Green Growth Knowledge Platform (GGKP)
Third Annual Conference
Fiscal Policies and the Green Economy Transition: Generating Knowledge – Creating Impact
29-30 January, 2015
University of Venice, Venice, Italy

Fiscal considerations in the design of green tax reforms

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The GGKP's Third Annual Conference is hosted in partnership with the University of Venice, The Energy and Resources Institute (TERI) and the United Nations Environment Programme (UNEP).

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Conference edition,15.01.2015

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[1] We thank Jacqueline Cottrell, Swantje Küchler, Jan Allmann and Oliver Grob (all Green Budget Germany) for their invaluable support researching, editing and conceptualizing this study, and Ian Parry (IMF) for very helpful comments.

1 Introduction

Fiscal policy is a crucial instrument on the way to greener economies. Choices regarding the source of government revenues and the recipients of government spending fundamentally influence both consumption and investment decisions by businesses and households. The rationale is that taxes change prices of products and services and therefore influence the production and consumption choices of market actors. With debt levels increasing rapidly in developed countries after the financial crisis of 2008, Finance Ministries have become increasingly interested in environmental taxes as an attractive option to improve their fiscal position.Developing countries, on the other hand, still lack adequate funding options for socially desirable investments in further poverty reduction, health, education, transport etc. due to the difficulty of raising significant revenue from personal income and capital taxes. Reducing energy subsidies and establishing broad environmental taxes such as energy taxes, which are relatively easy to administer, are attractive ways to create revenues.

The purpose of this paper is to develop a conceptual framework for understanding the revenue potential of such green fiscal instruments. The first section of this study defines and categorizes the relevant concepts of green fiscal reform. We discuss the various goals of environmental fiscal reform (EFR) and differentiate between the different types of instruments, such as taxes, fees/charges, the removal of environmentally harmful subsidies and quantity instruments such as cap-and-trade systems.

Second, we discuss theoretical considerations regarding the apparent tensions, but also synergies between fiscal and environmental goals using stylized examples to explain the most crucial points.

Third, we develop a conceptual framework for the revenue potential of Environmental Fiscal Reform (EFR) instruments, which includes questions over behavioral responses to price increases, the effects of tax reductions & exemptions, interdependencies with other revenues, inflation & time effects, administrative costs and spending decisions. We frequently resort to case studies, which were picked to illustrate certain conceptual points.

The so developed conceptual framework should help policymakers to identify the revenue potential of an envisioned EFR instrument and guide them in decisions regarding potential trade-offs between environmental and fiscal goals. We find that the more promising candidates for environmental taxes from a fiscal perspective have large and inelastic tax bases such as energy and carbon taxes, but to a lesser degree also taxes on resources, water, land and waste. Others with a small and/or elastic tax base are mostly taxes on products like batteries or selected packaging materials are less attractive from a fiscal point of view.

Before we draw conclusions we sketch out questions for further research, which could not be fully addressed in this paper.

2 Background of EFR from a fiscal perspective: Definitions, revenues and potentials for improvement

In the 1970s and early 1980s, environmental policy was mainly driven by command and control-regulations, such as emissions standards, environmental quality controls, and detailed rules for business processes and technologies. Fuel taxes, though long established in many countries, were largely designed from a fiscal rather than environmental perspective; only tax differentiation along environmental criteria such as the lead content (and more recently the sulphur content) was used as an environmental incentive. Later, a new orientation towards market-based instruments gradually started to shape environmental policy, not least because of the need to find more cost-effective and flexible tools for environmental progress (EEA, 1996) The increasing attention paid to environmental issues like global warming and rising air pollution in rapidly expanding urban areas also drove this process. There was (and partly still is) insufficient implementation and enforcement of command & control regulation, often because actors tried to evade costs by finding ways to circumvent environmental rules. The self-interest of actors was in conflict with the goals of environmental regulation because costs induced by additional regulation would reduce competitiveness. Furthermore, actors were starting to realize that a patchwork of regulations is a cumbersome way to try and promote all the potential (often unexpected/unknown) behavioral responses for cutting emissions across the economy, which would be automatically exploited by a well-designed set of environmental taxes. New environmental policies were then developed to use profit maximization as a core motivator and to create financial incentives for businesses to behave in environmentally friendly ways. Setting economic incentives to change behavior in the desired direction has thus become one main approach to address this challenge. Accordingly, the concepts of EFR have been on the political agenda for more than two decades and meanwhile have been introduced in many countries with positive impacts on the environment and human health, the economy and employment; and most importantly for the purpose of this study: on government revenues and their fiscal positions. The extent to which EFR-elements have been introduced is limited in most countries. This study should help policymakers evaluate EFR potentials in their own region or country from a fiscal point of view.

2.1 Definition of Environmental Taxes, Green Tax Reform and Environmental Fiscal Reform

2.1.1 The rationale behind an Environmental Fiscal Reform

Before defining and categorizing the different forms of EFR, it is important to understand what EFR instruments are meant to accomplish. They are useful to achieve a range of goals, which can be broken down into three broad categories: 1. Environmental benefits, 2. Raising fiscal revenues and increasing fiscal efficiency, and 3. Encouraging economic growth, innovation and job creation.

Environmental benefits

The most common rationale for EFR is its positive environmental impact. Increasing the price of environmentally harmful behavior, e.g. using an environmental tax, discourages it through market mechanisms, i.e. a price signal. Such a government intervention can correct a market failure if the environmental damage of a given action constitutes an externality. Negative externalities arise whenever the actions of one party make another party worse off, yet the first party does not bear the cost of doing so (Gruber, 2011). Externalities cause market failures, which in turn lead to economic inefficiencies. Market actors receive a distorted price signal because the externalized costs are not included in the price paid by the actor. Artificially increasing the price of environmentally harmful behavior in such a way that its external costs are fully internalized within the price incentivizes actors to account for the social and environmental costs of their behavior. The EFR intervention gives market actors a “correct” – or at least a more accurate - price signal, better reflecting the full and thus true costs of a certain behavior.[2] After the intervention, markets

[2] Measuring the value of external costs of environmental damages is often controversial and quite difficult to achieve accurately. A variety of methods are used to estimate various costs including the costs to health, productivity and damages from pollution etc. (Freeman, 2003).

can operate at a more efficient level, increasing social welfare through optimal allocation (Milne & Andersen, 2012).[3] Unlike with command & control interventions, market actors generally have the free choice over how to respond – and hence very much in line with the philosophy of a market economy - can thus individually adapt their behavior, leading to a situation in which the environmental damage is avoided at minimal costs i.e. the environmental damage is avoided where the costs of doing so are the lowest, whilst still achieving the same environmental objective. This is often referred to as the first dividend of EFR (Goulder, 1995).

The internalization of external costs is mostly attractive from a theoretical perspective. In practice, it is often difficult to estimate the external cost of certain actions, say producing and using a plastic bag. However, it is important to mention that a lot of work and progress has been made allowing us to accurately assess the external costs in many areas (Meunier, 2014a, 2014b, 2014c; I. Parry, 2014). Since it is difficult to set a tax equal to external costs, often EFR instruments try to achieve concrete behavioral targets, such as decreasing the usage of a resource by a certain amount. One good example is the Irish plastic bag levy, which achieved a 94 % reduction in the use of plastic bags within a single year (Convery, McDonnell, & Ferreira, 2007a, see also case 4 under 4.1 further below).

Raising fiscal revenues

The second obvious benefit of EFR is that it creates revenues for government spending. Be it through taxes, fees and charges, the removal of environmentally harmful subsidies (EHS) or the auctioning of pollution allowances, EFR enables governments to collect funds, which it does not need to raise elsewhere. These revenues can then be spent in various ways: Either for balancing the budget, for reducing overall public debts, for reducing other more distorting taxes and social security contributions or to increase spending, or for general consumptive or environmental purposes. Spending can also take the form of financing technological innovations or funding installations necessary for a green transition. Revenues can furthermore be recycled to protect the vulnerable (either individuals or companies or both) from the impact of changing prices resulting from the implementation of EFR instruments.

Fiscal efficiency gains

Moreover EFR can be useful to improve the efficiency and equity of fiscal systems. This fact can help to let markets operate more efficiently: Regular taxes, such as payroll taxes, distort markets in a way that makes certain goods (e.g. labor) artificially unattractive, creating deadweight losses (i.e. inefficiencies) in the economy; this applies particularly when there is unemployment. Though offsetting this is the impact of higher energy prices on factor markets, i.e. production costs and reducing employment (termed the ‘tax-interaction effect’) in the presence of pre-existing distortionary taxes (Bovenberg & Goulder, 1996). Therefore, EFR can be used to increase employment by using its revenues to lower the tax burdens and distortions on labor – i.e. because EFR raises revenues efficiently, its funds can be used to lower other distortive taxes creating a second social welfare gain. This is often referred to as the second dividend of EFR (OECD, 2000). Additionally, environmental taxes, especially on energy, often have administrative advantages and therefore the potential to save the costs of bureaucracy (see section: 4.5).

Creating jobs and economic growth

EFR is also useful to achieve political goals in the areas of labor market and industrial policy. When environmentally harmful behavior becomes more expensive, market actors search for and tend to find ways to achieve their goals by changing their production and consumption patterns. From a macroeconomic perspective the following happens: If EFR revenues from energy taxes on fossil fuels are used to reduce taxes on labor, labor becomes more attractive relative to other production factors, which rely on the use of energy. Therefore, energy tends to be substituted by labor. The knowledge and engineering capacities of people are used to find innovative ways to use energy more efficiently and substitute fossil energies with renewable energy sources. In other words: It causes unemployment for kilowatt hours, not people. Several

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3 It is important to understand that an environmental price increase as described above is not merely an efficient way to improve the environment. It is an instrument to correct market failures achieving economic welfare gains.

studies find that when structural unemployment[4] exists in an economy, environmental tax reform can boost employment and profits (Bovenberg & Van der Ploeg, 1998; Kolm & Holmlund, 1997; Schöb & Koskela, 1996).

Encouraging innovation

A high tax on the use of fossil fuels and its emissions makes investments in alternative forms of energy production more attractive leading to innovation in these fields. According to the Porter Hypothesis, environmental regulation including incentives can help businesses to overcome market failures in innovation; thereby allowing them to get a competitive edge over their competitors in countries without taxes that incentivize innovations (Porter & Van der Linde, 1995).[5] Higher prices can also lead to new consumption patterns such as car-sharing solutions, which can be viewed as an innovation in consumption patterns as well as in retail markets. Obviously innovation leads to job creation in new and possibly politically favored industries. In several countries EFR revenues are used to finance technological innovations in areas of energy efficiency and renewable energy. If revenues are recycled to fund environmental innovation, one may need lower tax rates to achieve environmental goals because switching to alternative technology becomes cheaper (COMETR, 2007).[6]

2.1.2 Defining and categorizing green reforms

It is worthwhile briefly defining and categorizing some of the concepts that will be used in this paper. The overlapping concept we examine is **Environmental Fiscal Reform (EFR)**. EFR is an inclusive concept, which refers to the pricing of environmentally harmful behavior. It includes explicit price-instruments such as environmental taxes and fees and charges. OECD, IEA and the European Commission also use a different term and have agreed to define environmentally related taxes as any compulsory, unrequited payment to general government levied on tax bases deemed to be of particular environmental relevance (OECD 2006). Here that term and the term environmental tax are often used as synonyms. EFR, as defined here, also covers quantity instruments with price effects such as cap-and trade systems, if these happen to create positive revenues. Furthermore it covers the removal of EHS, since this also has the effect of discouraging environmentally harmful behavior using market mechanisms.

Within EFR, experts often speak of the narrower concept of an **Environmental Tax Reform (ETR)** or also Green Tax Reform. According to a definition by the European Environment Agency, ETR refers to a “reform of the national tax system where there is a shift of the burden of taxation from conventional taxes, for example on labor, to environmentally damaging activities, such as resource extraction or pollution. The burden of taxes should fall more on 'bads' than 'goods' so that appropriate signals are given to consumers and producers” (EEA, 2005). Given that ETR is a subset of EFR (see Figure 1), we will generally speak of EFR, unless a clear distinction is called for.

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[4] Structural unemployment exists in an economy in which wages are slow to adjust and labor is relatively immobile between sectors. Changes in demand and in production technology can create structural imbalances in the labor market so that at a given wage, the supply of labor is higher than demand for it.

[5] Though the Porter hypothesis is contentious among economists, there is some rationale behind it, which is convincing.

[6] Note that this logic only applies if a tax is set to achieve an environmental target (e.g. reduce emissions by x). It does not apply if a tax is set to reflect external costs, because in this case, the tax should not be lowered below efficient levels.

Figure 1: Illustration of the hierarchical structure of EFR and ETR

Source: Own figure

2.1.3 Differentiation between areas of application: Energy, transport, pollution and resources

In order to understand the impact and functioning of EFR it is important to know what kind of environmental damage is targeted by the various instruments. However, there is no perfect way to differentiate between the areas of EFR. Nonetheless, a categorization is useful and necessary to understand, where and how revenues are raised. This study builds on the differentiation proposed by OECD and Eurostat (OECD 2014b Eurostat, 2014), which differentiates between the following tax bases: **energy, transport, pollution and resources**. Box 1 shows the definitions separating these areas. It is important to note that we will apply these categories to all the different forms of EFR, while Eurostat only considers taxes. Furthermore, it is clear that these categorizations differ across studies, as for example some publications count the damage from burning fuel used in the transport sector into transport, while we argue that transport fuel is merely a form of energy and should be treated as such.

Box 1: OECD and Eurostat-definition of different tax bases[7]

Energy taxes: This category includes taxes on energy production and on energy products used for both transport and stationary purposes. The most important energy products for transport purposes are petrol and diesel. Energy products for stationary use include fuel oils, natural gas, coal and electricity. Carbon dioxide (CO_2) taxes are also included under energy taxes rather than under pollution taxes. This is mainly caused by the fact that it is often not possible to identify CO_2-taxes separately in tax statistics, because they are integrated in energy taxes.	**Transport Taxes:** This category mainly includes taxes related to the ownership and sales of and in case of congestion charges, the use of motor vehicles. Taxes on other transport equipment (e.g. planes, ships or railway stocks), and related transport services (e.g. duties on charter or scheduled flights) are also included here, when they conform to the general definition of environmental taxes.
Pollution taxes: This category includes taxes on measured or estimated emissions to air and water, management of solid waste and noise. An exception are the CO_2-taxes, which are included under energy taxes as described above.	**Resource taxes:** This category includes taxes linked to the extraction or to the use of natural resources, such as water, forests, wild flora and fauna, etc., as these activities deplete natural resources. Excluded are taxes on economic rents from the extraction of ressources.

Source: Eurostat (2014)

7 See Appendix 1 for a more detailed list of instruments in each category.

2.1.4 The various forms of EFR: Taxes, charges/fees, removal of EHS, quantity instruments

EFR can raise revenues in different ways. The most straightforward way is to levy a tax or a charge/fee on carbon dioxide or a standard pollutant. The most common examples are fuel taxes, which raise revenue per unit of consumption or charges and fees, which are linked to the provision of a specific service (e.g. waste charges). Another way to increase revenues is to reduce spending in form of EHS. A reduction in EHS is conceptually similar to an environmental tax, as certain actors are forced to pay more (receive less) for causing environmental damage. A quantity instrument, on the other hand, raises revenues by first limiting the amount of a certain resource to be used and then selling or auctioning off permission allowances for environmentally harmful behavior (e.g. cap-and-trade). However, traditionally allowances have been given away freely rather than auctioned or sold. The following section explains each of these possibilities with reference to their significance from a revenue point of view. The conceptual focus of this study, however, will be on environmental taxes since they are both conceptually and practically the most important form of EFR.

Taxes

In the context of EFR, an environmental tax is "[…] a tax whose tax base is a physical unit (or a proxy of it) that has a proven specific negative impact on the environment. Four subsets of environmental taxes are distinguished: energy taxes, transport taxes, pollution taxes and resources taxes" (OECD, 2014b). The revenues can be used for government spending or deficit reduction, however, in the case of an ETR, the tax is recycled as part of a green tax shift and does not increase the overall tax burden.

Environmental taxes can be subdivided in quantity (*ad quantum*) and value (*ad valorem*) taxes. Quantity taxes levy a certain amount per unit consumed. The assessment basis for those cases may be energy (e.g. MWh, PJ), volume (e.g. liter, m^3), products (e.g. number of vehicles), weights (e.g. kilograms, pounds), etc. Tax revenues from quantity taxes only fluctuate with the produced/consumed amount of the taxed entity and not with prices. This is in line with the environmental purpose of EFR because the marginal environmental damage of the burning of one liter of diesel fuel depends only on its physical quantity and not on its market price. However, if not regularly adjusted to price levels, the real value of quantity taxes is diminished by inflation over time (see section 4.4.1). Table 1 shows some examples of quantity taxes in OECD countries.

Table 1: Selected examples for quantity taxes[8]

Country	Instrument	Tax Base	Tax Rate	Tax Revenue
		Energy		
Germany	Duty on electricity consumption	General electricity consumption	EUR 20.5 per MWh	EUR 7,0 million, 0.26 % of GDP (2013)
Germany	Duty on mineral oils	Diesel	EUR 0.47 per litre	EUR 39,351 million, 1.6 % of GDP (2012)
Netherlands	Energy tax	Natural gas - up to 5,000 m^3 per year	EUR 0.15 per m^3	EUR 4,249 million, 0.68 % of GDP (2010)
		Transport		
Japan	Automobile tax	Passenger cars with cylinder volume below 1,000cc - Non-commercial use	EUR 227.6 per year	EUR 15.410 million, 0.0003 % of GDP (2012)
USA	Heavy highway vehicle	Logging vehicles weighing	EUR 324.5 per year	EUR 832 million,

8 This study tries to be consistent in terms of currency, which is why units where converted in Euros using the IMF exchange rate of January 1st of the given year.

	tax	75,001 pounds or more		0.007 % (2012)
Pollution				
USA	Ozone depleting chemicals tax	First use or sale of Halon-1301	EUR 109.34 per pound	EUR 3.15 million, 0.00003 % of GDP (2012)
Belgium	Tax on the landfilling and incineration of waste (Flanders)	Landfilling or incineration in general	EUR 175.2 per tonne	EUR 32.7 million, 0.008 % of GDP (2011)
Denmark	Duty on polyvinyl chloride and phatalates	Cables, wires, cords when containing phatalates	EUR 0.33 per kg	EUR 2.76 million, 0.0012 % of GDP (2012)
Resources				
Italy	Charge on packaging	Plastic	EUR 140 per tonne	EUR 20.7 million, 0.0014 % of GDP (2012)
Note: The listed tax revenues describe the overall tax revenues of the respective instruments, while the tax base may be one single example of the instrument (e.g. there are several other tax bases for lighter logging vehicles in the USA that are all cumulated in tax revenue of the Heavy highway vehicle tax).				

Source: Own table based on (OECD 2014b)

Value or ad valorem taxes levy a certain percentage on prices of goods. They are most common in the form of value-added taxes (VAT). The revenue of value taxes depends not only on the consumed/produced quantity of the taxed entity but also on its price. This means that market factors, for example global demand or supply shocks influencing prices, have a direct effect on tax revenues. Given that value taxes depend on price levels, it follows that revenues increase with price levels. Therefore general inflation has no influence on the real value of revenues, because they change along with price levels. Value taxes are much less common than quantity taxes in the context of EFR. Table 2 gives some examples.

Table 2: Selected Examples for value taxes[9]

Country	Instrument	Tax Base	Tax Rate	Tax Revenue
Energy				
Spain	Tax on electricity	Production or importation of electricity	4,864 %	EUR 1,483 million, 0.14 % of GDP (2010)
Transport				
Korea	Individual consumption tax	Purchase of passenger vehicles with engine displacement larger than 2,000cc	10 % of the manufacturer's price.	EUR 867 million, 0.107 % of GDP (2010)
Pollution				
Italy	Duty on pesticides	Pesticides	2 % of previous year's turnover on the sale	EUR 8 million, 0.0005 % of GDP (2008)
Resources				
USA	Salmon enhancement tax (Alaska)	Salmon sold in or exported from Alaska	2-3 % of the value, depending on the aquaculture region	EUR 6.1 million, 0.0003 % of GDP (2011)
Note: The listed tax revenues describe the overall tax revenues of the respective instruments, while the tax base				

9 Own table based on (OECD, 2014a)

may be one single example of the instrument (e.g. there are several other tax bases for other passenger vehicles with different cylinder capacity classes that are all cumulated in tax revenue of the Individual consumption tax).

Source: Own table based on (OECD 2014b)

Another important distinction is between direct and indirect taxes. The distinction separates between the actor, who on the one hand consumes the tax-base and therefore pays the tax and the actor, who is responsible for transferring the tax to the respective government agency (Eurostat, 2014). A **direct tax** refers to any levy that is both imposed on and collected from a specific actor. An example of direct environmental taxation would be a motor vehicle tax, where the vehicle owner is also responsible for transferring the tax to the government. **Indirect taxes** are collected from an actor who does not pay the tax. A tax on electricity which is collected from energy suppliers or merchants and not from the consumers, who end up paying the tax, would be considered an indirect tax. The distinction matters mostly for theoretical and administrative reasons and transaction costs, since it may be impractical or simply too costly for millions of consumers to each file a separate environmental tax statement.[10]

Charges / fees:

User charges or fees are compulsory payments made by consumers (individuals or industry) for the provision of a particular service. User charges are usually applied in the context of water and energy services as well as in the disposal of waste. For example, charging the collection of waste generally provides an incentive to reduce waste production at source. Contrary to taxes, the proceeds of charges do not end up in national budgets, as they are used to pay the service provider, which can be a private or public (World Bank, 2005). [11] Other examples include ecosystem conservation, hunting rights, mining activities or transport (vehicle registration, highway tolls etc.). Charges and fees generally raise less revenue than taxes. Table 3 shows further examples from OECD countries.

Table 3: Selected Examples for charges / fees

Country	Instrument	Service / Object	Fee	Revenue
Energy				
Germany	Concession fee	Fee on electricity and gas for the use of public domains for the building of electricity and gasoline lines	Electricity: between 0.51 ct./kWh and 2.39 ct./kWh	EUR 3.5 billion, 0,12 % of GDP (2011)
Transport				
Sweden	Road user charge	The use of a lorry with a total weight of 12 tonnes or more, with 4 axles or more, EURO II standard or higher	EUR 1,418 per year	EUR 89.96 million, 0.023 % of GDP (2012)
Pollution				
Switzerland	Prepaid fee on batteries	Waste management of automotive batteries	EUR 0.41 per kg	EUR 11.48 million, 0.002 % of GDP (2013)
Belgium	Waste water charge (Flanders)	Management of water resources	EUR 0.8968 per m^3 drinking water	EUR 223.3 million, 0,07 % of GDP

10 The OECD (OECD, 2008) ranked the effects of different taxes on growth, suggesting that taxes on immovable property are least damaging (if levied at moderate levels), followed by consumption taxes, the personal income tax and, lastly, the corporate income tax. A more recent report (vivid economics, 2012) finds that growth is least affected by energy taxes while other consumption and direct taxes have more negative impacts.

11 According to a discussion in (Eurostat, 2001) user charges/fees only apply to pure service costs (e.g. the service cost of running a waste management system); however if charges are higher than what is needed to cover service costs (say to pay for the external environmental cost of a waste site), then the difference between the full charge and the charge needed to cover service costs should be considered an environmental tax.

				(2010)
Canada	Charge on municipal waste (Quebec)	General waste disposal	EUR 15.10 per user / individual calculations based on volume and type of waste	EUR 117.3 million, 0.018 % of GDP (1998)
Resources				
Korea	Deforestation Charge	Ecosystem conservation - Management of land, soil and forest resources	EUR 178.32 per area unit	EUR 65.5 million, 0.008 % of GDP (2012)
Sweden	Hunting fee	Management of biodiversity and wildlife - grown elk shot above the permitted number	EUR 789 per elk	EUR 0.19 million, 0.00007 % of GDP (2000)
Note: The listed charge/fee revenues describe the overall revenues of the respective instruments, while the charge/fee base may be one single example of the instrument (e.g. there are several other charge/fee bases for other lorries with three instead of four axles and with different fulfillments of EURO standards that are all cumulated in the revenue of the Swedish Road user charge).				

Source: Own table based on (OECD, 2014a)

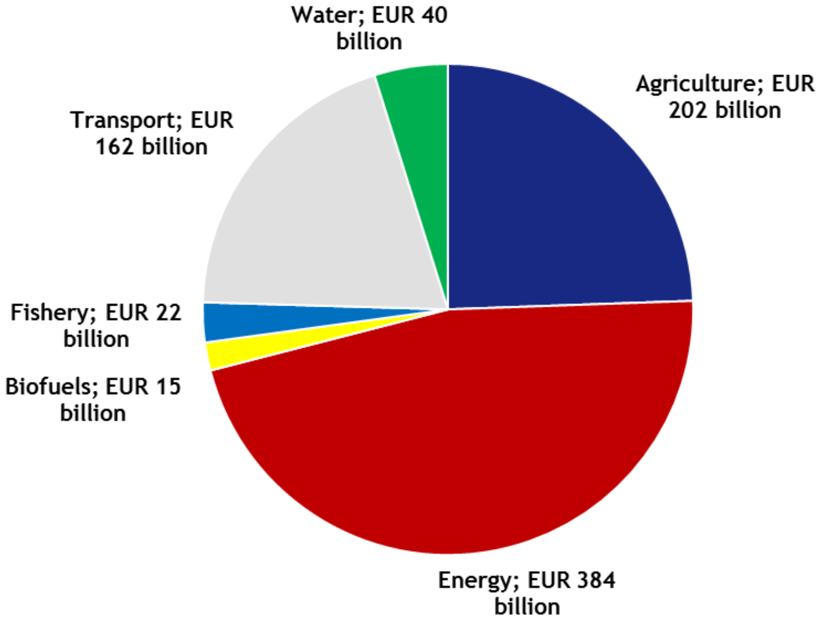
A special case, which could be characterized as a kind of "charge" is the renewable energy surcharge, which is raised as a quantity levy on electricity payments in many European countries, most prominently Germany (with its so called EEG-Umlage). Strictly speaking this is not a charge, tax or levy, as it is not administered or collected by government agencies. Instead a private agent calculates the prospective payments to renewable energy producers in a given year, and allocates these costs to electricity users via utilities as a charge per kilowatt hour. Today this charge stands at 6.24 cents/kWh and raises roughly 20 billion EUR per year. It is interesting from a revenue perspective, since the necessary payments are calculated first and then the "charge" is set accordingly. Therefore the charge fluctuates according to funding requirements.

Removal of environmentally harmful subsidies:

The removal of EHS is highly relevant from a fiscal perspective. Some resource-rich emerging economies spend a large amount of revenues on fossil fuel consumption subsidies, which have significant fiscal impacts. The Middle East and North Africa (MENA) Region is home to 5.5 % of the world's population, 3.3 % of its GDP—and 48 % of its energy subsidies (World Bank, 2014). For example, according to the IEA, in 2012 Iran subsidized fossil fuels with 62.5 billion EUR (IEA, 2012). The industrialized countries of the G20 spend 70.6 billion EUR annually just on subsidies for exploration for fossil fuels (Oil Change International, 2014). According to the OECD, the United States subsidizes the use of fossil fuels with 10.1 billion EUR, while the IMF estimates this number at 10.8 billion EUR or 317.6 billion EUR depending on the methodology used (IMF, 2003; OECD, 2012). The OECD estimates that removing global energy subsidies to fossil fuels worth around 500 billion EUR could boost global growth by 0.3 % and even more for larger subsidizers such as India, which could increase growth by more than 2.5 percentage points (IEA, 2010; OECD, 2010).[12] In 2012, EU countries spent 15.3 billion EUR subsidizing power production from fossil fuels (Ecofys, 2014). According to Germany's Environment Agency (UBA), Germany had EHS worth 52 billion EUR in 2014 (UBA, 2014). Large subsidy items were tax exemptions for aviation (7 billion EUR) followed by energy (22 billion EUR), building/housing (6 billion EUR) and agriculture/fishery (0,53 billion EUR). The Institute for European Environmental Policy estimates the value of global EHS at 825 billion EUR, with the largest share going to energy (see Figure 2).

12 In the Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels the OECD finds over 500 measures in all 34 OECD countries, which in one way or another subsidize the production or consumption of fossil fuels (OECD, 2013).

Figure 2: Estimated global sector-shares of environmentally harmful subsidies



Source: Own figure based on (IEEP, 2014)

The large variation in the EHS values from these different sources indicates that EHS are difficult to assess, since definitions and estimation strategies for EHS vary widely (Green Budget Europe, 2014). Environmentally harmful subsidies are best defined as policies with a fiscal impact, which increase incentives for environmentally harmful behavior. However, since this study focuses on fiscal questions, we choose to define subsidies more narrowly, as a transfer of funds by government to producers or consumers which has a direct fiscal impact. This includes foregone revenues from explicit exemptions from paying taxes / fees or charges, which would otherwise have been due. Typical examples are found in the fields of energy (e.g. diesel fuel subsidies or subsidies for coal exploitation), agriculture (e.g. pesticide practices), industry (e.g. wide-ranging exemptions from taxes and charges) or transport (aviation subsidies, e.g. lack of kerosene taxation, VAT exemptions for international air traffic or tonnage taxes for maritime transport, which are more favorable than corporate taxes). The removal of EHS deserves its own category for two reasons: First, the removal of EHS, for example the phase out of a fuel tax exemption in agriculture, operates in a very similar way to the introduction of a new tax, inasmuch as the measure brings about a price increase which internalizes some/all of an external cost associated with a particular behavior. According to public perception, EHS removals are often considered as a new tax. Second, the scale of EHS, especially in the form of fossil fuel subsidies is so large that it deserves special attention both from an environmental and from a fiscal perspective. The removal of EHS relieves national budgets and weakens environmentally harmful incentives and is an opportunity to obtain clear fiscal and environmental benefits (EEA, 2005; THE WORLD BANK, 2005; Umweltbundesamt, 2010). Reducing the extreme subsidies to the shipping and aviation industry will actually require international co-operation, since ships and planes are likely to react more or less elastic to a tax, simply by loading fuel abroad.[13] Such cooperation would increase EFR revenue potential even further and allow for more fiscally and environmentally sound revenue streams (UNEP, 2010).

13 While ships can easily divert to other ports to re-fuel, it is more time-consuming and costly for planes to divert elsewhere to re-fuel.

Table 4: Selected examples for environmentally harmful subsidies

Country	Instrument	Object of subsidization	Subsidy per unit	Fiscal expenditure
Energy				
United Kingdom	Reduced Rate of VAT (20 %) for Fuel and Power	Fossil-fuel consumer support to natural gas	1973-1994: 0 % VAT 1994-1997: 8 % VAT 1997-today: 5 % VAT	EUR 4,203 million, 0.21 % of GDP (2011)
USA	Fuel-Tax Exemptions for Farmers	Fuel used in agriculture (Diesel, Kerosene)	0 % of Fuel Tax	EUR 783.9 million, 0.007 % of GDP (2011)
Transport				
Germany	VAT exemption for international aviation	International flight tickets	0 % VAT	EUR 4,237 million, 0.16 % of GDP (2008)
Pollution				
Germany	Reduced VAT rate for meat and diary industry (responsible for 18% of worldwide greehnouse gas emissions)	Meat and diary products	7 % VAT	EUR 5.09 million, 0.0002 % of GDP (2006)
Ghana	Subsidies for mineral fertilizers	Mineral fertilizer	-	EUR 51 million, 0.16 % of GDP (2012) i.e. 46 % of agricultural budget
Resources				
Germany	Exemption from water abstraction fees for lignite producers	Water	Around 70 % of used water is exempted from abstraction fees	22.7 million, 0.0002% of GDP (2013)

Source : Own table based on (OECD, 2012; UBA, 2010) and on (WWF, 2013)

Quantity Instrument (ETS):

Another possibility of raising EFR revenues is the selling or auctioning of allowances or user permits. Quantity instruments differ from price instruments such as taxes or charges, as they do not directly increase the price per unit; however they do so indirectly by capping the permitted consumed/produced quantity of a certain resource or pollutant below current rates of consumption.[14] The most well-known example is a cap-and-trade scheme on emissions, e.g. of SO_2 or CO_2. In this case, a cap on the amount of emissions is set by a central authority and emission certificates are then sold or auctioned to the polluting actors - which clearly has a significant influence on the revenue-raising potential of a particular scheme. Companies within the scheme are required to hold the number of certificates equivalent to their emissions. As long as the cap is low enough, emissions certificates become valuable, thus increasing the price of the environmentally harmful behavior just like a tax would. The transfer of certificates (trade) thus leads, in theory, to pollution reduction at the lowest cost to society. The selling or auctioning of certificates may also generate a significant amount of fiscal revenues, but this depends on the type of allocation, and on a soundly designed and working emission trading scheme.

As an example, the European Union Emission Trading Scheme (EU ETS) has shown its limited effectiveness due to a number of design errors, [15] but also the unfortunate coincidence with the financial and economic

[14] If for example, the amount of waste each company can dispose per year, is capped below current output, then a company which would like to produce more waste than the company limit could purchase “rights to dispose waste” from a company, which is willing to produce less waste. Through this process, “the right to dispose waste” would become valuable and obtain a price, which is higher than before the intervention.

[15] This refers to the ETS past performance to raise significant revenues and lead to technological changes in production technologies. The EU ETS achieves its core goal, namely to reduce emissions at low costs. The criticism of many authors is simply

crisis. Inter alia, during Phases I and II, allowances for emissions have typically been given to firms for free (in a process of so-called "grandfathering", where firms receive permits, for free, on the basis of past emissions). This process of free allocation has resulted in windfall profits for firms at the expense of government revenues. In 2014, the price of CO_2-certificates stood at 5-6 EUR/ton, which is considered too low to achieve the desired environmental and economic incentive effects. For instance the German Environment Agency estimates the social costs of carbon at between 40 EUR/ton and 120 EUR/ ton in the short run and between 130 EUR/ton and 390 EUR/ton in the long run (German Environmental Agency, 2012).

Due to these improvements, in 2013 the auctioning of EU-ETS certificates provided total revenues amounting to 3.2 billion EUR (BMF, 2013; EEX, 2014; SRU, 2013). Nevertheless, according to the IMF, tens of billions of dollars have so far been foregone each year in the EU-ETS (IMF, 2008). Tightening the cap to achieve a reduction target of 30 % would lead to additional annual revenues of around 30 billion EUR (vivid economics, 2012). Similarly, the levels of free transfers envisaged in previous drafts of US legislation for an emissions trading scheme was estimated to result in fiscal losses of around 469 billion EUR between 2011-19 (Congressional Budget Office, 2009).

Thus, in comparison with price instruments, quantity instruments seem to be less attractive from a revenue-based point of view. The reason for this is that it is much harder to anticipate revenue streams, since certificate prices and therefore auctioning revenues can wildly fluctuate depending on market situations. An automatic correction rule would need to be applied, which turns out not easy to implement afterwards, and thus –with that experience – may be not even prior to any new implementation.

The analysis of this study, however, will focus on price instruments. The reason for this is that in order to conceptualize revenue impacts, price instruments are simpler to understand and they are more commonly used in practice. A future analysis of the fiscal potential of quantity instruments can build on the conceptual framework developed in this study.

2.2 Case 1: Environmental tax revenues in the European Union [16]

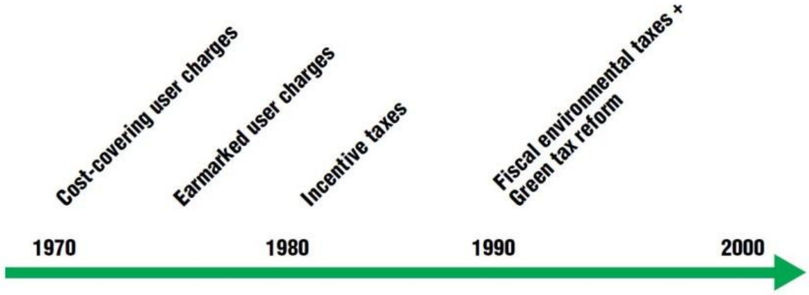
Having explained, how and in which form EFR revenues are raised, it is important to understand, which relevance and size EFR revenues have in practice. Since the member states of the European Union together with other European countries such as Norway, Switzerland and Turkey are most advanced in terms of the implementation of EFR (and since they publish the most comprehensive data), it is sensible to start here in order to give readers an impression of the possible magnitude and structure of EFR revenues.

First elements of European EFR started in the 1970 and 1976 in France and the Netherlands, which used economic instruments for water pollution control (Andersen, 1994). In the 1980s the idea of incentive taxes gained prominence, while it was only in the 1990s that the idea of Environmental Tax Reform (ETR) and Green Tax shifts became politically relevant. Finland was the first country in 1990 to introduce a CO_2-tax. Denmark (1991), Sweden (1992) and the Netherlands (1993) were the first countries to enact a comprehensive EFR program. The United Kingdom (1996) and Germany (1999) followed. Slovenia was the first country from Eastern Europe to follow in 1999 (Schlegelmilch 1999). Over the last years EFR elements were implemented in Ireland and Greece in the wake of deficit reduction and fiscal consolidation, while in recent years other countries such as Italy and Portugal made significant leaps towards EFR. It is worth mentioning that some of these environmental taxes such as taxes on electricity consumption are not particularly well targeted. For instance, electricity taxes target consumption, not emissions and so do not promote fuel switching and use of control technologies. However, they have indirect positive impacts as they aim at reduced electricity consumption which mostly triggers positive environmental impacts, and therefore should be regarded as environmental taxes.

that the cap is set too high and that too many allowances were given away for free. These problems could be solved through rather straightforward reforms, which would lead to higher allowance prices, revenues and behavioral changes (Kronberger Kreis, 2014). One can therefore conclude that the ETS' problems are due to political economy rather than economic issues.

16 Note that this section is on tax revenues only, since there is no comprehensive data on general EFR revenues.

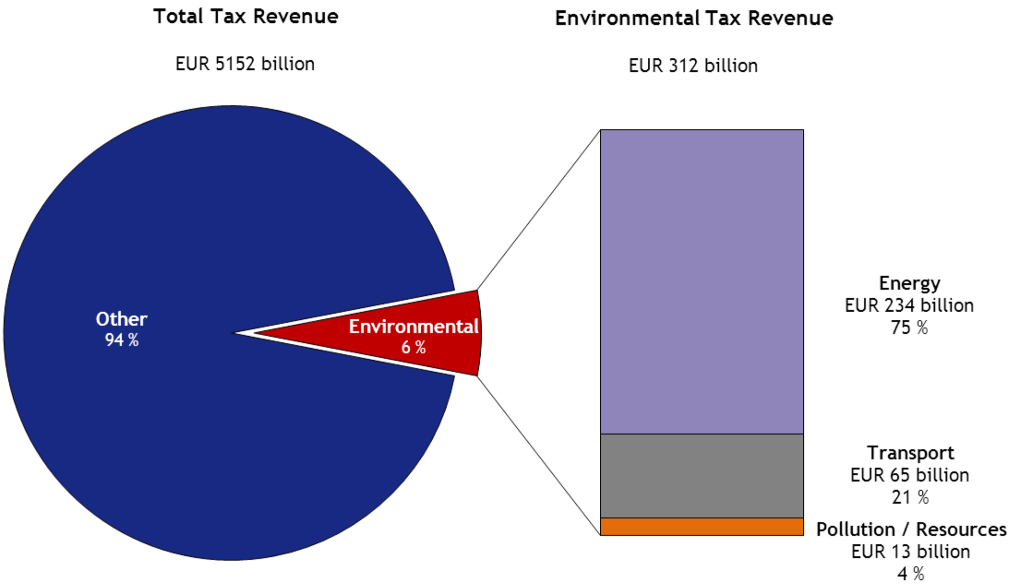
Figure 3: Chronological development of environmental taxes



Source : (EEA, 1996)

Today, revenues from environmental taxes play a significant role in EU countries. In 2012, they raised a total of 312 billion EUR and made up 6 % of total tax revenues; this figure equates to 2.4 % of gross domestic product (GDP). The major part, 234 billion EUR (75 %), is generated by energy taxes. Transport taxes contribute 65 billion EUR (21 %) and pollution/resources remain a small proportion with 13 billion EUR (4 %) (see Figure 4).

Figure 4: Total environmental tax revenue by type of tax, EU-28, 2012

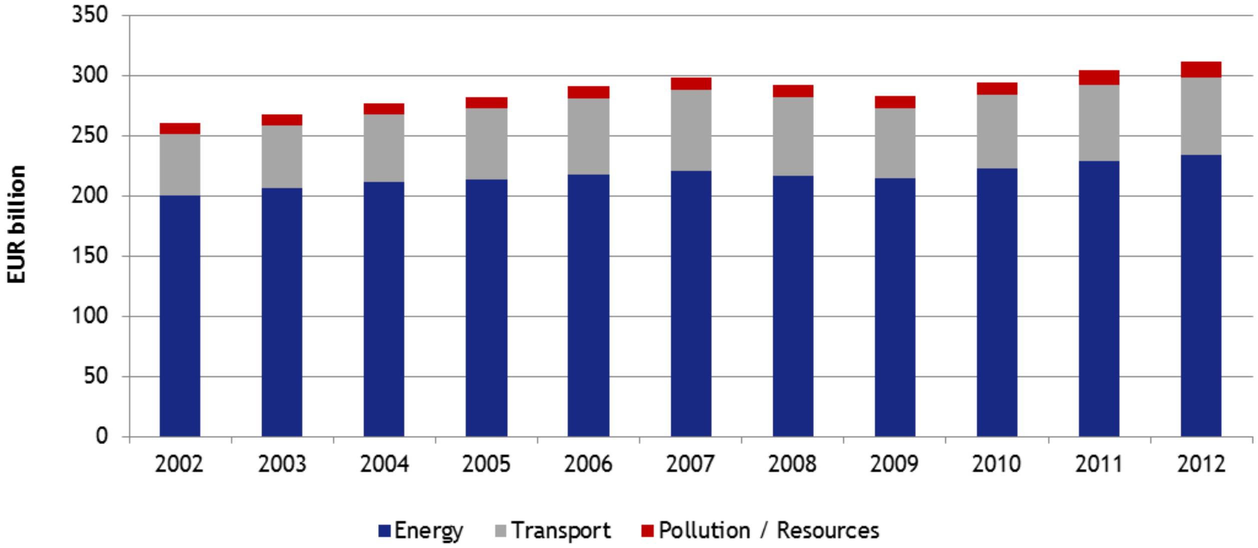


Source: Own figure based on (Eurostat, 2014)[17]

As can be seen in Figure 5, environmental tax revenue in the EU-28 increased between 2002 and 2007 before the effects of the financial and economic crisis caused a reduction in economic activity, leading to falling tax revenues in 2008 and 2009 in absolute terms. The decrease in revenues during the crisis only offset to some degree the general development of rising environmental tax revenues. In 2010, environmental tax revenues returned to an upward path. By 2012, the level of environmental tax revenues was some 13.2 billion EUR higher than at its previous peak in 2007. The share of environmental tax revenues to GDP decreased slightly from 2.6 % of GDP to 2.4 %, since revenue growth did not keep up with overall GDP growth. Another reason for this decline is the devaluation of quantity taxes through inflation (Transport & Environment, 2011).

17 Environmental taxes here only refer to the excise tax component and NOT to the VAT component, which is usually also charged on these tax bases.

Figure 5: Development of total environmental tax revenue by type of tax, EU-28

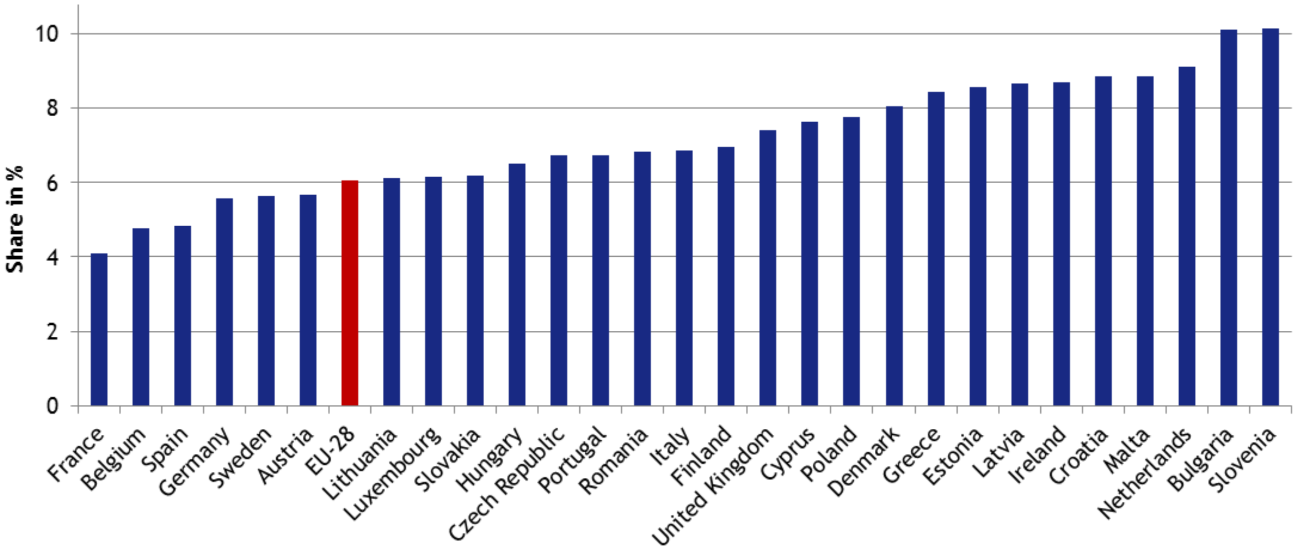


Source: Own figure based on (Eurostat, 2014)

Today environmental tax revenues in EU member countries cover a small but significant 4 to10 % of total tax revenues (see Figure 6 for 2012 data). On average 6 % of member state revenues stem from environmental taxes, while some smaller states such as Slovenia and Bulgaria raise over 10 % of their national budgets through environmental taxes. However, one should be careful making comparisons, since low environmental tax revenues could be the cause of low environmental taxation or they could stem from high environmental taxes, which have induced producers and consumers to shift away from environmentally harmful behavior (see section 4.4.2). High environmental tax revenues may reflect higher energy intensity or simply more environmental damage, which is why high revenues are not necessarily to be equated with an environmentally healthy country. Another caveat is that high levels of revenue can stem from comparatively low environmental tax rates, which motivates non-residents from neighboring countries to purchase a good in the low tax country – so-called "fuel tourism". One famous or rather notorious example is Luxembourg, which raises high fuel revenues by inducing non-resident consumers to buy fuel in Luxembourg due to relatively low rates.[18]

[18] Luxembourg has the EU's lowest tax rate on diesel, just implementing the required EU minimum tax rate(0.33 EUR/liter). However its diesel tax revenues per person are more than three times higher than that of the country in second place, Slovenia. The reason is that people especially commercial trucks use the small country as a pit stop in order to avoid higher taxes in neighboring countries (Nilsson, 2012).

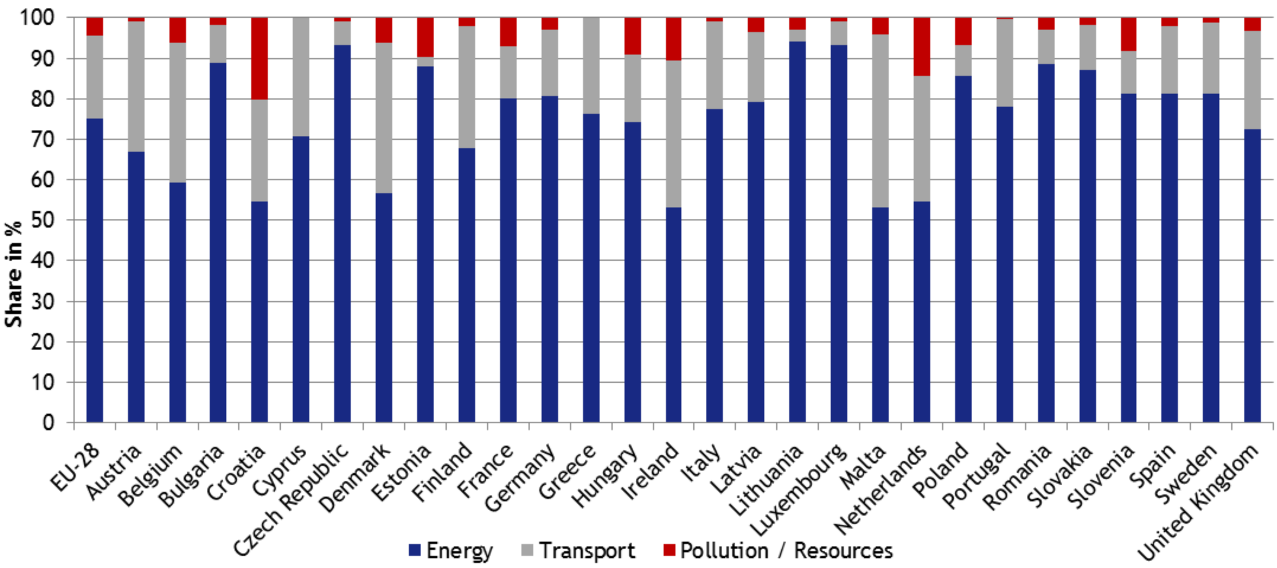
Figure 6: Revenues from environmental taxation as percentage of total tax revenues in EU-28



Source: Own figure based on (Eurostat, 2014)

The make-up of EFR revenues differs between countries (see Figure 7). Energy taxes account for at least 50 % of environmental tax revenues in all countries. They were particularly prominent in Lithuania, Luxembourg and the Czech Republic, where they accounted for more than 90 % of environmental tax revenues. In Malta, Ireland, Croatia and the Netherlands, on the other hand, they only accounted for 50 – 55 % of revenues. Transport taxes raised some 21 % of the EU-28 total in 2012, mindful that according to our definition this category comprises vehicle ownership taxes only, not road fuel taxes. Their relative importance was highest in Malta (43 % of all revenues from environmental taxes), Denmark (37 %) and Ireland (36 %). Pollution and resource taxes play a minor roll, 4 % of total environmental tax revenues, in the EU-28 in 2012. Croatia (20 %) and the Netherlands (14 %) are the exception.

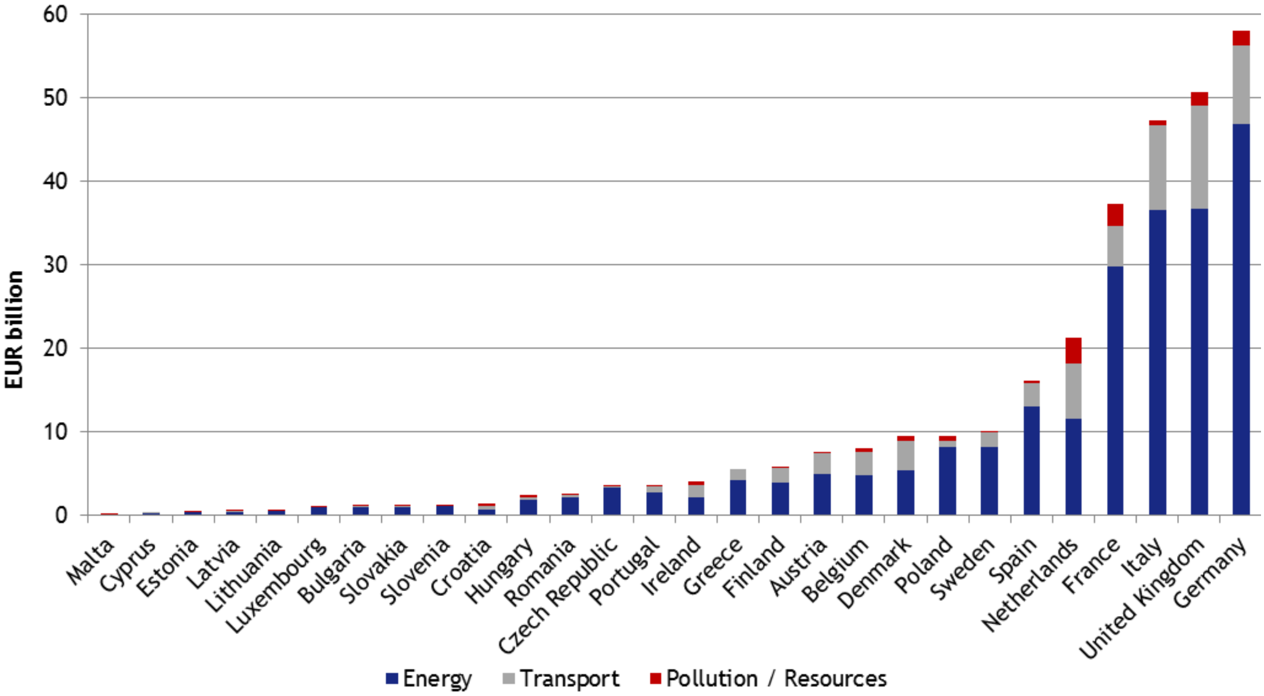
Figure 7: Share of environmental taxes by tax category, EU-28-countries, 2012



Source: Own figure based on (Eurostat, 2014)

Not surprisingly, the largest tax revenues are raised in the largest EU economies. Germany raises the most environmental tax revenue with 58 billion EUR, the UK follows with 51 billion EUR and Italy is ranked third with 47 billion EUR. The top 3 therefore cover 50 % of total European environmental tax revenue (Figure 8).

Figure 8: Total environmental tax revenue by type of tax, EU-28-countries, 2012



Source: Own figure based on (Eurostat, 2014)

The EU case exemplifies that environmental taxes can raise significant and fairly stable revenues over time. On the other hand, the fact that revenues have actually decreased as a share of GDP from 2002-2012 seems to indicate that significant environmental tax shifts have not recently materialized on an EU wide level and respectively that inflation has a strong negative impact on these mostly quantity-depending and hardly indexed environmental taxes.[19] The case further shows that environmental tax revenues are mostly levied on energy products (including transport fuels) in the EU, while transport, pollution and resource taxes generate comparatively less. This is also reflecting that vehicles, fuels, and electricity all have income elasticities below unity, so the base of these products increases by less than in proportion to GDP over time.

While it is useful to have an idea of the actual revenue of environmental taxes in some countries, the main goal of this study is to better understand the **revenue potential** of EFR. According to OECD estimates, revenues from environmentally-related taxes amount to roughly 1.7 % of GDP on average across member countries, varying from about 0.7 % on average in North America to 2.5 % in Europe. More than 90 % of these revenues come from taxes on fuels and motor vehicles (OECD, 2010). It is furthermore almost undisputed that a large part of their revenue potential remains untouched. These are mainly taxes on resources, land, and waste. The Institute for European Environmental Policy estimates that countries could realistically source 15 % of total tax revenues from environmentally-related taxes in the medium to long term – the average currently being 6% (Bassi, ten Brink, Pallemaerts, & von Homeyer, 2009). To achieve this, it is required to better aligning tax rates with environmental damages apart from broadening tax bases and including new tax bases. In developing countries, EFR potentials are likely to be comparatively higher. For example, in 1999 Mauritania doubled the revenue it earned from its fisheries; this represented about 30 % of total tax revenues. Conversely, in many countries, subsidies for fossil energies represent a significant drain on public finances and a very real opportunity to boost revenues. For example, the power subsidy to Indian agriculture – which benefits large farmers – costs the country 6 billion USD per year – and is twice the national health budget (OECD, 2005).

19 Ireland, Portugal and Greece have recently made some considerable progress, however due to their size and the recency of reforms, this does not yet show up in the revenue figures.

It is not possible to practically say how much revenue could be raised by various EFR instruments across countries more generally, since this depends on the specific situation within each economy. Therefore, we have elected to focus on the revenue potential of a single country, Portugal, where the EFR revenue potential was recently assessed by the European Environment Agency (EEA) alongside Portugal's deficit reduction program.

2.3 Case 2: Revenue potential of EFR in Portugal

In the mid-1990s Portugal led Europe as environmental-related taxes covered 11.5 % of total tax revenues. This ratio decreased over time and real revenues from environmental taxes are now 5 % lower than in 1995, and when considering their relationship to GDP these taxes have declined in fact by 1/3. In 2010, the share of environmental taxes to total tax revenues stood at 7.9 %, or 2.5 % of GDP. This put Portugal on the 14th place within the EU27 (EEA, 2013).

In order to reverse this trend, the EEA evaluated different EFR policies and estimated the potential extra revenue that could be generated by these reforms and found that Portugal could increase its EFR revenue by 65.5 % until 2016 exemplifying the immense revenue potential for EFR in the country. These assessments are mainly based on comparisons between the maximum taxation in Europe and the actual taxation in Portugal. In 2013 the Troika suggested to generate revenues to alleviate the difficult fiscal situation in Portugal by:

- Amending the personal income tax to yield an additional 3 billion EUR;
- increasing corporate tax revenues by 200 million EUR; and
- increasing indirect taxes by 685 million EUR and social contributions by 270 million EUR.

In the following, we highlight some EFR policies, which could and partially were used to substitute some of the aforementioned tax increases.

Energy

In the energy sector, gas has continued to replace mineral oils as a major source of energy. Since mineral oils have traditionally been taxed higher than gas, environmental tax revenues decreased due to consumers switching to the lower taxed fuel in industry and heating use. Aligning gas taxes to the Spanish level could reverse this trend and has the potential to raise annual revenues of 60 million EUR in 2016 (EEA, 2013).

An adjustment of electricity taxes to the level in Spain and Greece would generate further revenues of 166 million EUR in 2016 (EEA, 2013).

Taxes (in real terms) on diesel and petrol decreased by 10 eurocents per liter since 1995. While diesel is taxed at 367 EUR per 1000l, which is scarcely more than the EU minimum rate, petrol is taxed significantly higher at 585 EUR per 1000l (EEA, 2013). Balancing the taxation of diesel and petrol would increase revenues by 594 million EUR in 2016.

A more ambitious target would be the implementation of a carbon taxation scheme. The proposed EFR includes a carbon tax for non-ETS emitters starting with 5 EUR per ton of CO_2 in 2015, increasing it to 35 EUR by 2030. Revenues are projected at 82.5 million EUR in 2015 and will rise to 171 million EUR in 2016 (Pereira & Pereira, 2014).[20]

Transportation

An important transport-related instrument is the so-called Eurovignette on heavy-good vehicles (HGV). This would create an incentive to renew the HGV fleet and thereby reduce emissions and could be realized using an additional external-cost charge on top of infrastructure tolls. Extra revenues would amount

[20] Interaction effects such as those between a new carbon tax and a higher tax on heating gas were not explicitely modeled, however, they would likely undermine each other's revenues.

to 170 million EUR in 2016 (EEA, 2013). Generally, it is necessary to re-structure taxes within the energy/transport sector, apart from also raising taxes. For example, there should be a partial shift away from fuel and vehicle taxes towards distance-based taxes to more effectively address congestion, and road damage (from trucks).

Pollution and resources

Considering pollution and resource taxes, an increase in the existing water abstraction levy to a more substantial tax including all utilities and industries has a revenue potential of 101 million EUR in 2016. At the same time, such a measure would alleviate the common water scarcity in Portugal and could reduce water pipe leakage from 40 % to 10 % and could provide more funds for maintenance of pipe infrastructure (EEA, 2013). Higher tax rates on waste would not only support waste minimization and waste recycling but also create additional revenues of 112 million EUR in 2016.

Removal of EHS

Company cars account for 55 % of the annual sales of all passenger vehicles in Portugal. Increasing the annual taxes relating to the acquisition costs from 9 to 18 % for newly purchased company cars has a significant revenue potential of 420 million EUR in 2016 (EEA, 2013).

To sum up, Portugal has many possibilities to use environmentally-related taxation and subsidy reform as a means of creating revenues. The now implemented EFR of 2014 is an important leap forward. If the revenues are recycled, the effects on GDP and public debt are expected to be positive (Pereira & Pereira, 2014). While Portugal is only one case study, it is nevertheless a useful example to give readers an idea of EFR potential more generally.[21] Table 5 sums the added revenue potential for various EFR instruments in Portugal.

Table 5: Illustrative potential for environmentally-related taxes and removal of environmentally related tax expenditures in Portugal, 2013-2016 [in million EUR]

	2013	2014	2015	2016	Comment
Environmentally related taxes					
Energy taxes					
Motor fuel excises	69	137	137	137	Adjust Tax rates with inflation to 2020 effective level
Electricity	83	166	166	166	Align to level in Spain and Greece
Gas; industry/heating	30	60	60	60	Align to tax rate in Spain of 1.15 EUR/GJ
Carbon tax		83	171	171 108	CO_2/Carbon tax for non-ETS emission Further increase by 2016
Hydro Power		116	116	119	Royalty of 10-20% for large hydropower
Annual offset tax on diesel vehicles		594	594	594	Balanced taxation on passenger vehicles' motor fuels. Offsetting tax per passenger vehicle, in average 200 EUR
Sum	**182**	**1,156**	**1,244**	**1,355**	
Transport Taxes					
Air travel tax	49	98	98	98	Longer flights 14 EUR, shorter flights 3 EUR per passenger
HGV vignette scheme			170	170	based on costs of air pollution and Heavy Goods Vehicles
Sum	**49**	**98**	**268**	**268**	
Pollution and Resource taxes					
Water abstraction levy		101	101	101	Water pipe leakage could be reduced from 30-40% to 10%
Water and incineration tax	56	112	112	112	Apply rate of 35 EUR/ton -supporting reuse and recycling industry

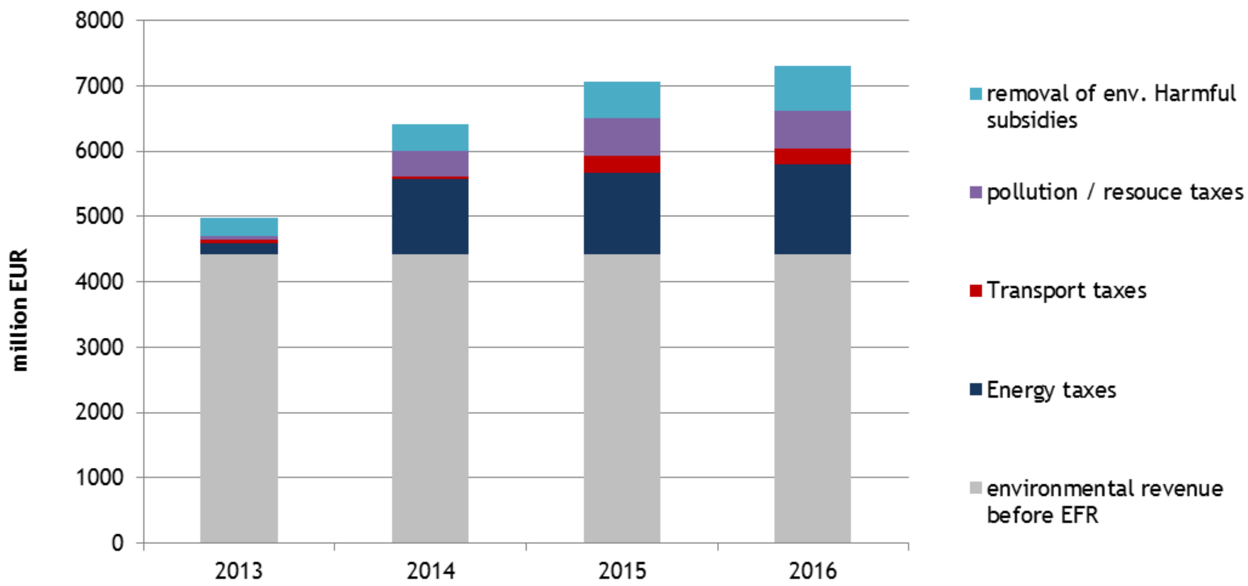
21 The EEA further evaluated the EFR potential in Spain, Italy and Ireland. See http://www.eea.europa.eu/highlights/fiscal-reform-can-create-jobs

Beverage packing		107	107	107	Apply rates according to environmental burdens.
Shopping bags		30	30	30	Same rate as Ireland (15ct/pc)
Resource taxes		35	35	>35	Royalty on resource rents as in Estonia.
SO_2 and NO_X			95	95	Same rates as for HGVs to reduce health costs.
Pesticide tax			100	100	Supporting biodiversity and human health.
Sum	**56**	**385**	**580**	**580**	
Sum Environmentally related taxes	**287**	**1,639**	**2,092**	**2,203**	
Removal of environmentally harmful subsidies					
Charge Category					
Railways and inland navigation	27	27	27	27	Fuel Tax exemption
Agriculture	67	67	67	67	Fuel tax reduction
Certain Industries and fixes engines	45	45	45	45	Fuel tax reduction
Fuel oil, gas oil, kero-sene	27	27	27	27	Align reduced VAT rates to standard (non-motor fuels)
Agriculture	41	41	41	41	Align reduced VAT rates to standard
Company Cars	60 9	180 27	300 45	420 63	18% of acquisition cost in annual tax declaration (up 9%). Change to list price
Total	**276**	**414**	**552**	**690**	
Grand total	2013	2014	2015	2016	
All sources	**563**	**2,053**	**2,644**	**2,893**	

Source: own table based on (EEA 2013)

Figure 9 shows the development of Portugal's EFR revenues, should the proposed reforms be implemented. The analysis above rests on modeling results from the EEA for the EU Commission which are mainly based on comparisons between the maximum taxation in Europe and the actual taxation in Portugal.

Figure 9: Revenues of existing environmentally-related taxes and additional revenues through proposed EFR: Prognosis 2013-2016 [in million EUR]:



Source : Own graph based on (EEA, 2013)

With these practical examples in mind, the next section focuses on theoretical considerations regarding the fiscal perspective on EFR.

3 Theoretical considerations: the right tax bases and tax rates from a revenue and an environmental perspective

In general taxes should fulfill a range of criteria from a purely fiscal perspective: they should raise a **large** enough amount of revenue to justify administrative and political expenses. They **should impose the least possible distortions** to the economy, which means that taxes should fall on products/activities that are **inelastic** in order to minimize the welfare damage, which arises from actors trying to shift away from the taxed behavior. According to the optimal tax literature, an optimal tax is one "which minimizes the aggregate deadweight loss for any given tax revenue or level of public expenditure" (Sandmo, 1976). From both the governments and firms' perspective tax burdens and revenues should further be **stable** in order to minimize uncertainty. Taxes **should minimize resource costs** involved in assessing, collecting and paying the taxes (administrative efficiency) (Sandmo, 1976). Lastly tax burdens should be **equitable and manageable**, meaning that the ability to pay should be an important criterion for the level of the tax and the selection of the tax base (World Bank, 2005). While it is difficult to find robust empirical evidence, it is generally understood that fiscal frameworks conducive to sustained growth often feature broad-based taxation systems with few exemptions, relatively low marginal rates and efficient public expenditure regimes (PWC & World Bank, 2011).

While there are many EFR instruments, which fulfill the aforementioned criteria, these fiscal goals are sometimes at odds with the environmental objectives of an EFR. The first goal may be to **correct behavior**: In the presence of a negative externality, the goal of a so-called Pigouvian tax is to increase economic welfare by making a specific environmentally harmful behavior less attractive by (artificially) increasing its price through taxation (Pigou, 1924). The goal of an environmental tax could even go further and try to **stop behavior** by increasing prices until the behavior stops (or reaches a predefined target). This brings out the fundamental tension between the fiscal and environmental goal behind a tax: The fiscal goal is (generally) to raise money without affecting or distorting behavior, while the environmental goal is to explicitly correct or stop behavior in a way that eliminates the inefficiencies from environmental damage (W. Jaeger, 2012). Consolidating these objectives is the main challenge to a sound policy design and the core purpose of this study. According to Blackman und Harrington (2000) the "objective between raising revenue and achieving environmental goals is inversely related". This idea will be developed using the following stylized example.

3.1 Tensions between fiscal and environmental goals

To explain the fundamental tensions between environmental and fiscal goals, we develop a simple economic model. We start with an idea of the **total potential revenue**[22] of an EFR instrument, using a fictional national tax on CO_2 in the power sector as an illustrative example. The revenue of an EFR instrument is the product of the tax base **Q** (amount of taxed CO_2 emissions) times the tax rate **t**. However, the demand for the tax base **Q** itself depends on the tax rate **t** and the overall price level **P** of the taxed entity.

Emissions **Q** - or one could think of consumption of CO_2 - declines with increasing prices and taxes for CO_2. Suppose the goal is to raise a certain amount of revenue with such a CO_2 tax in country X. Emissions today stand at point **a** = 100 million tons of CO_2. At this starting point the emission of CO_2 is free, since neither a tax nor a natural price for CO_2 exists. The output of CO_2 or demand for CO_2 emissions in this country depend on its costs or price and follows a very simple linear demand curve[23], where for every unit increase in the price level (**P+t**), emissions fall by **b** = 1 million tons of CO_2.

22 We speak of "potential" revenues since exemptions, deductions, and all other revenue reducing factors are ignored.

23 Using a linear demand curve is practically unrealistic, however, justifiable for illustrative purposes.

$$(1)\ Q_{total} = a - b \times (P + t)$$

Since there is no natural price for CO_2, we assume that the price **P** is always zero. Therefore, demand for CO_2 emissions only depends on its tax rate **t**. Equation **(1)** shows that $\mathbf{Q_{total}}$ declines as **t** increases.

We can calculate the potential revenue $\mathbf{R_{total}}$ from this tax by multiplying $\mathbf{Q_{total}}$ with the tax rate **t**:

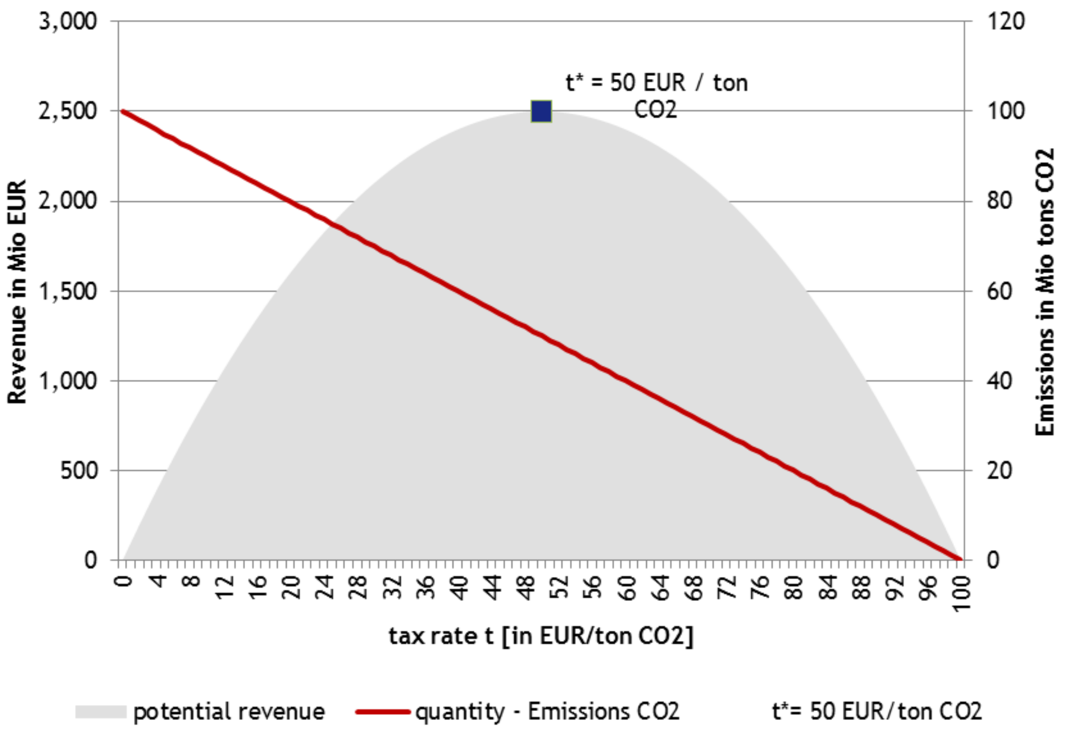
$$(1)\ R_{total} = Q_{total} \times t$$

$$(2)\ R_{total} = (a - b \times t) \times t$$

$$(3)\ R_{total} = a \times t - b \times t^2$$

In equation **(3)** we simply replace $\mathbf{Q_{total}}$ by the expression from equation **(1)** and then write it out to get **(4)**. One can see from equation **(4)**, that the EFR revenues from the tax first increase with **t** (since **a > b**) and at some point fall, since the behavioral effect described in the second part of the equation (**b * t²**) outweighs the increased revenues from higher rates. Figure 10 illustrates this.

Figure 10: Revenues and quantities under a hypothetical CO_2 tax



Source : Own graph and calculations

As long as the demand for the tax entity is inelastic,[24] revenues increase with rising tax rates. Once demand becomes elastic, revenues fall as taxes are increased. The revenue maximizing tax rate is found quite simply by taking the derivative of $\mathbf{R_{total}}$ with respect to **t**:

$$(4)\ t^* = \frac{a}{2b}$$

In our example,[25] revenues are maximized at a tax rate **t*** = 50 EUR/ton CO_2, and revenues at **t*** amount 2.5 billion EUR. The intuition here is very simple: First revenues increase, because the effect of an increase in tax rates is larger than the effect of lowered emissions. After a certain point, however, as taxes

24 The elasticity of demand for CO_2 here is defined as the change in Q which results in from a change in t: $\in = \left\{\frac{\Delta Q/_Q}{\Delta t/_t}\right\}$. As long as $\in \leq |1|$, demand is inelastic. Once $\in \geq |1|$, demand is elastic.

25 It should be clear that this linear demand curve is only used for illustrative purposes. Fuel demand curves are commonly modeled convex demand curves are more common in CGE models.

increase, the tax base shrinks to a point, where the behavioral effect on the tax base outweighs the revenue raising effect of higher tax rates.

The example shows why from a fiscal perspective, low-marginal rates and an inelastic demand are ideal: Increasing the tax rate from 0 to 1 EUR/ton CO_2 leads to an additional revenue of 99 million EUR. Raising it from 1 to 2 EUR/ton CO_2 increases revenues by 97 million, while increasing the tax from 49 to 50 EUR/ton CO_2 increases revenues by only 1 million EUR; it decreases thereafter. From equation **(5)** we learn that from a fiscal perspective, the maximum tax rate **t*** increases with the size of the tax base and decreases with the size of the behavioral response to an increase in taxes **b**. It is critical to understand then, that from this line of reasoning, tax rates on comparatively narrow bases and a with a strong sensitivity to tax rates should generally be lower, while taxes on large bases and less sensitivity to prices can be higher.[26]

This example can be used to illustrate the critical tension between fiscal and environmental goals. From a **fiscal perspective** it is never reasonable to set a tax rate higher than **t***, because this increase in rates will lead to decreasing revenues. Therefore, from a fiscal perspective it is reasonable to set rates where demand is inelastic and to never increase taxes to a level where an extra unit of taxation leads to decreasing revenues. Ideally taxes should be increased as long as the elasticity with respect to this particular tax base is lower than the elasticity of other taxes in the economy.[27] It is therefore fiscally sound to spread low rates over broad tax bases (W. Jaeger, 2012).

The **environmental perspective** on this issue differs, however. Recall that the environmental goals behind EFR instruments are either to correct behavior (i.e. internalize external costs), or even to stop or reduce it to a certain point.[28] The distinction is made, because in practice it is often difficult to assess the marginal damage cost of a pollutant. The pragmatic approach is then to choose a tax rate, which is high enough to effect real transition to environmentally friendly behavior.[29]

If the goal of a tax is to **phase out** certain behavior, then fiscal and environmental goals most clearly conflict. For a behavioral change to occur one would like to target taxes on behavior, which quickly reacts to prices (high elasticities) and set rates high enough, that behavioral change is fast and visible. One may actually want to target a narrow base and actors, who can most easily avoid environmental damages without burdening large parts of the population. Governments often try to increase the behavioral response to such an EFR by supplementing it with information campaigns (e.g. to save energy), which should further increase the behavioral response to the tax. This clearly contradicts the fiscal principles considered above, because from a fiscal perspective behavioral reactions should be kept to a minimum.

The goal to **internalize external costs**, on the other hand, can but does not have to contradict fiscal goals. For optimal internalization, the tax base should ideally be closely linked to the environmental damage. For example, one could reduce emissions of CO_2 from electricity production by taxing the end product electricity, or a polluting input such as coal or the emission of CO_2 itself. If electricity is taxed, there is an incentive to reduce the amount consumed, however this includes electricity from renewable energy and does not give an incentive to switch between technologies. A tax on coal as input fuel would also decrease emissions. It would be based (and in fact is wherever applied) on calculated emissions based on the fuels used. This is, from an administrative perspective, much simpler than aiming to measure them at the chimney and then tax CO_2 emissions accordingly. However, this would not be an incentive to install climate friendly technology such as carbon capture and storage (CCS). Only a direct tax on CO_2 emissions

26 The elasticity with respect to tax revenues corresponds directly with the breadth of the tax-base. If for example government chooses to raise a tax on leaded gasoline one can imagine that consumers would react quite strongly by substituting leaded gasoline for another unleaded gasoline thereby decreasing revenues. If on the other the tax base is broader, say on transport fuels, then the elasticity is lower and revenues more stable since it becomes more difficult for drivers to find an adequate substitute.

27 The economic debate on this issue is covered in Jaeger (W. Jaeger, 2012).

28 CO_2 emissions are a good example to illustrate the difference between these approaches. On the one hand one may try to measure the marginal external cost of CO_2 and then set a tax to internalize this cost. Once this tax is set, emissions may stabilize at a certain level. On the other hand, the goal may be to completely phase out CO_2 emissions within a country, in which case the tax should be set high enough, so that emissions eventually seize to exist.

29 In the case of climate change mitigation, for example, tax rates on the order of 150 USD/tC (equivalent to around 20 USD per barrel of oil) are widely considered necessary to promote substitution from fossil fuels to renewable energies (Heal, 2009).

leads to ideal incentives.[30] As long as the base of the environmental damage is fairly large, as is the case with CO_2, fiscal and environmental perspectives may be aligned. Accordingly, EFR are most efficient from an environmental perspective, if the environmental damage is large and the tax targets it well (UNEP, 2010). However, if the environmental damage is very concentrated and elastic, taxing it may not be attractive from a fiscal perspective (Blackman & Harrington, 2000).

With internalization as the goal, a Pigouvian tax should be set to a rate equal to the marginal damage cost of the environmentally harmful behavior. According to Germany's Federal Environment Agency, the external costs of CO_2 amount to 80 EUR/ton in the short run (UBA, 2012).[31] Therefore, if a Pigouvian tax is chosen, the tax rate should equal external costs, namely 80 EUR/ton CO_2. One can see that within our stylized example above, this would not be sensible from a fiscal perspective, since the revenue-maximizing tax rate **t*** = 50 EUR/ton CO_2, which is lower than the marginal damage cost. In this case, a tax of 80 EUR would generate 1.6 billion EUR, while a lower tax of 50 EUR would generate 2.5 billion EUR. However, in practice, this is not likely to be the case – it is more plausible, that the external cost of an environmental tax base is far lower than the optimal tax rate from a fiscal perspective. If elasticities are low enough, it may even be reasonable to increase taxes beyond the marginal damage cost for fiscal reasons.

At this point, one has to think about the question regarding the **priority of goals**, if fiscal and environmental goals are in conflict. In a case as described above, i.e. one where the ideal Pigouvian rate is unsound from a revenue perspective, it should be quite clear that **environmental and economic objectives should override fiscal concerns**. As a matter of fact, the goals do not clash if one looks at the problems more closely. The reason for this is that a Pigouvian tax sets a price at an economically efficient level. After accounting for potential losses from the "tax-interaction effect", one can think of the revenues collected by price-correcting taxes as a free lunch from a fiscal perspective. This is true because these revenues do not distort behavior from an efficient level. The economic and fiscal debate on taxation is about identifying the least distortive taxes. Accordingly, this line of reasoning does not apply to **Pigouvian taxes, because they do not distort behavior, they correct it.** Any distortion away from this efficient level, for example by setting an inefficiently low price through tax reductions or exemptions will lead to unwelcome market inefficiencies. For this reason, one should consider tax rates, which are **lower** than the Pigouvian rate as environmentally harmful subsidies (EHS). This is a crucial perspective to allow for a revision of often used, but inadequate definitions for EHS (e.g. UBA, 2014).

The situation becomes more complex, when contemplating setting a rate **above** the internalizing Pigouvian rate. It makes no fiscal or environmental sense to set a tax rate much higher than the Pigouvian rate if demand is very elastic. A tax rate which extends beyond the external costs of the taxed entity is then only reasonable if the tax base is fairly inelastic compared to other taxes in the economy, or if other reasons, such as low administrative costs, make this revenue stream particularly attractive (see section 3.5). Generally it makes sense to try to conceptually separate the two goals: If an EFR instrument is attractive for environmental reasons, but less attractive for fiscal purposes, one should aim to set rates at the Pigouvian rate. If an environmental tax base is, above and beyond its environmental attributes, an attractive source to generate revenues, one may consider setting rates higher than the Pigouvian rate. Setting the effective rate lower than the Pigouvian rate constitutes a market distortion and an environmentally harmful subsidy, which should be generally avoided.[32]

This line of argument is well summarized by the Norwegian commission on green taxes: "In principle, environmental taxes should be evaluated based on their environmental impact, irrespective of revenue potential. Accordingly, the primary purpose of such taxes – the correct pricing of environmentally harmful activities – must form the starting point for any discussion of their use. Nevertheless, the future revenue po-

30 One could also combine an input fuel tax with rebates for e.g. carbon capture and storage (CCS), which would then give an incentive to use such technology.

31 Estimations on the social costs of carbon differ substantially. The US government estimates this cost for 2015 at between 12 USD and 116 USD depending on the discount rate used (US Environmental Protection Agency, 2013).

32 This assumes that resources from Pigouvian taxes are spent productively. If tax revenues are used on low-value spending instead, optimal tax rates may be lower than the Pigouvian rate.

tential of environmental taxes must also be considered closely in the context of a green tax shift" (Ministry of Finance Norway, 2014).

3.2 Synergies between fiscal and environmental goals

Where there are tensions, there can also be synergies. These generally exist wherever the fiscal objective points in the same direction as the environmental objective. This is the case, when EFR instruments target a rather broad base, and the internalization of external effects can be achieved by realistic tax rates. As we see in the cases below, fuel taxes, which raise the majority of EFR revenues, are the best example.

Fiscal and environmental objectives also tend to overlap in the case of cutting exemptions and reducing environmentally harmful subsidies. Most of these subsidies are neither justifiable by fiscal nor by environmental considerations, and usually exist due to certain political constellation. Their removal tends to strengthen environmentally sound incentives, raises revenues and eliminates inefficiencies in the tax system. Removing EHS is also an attractive argument for political communication, as one can argue against wasting taxpayers' money, which can be the basis for unconventional alliances.

It is also possible to alleviate the tension between fiscal and environmental goals combining several instruments. To tackle an externality, one should use instruments, which directly target the environmental harm, e.g. emissions (where we want to erode the tax base rapidly) and another instrument targeted at a relatively immobile base (e.g. vehicle ownership, electricity consumption) to meet fiscal objectives. Thereby, environmental targets can be reached without quickly eroding fiscal revenue streams.

Politically it is very important to understand that for the vast majority of environmental taxes, there are synergies and that usually both, the budget and the environment, benefit.

4 Conceptual framework for EFR revenues

With these considerations in mind we develop a **conceptual framework for EFR revenues**, which allows for a clear and distinguished understanding of the relevant factors and the trade-offs involved. This framework is built for policymakers, who are considering an environmental tax on a certain tax base. It first estimates the **total potential revenue** of an environmental tax.[33] The total potential revenue depends on the size of tax base, the tax rate and the behavioral responses to price increases by the taxed actors. It explains how much revenue could possibly be generated, before considering exemptions, economic effects, political spending, etc. After this we explain the **net revenue** raised by the environmental tax. This revenue is the total potential revenue minus reductions in revenue due to tax **reductions and exemptions**. After this we consider what happens to **revenues over time**, as they tend to be reduced by **inflation** and **increasingly strong behavioral responses** away from the tax base. Overall revenues are then further reduced (or increased) by **external revenue effects**, which describe the effect of the tax on general tax revenues. Having subtracted those we obtain the **effective total revenue**, which is available for expenditures. From this we subtract **administration costs** related to the environmental tax. In a last step we subtract **compensatory spending**, which may be necessary to reimburse certain actors. In the end, we suggest how much revenue might remain to be available for discretionary political spending. In a last step, we consider how these revenues may best be allocated.

33 The framework works for all EFR instruments, however for simplicity it is sensible to focus this discussion around environmental taxes.

Figure 11: Conceptual framework to estimate EFR revenues

Variables	Explanation	Identity
$(1-\varphi_{normal}) \times Q_{total} \times t_{normal}$		Total potential revenue
$\varphi_{normal} = f(t_{normal}, P)$	describes the behavioral response of the tax base and depends on the tax rate and the absolute Price level	
$-(1-\varphi_{reduced}) \times Q_{reduced} \times (t_{normal} - t_{reduced})$		Reductions
$\varphi_{reduced} = f(t_{reduced}, P)$	see above	
$-Q_{exempt} \times t_{normal}$		Exemptions
$-\sigma \times (Revenue_{total} - real\ Revenue_{EFI})$		Effects on external revenues
$\sigma = f(behavioural\ response)$	positive and negative external revenue effects	
$-\{real\ Revenue_{EFI}\} \times \left\{1 - \frac{1}{(1+\pi)^{(1+t)}}\right\}$		Time and inflation
$-C_{admin}$		Costs of administration
$C_{admin} = f(administrative\ efficiency)$	measurement & evaluation; collection, monitoring & enforcement, theft & corruption	
$-S_{compensations}$		Compensatory spending
$S_{compensations} = compensatory\ spending$	equity and business transfers	

Source : Own figure

Our developed framework, as depicted in Figure 11, will be developed in the next sections using practical examples and cases.

4.1 Potential EFR revenues

As shown above, total potential revenues depend on the tax base, the tax rate and the elasticity of the tax base with respect to the tax. Equation (1) shows this relationship in a simple way.

$$(1)\quad Revenue_{potential} = (1-\varphi_{normal}) \times Q_{total} \times t_{normal}$$

Q_{total} and t_{normal} describe the total tax base and the planned tax rate, which may be considered by a government. The variable φ_{normal} describes the behavioral effect on the tax base. As shown in equation (2), φ_{normal} is a function of the tax rate t and the price level P.

$$(2)\quad \varphi_{normal} = f(t_{normal}, P)$$

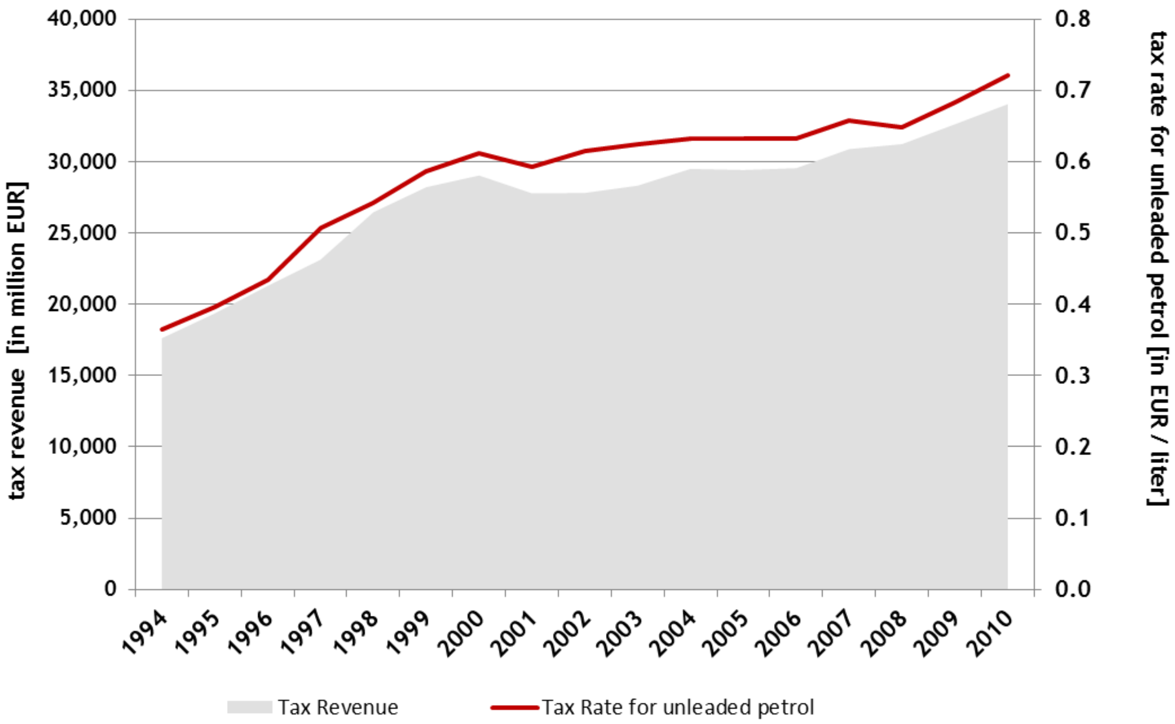
Without saying anything about the functional form of this equation, we know that φ_{normal} increases along with taxes and price levels. One can think of φ as an expression describing the elasticity of the tax base: the stronger the behavioral response to a tax increase, the higher φ. Equation (1) shows that the potential EFR revenues increase, with the size of the tax base and the tax rate while it falls as elasticity increases.

In practice there are many EFR instruments with very large potential revenues. **Broad energy taxes** on transport fuels are the most common example. Transport fuel taxes offer a very large base and are difficult to avoid (low elasticities), since at least in the past, there were few acceptable substitutes given the need for mobility. In 2012, Germany's total revenue from environmental taxes amounted to 58 billion EUR, of which 35.5 billion EUR (61 %) were raised by taxes on petrol and diesel fuel alone (FÖS, 2014). If a broad base and low elasticities are given, EFR can be used to generate large, stable and fiscally attractive revenue streams, as is shown by the following example.

Case 3: Broad base, low elasticity: Fuel duty in the UK

The UK raises around 4 % of total government revenues through various taxes on hydrocarbon oil, better known as the fuel tax. Rates per liter for the most common fuels, unleaded petrol, diesel, biodiesel and bioethanol are equal at 0.72 EUR /liter. Assuming a final price of 1.40 EUR/liter of unleaded petrol, this means that the tax makes up 53 % of final consumer prices. Figure 12 shows that even a relatively high tax on such a broad and inelastic base tends to create very constant and predictable revenue streams. The fact that revenues rise along with the tax rates indicates a small behavioral response to price increases since fuel use decreased by a moderate 2 % between 2000 and 2012. However, this has also been favored by the fact that the world oil price decreased at least until 1999 which was offset mostly by that duty.

Figure 12: Tax revenues and tax rate for UK fuel duty



Source: Own based on publicly available data by HM Revenue & Customs (see http://customs.hmrc.gov.uk/)

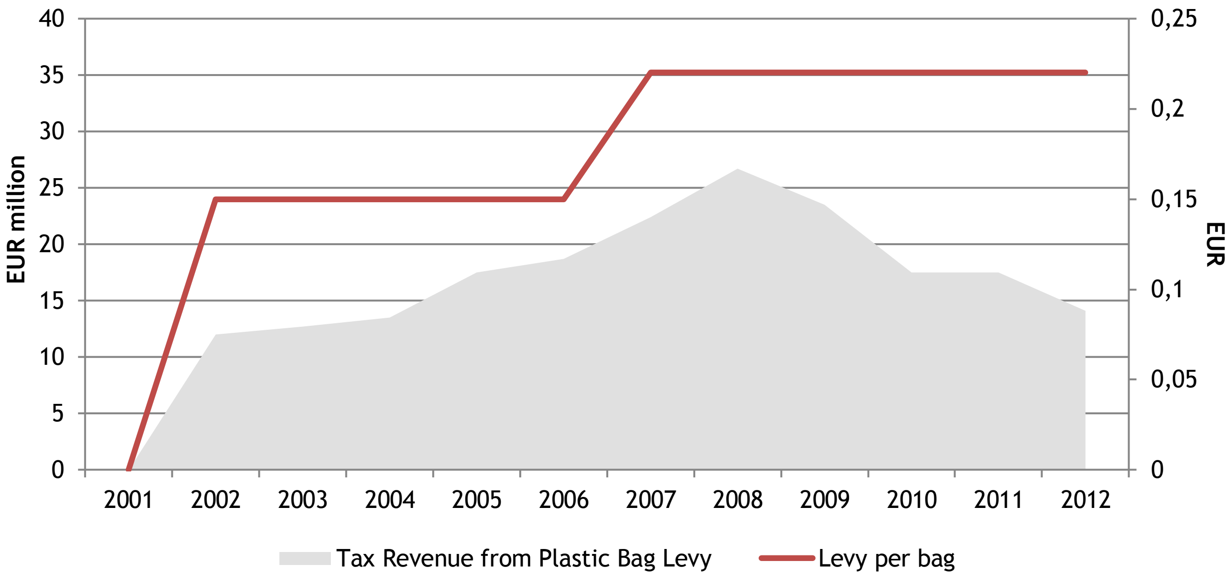
In order to adjust for inflation based devaluation and to discourage the use of hydrocarbons as a fuel, in 1993 the UK introduced the "Fuel Duty Escalator", which automatically set an annual increase of rates 3 % (later 5 % and eventually 6%) in addition of inflation. The escalator was effectively cancelled by the Labour-party government following severe disruption caused by the fuel tax protests in response to the spike in oil prices in 2000. This clearly demonstrates that while taxes on goods with inelastic demand are fiscally attractive, they are also politically contentious precisely because they are difficult to escape and their effect on prices is very transparent to consumers. However, value added taxes would have even stronger effects, hence here quantity-based taxes have advantages in that they cushion world oil price increases.

A tax on **a narrow base** can be useful to target a specific and unwanted environmentally harmful entity with the goal of discouraging its use. Given a narrow tax base for an elastic good, revenues can be expected to fall rapidly in response to a tax increase, making such a measure fiscally less attractive. Ireland's tax on plastic bags provides a prime example.

Case 4: Narrow base, high elasticity: The Irish levy on plastic bags

In March 2002 the Irish government introduced a levy of 0.15 EUR per plastic bag. This tax was several times higher than the ordinary price of a plastic bag, indicating the behavioral purpose of this EFR instrument.[34] The effect of the tax on the use of plastic bags was dramatic, and usage fell almost immediately by more than 90 %. Formerly consuming 328 bags per capita every year, Irish consumers decreased their usage to 21 bags per capita more or less overnight. Nevertheless the tax revenues in 2002 amounted to 12 million EUR and constantly increased over the following years as people recovered from the initial tax shock. In 2006, consumption had increased to 31 bags per capita again. In response, the levy was raised to 0.22 EUR per plastic bag on 1 July, 2007 to further discourage consumers. From then on, after a slippage in the behavior of consumers and an implementation delay in several stores, the plastic bag use and accordingly the tax revenue constantly decreased in the period between 2008 and 2012. Bag use decreased from around 30 to 16 bags while revenues fell from 26.7 million EUR to 14.1 million EUR (Figure 13). This is a rare example in which a tax increase led to such a great behavioral response. After one year (2007-2008) tax revenues fell after the rate increase indicating once again a strong and revenue-reducing response.

Figure 13: Tax revenue development of Plastic bag levy in Ireland 2002-2012



Source: Own figure based on (OECD 2014b) calculated with the assumption of a stable populace

It is noteworthy, however, that the tax implemented in March 2002 is not Pigouvian in character – there was no attempt by the Irish government to identify the marginal external costs of plastic bag usage and determine the optimum (Pigouvian) level of a tax. Instead, it was explicitly aimed at changing consumers' behavior, and stimulating them to avoid paying by bringing their "permanent" reusable shopping bags with them (Convery, McDonnell, & Ferreira, 2007b; Department of the Environment, Community and Local Government, 2014). The Irish plastic bag levy was readily accepted and proved to be very popular (90 % support rate), as it was complemented with a good communication strategy. Administrative costs were limited as the Irish used existing VAT structures to collect the tax. However, it should be noted that the success of this levy should be attributed to its success in changing behavior, while the generated revenue was a welcome side effect (Convery et al., 2007b).

Summary

The case of the UK fuel tax and the Irish levy on plastic bags are useful examples to illustrate the key concepts of potential EFR revenues, namely: The breadth of the tax base, and its elasticity with respect to the tax rate.

[34] Irish based importers estimated the value of the tax at an average rate of 1,5 % per bag (OECD, 2006).

In practice, however, EFR revenues rarely live up to their full potential, because in many cases reductions and exemptions are granted for various reasons. The next step of the conceptual framework will deal with this issue.

4.2 Net EFR revenues: EFR revenues after the reduction of subsidies in the form tax expenditures such as exemptions and reductions

The potential of EFR revenues is often undermined by various and often perverse subsidies to certain producers and consumers (UNEP, 2010). While the reasoning and goals behind some of these may be sound, the following section will describe their fiscal justification, their effects on revenues within the conceptual framework, and lastly explain why they should be avoided.

Exemptions, reductions and political meddling

From an environmental perspective, tax exemptions and reductions for certain actors are counterproductive as long as they do not relate to environmentally-friendly activities or technologies. This makes intuitive sense, since the environment does not care who damages it. The environmental damage or externality is equally strong irrespective of its source, which is why the tax-induced price increase internalizing the externality should affect everyone equally.

However, there are fiscal, economic and equity reasons to compensate or support certain actors in the face of increased prices resulting from EFR measures. EFR instruments sometimes have regressive effects, meaning that they disproportionally affect poor consumers, and there is an equity case to compensate vulnerable consumers and facilitate behavioral responses to increasing prices. For instance, the US spends around 3.0 billion EUR per year on its Low Income Home Energy Assistance Program and California exempts schools from fuel taxes worth 10 million EUR per year (OECD, 2012; U.S. Department of Health & Human Services, 2014). Ideally, however, these measures should ensure, that consumers experience the incentive effect of EFR measures and are compensated in other ways, e.g. elsewhere in the tax system.

The most common exemptions and reductions, however, are not to assist low-income consumers but rather to support businesses, who claim that their (international) competitiveness would be undermined if they were forced to pay the full amount of an environmental tax. Given international competition, it is sensible, also from an environmental point of view, not to tax businesses to a level which forces them to relocate to countries with lower environmental tax burdens.[35]

Revenue considerations also shed some light on why it may make sense, from a fiscal perspective, to grant lower tax rates to some groups than others. We showed before, that potential revenues depend on equation (1),

$$(1)\ Revenue_{potential} = (1 - \varphi_{normal}) \times Q_{total} \times t_{normal}$$

where the elasticity with respect to tax increases is described by (2)

$$(2)\ \varphi_{normal} = f(t_{normal}, P).$$

Now suppose that there are various consumer groups, which react very differently to tax increases. For instance, it is rather difficult for domestic households to substantially decrease their heating consumption. A few industrial consumers of heating energy, on the other hand, are much more sensitive to price increases, as they can change production methods or move production abroad[36] more easily. Therefore $\varphi_{industry}$ tends to be much higher than $\varphi_{household}$. Now if it is possible to discriminate between these groups, it may be sensible to offer them different tax rates, just as a price discriminating monopolist would like to

[35] However, an important restriction is that this applies only to globally relevant emissions such as CO_2. For locally harmful externalities, such as air pollution this does not hold true.

[36] Note that one should distinguish good and bad behavioral effects. Motivating actors to switch to more environmentally friendly productions methods may be a welcome effect, which decreases the tax base, while inducing the same actor to use less energy because she is moving production abroad is not desirable; both from a fiscal and an environmental perspective.

offer different prices to various consumer groups. If elasticities vary and if revenue maximization is the goal, it is sensible to offer lower rates for the most elastic groups.

In our conceptual framework, we subtract the revenues lost by reductions and exemptions from the potential EFR revenues. Equation (3) describes the **value of lost revenue** due to reductions. It is important to understand that the value of lost revenue decreases as $\varphi_{reduced}$ increases. This means that if elasticities for certain groups are very high, it may be cheaper (or at some point even beneficial) to offer them lower rates.

(3) $-(1-\varphi_{reduced}) \times Q_{reduced} \times (t_{normal} - t_{reduced})$

Equation (4) describes lost revenues due to a tax exemption, which is nothing else than a tax reduction with a reduced rate of zero.

(4) $-Q_{exempt} \times t_{normal}$

This line of reasoning explains the fiscal rationale behind giving subsidies to certain groups. However, there are good arguments to refute these claims. First of all, as indicated above, the environment does not care who or what damages it. We have shown that Pigouvian tax rates are foremost market-correcting, which overrides the fiscal logic. Choosing to subsidize groups with elastic demands by giving them exemptions and reductions damages the environment the most, since as we have seen, these groups tend to react most strongly to price decreases and therefore increase their environmentally harmful behavior relatively more than any other group if prices are not set to the right level. Also, if the goal is to reach environmental targets, it may actually be useful to first target those who react most quickly to price increases as this indicates the ease with which they can stop doing environmental harm. Generally companies should go out of business if they cannot compete with energy properly priced. This will ensure and promote an efficient allocation of resources across sectors over the longer term. The argument of carbon leakage (industries moving to low-tax countries) is, if at all, valid only for a small group of about six industries which have both: high energy costs and strong international competition. It is mainly: Lime, cement, iron steel/aluminum, refined petroleum, fertilisers and nitrogen, starches, pulp and paper and basic chemicals (Michael Grubb 2012) (Dröge et al., 2009).

However, there are remedies through compensatory measures, which have clear advantages over tax breaks. Exemptions and reductions are further unattractive for administrative and political reasons. Each exemption and special treatment of a tax increases its complexity and therefore its administrative costs and opens the door for rent-seeking behavior.

It is not easy to accurately discriminate between those, who “deserve” (based on a defined reason) a tax exemption and those who do not. Offering a lower tax rate for actors, who fulfill certain criteria (e.g. indicators showing that their international competitiveness is threatened), often has the effect that firms will try to shift their behavior to fulfill these criteria. This distorts markets in unpredictable ways.

An excellent example of this is the reduction in the German Renewable Energy Charge (EEG-Umlage) for energy intensive firms. Firms qualify as energy intensive if their share of electricity costs compared to gross added-value reaches 15 %. The reduction in charges was attractive enough so that many firms, who did not previously qualify, tried to meet this standard. One accounting trick to reduce gross added value was to reclassify full-time employees as external contractors, which increased the share of electricity costs to the desired level (Eder & Wetzel, 2013). As actors try to qualify for exemptions, governments tend to adjust their rules to make circumvention more difficult. This tends to provoke situations in which intensive lobbying leads to a constant readjustment of tax rates and bases. With exemptions in place such behavior becomes more likely, which generally destabilizes revenue flows and guarantees political complexity.

In spite of this problem, broad environmental taxes, such as electricity taxes, are often designed with ample exemptions for those groups best able to shift the political balance in their favor. This complicates matters from a revenue perspective, as the case of the German electricity tax below illustrates.

Case 5: Reductions, exemptions and political interference in the German Electricity Tax

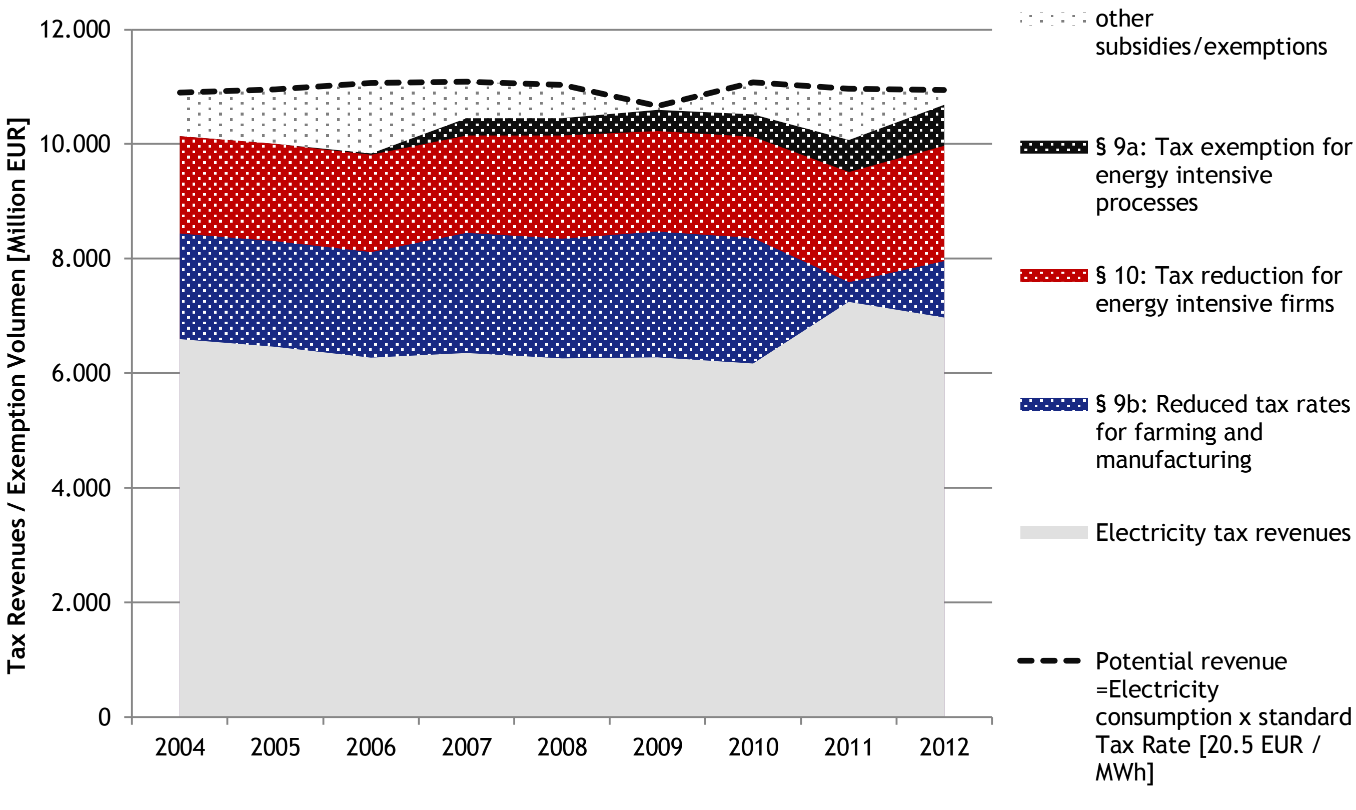
The German electricity tax (Stromsteuer) is structured as a quantity tax, with most consumers paying the maximum normal rate of 20.5 EUR/MWh. In 2012 final net electricity consumption stood at 534 TWh. If all consumers paid the full rate, (potential) revenues would amount to 10.7 billion EUR (revenue = tax rate x quantity). However actual revenues amounted to only 6.9 billion EUR.

Three exemptions explain most of the shortfall.[37]

1. First, certain producer groups such as farmers and the manufacturing industry pay a reduced rate amounting to 75 % of the normal tax (§ 9b StromStG: Allgemeine Steuerbegünstigung).
2. Second, energy intensive firms only pay 10 % of the tax after a certain threshold of tax payments relative to the firm's labor expenses is reached (§ 10 StromStG: Spitzenausgleich).
3. Third, electricity used for certain processes, such as electrolysis or chemical reduction, are completely exempt from the tax (§ 9a StromStG).

Figure 14 shows how these exemptions compromise tax revenues. In 2012, these three exemptions decreased revenues by 3.7 billion EUR, which is equal to 35 % of the total potential tax revenue without exemptions (see Figure 14).[38]

Figure 14: German Electricity tax revenues and the value of tax exemptions and reductions



Source: Own graph based on (BDEW, 2014; Bundesregierung, 2013)

The German electricity tax provides some good examples for political interference influencing EFR revenues. In order to pass the ecological tax reform, which included the electricity tax, some exemptions were needed to overcome political opposition from business groups. This became evident when a first draft of differently designed tax reductions met with negative reactions from affected sectors, while a second version, with differently designed tax reductions, met with higher levels of political acceptance.

37 There are further exemptions for environmentally-friendly technologies such as cogeneration of heat and power with a net efficiency of at least 70 %. However, they matter less in revenue terms and are not included in Figure 14.

38 Note that for simplicity, we assumed that charging everyone the full rate would not lead to behavioral responses. In reality, potential tax revenues would likely be somewhat lower as the now privileged groups would reduce consumption.

Two examples of these reductions are the reduced rates for certain producer groups (§ 9b – **blue area** in Figure 14) and the lowered rate for energy intensive firms (§ 10 – **red area**). Tax rates and revenues from the electricity tax increased until 2003, after which rates remained constant. From 2006-2010, revenues declined slightly due to political interference (see grey area). Business lobby groups successfully used the implementation of the EU Energy Tax Directive (2003/96/EC) to obtain a tax exemption for certain industrial processes (§ 9a – **black area**). The decline in revenues from 2006-2010 (**grey area**) is fully explained by the increase in exemptions for industry (see **black area** in Figure 14).

In the course of fiscal consolidation in 2010 in the wake of the 2007-2008 financial crisis, the opposite was implemented: As government needed extra income, it decided to charge farmers and manufacturers a higher rate (75 % of the normal rate instead of the previous 60 % - see **blue area** for § 9b) and also decreased the reduction for energy intensive firms, which now had to pay 10 % instead of 5 % of the tax for electricity above the threshold (see **red area** for § 10). The effect can be seen most clearly in 2011, where revenues increased substantially (by over 1 billion EUR), while the volume of exemptions decreased by 1.5 billion EUR (FÖS, 2010).[39]

This episode in the German electricity tax is also useful to illustrate revenue effects, which are very difficult to foresee in the design of environmental tax reform. Reducing exemptions to the energy tax by reducing the general reduction in rates for certain groups (**§ 9b**) and reductions for energy intensive firms above a certain threshold (**§ 10**) would be predicted to result in increased revenues, as the volume of exemptions decreased for both groups. However, the volume of exemptions for energy intensive firms (**§ 10**) increased by 13 % from 2010-2012. The reason for this increase is an interaction between the two tax exemptions:

The changes in **§ 9b** meant that farmers and manufacturers now paid 3 EUR / MWh more in taxes, i.e. 15.3 EUR instead of 12.3 EUR, increasing their expenditure for electricity taxes by 25 %. This increase led to a situation in which some of these firms now had tax payments high enough to pass the threshold and qualify for the exemption for energy intensive industries from **§ 10**, meaning that above the threshold they were now only paying 10 % of the normal tax rate (or 2.05 EUR / MWh). This effect was large enough to outweigh the rate increases from 5 % to 10 % for electricity consumed above the threshold for these firms.

There are countless examples of subsidies in the form of exemptions and reductions. According to an OECD study, tax revenues from coal, coke, heavy fuel oil and electricity production are generally “close to zero” (OECD, 2001). While they may be necessary for political reasons, there are good reasons to minimize the scope of such subsidies as much as possible. Not only do they decrease revenues, they distort consumer decisions, thus delaying structural change, and they incentivize environmentally harmful behavior, often for precisely those groups that cause the largest amount of damage.

Until this point we have looked at EFR in isolation, ignoring the outside effects an EFR instrument might have. However, it is crucial to extend this analysis and look at the potential revenue effects of an EFR on other government revenues.

4.3 Interdependencies with raising other revenues

We have seen that it is quite uncommon for an increase in the tax rate to provoke such a strong behavioral response that it leads to a sharp decrease in revenue, as happened in the case of the Irish levy on plastic bags. However, nothing has been said about the effect on other tax revenues. Therefore, our analysis will now turn to effects of an EFR more inclusively, and ask how other revenues are affected by such an instrument.

Consider a situation in which a government decides to introduce a broad-based air travel tax on CO_2, which increases the cost of kerosene. While this tax would surely raise revenue by itself, one should consider the broader effects of this tax. Ceteris paribus, one would expect air travel to decline. This would decrease tax revenues from payroll taxes and corporate taxes from the airline industry. The effect on tax

39 Part of this increase was due to a one time change in calculation methods, which is why the revenues and the volume of exemptions decreases slightly from 2011-2012.

revenues on corporate profits is clearest, as profits will decrease due to higher fuel taxes, which in turn lowers the tax base for profit taxes. Furthermore, if other excise taxes, such as the German ticket tax (TU Chemnitz, 2013), exist, their revenue would drop in line with the behavioral response away from air traffic.[40]

However, the effect on general revenues could be balanced out. Some potential passengers of air travel may substitute a domestic vacation for their international trip. Accordingly, tax revenues from domestic tourism would rise. At the same time, economic activity may shift to other forms of transport, which then grow and balance the losses from payroll and corporate taxes from the airport industry. It is therefore impossible to say from the outset if external revenue effects are positive or negative.

Another often-mentioned interaction effect of EFR instruments is that with general consumption- or value-added taxes (VAT). Some argue that as the price of a said fuel is increased, the government not only increases its revenues through the environmental tax but also through value added taxes, which are measured as a percentage of the price. For example assume that the price of fuel rises from 1.50 EUR/liter to 2 EUR/liter due to a new fuel tax worth 0.50 EUR/liter: If a government levied VAT at 20 % on all goods including fuel, the argument goes, it would make an extra 0.10 EUR/liter as a result of the price increase. This argument, however, is misguided in terms of revenues. Assuming that VAT is collected from all commerce, one must take into account that the extra income spent on fuel in this case will not be spent on another product from which VAT would have been collected. So, while more VAT is collected at one point, it is lost at another. We would only expect effects on VAT revenues, if the EFR instrument leads to a situation in which more/less income is now spent on products which are taxed with higher/lower VAT rates.[41] This effect can be assumed to be small and has to be analyzed on a case by case basis.[42]

A clearly negative effect on general revenues exists if an EFR payment can be deducted from other taxes. A 100 % deduction of an EFR payment from a different tax base would not raise any additional revenue, as long as the deduction is taken up by all actors. For example, energy taxes are usually counted as an expense of a company and hence they are deductible from the profits and therefore reduce the profit/corporation/income tax base. However, if for instance profit taxes are at 20 %, then 20% of the energy tax collected from this firm, is lost due to the deductibility of this expense from the firm's profits. While deductions should be taken into account, at this point we are more concerned with rather subtle behavioral effects. The revenue effect of these is very difficult to estimate empirically, since the effects are usually small and go through many interactions. Therefore, they should first be understood conceptually and integrated within the developing framework.

Equation (1) shows that external revenues, which are the difference between total revenues and the revenue from our EFR instruments, may be affected from introducing the EFR instrument.

$$(1)\ -\sigma \times (Revenue_{total} - \ real\ Revenue_{EFI})$$

The external revenue effect depends on σ, which can be positive and negative. Equation (2) defines this variable very broadly, as it describes the external revenue effect as a consequence of the behavioral response resulting from the EFR instrument.

$$(2)\ \sigma = f(behavioural\ response)$$

Economic literature offers theoretical considerations, which guide us in understanding the external revenue effects of EFR. Fullerton (1997) asks us to imagine a world, in which all government spending requirements are met by an optimal Pigouvian tax, which does not distort the economy. At this point raising tax through distortionary taxes on labor or capital would damage overall welfare. Now assume that revenue requirements for public goods increase to a point, where distortionary taxes are necessary. Then

40 One can think of these revenue effects as fiscal externalities of a tax (Lawson, 2013).

41 This effect is probably more significant in developing countries, since a larger share of spending is VAT free. This is mostly owed to the large size of the informal sector, which tends to operate outside VAT enforcement.

42 An important assumption in the former case is that households have the same income and do not reduce their savings. If we relax this assumption and assume that they reduce savings then additional income is spent and hence also VAT revenues tend to increase depending on the size of the additionally spent money.

Fullerton asks: "If the government's revenue requirement increases so that distortionary taxes are now necessary to raise additional revenue, will it be optimal to raise the tax on the polluting, or 'dirty,' good by more, or by less, than the tax on nonpolluting, or 'clean,' goods?" The answer to this question depends on the elasticity of the Pigouvian tax base as well as the surrounding tax system. Generally one can say that with a view to general revenues, environmental taxes should be higher the more inelastic its tax base and the less efficient the general tax system is. However, there are some further effects, which should briefly be illustrated.

The **effect of an environmental tax on productivity** and therefore on external revenues can swing both ways. An environmental tax could decrease productivity, by forcing companies to use less effective technology in production, which in turn would negatively affect overall revenues. On the other hand, Williams (2002) evaluates a model where pollution negatively affects health and labor productivity, which would decrease external revenues. He finds that there is significant scope for what he calls 'benefit-side tax interaction effects,' or more generally for green tax reform, to produce environmental net benefits as well as reduced distortions in the tax system (Williams Iii, 2003; Williams III, 2002). Since a pollution tax could decrease morbidity and mortality and therefore increase the labor supply, it could enlarge the base of taxable income. At the same time, lower health costs imply lower demand for medical care, which again narrows the external tax base and depresses optimal rates (W. K. Jaeger, 2002; Koç, 2007; Lans Bovenberg & de Mooij, 1997). Considering these examples, it is impossible to generally predict EFR effects on productivity, since the various effects need to be examined on a case by case basis. However, one should bear in mind that much of these considerations will have to remain theoretical, since it is extremely complex to model these subtle effects in a reliable manner.

Another key question in evaluating effects on external revenues relates to assumptions about **individuals' preferences**. If the environmental tax is on a pollutant, which is a complement to leisure, then the tax will generally enlarge the tax base and reduce distortions. For example, West and Williams (West & Williams III, 2007) find that gasoline and leisure are complements, so that raising the price of gasoline can be expected to increase labor supply (and consumption), causing a fiscal welfare gain in addition to an environmental welfare gain.

The last and maybe most important factor for EFR effects on external revenues is the **efficiency of preexisting tax programs**, because the "introduction of an environmental tax inadvertently also makes the overall tax program more efficient" (W. Jaeger, 2012). If EFR revenues are used to lower other distortive taxes, this can improve the efficiency of overall tax programs. Parry and Bento (I. W. Parry & Bento, 2001, 2000) find that gains from a Pigouvian tax reform are significantly larger if revenues are recycled to reduce labor taxes because the preexisting inefficiencies in the tax system distorted consumption decisions and factor markets.[43]

The discussion shows how complex it is to make general statements about the external revenue effects of EFR instruments. Since they can be potentially large, they should be evaluated for each case individually, however one should be careful about drawing the wrong conclusions. As a rule of thumb, the tax rate should equal the Pigouvian rate, because up to this point taxes are being raised, while correcting and not distorting the economy. Whether an EFR rate should possibly be higher than the Pigouvian rate depends on its fiscal merits irrespective of its environmental effect. That is: if external fiscal effects are positive or if the tax is raised on an inelastic base and is comparatively easy to administer and collect, one may want to use it for fiscal purposes that go beyond its environmental goals.[44]

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43 According to them the optimal rate is still the Pigouvian rate.

44 The one possible exception to this line of reasoning is, when environmental taxes produce significant co-benefits that are not likely to be fully internalized through other policies in the foreseeable future. In this case tax rates above the Pigouvian rates can be optimal. I. Parry, Veung, & Heine (2014) estimate that carbon prices in countries with co-benefits would be quite substantial, before even counting climate benefits(e.g., because of the health co-benefits from reduced air pollution).

4.4 Development of revenues over time

Having discussed effects on external revenue effects, we now turn the analysis to the development of EFR revenues over time. There are two reasons why real EFR revenues are expected to diminish over time. An EFR generally increases prices of pollutants, giving market participants an incentive to substitute away from them. However, in the short run it is generally more difficult to change behavior, as for example it takes time for consumers to buy more energy efficient cars and housing appliances. In the short run they can only choose to use them less, while in the long run they can adapt and substitute more easily. From a fiscal perspective, this means that elasticities with respect to taxes increase over time. This means that revenues will shrink as actors move away from the tax base.

Additionally, since most taxes are quantity taxes, their real value is diminished by inflation unless they are continually adjusted upward. We will first describe this effect and then move to broader behavioral effects over time.

4.4.1 Devaluation of quantity taxes through inflation

In the case of **quantity taxes**, the tax rate is externally set by government for a specific physical unit (e.g. EUR/MWh). This means that real government revenues decline over time, unless rates are continuously adjusted for inflation. Within the conceptual framework this means, that the potential EFR revenue is decreased by inflation each year. Equation (1) shows this effect.

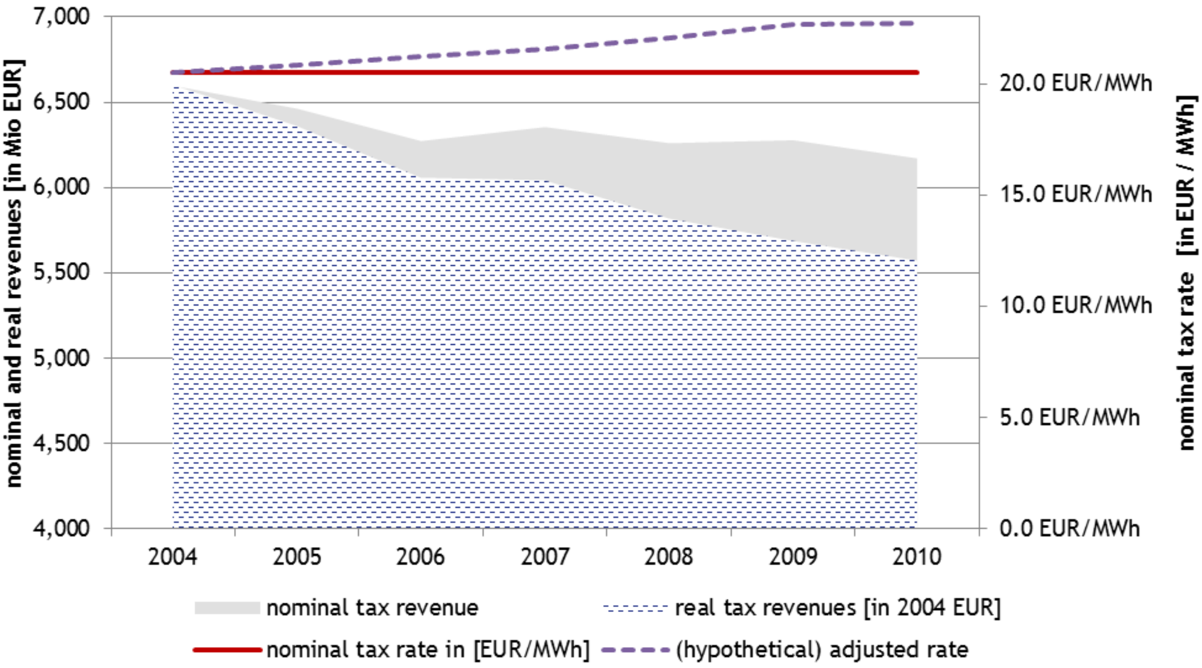
(1) $-\{real\ Revenue_{EFI}\} \times \left\{1 - \frac{1}{(1+\pi)^{(t)}}\right\}$

At an annual inflation rate of 3 %, this means that an unadjusted quantity tax loses over 25 % of its real revenue value every 10 years. This effect is illustrated in the following example.

Case 6: Inflationary effect of a quantity tax - Germany's electricity tax

In April 1999 the German tax on electricity was introduced as a part of the German green tax reform. In the first four years the tax rate was readjusted several times and newly determined after the European currency reform. In 2003 the tax rate was fixed to 20.50 EUR per MWh, which is still valid in 2014. From 2004 to 2010 electricity consumption remained very stable and amounted to about 520 TWh per year, except for 2009, when a decrease of 30 TWh occurred as a result of financial crisis in 2008. At the same time nominal tax revenues decreased slightly starting at 6,597 million EUR in 2004 and ending at 6,171 million EUR in 2010. **Real tax revenue** (in 2004 Euros), however **declined more significantly**, as it dropped from 6,597 million EUR in 2004 to 5,569 million EUR in 2010 (see Figure 15). After 6 years, the lost revenue due to inflation in the year 2010 amounted to 602 million EUR or 9.8 % of total revenues. As shown in Figure 15, nominal rates would have had to rise to 22.7 EUR / MWh (an 11 %) increase, in order to keep real revenues unaffected by inflation.

Figure 15: German electricity consumption and electricity tax revenue development 2004-2010



Source: Own graph and calculations

Maybe an even more striking example is the U.S. federal fuel tax. This tax has been frozen at a nominal rate of 18.4 US cents/gallon or 4,86 cents/liter since 1993. Given official inflation figures, the real value of this tax has eroded to 11,1 cents/gallon (in 1993 USD) until 2013. This means that over 20 years it has lost roughly 40 % of its value. Since revenues are earmarked for the Highway Trust Fund, this fund has come under increasing pressure eroding the quality of road infrastructure in the U.S.

The examples illustrate that automatic inflation adjustment of quantity taxes makes sense for two reasons. First, fiscal revenues are not eroded over time. However, more importantly, the behavior correcting effect of the tax does not lose its bite, which happens when tax rates are continuously devaluated. Therefore it is advisable to design a tax in a way that gives certainty to all involved actors, to what extent and at what, time tax rates are adjusted upwards (see case 3 above on the UK fuel duty escalator). Depending on the situation, this could be done annually or over longer periods, such as 5 years in order to interfere with tax rates less frequently. Likely an annual adjustment is more adequate to avoid some perverse behavior such as buying a lot of fuel before a large discrete jump in the tax rate.

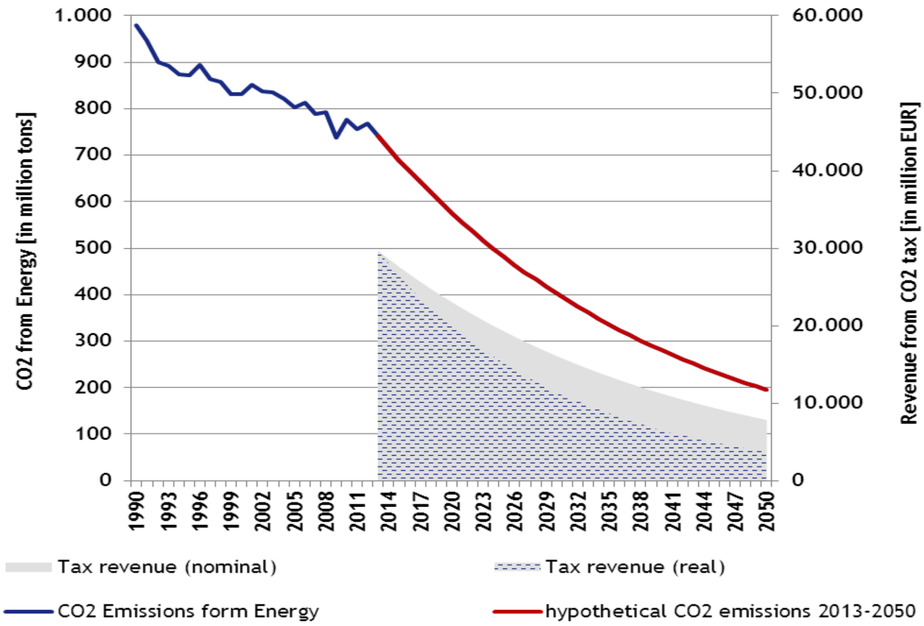
4.4.2 Revenue loss due to increased behavioral response over time

If an environmental tax is set at the Pigouvian rate, one would expect the environmentally harmful behavior to decline to an optimal level. As we have seen, tax revenues are created and depend on the tax rate, as well as the behavioral effect due to the price increase (elasticity). The higher the elasticity, the greater the response, and the lower the tax revenues raised. This would suggest that after a tax is introduced, behavior would adapt and then stay constant, along with (nominal) tax revenues. However, as described above, behavioral responses increase over time as innovation makes substituting away from the tax base cheaper and easier.

Estimations suggest that the price elasticity for energy varies between -0.13 and -0.26 in the short run and between -0.37 and -0.46 in the long run (European Commission, 2007). Considering that the behavioral response doubles over time, it is only reasonable to assume that the tax base and accordingly the revenues will slowly vanish. Within the conceptual framework, one can think of this effect as an increase in the behavioral response φ as time passes.

Figure 16 shows the declining revenues (nominal and real) for a hypothetical case, in which a 40 EUR / ton CO_2 tax leads to a 75 % reduction in emissions between 2013-2050 (dropping from 750 Mio tons CO_2 to around 200 Mio tons CO_2). It is assumed that the real tax rate stays flat, while the behavioral response increases as technology and behavior evolve. The initial tax revenues from the CO_2 tax (assuming no exemptions and full compliance) would amount to 30 billion EUR in 2013. However, tax revenues would fall quite drastically over time. As Figure 16 shows, nominal tax revenues decrease due to the fact that the tax base (CO_2 emissions from energy) declines, as producers switch away from CO_2 intensive energy production (behavioral change).

Figure 16: German CO_2 emissions and tax revenue from a hypothetical tax on CO_2



Source: Own graph and calculation

If governments find themselves at a point where substantial revenues are being lost due to behavioral responses, it may either adjust rates upwards, if the tax base is fairly inelastic and if the EFR instrument is advantageous from a fiscal perspective, or it may choose to find broader tax bases to raise revenue for its funding requirements. One idea in this hypothetical situation would be to switch from a tax on CO_2 to a broader tax on energy, including energy from renewable sources, simply to stabilize important revenue streams. While this behavioral time effect is crucial from an environmental perspective, it is less important from a fiscal perspective because such behavioral effects are rather slow and foreseeable. If governments notice declining trends in EFR revenues, they usually have plenty of time to react to secure their revenues.

4.5 Administrative perspective on the revenues of environmental taxes

In order to evaluate the net revenue potential of an EFR instrument, i.e. the revenue left, after all costs have been paid, it is necessary to look at the administrative cost of an EFR instrument. Generally EFR revenues have low administrative costs. Taxes on petroleum products are usually levied on a limited number of petroleum refineries and depots, and are hence relatively simple to administer and enforce. For instance, the administrative costs of the ecological tax reform in Germany are estimated to comprise just 0.13 % of the revenues raised (OECD, 2006). Several examples also indicate that the administrative costs of a scheme involving a large number of tax payers can be kept at relatively modest levels. Administrative considerations should enter the discussion at the stage of policy design, as good administrative choices can minimize bureaucratic costs. Within the conceptual framework one can think of administrative costs as reducing net revenues by (1):

(1) $-\ C_{admin}$

The administrative costs are a function of a government's administrative efficiency (2) with respect to the EFR instrument in question.

(2) $C_{admin} = f(administrative\ efficiency)$

One should think of administrative efficiency as the bureaucratic cost per unit of tax revenue. The fundamental administrative challenge from a revenue perspective is to maximize revenue while minimizing administrative costs. Efficiency increases as costs per unit of revenue decreases. The first simple insight from this consideration is that **administrative efficiency increases with the size of revenues**. An EFR instrument, which is aimed at a very esoteric problem and generates small revenues, would not be efficient from an administrative point of view, simply because bureaucratic structures would need to be built up for a small stream of income. Therefore it is important to look for proportionality between administrative expenses and the amount of collected revenues. Second, administrative efficiency decreases with the amount of complexity an EFR instrument generates for the processes of **assessing**, **paying & collecting**, and **monitoring & enforcing** payment of revenues and essentially depends on the administrative capacity within each country.

4.5.1 Assessing, paying & collecting, and monitoring & enforcing EFR payments

In order to project and later control tax revenues, governments need to **assess** the expected amount of revenues. Box 2 explains how taxes are estimated in different countries. The ease of measuring EFR tax bases can be one key argument for their introduction, especially in developing countries, because governments usually have access to solid data on the amount of imported fuels or the amount of electricity produced. In comparison, in countries with large informal sectors, it may be much more difficult to assess the tax base for an income tax or a broad VAT tax than it is to assess the amount of petroleum used in a given year.

However, measuring the tax base becomes more complex the more exemptions and reductions are granted to certain groups. Exemptions add complexity to all administrative processes. In the case of assessing taxes it complicates matters, as with exemptions it is not enough to estimate the size of the tax base, because one also needs to estimate how much of the tax base is used by various groups who are privileged in different ways.

Box 3: Estimating tax revenues

Estimating tax revenues:

There are several tools available for policy makers to estimate tax revenues, starting from simple spreadsheet models to more sophisticated computational models. Methods and procedures for revenue differ between countries.

In Germany, tax estimation is handled by a working group, "Arbeitskreis Steuerschätzung", which consists of eight parties including the German Ministry of Finance, the German Ministry of Economics, economic research institutes, the Federal Statistical Office and the Federal Bank of Germany. In Austria, only two parties, the Ministry of Finance and one economic research institute are responsible for the estimation. In the UK, the treasury department and revenue office are responsible for the projection, whereas in Canada the estimations of four economic research institutes are averaged (German Ministry of Finance, 2008).

Professionals differentiate between **direct** and **indirect methods** of estimation. **Direct methods** are exclusively based on observed developments in the past. They are primarily useful for short-term estimations, as they do not take exogenous factors into consideration and simply try to project the development of a trend based on past movements. Projections can be calculated deterministically, i.e. using statistical trend regressions or purely algebraic methods or stochastically, e.g. using the Box-Jenkins[45] method (Berberich, 2012).

Indirect methods take exogenous factors, such as the effect of economic growth on the tax base, into account. They are more complex because they need solid data and sophisticated modelling to estimate the relationship between various exogenous factors on the tax base. They are usually applied to taxes, which strongly depend on economic developments and need explanatory variables and forecast values (Berberich, 2012).

Indirect methods usually use the predicted cash tax revenue as the dependent variable. This process includes macro simulations, econometric models and the elasticity method.[46] Micro simulations, on the other hand, use a two-step process. In a first step the tax-base is estimated in detail[47], making it possible to separate the tax base into groups, which may qualify for certain reductions and exemptions. In the second step, the tax base is multiplied by the various tax rates (Berberich, 2012). These simulations consider the tax rate and provisions for the amount of deduction as well as delays of payments and assessments using Lagrangian functions. The UK and the US use this method for the projection of revenues from corporate income tax (German Ministry of Finance, 2008).

Generally, the estimation of revenues becomes more difficult with the amount of exemptions and special privileges. It is also more difficult to project first time revenues, since there is no historical data to rely on. After a few years, estimations can improve once more data and the factors influencing the tax base can be better understood. Actually one can use revenues to estimate the size of the tax base, if this is not generally known. There is a clear **trade-off** between using crude and simple calculation models and using highly sophisticated models. Simple calculations avoid unnecessary complexity and can, after some time, be good enough to give a good understanding of the likely development of revenues. On the other hand, more complex models, allow governments to understand, which factors influence behavioral change in various groups. For instance, a good model may be able to show whether revenue reductions from a fuel tax are due to a switch to more efficient vehicles or whether they are the result of more cars crossing the border to buy lower-taxed fuel abroad. As such knowledge has important policy implications; they should be used if the necessary infrastructure exists. Good models further allow estimating, which actors are worst hit by the tax, which may be the basis for justified compensation payments.

Perhaps the most important factor influencing administrative efficiency are choices regarding the **payment and collection** of EFR revenues. One important question here is at what point or level of aggregation, a tax should be paid. Environmental and fiscal goals may once again be in conflict. From an environmental point of view, one should try to target and price the environmentally harmful behavior as directly as possible as this leads to efficient abatement. For example, if one raised a tax on the CO_2 content of coal, one

45 Box-Jenkins-method: Box-Jenkins is a mathematical model designed to forecast data within a time series. Considering the differences between several data points, the model alters time series to make it stationary. By doing so, the model is able to pick out trends, typically using autoregression, moving averages and seasonal differentiating in the time series.

46 Elasticity-method: in this context the elasticity coefficients measure the change of tax revenues (for one tax, a group of taxes or the whole tax system) in proportion to GDP. An elasticity of 1.2 therefore means that tax revenues increase 1.2 % if GDP increases by 1 %.

47 Revenues are calculated depending e.g. on the demand elasticities of the tax bases and the sectors as well as the considered time horizon. For instance, demand for transport fuel tends to be less elastic than demand for power fuel. Demand for aviation is likely to be less elastic than demand for road fuel, given that there are fewer options for substitution. Demand for heating fuel is also highly inelastic, since private households tend to have few choices regarding heating consumption as often large investments are required for reductions. This explains why the level of energy consumption follows very much along the variations of temperatures and climatic conditions. Further aspects like the demand in markets with reductions, exemptions, thresholds or side-conditions such as energy management systems, have to be considered, too. All these can lead to quite complex models for revenue calculations which only sophisticated computational models are able to perform.

may be able to collect the tax from coal importers (upstream), or one could tax each coal-fired power plant for their emissions (downstream). The first option is preferable from an administrative perspective since there are fewer coal importers than power plants, which decreases transaction costs per unit of revenue. However, consider that with the first option, there is no incentive to reduce emissions after the coal has been purchased, so a coal-fired power plant would have no incentive to invest in abatement technology such as carbon capture and storage (CCS). If the tax was collected on the final emissions of coal plants, however, the plant has an incentive to invest in abatement equipment. This trade-off has to be evaluated on a case-by-case basis. For instance Flachsland (2011) finds that the suitable point of regulation for a possible inclusion of the transport sector into the EU Emissions Trading Scheme, ETS, is in the up- to midstream of the fuel stream, while Joas & Flachsland (2014) find that the added costs of downstream implementation are negligible in the power sector. Compared to overall system costs, the transaction costs are so small and even the differences between upstream and downstream are so small, that they can reasonably be ignored. For this reason, policy makers may decide rather pragmatically to harness motor fuel and vehicle excises rather than complex road pricing arrangements to control congestion costs (UNEP, 2010, S. 2010). However, the balance of this might shift, once cheap technology for the latter option becomes universally available.

Another aspect regarding the question of payment and collection of revenues is the presence of pre-existing administrative structures, which should be used to limit additional administrative costs.

Case 7: Building on administrative structures in the course of Germany's Ecological Tax Reform

With the law to "launch the ecological tax reform" in 1999 Germany started an ongoing process to green its public finances. At the same time, due to continued European integration, Germany's customs administration was losing tasks, as borders and customs rules continued to vanish. As capacities were freeing up within the customs administration, and because customs bureaucracies are experienced in dealing with large (importing) companies, it was suggested that the administration of the new ecological taxes should be administered by the customs departments.

As a result in Germany, today energy taxes (including all fuel taxes), the electricity tax, the aviation tax and the tax on nuclear fuel are handled by the customs administration. Energy taxes are generally collected at the point of storage or directly from the producing companies. In the case of electricity taxes, electricity producers need to register with the customs office and pay taxes. Since energy and electricity markets are fairly concentrated at the highest level, customs offices only have to collect taxes from a few well-established and professional companies.

Since the customs administration was used to dealing with these kinds of clients, it was very cheap and straightforward to implement the EFR using these pre-existing structures. Using competent and recently available "human capital" to administer new EFR instrument proved to be an effective and highly efficient administrative choice. In fact the energy tax is one of the most efficient taxes in Germany as only around 0.13 % of revenues are used for public administrative expenses.

Since it is possible to use pre-existing administrative tax structures, it may often be cheaper from an administrative perspective to use taxes instead of cap-and-trade systems, which often require a newly built infrastructure and tend to be associated with relatively high administrative costs. For example Denmark has introduced a carbon dioxide tax on certain energy products, but the tax does not require a separate administrative system, but is collected jointly with the VAT and therefore needs no additional administrative structures.[48]

The final administrative challenge relates to the **monitoring and enforcement** of EFR payments. The difficulty of this depends on the one hand on the design features of the instrument and on the other hand on the administrative capacities of various government agencies.

Designing an EFR instrument to price forest resources, for example, it may be preferable to levy a tax over concessionary areas or timber exports rather than trying to enforce a "stumpage" fee, which would

48 For more information see

require the monitoring of large and often remote forest areas (UNEP, 2010). While the design of an EFR should try to limit unnecessary complexity for monitoring and enforcement, it should also consider the competency and honesty of administrative agencies, to ensure that corruption is kept to a minimum. In fact, in some countries administrative capacities and corruption are so problematic that here is a risk that well-intended EFR instruments will have no considerable revenue effect whatsoever. Using established and reliable parts of administration can then turn out to be the most effective approach how to deal with this issue.

Case 8: Lumber royalties in Southern Tanzania

Forests and woodlands cover roughly 40 % of the total land area in Southern Tanzania, and support the livelihoods of 87 % of the low-income population living in rural areas. About 16 % of households from villages located near forests in southern Tanzania benefited from logging and timber trade during 2005. Royalties on lumber amount to around 58.8 EUR per cubic meter or roughly 25 % of export prices. The potential revenues of such royalties are relatively large and were estimated at around 50.4 million EUR in 2005.

However, government has lost the largest amount of potential revenues due to non-collection of royalties and under-valuation of forest products. Indeed, revenue lost by central and district governments due to the under-collection of royalties has reached up to **96 % of the total amount of potential revenue due**. The central government estimated that nationwide losses of revenue to the Forestry and Beekeeping Division amounted nationally up to 48.72 million EUR annually due to the under-collection of natural forest product royalties in the districts. Some district council budgets would have increased by several times over if all potential timber revenues were actually collected. Substantial revenue losses were also apparent prior to and during shipment. For instance, the trade statistics show that China imported ten times more timber products from Tanzania than appear on Tanzania's own export records. This suggests that Tanzania collected only 10 % of the revenue due from these exports (Milledge, Gelvas, Ahrends, TRAFFIC, & Africa, 2007).

This example shows the importance of a sound policy design and functioning mechanisms for monitoring and enforcement to address administrative challenges. It also illustrates the extent to which EFR instrument design should be adjusted and modeled according to the administrative capacities within each country. Avoiding complexity and exemptions in the design of EFR instrument may help to contain these problems. Despite some negative examples, one should keep in mind that many EFR instruments e.g. taxes on transport fuel are generally easier to administer than direct taxes, such as income taxes. This is especially true for countries with very large informal sectors.

4.5.2 Institutional options for EFR administration

In the context of EFR administration it is important to decide which institutional actors should be responsible for the different aspects of reform. Usually the key actors are the Ministry of Finance, the Ministry of the Environment and the Economic Ministries responsible for industries relevant to the EFR instrument.

Generally, the **Ministry of Finance** will be the key administrative agency for EFR measures. It is usually responsible for EFR implementation within the existing fiscal framework, often collects revenues, and sometimes also has a veto on spending. It is therefore crucial to align the goals of EFR instruments with the interests of the finance ministry. It is reasonable to assume that bureaucrats within the finance ministry will tend to approach EFR from a fiscal perspective, which we have explained throughout this report. Therefore, it is important that EFR instruments are designed in a way that makes them an attractive revenue source for the Ministry. Depending on the case, this may mean that one has to make pragmatic decisions in designing instruments in a way that makes them attractive both from a fiscal and environmental perspective.

The **Environment Ministry** often has a bigger stake in the environmental impact of EFR instruments. As we have argued before, if in conflict, environmental goals should have priority over fiscal goals.[49] One should

[49] Note that this conclusion is also rational from a fiscal perspective, as we have explained, because Pigouvian taxes raise revenues without distortions. However, in practice, agents with a revenue perspective still need to understand this point.

therefore give the agent with the biggest stake in achieving an optimal market outcome (i.e. the internalization of external effects leading to a reduced environmental impact) the power to work out the structural design of an EFR. This includes the selection of the tax base, the choice of the tax rate, and development of optimal compensation strategies. In practice, of course, these decisions will be made in consultation with other stakeholders and should take their perspectives into account where possible and feasible, without compromising the environmental objectives of the measure. Additionally, the Environment Ministry should be in charge of evaluating the reform according to both fiscal and environmental performance measures. This is important because in practice, tax rates may have to be adapted to achieve environmental goals.

Economic Ministries responsible for energy or electricity, water, agriculture, trade and industry will generally try to maintain their own power base in the bureaucracy, and may be closely allied with the key interest groups of their constituency (for instance energy producing companies) which may make some forms of EFR difficult (World Bank, 2005). The influence of these Ministries should play a role mostly, when it comes to questions of compensation, because some actors may need support. However, their influence in the design process should be kept to a minimum, since it is often Economic Ministries in alliance with industry lobby groups, who undermine the effectiveness of EFR instruments by demanding an array of exemptions and special privileges. Given the strength of Finance Ministries, it may be useful to use the revenue interest of EFR to bring them on side in discussions with Economic Ministries, who tend to favor exemptions and reductions for their constituents.

Furthermore, it is important to understand the interests of federal and local agencies, which may only support EFR and carry out its enforcement if revenues and responsibilities – or at least a proportion of them – are recycled to them. These questions, however, relate to the governance structures of each country and are not specific to EFR reform but to policy change more generally.

Administrative concerns in EFR reforms are a crucial aspect and should be kept in mind throughout the process of designing and implementing reform. Depending on the instrument in question this may lead to important adaptations. Generally, it can be said that EFR have the advantage of being relatively easy to administer and therefore may prove particularly attractive in those industrializing countries where tax collection mechanisms are not yet highly developed.

4.6 Allocating EFR revenues

At this point we have arrived at the last part of the development of a conceptual framework for EFR revenues. Having calculated the total potential revenues and subtracted revenues lost due to exemptions and reductions, external revenue effects, time and inflation, and administrative expenses, we arrive at the revenue, which is actually available for spending. However, we make one last distinction, namely between generated revenues and those available for free government spending. The difference between these two is the amount of revenue, which needs to be spent to protect the vulnerable and to facilitate transition.

Accordingly, final revenues are further reduced by compensatory spending (1).

(1) $-S_{compensations}$

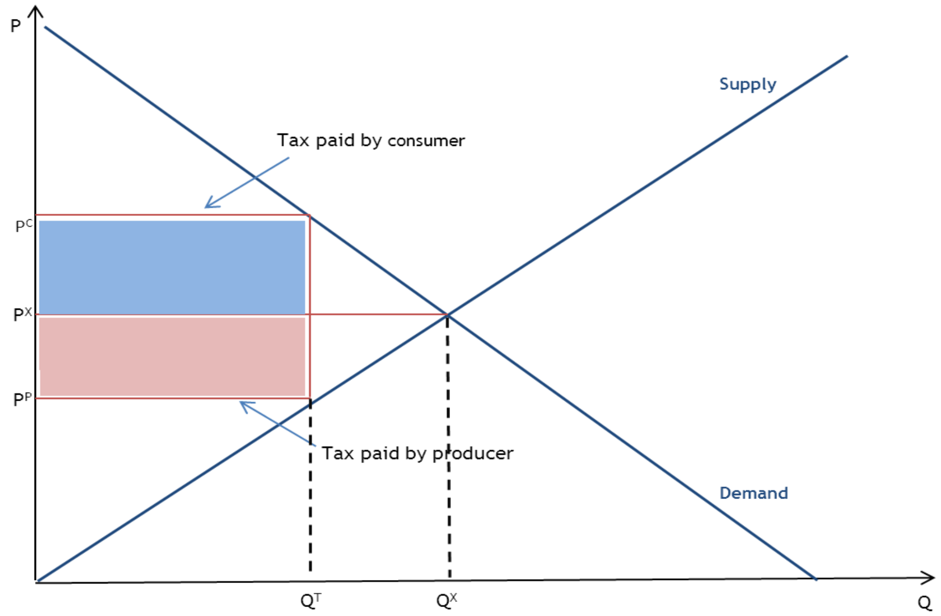
Compensatory spending here is defined as the amount of spending, which is necessary to obtain sufficient political support for EFR. It should be clear that this is a purely conceptual idea, which is impossible to quantify with any degree of accuracy.[50] However, the concept of compensation is important to each policy-maker, who is interested in the revenue potential of EFR, which is freely available for spending. Therefore it is reasonable to subtract the foreseeable compensation spending of an EFR. The necessity for such spending needs to be investigated carefully in each individual case.

50 Estimates of tax incidence on different household and producer groups are often feasible, however, compensation also depends on the political influence of these groups, which is why this variable is conceptual in character.

4.6.1 Compensatory spending

The first step of analyzing possible compensatory spending is to find out, who bears the economic burden of an EFR. The economic burden of EFR instruments tends to be concentrated among actors, who are least-well equipped to change behavior. This has nothing to do with EFR instruments, but is true for taxes more generally.[51] Figure 17 shows that the economic burden of a simple tax is split 50:50 between producer and consumer groups, when their demand and supply is equally elastic.

Figure 17: Tax burden for consumer and producers with equal elasticities



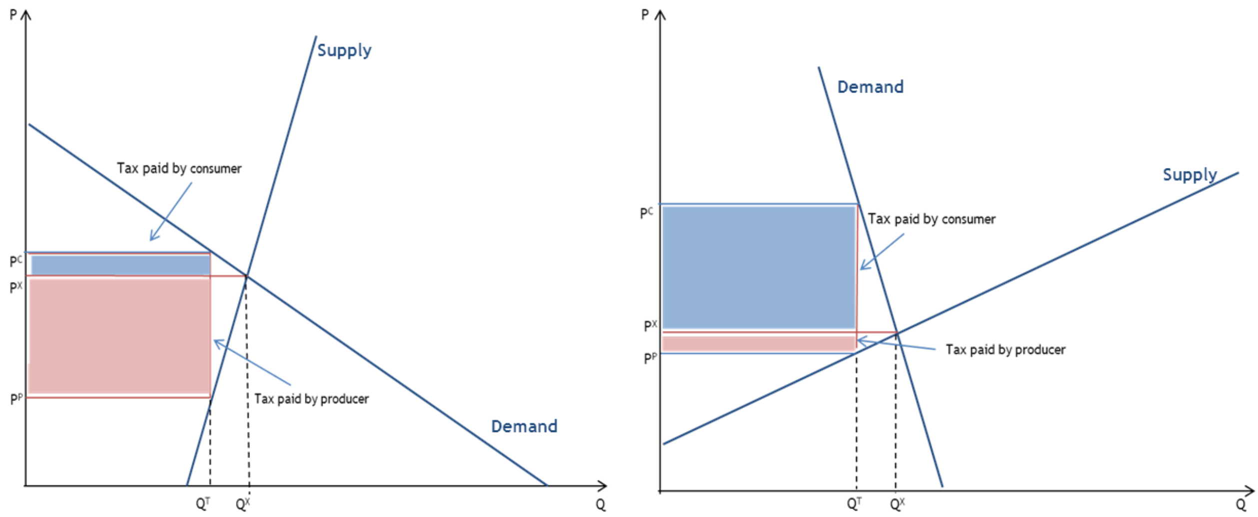
Source: Own graph

However, as indicated by Figure 18 this situation changes, if for example supply is much less elastic than demand (left hand side of the two charts) producers bear a larger part of the economic burden, then producer prices fall much more than consumer prices increase. Such a situation could occur in the case of resource taxes on land use. The supply of land is essentially fixed, while the demand for it is more elastic. If a tax is raised on land ownership or land use for certain purposes, this tax will mostly burden owners of land. Land prices would be expected to change little, given that the willingness to pay for land has not changed. However, the producer price for land would be much lower, meaning that the economic burden of such a tax mostly falls on one group.

While one may see little need to compensate land owners, the situation changes when we look at a situation in which demand is very inelastic. This is the case in domestic electricity consumption, where short term demand is inelastic, because substituting or saving electricity is quite difficult in the short run. In such a situation, the price increase is mostly passed on to consumers, who pay a higher price, while producer prices barely change. Since poor consumers are often least able to substitute away from a tax, for example by using new and energy efficient products, they may be hit the worst.

51 The same is true for corporate tax burdens: Firms, who are least able to evade taxes and shift profits, tend to be most burdened by corporate taxes.

Figure 18: Tax burdens for consumers and producers with varying elasticities



Source: Own graph

This demonstrates that when considering compensatory spending, it is crucial to determine, who is most burdened by EFR induced price increase.

For example, compensatory spending is often necessary due to **equity considerations**. EFR instruments on energy are sometimes regressive, meaning that they have a greater relative impact on low-income households than high-income households. This is simply the case because lower-income households tend to spend a larger share of their income on energy, particularly on heating fuels. For motor fuels the opposite usually applies: Subsidies would favor the rich, but not the poor because the latter hardly own vehicles. Electricity taxes can be progressive too, if the rich have better access to the grid and therefore spend more on electricity as a share of income.[52] Especially in developing countries regressive EFR instruments justifiy compensating or protecting low-income households for their additional EFR burdens (Eskeland & Kong, 1998). The removal of fossil fuel subsidies in Indonesia and its accompanying compensatory spending offers a good illustration of this fact.

Case 9: Fossil Fuel Subsidies in Indonesia

Fossil fuels are generally considered to be a public good in Indonesia. Fuel subsidies are common, despite the fact that Indonesia has lost its position as a net fuel exporter. Government subsidies are paid for electricity, coal, and various fuel products (iisd, 2012). The Ministries of Energy and Finance cooperate to set fuel prices,[53] which are generally below world market levels. The main distributer of oil in the country, Pertamina PT, receives all subsidies and has to give monthly reports about the amount of subsidized fuel, sold, its value and the international benchmark price. Based on these data, the amount of subsidies are calculated (iisd, 2010). Figure 19: Fossil fuel subsidies in Indonesia shows how fuel subsidies have developed. They tend to fluctuate with world market prices and amounted to roughly 16 billion EUR or 17 % of total government expenditures in 2013.

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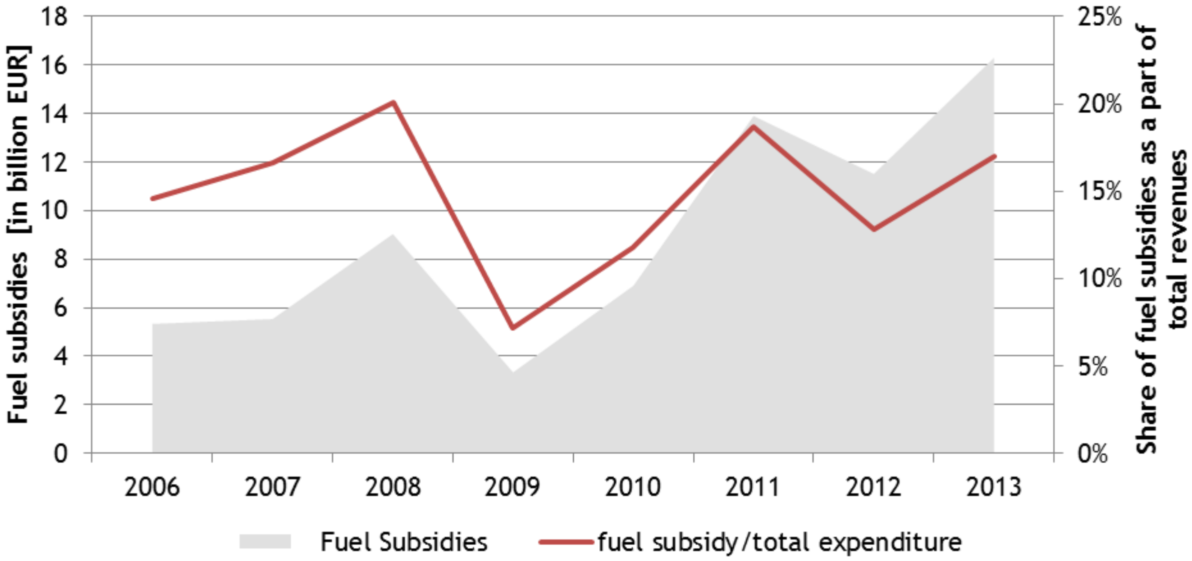
52 It is also of note, however, that often the negative impacts of environmental damage and destruction fall mostly on poorer households. Improving the environment may thus in itself have a progressive and balancing effect, which should be explained and communicated alongside the implementation of EFR.

53 The common “Premium-RON88” has an average price of 1.85 USD per gallon in 2012, compared to e.g. 8.26 USD per gallon in the Netherlands. Only oil exporting countries like Saudi-Arabia or Venezuela have lower fuel prices (iisd 2012).

Figure 19: Fossil fuel subsidies in Indonesia



Source: Indonesian Ministry of Finance (2012)

In 2000, Indonesia tried to reduce fuel subsidies and increased prices for diesel by 9 %, for gasoline by 15 % and for kerosene, which is mostly used for heating, by 25 %. The revenues were recycled to general spending, e.g. in health-care and education (iisd, 2010). Since price increases were mostly felt by Indonesians on low or middle incomes, violent demonstrations, mainly by students, taxi and bus drivers and small entrepreneurs broke out and plans to cut subsidies further were put on hold. In 2005, however, fuel prices had risen substantially, forcing the government to take steps to reduce subsidies. However, having learned from previous mistakes, Indonesia used well-targeted compensation programs to keep the peace. The Indonesian government removed subsidies for industrial users and raised gasoline and kerosene prices by more than 150 % within one year (World Bank, 2012).

Despite this immense increase, opposition against the reform was relatively low, which can be explained through the compensation program Bantuan Langsung Tunai (BLT). Revenues were used to reduce the state budget deficit by 3.78 billion EUR in 2005 and 8.4 billion EUR in 2006 and a cash transfer program to compensate poor households was implemented. All households with monthly fuel expenditures below 175 000 IDR (15 EUR) received monthly payments of 100 000 IDR (8.6 EUR) over six months. 28 % of all Indonesian households received those payments (Widjaja, 2008). Between 2005 and 2006, compensatory spending for the BLT program amounted to 1.93 billion EUR and made up more than 50 % of the added revenues from subsidy cuts in 2005.

The Indonesian case illustrates that while EFR reforms maintain their economic and environmental appeal, one may need to be prepared to recycle large parts of revenues to those who cannot easily carry the burden of higher prices. While compensatory spending may often try to remedy regressive effects of EFR instruments, they can also be issued to obtain political support and maintain the international competitiveness of certain industries. In this case, compensation is often given to companies, which supply goods very elastically, of the concern that it is easy for them to reduce output by moving production to other countries. However, one always has to keep in mind that “Environmentally-related taxation is by definition intended to distort production decisions and have a disproportionate impact on polluters” (OECD 2010a).

In a recent study, concrete steps for an ETR were developed and analyzed. That proposal builds on the mostly good tax bases on local level which indeed are often on natural resources and other environmentally relevant activities. These could be extended and increased while payments from the federal level could be reduced to not increase overall tax burden. Then federal taxes such as on income could be reduced (Schlegelmilch 2011).

The use of Sweden's NO_x -charge is a good case in point. The charge was introduced in 1992 and at current exchange rates amounted to more than 4,000 EUR/ton NO_x. It initially applied to all boilers producing at least 50 GWh meaning that around 200 Swedish power plants were affected. The complete revenue, however, was given back to producers favoring those with the lowest amount of pollution per unit of energy. While this did not raise any revenue, it created an environmental effect decreasing median emissions by more than 50 % within the first 8 years. The Swedish EPA manages the scheme at a small administrative cost amounting to 0.2–0.3 % of revenues. The entire revenue remaining, amounting to about 600 million SEK (about 70 million EUR) per year is refunded to affected companies (Millock, Nauges, & Sterner, 2004). One should note that while this kind of compensatory spending is not attractive from a revenue perspective, it has clear advantages over tax reductions and exemptions, which are more common than outright compensatory spending. First, lower prices, unlike compensatory payments, reduce the corrective incentive of an environmental tax. Second, exemptions and reductions are often obscure and more open to political manipulation, whereas compensatory spending is very transparent and therefore potentially easier to phase out in the long run. Lastly, it makes subsidies to industries more transparent, which is why one should generally favor compensatory spending over exemptions and reductions.

Financing transition costs is another option which clearly requires a closer look. This can be a way to address competiveness concerns regarding firms in other countries who do not face similar taxes. Thereby firms should be targeted, which already take steps to reduce pollution instead of simply return to each polluter the taxes paid (OECD, 2005). Furthermore it is also important that compensations are designed in a way that does not encourage firms to produce more (World Bank, 2005). Revenue recycling might be an effective way to increase acceptability of reforms by industries. For example in China, a combination of pollution taxes and support for pollution abatement expenditures has proved effective.

Compensation to the poor: To compensate poor households for increasing water and electricity prices, in some cases a differentiation in pricing for different types of users might be an effective way to mobilize compensation funds. Thereby it is important to find a way that the poor benefit without undermining incentives for compensation (OECD, 2005). The Case of BLT in Indonesia shows that also cash transfer programs can raise the acceptance of EFR among population.

Having shown that compensatory spending may be necessary for equity reasons, or simply to reduce the political pressure from adversely affected industries, there is usually enough EFR revenue left, which can now be used for discretionary government spending. The next section explains and evaluates some of the spending options.

4.6.2 General spending decisions

At this point of the analysis, we are left with EFR revenues, which can be used to fund any government spending. There is an ongoing debate regarding how EFR revenues should best be allocated (OECD, 2005; World Bank, 2005). However, considering the fact that EFR revenue is, at this point, equivalent to all other revenues, answering the question of how EFR revenues ought to be spend is just like answering the question of how government revenues should be spent generally. It should be clear that there is no straightforward answer. However, there are some spending common spending options for EFR.

Earmarking revenues for green investments

One way to spend EFR revenues is to earmark them for environmental spending. This may be popular, as people understand that their price increases from the environmentally harmful behavior (e.g. driving) lead to investments in public goods related to the environment. If the goal of an EFR is to reach certain environmental targets, green spending can help to speed up the process. If funds are used in this way, tax rates can be comparatively lower if a certain environmental target is to be achieved.[54] However, there are two general problems with this approach.

[54] Modelling results within the COM ETR project (http://www2.dmu.dk/Pub/COMETR_Summary_Report.pdf) showed that emissions reductions could be achieved with substantially lower tax rates if 10 % of revenues were invested in energy efficiency measures, which shows the important interaction of taxing and spending decisions.

Connecting EFR revenues to outright subsidies for certain groups may encourage rent-seeking behavior among the recipients of EFR payments (UNEP, 2010). This may be strategically beneficial since EFR revenues are used to fund a lobby group, which is favorable to EFR and can increase the likelihood of its continuation. On the other hand, recipients might grow dependent on payments and lobby for high tax rates, which may no longer be warranted from an environmental perspective.

The second problem relates to earmarking more generally, which is constitutionally forbidden in some countries. Earmarking generally complicates the budget process, as it invites all sorts of groups to earmark certain revenue streams for their pet spending projects. Earmarking may also prove problematic as revenues raised do not match the need of a particular spending project, as was the case between the UK Climate Change Levy revenues, which were earmarked to fund reduced National Insurance contributions, but which did not raise sufficient revenues (see e.g. Cottrell et al 2013). An earmarked revenue stream is therefore very unattractive from a fiscal point of view, since both politicians and the Finance Ministries generally demand the freedom to allocated revenues according to current requirements (World Bank, 2005).

Chile, for example, considers the legal obstacles of earmarking. There, the UNEP has conducted a project together with CIPMA (Centro de Investigation y Planification del Medio Ambiente) to develop a sustainability fund for the mining sector. This proposed fund would support sustainability issues and serve diversify production, integrate mining companies into the community. It would also conserve water and biodiversity. The financing would be realized voluntarily by public sector and mining companies. However, it would be really difficult to base the fund on taxes because any change in the tax system which includes earmarking would require a presidential decree or a change in the constitution due to a prohibition of earmarking in Chile's constitution.

Environmental tax shift

Recycling revenues to lower other distorting taxes in the economy is a common usage of EFR revenues. The revenues from Germany's environmental tax reform were mostly used to lower pension payments, which were driving up labor costs and causing unemployment. Recycling revenues to lower distortive taxes is often described as the second dividend of EFR, since this step creates wealth by removing existing distortions such as tax-induced unemployment (W. Jaeger, 2012). Using EFR revenues to lower other distortive taxes is surely an attractive option, however to maximize economic welfare, one still needs to identify the most distortive taxes. This is likely to vary between countries. One should be careful, however, to keep in mind the political and communication aspects of this issue. For example, Takeda (Takeda, 2007) finds that strong double dividend effects arise when revenues are recycled by lowering taxes on capital but not on labor or consumption. While this may be economically correct, it may result in undesirable outcomes, such as more inequity and regressiveness within the tax system, as well as being politically dangerous and destabilizing to raise an environmental tax on a large amount of actors and then use the proceeds to lower taxes on capital, which would benefit only a small group of people.[55]

Using revenues for various purposes

While it may make sense to use revenues to decrease distortionary taxes, it is not always the case that lowering taxes has greater benefits than increasing spending or cutting deficits. Economic well-being may be most increased if revenues are used to fund investments in general infrastructure, health, education or transfer programs for low-income households. Another option to use EFR revenues is to finance a tax cut, as was proposed in the 2009/2010 South African budget.

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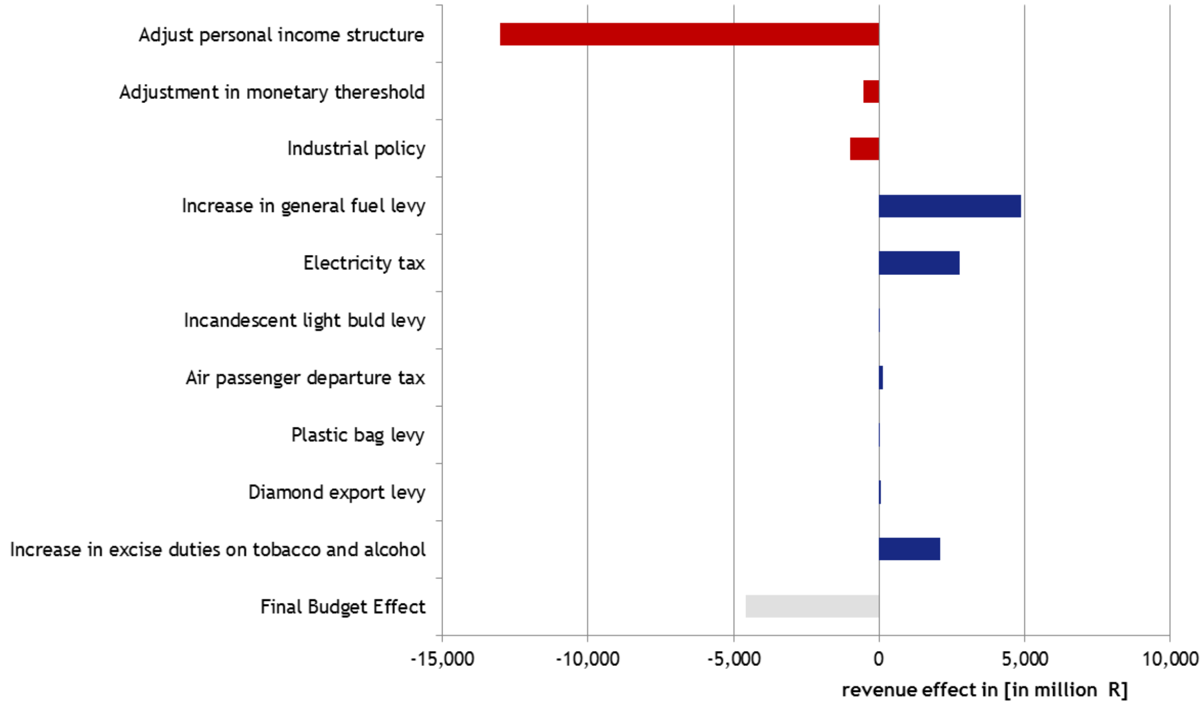
[55] However, corporate income taxes paid most industries with access to international capital could end up being large borne by labor (the exception being industries where there's domestic rents (like construction, banking, telecoms), yet a quite indirect and uncertain effect.However, in terms of communication it will simply be politically deadly for instance to increase taxes on heating fuel and use the funds to lower taxes on capital returns. The politics here tend to be quite clear, that economics don't really matter.

Case 10: EFR spending in South Africa

In its 2009 budget the South African Revenue Service (SARS) proposed a tax cut worth 13,500 million R to personal income taxes and another 1,000 million R to business taxes. This tax cut could be mostly paid for by increasing indirect taxes, most of them environmental taxes. The overall effect was still a loss of revenues worth 4,575 million R as shown in Figure 20. However, it also shows that the largest part of the tax cut was financed by an increase in the general fuel levy as well as the electricity levy (Speck, 2012).

Figure 20: Financing tax cuts through EFR in South Africa



Source: Own Figure based on (Speck, 2012)

Probably the most sensible way to approach spending decisions is to evaluate them from a political and strategic perspective. One strategy worth considering is to identify the highest national political priority at any given moment (often non-environment-related subjects, e.g. high pension contribution rates, etc.) and consider using the EFR revenues toward this goal. Understanding the cultural and socio-political country context, one should identify winners and losers and use funds to activate powerful stakeholders and seize the opportunity to build coalitions (e.g. well-supported and popular political leaders who have the steadfastness to lead the process through ups and downs). Approaching spending choices from a political point of view is reasonable, given that spending decisions are fundamentally political in character. Thus, one should use EFR revenues for whatever they are most needed in a given time and place and stay flexible in order to successfully implement reforms.

4.7 A conceptual framework for ideal tax and fiscal policy design

Throughout this study, we have developed a conceptual framework, which allows policy makers to understand the steps to estimate the amount of spendable revenues which can be created through an EFR instrument. This is summarized below.

Having identified actual revenues we went on to subtract spending on administration and on compensation, since only after doing this we arrive at the revenues which can be freely allocated by government.

Going through each of these steps and evaluating the various trade-offs should help to guide decision makers through the process of instrument design, as it enables policy-makers to distinguish between EFR instruments which are not only attractive for environmental reasons but can also be used as a significant and welcome source of government funding.

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Figure 21 goes through the various steps. At first we determined **total potential revenues**, which depend on the size of the tax base, the tax rate, the price level, and the expected behavioral effect, which will result from a price change.

In a second step, we subtract the revenues lost due to **reductions and exemptions** for certain groups. We noticed that since the reaction to a tax may be different for various groups, it may be reasonable to offer lower tax rates to certain actors from a fiscal, however not from an environmental perspective.

Third, we looked at **the effect of an EFR instrument on general revenues** and showed that depending on the situation this effect could either be positive or negative.

Forth, we considered **the tendency of EFR revenues to decline over time**. This is true because inflation devalues quantity taxes and because the elasticity with respect to a tax tends to increase over time, which causes the tax base to shrink.[56]

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[56] Note that for simplicity this second effect is not modeled in.

Figure 21: Conceptual framework to estimate EFR revenues

Variables	Explanation	Identity
$(1-\varphi_{normal}) \times Q_{total} \times t_{normal}$		Total potential revenue
$\varphi_{normal} = f(t_{normal}, P)$	describes the behavioral response of the tax base and depends on the tax rate and the absolute Price level	
$-(1-\varphi_{reduced}) \times Q_{reduced} \times (t_{normal} - t_{reduced})$		Reductions
$\varphi_{reduced} = f(t_{reduced}, P)$	see above	
$-Q_{exempt} \times t_{normal}$		Exemptions
$-\sigma \times (Revenue_{total} - \ real\ Revenue_{EFI})$		Effects on external revenues
$\sigma = f(behavioural\ response)$	positive and negative external revenue effects	
$-\{real\ Revenue_{EFI}\} \times \left\{1 - \frac{1}{(1+\pi)^{(1+t)}}\right\}$		Time and inflation
$-\ C_{admin}$		Costs of administration
$C_{admin} = f(administrative\ efficiency)$	measurement & evaluation; collection, monitoring & enforcement, theft & corruption	
$-S_{compensations}$		Compensatory spending
$S_{compensations} = compensatory\ spending$	equity and business transfers	

Source: Own Table

5 Alleviating the tension between environmental and fiscal effectiveness

At the outset of this study we discussed the apparent tension between the environmental and fiscal effectiveness of various EFR instruments. The argument goes as follows: The attractiveness of a tax increases with elasticities from an environmental perspective, as by definition, the behavioral response is large. The opposite is true from a fiscal perspective, since unstable revenues and large behavioral effects are unattractive from a fiscal perspective.

However, at this point in the report it should be clear, why the fiscal argument does not hold in the case of EFR. The preference for low marginal tax rates, and broad and immobile tax bases from a fiscal perspective, rests on the consideration that a certain amount of revenue should be raised without distorting the economy from its optimal point of allocation. This optimal point of allocation, however, is not the starting point in the case of environmental taxes. The point of an EFR is precisely to correct the existing inefficient allocation in an economy and help it find its optimal point of allocation through a tax-induced price increase. This means that worries over distorting the economy (fiscal view) are misplaced when looking at EFR instruments, because it is their purpose to affect and correct behavior. Once this is understood, one can see that EFR revenues from Pigouvian taxes are a “free-lunch” from a fiscal point of view. The previously developed framework should help to evaluate this free-lunch in depth and on a case by case basis.

One question remains unresolved, however: Whether EFR instruments should be used to raise additional revenues through rates that are higher than the ideal Pigouvian rate. To answer this question, policymakers should compare an EFR tax base to all other potential taxes within an economy and make an informed decision depending on the fiscal characteristics of a certain tax base. For instance, one may wish to use transport fuel as a tax base to raise revenue irrespective of any environmental considerations, simply because its base is very broad and relatively inelastic.

Another important step to reduce fiscal concerns over EFR instruments is to harmonize environmental taxes internationally. An increased elasticity of the tax base due to companies potentially moving to low-tax havens – though there is not a great deal of evidence for it except in very few sectors as mentioned above - is unattractive both from a fiscal and from an environmental perspective. One partial response to international tax competition is to seek agreement on minimum tax levels. This applies for the European Union where – as the only region in the world – minimum tax rates for all energy products are prescribed since 2004. The EU has thus sought to manage downward pressures on rates by adopting minimum rates, which is potentially less constraining than "tax harmonization" in that it provides some protection to countries wishing to set relatively high rates while allowing them flexibility to increase their rates. A major rationale behind is the problem of fuel tax tourism. Different levels of taxation provide the incentive particularly to those close to the border to fill up their vehicles abroad where rates are lower. To avoid such an incentive, triggering tax decreases and potential "tax races to the bottom", minimum rates are an important way forward. Yet, if no increases or at least automatic inflation indexations are foreseen (like in the EU) then they mainly prevent worse situations, but do not really offer perspectives.

On the other hand, the EU thus managed to make some laggards having to increase their tax rates to these minima. However, the entire fiscal policy in the EU is based on unanimity voting or in other words: Every single member state of the EU-28 has a veto right which makes any ambitious fiscal policies extremely difficult. This is proven by the current negotiations on a proposal from the European Commission from April 2011 which are about to fail since there is no substantial progress, but substantial opposition by some. However, setting minimum rates rather than harmonizing taxation may also be based on sound economic logic (differing levels of tax and market distortions may justify some variance in emissions prices across countries).

6 Questions for further research

This study developed a conceptual framework, which opens a range of questions for further research. In the following, we have assembled some of the most crucial questions and issues, to which we further research is required as we did not yet find satisfying answers.

1. How should the sensitivity of EFR as well as other tax bases due to trade and competitiveness issues be treated?
2. Which practical criteria can be used to decide whether an EFR tax should be raised above its Pigouvian rate?
3. Whether EFR instruments should be used to raise additional revenues through rates that are higher than the ideal Pigouvian rate. To answer this question, policy-makers should compare an EFR tax base to all other potential taxes within an economy and make an informed decision depending on the fiscal characteristics of a certain tax base. For instance, one may wish to use transport fuel as a tax base to raise revenue irrespective of any environmental considerations, simply because its base is very broad and inelastic.
4. EFR-elements are crucial for accelerating and enabling the transition to a green economy as investments and consumption changes are required, which can be triggered by such instruments. However, once society has gone through the largest parts of such a transition, should the various EFR-elements be kept? Should they be strengthened to reach rather the right end of the Laffer curve? Can these EFR-elements then be abolished because the transition has more or less been achieved? Hence, is there an EFR-relief possible after that transition period? This may be a very important element for the communication strategy using arguments like: "We mainly have to implement EFR-measure until we are close to having achieved a green economy and we have gone through the major parts of the transition phase. Then there will be light at the end of the tunnel and we enter a brighter future."
5. The political economy of the ETS requires more in-depth examination and evaluation to better conclude for future design and implementation aspects.

6. We encourage empirical research on the optimal fiscal and environmental EFR rates to connect our theoretical considerations to real world problems.
7. In order to better determine optimal rates, more research on the external costs of environmentally harmful behavior as well as on the elasticities of demand and supply are needed for optimal policy design.

7 Conclusion

In this study we developed a conceptual framework to understand the revenue potential of EFR instruments. We find that large and untapped EFR revenue potential exists in all countries. However, determining EFR potential should be done on a country by country and case by case basis. Our conceptual framework can help guide this process.

By first examining a certain tax base and its elasticity with respect to price increases, we can determine the potential revenue for a given tax base and rate. Having chosen the optimal (Pigouvian) rate, we subtract the value of the envisioned rate reductions and tax exemptions. Ideally, one can pass an EFR without them, however, if in place they have to be taken into account. Next, we estimate the EFR instrument's effect on general revenues. This effect might actually be positive or negative depending on the instrument and surrounding tax system. Looking at revenue potential over time, we further take into account inflation effects (which can be eliminated through automatic rate adjustments) and time effects, as the tax base decreases, which is essentially the goal of an EFR.

Then, we looked at the administrative costs of an EFR instrument as well as the necessary compensatory spending. At last we consider how the remaining revenue could be allocated.

The study offers policymakers a tool, which can help to make sense of the revenue potential of an EFR instrument. While being transparent about all trade-offs, it should also help to understand the extremely attractive feature of an EFR, namely raising government revenue whilst fixing and not distorting an optimal allocation of resources.

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9 Appendix

Appendix 1: Eurostat definition for tax bases

Energy taxes:	Transport Taxes:
Energy products for transport purposes • Unleaded petrol • Leaded petrol • Diesel • Other energy products for transport purposes (e.g. LPG, natural gas, kerosene or fuel oil) Energy products for stationary purposes • Light fuel oil • Heavy fuel oil • Natural gas • Coal • Coke • Biofuels • Electricity consumption and production • District heat consumption and production • Other energy products for stationary use Greenhouse gases • carbon content of fuels • emissions of greenhouse gases (including proceeds from emission permits recorded as taxes in the national accounts)	- Motor vehicles import or sale (one off taxes) - Registration or use of motor vehicles, recurrent (e.g. yearly taxes) - Road use (e.g. motorway taxes) - Congestion charges and city tolls (if taxes in national accounts) - Other means of transport (ships, airplanes, railways, etc.) - Flights and flight tickets - Vehicle insurance (excludes general insurance taxes)
Pollution taxes:	**Resource taxes:**
Measured or estimated emissions to air • Measured or estimated NOx emissions • Measured or estimated SOx emissions • Other measured or estimated emissions to air (excluding CO2) Ozone depleting substances (e.g. CFCs or halons) Measured or estimated effluents to water • Measured or estimated effluents of oxydisable matter (BOD, COD) • Other measured or estimated effluents to water • Effluent collection and treatment, fixed annual taxes Non-point sources of water pollution • Pesticides (based on e.g. chemical content, price or volume) • Artificial fertilisers (based on e.g. phosphorus or nitrogen content or price) • Manure Waste management • Collection, treatment or disposal • Individual products (e.g. packaging, beverage containers, batteries, tyres, lubricants) — Noise (e.g. aircraft take-off and landings)	- Water abstraction - Harvesting of biological resources (e.g. timber, hunted and fished species) - Extraction of raw materials (e.g. minerals, oil and gas) - Landscape changes and cutting of trees