy must be

[3]For example, "*taxis in Mexico City travel about nine times the annual average mileage for personal vehicles*" (Eskeland & Devarajan, 1996, p. 29).

set extremely low. Only the owners of the worst cars will then have the incentive to give up their vehicle in exchange for this fixed amount. The least valuable cars that are taken out through this policy will be a mix of the oldest, most-polluting cars and crash vehicles. The crash vehicles do not necessarily require removal from an environmental point of view but the policy can simultaneously help improve public safety in countries where crash vehicles might otherwise continue to be used.

A scrappage subsidy can be combined with car import taxes to create a revenue-neutral deposit-refund system. In this case, the country would increase the vehicle tax it charges on newly imported / manufactured cars: it would withhold already the amount of money which it will later pay as a scrappage subsidy when the car is eventually scrapped. This is essentially "*a refund provided upon proof of proper disposal*" (Metcalf & Weisbach, 2009, p. 534).

11.7 Conclusion

In line with Coase (1960) and Pigou (1932), we need to beware of the risks that the benefits from internalising an environmental external cost through taxes could be less than the costs of government intervention. Here we have suggested two simple strategies for handling this concern: countries should start environmental taxation by focusing on the environmental problems with the greatest social costs and where taxation is easiest to implement. Fortunately these two priorities coincide in most countries, as those environmental tax bases that are easiest to tax (fuels) are also the culprit for the majority of the nine million pollution-related deaths per year (Watts *et al.*, 2017; Landrigan *et al.*, 2017) as well as for of most greenhouse gases. And if the highest social costs coincide with the greatest feasibility of environmental taxation, the risk of undue government intervention seems to be contained.

We have then identified how exactly fuel taxation can be undertaken with the least cost given different country circumstances and vulnerabilities for government failure. Lastly, we considered the cases of countries that have taken these first steps, found that they worked and are ready for the next step in environmental taxation. We described what additional tax bases they could focus on while remaining very prudent in both the scope and the types of taxation.

Over time, it will be essential to go far beyond the tax schemes described in this chapter. However, government capacity has to be built over time, and most Finance Ministries are very new to environmental taxation. Therefore, this chapter has therefore sought to help these ministries get started safely.

Chapter 12

Equity: Managing distributional implications*

In Law and Economics, there are controversial debates whether distribution should be a separate objective of our efforts to improve the law or not.[1] Some argue in favour of concentrating on efficiency only, others not. For Finance Ministries, however, there is no such choice. Politically, Finance Ministries are held accountable for distributional outcomes, and in Public Economics it is widely accepted that distributional objectives are one of the core objectives of fiscal policy (e.g. Calitz & Siebrits, 2006). So as distribution impacts the institutional role and deliverables of Finance Ministries, a Law and Economics analysis of environmental taxation must take distributional implications into account.

Most previous analyses of equity issues with environmental taxation have focused on the USA and Europe. Therefore, the chapter reviews that literature, but then adds to it, by focusing on developing countries where distributional and environmental problems tend to be greater to start with.

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[1] See, for example, Posner (1979) and Sanchirico (2001) for polar perspectives within the mainstream of that debate.

12.1 Learning from the fuel subsidies literature

The literature on distributional effects of fiscal reforms of fuel prices is divided into two fields: there is an extensive literature on distribution effects for the reduction of fossil fuel subsidies and a smaller literature on the impact of carbon pricing. Maintaining that split makes sense for certain types of environmental taxation: as discussed above, carbon taxes and emissions trading systems have often been applied downstream on the source of the emissions rather than upstream where the fuels enter the economy. Also, environmental taxes have been applied to a wider tax base than fossil fuels, such as to forestry where the distributional consequences differ severely from fuel price changes. However, in the chapter on administration, we described why for developing countries, it makes sense to focus environmental taxation on precisely the upstream taxation of fossil fuels. In this case, the increase of environmental taxes and the reduction of fossil fuels have similar impacts on income distributions. There are some important caveats in specific cases, which we deal with, but it would be wrong to ignore the results from the fuel subsidies literature when investigating the effects of environmental taxation.

Using the results from both streams of the fiscal literature is also essential because the absence of environmental taxation can have impacts that economically resemble subsidies. Stiglitz (2006) and the IMF (Coady *et al.*, 2017) suggest that when an environmental externality is not being taxed according to its damage to society, there is an implicit (post-tax) subsidy, similar to a tax expenditure. Therefore, in the following, we will use results from both fossil fuel and environmental tax reforms apart from specific caveats for which we concentrate on the environmental tax literature only.

With many caveats which we explore below, the subsidies literature broadly finds that "*Fossil fuel subsidies are almost always highly regressive, as the main beneficiaries either higher income households or specific industries. Diesel and gasoline subsidies are particularly regressive, as they are used primarily for private transport*" (IEA, 2016, p. 21).

Despite this regressivity, fuel subsidies do provide important benefits to the poor. Removing them may require alternative poverty alleviation policies. When those are put in place, significant efficiency gains are possible. "*Investing the public revenues freed by a subsidy reform to promote development goals, such as health,* *education, or access to basic infrastructure, predominantly benefits poor household and can thus generate a 'double progressivity'*" (Schwerhoff *et al.*, 2017, p. 3).

The remainder of this chapter is structured as follows. We follow Atkinson & Stiglitz (1980) in decomposing the impacts of fuel price changes into their effects for the uses of income (section 12.2) and the sources of income (section 12.3). For the uses of income, section 12.2.1 considers the effect that most environmental tax bases are normal goods, so that consumption rises with income, implying that higher income groups pay a greater absolute amount of environmental taxes on fuels. This progressive effect is often dominated by the regressive effect which the tax has when the poor spend a larger proportion of their income on the taxed product – we consider this effect and its quantitative importance in section 12.2.2. Section 12.3.1 turns to General Equilibrium effects that occur as environmental taxes change the incomes from factors of production, impacting higher-income households differentially due to their higher share of income derived from capital. Section 12.3.2 considers that also resources and ecosystem services as additional factors of productions are of unequal importance for rich and poor, implying that environmental tax reforms conserving these factors have distributional consequences. Section 12.4 presents results on the net joint impact, focusing on the more easily quantifiable channels from sections 12.2.1, 12.2.2 and 12.3.1. It shows that environmental taxation can enable net improvements in income distributions, mostly as the progressive General Equilibrium effects on income sources trump the regressive impact on income uses. We first consider this net impact without simultaneous changes to expenditure policies (12.4.1) and then the joint impact when revenues from environmental taxation are used for expanding poverty alleviation measures (12.4.2). For those poverty alleviation measures for which the quantitative literature finds the largest impact, we review the administrative feasibility (12.5) before analysing the extent to which these distributional concerns require a trade-off between efficiency and equity objectives. We find that this trade-off is small: it is feasible with carefully designed environmental tax reforms to simultaneously pursue output and distributional objectives.

12.2 Uses of income

12.2.1 Absolute amounts of expenditure

In the absence of environmental taxation, the social cost of greenhouse gases emitted in the production of a good is omitted from the price of the good. The decision of the government not to price these emissions conveys an implicit benefit to the consumers and producers of the product, since these product features are then implicitly paid for by society at large, similar to an indirect subsidy. This benefit is implicitly paid on a specific-rate basis, meaning that the benefit accrues per unit of the product. When this product is a "normal good" – such that its consumption rises with the income of consumers – the absolute number of times that this implicit benefit accrues to any given consumer rises with that consumer's income. This means that for all carbon emitted in the consumption of normal goods, the benefits of omitting the social cost of production from the goods price accrues more often to a rich than to a poor person. In that sense, the absence of environmental taxation is a regressive policy, which distributes economic benefits to higher-income groups. The costs of this implicit transfer are borne by society as a whole, for instance through climate change.

The aforementioned implicit benefit can be an abstract concept but it represents actual monetary benefits in the sense of a tax expenditure: these benefits are forgone taxes that would have been collected from the consumer but that were not collected because of the absence of environmental taxation. Modern fiscal theory suggests that such tax expenditures need to be treated much like direct government expenditures, so this implicit transfer needs to be viewed much like a payout.

Besides this static impact on inequality, this implicit transfer also has a dynamic impact. A person who is presently rich and therefore consumes a greater absolute amount of a given normal good that whose production causes pollution receives a greater absolute amount of these implicit benefits, making this person even more well-off in the next period. In the next period, this person may then consume even more of this normal good, further exacerbating the inequality. The absence of environmental taxation, therefore, acts as a scalar on the pre-existing income inequality in society and grows that inequality further. Ceteris paribus, the more unequal a society is at present, the greater is this scalar effect for its future inequality. The absence of environmental taxation, therefore, burdens future generations not only through the destruction of the environment that could have been averted, but also because it encourages the growth of inequality over time.

The empirical literature on fuel subsidies quantifies to what extent the absolute amount of benefits from under-priced fuels falls on higher income groups. For a sample of 20 developing countries, Arze del Granado *et al.* (2012, p. 2234) show that "*In absolute terms, the top quantile captures six times more in subsidies than the bottom.*" For gasoline and LPG, the income quantiles benefit 20 and 14 times more than the bottom quartile (ibid). "*Even when subsidies reach a substantial portion of the poor, most of the benefits still accrue to the well-off*" (...) as "*middle- and high-income groups receive the largest share from energy subsidies, partly because of higher consumption levels and the higher rates of car ownership and connection to the national electricity grid among these segments of the population*" (Sdralevich *et al.*, 2014, p. 13).

These findings robustly hold for many countries. In India, the richest ten per cent of households capture seven times more benefits than the poorest ten per cent of households (Anand *et al.*, 2013). In Angola, about 80 % of refined fuels (gasoline, LNG, diesel, and kerosene) is consumed by the richest 40 % of households. The poorest 40 % consume only 7 % of these products. As a result, the richest 40 % capture 77 % of fuel subsidies and the poorest 40 % receive only 10 % of these subsidies. The bottom 20 % only 1 % of price subsidy (Fabrizio *et al.*, 2014). Likewise in Ghana, about 78 % of the fuel subsidies in Ghana is captured by the top quantile and less than 3 % of low prices benefited the poorest one (Cooke *et al.*, 2016). For Indonesia, Dartanto (2013) finds that between 1998 and 2013 almost 70 % of fuel subsidies benefited the top 30 % income groups. Araar *et al.* (2015) analyse the case of Libya, confirming that the benefits from suppressing motor and electricity prices are regressively distributed in absolute terms. Moreover, Arrar & Verme (2016) confirm that generally for energy subsidies in the Middle East and Northern Africa, the absolute amount of the benefits received increases towards the richer households.

12.2.2 Relative amounts of expenditure

12.2.2.1 The classic argument

While the poor have a lower total expenditure on most polluting products such as energy and hence do not benefit from the mentioned implicit subsidies as often, in many countries the lower middle class spends a larger proportion of their income on energy. For richer countries, this asymmetry can start already from the very poor. As a result, in developed countries, the relative income effect implies that low-income households will generally be harder hit by an environmental tax on fuels than the rich.

The effect also holds for subsidies. Clements *et al.* (2013, p. 24) find that "*although most of the benefits from energy subsidies are captured by higher-income groups, as noted earlier, energy price increases can still have a substantial adverse impact on the real incomes of the poor, both through higher energy costs of cooking, heating, lighting, and personal transport, as well as higher prices for other goods and services, including food*".

One explanation is that there can be a minimum amount of carbon-intensive goods that all people must consume. This need is called a subsistence level of carbon-intensive consumption (Klenert & Mattauch, 2016). Grainger & Kolstad (2010) show the existence of such a subsistence level in the USA, where the consumption of carbon-intensive goods does not fall below a certain level even for the poorest citizens. They find that the existence of this subsistence level in carbon-intensive goods is the main explanation of the relative income effect in that country.

While this effect is a serious concern, it does not apply in all country circumstances. We turn to this variation next.

12.2.2.2 Variation of the problem in different country circumstances

Equity of income or consumption

Results on the regressiveness of a carbon tax stemming from expenditure shares importantly depend on how income is measured. Using consumption as a measure of income, Mathur & Morris (2014) find that a US carbon tax is much less regressive than when reported incomes are used for this analysis. This result is widely confirmed in the environmental tax literature also for other countries (Metcalf & Hassett, 2012; Sterner *et al.*, 2012). "*The primary force driving this difference is the tendency for consumption to be more evenly distributed than income, especially in the lower brackets*" (Mathur & Morris, 2014, p. 329).

These differences matter in particular for the poor in developing countries where consumption surveys can be a more accurate indicator of real income than stated incomes. Moreover, also in developed countries, it can be that "*annual income is a poor proxy for lifetime well-being*" when people "*have transitorily low income or may be at a low income-earning stage of their careers. In both these cases, consumption to income ratios may be unusually high and may provide a misleading picture of the distributional impact of consumption-related taxes (like energy taxes) or carbon pricing policies*" (Metcalf & Hassett, 2012, p. 22). As a result, studies on the distributional consequences of carbon taxation tend to find that when consumption is used to rank people's well-being, the relative effect of environmental taxes on household expenditures is more evenly distributed between the poor and the well-off.

Development levels

For the richest countries, it is generally true that the poor spend a larger proportion of their income on carbon-intensive products; but this asymmetry does not always apply in poorer countries (Sterner *et al.*, 2012). In particular for motor fuels in poor countries, the share of income spent on this consumption systematically rises with the income of individuals. How important this effect is varies between tax bases.

Tax bases

The distribution of expenditures on different polluting products importantly varies, and so do therefore the distributional consequences which environmental taxation imposes through expenditure shares.

For the environmental taxation of fuels, evidence from the subsidies literature suggests that, in developing countries, increasing the price of gasoline and electricity subsidy is generally progressive, as the share of these products generally rises with personal income, but that the opposite is true for kerosene prices (Arze del Granado *et al.*, 2012). In Ghana, for example, the poorest quantile does spend a larger share of their income on kerosene, but that is not true for gasoline, diesel, and LPG (Cooke *et al.*, 2016). In China, "*the proportions of coal and electricity expenditures in the total expenditure decreases with the improvement in income, while the share of transport fuel expenditure in the total expenditure increases with income improvement*" (Jiang *et al.*, 2015, p. 119). Sdralevich *et al.* (2014, p. 13) confirm that "*the share of subsidy spending on kerosene, liquefied petroleum gas, and food that accrues to the poor tends to be higher than for diesel, gasoline, and electricity, but there is wide variation across countries.*"

For other environmental tax bases than fuels, the distributional consequences are much less clear. "*Natural resource rents on commercial resource extraction are generally progressive, as the benefits of commercial natural resource extraction generally accrue to larger producers –often foreign-owned. However, rent taxes on small-scale extraction such as permits fees for small-scale timber or fisheries can be regressive*" (Boyd *et al.*, 2005, p. 24). This regressive impact of taxing timber is, in particular, a concern for domestically consumed products such as charcoal, which is produced and consumed by poor households (Anthon *et al.*, 2008). At the same time, it is not so clear-cut that taxation of natural resources is regressive. As for fuels, also in forestry, there is a contradiction in the distribution of the absolute amount of forestry taxes and the relative amount as a share of personal income. This is because, similar to fuels, the share of total consumption derived from forest services tends to be higher for the poor, whereas the absolute amount of consumption derived from this source rises in total household income (Campbell *et al.*, 2002; Cavendish, 2000; Narain *et al.*, 2005; Anthon *et al.*, 2008).

Time

The distributional consequences of environmental taxes are likely to be better in the long-run compared to the short run. Given the credit constraints of the poor, it can take them longer to adjust than richer households. For example, if rich households purchase new cars whereas the middle-class purchases used ones, the poor are locked into the energy-related capital which was purchased in the past on the basis of low fuel prices. Cockburn *et al.* (2017) confirm that consequentially the distributional consequences of proposed fiscal policy increasing fuel prices in Egypt and Jordan are better in the long- than in the short-run.

Indirect price changes

The poor are affected not only by the cost shock that an environmental tax reform imposes on the taxed product itself (e.g. the impact of a carbon tax on the fuel price) but also its effect on products which use the taxed product as an input. There is much debate on the quantitative importance of these indirect cost shocks for income distributions.

There is some evidence that the indirect price changes from environmental taxes are more evenly shared than direct price changes. In the USA, "*the indirect component* [of price changes] *is roughly proportional between the top and bottom deciles*", because "*direct consumption* [of fuels] *has the characteristics usually associated with necessary consumption, while indirect consumption has a more varied distribution*" (Mathur & Morris, 2014, p. 329).

Besides the question of how evenly indirect price changes are shared between the rich and the poor, there is a debate on the size of these indirect price changes. Arze del Granado *et al.* (2012) find that the indirect cost channel is significant – in their sample of 20 fuel subsidy reforms, more than half the of the income shock to households came from indirect effects on the price of other goods and services. In India by contrast, only 25 % of the total cost shock experienced as a result of phasing out underpriced fuels would come from price changes of goods and services using fuels as an input (Anand *et al.*, 2013).

How important the impact on the price of other goods is also depends on the structure of the economy. In Angola, for example, the fact that the economy importantly relies on imported goods, implies that only 10 % of the cost shock for the bottom 40 % would come through changes in the price of other goods and services; 90 % of the shock stems from the change in the fuel price itself (Fabrizio *et al.*, 2014). Besides import shares, the extent of indirect price changes also depends on the fuel intensity of production. For example, in India, there would be little effect of fuel price changes on the agricultural sector (Morris & Sterner, 2013).

12.3 Sources of income

12.3.1 Factor income shares

Besides its impact on household expenditure, carbon taxation may also have general equilibrium effects impacting household incomes. Factor prices may change as a result of carbon taxation, and studies accounting for this channel are generally more optimistic about the distributional consequences of environmental tax reforms than studies considering only the partial equilibrium effects of changes on household expenditure. "*Once one allows for sources-side incidence (i.e. differential impacts of changes in real factor prices), carbon policies look more progressive*" (...); "*this holds true whether we rank households by annual income or consumption*" (Metcalf & Hassett, 2012, p. 31).

In general, higher income groups have a larger proportion of their income from capital income; "*if carbon-intensive industries are also capital-intensive and capital is easily substituted by labour, returns on capital will decline more than real wages*" (Beck *et al.*, 2015, p. 41). Therefore, "*when some of the carbon tax burden is borne by households via their sources of income, then the burden on lower deciles is reduced relative to the case when the entire burden is on households in their roles as consumers*" (Mathur & Morris, 2014, p. 332). This finding is significant because a 1:1 pass-through is rather the exception than the standard (Metcalf *et al.*, 2008).

Besides the impact on capital, another consideration is the change in the relative value of government transfers. Carbon taxes can reduce both real wages and the return on capital, while government transfers that are adjusted for inflation would not generally be affected by carbon taxes. Distributional outcomes then vary depending on the share of incomes which households derive from these different factors of production, the factor intensities of pollution-intensive industries, and factor substitution rates in these industries as well as the economy as a whole. In developed countries, the poorest decile generally has a larger proportion of their total income from transfers – leading to the carbon tax burden being shared progressively (Rausch *et al.*, 2010).

Besides impacting households differently depending on the factors from which they derive their income, environmental taxation may also contribute to changing the overall factor intensity of the economy. Coste, Calì & Heine (2019) find that environmental taxation empirically causes a shift towards more labour-intensive production. Labour-intensive production, in turn, is often seen as providing improved employment opportunities for the poor.

12.3.2 Distribution of averted damages

Besides the distributional consequences of the environmental tax itself, it is essential to consider the distribution of the environmental gains realised as a result of the policy. These gains tend to accrue more to the poor, in particular at the very bottom of the global income distribution.

One reason is that the physical damages from environmental destruction are concentrated in poor areas. This holds for climate change, for which the damage for the Southern hemisphere is expected to be greater than for the Northern hemisphere. The poor also generally live closer to sources of air, soil and water pollution.

But not only the distribution of the physical damage hits the poor more than the rich – also the impact per unit of that physical damage is worse for the poor, in terms of utility and income. Under a standard definition of concave utility functions, the same loss implies a greater reduction of utility for the poor. This means that the consequences for well-being are distributed even worse than the already unequal distribution of the physical damage. This asymmetry is further aggravated in monetary terms because the poor derive a greater proportion of their income from those sectors that are damaged most, such as agriculture, forestry, fisheries. "*It is normally the poor who rely most on the natural resource base for their livelihoods*" (Boyd *et al.*, 2005, p. 21). For example, "*forest resources contribute to the livelihoods of 90 % of the world's 1.2 billion people living in extreme poverty*" (World Bank, 2004, p. 1). This importance of natural resources to the poor may be most pronounced during bad times: for example, it has been shown that forest-derived incomes provide safety nets in the sense of a substitute income during shocks to other income sources of the poor (McSweeney, 2005; Pattanayak & Sills, 2001).

Each of these asymmetrically-distributed effects is aggravated by the lack of resilience to shocks that come from lacks of information (e.g. not only have the poor a higher likelihood to come in contact with toxic chemicals but they also tend to lack information about such dangers and hence will not seek protection), credit constraints (e.g. the inability to invest in climate-resilient agriculture, housing, etc.), government administrative capacity, among other factors.

12.4 Net effect

12.4.1 Without compensation

Here we consider the literature on the joint, static impact of environmental taxation on the uses of income and the changes in production factor incomes. We do not include our preceding considerations on the distribution of averted damages since these usually are not quantified.[2] In making this omission, we introduce a bias towards finding a regressive impact.

Unfortunately, most of the literature on environmental taxation does not consider the General Equilibrium effects on factor incomes, but only the expenditure side. Additionally, the available studies are for developed countries, whereas the question of distributional and poverty impacts may be most important in developing countries. Nevertheless, the results are informative with the following caveat. As we discussed above, the cross-country evidence suggests that the likelihood of a fuel price increase regressively impacting the uses of income is larger in developed countries than in developing countries. Therefore, we would rather expect a bias towards finding a result of overall regressiveness by focusing on developed countries.

Metcalf & Hassett (2012) and Rausch *et al.* (2011) both estimate the net distributional effect of carbon taxation in the United States, taking into account the effects on household income and expenditures. Both find that the distributional impact importantly varies depending on whether full path-through of the tax to consumers is assumed. When a proportion of the tax burden is passed backwards to companies so that the factor input prices for capital and labour change, the tax becomes significantly more progressive. In the highly detailed CGE analysis of distributional outcomes between among 15,000 US households in Rausch *et al.*

[2] Again, we are following the standard bias in the Pigouvian literature towards zero-rating factors of which we know the direction of the impact but do not have information for a precise quantification. Again the impact of making these exclusions is to bias the results on the case for Pigouvian taxation conservatively, which is the opposite of what Demsetz (1996) claimed.

(2011), the net impact from the tax alone (already before the revenue use is considered), is progressive. In the distributional analysis based on household income and consumption surveys in Metcalf & Hassett (2012), the authors consider the impact of a carbon tax whose burden is shared 50-50 between consumers and firms, and where that burden on firms is again split 50-50 between the owners of labour and capital. They find that the net impact of carbon taxation is mildly regressive to mildly progressive, depending on whether stated consumption (progressive) or stated income data (regressive) is used for the ranking of households.

Beck *et al.* (2015) investigate the distributional consequences of carbon taxation in British Columbia. They find that the differences between households regarding the share of energy in their consumption bundles appear to vary less across the income spectrum than the factor composition of their income sources. Therefore, "*while consumption shares of each good fall within a fairly narrow range for all households, the share of income from labour, investment, and government transfers varies very significantly across households*" (Beck *et al.*, 2015, p. 52). Accordingly, "*it would take a very substantial change in product prices for the small differences in consumption shares to impact significantly on relative household welfare*" (ibid). "*In other words, the progressivity of the carbon tax comes from the income source heterogeneity*" (id., p. 55).

12.4.2 With compensation

12.4.2.1 With basic incomes

The above-mentioned encouraging results from Beck *et al.* (2015), Metcalf & Hassett (2012) and Rausch *et al.* (2011) refer to a progressive net impact before the use of revenues, i.e. before any compensation has been paid. The authors also consider the net impact when compensation is paid in the form of per-capita transfers and find that the progressivity increases further. Other authors confirm this finding. Even in studies that do not consider the General Equilibrium impacts on the sources of income and that find a regressive impact of environmental taxation when no compensation is paid find that there is a net improvement in distribution when the revenue is used for per-capita transfers.

In their analysis of carbon taxation in the US, Metcalf & Hassett (2012) find that when three quarters of the revenues are used for per-capita compensation payments, the carbon tax reform becomes highly progressive. This finding holds even under the assumption that the entire tax burden is paid by consumers – when that tax burden is shared between households and firms (i.e. when it changes factor prices for capital and labour) that progressivity increases further.

A recent paper of the US Treasury agrees. Even without consideration of the effects on factor incomes, a revenue-neutral carbon tax of which the receipts are rebated back to citizens on an equal per-capita level would benefit the bottom 70 % of the US population (Horowitz *et al.*, 2017). Landis *et al.* (2017, p. 20) consider this case in a CGE model for Switzerland, finding that "*as a given amount of revenue has the higher relative impact on the income of low-income households, the per-capita recycling yields a markedly progressive incidence pattern.*"

Klenert & Mattauch (2016) consider such reforms theoretically, confirming that "*for the case of uniform lump-sum recycling, the overall effect of the tax reform is progressive*", even if there is a subsistence level of carbon-intensive products that also poor household must always satisfice (Klenert & Mattauch, 2016, p. 101). Sdralevich *et al.* (2014) analyse such a similar fiscal shift, from fuel subsidies to per-capita transfers, in Middle Eastern and Northern African countries. They find that for motor fuels, LPG and electricity alike, in none of the countries do the poor benefit as much from the low-priced fuels as they would have in the case where the revenues had instead been used for an even per-capita handout. For most fuels, the distributional consequences of an even handout would be vastly superior.

An informative case study for a reform of this type is Iran. From 2010-2012, Iran replaced its fuel subsidies with a minimum income, using 50 % of the saved revenue. This was enough to reduce inequality dramatically, from a Gini coefficient of 0.42 to 0.34 (Salehi-Isfahani, 2011).

12.4.2.2 With reductions in other taxes

When the revenues from an environmental tax are used to proportionately reduce all other taxes payable by all agents across the entire income spectrum, "*the benefit to the highest income households of the reduction in other taxes is greater than their share of the burden of the carbon tax*" (Mathur & Morris, 2014, p. 333). If instead the revenues are used for a more targeted reduction of taxes paid by lower income groups, more progressive outcomes can be reached (Chiroleu-Assouline & Fodha, 2014).

12.4.2.3 With reductions in the personal income tax on low-earners

Chiroleu-Assouline & Fodha (2014) model a carbon tax whose revenues are used to finance budget-neutral reductions in wage taxes for low earners. They prove that "*whatever the degree of regressivity of the environmental tax alone, it is possible to re-design a recycling mechanism that renders the tax reform Pareto-improving, by modifying the progressivity characteristics of the tax system, instead of lump-sum transfers or any other form of homogeneous compensation*" (id., p. 126). Their model assumes fixed labour supplies and that the poor pay wage taxes to start with, so this model does not consider the informal, untaxed employment of many of the poor in developing countries.

In the case of Russia, Orlov & Grethe (2012) undertake a CGE analysis of the net impact of a tax shift from labour to carbon taxation. They find that *"overall, substituting carbon taxes for labour taxes results in increases in net income of low and middle-income household groups (from decile 1 to decile 6), with the relative increases in net income being especially large for the poorest households*" (id., p. 696).

Reducing the personal income tax (PIT) can, however, also be regressive (e.g. Metcalf, 1999). This result is confirmed in Klenert & Mattauch (2016) for the case where also the poorest citizens need to consume a certain minimum (subsistence) level of pollution-intensive goods, which is likely in developed countries (Grainger & Kolstad, 2010) but less likely in developing ones Sterner *et al.* (2012). If pollution-intensive products are normal goods without a threshold, subsistence level consumption, Klenert & Mattauch (2016) find that an environmental tax that is rebated through a reduction of the personal income tax neutralizes any regressive impact. A notable case where reducing the PIT can have regressive effects exists in developing countries where the poor are typically not liable to pay PIT. If, for example, the poor are in the informal market and do not pay PIT anyway, a carbon tax (which captures the informal sector) whose revenues are used to reduce PIT (which does not capture the informal sector) may be regressive. This is a static effect, however, because the reduction of the PIT would also support the poor by helping to absorb them in the formal sector. To maximise this effect, the PIT reduction should not be applied across the entire income spectrum but be focused on lower income groups.

12.4.2.4 With reductions in the corporate income tax

Marron & Toder (2015) model the distribution effects of an environmental tax reform whose revenues are used to lower corporate income taxes. Since the benefits of reducing corporate income taxes are greater for more affluent households compared to poorer ones, they find that this reform would be regressive, even though it may raise economic growth (Metcalf, 2007).

12.5 Feasibility of compensation

The preceding section found that a progressive net effect of environmental taxation is possible, potentially without compensation, but certainly when the revenues are used to compensate the poor. However, to be a viable political strategy, a carbon tax reform which raises the cost of fuels and compensates the poor must be administratively feasible. To control the risk of governance failure, compensation should at best also be simple, reusing where possible existing governance systems that are known to work, and modern surveillance technologies that protect payments against corruption.

12.5.1 Feasibility on the tax side

In chapter 11 we have shown why the carbon tax itself is feasible even in countries with minimal administrative capacity. However, in light of the previous sections, a pro-poor environmental tax reform can involve simultaneous changes not only of the tax but also of compensatory fiscal policies. Here we, therefore, consider if that compensation side would also be feasible.

12.5.2 Association of distribution and feasibility concerns

In section 12.2 we have seen that the need for compensating the poor for environmental tax reforms might increase as we go from the very poorest economies towards lower-middle-income countries. This was because in the poorest economies, the share of fuel expenditures already decreases in personal income, so the tax burden on its own is more likely to be progressively distributed, even before considering General Equilibrium effects and the distribution of gains from the averted environmental damages. Equally, in the most impoverished economies, the administrative problems in paying compensation might be the most severe. As a result, there is a tendency for the need and the feasibility of compensation for environmental tax reforms to coincide. The coincidence is far from perfect, however. For example, oil-producing countries often have low fuel prices, high environmental damages, a need for appropriate price signals to diversify, and hence perhaps the greatest need for environmental taxation (or subsidy reduction), but also significant governance issues associated with the Resource Curse. So the administrative feasibility of compensation schemes cannot be taken for granted. As a result, it remains critical to carefully consider the administrative feasibility of environmental tax reforms with compensatory poverty alleviation policies despite the mentioned general association between need and ability.

12.5.3 Concerns in the literature

The literature generally suggests that compensation for higher fuel prices is feasible in various country contexts, but that different types of compensation strategies come with different demands for administrative capacity.

Concerns about the feasibility of compensation have been voiced for targeted transfers. Hallegatte *et al.* (2016) argue that in countries with weak institutions, higher income groups are typically more able to attain government transfers. Raworth *et al.* (2014) agree that means-tested transfers require substantial institutional capacity and might therefore not work in all countries. However, even in those cases, Sdralevich *et al.* (2014) suggest that countries should not continue using their low-priced fuels, but instead focus on alternative compensation mechanisms that are easier to implement. The argument here is that even if simple compensation schemes are not as well-targeted as means-tested transfers, they will nevertheless still represent a large improvement in targeting relative to low-priced fuels. Therefore, "*when cash transfers are not feasible because of limited administrative capacity, other initiatives, such as public works programs, can be expanded while capacity is developed*" (Sdralevich *et al.*, 2014, p. 29).

Useful public works, however, are also not easy to implement, even though schemes such as "Workfare" can have strong targeting on the poor through self-selection mechanisms (Jalan & Ravallion, 2003). Where these administrative capacities are lacking, it has been suggested that universal per-capita transfers (or "basic incomes") might perform better (Murgai *et al.*, 2013). It is the same per-capita transfers for which we have seen many quantifications in the literature suggesting that there would be a strong improvement in income distributions. In the following, we, therefore, consider whether at least basic incomes would be feasible as a method for paying compensation for environmental taxation. This focus is not to suggest that basic incomes should be the preferred method to pay such compensation, but to scope out whether even in cases where administrative capacity is weak, there is a functioning route for pro-poor environmental tax reforms.

12.5.4 Feasibility of per-capita transfers

Despite their popularity in the environmental tax literature, a concern for the feasibility of using Basic Incomes as a compensation policy has been that countries might lack the financial inclusion to carry out per-capita transfers. However, recent technical advances in the availability of new cash transfer methods mean that the feasibility of per-capita transfers has increased rapidly, even in countries with low administrative capacity for fiscal policy.

Electronic delivery is becoming a common feature of many social cash transfers in developing countries (HPN, 2012).[3] These systems are already being used to compensate the poor for so many comparable interventions, such as for fuel subsidy reforms and basic incomes,[4] that it seems entirely feasible to equally implement

[3] In 2016, there were 277 million registered mobile money accounts and over 100 million active users in Sub-Saharan Africa (GSMA, 2017). For instance, in Kenya, registered mobile money accounts were slightly less than 35 million in 2016 (IMF, 2017), which shows that this technology has the potential to reach large segments of the population (more than one account per adult; IMF, 2017). Similarly, in Ivory Coast, there were 944 registered mobile money accounts per 1000 adults in 2016 (ibid). Many African countries mobile money accounts have already outnumbered commercial bank accounts (ibid). Also, these data show the existence of a negative correlation between registered mobile agents and ATMs in Africa, suggesting that mobile money can be a valuable substitute for more traditional electronic cash transfer modes.

[4] For instance, in 2008, the Dominican Republic reformed LPG subsidies and introduced electronic cash transfers destined to the 40 % less affluent segment of the population via chip cards (Inchauste & Victor, 2017). Magnetic strip cards are instead regularly used by Brazil to transfer cash to more than 12 million households (Pickens *et al.*, 2009). In Kenya, electronic cash systems have been used to pay basic incomes (GiveDirectly) and to pay disaster relief (Oberländer & Brossmann, 2014). Niger used electronic cash for a social protection program after a drought/food crisis in 2009/2010 (Aker *et al.*, 2011).

long-term cash transfers to compensate the poorest segments of the population for carbon taxes. More generally, the availability of multiple technical solutions,[5] each of which may better apply in different contexts, suggest that per-capita transfers are a feasible fall-back option in a great variety of country circumstances.

12.6 Trading off equity and efficiency?

12.6.1 The classic argument

The literature finds that the impacts of environmental tax reforms for economic output would be best when the revenue is used for reducing other, more distortionary taxes rather than per-capita rebates to finance a basic income (e.g. Goulder & Hafstead, 2013). At the same time, the literature equally finds that the distributional impacts are best under the opposite revenue usage (Klenert & Mattauch, 2016). Carbone *et al.* (2013) rank, in a US context, how well reductions in other taxes affect output: corporate income tax, labour taxes, consumption taxes, lump-sum dividends. This ranking is consistent with other studies (Mathur & Morris, 2014), and it contradicts recommendations on the grounds of distributional concerns which often supported per-capita transfers as a politically viable and administratively simple way of redistributing revenues.

Many authors have therefore suggested that environmental tax reforms are necessarily torn between contradicting objectives for output and equity. And that trade-off can certainly exist, but it is important to differentiate between trade-offs existing on the mere basis of the economic evidence and trade-offs resulting from political dynamics. Here we consider both in turn.

[5] There are now three main technological solutions to transfer cash electronically (Oberländer & Brossmann, 2014): chip cards; magnetic stripe cards; mobile money. Chip cards and magnetic stripe cards require recipients to cash compensation at designated pay points after being identified. Identification can occur via PIN or biometric identification systems (e.g. iris scans) for chip cards. For magnetic stripe cards, identification can occur via PIN or signature. The designed pay points can be of different types, such as ATM; post offices or Point-of-Sale (PoS) devices. Mobile money is an alternative possibility which requires governments to create accounts for recipients with mobile network operators. Each account is connected to a phone number and a PIN. The transfers can be accessed: i) by providing the PIN to a mobile money agent, meaning a designed private entity that receives a fee for the service; ii) directly via phone to make transfers to other accounts and buy goods and services (Aker *et al.*, 2011; HPN, 2012).

12.6.2 Economic evidence

Since there is some uncertainty over the net distributional effect, we note here the consequences for different cases.

If it is true that the net impact on distribution is progressive already before compensation, there is no trade-off in the sense that the environmental tax reform would not force a need for compensation. Environmental taxation can then still be undertaken together with reforms to improve income distributions or reduce poverty, and the revenues raised through the environmental tax can be used to finance such policies. But the trade-offs for revenue use are in this case not different to general trade-offs from using tax revenue for improving income distributions or lowering poverty. There would not be an added complexity caused by environmental taxes compared to those normal trade-offs of fiscal policy.

As for revenues from other taxes, if policymakers choose to finance additional poverty alleviation measures, the choice of the measures impacts the efficiency cost. There is a trade-off in the sense that reducing more distortive taxes may likely have better consequences for economic output but lower distributional gains. Also in this case, strategies exist for managing this trade-off, for example by concentrating the tax reductions on low-income households, which would be conducive to distributional objectives while also being supportive of labour market participation incentives and incentives for the most relevant section of the population to transition from the informal to the formal labour market.

If instead, the net impact is regressive, there is a trade-off. The quantitative importance of this trade-off can be conceived as the proportion of tax revenues that must be devoted to attaining distributional objectives before the remaining revenue is used to pursue output objectives. The quantitative literature suggests, however, that the proportion of revenues needed for redistribution is small. Even those studies that find a net regressive effect of environmental taxation before compensation, report that a significant proportion of the tax revenues remains after compensation has been paid so as to prevent any negative distributional consequences for the poor. For Europe and the United States, a maximum of 10-12 % of the tax revenues would be sufficient to compensate the 20 % poorest (Dinan, 2015; Vivid Economics, 2012). In Iran, using 50 % of the revenue for compensating the bottom 80 % resulted in a large reduction of poverty and inequality (Salehi-Isfahani, 2011). In a dynamic CGE-microsimulation model of proposed fuel subsidy reforms in Egypt and Jordan, Cockburn *et al.* (2017) confirm that "*a modest reinvestment of fiscal savings into cash transfers creates a win-win scenario of reduced poverty without significantly sacrificing the fiscal and growth benefits from the reform*" (id., p. 1) "*This illustrates the possibility to combine government objectives to cut energy subsidies and the fiscal deficit, stimulate investment and growth, while combating poverty*" (id, p. 19). The estimates hence vary, but they have in common that a substantial proportion of tax revenues would remain even after revenues are used to compensate the poor.

And even the proportion of revenues spend on distributional objectives does not necessarily represent a loss in efficiency – it depends on how the compensation is carried out. Recent research by World Bank and IMF economists questions the existence of overall efficiency-equity trade-offs: policies to improve income distributions can raise growth (Brueckner & Lederman, 2015; Dabla-Norris *et al.*, 2015; Ferreira *et al.*, 2014; Grigoli *et al.*, 2016; Ostry *et al.*, 2014). Whether those policies are feasible for compensating losers of environmental tax reform, however, needs to be reviewed in each country circumstances, implying the need and opportunity for environmental tax and poverty reduction experts to collaborate. Across countries, the takeaway message from this literature is, however, that even under pessimistic assumptions, attaining distributional objectives does not contradict the use of a significant proportion of the revenues for fiscal reforms stimulating output.

12.6.3 Political dynamics

Notwithstanding the economic evidence, there are significant risks of a political struggle for competing uses of the revenues from environmental tax reforms for either efficiency / output or distributional objectives. This struggle exists at the time when an environmental tax is implemented, but also afterwards, handling the trade-off between efficiency and distributional objectives can be a continued political struggle. British Columbia is a good example where the revenues were initially mostly used for broad-based tax cuts in line with the objective to raise economic output, but gradually more revenues were used for distributional objectives, to the extent of over-compensating perceived losers. Beck *et al.* (2016) offer valuable insight with applicability far beyond the borders of Canada. Also after compensation has been adequately provided, over time political pressure can mount to also dedicate the large remaining share of revenues to redistribution. It then appears as if the trade-off between output gains and distributional objectives for environmental tax reforms is mostly a problem of political economy, to which we turn next.

12.7 Conclusion

Environmental tax reforms impact the income distributions of countries through many channels. This chapter has reviewed the most research on each of these transmission channels to gauge the overall impact of environmental taxation in countries at different development levels.

A first result is that the transmission channels do really all need to be taken into account. Many earlier studies only considered a subset of the transmission channels, such as the impact on relative amounts of expenditure, but did often make inferences over the overall distributional consequences of environmental tax reforms. Instead, it is essential to consider the overall effect in order to adequately inform policy choices.

A second result is that the more complete and the more recent studies tended to show much more positive distribution impacts than the earlier literature, in particular of the late 1990s and early 2000s. It is therefore essential for Finance Ministries to update their policy assessments.

Thirdly, even in cases where there is a distributional problem with environmental taxation, that problem is small and can be addressed with a minor proportion of the revenue raised from environmental taxes. For scholars of Law and Economics who are focused on efficiency, this is an important finding. Because addressing distribution problems only requires a fraction of the tax revenue, it is defensible to focus on the efficiency properties of environmental tax shifts.

Fourthly, we have provided evidence against the following more complex argument which has been routinely made against environmental taxation. Recall that Coase pointed out that any proposal for policy interventions on social costs should not only consider the benefits from the intervention itself but also the costs created for other parts of the overall economy and the risk of government failure along the way. A popular equity-version of that argument goes as follows: The social welfare system in many developing countries today functions in the form of low-priced fuels. Now environmental taxation is proposed to replace these low-priced fuels with targeted welfare payments. But the first policy is much simpler for the government to execute than the second, and therefore environmental taxation could effectively fail the poor in exactly those countries where low-priced fuel is one of the few benefits they get from their government. Against this argument we have shown that firstly the poor are not presently benefiting much from this system of low fuel prices, secondly they would gain much more if those low fuel prices were replaced, thirdly the conversion to the new system is not administratively difficult, and fourthly the new system costs a fraction of the previous one and thereby creates opportunities for efficiency gains in the rest of the economy.

Chapter 13

Acceptability: Political economy strategies*

Public support for environmental tax reforms is often too low to trigger policy change. Low levels of support for environmental tax reform may force policymakers to maintain the status quo, i.e. a state of the world in which climate change is still a significant threat to the long-term well-being of humanity.

Various factors account for these low levels of support. Scholars and policymakers have long studied why environmental tax reforms generate little enthusiasm in the public. We add to this literature in particular by integrating ideas from Behavioural Law and Economics to address key impediments of support for carbon taxes.

This chapter derives nine high-level operational strategies to foster public support for environmental taxation. Besides providing these general guidelines, we discuss behavioural aspects of the political economy of choosing the tax rate. Lastly, the chapter suggests that when the effectiveness of different behaviourally informed strategies is highly uncertain, policymakers could adopt polyfunctional

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policies, i.e. techniques that simultaneously address multiple barriers for public support of environmental taxation.

The remainder of the chapter is structured as follows. Section 13.1 reviews essential political economy aspects of introducing efficient and effective environmental tax reforms. We provide nine high-level suggestions on how to ease these constraints in section 13.2. Section 13.3 discusses political economy trade-offs in the choice of carbon tax rates. Section 13.4 puts forward recommendations on how to choose between different behaviourally informed strategies when the effectiveness of any one of them is uncertain. Section 13.5 concludes.

13.1 Political barriers to efficient environmental tax reforms

This section reviews the various factors that reduce public support for carbon taxes.

13.1.1 Concentration of losses and rational ignorance

13.1.1.1 Concentration of losses

Losses from environmental tax reforms are more concentrated than benefits. Among net beneficiaries of carbon taxation, there are at least future generations and the young, but also the majority of today's population is likely to benefit from environmental tax reforms which reduce other, pre-existing taxes (see Heine & Black, 2019). Well-designed carbon taxes mitigate climate change and generate various co-benefits. For instance, they improve air quality, reduce traffic congestion, reduce energy costs and improve the energy security of oil-importing countries (Baranzini *et al.*, 2017; Haines *et al.*, 2009; Ürge-Vorsatz *et al.*, 2014). Benefits can also derive from the careful use of the revenues generated by the carbon tax. These benefits, while tangible at the aggregate level, are spread out among a broad segment of the population. Conversely, the costs of environmental tax reforms are usually more concentrated on a smaller proportion of individuals, such as stakeholders of the oil industry. As a result, for many governments, it is difficult to introduce environmental tax reforms even when those create net (Kaldor-Hicks) improvements for the population.

The interest of losers to block reform is often stronger than the interest of winners to promote change. The higher concentration of losses in society implies that, in many instances, losers have stronger incentives to defend their position on environmental tax reforms than net beneficiaries (Stigler, 1971; Trebilcock, 2014). Thus, losers have stronger incentives to invest resources to prevent the implementation of new environmental taxes and to support alternative environmental policies that better align with their private interests (Buchanan & Tullock, 1975). Also, the smaller group size of losers allows them to more effectively organize to have their voice heard in the policy process (Olson, 1974; Peltzman *et al.*, 1989; Stigler, 1971; Vogt-Schilb & Hallegatte, 2017). South Africa is an example where these dynamics seem to have occurred. South Africa has long tried to introduce a carbon tax, but progress on this issue has been slow, also due to opposition of the influential and highly carbon-intense mining sector (Acosta, 2015). In 2015, a first tax bill was proposed. This carbon tax was expected to apply starting from 1 January 2017. However, the approval of the tax bill was significantly delayed and, in December 2017, a new tax bill was put forward (South Africa Treasury, 2017), and it is now expected to apply from 1 January 2019.

13.1.1.2 Rational ignorance

Since benefits to the public are spread out and vested interests are expected to be active in defending the status quo, the public may decide to remain uninformed about the reform. When the costs of obtaining information about environmental tax reforms are higher than the expected benefits of having this information, citizens may prefer to remain "rationally ignorant" (Downs, 1957).[1] Citizens may decide to remain rationally ignorant about environmental tax reforms because they believe that their ability to, and potential interest in, affecting policymaking is substantially weaker than the one of vested interests.

[1] An individual is rationally ignorant when he chooses to refrain from acquiring knowledge about an issue when the cost of educating himself about it exceeds the potential benefit that the knowledge would provide.

13.1.2 Discounting

Benefits of carbon taxes are more spread out over time than their costs, worsening the public's view of the policy's cost-benefit relation. Climate change mitigation policies are in the long-term interest of humanity. Similarly, some of the co-benefits of carbon taxes, such as the reduction of traffic congestion and improvements in energy efficiency, do not materialize immediately in the aftermath of the tax reform. Conversely, energy prices increase in the short term. Therefore, individuals will discount a greater proportion of the benefits than of the costs of environmental tax reforms, thus weakening the support for these policies. This effect is compounded by individuals discounting future gains more than future costs (Hardisty & Weber, 2009). Therefore, even when there are no significant differences in the distribution of benefits and costs throughout time, discounting can make carbon taxation less palatable for the public.

This problem is larger in developing countries because the discounting of future benefits rises in poverty. Poverty correlates with and causes higher discount rates (Haushofer & Fehr, 2014). Liquidity constraints, reduced access to the formal credit market, higher stress, as well as enhanced negative emotional states, lead individuals that live in poverty to be more impatient than the wealthy (Haushofer & Fehr, 2014; Adamkovič & Martončik, 2017). Consistently, estimates of discount rates in developing countries are often higher than in developed ones (Cardenas & Carpenter, 2008; Duflo *et al.*, 2011; Tanaka *et al.*, 2010). To the extent that impatience over benefits from carbon taxes is a more widespread phenomenon in developing countries, their challenges for implementing environmental tax reforms are exacerbated.

13.1.3 Beliefs, knowledge, and understanding

13.1.3.1 Conveying the functions of taxation

Public misunderstanding of carbon taxes can be a structural barrier to new environmental taxation. Many citizens and businesses think that taxes are only revenue-generating measures (Dresner *et al.*, 2006). The Pigouvian principle of using taxation to steer markets by internalising external costs is not widely understood in the population. Similarly, many are sceptical of the effectiveness of environmental taxes. For instance, a significant number of individuals do not believe that environmental taxes can increase welfare or generate co-benefits such as the alleviation of traffic congestion (Kallbekken *et al.*, 2011; Rienstra *et al.*, 1999). Relatedly, carbon taxes are often perceived as being less environmentally effective than alternative measures such as subsidies for public transport or regulations (Steg *et al.*, 2006). In addition, the costs of environmental taxes are more salient (e.g. energy price increases) than their benefits (e.g. reduced air pollution), and, therefore, the public might be more attentive towards the costs than towards the benefits (Dal Bó *et al.*, 2018). Thus, large segments of the population do not understand, are not aware of, or do not believe in the existence of the benefits that well-designed environmental taxes can generate.

The misunderstanding of costs and benefits also depends on the following aspects of the design of environmental taxes:

Earmarking Individuals often tend to be more sceptical of the ecological effectiveness of carbon taxes when revenues are not earmarked to finance environmental projects (Carattini *et al.*, 2017a; Gevrek & Uyduranoglu, 2015). This effect underscores the public's misconception of environmental taxes as a revenue-raising instrument for environmental expenditures, associating only the expenditure side with positive change. The first-best policy measure for addressing this problem is to explain the environmental effectiveness of the tax itself. When the government is not able to convey this information, earmarking revenues is a second-best way of safeguarding political support when the public continues to believe that only expenditure policy matters.

Tax shifts While tax shifts are very popular among economists, in the eyes of the public, they are the least preferred revenue use. People often neither understand the reason why tax shifts can be beneficial nor the link between policies that reduce carbon emissions and tax reductions in other sectors (Carattini *et al.*, 2017b; Clinch *et al.*, 2006).

Tax rates Fear of the financial consequences of high environmental tax rates is widespread (Carattini *et al.*, 2017b).[2] Both in developed and developing countries,

[2]There is a paradox here. If the revenues from environmental tax reform are used to reduce other taxes, it is possible to reduce high tax rates. After all, labour and capital are currently taxed high

the lower the private cost of the tax, the more favourable are citizens' attitudes towards environmental taxation are (Gevrek & Uyduranoglu, 2015; Kallbekken & Sælen, 2011).

13.1.3.2 Worldviews

The perception of the costs and benefits of carbon pricing is also affected by worldviews (World Bank, 2015).[3] In the context of climate change risk perception, worldviews affect how climate change information is sought, perceived and accepted. For instance, worldviews affect the degree of acceptance of expert opinions on climate change (Kahan *et al.*, 2011), and determine attitudes towards carbon taxation (Cherry *et al.*, 2017). The recent diffusion of 'echo-chambers' (sources of information tailored to the target individual enabled by technological progress in social media), is likely to strengthen the self-confirmation of worldviews on environmental tax reforms (Cherry *et al.*, 2017).

13.1.3.3 Poverty and attention

The magnitude of misunderstanding can be more significant among the poor. This problem arises not only due to the possible lower levels of education among the underprivileged. Poverty can act as a cognitive tax.[4] Being forced to always think about pressing financial issues ends up constraining cognitive capacity (Mullainathan & Shafir, 2013; World Bank, 2015). This decreased cognitive

in many countries while carbon is commonly exempted. An environmental tax reform, therefore, presents an opportunity to reduce marginal rates by widening the tax base. However, to translate the possibility of reducing high marginal tax rates into support for carbon taxation, the population would first need to understand the tax shift. And, as mentioned above, this condition is often not fulfilled. As a result, the rise of environmental taxation from zero to a medium-size level will be opposed even when those taxes allow reducing labour and capital taxes from high to medium-sized levels.

[3] A worldview is a "*socially constructed orientation that dictates how one interprets and interacts with reality*" (Cherry *et al.*, 2017, p. 194). Worldviews are a separate hurdle for climate policy than lack of knowledge, their influence on the perceived risks of climate change is not lower among individuals with higher levels of education in science and numeracy (Kahan, 2012).

[4] Quantitatively, the effect of poverty on attention capacity can be non-trivial. For instance, temporary financial scarcity can decrease IQ by about 10 points (Mani *et al.*, 2013). Thus, the general lack of understanding about the benefits of a complex multi-component tax shift policy like environmental tax reform might be further exacerbated among segments of the population that live in poverty.

capacity can reduce support for complex policies like environmental tax reforms that have direct and indirect effects and raise one tax while decreasing another.

Poverty reduces attention towards the benefits of environmental tax reforms. Many of the co-benefits of carbon taxes, such as the link between a tax and reduced traffic congestion or climate change mitigation, may require relatively high levels of attention to be assimilated. Reductions in cognitive capacity may reduce the level of attentiveness towards these links. This problem is likely to be particularly substantial when the revenue is used to decrease otherwise unrelated taxes. This helps explain why it seems to be particularly difficult to communicate the benefits of tax shifts to the public effectively. Also, cognitive depletion can force individuals to focus on the present and forget more long-term goals (Mullainathan & Shafir, 2013; Shafir, 2017). Poverty-induced cognitive depletion is thereby likely to further exacerbate the problems with the benefits from environmental taxation materialising mostly in the long term.[5]

13.1.4 Trust in government

A lack of trust in the government can be a significant source of opposition to environmental tax reforms (Clinch *et al.*, 2006; Dresner *et al.*, 2006). Explaining that green taxes would increase government revenues may not necessarily trigger strong support for reform. Citizens may fear that the increase in energy prices will not lead to a tax shift or spending strategy that can meaningfully benefit them, but that the government may instead misappropriate these revenues (Rivlin, 1989). Building citizens' trust can be a particularly hard endeavour. Citizens need to believe that they will benefit from the reform, and the perceived support that special interests have for a particular distribution of the revenues can condition this belief. For example, from the World Bank's experience with fuel price reforms we know that, in countries with low trust in government, a promise of the government to compensate citizens for the fuel price increase through cash transfers may have limited credibility because citizens fear that special interests would oppose such arrangements (Inchauste & Victor, 2017). Similarly, in the context of environmental tax reforms, citizens and special interests may perceive that they

[5]The negative effect of poverty on the endorsement of environmental taxes goes beyond the erosion of public support that already comes from discounting because it is also the result of an increased lack of attention towards future benefits.

both benefit from maintaining the status quo (i.e. no tax). When citizens doubt that the government will use revenues in their favour because special interests are likely to prevent this use of revenue, it can be difficult to disrupt this perceived mutually beneficial equilibrium to one in which citizens benefit the most (e.g. tax with redistribution of revenues through cash transfers).

13.1.5 Risk aversion

Risk aversion reduces support for environmental tax reforms. Environmental taxes are a new concept to most people. Therefore, in the eyes of many citizens, environmental tax reforms have uncertain payoffs. In these situations, risk-averse individuals prefer the status quo to the reform.

Risk aversion can be a more significant impediment in developing countries. Risk aversion falls in the income or wealth of individuals (Guiso & Paiella, 2008; Heinemann, 2008; Hopland *et al.*, 2016; Liu *et al.*, 2016; Ogaki & Zhang, 2001). Also, liquidity constraints and negative emotional states are often correlated with, and increase, risk aversion (Haushofer & Fehr, 2014).[6] All these factors may cause higher levels of risk aversion in developing countries, and thus lower support for new policies like carbon taxation.

13.1.6 Perceived coerciveness

Opposition to carbon taxes can derive from their perceived coerciveness. Policies that society sees as coercive, i.e. those perceived as limiting freedom or as punishing negative conduct, receive less support than measures which are regarded as rewarding positive behaviour (Attari *et al.*, 2009; de Groot & Schuitema, 2012; Steg *et al.*, 2006). This factor may also account for the stronger support that reductions of fuel subsidies receive over carbon taxes (de Groot & Schuitema, 2012).

[6]However, the relationship between risk aversion and poverty, especially in developing countries is not uncontested (Bouchouicha & Vieider, 2018; Cardenas & Carpenter, 2008; Vieider *et al.*, 2018). It is, therefore, not conclusively resolved whether risk aversion is a more significant impediment to environmental tax reforms in developing countries than in developed ones, but there is some evidence suggesting so.

13.1.7 Popular concerns about distributional outcomes

13.1.7.1 Income distribution

People support tax reforms less when they view them as regressive, and these preferences may not necessarily be due to pure self-interest (Gsottbauer & van den Bergh, 2011; Kallbekken & Sælen, 2011). In 2015, more than 90 % of Swiss voters rejected a proposal to substitute the national value-added tax with an energy tax, and distributional concerns were among the most prominent motives for this vote (Baranzini *et al.*, 2017). Similar preferences seem to affect environmental taxation in Sweden and Turkey (Brannlund & Persson, 2012; Gevrek & Uyduranoglu, 2015). For the political economy of environmental tax reforms, it therefore appears essential to communicate the evidence from chapter 12 regarding the progressive distributional impacts that these policies can have in reality.

13.1.7.2 Rural-urban distribution

Perceived regional inequalities in policy outcomes undermine support. After the introduction of the carbon tax in British Columbia, a large part of the population in the rural North felt that the reform imposed an unfairly high tax burden on them compared to on citizens of the urban South. In reality, the opposite type of discrimination appears to have occurred (Beck *et al.*, 2016). Notwithstanding, the tax was seen by many as discriminating against the North, in a context in which people already perceive the South as privileged. Thus, opposition to a carbon tax can also derive from pre-existing tensions between regions (and other social groups), even independently from the actual distribution of tax incidences.

13.1.8 Shame and stigmatization

Social stigmas associated with receiving public handouts may reduce support for the compensation payments provided as part of many environmental reforms. The shame of being poor and the experience of being socially stigmatised can substantially limit participation in programs destined to alleviate poverty (Bastagli *et al.*, 2016; Bissett & Coussins, 1982; Kissane, 2003; Shafir, 2017). This general finding carries over to environmental tax reforms. When revenues from environmental taxes are destined to compensate low-income households, any shaming which society attaches to compensation recipients may impair the achievement of the planned distributional effects of, and reduce support for, the policy change.

13.2 Behaviourally informed strategies to address these barriers

This section presents nine policy options to increase public support for carbon taxation, addressing the obstacles discussed in section 13.1.

These are high-level guidelines that might not be suited to each context. The adoption of each of the strategies discussed below should be adapted to the specific country circumstances in which environmental tax reforms take place.

13.2.1 Promote carbon taxes via media campaigns

13.2.1.1 Constraints addressed

Carefully planned media campaigns can substantially increase public support for carbon taxes, because they address the following constraints:

Reduce misunderstanding Engaging in an extensive campaign aimed at educating citizens about the functioning and effects of environmental tax reforms can improve public understanding of the impact of these policy instruments (Carattini *et al.*, 2017a; Conway *et al.*, 2017). Experiences with energy subsidy reforms in the Middle East, North Africa, and South-East Asia corroborate the potential effectiveness of this strategy (Sdralevich *et al.*, 2014; Inchauste & Victor, 2017).

Increase trust in government By informing citizens about the expected distributional impact of the measure and the planned use of revenues, governments send citizens a costly signal, i.e. a promise that is politically costly not to fulfil. These signals can increase public trust in the benefits of reform (see below section 13.2.8).

Address risk aversion By reducing uncertainty about the payoffs from reform, information provision can increase public support towards policy change among risk-averse individuals.

13.2.1.2 Using diverse media channels

Government communications via texting and social media may allow the reaching of segments of the population that would otherwise remain uninformed. Diffusion via traditional media (e.g. television, newspapers, radio) could be complemented by the use of social media and mobile phones. These newer channels for government communication were successfully used to inform citizens about energy subsidy reforms in Indonesia, where text messages were sent to 240 million active mobile phone numbers (Inchauste & Victor, 2017).

13.2.1.3 Simplifying messages

While they are inherently complex policies, environmental tax reforms need to be communicated with simple messages to be understood beyond niche audiences. Support can increase if an information is conveyed by using accessible language or with the support of user-friendly graphic representations. These practices can be particularly helpful to communicate with individuals whose attention towards the long-term benefits of environmental taxation is decreased by financial scarcity.

13.2.1.4 Timing campaigns

Campaigns devised during periods of relative prosperity can be more efficacious. During periods of financial distress, individuals may lack the attention and the interest required to understand the benefits of environmental tax reforms. Sometimes the wealth of large segments of the population follows predictable cycles, such as when farmers sell a large part of their products at a particular point in time, and few other sources of revenues are available during the rest of the year (Mani *et al.*, 2013). In these contexts, a strategy that can help individuals assimilate information on the benefits of the reform is to organise information campaigns (and enrolments in compensation schemes) in periods of relatively higher wealth (cf. Bryan *et al.*, 2017).

13.2.1.5 Communicating distributional impacts

Being transparent towards the public about the distributional effects of the reform can be crucial. Distributional concerns commonly feature among the main reasons why large segments of the population oppose environmental tax reforms. The public may (often mistakenly) perceive carbon taxes as regressive. Providing information about the distributional effects of environmental tax reforms can correct these beliefs. Doing so requires, firstly, carrying out ex-ante analyses of the distributional impact of the reform and, secondly, periodically updating these studies after the environmental tax is implemented. Since part of the distributional effect of increases in energy prices is due to government spending, it is critical that media campaigns broadcast the use of revenues (as for fuel subsidy reforms, cf. Inchauste & Victor, 2017). For instance, in 2010, Iran launched a successful campaign in support of an energy subsidy reform that stressed various distributional elements: (i) every household was eligible for compensation; (ii) public revenues that were previously destined to energy products were now given directly as per-capita transfers to households; (iii) for most of the population, the compensation corresponded to a non-trivial share of total income; (iv) substantive efforts were undertaken to explain to the population how low energy prices lead to social inequities. Similar campaigns could be devised to support environmental tax reforms. These campaigns could also stress that making polluters pay for the harm they cause to society is not only a welfare-enhancing and environmentally effective measure, but it can also be supported from a fairness standpoint (Guillaume *et al.*, 2011).

13.2.1.6 Communicating the net effect of a policy package as a whole

Governments should communicate the net effects of all components of the reform, including of the revenue use, instead of only the impact of the environmental tax increase itself. Individual components of an environmental tax reform can have negative consequences for some social variables whereas the net effects of the reform as a whole are positive. For example, all tax hikes can increase poverty before considering the use of the revenues. Reporting the partial impact of the tax increase alone can then be a misleading representation of the overall change in poverty – it risks that the public judges the desirability of a whole policy package based on the partial impacts of its components. This has often happened in public debates on environmental taxation where the public discourse focused on how an environmental tax would raise poverty or inequality, not expenditures or tax shifts financed by the tax. It is essential that governments report the net effect of an entire reform package taken together.

13.2.1.7 Using social norm compliance

Creating and consolidating social norms in favour of environmental taxes can ensure more long-term support for these policies after pro-reform campaigns end. The willingness to pay for environmental taxes rises in the prevalence of social norms favouring environmental protection. While in the short-run the government can use information campaigns and other promotion efforts to momentarily raise support for the policy, such efforts would be expensive to maintain in the long-run. Social norms, however, are more self-sustaining sources of support. The question arises, therefore, how a government can nurture the development of pro-environment social norms.

A social norm emerges when a sufficiently large proportion of individuals endorses an opinion or a behaviour.[7] Environmental protection might already be a social norm in many societies, and the idea that people should pay for the harm that they cause to society is engrained in numerous legal systems, moral philosophies, and international agreements.[8] Highlighting that large segments of the population endorse a particular policy can trigger further support for the measure because people like to conform to others' behaviour to gain social acceptance and status, or because, in situations of ambiguity, following others provides a cue on how to behave oneself (Kinzig *et al.*, 2013). In countries where a large proportion of individuals hold pro-environment or pro-carbon taxation attitudes, survey data can be used to create and reinforce such popular opinion. Similar techniques have been used to create and reinforce social norms in many domains of political action on external costs, such as for policies to reduce littering and juvenile alcohol abuse and for policies incentivising behaviours that limit the spread of diseases (Kinzig *et al.*, 2013). In many countries, large segments of the population

[7] A common definition of social norms is rules "*governing an individual's behaviour that third parties other than state agents diffusely enforce by means of social sanction*" (Ellickson, 2001, p. 3).

[8] Note that the fact that moral philosophies and the law support the Polluter Pay Principle does not necessarily imply that there are not divergences on how this principle should be implemented. These divergences may undermine the formation of a social norm (World Bank, 2015).

hold positive attitudes towards the environment and environmental policy. For instance, in 2016, 73 % of survey respondents in Bangladesh considered climate change to be a "very serious problem" and 24 % a "somewhat serious problem". Similar data comes from Rwanda where these attitudes stand at 65 % and 23 % respectively (World Bank, 2016). Also, in 2015, a vast majority of US citizens supported the regulation of CO_2 emission (Howe *et al.*, 2015). These attitudes could be further strengthened by strategically appealing to behaviours for group conformity. Policymakers can highlight that many citizens endorse these measures and the underlying shared values so that individuals who do not yet hold these values, conform or adopt them because others do (de Groot & Schuitema, 2012).[9]

13.2.1.8 Emphasising local harm

Stressing the local consequences of failing to act on global problems can lead to broader support for change. Global climate change is often perceived as a distant issue. Framing messages about the social costs of carbon emissions at the regional/national level can trigger a more favourable response towards carbon taxation than messages about the global ramifications of the warming.

Highlighting co-benefits can increase the saliency of the local benefits derived from environmental tax reforms. Many co-benefits of environmental taxes are more local than climate change mitigation. For instance, as discussed in Heine & Black (2019), environmental taxes can reduce traffic congestion and improve air quality. Policymakers could stress these benefits to reduce citizens' perceived distance from the benefits of environmental action. Explaining co-benefits may also increase attention towards problems related to carbon emissions because these benefits can be more easily understood by the public than the more abstract concept of "social cost of carbon".

13.2.1.9 Pluralistic advocacy

Environmental tax reforms are more widely accepted when a variety of experts and leaders endorse them. Information campaigns may also fail to reach the desired level of support because worldviews determine how information on environmental policies is sought, perceived and accepted (Cherry *et al.*, 2017; Kahan

[9]Note that advertising pro-carbon taxes attitudes in societies with low support for ecological policymaking may have the boomerang effect of weakening preferences for carbon pricing.

et al., 2011; Kahan, 2012). A strategy that addresses this issue is Pluralistic Advocacy (Kahan *et al.*, 2011). Pluralistic Advocacy suggests that policy reforms are more readily accepted by the population when a diverse set of experts and leaders support them (Trebilcock, 2014). Different segments of the population vary in their choice of opinion leaders from whom they accept information about new policies. Thus, pursuing multiple channels for sending the same signal increases the chances of successful receipt. In other words, the broader the spectrum of advocates for the reform, the more likely is widespread popular support. Showing public support from leaders of different social groups is particularly important in societies divided along, religious, racial and ethnic lines. Examples of a successful use of this strategy include the energy subsidy reforms of Iran in 2010 and Indonesia in 2005. In both cases, pro-reform campaigns involved supporters from very different professional backgrounds (e.g. academics, politicians, government officials, journalists, clerics and other public figures) to speak publicly in favour of the reform in a coordinated and consistent manner (Guillaume *et al.*, 2011; Inchauste & Victor, 2017). To provide at least a tacit coordination of the signals sent by such a diverse set of agents, effective Pluralistic Advocacy may require training information providers via in-person workshops or webinars.

13.2.1.10 Framing messages

Framing messages to match the pre-existing narratives and values that prevail in a social group can foster support for environmental taxation. Framing does not entail the provision of inaccurate information. Instead, it consists of assigning weights to different items of information, and it is a necessary part of communication. Since the narrative schemes and values vary between cultural groups, the same information can receive different degrees of attention and acceptability by various segments of the population. Thus, in culturally prismatic societies, effective communication may require shaping information about carbon taxation and about the risks that it aims to tackle in a way that is palatable to specific target recipients. For instance, highlighting the progressive impact of environmental tax reforms can be a more effective communication strategy to target individuals that endorse egalitarian values than segments of the population that attach greater value to social hierarchy.

13.2.2 Create channels to inform citizens

13.2.2.1 Channelling information

Creating information channels, like hotlines, to inform citizens about environmental fiscal policies can effectively increase support. For instance, in 2005 the government of the Dominican Republic created a hotline to inform citizens about the status and amount of compensation for an increase in fuel prices (Inchauste & Victor, 2017). In 2010, Iran used a website and media campaign for this purpose.

This strategy addresses the following constraints.

Reduce misunderstanding Media campaigns may not reach or sufficiently inform a section of the public. A successful communication strategy may require complementing media campaigns with several information channels, such as information offices, public debates, hotlines and online chats.

Increase trust in government As discussed below (section 13.2.8), transparency about the structure of the reform, and in particular about the use of revenues, can increase citizens' expectations that the government will respect its commitments.

Address risk aversion As mentioned above, providing information about the structure and the effects of fiscal reform can reduce perceived uncertainty about the payoff of the measure, and thereby increase support among risk-averse individuals.

13.2.2.2 Educating information providers

The effectiveness of these channels can be improved through better training of information providers. To be useful, the operators of information hotlines need to be instructed about a wide range of reform aspects, from the design of the tax scheme, the planned use of revenues, the net environmental and distributional effects, down to more practical aspects, such as how citizens can access compensation.

13.2.2.3 Effectiveness of communication campaigns

The quantitative effects of such measures can be significant. For instance, providing information about the possibility of applying for a program aimed at increasing water access among Moroccan households coupled with direct assistance in the application process has raised the application rate from 10 to 69 % (Devoto *et al.*, 2012).

13.2.3 Smart spending: use revenue to address distributional and environmental concerns

Obtaining public support for carbon taxes may require the use of revenues to address distributional and ecological concerns. The public often has strong preferences for non-regressive and strongly pro-environment carbon taxes. Successful reforms satisfy these preferences.

13.2.3.1 Compensating the poor

Compensating the poor via cash transfers can be an effective way of obtaining support among disadvantaged households and inequality-averse individuals. However, particular attention needs to be paid to determining the fraction of the population that is entitled to receive compensation. Individuals who feel unjustly excluded from coverage might initiate protests (Inchauste & Victor, 2017). This is a problem because means-tested transfers necessarily involve cut-off points, and at the margin there can easily be arbitrary exclusions when one person who has a marginally higher income than a person who receives the compensation is excluded from it. A straightforward way for ruling out arbitrary cut-offs is to provide compensation universally (e.g. as a universal basic income). There is a trade-off between (i) increasing the progressiveness of the reform by targeting poorer households via means-tested transfers and (ii) avoiding opposition by those segments of the population that would not receive the targeted transfers. When excluding the middle/high-class from cash transfers would significantly reduce the political feasibility of the environmental tax reform, governments should consider opting for universal transfers. For an example of a universal cash transfer in the context of a fuel price reform in Iran see below (Box 2).

13.2.3.2 Making compensation accessible

The inclusiveness of procedures to obtain compensation increases when they are simple to complete (Bertrand *et al.*, 2004; Bryan *et al.*, 2017). There are various ways of doing so, such as to decrease the complexity and length of the forms used to subscribe to a compensation scheme. In 2010, Iran increased the inclusiveness of its fuel subsidy reform by informing citizens that authorities were going to be lenient with minor mistakes in the applications for compensation (Guillaume *et al.*, 2011). To the extent that these measures augment the perceived accessibility of the benefits of environmental tax reforms for the least affluent segments of the population, they may also address distributional concerns.

13.2.3.3 Reducing salient taxes

Environmental tax shifts need to be easily understandable. Governments should use the revenues from environmental taxes to explicitly reduce other taxes instead of averting the increase of other taxes. When revenue from carbon taxes is used for tax shifts, governments can either reduce pre-existing taxes or avoid future tax increases. Citizens are more likely to be aware of and understand the benefits of tax shifts when revenues are used to reduce an existing tax than when they are used to prevent a tax increase. For example, Sweden used the revenues from its 1991 environmental tax reform to explicitly reduce personal income taxes whereas Germany used the revenues from its 1998 environmental tax reform for budget consolidation and to avert the increase of social security contributions which would have had to be raised in the absence of the reform. Implicitly, the German environmental tax reform thus prevented an otherwise-needed increase of other taxes. However, large segments of the population did not understand the connection between the increase in environmental taxation and the non-increase of other taxes. Of those who did understand this connection, many did not understand how they personally benefited from the policy. It is therefore plausible that pursuing the explicit tax reduction triggers more public support than using revenues for averting a tax increase. Countries should strive to keep the tax reduction aspects of an environmental tax reform as easy to understand as possible.

Governments should carefully select particularly salient pre-existing taxes as the ones to reduce when implementing an environmental tax shift. Taxes vary in their saliency (Finkelstein, 2009; Lunn, 2014). Governments should select those taxes that are well known to the broad public as the ones to reduce in an environmental tax reform. This consideration can be at odds with objectives to reduce the complexity of tax systems: often, government economists prefer tax systems to be made up of a small number of taxes that each carry major revenue rather than many taxes that each contribute small sums. Preferences of government economists may then favour using the additional revenues from an environmental tax reform to completely eliminate a pre-existing small tax rather than to reduce one of the broad-based taxes that bring in most of the revenues. However, for the government to be able to communicate its environmental tax reform to the public, it is essential that the tax shifts enabled by an environmental tax reform enjoy prime visibility. To the extent that small pre-existing taxes are not well known, they are the wrong target for reducing taxes.

Governments should focus on reducing pre-existing taxes for which the legal tax liability (not the incidence) falls onto the section of the population whose support is sought. The taxes to be reduced should be carefully chosen to be the most unpopular as well as the ones perceived as regressive. In the past, environmental tax reforms sometimes involved reductions of taxes that were seen as progressive or otherwise were rather a concern to economists than to the public. Such choices may squander the popular support for the tax which could otherwise have been won through the reduction of pre-existing taxes. Also, as environmental taxes are commonly perceived as regressive, it is essential that any reduction of pre-existing taxes financed with revenues from the environmental tax is seen as a progressive change.

In Germany, most of the revenues from environmental taxation were used to reduce the employer's contribution to social security charges (Knigge & Görlach, 2005). Economic evaluations suggest that this choice was also wise for raising economic output (see Heine & Black, 2019), and that even the distributional consequences may have been positive because the fiscal incidence even of a social security charge imposed on employers may rest with workers. However, the public did not see it this way. Employers' social security charges were not particularly unpopular and were furthermore seen as progressive. As a result, this tax shift did not significantly raise the popularity of the environmental tax reform despite economic evaluations generally being positive. A general message to learn is that the public is not likely to differentiate between the legal attribution of a tax liability and its economic incidence (Sausgruber & Tyran, 2011; Weber & Schram, 2017; Dal Bó *et al.*, 2018). People tend to prefer taxes that have a statutory incidence on others, even when this arrangement implies bearing a higher economic incidence. If the tax or charge that was reduced through an environmental tax reform was previously payable by employers, the policy will more likely be seen as benefiting the owners of firms than as benefiting workers. The revenues from environmental tax reforms should, therefore, be used to reduce taxes for which the legal liability rests with the group whose support is sought – the economic incidence can be of secondary importance to the tax shift's political viability.

13.2.3.4 Improving energy access

A share of the revenues should be used to increase energy access for underserved households. Energy price increases may hinder the satisfaction of basic needs, such as nutrition (via cooking) and safety and education (via lightning). These dramatic effects explain opposition to environmental taxes that increase the price of energy. In countries where the lack of energy access is a social issue, revenues from environmental taxation could be used to finance programs that improve the access to, and reliability of, energy supply. For instance, revenues could be used to finance (i) the expansion of grids, (ii) the provision of technology for accessing energy such as photovoltaic, solar water heaters, efficient lighting and cooking stoves, and (iii) the development of mini-grids in remote areas. Evidence from successful fuel subsidies reforms suggests that if the revenue from carbon pricing is used to finance such energy access programs, the public fear of increases in energy prices can be tempered.

13.2.3.5 Earmarking revenues

Earmarking part of the revenue can increase support among individuals that are sceptical of the ecological effectiveness of carbon taxes (Carattini *et al.*, 2017a,b). Earmarking is generally discouraged as it contributes to the fragmentation of governments' budgets. However, the literature shows that it does significantly improve public acceptability of environmental taxes. Governments should therefore carefully evaluate the use of earmarking. Several options are at their disposal. Maybe the strongest form of earmarking is to reserve revenues for special off-budget funds. Those funds enjoy large popularity among environmental advocates, but funds may encounter significant governance problems as it is hard to retain the discipline that comes from the established oversight mechanisms of general budget rules. A less problematic, soft version of earmarking is a commitment by the government that an environmental tax reform will be revenue-neutral. This commitment could take the form of a political promise or be formalized by imposing revenue neutrality into the parliamentary bill that establishes the tax (see section 13.2.8). The strategy of expanding energy access can be another particularly effective form of light earmarking.[10]

13.2.4 Antedate benefits of environmental tax reforms

13.2.4.1 Antedating benefits

Governments can address various factors hindering support for environmental tax reforms by paying compensation before, not after, the environmental tax is introduced or the tax rate increases. Many environmental tax reforms have been sequenced such that the environmental tax increase happened before large parts of the benefits from the reform were felt by the population. There are large gains from antedating the distribution of benefits before the tax incidence is felt. Benefits can be distributed (and felt) before the costs of a reform are realised, by reducing other tax or distributing compensation payments before the environmental tax increase takes place. An example of this change of sequencing is the 2010 fossil fuel subsidy reform of Iran, where cash transfers were distributed to compensation recipients before the reduction in fuel subsidies was implemented (Box 2).

Antedating benefits addresses the following constraints.

Address discounting Since a more substantial proportion of the benefits than of the costs of environmental taxation are spread out over time, discounting makes

[10] For instance, revenues from carbon taxes could be used to finance programs that improve the cooking facilities of the urban poor. In many developing countries, cooking represents a significant share of the energy consumed by the urban poor. Investing in improve cooking facilities may allow to both compensate households that rely on carbon-intensive energy to cook and reduce emissions. Since financial constraints are a major obstacle to the further adoption of improved cooking stoves (ACCESS 2014), earmarking revenues to support household's investments in this technology may help addressing public concerns towards the effects of environmental tax reforms on energy prices.

environmental fiscal reforms less palatable to the population. However, anticipating gains can reverse this pattern. The effect of this policy can be substantial for individuals that have high discount rates due to financial constraints.

Increase trust in government and reduce risk aversion If the distribution of the revenue to the public occurs after the introduction of the carbon tax, risk-averse citizens and citizens who have little trust in the government might oppose the reform for fear of not receiving these benefits.

Educate about tax shifts Cutting taxes on the first day on which the carbon tax is applied can help citizens to understand tax shifts by making salient the strict relation between the introduction of the environmental tax and the reduction of pre-existing taxes.

13.2.5 Antedate cash transfers and make them visible

13.2.5.1 Antedating benefits in the special case of cash transfers

Distributing cash transfers before citizens feel the tax incidence can be an effective policy choice. Distributing cash transfers on the day in which the carbon tax is introduced leads compensated households to discount a large part of the gains less than the costs, helping to increase support for the reform (Rentschler, 2018). This effect is further amplified if, as it is sometimes the case, delayed financial gains are discounted more than delayed losses (Hardisty & Weber, 2009). Also, concrete benefits tend to be discounted less than more abstract ones (Lempert & Phelps, 2016). Arguably, a lump sum payment is a less abstract gain than the health benefits that may derive from earmarking revenues for additional environmental expenditures. Therefore, paying compensation before or on the day of the environmental tax increase can be a crucial tool for managing the political economy.

13.2.5.2 Increasing the value of compensation through sequencing

Distributing electronic cash transfers and making them visible before introducing environmental taxes can increase the value that recipients assign to com-

Antedating benefits payments and locking them

In 2010, Iran managed to implement a much larger increase in fuel prices, in one shot, than even the most ambitious environmental tax reforms. The free market price of diesel increased by about 2000 %, from IRR 165 to IRR 3,500 per litre (Guillaume *et al.*, 2011). This price change implies an increase in the cost of a tonne of CO_2 contained in diesel from 6 to 133 USD / t CO_2. This rate of change probably substantially larger than those triggered by any environmental tax reforms till date, so this case study is particularly relevant for analysing which strategies can enable large change in carbon pricing. Here we analyse features of the Iranian reform which can help other countries implement environmental taxes.

Information campaign The fuel price increase was prepared by an extensive information campaign, using a polyfunctional approach: different types of media were used and a diverse set of communicators (politicians, businessmen, clerics, researchers) was employed to reach different sections of society. The authorities also instituted phone hotlines to answer citizens' questions.

Compensation The fuel price increases were transparently linked to compensation schemes. The tax bill establishes that at least 50 % of the revenues had to be destined to households for compensation, initially in the form of bimonthly cash transfers (6 per year) and subsequently also as public goods. 30 % of the revenues were destined to support firms during the transition phase toward less energy-intensive production. The remaining 20 % were retained in the public sector.
Sequencing the reform to antedate benefits: Cash transfers were made visible on bank accounts before, and made available on the same day of the price increase. These transfers were made before the reform took place on frozen personal bank accounts that were visible to the compensation recipients via a website (www.refahi.ir) and publicised in the media. Authorities made it clear that the sum deposited in each bank account will be made available on the same day as the (subsequent) fuel price increase. The government hence already paid the compensation into citizens' accounts to send a stronger signal of its commitment to carry through with its commitment for compensation. However, it locked the withdrawal of the money from these personal accounts during the period preceding the fuel price increase. While this lock was in place, the government communicated that in case it has to abandon the fuel price increases due to opposition, the accounts could not be unlocked, so the compensation payments could not flow. As the compensation in these locked accounts amounted to very significant sums for most Iranians, the cash transfers and the locking mechanism provided a strong incentive for the population to support the reform implementation (Guillaume *et al.*, 2011).

Box 2: Iran's 2010 reform is the closest real-world application of the strategy suggested in this chapter. It is also the largest adjustment of implicit carbon prices globally that has been achieved till date.

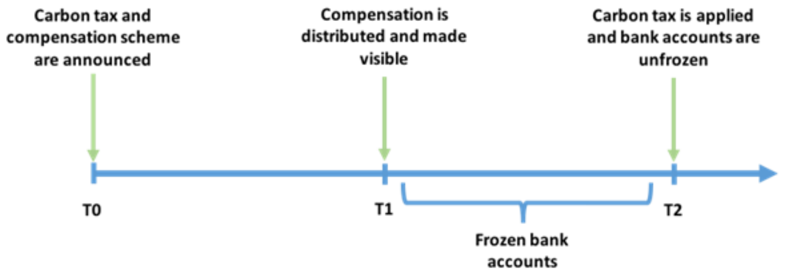


Figure 13.1: Sequencing of an environmental tax reform with antedated, contingent benefits

pensation. Everything else being equal, individuals tend to attach a higher value to items to which they feel entitled. This phenomenon is referred to as the endowment effect (Marzilli Ericson & Fuster, 2014).[11] Endowment effects can be triggered by either (i) increasing the expectations to receive something, or (ii) making the item more salient to the recipient, or (iii) increasing the psychological proximity of the entitlement by inducing a person to think more intensively or for a longer time about it (Marzilli Ericson & Fuster, 2014). Distributing and making visible compensation upfront can fulfil several of these criteria, and thereby increase the utility value that recipients attach to any monetary value of compensation.

13.2.5.3 Making endowment effects work in favour of, instead of against, reform

Once citizens assign a high value to cash transfers, it will be more difficult to block the reform.

A frequent strategy for political forces mobilising citizens against environmental tax reforms is to depict these taxes as taking away an endowment (e.g. a low energy price). The chances of success for this opposing strategy would substantially decrease after citizens start feeling endowed with the expected benefits from the reform (e.g. cash transfers or reductions of other taxes). Therefore, triggering an endowment effect among compensation recipients can be a crucial factor

[11] In this context, ownership does not necessarily have to be interpreted as legal ownership.

in fostering support for environmental tax reforms. Such a technique was used (maybe without this intention) by Iran in its 2010 reform (Box 2). Iran distributed and made visible cash transfers on the bank accounts of the recipients before the reform was implemented. The time gap between when the cash transfers were credited (and made visible) to compensation recipients and the day in which the price increase took place allowed for the citizens to become aware and used to the prospect that they will receive a cash transfer. This time gap hence allowed for the formation of an endowment effect. In turn, this sense of endowment may have increased citizens' support for the reform and, relatedly, the contingent political cost for the government of reneging on the announced reform.

13.2.5.4 Replicability

This strategy for managing the political economy by antedating, visualising, locking and unlocking cash transfers is technically feasible in many country circumstances. Iran implemented its cash transfers through physical and formal bank networks, supported by information disclosure on an online platform visible to compensation recipients (Box 2). Not all countries have the level of financial inclusion to use formal banks in this manner, but section 12.5.4 has explained how countries with lower administrative capacity can realistically use other electronic transfer systems. We can therefore generalize that also in countries below the level of development of Iran, the strategy of antedating contingent benefits is available to policymakers in many countries. And it is certainly available in the EU, even though no European environmental tax reforms have used it till date.

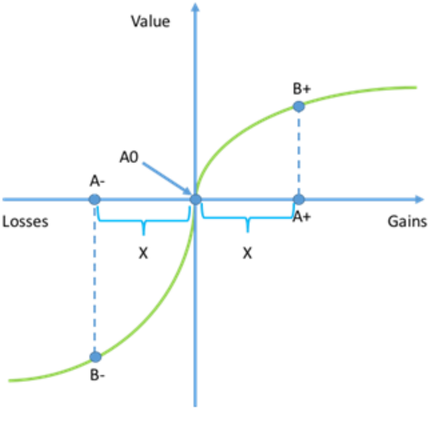
13.2.6 Communicate the connection of fiscal shifts components by letting them coincide

13.2.6.1 Situation with compensation payments

Timing the unlocking of compensation payments to coincide with the onset of the environmental taxes helps communicate the logic of a fiscal shift. A key impediment to environmental tax reforms till date has been that the public rarely understands the connection between the introduction of an environmental tax on

The endowment effect and loss aversion

The most widely supported explanation of the endowment effect is loss aversion. Research on loss aversion highlights that a change in wealth of size "X" is perceived as a less severe event (meaning that the drop in utility is lower) when it is seen as a foregone gain than when the same amount of change is seen as an incurred loss. Whether people see the change in wealth as a loss or as a gain depends on their reference point (e.g. the status quo) (Marzilli Ericson & Fuster, 2014).



The above diagram illustrates the utility function of a loss-averse individual. The utility function is sigmoid, with the segment of the utility function in the domain of losses diminishing at a faster rate than the increase of the function in the domain of gains. As shown in the figure, a change of X (say 100 dollars) triggers a lower increase in utility in the domain of gains than the decrease in utility due to a change of equal dollar amount occurring in the domain of losses.

Box 3: The endowment effect could explain the success of the Iranian strategy.

the one hand and the expansion of (compensatory) expenditures policies or the reduction of traditional taxes on the other hand. This link is easier to communicate when these separate fiscal changes occur exactly on the same day.

Such exact coincidence can be challenging to organise, e.g. because potential delays in implementing the different components of an environmental fiscal shift may not coincide – it may take longer to organise the compensation payment system than the environmental tax or vice-versa. Preparing transfers and then locking them in accounts is a strategy to improve the chance of having an exact coincidence of measures. The finance ministry is going to be guaranteed maximum attention if it unlocks the compensation on the same day as the environmental tax increase.

This twin-action should be communicated in a splashy event to establish as salient a linkage as possible between the environmental tax and its revenue use, so the popularity of the second helps the political stability of the first.

13.2.6.2 Situation with reductions of pre-existing taxes

This strategy applies in the same way when instead of compensation payments environmental tax revenues are used for reducing other taxes. In this case, the vehicle of the locked compensation accounts cannot be used, but there are other options to ensure coincidence of changes. The environmental tax increase and the decrease of the other tax can be announced in the same finance minister speech, and legally be passed on the same day in parliament. All such efforts help mitigate the risk of tax shifts not being understood.

13.2.7 Label carbon taxation as subsidy removal

13.2.7.1 Choosing the right label

Labelling environmental tax reforms as subsidies removal may reduce their perceived coerciveness. Political debates in many countries suggest that the public views carbon taxes as more coercive than the removal of fuel subsidies. Economically, a failure of the government to implement policies internalising large-scale environmental externalities is equivalent to the provision of a (post-tax) subsidy

(Coady *et al.*, 2017; Stiglitz, 2006). It is, therefore, possible to frame environmental tax reforms as a reduction in post-tax fuel subsidies. Anecdotal evidence from many presentations of the authors on environmental fiscal policy for various audiences suggests that this labelling is extremely relevant for the likelihood of popular support for environmental fiscal reforms.

Labelling environmental tax reforms as subsidies removal also helps communicate that the costs of environmental degradation are coercively paid for by people. The term "fuel subsidy" communicates that somebody is coercively paying for that fuel – for example, the general taxpayer. By contrast, the term "environmental tax" does not communicate well that there is also somebody coercively paying for the cost of pollution. The concept of an "external cost" is complicated to understand, even though without that understanding it is equally difficult for people to comprehend how environmental taxes reduce coercive payments. Indeed, the term 'tax' appears to rather be limited to a forced exchange between a person and the government apparatus. Instead, using the terminology "fuel subsidy" directly communicates that the status quo causes forced expenditures. The term also better captures the notion of a "distortion" imposed by the failure of a government to price externalities – another aspect that is hard to understand when the term "environmental tax" is used.

Labelling matters. There is evidence that labelling a policy instrument as a fee or a charge instead of a tax can increase support for the measure (McCaffery & Baron, 2006; Rabe & Borick, 2012). Labelling an environmental tax reform as a shift from (post-tax) fuel subsidies to other expenditures goes a step further, as it moves the discussion from imposing a perceived coercive measure to redirecting support from polluting entities to (likely less affluent) households.

13.2.8 Send costly signals as commitment devices

13.2.8.1 Signalling commitment

Making commitments that are costly to renege can increase trust in the government following through with its declarations of how the revenues from environmental taxation will be used. Lack of trust in public authorities, especially with regards to the use of revenues, limits support for environmental tax reforms. Increasing trust may require sending costly signals to the population about the planned use of revenues. The costliness of a signal enhances its credibility. An example of such signals is the widespread announcement about how the revenues will be spent. Such announcements can create clear expectations in the population, and failing to meet them can impose a significant political cost on the incumbent government. Foreseeing those contingent consequences, the public believes the promise. Also, when revenues are used to implement a tax shift, it can be beneficial for governments to commit to that revenue use from the start, e.g. by establishing revenue neutrality into the tax bill itself. British Columbia followed this approach (British Columbia Finance Ministry, 2017).

Research indicates that middle-class citizens' support towards redistribution can increase if they are granted the possibility to check how revenues are used even in cases where that redistribution implies a loss for them. This effect seems to exist among young people and individuals that are particularly sceptical towards the implementation of social safety nets (Silva *et al.*, 2016). This evidence suggests that there is an intrinsic value for being transparent about the outcomes of an environmental tax reform independent of the content of the information being communicated.

In the lead-up to their fuel price reform, the Iranian government sent various costly signals to the population about how revenues would be used. For instance, the government invested in creating about 16 million new bank accounts and expanded the ATM network to areas of the country that were previously not covered by this service, and publicised that these investments were taking place. Similarly, displaying the compensation sum in the bank accounts in advance of the price increase is likely to have made the government's commitment that the compensation was going to take place more believable to the population.

13.2.9 Time the reform to reflect cyclical variations in energy use and prices

In many countries, energy consumption has seasonal patterns. Environmental tax reforms should best be started during the time of the year in which energy use is the lowest. In Iran, for example, the moment when fuel prices were increased was chosen to coincide with the season of the lowest energy use, to allow people more time for adjustment and thus weaken the opposition.

Global fuel price and business cycles suggest that the political economy for introducing or raising carbon taxes may currently be unusually opportune. When fuel prices are low, it might be easier to introduce new carbon taxes (or increase the tax rate of existing ones). Currently, fossil fuel prices are below their averages of the last ten years.[12] Simultaneously, and contrary to historical trends, these lower prices of energy commodities do not reflect weak global economic growth, and it might be easier to introduce carbon taxes during a period of economic expansion than during a downturn. Also at the same time, public debt levels in many emerging economies are rising, so new sources of revenue would come in particularly handy now. The coincidence of these three factors suggests that in many jurisdictions the current moment is a particularly favourable time to implement a carbon tax.

13.3 Beware the risks of starting small

This section highlights political economy trade-offs between choosing a tax rate that matches or that is below the social cost of carbon. Many political analysts argue that purposefully starting with a tax rate below the social cost of carbon improves the political palatability of carbon taxation. However, Behavioural Law and Economics suggests that there are also political advantages in immediately starting off with the efficient rate, and these advantages have largely been ignored in the environmental tax literature. Below we discuss criteria that can guide policymakers in the choice between the two options. Before we briefly recap from chapter 2 what the efficient choice would be.

13.3.1 Pigouvian efficiency

Carbon taxes are more efficient if the tax rate is immediately set at the social cost of carbon (Williams, 2017). The level of carbon prices consistent with countries' mitigation commitments under the Paris Agreement requires implementing globally a carbon price between 40 and 80 USD by 2020 (Stiglitz *et al.*, 2017). Delay-

[12] The IMF tracks the world prices of oil, gas and coal in the Commodity Fuel (Energy) Index. The average index figure for the period 2008-2018 was 146.7, but for 2018 it currently stands at only 131.5, and prices are forecasted to fall further, for the index to reach 113.2 in the year 2023 (IMF, 2018, series PNRGW).

ing the introduction of this carbon price level significantly increases the costs of reaching any given mitigation target (Rozenberg *et al.*, 2015; Stiglitz *et al.*, 2017).

13.3.2 The classic case for starting small and then increasing tax rates gradually

Contrary to Pigouvian efficiency, political economy considerations may suggest starting carbon taxation with a rate that is lower than the social cost of carbon (Trebilcock, 2014; Vogt-Schilb & Hallegatte, 2017; Williams, 2012). This advice can be based on the following considerations.

13.3.2.1 Costs of adjustment

Introducing a carbon tax with a phase-in period reduces the adjustment cost incurred by polluting entities, who then have fewer reasons to oppose the reform. And even with such a reduced price signal, a tax rate below the social cost of carbon may already discourage pollution-intensive companies from further investing in polluting capital, while allowing them to carry on the production with existing assets (Williams, 2012). Whether these positive incentive effects hold depends on the credibility of future rate increases: only if market participants expect that the existing low tax rate will rise in the future will the tax have its intended behavioural consequences. But when that expectation is created, a carbon tax can be effective today even if the current rate is low.

13.3.2.2 Learning by trying

Increasing the tax rate slowly and implementing trial periods allows citizens to first learn about carbon taxes before major adjustments are made. Large segments of the population in developed and developing countries are averse to environmental taxes with high rates (Brannlund & Persson, 2012; Gevrek & Uyduranoglu, 2015; Kallbekken & Sælen, 2011). However, this aversion seems to decrease after the introduction of a low carbon tax as the public learns more about the costs and benefits of the measure (Carattini *et al.*, 2017b). There is then a case to start environmental taxation with low rates, in order to trigger this learning process, and only then ramp up the policy.

13.3.2.3 Signalling support

Phasing-in carbon taxes gradually can create and reinforce social norms which support pro-environmental taxation. Introducing an environmental tax sends a signal that society values making polluters pay. To the extent that even a tax rate below the social cost of carbon conveys the message that other members of society support making polluters pay, a gradual phasing-in of environmental taxes may help first develop the pro-environmental values in society which are needed to scale up the policy without too much public resistance subsequently.

13.3.3 The case for big-bang reforms

13.3.3.1 Gradual adjustments may not work

Despite the above strategies, once started at a low tax rate, adjusting the rate upward over time can be politically strenuous. The initial rate anchors expectations, defining what is publicly considered a "high" or "low" carbon tax rate. Raising rates gradually may not be much easier than a one-time large adjustment. Most countries struggle even with keeping the real value of their environmental tax rates stable, for instance by failing to update tax rates in the fact of inflation (OECD, 2010b). Raising the rate is then all the harder.

13.3.3.2 Rule-based tax rate increases

Commitment devices may ease price adjustments over time but are not failure-proof either. Policymakers can manage political difficulties in gradually raising low environmental taxes by adopting commitment strategies that facilitate the path towards more efficient tax rates. A standard commitment device is to announce a defined tax rate increase schedule. This strategy has been adopted by British Columbia, France, and Switzerland (Carattini *et al.*, 2017b), and more recently South Africa. Ideally, these tax rate adjustments could be scheduled in the initial tax bill to subsequently take place automatically, without the need for further approval through another Parliamentary vote in the future. Automatic increases in the tax rate may partially shield them from fluctuations in political attitudes towards carbon pricing, and thus increase the ex-ante credibility of the scheduled rate increase.

However, even where a country commits to increasing its carbon price signal over time, it may subsequently diverge from this course of action. The UK's experience with the Carbon Price Floor (CPF) is a clear example of these difficulties. The CPF was first introduced in 2013, and it was planned to increase the price every year until 2020 up to 30 £ per tonne. However, in 2014, concerns over competitiveness and consumer prices led the UK Government to cap the CPF at 18 £ until 2020. This price freeze was subsequently extended to 2021 (Hirst, 2018). This experience repeats the UK's previous difficulties with its environmental taxation of fuels: in 1991, the UK committed to raising its fuel taxes by a set percentage per year, but in 2000 this policy was abandoned (Seely, 2011) following protests by truck drivers during the run-up to an election. Starting with a low tax rate is therefore difficult to correct, and may lock in an inefficiently low carbon price for the long term.

13.3.3.3 Avoiding a tax increase in the lead-up to elections

If governments pre-commit to tax rate increases through a rule, some (actual or expected) rate increases will necessarily interfere with the sensitive period before elections. If governments instead implement gradual price increases without a rule-based pre-commitment to avoid the political cost of such those expected tax rate increases during a sensitive time, then the government also gives up the opportunity to incentivise forward-looking green investment. Either the rule-based commitment to raise prices is taken into account by the public and markets or not. The only way to both incentivise that forward-looking green investment and to avoid interference of tax rate increases with election cycles is to refrain from a long spaced-out gradual ramp-up of environmental tax rates and instead use a 'big bang' approach, instituting a significant green tax in one go during a period with sufficient time gap towards the next election.

13.3.3.4 Addressing rational ignorance

Tax rates set at the social cost of carbon may trigger stronger interest in the population because they allow increasing the size of compensation. When the costs of obtaining information about carbon taxes exceed the benefits, citizens may decide to remain "rationally ignorant" (Downs, 1957). An individual is rationally ignorant when he chooses to refrain from acquiring knowledge about an issue when the cost of educating himself about it exceeds the potential benefit that the knowledge would provide.

Gradualism favours rational ignorance in the population because low environmental tax rates imply that the government collects only a small amount of revenue that can be used for compensation payments or tax shifts. For example, if the government undertakes a reform which combines the increase of an environmental tax with the increase of cash transfers, then a low environmental tax rate will finance only low cash transfers which will, in turn, be unable to generate the interest of beneficiaries. When the reform is proposed, beneficiaries will then be 'rationally ignorant' about their potential gains and not speak up. This rational ignorance does not apply for the losers of the reform though: since the losses from environmental tax reforms are more concentrated than the gains, even a small tax may already trigger the significant attention of those losers, so they are going to mobilise against even a low initial tax rate. As a result, with small initial environmental tax rates, the debate about the reform will be dominated by the losers of the reform, whereas for a larger environmental tax rate, the winners of the reform will more likely start caring enough to speak up as well. Therefore, the rational ignorance problem becomes smaller when an environmental tax is immediately set at the efficient level rather than being gradually phased in starting with a very low tax rate.

This finding is further strengthened because the inter-temporal evaluation of rewards is not independent of their size. Individuals tend to prefer delayed rewards vis-à-vis immediate rewards when the absolute size of the reward increases (Ballard *et al.*, 2017). For illustration, imagine how you would choose between receiving the following money amounts under two alternative situations:

Situation␣1 Choice between receiving 10 USD today or 20 USD tomorrow

Situation␣2 Choice between receiving 1000 USD today or 2000 USD tomorrow

Economic experiments systematically find that a larger proportion of participants chooses the higher amount in situation (2) than in situation (1) even though the relative size of the rewards is kept constant in the two situations. The higher the stakes get, the less rationally ignorant the population becomes: the trade-offs are evaluated more seriously. This is important for the political viability of environmental tax reforms. As shown in Heine & Black (2019) and Parry, Veung, Heine

(2015), environmental tax reforms can create substantial net economic benefits for current generations, but it is critical that the population perceives the stakes to be sufficiently great for the winners to realise whether they should support the reform. The greater the environmental tax at the beginning of the reform is, the greater are the revenues that can be used for creating benefits, and hence the lower the problem of rational ignorance is.

13.4 Choosing from the arsenal of potential behavioural strategies

This section discusses issues that arise in choosing one or more of the policies described above. In situations in which benefits from different strategies are unknown and unknowable, we suggest adopting polyfunctional measures, meaning measures that address multiple factors that reduce support for environmental tax reforms.

13.4.1 Quantifying costs

Many behaviourally informed policies can be implemented at low cost (Sunstein, 2014). For instance, framing the carbon tax as an (implicit) subsidy removal is unlikely to cost much. Similarly, it can be cheap to instruct hotline personnel on how to best interact with citizens. These measures may, however, have non-trivial impacts on the acceptability of carbon taxes. Thus, using strategies from Behavioural Law and Economics to address political hurdles does not necessarily imply bearing significant costs. The relatively low cost of these techniques may allow implementing multiple strategies even with a limited budget.

13.4.2 Quantifying benefits

However, it can be difficult to quantify the benefits of a behavioural strategy. In this setting, this issue implies that it can be difficult to estimate the effect of each policy described above on the support for carbon taxes.

13.4.3 Choosing under uncertainty

Uncertainty about the benefits of behaviourally informed policies can make it difficult for policymakers to choose the best policy. Existing research can ease these choices. For instance, it can provide hints on which (financial) context triggers stronger risk aversion and cognitive depletion. However, on other occasions, it might be worth gathering country-level data before choosing. Even then, there will be occasions in which existing evidence does not provide sufficient information on the possible benefits of different policies to make an informed choice and gathering new evidence is not a viable solution (e.g. because of time or budget constraints).

13.4.4 Choosing polyfunctionality

When uncertainty is high, selecting strategies that address multiple factors that hinder support for environmental tax reforms can increase the effectiveness of policymaking. When uncertainty about the benefits is significant, a useful rule of thumb is to adopt a polyfunctional policy, i.e. a strategy that simultaneously addresses multiple factors hindering support for policy reform. Most behavioural strategies discussed in this chapter address multiple factors that reduce public support towards reform.

13.4.5 Polyfunctional strategies

Information campaigns address lack of knowledge and understanding, lack of trust in government, rational ignorance and risk aversion. Information campaigns are a primary means to address public misunderstanding of the benefits of environmental tax reforms, but they can also foster trust in the government when the campaign sends the signal to the public that the credibility of the government would be compromised in case the announced reform does not take place as promised (e.g. with regards to the use of revenues). By setting clear expectations for citizens about the expected effects of reform, informational campaigns can equally reduce opposition to reform that stems from risk aversion.

Complementary information channels address lack of knowledge, understanding, trust in government, as well as rational ignorance and risk aversion. Information channels such as hotlines and public debates tackle the same problems addressed by information campaigns. However, contrary to information campaigns, these alternative channels enable citizens to request specific information actively, and therefore the two measures should complement each other.

Antedating benefits addresses discounting, risk aversion, lack of trust and rational ignorance. Since future benefits are discounted, the more cash transfers are antedated, the more citizens will value them. Anticipating benefits will also reduce citizens' fears that the government will not stick to the promised use of revenues. In addition, when antedated payments are made visible on frozen accounts, support for the tax could be further enhanced due to the endowment effect. Since anticipating benefits increases the perceived value of reform, it can also induce citizens to gather further information and therefore help in overcoming the rational ignorance problem.

Committing to reform through costly signals addresses lack of trust in government and risk aversion. Governments' investments in convincing citizens that revenues will be spent as announced, may increase support for reform among citizens that are sceptical of governments' intentions but also among risk-averse individuals.

Smart spending addresses distributional concerns, lack of knowledge and understanding, rational ignorance, and risk aversion. Using revenues to decrease taxes that are salient to the public can help citizens understand the benefits of reform and therefore reduce also the problems of rational ignorance and opposition to reform due to risk aversion. Using revenues to compensate poor households can instead foster support among compensation recipients but also reduce citizens' aversion for regressive reforms. Since risk aversion rises in poverty, compensating underprivileged individuals can address also opposition due to risk aversion.

13.5 Conclusion

Public support for ambitious environmental tax reforms is often too low to trigger policy change. This chapter has identified and discussed various factors that reduce public support for environmental taxation.

Building on findings from Behavioural Law and Economics, this chapter has put forward various high-level operational strategies to increase public endorsement for carbon taxes. Some of these suggestions are relatively straight-forward and cheap to implement, and therefore could be readily adopted even in developing countries. These behaviourally informed strategies provide policymakers with additional tools to successfully address political economy constraints to environmental tax reform.

Devise information campaigns that appeal to (i.e. target) diverse segments of the population. Targeting should take place both in terms of content and of who delivers the information. The content should focus on the negative consequences of carbon emissions at the local or national level, and messages should be tailored to leverage pro-environmental values already endorsed by different social groups. These media campaigns should be complemented with other communication channels (e.g. hotlines) that allow citizens to obtain further information at-will about the reform and especially about the planned use of revenues.

The planned use of revenues should be aligned with citizens' preferences for redistribution and environmental protection. This alignment should be made clear to the public also by carefully structuring the tax shift or spending side of the reform. The use of revenues is doubtless a crucial determinant of the political acceptance of environmental tax reforms. It is therefore critical for government to communicate environmental taxation as part of a wider package of measures, where the revenues from the tax are used to enable tax reductions, compensation payments or public spending on environmental protection. A tax alone will unlikely inspire public enthusiasm. In case revenues are used for tax shifts, governments should focus on reducing pre-existing taxes that are widely known to the public and that are perceived as falling onto the segments of the population from which the government is seeking support.

While the use of revenues for tax shifts is the most efficient, another approach which can be more popular is to use revenues for compensation payments. These can take the form of means-tested or universal per-capita transfers. The evidence till-date suggests that while the first option can often be more progressive, the second is often more popular. Another possibility is to earmark revenues for environmental projects. There are important fiscal reservations to this earmarking approach, but the available evidence strongly suggests that it is popular.

Make credible commitments to the planned use of revenues. Announcing that revenues will be used according to people's desires will not increase support for reform if the public does not believe that this promise will be fulfilled. The announcement of the spending side of the reform should be made credible to the public via sending costly signals, i.e. commitments that are politically costly not to fulfil. If revenues are used to compensate households or earmarked for environmental projects, these signals could consist in investments in infrastructures that make possible the cash transfers or the realisation of the environmental projects. Citizens' trust in the government can be gained also by increasing transparency on the spending side.

Traditionally, the costs of environmental tax reforms accrue before most of the benefits. This sequencing can be politically deadly, and governments should use available policy design options for reversing this order. For example, if the environmental tax reform contains compensations via cash transfers, those should be paid before the environmental tax takes effect. The effectiveness of this strategy can be further increased by making visible such cash transfers on bank accounts in the names of the recipients but locking the accounts while making a public commitment that recipients will be able to access the money on the first day in which the price on carbon is applied.

Label environmental fiscal reforms as subsidies reforms. The public can perceive the introduction of a new tax as an attempt by the state to force citizens to change their energy consumption habits. This attempt is unlikely to be welcome. Highlighting that the introduction of an environmental tax is a reduction of the (post-tax) subsidies that society implicitly grants to polluters can improve citizens' perception of the reform.

Environmental tax reforms should best take place during periods in which energy costs for the public are low. In countries where energy consumption follows predictable cycles (e.g. seasons), environmental tax reforms should be initiated during the time in which energy use is the lowest. More generally, the current low global fuels prices make this moment a particularly favourable one to implement energy tax reforms.

The chapter has also highlighted that starting with low tax rates is not always the best political economy strategy. It is generally believed that gradualism is a better strategy to introduce carbon taxes. The analysis provided in the previous pages suggests that there are also advantages in setting the tax rate at the level of the social cost of carbon from the moment in which the tax is first introduced. Whether gradualism is a better political economy strategy depends on the specific context in which a reform taxes place. Policymakers should therefore make this choice on a case-by-case basis, and this chapter has laid out key considerations to inform this choice.

Lastly, the chapter has suggested adopting polyfunctional strategies, i.e. strategies that help simultaneously overcome multiple hurdles to the public support for carbon taxes. Following this approach enables policymakers to act with confidence even in the face of uncertainties regarding the importance of each hurdle individually.

Part V

Synthesis

Chapter 14

Conclusion

Environmental law in most countries today is dominated by a sectoral scatter of regulatory policies implemented by Environment Ministries. For decades, economists have suggested that replacing these regulations with broad-based environmental taxes could generate substantial efficiency gains. This transition has not happened, however. To the contrary, environmental taxes have been stagnating or even regressing over the last fifteen years, even as countries adopted ever more stringent objectives in emerging international environmental law.

An institutional explanation is that tax policy is not under the control of Environment Ministries, so even if these institutions do agree with the economic efficiency gains from replacing regulations with environmental taxes, the policy instrument is not under their control – to act they would need the greater engagement of Finance Ministries who have generally been reluctant to make tax policy available for environmental objectives. This thesis has pointed out reasons for Finance Ministries to reconsider their position. Firstly, environmental problems have escalated from posing sectoral to economy-wide risks; climate change threatens macrostability and thus the core institutional mandate of Finance Ministries. Secondly, international legal obligations to meet environmental targets have fundamentally shifted with the Paris Agreement; so if countries must mitigate climate change now, their Finance Ministries have an interest in the least-cost instrument being used, which is the tax policy under their control. Thirdly, as most countries never had binding obligations anywhere near the stringency of the Paris Agreement, they have not built the institutional capacity. For most of these countries, Finance Ministries are the only institution with a large enough capacity to implement an economy-wide structural change of this scale.

However, paving the way for Finance Ministries to assume their role in environmental lawmaking requires overcoming a series of roadblocks. There are disagreements even about the fundamental objective of environmental law, so chapter 4 has described where the perspectives of different schools of thought on this question meet on the purpose of environmental taxation.

That purpose is also put into question by concerns that environmental taxation might be interventionist. Chapter 2 reviewed foundational texts on the definition of free markets to derive that environmental taxes do not distort the Invisible Hand. A Pigouvian tax rate would be set equal to or below the rate that freely bargaining individuals would achieve if they were able to negotiate about the social cost in question. The degree of government interference is also less authoritarian than with regulations because environmental taxes provide freedom for the choice of mitigation technology, do not restrict the set of behavioural responses (abatement, input substitution or output substitution), allow gains from flexibly spreading mitigation quantities between emission sources with different marginal costs, and reward dynamic optimisation.

We addressed the concern that environmental taxation can create government failure. First, we went back in time: positions with which Coase (1960) attacked Pigou (1932) were actual points of agreement between the two. So these misunderstandings should be corrected in current teaching (e.g. Demsetz, 1996; Schmidtchen *et al.*, 2009). We then elaborated on how the common concern of government failure can be managed. Coase (1960) had expressed that, if the government does intervene on social costs, the risk of government failure might be worse with environmental taxes than with regulations. However, chapter 2 described why the opposite can equally be the case. Environmental taxation only requires the government to calculate the net external costs of activities; the determination whether the private benefits from continuing an activity exceed those costs can be left to private market participants, unlike for regulations where government also needs to have information about the latter to undertake a cost-benefit analysis as to whether the activity should be prohibited. As a result, environmental taxation makes government less intrusive than the regulatory counterfactual. Besides information constraints, we also described why other sources of government failure – corruption, evasion, informality – can better be controlled with a particular type of environmental taxes (upstream fuel taxes) than with regulations. In chapter 11 we elaborated on these points for a series of country circumstances, showing the robustness of the policy by focusing on developing countries where the risk of governance failure is the most severe.

Another central concern of Law and Economics scholars with environmental taxes is causation. Almost sixty years after Coase (1960), it is still held that Pigouvian taxes would fail to recognise the shared causation of social cost. We read that "*according to the Pigovian view there is only one agent who causes the external cost*" (...) so that "*the modern view*" suggests that Finance Ministries should not enforce the Polluter Pays Principle (Schmidtchen *et al.*, 2009, p. 4) because "*everyone involved is fully responsible for all the damage done*" (de Meza, 1998, p. 273). Chapter 4 investigated this critique, the underlying disagreements about the meaning of the Polluter Pays Principle, the calculation of Pigouvian tax rates, and different theories for apportioning responsibilities for social costs from several opposing schools of thought. We then related these theories of causation to the way the burden of environmental taxes is shared between producers and consumers, exporters and importers, and third parties through the passing through of tax incidences. We show that in a competitive market, each consumer/producer ends up paying for that share of the social cost that consumers/producers on the margin caused. Therefore, the common critique in Law and Economics – that Pigouvian taxation would contradict shared causation – is wrong.

Chapter 4 also showed that Pigouvian taxation and Coasean bargaining do not address the same types of social costs, and should, therefore, be seen as complementary rather than alternative policy options. The methodology for calculating Pigouvian tax rates uses a definition of external costs that excludes those cost items for which there is reciprocal causation. The costs contained in the tax rate calculations are precisely those that do not allow a bargaining solution. It is after the tax is imposed that bargaining on the apportionment of these costs becomes possible. After the tax, the producer and the consumer of the polluting good bargain about their incidence of the tax bill which jointly adds up to the victim's external damage. Pigouvian taxation is, therefore, a market-building mechanism for Coasean bargaining. And our causation framework shows that this Coasean bargain in combination with this methodology of calculating Pigouvian taxes ensures that the producer, the consumer and the victim each end up paying approximately that share of the social damage that they each caused.

This causation framework is not restricted to solving theoretical problems. Chapter 6 showed how this framework helps to address two current problems of emerging climate law. There is a fierce debate on apportioning the responsibility for "embodied emissions" which are released in the production of traded goods. The Paris Agreement attributes these entirely to the producing country, whereas many scholars have suggested they should be attributed to the consuming country as the latter's demand would have caused the emissions. The current practice is also questionable under the legal principle of "Common but Differentiated Responsibilities" which seeks to favour developing countries whereas the production-based accounting attributes greater responsibility to mostly poor countries which rely most heavily on the export of emissions-intensive commodities. The controversy is so great that some analysts regard it as a major barrier to the successful future evolution of the climate regime. A similar debate exists for emissions released in international space, for which present climate law has no way of attributing responsibility to states so that these emissions fall outside of the legal structure of Nationally Determined Contributions (in the Paris Agreement) or the Effort Sharing Decision (in the EU). These are not only political games, about which a thesis might not be able to do anything – instead, these debates reflect actual knowledge gaps that Law and Economics can fill. As an OECD paper points out "*it would be impossible to apportion shipping emissions to countries*" (Merk, 2013, p. 4), but our causation framework does provide such a methodology. Accordingly, embodied emissions and emissions released in international space could be attributed to the countries who cause them, so we can continue to rely on the nation-state as our individually responsible entity for regulating social costs in international law. We may still prefer to move towards a global governance model of international law if that is feasible, but we have a backup option. Moreover, it is not true that bringing climate law in line with the causation of social costs requires a switch as radical as the one from full production-accounting to full consumption-accounting: the truth lies in the middle, which itself is conducive to balancing opposing interests in the already contentious climate negotiations.

The analysis amounts to pointing out that countries have additional responsibilities that they may not currently be aware of, by showing how they cause social damage even outside their jurisdictions. But pointing fingers is not sufficient; one also needs to show feasible policy solutions for acting on these responsibilities and taxing emissions according to the damages that one's citizens caused overseas. International law sets strict limits to states that regulate overseas harm through unilateral policy actions which have an extraterritorial extension. And the devil is famously always in the detail. Chapters 7 and 9 therefore dived into two sector examples of taxing emissions in international space and embodied emissions. For these two sector applications, we refrain as much as possible from simplifying assumptions, to be fair to critiques of environmental taxation that claimed Pigouvian schemes were not practicable enough for complex market settings. The maritime and the forestry sector are purposefully chosen as two sectors in which the efficient implementation of environmental taxation is particularly challenging, to provide a robustness check for the feasibility of Pigouvian taxation; proving that tax solutions to the problem of social cost are not "*the stuff that dreams are made of*" (Coase, 1988, p. 185) and that it is not automatic that "*carrying them out means heading towards regulatory failure*" (Schmidtchen *et al.*, 2009, p. 5). Government failure remains a possibility, but the mechanisms that we design minimise complexity and reuse existing administrative frameworks to control this risk. The schemes proposed in chapters 7 and 9 have also subsequently been reviewed positively for their real-world applicability by the European Commission, the International Monetary Fund, the Dutch Transport and French Finance Ministries, the International Tropical Timber Organisation and the MIT Climate CoLab.

Chapters 7 and 9 developed two new solutions for taxing emissions overseas under the restrictions for extraterritorial regulation. Previous maritime proposals had suggested that taxes on emissions in international space can only be established through port state jurisdiction. However, chapter 7 shows that an individual port can tax emissions released along global supply chains through the cargo, also covering emissions of ships that never access the taxing state's jurisdiction. This mechanism raises environmental effectiveness and reduces risks of tax avoidance and trade route distortions. Chapter 9 shows that private law enforcement through certification companies can be used to replace the missing overseas public law enforcement capacity of the state that is implementing the tax.

Chapter 7 and 9 also develop two new solutions for the calculation of Pigouvian taxes in situations of extreme information problems. Recall that Coase (1960) criticised the applicability of Pigouvian taxation because he was "*unable to imagine how the data needed for such a taxation system could be assembled*" (id., p. 41) because "*the proposal to solve the smoke-pollution and similar problems by the use of taxes bristles with difficulties*" (id., p. 42). Previously, we showed how these information problems can be overcome for emissions that occur within the jurisdiction implementing the tax (Parry, Heine, Lis & Li, 2014), but here we deal with cases where the government does not have the jurisdiction to enforce the law on emissions which occur outside their territory. We solve this problem by combining taxes with subsidies. The tax is set equal to the marginal damage under a default assumption of a standard emissions factor; the subsidy is provided for being better than the default value. Related "Feebate" schemes have been developed before (e.g. Fullerton & Wolverton, 2003), but for cases where the taxpayer and the subsidy recipient are the same entity. Chapter 7, however, shows that for taxing transboundary externalities, these entities should be separate because that avoids the extraterritoriality problem while not creating any efficiency problems. The tax-subsidy scheme makes it possible to raise all the needed data to converge towards optimal environmental tax rates even if the government has no information to start with. This is an important finding for current EU lawmaking which is creating "Measurement, Reporting and Verification" (MRV) rules which are then not necessary. For the forestry sector, the EU is applying detailed "Due Diligence" schemes for raising the data to enforce the European Timber Regulation (a ban), but Chapter 9 shows that existing private certification systems can be used to raise the data for taxing the externality (even though taxes usually require even more data than bans).

The schemes developed in chapters 7 and 9 could be implemented by the European Union acting unanimously without requiring a global agreement. Chapter 8 shows that the availability of a unilateral outside option for taxing maritime emissions makes the achievement of a global agreement for taxing these emissions more likely. The availability of an alternative mechanism can help overcome hold-up problems which exist as long as a unanimous global agreement is the only option for taxing maritime emissions. Current international environment negotiations heavily rely on unanimity, which can create a gridlock whenever individual countries block, such as the United States currently. In such circumstances, a requirement for unanimity can be used strategically to extract concessions for agreement. If, however, scholars can create economically and legally feasible unilateral mechanisms, the risks of hold-ups can be reduced, thus helping to speed up our long-delayed efforts of global climate change mitigation.

Another critique of environmental taxes is that, while they may be efficient on their own, they might not perform well in combination with other policy instruments. This is a serious challenge from two standpoints. First, environmental taxes are a newcomer to an existing environmental law that is dominated by many other policy instruments. So if environmental taxes had problematic interaction effects with the other policy instruments, their second-best efficiency might be severely undermined. Second, there can be many interacting market failures in environmental law which can justify the coexistence of several policy measures (Acemoglu *et al.*, 2012; Grubb *et al.*, 2014b). For both reasons, we investigate interaction effects in the following settings. Chapter 2 explains why green bonds perform better when they are combined with carbon taxes than when they are combined with emission trading schemes. Also the fiscal neutrality of the VAT system improves through the combination with environmental taxation. Chapter 9 reviews some long-standing problems of sustainability certificates (eco-labels) which significantly improve when these certificates are combined with taxes. There are limits to the market absorption capacity for competing certificates, but chapter 9 shows how that this problem is reduced when certificates are combined with taxes. The problem of threshold costs for producers that start with certification at the bottom improves as well as the dynamic incentives of producers in the upper market segments. These examples show how environmental taxes can be integrated into a Smart Mix of policy measures.

In making each of these propositions, we have assumed that the case for and against environmental taxation can be judged independent of the macroeconomic state of the economy. However, during economic recessions, political commentators often disagree with that position and demand to ease environmental tax rates on business during the bad times. Finance Ministries may share this concern and worry that taking on a new institutional role in environmental policy may contradict their existing role in managing macroeconomic business cycles. However, chapter 5 finds that there is already a cyclical variation of environmental tax burdens, even without the variation of tax rates. This implicit and automatic adjustment supports the traditional approach in Law and Economics not to vary liability rules along the business cycle.

Another potential conflict between environmental taxation and the existing institutional responsibilities of Finance Ministries is equity. Many commentators have argued that environmental taxation would harm the poor, so Finance Ministries should not adopt this policy instrument given the duty of fiscal policy to improve income distributions. However, chapter 12 finds that environmental tax reforms do not pose significant problems for income distribution. Our review of theoretical and empirical evidence from across the world suggests that there is no major equity-efficiency trade-off with environmental taxes; instead, environmental tax reforms can be designed such that they significantly improve income distributions. Accordingly, Finance Ministries do not need to fear a clash of their institutional responsibilities.

We thus reviewed many potential barriers to environmental taxation and found that none explains why Finance Ministries are not taking up this policy instrument. The reasons may then be political. And indeed several governments have fallen over environmental tax reforms. But it does not need to be like that.
Chapter 13 applies Behavioural Law and Economics to formulate strategies how the political economy of environmental tax reforms can be improved.

Based on these findings, the thesis makes the following policy recommendations. Finance Ministries in all countries should implement environmental taxation as soon as possible. The less delay there is, the lower will be the cost of complying with their countries' obligations under the Paris Agreement. The type of environmental taxation must, however, be adapted to the country's institutional capacities, so that this effort at controlling market failure does not lead to additional government failure. Developing countries should start with a simple design, focusing on upstream fuel taxes. Middle-income countries with greater government capacity can reap further efficiency gains from a system of upstream taxation with downstream rebates. Care must be taken when extending environmental taxation from fuels to other tax bases where the administrative challenges are more significant. Advanced countries can create global public goods by applying environmental taxation also to damage occurring beyond their borders; indeed they have a responsibility to do so because their global demand causes much of this overseas damage. To enable such global environmental policy without risking significant tax competition, extraterritoriality, competition or trade distortion problems, countries should use consumption-based excise taxes. The rates for each of these environmental taxes should equal the environmental damage – so not be set below the Pigouvian rate as has mistakenly been suggested in the political economy literature which did not take into account the behavioural problems created by starting tax reforms too small. For pricing damage when there are significant information problems, the tax rate should be set according to a default assumption of what the environmental damage is, with a tax rebate available to those emitters who demonstrate that they performed better than what was assumed. In this way, efficient Pigouvian taxation can be realised even under the tightest information constraints, and under restrictions for extraterritorial policy action.

At the time at which this dissertation is submitted, international environmental law is under massive pressure. Whereas environmental law used to rely on international agreements, a rise of nationalism is undermining multilateral efforts to protect the global commons. The EU is fighting a war on two fronts. On the one side, the Paris Agreement, as its most significant environmental legal breakthrough, is being eroded by countries dropping out. On the other side, even what was agreed in Paris is insufficient, and the cost of stabilising the climate is escalating with continued policy delay. In this situation, the EU must break the circle in which individual countries tone down their environmental commitments because others do. To break the circle, the EU should unilaterally increase its climate action, and do so in the least-cost manner which creates maximum economic co-benefits. The reason why least-cost policy action is needed goes beyond normal efficiency-preferences in Law and Economics: it should be least-cost to overcome the political perception of there being a conflict between national economic interest and environmental protection. Europe must demonstrate that these two can be combined. But that necessity makes it even more important to use efficient policy instruments for environmental law. Environmental taxation is that efficient policy instrument. And the EU can use it to act globally, even when additional multilateral agreements cannot currently be obtained. The residual main barrier is then that Finance Ministries who control tax policy must make this tool available. They must take the helm to defend the Paris Agreement and secure sufficiently strong mitigation action to protect the macroeconomy from climate change.

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Appendix A

Summary

The state of environmental taxes in the world today is a paradox. Countries are adopting increasingly stringent environmental objectives, in particular for climate change mitigation, and economists have increasingly championed tax policy as the most efficient policy instrument for exactly those social costs. Nevertheless, environmental taxes are not progressing. Tax rates are far below the levels required for implementing the Paris Agreement, and the overall gap between the rates of fuel taxes justified by environmental costs and countries' actual fuel tax rates is growing. This failure is not compensated by a corresponding take-over from alternative policy instruments such as markets for emissions permits, regulations, technology policies, green bonds, improved environmental litigation opportunities or private sector breakthroughs. Instead, time is running out, while the marginal social cost of emissions is escalating. There is, therefore, a sense of urgency in discovering solutions for the impediments of policy action. Many of these impediments to environmental taxation are deeply intertwined legal and economic problems. Also some of the starkest critiques of environmental taxation have come from economic analysts of law. This thesis, therefore, scrutinises a series of challenges to environmental taxation with the purpose of providing theoretical and policy solutions.

Contrary to prominent positions in Law and Economics, we show that environmental taxes take into account the reciprocal causation of social costs. We relate causation to the way how the burden of environmental taxes is shared between producers and consumers, exporters and importers, and third parties. In a competitive market, environmental taxes make each agent pay approximately that

share of the social cost that this agent caused.

This causation framework provides a solution for current problems in emerging climate law for state responsibilities over embodied emissions and emissions in international space. We also show how countries can unilaterally act on these responsibilities and tax emissions outside their jurisdictions. This becomes possible through new solutions for the taxation of overseas damages that avoid extraterritoriality violations. Our proposals extend the literature on WTO-consistent consumption-based carbon pricing and provide two new solutions for the determination of efficient environmental tax rates under situations of extreme information scarcity. These schemes would not require an international agreement since they overcome problems of tax competition, trade distortions and competitiveness. The availability of this unilateral policy option overcomes hold-up problems in international negotiations, easing the adoption of an ambitious global agreement.

We add to the literature on Smart Mixes by showing that environmental taxes perform better than emissions trading systems when they are combined with green bonds. Long-standing problems with sustainability certificates (eco-labels) can be reduced through a particular combination of those policy instruments with taxes. As a contribution to the literature on tax-subsidy combinations (Feebates), we show how Feebates must be modified to cover transboundary harms.

We show how environmental taxes can be designed so as to reduce the risks of government failure, administrative and compliance costs. Depending on market circumstances, the tax rate is as interventionist or less than the approach proposed by Coase (1960). We provide evidence against wide-spread critiques that environmental taxation would be regressive. It is also not true that the burden of environmental taxes would not adapt to the business cycle – even when environmental tax rates are held constant during a recession, their burden for businesses varies procyclical, as does the causation of the underlying social costs. Using Behavioural Law and Economics we also propose strategies for improving the political economy for these taxes.

Based on these findings, the thesis recommends that Finance Ministries make tax policy available as a central tool in environmental law, so that the Paris Agreement can be implemented at least-cost. Europe should not wait for unanimous global agreements to implement environmental protection: taxes can be used unilaterally to legally and economically protect the global commons, and pursuing such unilateral outside options helps to enable global agreement.

Appendix B

Samenvatting

De toestand van de milieubelastingen in de wereld van vandaag is paradoxaal. Landen nemen steeds strengere milieudoelstellingen aan, in het bijzonder voor het tegengaan van klimaatverandering, en economen pleiten voor steeds meer fiscaal beleid als het meest efficiënte beleidsinstrument om die maatschappelijke kosten te internaliseren. Toch wordt er weinig vooruitgang geboekt wat betreft de invoering van milieubelastingen. De belastingtarieven liggen ver onder de niveaus die vereist zijn voor de tenuitvoerlegging van het Akkoord van Parijs, en het algemene verschil tussen de tarieven van brandstofbelastingen die gerechtvaardigd worden door de milieukosten en de werkelijke brandstofbelastingtarieven van de landen wordt groter. Dit falen wordt niet gecompenseerd door een overeenkomstige overname door alternatieve beleidsinstrumenten, zoals markten voor emissierechten, regelgeving, technologiebeleid, groene obligaties, betere mogelijkheden voor milieugeschillenbeslechting of doorbraken in de particuliere sector. De tijd dringt en de marginale maatschappelijke kosten van emissies blijven maar toenemen – zonder dat er maatregelen werden genomen. Het is dus dringend tijd om oplossingen te vinden tegen de belemmeringen van deze maatregelen. Veel van deze belemmeringen voor milieubelastingen zijn nauw verweven met juridische en economische problemen. Ook rechtseconomen hebben schrijnende kritiek op milieubelastingen geuit. In dit proefschrift wordt daarom een reeks uitdagingen op het gebied van milieubelastingen onderzocht met als doel theoretische en beleidsoplossingen aan te reiken.

In tegenstelling tot prominente standpunten in de rechtswetenschappen en de economie, laten we zien dat milieubelastingen rekening houden met het wederkerig verband tussen sociale kosten. In dit proefschrift wordt het oorzakelijk verband gerelateerd aan de manier waarop de last van milieubelastingen wordt verdeeld tussen producenten en consumenten, exporteurs en importeurs, en derden. In een concurrerende markt laten milieubelastingen elke agent precies betalen voor dat deel van de sociale kosten dat door deze agent veroorzaakt werd.

Dit causaal raamwerk biedt een oplossing voor de huidige problemen in de opkomende klimaatwetgeving voor staatsverantwoordelijkheden over de emissies bij de productie van verhandelde goederen en emissies in de internationale ruimte. We laten ook zien hoe landen unilateraal kunnen handelen op basis van deze verantwoordelijkheden en emissies buiten hun rechtsgebied kunnen belasten. Dit wordt mogelijk door nieuwe oplossingen voor de belasting van overzeese schade die extraterritoriale schendingen voorkomen. Onze voorstellen breiden de literatuur over WTO-conformiteit uit voor consumptie gebaseerde koolstofprijstelling en bieden twee nieuwe oplossingen voor het bepalen van efficiënte milieubelastingtarieven in situaties van extreem gebrek aan informatie. Voor deze regelingen is geen internationale overeenkomst nodig, aangezien zij een oplossing bieden voor problemen op het gebied van belastingconcurrentie, handelsverstoringen en concurrentievermogen. De beschikbaarheid van deze unilaterale beleidsoptie maakt een einde aan de hold-up-problemen in internationale onderhandelingen en vergemakkelijkt de totstandkoming van een ambitieus internationaal verdrag.

We voegen toe aan de literatuur over Smart Mixes door te laten zien dat milieubelastingen beter presteren dan emissiehandelssystemen wanneer ze gecombineerd worden met groene obligaties. Langdurige problemen met duurzaamheidscertificaten (milieulabels) kunnen worden verminderd door een bijzondere combinatie van die beleidsinstrumenten met belastingen. Als bijdrage aan de literatuur over belastingen-subsidiecombinaties (Feebates) laten we zien hoe Feebates moeten worden aangepast om grensoverschrijdende schaden te dekken.

We laten zien hoe milieubelastingen zodanig wijd ontworpen kunnen worden dat de risico's van een falende overheid, administratie- en nalevingskosten worden beperkt. Afhankelijk van de marktomstandigheden wordt het belastingtarief even interventionistisch of lager dan de door Coase (1960) voorgestelde aanpak. We leveren argumenten tegen de wijdverbreide kritiek dat milieubelastingen regressief zouden zijn. Het is ook niet waar dat de milieubelastingdruk zich niet aan de conjunctuurcyclus zou aanpassen – zelfs wanneer de milieubelastingtarieven tijdens een recessie constant worden gehouden, varieert hun druk op bedrijven procyclisch, evenals het oorzakelijk verband van de onderliggende sociale kosten. Aan de hand van gedragswetenschappen stellen we ook strategieën voor om de politieke economie voor deze belastingen te verbeteren.

Op basis van deze bevindingen wordt in dit proefschrift aanbevolen dat de ministeries van Financiën belastingbeleid beschikbaar stellen als centraal instrument in het milieurecht, zodat het Akkoord van Parijs tegen zo laag mogelijke kosten kan worden uitgevoerd. Europa moet niet wachten op unanieme mondiale overeenkomsten om milieubescherming te implementeren: belastingen kunnen unilateraal worden gebruikt om de commons in de wereld juridisch en economisch te beschermen, en het nastreven van dergelijke unilaterale externe opties draagt bij aan een mogelijke mondiale overeenstemming.

Appendix C

Curriculum Vitae

European Doctorate in Law & Economics

Curriculum vitae
Dirk Heine

Short bio	
Dirk Heine has worked on environmental issues since 1998: initially with civil society groups (Greenpeace, Germanwatch, Open Knowledge Foundation, Common Future Think Tank) and from 2011 with public institutions (German Federal Ministry of Finance, International Monetary Fund, World Bank). He was a core member of teams creating the Coalition of Finance Ministers for Climate Action and the climate-macro programs of both the IMF and the World Bank, co-authoring the first environmental books to receive the IMF Management Award and the World Bank EFI Vice President Award.	
Education	
European Doctorate in Law and Economics at University of Hamburg, Erasmus University Rotterdam, and University of Bologna	2013-2020
Visiting Student at Université cath. de Louvain (03-08/2016), New School for Social Sciences (02/2016), IMK (07/2015), UC Berkeley (08-09/2012)	2012-2016
European Master in Law and Economics at Erasmus University Rotterdam, Ghent University, and Indira Gandhi Institute of Development Research	2010-2011
Bachelor in Economics at University of Cambridge (MA cantab)	2007-2010
Diploma in Chinese Language at Beijing Normal University	2006-2007
International Baccalaureate Diploma at United World College, Hong Kong	2004-2006
Work experience	
Economist at World Bank	Since 2016
Visiting Scholar at IMF (09/2011-04/2012, 02-06/2013, 01-02/2016)	2011-2016
Economist at German Federal Ministry of Finance	2012-2013
Board Member at Common Future Think Tank	2007-2010
Member of the Advisory Council to the Executive of Greenpeace Germany	2003-2004
Prizes and awards	
World Bank Economics, Finance & Institutions Vice President Award	2019
Massachusetts Institute of Technology Climate CoLab Judge Award	2015
European Association for Law and Economics Deloitte Prize	2015
IMF Management Award for "Getting Energy Prices Right"	2014
World Bank Apps-for-Development Award and Apps-for-Italy Award for "Yourtopia – Measuring Social Progress beyond GDP"	2011
EMLE Thesis Prize	2011

Publications	
Heine & Hayde. 'Environmental Taxation and Sustainable Forest Management', 'Letting Commodity Tax Rates Vary with the Sustainability of Production' and 'National Tax Policy for Cross-Border Deforestation Problems' in *Designing Fiscal Instruments for Sustainable Forests*, World Bank and International Tropical Timber Organization.	2020
Heine, Faure & Dominioni. 'The Polluter-Pays-Principle in Climate Change Law: An Economic Appraisal', *Climate Law* 9(3).	2020
Dominioni & Heine. 'Behavioural Economics and Public Support for Carbon Pricing', *European Journal of Risk Regulation* 10(3).	2019
Heine, Semmler, Mazzucato, Gevorkyan, Flaherty, Braga, Hayde & Radpour. 'Financing Low-Carbon Transitions through Carbon Pricing and Green Bonds', *Vierteljahreshefte zur Wirtschaftsforschung* 88(1).	2019
Heine & Black. 'Environmental Tax Reform: Benefits beyond Climate' and Coste, Calì & Heine. 'Productivity Effects of Environmental Taxes', in Pigato (ed.). *Fiscal Policies for Development and Climate Action*, World Bank.	2019
Dominioni, Heine & Martínez Romera. 'Regional carbon pricing for international maritime transport: challenges and opportunities for global geographical coverage', *Carbon and Climate Law Review* 12(2).	2018
Heine & Gäde. 'Unilaterally removing implicit subsidies for maritime fuels', *International Economics and Economic Policy* 15(2).	2018
Brandon, Engle, Hannam, Hallegatte, Heine & Oppermann. *Guiding Framework for the Use of Concessionality to Maximize Climate Action,* WBG.	2018
Parry, Heine, Kizzier, & Smith. *Carbon Taxation for International Maritime Fuels: Assessing the Options*, IMF.	2018
Parry, Veung & Heine. 'How Much Carbon Pricing is in Countries' Own Interests? The Critical Role of Co-Benefits', *Climate Change Economics* 6(4)	2015
Parry, Heine, Li & Lis. *Getting Energy Prices Right*. IMF.	2014
Parry, Heine & Lis. 'How Should Countries Tax Fuels to Correct Environmental Externalities?'. *Economics of Energy & Environmental Policy*, 3.	2014
Parry & Heine. 'Economics of U.S. Energy Policy', in Payson (ed.): *The Role of Government in the American Economy*. Praeger Publishers.	2013
Parry, Norregaard & Heine. 'Pricing Energy for Environmental Damages: Putting Principle into Practice', *Annual Review of Resource Economics* 4.	2012
Heine et al. A Multi-Disciplinary Justification of Sustainability Principles - Report to the World Future Council, Common Future Think Tank.	2008
Heine. A Climate for Change – A Concept for Emissions Trading Systems in line with Rawlsian Ethics. Harvard College Project for Asian and International Relations Student Paper Award; GRIN Publishing.	2007

Appendix D

Portfolio

European Doctorate in Law & Economics

Student		
Name of PhD student: Dirk Heine PhD period: 2013-2020 Promoters: Professor Michael Faure Professor Arne Heise Co-promoter: Dr. Emma Kate Aisbett Original co-promoter (in memoriam): Professor Arndt Schmehl, † 2015		
PhD courses		
University of Bologna (2013-2014)	**Grade**	**Points**
Note: For some of the exams in Bologna, the exact grade points were communicated or professors sent special recognitions to indicate the quality of the submission relative to the class average. Where applicable, these are listed below or indicated as "SR". The courses in the other universities were only marked on a pass/fail basis. The candidate did pass all the exams, so for those cases the grades are not listed.		
Introduction to the Italian Legal System	Pass	SR
Economic Analysis of Law	Pass	NA
Experimental Economics	Pass	24/30
Game Theory and the Law	Pass	SR
Behavioural Game Theory	Pass	30/30
Behavioural Enforcement Mechanisms	Pass	30/30
European Securities and Company Law	Pass	NA
European Competition and IP Rights	Pass	NA
Italian language A1	Pass	NA
EDLE conference reviewing thesis chapters (presentation and peer feedback, March 2014 and November 2015)	Pass	NA
University of Hamburg (Summer 2014, 2015-2016)		
Introduction to German Law		
Subsidies, Regulation, Procurement, and Consumer Information in WTO Law: Economic and Legal Concepts		
Economics of Law Enforcement		
Risk savvy		
Student Colloquium of PhD students with Professor Heise		
EDLE conference reviewing thesis chapters (presentation and peer feedback, June 2014)		

Erasmus University Rotterdam (2014-2015)
Academic Writing Skills for PhD Students
Empirical Legal Studies
BACT seminar series (attendance)
RILE EDLE student seminar series (attendance, peer feedback and two presentations)
Erasmus University Rotterdam and Dutch Academy of Sciences joint workshop on “Smart Mixes in Relation to Forest and Climate Governance” 04-05.02.2015
Erasmus University Rotterdam and University of Paris Nanterre joint conference on “The Future of Law and Economics”, 26-27.03.2015
Additional PhD-level training in research methodologies taken during the PhD in additional research centres
“Post-Keynesian Study Group Workshop for PhD Students”, University of Greenwich, 28-29.05.2015
International Summer School for PhD Students, Forum for Macroeconomics and Macroeconomic Policy (FMM), Berlin, 27.07.-01.08.2015
Visiting Researcher, International Monetary Fund, January 2016
Visiting Researcher and PhD-level classes in Advanced Macroeconomics, New School for Social Research, New York, February 2016
Visiting Researcher and PhD-level seminars, Université Catholique de Louvain, Hoover Chair for Economic Ethics, April-August 2016

Academic Conferences		
Conference/Forum	**Presentation /Attendance**	**Time**
Annual Conference of the Italian Society of Law and Economics, Lugano	Presentation	12.12.2013
Cambridge Trust for New Economic Thinking, “Finance and the Macroeconomics of Environmental Policies”, Cambridge	Attendance	10.04.2014
World Congress of Environmental and Resource Economists, Istanbul	Presentation	30.06.2014
Global Conference on Environmental Taxation, Copenhagen	Presentation	24.09.214
European Commission, DG Climate	Presentation	05.11.2014
European Federation on Transport and Environment	Presentation	10.12.2014
European Parliament, Conference on pollution regulation for shipping	Attendance	11.12.2014
University of Hamburg, Economics Faculty	Presentation	14.01.2015
Utrecht University, Law Faculty, “Law in the Risk Society”	Attendance	08-10.04.2015
European Parliament, “Progressive Economy Conference on Sustainable Development”	Attendance	3-04.06.2015
International Public Policy Association, Milan	Presentation	1-4.7.2015

Massachusetts Institute of Technology, "Climate CoLab", Cambridge MA	Presentation	06-07.10.2015
Dutch Transport Ministry	Presentation	06.11.2015
KU Leuven, "Ius Commune"	Attendance	26-27.11.2015
United Nations Framework Convention on Climate Change, COP21, Paris	Attendance	30.11.-06.12.2015
University of Copenhagen, Law School, "Transatlantic Maritime Emissions Research Network"	Presentation	20.06.2016
Greenpeace Germany Advisory Board	Presentation	05.07.2016
World Maritime University, "Nordic Council of Ministers Conference on Transformation to Low-Carbon Shipping"	Presentation	13.12.2016

<table>
<tr><th colspan="4">Prizes awarded during the PhD research</th></tr>
<tr><th>Institution that made the award</th><th>Name of the award</th><th>Research recognised</th><th>Time</th></tr>
<tr><td>World Bank</td><td>Award of the Vice Presidency for Economics, Finance and Institutions</td><td>Book on environmental fiscal policy (author of 2 of 4 chapters)</td><td>May 2019</td></tr>
<tr><td>European Association of Law and Economics</td><td>Deloitte Prize for the best paper in tax policy</td><td>Research on tax competition (main author)</td><td>Sept. 2015</td></tr>
<tr><td>International Monetary Fund</td><td>IMF Management Award</td><td>Book on Pigouvian taxes (junior co-author)</td><td>Apr. 2014</td></tr>
<tr><td rowspan="4">Massachusetts Institute of Technology, Climate CoLab competition</td><td>Judge Award - Transportation</td><td rowspan="3">Research on maritime carbon taxation (main author)</td><td rowspan="4">Oct. 2015</td></tr>
<tr><td>Public Choice Award - Transportation</td></tr>
<tr><td>Honorable Mention - Overall Competition</td></tr>
<tr><td>Finalist</td><td>Research on forestry taxes (main author)</td></tr>
</table>