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MASTER'S THESIS

EVALUATION OF ENVIRONMENTAL TAX REFORMS IN THE EUROPEAN UNION

Ljubljana, September 2017 MAJA KUNSTELJ

AUTHORSHIP STATEMENT

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INTRODUCTION

Environmental Tax Reform (hereinafter: ETR) has gained significant traction amongst policy makers in recent years, with the intention of offering industrialized and emerging countries a framework to increase the efficiency of environmental policies by reforming existing taxation structures. The idea was to construct a "reform of the national tax system where there is a shift of the burden of taxes, for example on labour, to environmentally damaging activities such as resource use or pollution" (European Environmental Agency, 2012). While the idea of imposing taxation to address environmental objectives is not necessarily new, the ETR debuted an explicit attempt to redistribute tax burdens across an economy in order to nudge society towards a sustainable development path and increased welfare through better functioning markets.

At the core of this argument is the need for boosting efficiency of existing taxation systems, which have arguably been dragging economic growth and the fulfilment of key social objectives. While society as a whole is becoming increasingly aware of the ongoing exploitation of natural resources and growing multi-source pollution, the joint polluting of industries and households, politicians are struggling to construct policies that are embraced by all of society's stakeholders. The ETR has proved to be one of those highly divisive instruments, with limited real life findings and contradicting empirical studies.

The economic crisis has seemed to reinvigorate the discussion, with the European Commission (hereinafter: EC) suggesting ETR holds potential as an austerity policy tool, given its revenue raising ability and double dividend prospective. ETR is based on the double dividend hypothesis, advanced by Tullock in 1967, and states that environmental taxes be implemented instead of revenue raising taxes to generate a primary dividend of welfare gain due to environmental improvement, along with a secondary welfare dividend arising due to the reduction of distortions in the taxation system (Pearce, 1991). While such policies were popular in the 1990s amongst Nordic countries and a handful of other Central or Eastern European (hereinafter: CEE) members, a larger scale implementation has yet to happen with governments seemingly shying away from formal ETR commitment due to industry competitiveness and equity concerns.

The purpose of this thesis is to explore the relatively new and divisive concept of explicit tax shifting through ETR, and its implication for environmental policy and public finance reform in the European Union (hereinafter: EU). Due to the limited evidence hailing from practical experiences with ETR and great political difficulty of implementation, there is little precedent to offer conclusive evidence whether ETRs generate a positive welfare effect and the lucrative, theoretically promised dividends. This information gap is why the potential of this complex policy instrument needs to be further assessed and overlaid into the policy mix of diverse economies.

Building on the existing literature, this thesis aims to add to the discussion by challenging why explicit ETRs have thus far not been more widely used in the EU, and provide insights into whether certain factors, or their interaction, exacerbate the potential of ETR. The goal of this thesis is to explore whether realistically ETR could be adopted throughout the EU and its systematic taxation restructuring applied as an alternative to traditional austerity measures. The aforementioned objectives will be achieved by: analysing economy wide effects of past ETR programs carried out by European countries, dedicating special attention to distributional and sectoral impacts; performing a principal component analysis to determine what key economic characteristics are associated with successful ETR implementation; discussing the potential of ETR to address budget deficits and replace traditional austerity measures; and evaluating the future role of ETR in European policy making.

The sections are ordered as follows: section 1 reviews the underlying economic theory behind ETR and addresses the potential and limitations of this policy instrument; section 2 describes the role of ETR within the EU environmental policy and delves deeper into policy design on a country level, supported by a principal components analysis; section 3 discusses ETR's potential as an austerity mechanism and ponders the instrument's role in the future policy mix. The thesis concludes with a synthesis of all the key findings.

1 THEORETICAL FRAMEWORK OF ETR

1.1 Development of environmental taxation theory

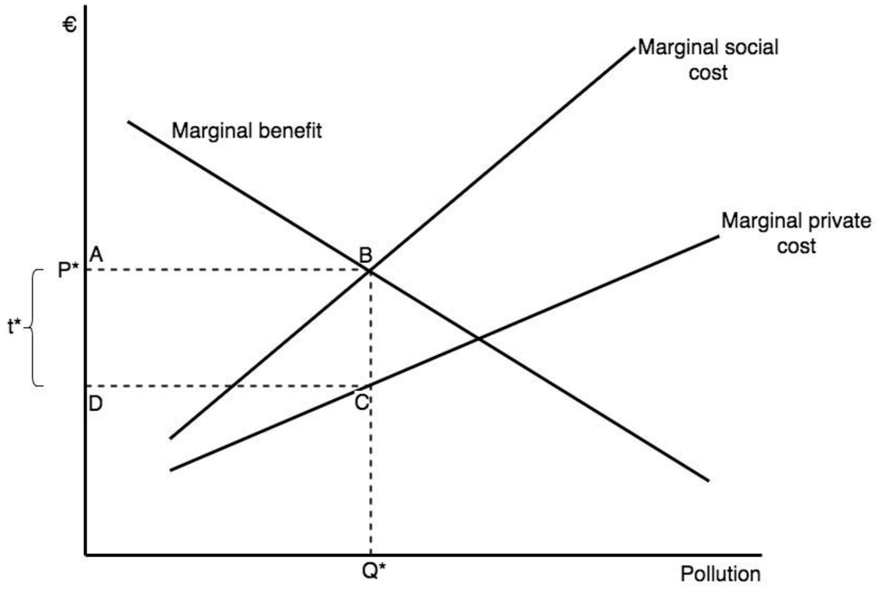
The ETR, also known as ecological tax reform and green tax reform, is a concept that was first introduced as a policy instrument in the early 1990s to offer a reconsideration of the present tax system (EC, 1997), however several seminal economic theories have addressed the topic much earlier and shaped how we perceive environmental taxation today and laid out the theoretical framework for policy design.

1.1.1 Pigouvian tax

The Pigouvian tax was perhaps the first economic theory that explicitly addressed externalities arising from market activities, and is also frequently referred to as the environmental tax due to its common application to combat negative externalities linked to environmental degradation such as pollution. It is a corrective tax in the sense that it re-establishes a socially efficient equilibrium when externalities are present.

The idea that there needs to be a mechanism to correct for inefficiencies that arise in the process of competitive allocation of resources (Sandmo, 1975) was argued by Arthur Pigou in his 1920 work The Economics of Welfare. Pigou addresses the divergence between the private interest of industrialists and the social interest in the presence of negative externalities, as they represent an additional cost to society not reflected in the price of the good, activity, or service, with no market incentive for industrialists to internalize this additional cost. This results in a socially inefficient outcome, as the marginal social cost (hereinafter: MSC), i.e. total cost from producing an additional unit of a good or service, including private and external cost, exceeds the marginal private cost and there is an over-production of the cost creating product as illustrated in Figure 1.

Figure 1. Pigouvian tax on externalities



Source: P. Ekins & S. Speck, *Environmental Tax Reform (ETR): A Policy for Green Growth,* 2011, p. 111.

The marginal social benefit (hereinafter: MSB) is the additional social value of producing one more unit of a given good, activity, or service. Akin to the demand curve, the MSB is downward sloping, suggesting that each additional unit generates less benefit. Hence, the socially efficient equilibrium Q* would be where MSB = MSC, which lies higher on the MSB curve and at which point the cost of the negative externality is perfectly reflected in the price of the product (P*).

To achieve this efficient allocation Pigou proposed an indirect tax t* in the amount of marginal damages, to be directly charged on externality sources to reduce over production and provide an incentive to change to less socially damaging production. This tax raises revenue in the amount of ABCD, leaving the potential for a short term double dividend should it be used to decrease distortive taxation, however the traditional Pigouvian framework does not address revenue recycling or how to deal with other distortions in the economy, discussed in the following sections.

While the Pigovian tax quickly gained traction and became the de facto instrument to deal with market failures due to externalities, several critiques have questioned the tax and its ability to: address the difficulty of accurately measuring the presence of externalities, the firm level scale of the tax rather than an industry wide efficient outcome (Carlton & Loury, 1980), and the distortive nature of the tax in a non-efficient tax system (Parry & Oates, 1998). Parry and Oates argued that as the Pigouvian tax increases production costs, it will alter production and investment decisions, hence impacting labour demand. Furthermore, should the cost hike be reflected in consumer prices, households will see their real net wages decline which could affect labour supply.

Addressing the difficulty of setting proper Pigouvian tax levels due to the generally accepted inability to measure marginal social damage, Baumol and Oates (1971) developed a theory of a first approximation known as the pricing and standards approach, which quickly gained traction due to its workability. In contrast to the Pigouvian technique, the pricing and standards approach is based on "a predetermined set of standards for environmental quality and then imposes unit taxes (or subsidies) sufficient to achieve these standards" (Oates, 1996). An example of a standard, that the authors admit can be somewhat arbitrary, is that "the dissolved oxygen content of a waterway will be above *x* percent at least 99 per cent of the time" (Baumol & Oates, 1971). By basing the taxes on the current levels of net damage, any shifts in the output and damage levels due to the tax will call for iterations, essentially creating a dynamic tax system that will always impose unit taxes sufficient to achieve the specified standards. This approach does not promise to achieve optimal allocation of resources like the Pigouvian tax, however represents a least-cost method of reaching specific environmental goals.

1.1.2 Optimal taxation theory

While Pigou developed the scheme of taxing externalities, the theory of optimal taxation is a set of normative prescriptions for tax policy as a whole, attempting to offer insight as how to best design taxes given equity and efficiency concerns. From an efficiency perspective, lump sum taxation is seen as the optimal way to finance the government given that it does not cause distortions in the market nor does it generate dead weight loss (Ramsey, 1927). Simply, a fixed amount is collected per person, which does not induce any behavioural responses. However, once redistribution concerns are factored in, the ability of individuals must be accounted for and progressively taxed, which in the optimality scenario translates into individual specific lump sum taxes. As one cannot observe individual ability, economic outcomes such as income or consumption are taken as proxies of ability and are taxed accordingly. Such taxation is known as a second-best scenario (with lump sum taxation being the first-best) due to resulting behavioural distortions (Mirrlees, 1971). These distortions are said to reduce the net social gain, cause the marginal rate of substitution to deviate from the marginal rate of transformation (i.e. violating conditions of social efficiency), and violate the law of one price as buyers and sellers face different prices due to before and after tax prices. In other words, consumers will substitute away from taxed goods and services, moving away from a socially efficient allocation.

As goods and services permit taxing different consumption components at different rates, Ramsey proposed a differentiated commodity taxation system to minimize distortions of consumer behaviour and foster an efficient tax system. This seminal contribution is known as the inverse elasticity rule, which states that high taxes should be placed on commodities with low price elasticities and vice versa (Kosonen & Nicodeme, 2009). The logic is that in the case of low price elasticity, even significant price increases would not result in substantial demand reductions, meaning that consumption of said goods or services occurs irrespective of price, yielding minimal distortions to consumer behaviour.

In practice, energy is seen as an attractive tax target due to consumer and firm energy demand being relatively price inelastic. Studies summarised by the Organization for Economic Cooperation and Development (hereinafter: OECD) (2013) found the short run price elasticity of energy to be relatively low, between -0.13 and -0.26, implying a small shift in short run energy trends following a price change. In contrast, long run elasticities were considerably higher, between -0.37 and -0.46, suggesting that when price changes persist, economic agents have time to adjust their behaviour. Further literature found that gasoline elasticities diverged even more between the short and long run, ranging between -0.15 to -0.28 and -0.51 to -1.07 respectively, suggesting higher fuel costs can significantly change behaviour and consumption patterns, with some papers even implying that elasticity of demand is higher in response to taxation than other price changes (Rivers & Scaufele, 2012; Li & Li, 2012). Hence, according to the Ramsey rule on differential tax rates, an optimal tax on final fuel consumption should be above the Pigouvian level. If such a rule would be applied to all inelastic goods, by definition taxing consumption items that are difficult to substitute and needed for everyday life such as food and energy, equity concerns may arise due to the high proportion of consumption said goods represent for low-income households.

Further research on tax differentiation, including recent work by Henrik Kleven, has supported the theory of an optimally differentiated rate structure. Kleven (2004) claims that higher taxation on externalities such as environmentally harmful behaviour and products is a wanted distortion due to its corrective effect e.g. reducing air pollution lowers rates of lung related disease and lengthens working lives, positively impacting growth.

However, in line with the theory of optimal taxation, environmental policies such as the Pigouvian tax are seen “as a burden on economic activity, at least in the short to medium term, as they raise costs without increasing output and restrict the set of production technologies and outputs” (Kozluk & Zipper, 2015). Bovenberg and de Mooij (1994) place a Pigouvian tax within the two scenarios and argue that a long run social optimum can only be achieved in the first-best case, where there are no distortionary taxes, such as an income tax present. In the second-best scenario, distortions to the labour supply via income taxation will result in the optimal tax to be below the Pigovian tax level.

Thus, as discussed above, economic theory suggests that apart from lump sum taxes, taxation will always create some form of distortion due to individuals taking action to reduce their tax liabilities (Bovenberg & Goulder, 1996). In order to efficiently design a tax system that will as closely follow the principles of optimal taxation, the key consideration must be how to "increase a tax system's capacities to raise revenues, promote growth and employment, while sustaining redistributive and allocative functions" (EC, 2011).

1.1.3 Porter hypothesis

Michael Porter believed that well-designed environmental policies could result in direct economic and environmental benefits, offering a so-called 'free lunch'. Policies that encourage innovation, in turn bringing about profitability and productivity gains that outweigh the costs of the policy, can yield direct economic benefits alongside environmental benefits (Porter, 1991; Porter & van der Linde, 1995). The so-called Porter hypothesis (hereinafter: PH) was introduced in 1991 and offered a premise contradicting traditional economic beliefs of environmental regulation hindering competitiveness by restricting production options and reducing profits. In fact, Porter argued that applying strict environmental regulation will enhance rather than hamper the competitive advantage of firms. Stringent yet efficient environmental regulation can be a trigger for innovation, which can not only offset the costs of compliance, it can even result in gains (Porter & van der Linde, 1995).

While the weak version of the PH states that properly designed environmental regulation may spur innovation, the strong version of the PH adds that this innovation will more than offset any additional regulatory costs, increasing firm competitiveness (Ambec, Cohen, Elgie, & Lanoie, 2010). Studies by Porter along with co-author van der Linde (1995) proposed that pollution is a waste of resources, and hence reducing pollution can improve the productivity of resources used. Their reasoning was that regulation raises corporate awareness and acts as a signal to companies that there are resource inefficiencies present that can potentially be solved with technological improvements. Furthermore, regulation kick-starts a transitional phase that signals a clear commitment towards the environment, reducing uncertainty surrounding the value of investments in abatement technologies and creates pressure to innovate and evolve. Several empirical studies (Ambec & Barla, 2006; Ambec & Lanoie, 2008) have since tested the hypothesis and generally found a positive link, albeit of varying strength, between environmental regulation and innovation, such as that increasing the cost of pollution by 1 % will increase research and development (hereinafter: R&D) expenditure by 0.15 % (Jaffe & Palmer, 1997). However, a comprehensive study by Ambec et al. (2010) showed a direct negative effect of environmental regulation on business performance, the size of which outweighs the positive effect on innovation and hence yields a negative net effect, at least in the short run.

The key emphasis that Porter argues can sway the outcome is the quality of the regulation itself, which already in his original writings he suggested to be market-based rather than rigid command and control regulation. Empirical evidence on the PH found that market-based, as well as flexible instruments such as emission taxes, tradeable permits, and performance standards are better at fostering innovation than technological standards due to giving firms more flexibility to generate solutions at minimal compliance costs (Burtraw, 2000; Isaksson, 2005). For instance, Burtraw (2000) found that switching from a technological standard to an emission cap "enhanced innovation and fostered organizational change and competition on the upstream input market", while Isaksson (2005) found that a charge on emissions significantly reduced emissions at a zero or very low cost. Simultaneously, abatement and technological development was detected (Ambec et al., 2010).

While the idea that environmental protection does not need to be detrimental to economic growth has been very popular politically, the PH has also been widely criticized for disregarding the profit-maximizing nature of firms and perpetrating the idea that firms are blind to the profit-increasing opportunities of environmental innovation (Palmer, Oates & Portney, 1995).

1.1.4 Double dividend hypothesis

Despite similar ideas being put forward earlier, Tullock (1967) is credited with formalizing the theory known today as the double dividend hypothesis (hereinafter: DDH). The hypothesis, more conservatively than Porter, states that by implementing environmental taxes instead of traditional revenue-raising taxes it is possible to generate a primary dividend of welfare gain due to environmental improvement, along with a secondary welfare dividend arising due to the reduction of distortions in the taxation system (Pearce, 1991). According to Goulder (1995), one can distinguish between two forms of the DDH, both of which assume a positive first dividend:

Weak form hypothesis: recycling revenues from environmental taxation through cuts in distortionary taxation is welfare-improving relative to recycling through lump sum payments that do not reduce distortion.

Strong form hypothesis: substitution of an existing distorting tax for an environmental tax will necessarily improve gross welfare by reducing the distortionary costs of raising a given level of revenue.

While most economists agree with the weak double dividend, the strong form has been the subject of much contention. The weak DDH simply addresses how the revenue raised with environmental taxes is used, arguing that it is better to use this revenue to reduce other taxes than to pay it out to individuals in the form of a lump sum payment. To be able to claim that environmental taxation leads to economic gains other than those linked to environmental improvement, the strong DDH needs to be true. The strong form hypothesis is concerned with raising revenue efficiently and reducing the distortionary cost of the tax system. Theoretically, the strong double dividend cannot exist in a revenue-optimal tax structure as it would not be possible to raise the same amount of revenue at a smaller distortionary cost. Consequently, the strong double dividend is only possible when imposing an environmental tax would produce a move towards a revenue-optimal set of taxes (OECD, 2010).

How the second dividend is defined has varied greatly in theoretical literature. For instance, by following Goulder's definition of welfare as the second dividend, boosting total employment when the labour market is in equilibrium i.e. no involuntary unemployment would not be considered as a gain. Alternatively, as unemployment is one of the major distortionary outcomes of taxation, a major portion of the DD literature has explicitly been devoted to the employment double dividend. In this case, if the labour market is in equilibrium, tax reductions addressing the labour supply can lead to additional employment and hence produce a positive second dividend. This could be done in the form of reducing direct labour income taxes or lowering sales taxes on goods that are desired by the labour force, under the assumption that these incentives are met with a positive response. If the cause for the labour market disequilibrium is oversupply of labour, boosting labour demand to promote greater employment would require lowering the cost of employing labour, such as lowering social security contributions (hereinafter: SSC) by employers (OECD, 2010).

Another common way of defining welfare gain is economic growth or more generally the level of gross domestic product (hereinafter: GDP). Further variations, such as those linked to Porter and innovation have also been put forward, however have been less popular in the context of policy instruments.

The size of the second dividend is influenced by netting the tax interaction and revenue recycling effect. When an environmental tax is added or increased, there will be an efficiency loss due to the tax interaction effect, as it will increase the price of the taxed good or service, creating a distortion in the market and in relation to other taxed goods. The tax interaction effect encompasses the adverse factor market distortions and productivity inefficiencies. In contrast, the revenue recycling effect reflects the offsetting efficiency gains due to allocating the revenue raised through environmental taxes to reduce pre-existing distortionary taxes (Bovenberg & de Mooij, 1994; Goulder, Parry, & Burtraw, 1997). Following the theoretical literature on the double dividend (Bento & Jacobsen, 2007; Williams, 2002; Bovenberg, Goulder, & Jacobsen, 2008), one can derive the efficiency effects of environmental taxation through a general equilibrium model.

In this model, taken from Fraser and Waschik (2013), the economy produces two goods, a clean good $Y = Y(L_y)$ and a dirty good $X = X(L_x, Z)$, where L_i denotes a perfectly mobile labour force, and Z denotes a factor specific to the production of the dirty good X. Constant returns to scale are assumed for production, with decreasing returns to scale for labour L_x used to produce X due to the presence of fixed factor Z in the production process. The model does not account for abatement technologies that could be installed in production, and hence considers emissions E to be proportional to the amount of the dirty good X. A consumer's endowment consists of labour $\bar{L}$ and the fixed factor Z. This representative agent derives utility from consuming goods (Y and X) and leisure (defined as $l = \bar{L} - L_y - L_x$), however suffers disutility from emissions E (given by the utility function $U = U(Y, X, l) - \phi(E)$). The government is assumed to only be levying a tax on labour t_L and to be giving consumers lump sum transfers in the amount of G. When the representative consumer maximises utility subject to a budget constraint:

$$p_x \cdot X + Y = (w - t_L) \cdot (L_y + L_x) + p_z \cdot Z + G \tag{1}$$

the indirect utility function (2) can be derived

$$V = V(p_x, w, p_z) - \phi(E) \tag{2}$$

In an economy where labour is the only production factor (i.e. there is no fixed factor Z, Z=0) efficiency effects of applying an environmental tax t_E can be deduced by differentiating the indirect utility function with respect to t_E, yielding:

$$\frac{1}{\lambda}\frac{dV}{dt_E} = \left(\frac{\phi'}{\lambda} - \frac{dp_x}{dt_E}\right)\left(-\frac{dX}{dt_E}\right) + t_L\left(\frac{\partial L}{\partial p_x}\frac{dp_x}{dt_E}\right) + \left(\frac{\partial L}{\partial t_L}\frac{dt_L}{dt_E}\right) \tag{3}$$

where λ is the marginal utility of income and $\frac{\phi'}{\lambda}$ the marginal external cost of pollution.

From the equation (3), we can identify the two core effects discussed earlier:

- the tax interaction effect, $t_L\left(\frac{\partial L}{\partial p_x}\frac{dp_x}{dt_E}\right)$, which shows how environmental policies increase the price of good X relative to leisure and lead to distortions in the factor market. Due to higher prices, consumers suffer from lower post-tax real income. This effect is negative; however its magnitude is related to labour supply elasticities.

- the revenue recycling effect, $(\frac{\partial L}{\partial t_L}\frac{dt_L}{dt_E})$, which shows how using revenues from environmental taxes to cut marginal tax rates on labour can boost labour supply, resulting in a positive welfare effect.

In addition, the term $\left(\frac{\phi'}{\lambda} - \frac{dp_x}{dt_E}\right)\left(-\frac{dX}{dt_E}\right)$ is known as the Pigouvian welfare effect, where efficiency gains from decreasing dirty good *X* consumption are multiplied by the marginal external cost of pollution and change in price of good *X*. This effect captures the benefits from environmental improvement.

If consumers were to be endowed with polluting factor *Z* (i.e. Z>0), two additional effects would appear:

- the Ricardian rent effect, $(Z \cdot \frac{dp_Z}{dt_E})$, where consumers see a reduction in rents earned from owning factor Z;
- the surrogate tax effect, $(t_L \frac{\partial L}{\partial p_Z}\frac{dp_Z}{dt_E})$, where due to lower consumer's factor income, there is a positive income effect on labour supply.

For the purpose of this thesis, the focus will be on the tax interaction and revenue recycling effects as their net result is most indicative whether the strong double dividend hypothesis holds true.

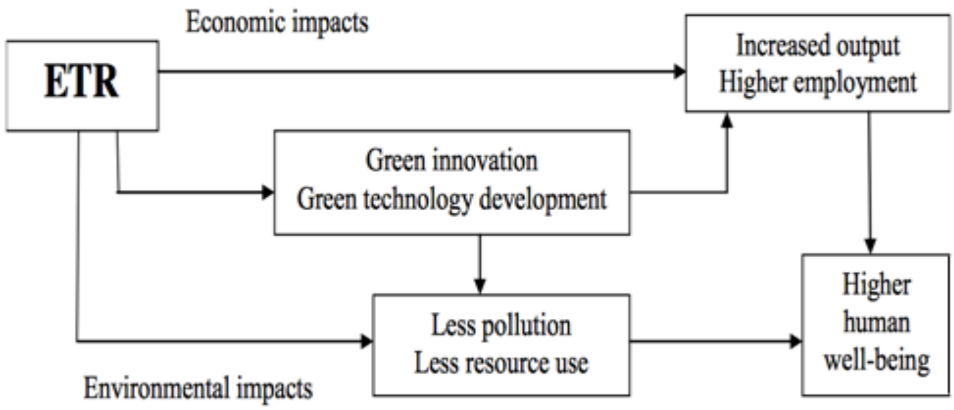
1.2 ETR

1.2.1 Policy design

ETR is a practical application of the DDH and a subset of the wider scoping environmental fiscal reform, which in addition to taxation, also refers to a range of pricing measures and subsidy reform to address multiple policy objectives. Tax shifting programmes have the objective of ensuring a more equitable distribution of tax burdens from both an environmental and sustainability standpoint. While environmental taxes have been a popular revenue raising instrument for decades, Pearce (1991) was the one to draw attention to the double dividend potential of environmental taxes after much public debate followed the first International Panel on Climate Change.

To design an ETR, policymakers must determine four elements: what type of environmental taxation to implement, which existing taxes to reduce, which revenue recycling methods to adopt, and what will be the scope of revenue shifting. These elements will ultimately influence the outcome and determine the impact the reform is able to generate, a standardized view of which is illustrated in Figure 2. Theoretical studies have transferred the DDH into ETR design by focusing on welfare, however numerical models demonstrated the benefit of using employment as a concrete and measurable second dividend. While both welfare and employment gains are desired, the distinction is important as employment creation (or unemployment reduction) does not necessarily translate into welfare gains and vice versa.

Figure 2. Duality of ETR objectives



Source: P. Ekins, *Implementing environmental fiscal reform in Europe*, p. 5.

One of the foundations of ETR is revenue neutrality, in other words the tax burden at the national level must remain constant when shifting taxes from conventional taxes to environmentally related activities, in order to ensure clear price signals that will result in the desired behavioral change (Bovenberg & van Der Ploeg, 1998). Alternatively, an ETR can also be revenue negative if the tax revenue is decreased (i.e. only part of the revenue is recycled, usually the case when governments need help to finance their current budgetary needs), or revenue positive if the tax revenue collected is increased. However, some public finance literature has suggested that while revenue-neutrality is desirable, it might not be attainable in combination with desired ETR outcomes due to the strong negative tax interaction effect (Goulder, Parry, Williams, & Burtraw, 1999).

If labour income taxes are lowered, a tax interaction effect will appear where commodity prices will rise, such as electricity prices for consumers, and after-tax real income will decline. In theory, lowering the tax burden on labour decreases the tax wedge, which is the difference between the value of marginal product of labour and the marginal opportunity cost of labour supply. This is in turn expected to boost labour force participation, hours worked and effort on the job. Bovenberg and de Mooij (1994), however, found that most often labour supply is not elastic enough to react to the small taxation relief provisioned in ETR schemes. Hence, if labour tax cuts are not sufficient to offset commodity price increases, employees will generate inflationary pressure by demanding compensation in the form of wage increases, resulting in a net negative effect of ETR. As such, countries that wish to lower income tax levels must forgo revenue neutrality to enable deeper cuts to the labour tax burden.

In contrast, if the revenue recycling mechanism is based on directly lowering non-wage cost such as SSC, no or only marginal changes in commodity prices will occur (Parry, 1995) and ensure an instant offset between energy taxes and unit labour costs, resulting in a neutral or net positive outcome. In addition to direct taxes (income and corporation) and SSC (paid by employers or employees) discussed above, revenue recycling can also be done through support schemes for investment expenditure or other compensatory measures.

The recycling mechanism is the most important feature of ETR as it ensures the cost effectiveness of taxes over regulation, and if not used to cut distortionary taxes or fund socially desirable spending, net benefits of taxes are significantly reduced (Fullerton & Metcalf, 1997; Crampton & Kerr, 2002). Furthermore, if environmental tax revenues are designated for a particular purpose, i.e. earmarked, policy makers need to resist the inclination to set the tax level in accordance to revenue needs rather than externality correcting levels, as otherwise this can result in tax levels significantly lower than the Pigouvian tax level (Opschoor & Vos, 1989). It is important that the implemented taxes can be justified on environmental grounds and can act as standalone policy instruments.

1.2.2 Barriers to implementation

1.2.2.1 Distributional concerns

Environmental taxes are usually levied on goods and services that are basic necessities, such as energy and transport, making them effective tools to raise revenue due to their broad tax base. However, targeting necessities puts a disproportionate strain on low-income households, who spend a larger share of their income on such goods compared to high-income households. A European Environmental Agency (hereinafter: EEA) report (2005) found that while pollution taxes are generally neutral in their distributional impact, electricity and heating taxes tend to be regressive. In contrast, transport taxes were found to be progressive and hence represent a higher burden for upper income groups. The rationale for this is that lower-income households are less likely to be able to afford means of transportation, i.e. car ownership is lower for that income group. After accounting for the two counteracting distributional effects, energy taxation is deemed moderately regressive prior to considering any government schemes and tax benefits. A Cambridge Economics study (2008) found that if the tax revenue is recycled through cuts in employers' SSC, and if these reductions are big enough to boost employment and disposable income of households on the lower income spectrum, regressive side effects of environmental taxation could be completely avoided or at least considerably mitigated.

Other proposed alternatives that are frequently used in practice are subsidies or so-called targeted tax credits, which attempt to compensate low-income households for the impact of raising energy taxes. Apart from low-income households, these schemes also include pensioners, and to a lesser degree students, as they are not privy to the benefits of lower labour taxation yet experience higher energy prices.

1.2.2.2 Competitiveness concerns

A country unilaterally applying taxes to key production inputs such as energy immediately raises costs of production and is perceived as a source of competitive disadvantage for the economy's industry. The OECD defines competitiveness as "the degree to which a country can, under free and fair market conditions, produce goods and services which meet the test of international markets, while simultaneously maintaining and expanding the real incomes of its people over the longer term" (OECD, 1992). Sectors that are most vulnerable to adverse consequences are energy intensive, internationally oriented, and without price setting ability, meaning they cannot reflect higher input costs in their market prices.

If firms are to relocate due to fear of negative consequences such as losing market share, there would be no environmental improvement on a global level from the environmental policy, as the emissions would simply be transferred somewhere else. This phenomenon is referred to as carbon leakage with respect to energy and carbon taxation, or more generally pollution offshoring. Thus far, analysts have failed to find any evidence that carbon leakage has occurred in the EU, however the possibility that ETR impacted the structural composition of the economy, namely increased the relative size of the non-energy intensive industry compared to energy-intensive, exists and could have been masked in key indicators such as economic growth (Andersen et al., 2007).

While loss of competitiveness is a popular political argument to halt deeper environmental reform, empirical evidence has thus far failed to find any significant negative effects of green tax reforms on competitiveness due to all ETRs having built in protection for vulnerable industries, such as partial or total exemptions from environmental taxes. No changes in competitiveness of potentially vulnerable sectors were detected in 45 out of 56 cases analysed between 1990 and 2002 as part of the comprehensive Competitiveness Effects of Environmental Tax Reforms (hereinafter: COMETR) report (Andersen et al., 2007).

In fact, elaborate industry protection schemes have become a core component of ETRs, to the extent that stipulations had to be created in the Energy Taxation Directive to curtail the extent of permitted exemptions to 5, or a maximum of 10 years. From a sectoral perspective, energy intensive industries have at most been subject to a modest, unadjusted gross burden of 5 % of gross operating profit (Andersen et al., 2007). Additional calculations in the COMETR report have found evidence that energy taxes are less harmful to competitiveness than market energy price increases of the same magnitude, alluding to the positive behavioral stimulus described by Porter. Furthermore, the revenue recycling effect helps mitigate any potential loss in competitiveness by reducing indirect employer labour costs, garnering an overall positive employment effect, particularly for labour-intensive sectors.

A new competitiveness concern of double regulation was raised to the European Council when the EU created a trading system for emission certificates, as it was implemented on top of existing carbon-energy taxation. Studies predicted that from 2008 on, the emission trading system (hereinafter: ETS) will increase effective carbon dioxide (hereinafter: CO_2) costs per kilowatt hour for energy intensive industries that are included in the system to the level of smaller business users in countries with ETR. However, by granting tax refunds for entities included in the EU ETS, double pricing could be avoided.

Ultimately, it cannot be claimed that energy taxes do not have any impact on competitiveness of energy-intensive firms, as they tend to be net losers of revenue-neutral taxation shifts, while labour-intensive industries tend to be net winners. However, this impact may be grossly exaggerated due to additional factors such as: other price factors (transmission and distribution tariffs, exchange rates); non-price factors (infrastructure, production methods, education); and revenue recycling methods implemented (Barker, Ekins, Junankar, Pollitt, & Summerton, 2009).

1.2.2.3 Sustainability in the long run

While a positive behavioral response has been identified in studies which show that environmental taxes have much lower rates of tax evasion compared to other taxes, the EC maintains that "the overall potential for environmental tax revenue is limited and not high compared to taxes on labour or other indirect taxes such as VAT" (EEA, 2016). In particular, environmental taxes are seen as short term instruments to fix a certain externality-causing behavior, and hence if the tax is successful in altering consumption and production patterns, the tax base and consequently the tax revenue should be decreasing over time. This is known as tax base erosion. For instance, for EU countries to be able to sustain their transport fuel tax revenues at the current level, i.e. maintain constant share of tax revenues to GDP, at least a 4 % annual average increase of prices would be required in order to account for reduced fuel consumption and projected GDP growth (EEA, 2016), significantly above current annual increases. Another option would be to expand the tax base by enlarging the range of emission sources included, however this seen as administratively unfeasible given the higher complexity would significantly increase marginal administration costs (Metcalf & Weisbach, 2009).

Furthermore, environmental taxes tend to suffer from built in inefficiency arising from our inability to measure emissions and other environmentally degrading externalities. As such, taxes are rarely levied on the actual externalities but are instead associated with the purchase of a good or service. These imperfect proxies can result in inadequate behavioral responses, where for instance an output tax on electricity will incentivise lower electricity consumption rather than promote generating electricity with lower carbon emissions. In economic literature, these taxes are known as imperfect externality-correcting taxes (Christiansen & Smith, 2012). To circumvent this issue, policy makers have increasingly been drawn to multi-part instruments, where regulation can for instance help steer towards the desired behavioral response and correct for the shortcomings of taxes, however such instruments can be inefficient if policies are not harmonized.

1.2.3 Economic models and simulations

ETRs have been a popular topic amongst academics, with more than 45 studies and 104 simulations of ETRs in Europe published before 2001. The extensive modelling based literature is most often divided into computable general equilibrium (hereinafter: CGE) models and macro-econometric estimation models. CGE models such as the GEM-E3, AIM and GTAP are said to be based on strong assumptions from neoclassical economic theory and use fundamental microeconomic data such as preferences and resource constraints to model particularly long run outcomes. In contrast, macro-econometric models such as MDM-E3, E3ME, E3MG, GINFORS, and PANTA-RHEI are time series based, focusing on historic data rather than theoretical assumptions, and are most often used to model short term dynamics (Ekins & Speck, 2011).

Despite a rich body of work, there still lacks consensus on the economic effect such reform can have. In a comprehensive meta-analysis, Hoerner and Bosquet (2000) found that in 54 % of studies, ETRs were found to have no or a moderate positive impact on GDP, with the number climbing up to 67 % when revenue recycling was done through reducing employers' SSC. When the second dividend is defined as increased employment, 74 % of studies recorded a positive effect, with an even higher share when employers' SSC were reduced. The employment increase is conditioned on labour market flexibility, otherwise the outcome of ETR is a wage spiral. Similarly, unions can prevent the labour market from clearing after the reform is implemented, as they disrupt the wage setting mechanism (Heady, Markandya, Blyth, Collingwood, & Taylor, 2000).

The International Labour Organization (hereinafter: ILO) (2011) maintains that there are no necessary or sufficient conditions to guarantee that increasing environmentally related taxes while simultaneously reducing taxation of labour will boost employment, however pre-existing market conditions that were found to increase the chance of a double dividend were involuntary unemployment, tax system inefficiencies and non-optimal internalization of external costs (Andersen et al., 2007).

In the presence of involuntary unemployment, the OECD (2004) identifies a further six factors that are associated with a higher occurrence of the employment dividend:

1. the ability to pass on the environmental tax to factors that are inelastically supplied and relatively under-taxed;
2. a significant portion of non-working households are consumers of goods produced with the taxed environmentally intensive inputs;
3. international market power of industry to raise the price of goods produced with a relatively intensive use of the taxed environmental input;
4. capital is relatively immobile internationally and can absorb some of the environmental tax burden from factors such as labour;
5. elasticity of substitution between the environmental input and labour is greater than the elasticity of substitution between energy and capital;
6. real wage increases in response to unemployment reductions are small, so that wage increases do not offset reduced labour taxes.

2 ANALYSIS OF ETR IN THE EU

2.1 Developments and trends in the EU

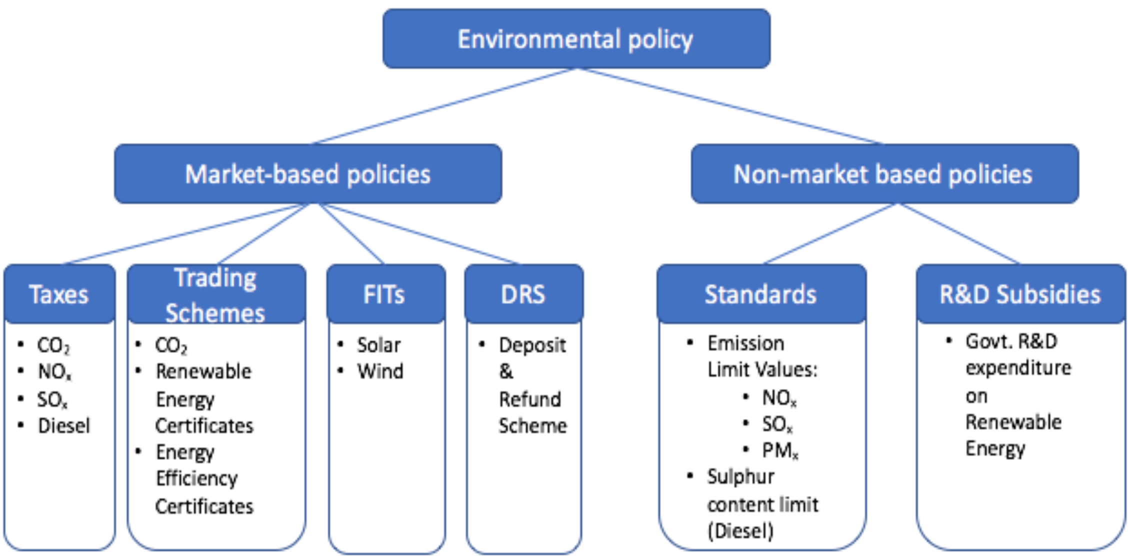
2.1.1 EU environmental policy instruments

The EU has one of the most developed and restrictive environmental policies in the world, with ambitious plans to steer economies of member states towards a more sustainable and environmentally friendly future. While some standards and targets are set at the EU level, countries still have the autonomy to dictate their own policy mix. Within the wide set of policy instruments to pursue environmental protection one can distinguish two main categories of instruments: market based and non-market based. Market based instruments (hereinafter: MBIs) are policy instruments relying on fiscal economic instruments to provide incentives for shifting away from environmentally harmful activities towards more sustainable alternatives. In economic terms, this refers to taxes, charges, and tradable permits, which change the price of the original emitting process by adding costs stemming from environmental degradation, thus influencing the economic incentive structure and behaviour with the ultimate goal of reducing or better yet eliminating environmental negative externalities.

A tax is said to cover "any compulsory, unrequited payment to general government levied on tax bases deemed to be of particular relevance. Taxes are unrequited in the sense that benefits provided by government to taxpayers are not normally in proportion to their payments" (OECD, 2010). Furthermore, an environmental tax is statistically defined as "a tax whose tax base is a physical unit (or a proxy of it) of something that has a proven, specific, negative impact on the environment" (Eurostat, 2013). Defining the tax base for environmental taxation is commonly linked to the polluter pays principle, which requires the cost of pollution to be borne by those who cause it, and is the foundation of European environmental policies. Tariffs or user charges, also an MBI, differ from taxes in that they are based on the user-pays principle, representing a direct charge for the provision and delivery of a specific service (e.g. water supply, wastewater, waste, etc.). Charges and fees are in turn defined by the EC as "compulsory and requited payments to general government or to bodies outside general government, such as environmental funds or water management boards" (EC, 2001). Tradeable permits in the EU fall within the realm of the EU ETS, which is the first and largest scheme in the world, allowing firms to purchase additional allowances of pollution above the prescribed cap. Subsidies are also a key MBI, however in contrast with taxes and tax like instruments which are the focus of this thesis, they aim to boost the production and consumption of inputs and goods with favourable environmental properties.

Alternatively, non-market based instruments impose regulations or non-monetary incentives to sway behavioural change. Figure 3 illustrates the most common types of instruments used in environmental policies of EU countries, where most rely on a policy mix of market and non-market instruments. The Institute for European Environmental Policy (hereinafter: IEEP) defines this as a hybrid policy approach, which aims to surpass cost effectiveness concerns from non-market instruments and issues of acceptance and environmental effectiveness from MBIs (IEEP, 2013).

Figure 3. Environmental instruments in the EU policy



Source: E. Botta & T. Kozluk, *Measuring Environmental Policy Stringency in OECD Countries: A Composite Index Approach*, 2014, p. 21.

Presently, EU member states have committed to 82 binding targets and 84 non-binding environmental objectives for the 2013–2050 period, some of which explicitly tackle socio-economic and environmental issues together. There are 9 policy areas that reflect EU environmental goals, specifically "energy, greenhouse gas emissions and ozone depleting substance, air pollution and air quality, transport (greenhouse gas emissions and air pollutants) and noise, waste, water, sustainable consumption and production, chemicals, biodiversity and land use" (EEA, 2016).

To achieve environmental policy goals, 18 binding and 24 non-binding MBIs are in place based on current EU environmental legislation. MBIs are classified into five, non-mutually exclusive categories (EEA, 2016): general and mixed instruments; taxation and environmental tax reform; tariffs, fees, charges and pricing policies; tradeable permits and quotas; and producer responsibility schemes.

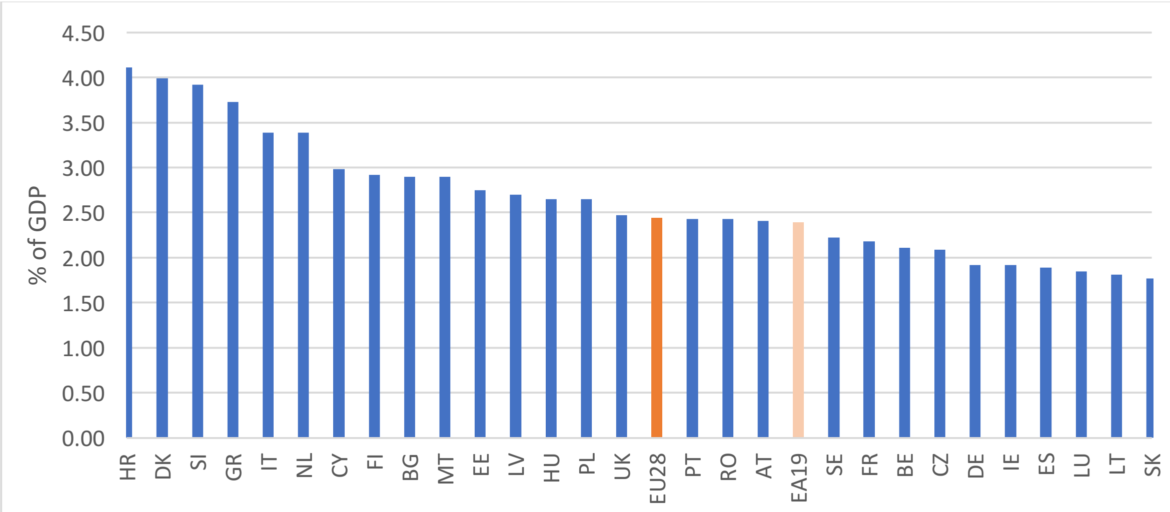
Currently only two tax based non-binding MBIs exist in European environmental policy, both of which address the energy sector. The Directive 2012/27/EU permits the usage of carbon and energy taxes to achieve end-use energy consumption savings if they are equivalent to the stipulated 2020 energy saving targets for energy efficiency obligation schemes (EEA, 2016).

2.1.2 Key trends and policy developments

Despite limited EU level policy instruments, environmental taxation and ETR programmes have been in recent years consistently moving up on the political agenda, as demonstrated by the Europe 2020 strategy and several EU policy documents (EEA, 2016). Environmental taxes have been shown to be less distorting in terms of economic behaviour compared to labour and corporate taxes, with significantly lower rates of evasion and administrative costs than income and value added taxes (hereinafter: VAT) (EEA, 2016).

For instance, Sweden reports a carbon tax evasion rate of only 1 % and in the United Kingdom (hereinafter: UK), a 2 % evasion level was recorded for energy taxes, compared to the 17 % evasion facing income taxes (Fay, Hallegatte, Vogt-Schilb, Rozenberg, Narlock, & Kerr, 2015). Additionally, the German Ministry of Finance estimates administrative costs to be 0.13 % of revenues and in the UK between 0.21 and 0.34 %, significantly lower than income tax costs of 1.27 % and VAT costs of 0.55 % of collected revenues (Milne & Andersen, 2012). On average, EU countries collect more than 2.4 % of GDP with environmental taxes, with Slovenia, Denmark, and Croatia raising the most with about 4 % and Slovakia and Lithuania the least with only about 1.8 %, as per Figure 4.

Figure 4. Environmental taxes as % of GDP in 2015



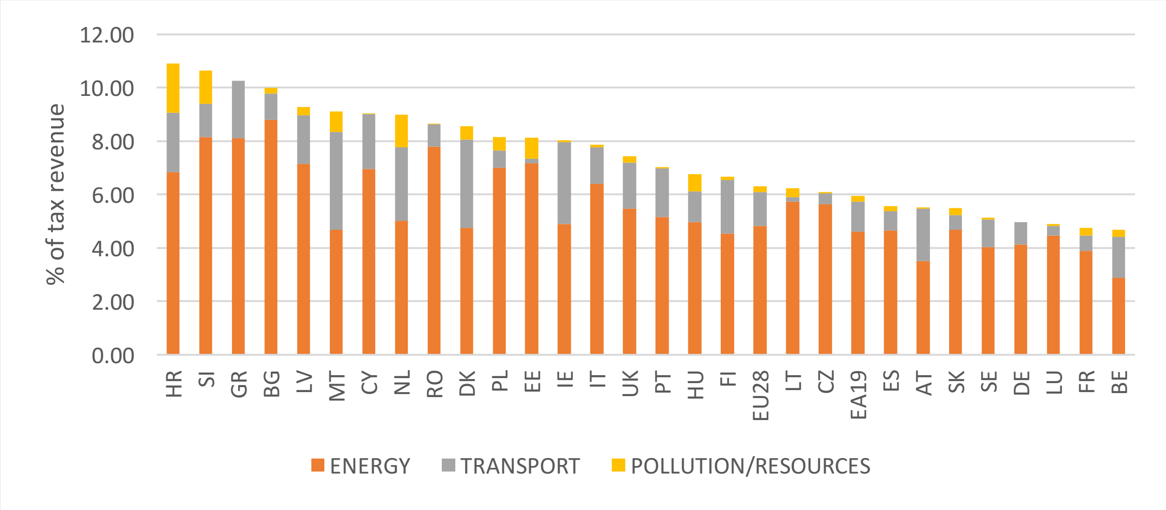
Source: Eurostat, *Environmental taxes,* 2017a.

Eurostat (2013) categorizes environmental taxes as: energy taxes (including fuel for transport); transport taxes (excluding fuel for transport); pollution taxes; and resource taxes. Energy taxes constitute of taxes on energy products and energy production. Most important energy products used for transport are petrol and diesel, while notable energy products for stationary use are electricity, coal, natural gas and fuel oils, including biofuels and renewable energy sources. Eurostat classifies CO_2 taxes as a form of energy taxation rather than pollution taxation due to carbon taxes in practice being associated with energy taxes and are otherwise hard to isolate, with CO_2 taxes being either a substitute for other energy taxes or are integrated within them (EC, 2001). Approximately 73 % of energy tax revenues in the EU are collected from transport fuel, with Slovenia, Italy and Greece having the highest overall energy tax revenue at about 3 % of GDP (Eurostat, 2017b).

Each type of environmental tax has corresponding tax bases on which it is levied (Eurostat, 2013). Taxes which will be the most significant in terms of revenue are those that have a broad tax base, such as energy or fossil fuels, while pollution and resource taxes are seen as having a relatively narrow base. Hence, it is no surprise that in practice, EU countries have been mainly levying energy, carbon and transport (vehicle) taxes, seen in Figure 5. To a lesser extent, countries are applying taxes to combat resource use, air and water pollution, while most countries use other instruments to address waste management (EEA, 2016).

For EU 28, 76 % of all environmental tax receipts were from energy taxes, 20 % from transport taxes and 4 % from pollution and resource taxes, and hence going forward the focus will be on energy, carbon and vehicle taxation schemes.

Figure 5. Environmental taxation breakdown in 2015



Source: Eurostat, *Environmental taxes,* 2017a.

It is interesting to note that transport fuel taxes have been a key revenue generating tool for EU countries since as early as the 1930s, while energy taxation aimed at achieving environmental objectives became widespread only from the 1980s onward (EEA, 1996). The EC tried to further promote energy taxation schemes as instruments to combat climate change by proposing an EU-wide carbon and energy tax in 1992, but was rejected by member states. In 1997, the EC submitted a revised energy products taxation proposal that omitted the prospect of an EU-wide carbon and energy tax, and rather focused on existing frameworks of mineral oil taxation in member states and its extension to include all energy products present in the internal market (Wier, Birr-Pedersen, Klinge Jacoben, & Klok, 2005). Following lengthy discussions, a significantly diminished version of the 1997 proposal was accepted as the Energy Taxation Directive in 2003 by the Council of Ministers. The Directive, which legally obliges member states to transpose it into national law, widened the scope of taxation to include energy products such as electricity, natural gas and coal, and prescribed minimum taxation rates (Speck, 2008).

Despite the Energy Directive prescribing certain levels of broad base energy taxation, EU member states preserved the right to design their national energy and carbon taxation regimes, with new member states granted a transition period under the European Council Directive 2004/75/EC. The difference in energy taxation schemes between older and newer member states is represented in Table 1, where there is a clear tendency by newer members to rely on fuel taxation for revenues, while older member states have already in 2007 been applying a wide array of taxes on energy products.

Table 1. Share of energy taxation in total taxation revenues, 2007 and 2014

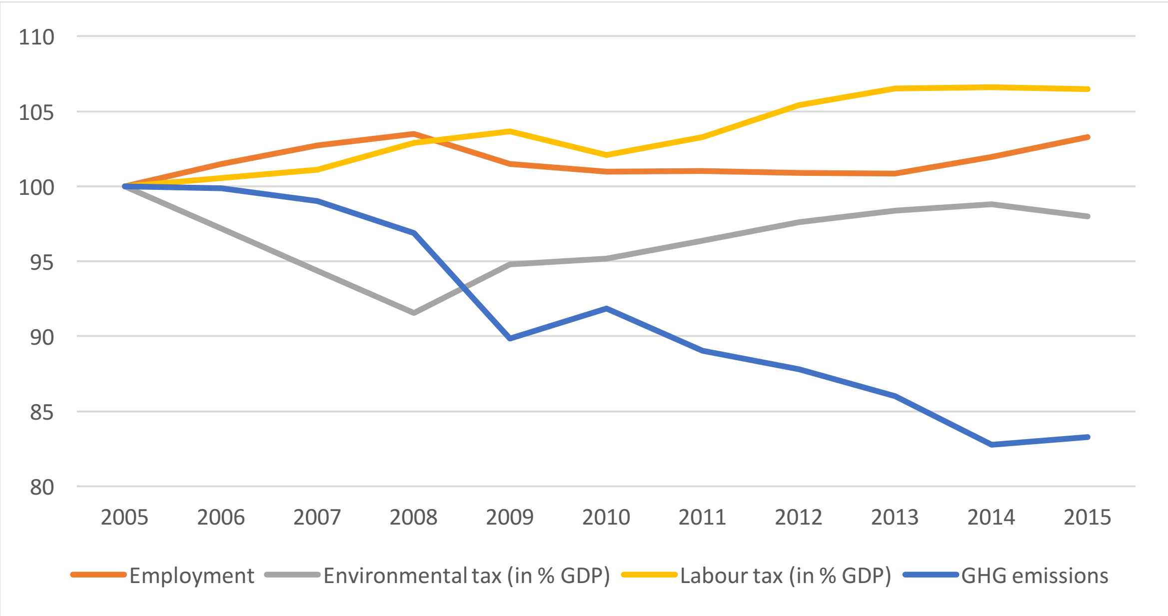
	2007		**2014**	
	Transport Fuel (%)	**Other energy (%)**	**Transport Fuel (%)**	**Other energy (%)**
EU 28	3.6	0.9	3.4	1.5
Belgium	2.7	0.4	2.4	0.3
Bulgaria	8.7	0.3	8.2	0.4
Czech Republic	5.9	0.3	5.2	0.6
Denmark	2.4	2.6	1.8	2.9
Germany	3.7	1.1	3.2	1.2
Estonia	5.5	0.2	5.9	1.3
Ireland	3.5	0.2	3.5	1.5
Greece	3.4	0.4	5.2	3.0
Spain	3.2	0.5	3.4	1.2
France	2.9	0.5	2.4	1.1
Croatia	5.2	0.3	5.8	0.5
Italy	3.4	1.7	3.6	3.2
Cyprus	3.6	1.1	5.9	1.0
Latvia	5.6	0.0	5.9	1.4
Lithuania	5.2	0.1	5.7	0.0
Luxembourg	6.5	0.1	4.8	0.1
Hungary	4.5	0.5	4.4	0.6
Malta	5.0	0.1	3.7	0.9
Netherlands	3.2	1.5	3.0	2.1
Austria	3.0	0.9	2.8	0.7
Poland	5.9	0.8	6.1	0.6
Portugal	5.8	0.3	4.4	0.5
Romania	5.0	0.8	6.1	1.7
Slovenia	5.7	0.3	7.1	1.1
Slovakia	6.1	0.7	4.6	0.2
Finland	3.0	0.8	2.9	1.5
Sweden	2.6	2.0	2.3	1.8
United Kingdom	4.4	0.7	4.2	1.3

Source: Eurostat, *Environmental taxes,* 2017a.

Since the process of liberalization of the electricity and gas markets began in the EU, the way energy taxes are levied was changed to comply with the legislation of a single energy market. While before taxes were often applied on the "carbon-content of the primary energy used to generate the electricity", they are now applied to electricity consumption, which has spurred some concern about weakening the incentive to reduce carbon emission by treating all electricity sources equally (EC, 2001). The EU addresses this with a provision on the taxation of energy products and electricity in fiscal legislation, more specifically with Directive 2003/96/EC, granting member states the ability to apply exemptions or reductions in the level of taxation for renewable and environmentally friendly electricity sources (EEA, 2016).

There was a significant drop in the prominence of energy and carbon taxes in environmental policy with the launch of the EU ETS in 2005. The scheme covered approximately 50 % of CO_2 emissions in the EU and was seen as the key policy instrument to achieve emission goals set out in the Kyoto Protocol. The trading scheme, combined with rising oil prices halted any development of energy taxes, with many European countries calling for rate reductions in 2008 (Speck, 2008). Following 2008, environmental tax revenues recovered in the EU as they played an important role in addressing budget deficits (Figure 6), however, in 2015, were as a share of GDP lower than in 2005.

Figure 6. Development of employment, emissions, and taxation in the EU (2005=100)



Source: Eurostat, *Environmental taxes,* 2017a; OECD, *Green Growth Indicators*, 2017a.

In contrast, labour taxes have also been increasing despite arguments proposing lowering the labour tax burden gaining traction in the years following the economic crisis. The implicit tax rate on labour has actually been trending upwards since 2009. In 2016, the EU 28 average was 47.2 %, up by 6.4 percentage points from 2009. Similarly, the average top personal income tax rate in the EU was 39 % or 0.9 percentage points above the 2009 level (EC, 2017). Greenhouse gas emissions fell by 22 % between 1990 and 2015, while at the same time the EU recorded 50 % growth in its economy. The EU progress report confirmed that member states remain on course to meet the 2020 emission reduction target, however also noted that while industrial emissions are declining, transport emissions seem to be trending upwards and need to be addressed (EC, 2016).

2.2 Country analysis

2.2.1 Countries that implemented ETRs

With labour based taxes constituting an overwhelming revenue source in 1980s and 1990s Europe, countries were faced with high unemployment rates and looking for ways to boost their economies. Significant tax reforms were undertaken in the 1990s with hopes of reducing labour costs and pursuing broad based taxes such as general consumption taxes (e.g. VAT and environmental taxes). While in the Nordic countries environmental protection and climate change concerns were already gaining momentum at that time, perhaps the key to ETR gaining traction as a policy instrument on the political stage was the EC stating in a seminal report that "if the double challenge of unemployment and pollution is to be addressed, a swap can be envisaged between reducing labour costs through increased pollution charges" (EC, 1994).

Six EU countries committed to explicit ETRs between 1990 and 2000, more specifically Sweden, Denmark, the Netherlands, United Kingdom, Finland, and Germany. At the time, according to European standards, these countries had average energy efficiency and jointly accounted for approximately 9 % of world carbon emissions (Hoerner & Bosquet, 2000), however had above average levels of labour taxation. Despite only 20 % of total CO_2 emissions stemming from direct private energy consumption of households and the rest arising from production processes, the majority of ETRs provided significant tax exemptions for industry, de facto focusing the tax burden on households (ILO, 2011). Most ETR packages pursued the environmental goal of reducing carbon emissions by taxing transportation activities and direct private energy consumption while cutting employer SSC to lower the cost of labour and spur job creation.

The majority of the six countries from the first wave of green taxation reforms in Europe extended their ETR policy instruments to cover the period post 2000, while Estonia and Czech Republic joined the second wave of ETRs by modelling their reform on the experiences from the first wave. For a summary of implemented ETRs, see Appendix A. Slovenia is often included in ETR discussion without formal commitment to the instrument due to energy taxation restructuring in 1997 to reflect a carbon component, and hence will also be considered for analysis.

2.2.1.1 Sweden

The Swedish energy taxation scheme has been developing in complexity since the implementation of petrol taxes in 1917 and taxes on diesel in 1937 (Speck & Jilkhova, 2009). By the early 1990s, Sweden had already four different types of taxes: taxes on energy products (particularly mineral oil), CO_2, sulfur (hereinafter: SO_2), and nitrogen (hereinafter: NO_X). In 1991, Sweden implemented the first major ETR in Europe as part of a large scale fiscal reform aimed at reducing personal income taxes. While short run deficits were expected, the reform aimed to be budget neutral in the long run (Speck & Jilkhova, 2009). The ETR was structured into two 10 year phases (Andersen et al., 2007):

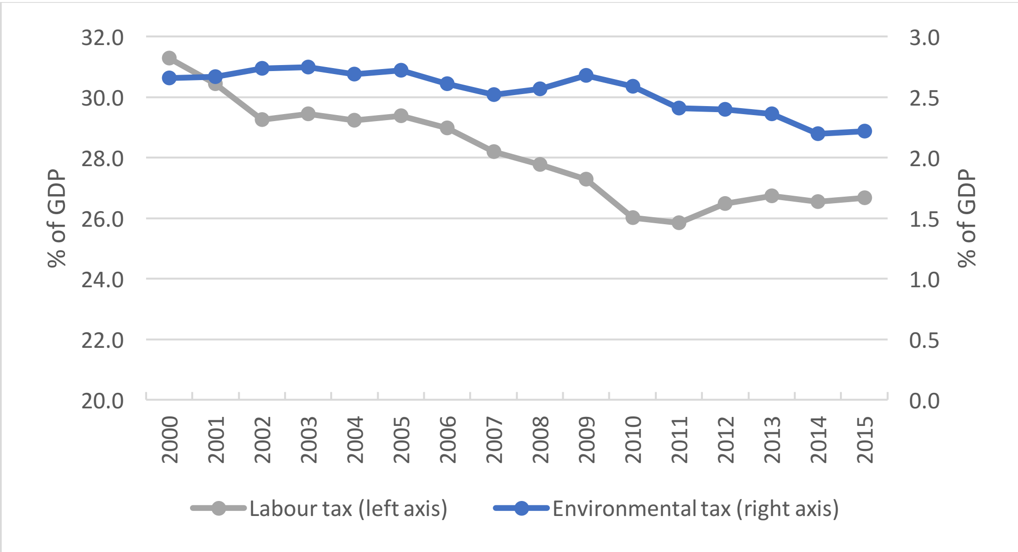
- **Phase I** began in 1991 and ended in 2000, with the goal of channeling 9.5 billion euros (hereinafter: EUR) or 4.6 % of GDP in 1991 into reducing personal income taxes (hereinafter: PIT) from 36 % to 31 % of GDP. This was intended to significantly reduce prior marginal tax rates as high as 80 % to 30 % for low income earners and 50 % for high income earners. To offset this shortfall, CO_2 taxes of 23 EUR per tonne of emissions and SO_2 taxes were introduced, as well as a VAT was levied on energy purchases. The fiscal reform anticipated to be revenue negative, as PIT revenues significantly exceeded the 2.4 billion EUR (1.2 % of GDP in 1991) raised with environmental taxes. The introduction of the carbon tax at first led to a significant increase of the implicit tax rate on energy as no special provisions were granted for the Swedish industry apart from a tax ceiling on the total energy tax burden. However, in 1993, the tax scheme was revised to include special provisions, causing a significant revenue fallout. For example, the manufacturing industry was completely exempt from paying energy taxes and enjoyed a reduced CO_2 tax burden of 25 % in 1993 and 50 % in 1998.

- **Phase II** ran from 2001 until 2010, with the government aiming to lower tax burdens for low and medium income groups, and to promote environmental sustainability of the economy. A tax shift of 1.6 billion EUR was recorded in the first four years, while the latter six years of the programme reduced labour taxes by a further 1.3 billion EUR and increased environmental tax revenue by 0.5 billion EUR (IEEP, 2013). Special tax provisions were carried over from the first phase, with the manufacturing industry paying only 35 % of CO_2 taxes in 2001. In 2008 however, the overall objective of energy and CO_2 taxation changed from tax-shifting to environmental protection, leading to the removal of several exemptions protecting energy-intensive industries, as well as to a major increase in the CO_2 tax level, which in 2010, was raised to 108 EUR per tonne of emissions (IEEP, 2013).

Between 1990 and 2007, it is estimated that CO_2 emissions were reduced by 9 % or at a rate of 0.5 million tonnes per annum. The Swedish economy grew by 48 % and employment was increased by 0.5 %(Cottrel, Mander, Schmidt, & Schlegelmilch, 2010). Businesses impacted by the ETR increased investments by 1.5 % in 2006 (Andersen et al., 2007), and most income groups saw a rise in real income of up to 1 % (EEA, 2011). Slight regressive tendencies were detected with the CO_2 tax, as income of the lowest decile was decreased by 0.46 percentage points more than that of the highest earning decile, particularly pronounced in rural populations (Cottrel et al., 2010). Overall, Sweden was able to successfully achieve both its environmental goal of reducing emissions and lower the tax burden on labour.

Since the end of the ETR, the country has been continually increasing its carbon tax rate, reaching the highest level in Europe in 2012 at 118 EUR per tonne of emissions (EC, 2017). However, a drop in environmental tax revenues was detected in 2011, shown in Figure 7, partly due to the government redesigning the carbon-energy tax system to increase coordination with the EU ETS. Carbon emissions included in the ETS are excluded or taxed at a reduced rate to prevent double taxation, which can help account for the slight decreasing trend of environmental revenues.

Figure 7. Labour and environmental tax revenues in Sweden, 2000–2015



Source: Eurostat, *Environmental taxes,* 2017a; OECD, *Green Growth Indicators*, 2017a.

2.2.1.2 Denmark

Denmark was one of the first European countries to introduce an explicit ETR, and is regarded to have achieved one of the largest tax shifts, amounting to 3 % in terms of GDP and 6 % of total tax revenue (Bosquet, 2000). With already existing energy taxes on electricity consumption, coal and oil products, Denmark introduced a CO_2 tax on consumption of energy products in 1992 for households and 1993 for businesses. The reform itself was structured in three distinct phases (Andersen et al., 2007):

- **Phase I** was introduced in 1992 and covered the period 1994 to 1998. While the focus of this phase was the household sector, businesses and subsequently special tax provisions were also included. Between 1993 and 1995, industry faced a reduced, 50 % lower tax rate on CO_2 of 50 kroner (hereinafter: DKK) per tonne of CO_2, which was supplemented by a three-tiered reimbursement scheme based on energy intensity of businesses. Refunds were to be awarded based on actual energy costs paid relative to total sales. Marginal tax rates on personal income were decreased resulting in revenue loss of approximately 45 billion DKK or 2.3 % of GDP in 1998. To offset the income tax revenue depletion, the newly established CO_2 tax and other environmental taxes raised revenues in the amount of 1.2 % of GDP while payroll taxes, stemming from increased employment, provided increased revenues of 1 % of GDP. The CO_2 tax generated the most of the 7.5 billion DKK raised from increasing energy taxes, while 4.5 billion DKK came from introducing smaller-base taxes, such as a wastewater tax, tax on tap water, and tax on paper and plastic bags.

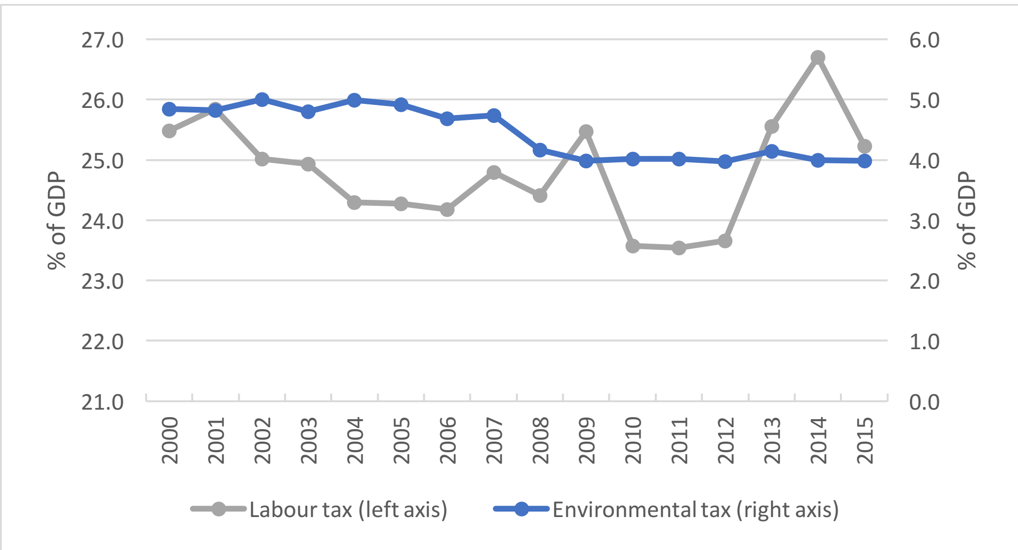
- **Phase II** was introduced in 1995 and covered the period 1996 to 2000. This time, the focus was industrial energy consumption, which was targeted by levying a reformed CO_2 tax, a newly introduced SO_2 tax, and to a smaller extent a natural gas tax. In turn, employers' SSC were reduced (i.e. reducing employers' contribution to the additional labour market pension fund by increasing government reimbursement amounts by 159 DKK) and subsidies for investment in energy efficiency programmes were introduced, combining for tax shifting of 2.54 billion DKK or 0.2 % of GDP in 2000. The same year, 85 % of tax revenues were recycled back to industry and only 13 % to households (Speck & Jilkova, 2009). The industry refund scheme from phase I was readjusted, where industrial energy consumption was now subdivided into heavy processes, light processes and space heating. Space heating was to be taxed at the same rate as households (i.e. full energy and CO_2 tax rates) while other activities were exempt fully from energy taxes and enjoyed reduced CO_2 tax rates.

- **Phase III** was introduced in 1998 for the period 1999–2002, and was designed to be revenue positive in the amount of 6.4 billion DKK or 0.3 % of GDP in 2002, and revenue neutral in the long run. As this third phase was associated with raising energy taxes (natural gas by 33 %, electricity by 15 %, diesel by 16 %, coal by 12 %, petrol and fuel oil by 5–7 % between 1999–2002), the programme targeted mainly households, since industrial energy consumers only paid energy taxes on space heating. The tax shift increased the above mentioned energy taxes and to a lesser extent corporate taxes, while reducing personal taxes, such as taxes levied on pension savings yields, and corporate tax on share yields.

All three phases of Danish tax reform employed a recycling mechanism that clearly distinguished the contributions of households and industry, ensuring that no cross-subsidisation occurs i.e. each economic sector receives back the amount they paid due to reforms in the form of tax cuts. For households, the implemented ETR was found to be regressive, as the newly implemented green taxes reduced the after-tax disposable income of the poorest decile by 0.5 percentage points more than of the richest decile (Wier et al., 2005). This effect was even more pronounced for rural households. However, this policy reduced CO_2 emissions by 24 % between 1990 and 2001, with industrial producers reducing CO_2 emissions per unit by 25 % (Withana, ten Brink, Kretschmer, Mazza, Hjerp, & Sauter, 2013). At the same time, no effect on the competitiveness of firms was found, as energy intensive industries were granted tax rebates of around 75 % and the cost of labour was reduced by 1.4 percentage points between 1995 and 2000 (Speck & Jilkova, 2009).

Following the 2001 parliament election, the Danish right wing government introduced a total tax freeze between 2002 and 2007, decreasing the real value of environmental tax rates until 2008. In that year, the Danish government proposed the 'Spring Package 2.0', which was meant to be a ten year (2010–2019) ETR programme geared towards helping Denmark achieve its goal of reducing greenhouse gas emissions by 40 % in 2020 compared to 1990 (Bragadóttir, von Utfall Danielsson, Magnusson, Seppänen, Stefansdotter, & Sundén, 2014) and tackle the rising labour costs. Akin to the earlier ETR phases, PIT would be reduced while energy and transport taxes increased. Following the election of a new government, along with a report by the Ministry of Economic and Business Affairs expressing concerns that additional taxation could damage industrial competitiveness, the 'Spring Package 2.0' was re-worked to lower overall taxation levels by 55 % compared to the original plan. This proposal was later repealed in a parliamentary vote and a new act was accepted, which lowered energy taxes on electricity used for heating (by 1 billion DKK) as well as increased income taxation (by 3.4 billion DKK) stating fiscal reasons. Environmental fiscal reform in Denmark took an even further step back in 2013, when politicians agreed to an economic growth plan, a part of which was to eliminate two taxes on electricity as well as lowering energy taxes for business processes to the prescribed EU minimum level (Danish Ecological Council, 2014). These political developments can be identified in the trend of labour and environmental tax receipts in Figure 8.

Figure 8. Labour and environmental tax revenues in Denmark, 2000–2015



Source: Eurostat, *Environmental taxes,* 2017a; OECD, *Green Growth Indicators*, 2017a.

2.2.1.3 Netherlands

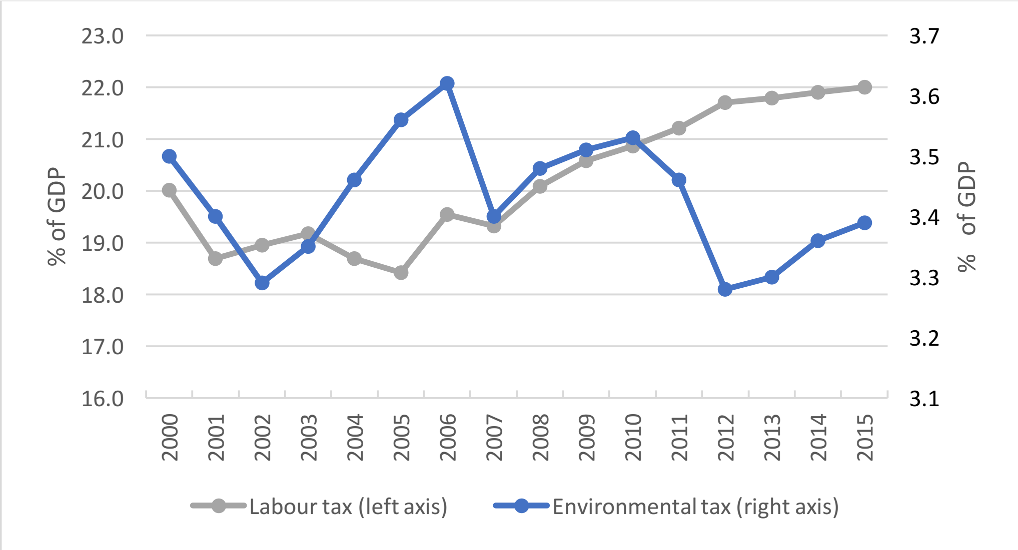
The Dutch government has been running some form of ETR since 1991, with several revisions, until finally committing to a formal ETR in 1998. The revenue neutral policy stepped into effect in 1999, with taxes on energy products (energy and CO_2) raising 3.2 billion EUR of revenues or 0.7 % of GDP in 2001. Revenues were recycled back to households by raising the tax-free allowance by 36.3 EUR, raising senior citizens' standard deduction by 45.4 EUR, and reducing the rate charged above the first income bracket by 0.6 %. In contrast, the industry saw a 0.19 % reduction of employers' SSC, a 3 % reduction of the corporate tax rate for the first 45.378 EUR and a 590 EUR raise in tax credit for the self-employed (Andersen et al., 2007). These revenue recycling mechanisms were found to have a small positive impact on employment, generating 9000 new jobs accounting for roughly 0.9 % of the active workforce size (IEEP, 2013).

The energy taxation scheme, on which the ETR was based, differentiates the tax rate between seven consumption levels for natural gas and six levels for electricity, with the highest level defined as consuming more than 10 million kilowatt hours per year (Andersen et al., 2007). Energy intensive industries, based on their consumption level, were exempt from or enjoyed significantly reduced rates on energy and fuel taxation under the condition that they signed long term voluntary agreements to improve energy efficiency with the Dutch government.

The Dutch ETR is often cited as a real life example of how regressive tendencies of ETR design can be neutralized in practice by implementing appropriate revenue recycling measures and exemptions. Household energy consumption was initially only taxed above a certain basic level due to a tax-free allowance, and beginning with 2001, a tax refund scheme was implemented on household electricity bills. In 2001, households received a tax rebate of 142 EUR, while in 2013, the per annum amount climbed to 319 EUR. In addition, the Dutch government funneled 15 % of revenues towards subsidies for energy efficient household appliances (EEA, 2011).

Since the implementation of the ETR, environmental tax revenues in the Netherlands have been very volatile, shown in Figure 9. While the Dutch are said to have the highest environmental taxes in the world, their tax structure is not well aligned with the costs of overall environmental damage. For instance, tax rates on fossil fuels, particularly coal are deemed to be significantly below the optimal level, while taxes on natural gas and electricity for households are disproportionally above the cost of environmental degradation they cause.

Figure 9. Labour and environmental tax revenues in the Netherlands, 2000–2015



Source: Eurostat, *Environmental taxes,* 2017a; OECD, *Green Growth Indicators*, 2017a.

Furthermore, by shifting most of the environmental tax burden to consumption rather than production, the tax base is not very stable as behavioural shifts away from polluting goods can erode the tax base and the potential to generate revenues (Netherlands Environmental Assessment Agency, 2017).

2.2.1.4 UK

The UK energy tax system has been heavily focused on transport fuel taxation since the 1990s and the inception of the road fuel escalator system, placing UK transport fuel taxes amongst the highest in the world. The so-called fuel duty escalator (hereinafter: FDE) was introduced in 1993, and increased the tax rates on fuel at the following annual rates: 3 % in 1993–1994, 5 % between 1994–1995 and 1997–1998, and 6 % between 1998–1999 and 1999–2000 (Cottrel et al., 2010). This scheme increased tax revenues from 12.5 billion pounds (hereinafter: GBP) in 1993 to 23 billion in 2020. At the same time, the UK government devoted approximately 7 billion GBP to reduce the standard income tax rate by 1 percentage point in the years 1995, 1996, and 1998; however FDE and income tax cuts were never explicitly linked (i.e. implicit ETR). The FDE was discarded in 2000 following significant protests over the high level of prices, which gave rise to new environmental taxes.

The UK deviated from the other countries in that they introduced three, relatively small scale ETRs, all of which were designed to target businesses rather than households. In turn, they offered a reduction in employers' national insurance contributions. In 1996, a Landfill Tax was introduced as part of the first ETR, charging businesses and local authorities for disposing waste in landfills (84.4 GBP per tonne of waste). Revenues were intended to reduce employers' SSC, with a small fraction earmarked to establish a special fund supporting investment in waste related research and activities. The scope of this ETR however was fairly minor, shifting only 0.05 % of GDP in 2005 (Andersen et al., 2007).

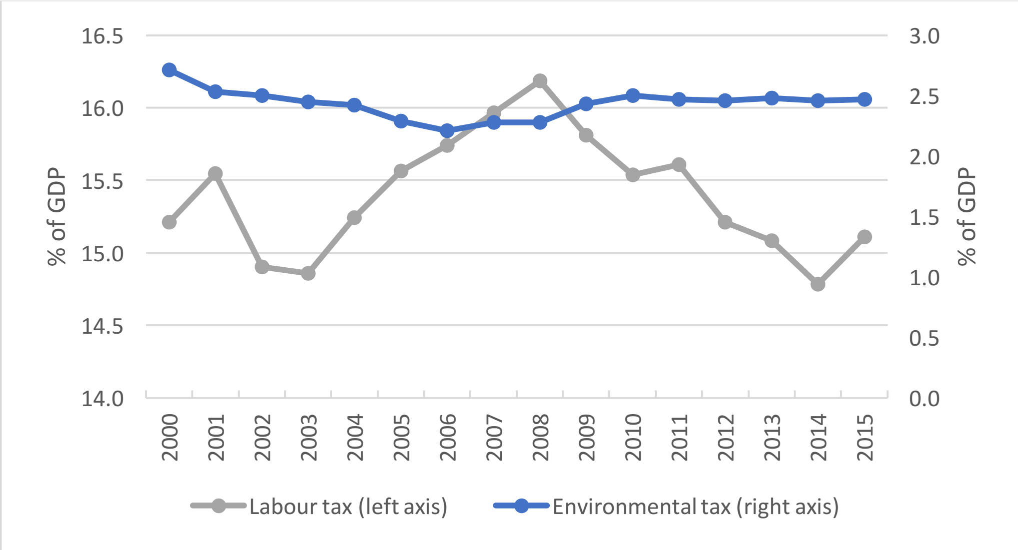
The second ETR, planned to be the largest of the three programmes, was based on the Climate Change Levy (hereinafter: CCL) that was introduced in 2001. The CCL is applied to electricity, gas and solid fuels (e.g. coal, lignite, coke, and petroleum coke). While revenue neutrality was initially planned, the CCL was revenue negative between 2001 and 2007 as the levy generated less revenue than needed for the provisioned reductions in national insurance contributions (Andersen et al, 2007). This ETR shifted 0.06 % of GDP in 2005 and approximately 0.1 % in 2010 or 5.23 billion GBP. Some economists link this to the fact that the CCL was only levied on industrial and commercial use of energy, while at the same time energy intensive companies were granted tax reductions of 80 % if they agreed to legally binding targets for energy efficiency improvement also known as Climate Change Agreements (OECD, 2005). Ex post analysis showed that these exemptions unnecessarily reduced the scope of the reform, as applying the full tax rate to all businesses would not have negatively impacted economic performance (Martin, de Preux, & Wagner, 2009). In April 2013, a carbon price floor (hereinafter: CPF) was implemented to help achieve revenue neutrality and broaden the tax base. Tax exemptions, particularly for owners of electricity generating stations and combined heat and power stations, were replaced with a carbon price rate (hereinafter: CPS). The CPS combined with the EU ETS price determined the target CPF. The CPF was initially set at 16 GBP per tonne of CO_2 and is expected to rise progressively to 30 GBP and 70 GBP per tonne of CO_2 in 2020 and 2030 respectively (IEEP, 2013).

The smallest scale ETR, shifting only 0.02 % of GDP, was implemented in 2002 with the Aggregates Tax, which is a tax of 2 GBP per tonne of sand, rock or gravel. Apart from reducing employers' SSC, 5 % of revenues were used to establish a special Sustainability Fund (Andersen et al., 2007).

Since all three ETRs were targeting industrial polluters, there is no evidence to suggest regressive consequences of the reforms on households. Furthermore, no negative impact was recorded on GDP or employment, while a positive trend in innovation and energy efficiency was detected (Withana et al., 2013). Overall, CO_2 emissions were reduced by almost 25 % in comparison to 1990, with energy intensive industry accounting for 30 % of this decline (Andersen et al., 2007).

Figure 10 shows that the UK has been sustaining its level of environmental receipts in terms of GDP relatively constant since 2000, and apart from a brief trend reversal during the height of the economic crisis, the tax burden on labour has been declining or maintained at pre-crisis levels.

Figure 10. Labour and environmental tax revenues in the UK, 2000–2015



Source: Eurostat, *Environmental taxes,* 2017a; OECD, *Green Growth Indicators*, 2017a.

This can be attributed to the way UK designed its ETRs. Rather than defining time frames for each phase of the ETR as was the practice in other countries, the revenue recycling mechanism in the UK is linked directly to a specific levy. Hence, there is an automatic device that earmarks tax revenues from the CCL, Aggregates tax, and Landfill tax for reducing labour taxation and promoting investments in energy efficiency, rather than it being an exceptional measure.

2.2.1.5 Finland

Finland implemented its first green tax reform only in 1997, however it was the first European country to introduce a carbon tax in 1990 at 1.2 EUR per tonne of CO_2, with expectations that it will be regularly increased. The CO_2 tax was imposed on all energy products, except transport fuels as they were already taxed with an oil pollution fee and precautionary stock fee (Andersen et al., 2007). Until 1994, the tax was levied according to the carbon content of the energy product, between 1994 and 1996 it was amended to also include the energy content of the energy product (the ratio changed from 60 % carbon content and 40 % energy content in 1994 to 75 % and 25 % respectively in 1996), and in 1997 it reverted back into a pure CO_2 tax (Andersen et al., 2007). The ETR reform was carried out in two phases (Hoerner & Bosquet, 2000):

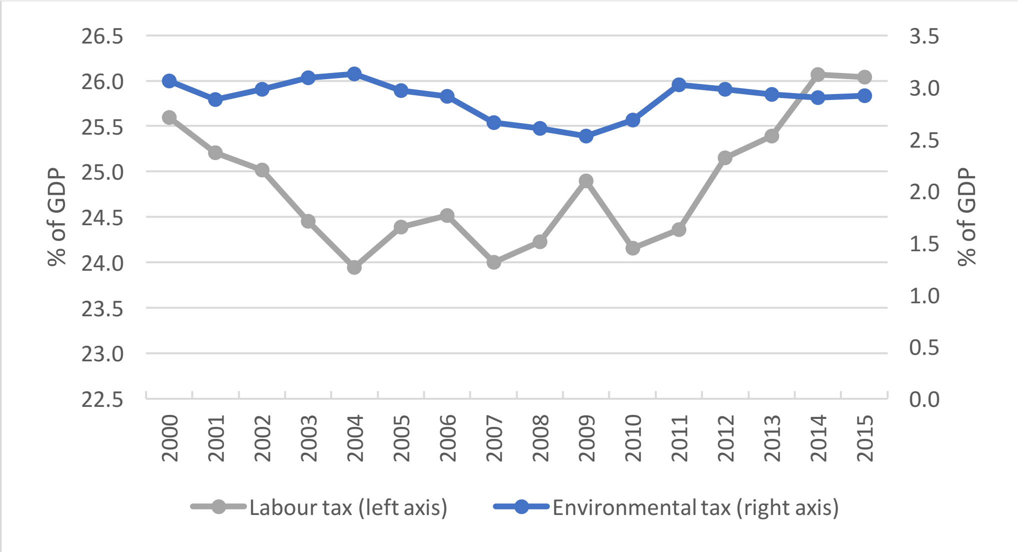
- **Phase I** began in 1997 and was designed to generate a deficit in order to boost employment, which in turn would in the long run boost labour related tax revenues. State PIT was reduced by 3.5 billion markka (hereinafter: FIM), while local income tax and employers' SSC contributions were reduced by a further 2 billion FIM, in total reducing tax revenues by 5.5 billion FIM or 0.9 % of GDP. To curtail this shortfall, CO_2 and landfill taxes generated 1.1 and 0.3 billion FIM respectively or about 0.2 % of GDP. Phase I provided almost no special tax provisions for industry apart from a reduced electricity tax rate and tax exemption for energy products used as raw materials in the production process, both of which the EU energy policy identifies as standard practice rather than exceptions in international energy policies (Andersen et al., 2007).

- **Phase II** was implemented in 1998, and similarly did not intend to be revenue neutral, but rather further cut labour taxes for 1.5 billion FIM in 1998 and 3.5 billion FIM in 1999 or 0.5 % of GDP. These cuts were partially offset by increasing CO_2 taxes and broadening the tax base of the corporate profit tax, resulting in a deficit of 1.5 billion FIM in 1998 and 2.5 billion in 1999. A refund mechanism, albeit very restrictive, for energy-intensive industries was debuted in 1998, where businesses with energy excise tax payments (excluding subsidies and motor fuel taxes) greater or equal to 3.7 % of value added were eligible for an 85 % tax return if the tax liability exceeded 300.000 FIM. In 1999, only 12 companies, predominantly from the paper and pulp industry, qualified and were able to claim back 85 million FIM.

The Finish ETR experience was unique in that it provided almost no special tax provisions for industry compared to the extensive schemes of other countries. As a result, both households and industry were almost equally affected by the CO_2 tax, however the recycling measures were disproportionately geared towards the household sector. No evidence of significant employment changes were detected, however the ETR resulted in slightly regressive outcomes for low income groups, with negative impacts on mobility and rural populations. The lack of employment effect can possibly be attributed to the relatively low share of environmental taxes in Finland's total tax revenue. In 2013, environmental taxes accounted for only 7 % of total tax revenue, half of which were transport fuel taxes and another third taxes levied on vehicles (EC, 2017).

The development of Finnish environmental taxes as a share of GDP is generally in line with other Nordic countries such as Sweden and Norway, with a slight decreasing trend in Figure 11 signalling a successful shift towards a greener economy. The displayed volatility in environmental revenues is however linked to variable energy demand, as most taxes are levied on imports of energy products.

Figure 11. Labour and environmental tax revenues in Finland, 2000–2015



Source: Eurostat, *Environmental taxes,* 2017a; OECD, *Green Growth Indicators*, 2017a.

2.2.1.6 Germany

Ten years before committing to an ETR, Germany was already levying energy taxes on natural gas (1989) and up to the year 1995 was running an electricity taxation scheme. Known as *Kohlepfennig*, the scheme levied a VAT differentiated for households and industry, while using its revenues to subsidize the national coal industry (Andersen et al., 2007). After it was abolished in 1995, years of political debate ensued before the energy tax scheme was overhauled and implemented as an ETR in 1999. The reform pursuing greenhouse gas reduction and lower labour costs was executed in two phases (Andersen et al., 2007):

- **Phase I** was implemented in 1999 and covered the years 1999–2003. Both households and businesses were targeted by raising taxes on petroleum products: mineral oil taxes in transport fuels (e.g. petrol, diesel), taxes on natural gas, taxes on heavy fuel oil, taxes on light heating fuel; as well as introducing a new electricity tax. The taxation increase was for the most part done on an annual basis, with smaller increases in tax rates for energy products other than transport fuels, so as to not hamper the competitiveness of the German manufacturing and agricultural sector. While the ETR was designed to be revenue neutral, the government deviated from this policy goal by using approximately 10 % of the revenue raised to consolidate the federal budget and 1 % to promote renewable energy. The rest was used to reduce, at an equal rate of 1.8 percentage points between 1998 and 2003, employees' and employers' statutory pension contributions. In total, the scope of the tax shifting reform was 18.6 billion EUR or 0.9 % of GDP in 2003, with households carrying 54 % of the burden. According to the

German Federal Environmental Agency, 250.000 jobs were created while CO_2 emissions and fuel consumption were reduced by 2–2.5 % and 7 % respectively (Robins, Clover, & Charanjit, 2009).

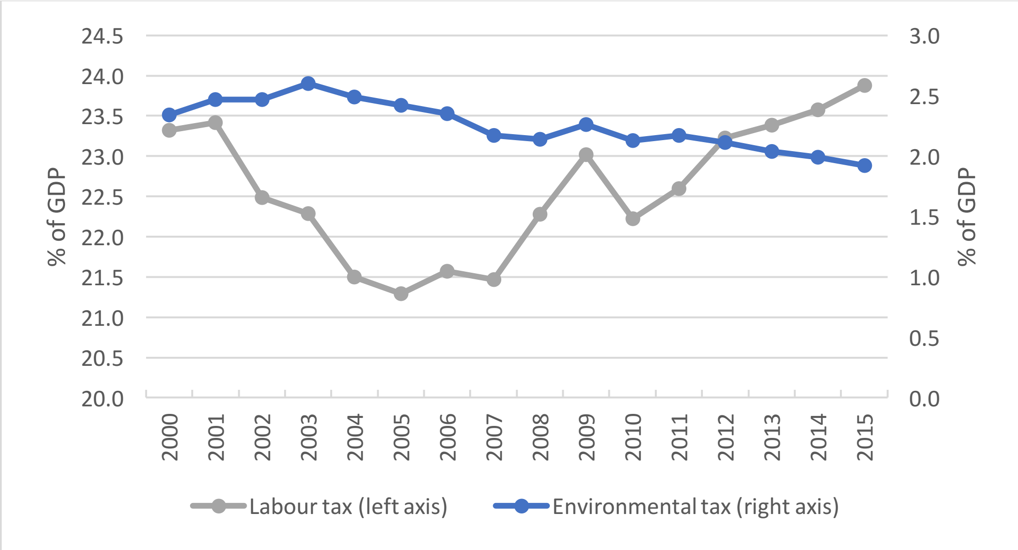
- **Phase II** was planned to begin in 2004 as a component of the wider scoping greening fiscal reform aimed at disassembling the current system of environmentally harmful subsidies and tax reductions. While these profound reform ambitions were quickly abandoned due to political backlash, amendments to heating fuel tax on natural gas and on heavy fuel oil were successfully made.

By reducing statutory pension contributions, the German government was able to execute this ETR with only minor regressive impacts, with the lowest income decile facing a 0.13 % reduction in after-tax income while no change was detected in the upper decile (compared to a respective 1.05 % and 0.47 % real income reduction when no adjustments are made). Employment was boosted by 0.75 % of the active population and GDP growth increased by 0.5 percentage points between 1999 and 2003. Furthermore, the ETR successfully reversed the trend of growing pension contributions, as without the reform they would amount to 21.2 % in 2003 compared to the actual 19.5 % (Andersen et al., 2007). The annually staggered tax increases allowed for the German economy to maintain its short term competitiveness, aided by tax reductions (80 % in 2002, 60 % in 2003) and a tax rebate scheme. It is important to note that the coal industry, along with non-energetic use of energy carriers, have always enjoyed a special status in Germany. In 1999, the EC also approved a special tax reduction scheme for the German manufacturing industry, with the stipulation that this can only be temporary relief and must be revised before the end of 2006 (Andersen et al., 2007). In order for manufacturing companies to qualify for these benefits, they had to commit to voluntary climate mitigation agreements with the German government, while from 2014 on they also need to implement an energy management and auditing system (IEER, 2013).

The German ETR was gradually implemented between 1999 and 2003, with little change in energy taxation, apart from some changes in 2006, provisioned for the following years. This is nicely illustrated in Figure 12, where environmental taxes are falling in terms of GDP, while labour taxation levels have returned to pre-ETR levels.

It is interesting to note that environmental taxes are shown to be decreasing while the German government has imposed additional taxes such as a heavy vehicle charge on motorways (2005), as well as a nuclear fuel and aviation tax (2011). Furthermore, reforms in 2011 cut back environmentally harmful subsidies by curbing the reduced energy tax rates granted to industry, which should have boosted environmental tax receipts (Vivid Economics, 2012).

Figure 12. Labour and environmental taxation in Germany, 2000–2015



Source: Eurostat, *Environmental taxes,* 2017a; OECD, *Green Growth Indicators*, 2017a.

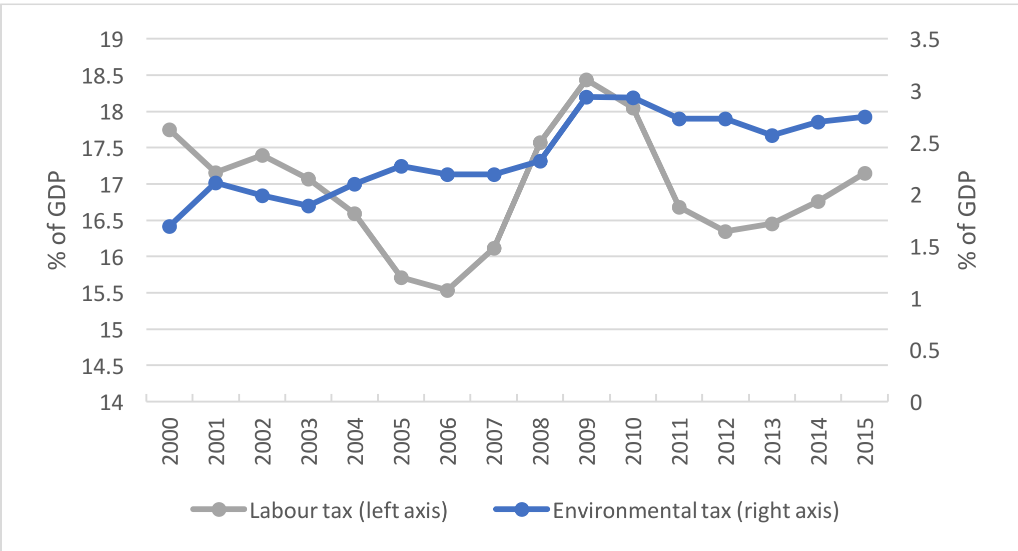
2.2.1.7 Estonia

Since the 1990s, Estonia has been levying fuel excises on motor and heating, environmental resource taxes, and pollution taxes with staggered tax rate increases. Before the Estonian government was ready to launch an ETR in 2005, the government ensured that the economy was stable enough to sustain a shift towards greener policies. This is in particular due the country's heavy reliance on the oil shale sector, which accounts for 4 % of GDP and 1.5 % of employment. Estonia has the most carbon intensive and third-most energy intensive economy amongst OECD countries, with 70 % of Estonia's energy supply or 98 % of electricity relying on oil shale extraction, resulting in the sector accounting for 80 % of environmental tax revenues (OECD, 2017b).

Estonia launched a two phase ETR in July of 2005, emulating the Swedish ETR model of using CO_2 and energy tax revenues to reduce personal and corporate income tax rates. Despite Estonia having relatively low marginal income tax rates and above average SSC, it pursued reductions in income tax rates due to negligibly low employee SSC of 0.5 % (versus employers' SSC of 32.4 %) preventing its use as a recycling mechanisms for households to offset energy price increases (Ekins & Speck, 2011). The key goal of the reform was to keep the overall tax burden constant (i.e. revenue-neutral), while the government expressed a desire to also boost funding for environmental innovations by 3 % of GDP. This was to partially occur through granting companies the choice to opt-out of paying CO_2 taxes if they invest the payable amount towards low-carbon technologies, a popular proposition amongst energy producers (OECD, 2017b).

The first phase covered the years 2006 through to 2008. Revenues from pollution charges and natural resource taxes increased by 20 million EUR between 2005 and 2009; while tax rates levied on oil products were the main contributor for energy tax revenues to more than double between 2003 and 2007, from 0.863 million krooni (hereinafter: EKK) to 1.869 billion EKK. Nonetheless, the effective tax rate on oil shale remained relatively low, despite it being the largest polluter in terms of CO_2. The transport fuel tax increase coincided with Estonia's need to begin levying EU stipulated minimum rates as the transitional period, and consequent exemption, was coming to an end. In turn, the raised revenues were used to reduce marginal PIT levels by 3 percentage points between 2006 and 2009 to 20 %. The policy package also gradually raised the tax-free allowance by 422 EUR and provisioned some tax exemptions for pensioners and families with more than two children to minimize regressive effects. The carbon tax was projected to raise employment by up to 1 % (Kiuila & Markandya, 2006). Reductions in income taxes were halted in 2008 due to cuts to the State budget and the global economic crisis. At the same time, excise duties on fuel continued to raise above the EU minimum rates throughout 2009–2010, and were linked to inflation (Vivid Economics, 2012). In 2009, Estonia was levying a tax of 2 EUR per tonne of CO_2, a rate that appeared insufficient to induce carbon abatement and was seen as a measure to primarily raise revenue (OECD, 2012). Since 2010 however, revenue from energy taxes as a share of GDP has declined due to the parliament accepting a reform supporting lower rates, seen in Figure 13.

Figure 13. Labour and environmental taxation in Estonia, 2000–2015



Source: Eurostat, *Environmental taxes,* 2017a; OECD, *Green Growth Indicators*, 2017a.

In 2013, when the second ETR phase was provisioned to begin, Estonia was engulfed in significant debate regarding the design of their environmental tax system and commissioned studies to evaluate the impact of instruments applied between 2000 and 2010 to better direct its green reform in the future. A joined study by the Stockholm

Environment Institute in Tallinn and Social Science Research Centre of the Tartu University (Lahtvee et al., 2013) presented the government proposals supporting annual increases in environmental tax rates of up to 5 % for the period 2016–2030. These additional revenues should be channeled towards combating inflation and boosting efficiency of resource use. This tax increase should include significantly reducing existing tax exemptions, as well as target the oil shale sector with an annual 16 % nominal rate increase in oil shale extraction rates along with a significant rise in oil shale related waste levies (OECD, 2017b).

2.2.1.8 Czech Republic

Aspects of ETR have been present in the Czech taxation system since the 1990s, with the government executing three tax shifting policies before the Ministry of Finance and Environment putting forward the first explicit ETR proposal in 2000. Economists usually refer to the period between 1995 and 2006 as the implicit ETR phase in Czech taxation, as several instances of excise tax increases on fuel coinciding with labour and profit tax cuts were recorded without any explicit connection (Ekins & Speck, 2011).

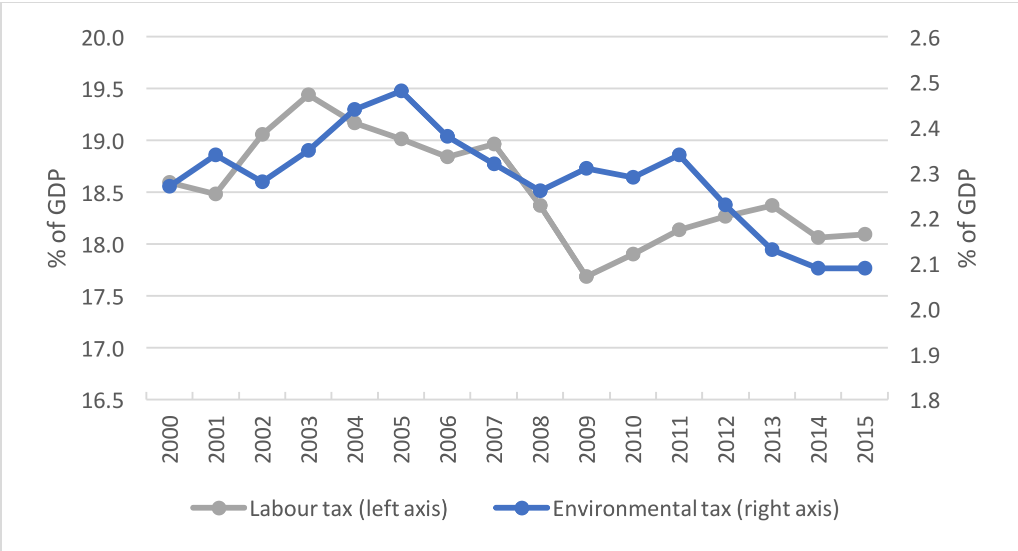
Following the 2002 elections, the Czech government signed a Coalition Agreement declaring the implementation of a revenue-neutral ETR as a key goal and government priority. Despite the initial political enthusiasm, progress was bogged down by several proposal iterations. Ultimately 2008 was targeted as a starting date as the Czech Republic's exemption from the EC Directive 2003/96 expired at the end of 2007 and the country needed new energy taxation legislation to comply with minimal rates.

The Czech ETR was designed for implementation in 3 phases, which at first were not intended to be revenue-neutral, however were later modified to be at the insistence of the Ministry of Finance. Phase I stepped into effect in 2008 and targeted both households and industry. It involved implementing a solid fossil fuels tax at 0.3 EUR per gigajoule, electricity tax of 1 EUR per megawatt hour (hereinafter: MWh) and a tax on natural gas usage for heating purposes of 1.1 EUR per MWh, from which households were exempt. The fuel and electricity tax were found to have increased prices for households by 10 % and 1 % respectively. Income taxation in 2008 was in turn reduced by 3 percentage points for companies, while a 15 % flat tax rate was applied for individuals (Ekins & Speck, 2011).

According to the Czech Ministry of the Environment (2016), phase II is still under preparation despite initial plans of it being implemented between the years 2009 and 2013, with the goal of transforming the system of charges on air emissions and implement staggered increases of SO_2 and NO_x. The revenue recycling was expected to reduce both SSC contributions by employers and employees by 1.5 % or 0.4 billion EUR (Vivid Economics, 2012). Furthermore, the third phase was expected to be prepared by the end of

2012 and implemented between 2014 and 2017. It aimed to extend and deepen environmental taxation to include additional natural resources, however, in reality, Figure 14 shows that environmental revenues have largely been falling during this period, while labour taxation began to rise following phase I labour tax cuts and only slightly dipping in 2014.

Figure 14. Labour and environmental taxation in Czech Republic, 2000–2015



Source: Eurostat, *Environmental taxes,* 2017a; OECD, *Green Growth Indicators*, 2017a.

Due to the relatively recent implementation of ETR in the Czech Republic, and its coinciding with the financial crisis, there is no currently available empirical research that successfully identifies the implications this reform had on the economy. However, several papers have emphasized the differences between environmental tax systems of CEE countries from older EU states, highlighting that these countries are only recently transitioning towards energy taxes with the adoption of the Taxation of Energy Products Directive, as well as have a tendency to earmark environmental tax revenues for green infrastructure investments to compensate for the lack of such infrastructure implementation in the past, potentially limiting the scope of revenue recycling effects (Speck & Jilkhova, 2009).

2.2.1.9 Slovenia

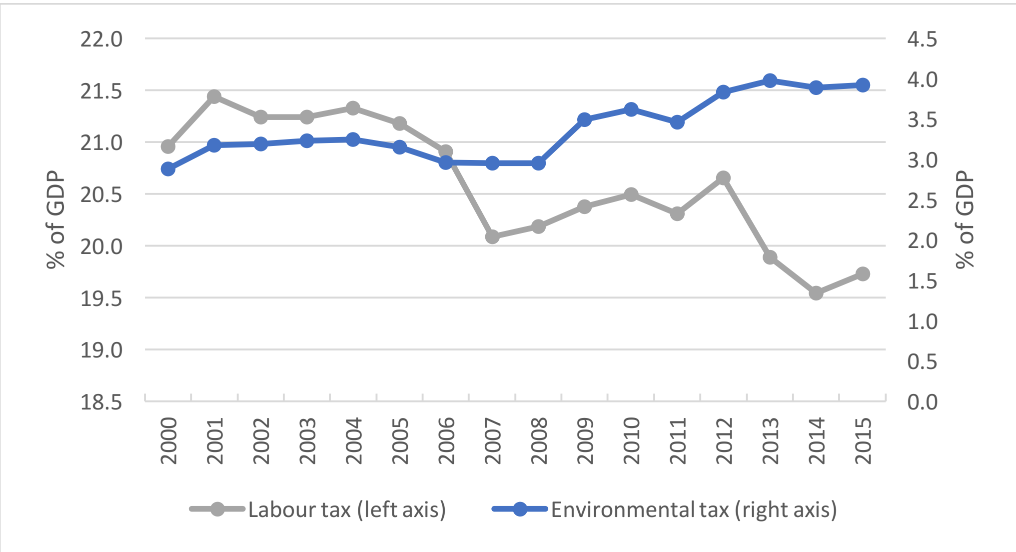
Slovenia is often included in ETR discussion without formal commitment to the instrument due to undertaking significant energy taxation restructuring in 1997. This involved Slovenia being the first country from the CEE region to introduce a CO_2 tax, which was applied based on the carbon content of all energy products, except for coal used in energy production (Speck & Jilkova, 2009). The tax base was a unit of pollution, defined as 1kg of

CO_2 emissions. At first the rate was set at 4.2 EUR per tonne of CO_2 and increased to 12.5 EUR per tonne of CO_2 in 1998 (Andersen, 2010). At the time, expectations were that the carbon tax would be a part of a wide-scale green tax reform, however ultimately, only the implementation of a carbon component in energy taxation was pursued.

After joining the EU in 2004, Slovenia had to implement the minimum excise rates dictated by the Taxation of Energy Products Directive, albeit as a new Member State was granted a transition period until 2007. In 2005, however, the Slovenian Government passed a major exemption to the CO_2 taxation scheme, exempting the largest CO_2 emitting firms from the tax if they were part of the EU ETS (Melichar, Havranek, Maca, & Scasny, 2005). This approach was seen as a monumental development, spurring Denmark and Sweden to consider following this model. At the same time, this move re-invigorated debates of what is classified as permissible state aid in the context of tax exemptions and reductions.

In response to the financial crisis, Slovenia has magnified its reliance on environmental taxation to generate revenues (Figure 15). The government has been steadily raising levies on energy products since 2009, while in the end of 2011 a CO_2 tax for transport fuels was implemented (Vivid Economics, 2012). At the same time, labour taxation seemed to fall drastically since 2012, suggesting an implicit tax shift between the two categories.

Figure 15. Labour and environmental taxation in Slovenia, 2000–2015



Source: Eurostat, *Environmental taxes,* 2017a; OECD, *Green Growth Indicators*, 2017a.

Reforming the taxation system has been a popular topic of contention in Slovenia, particularly since a green tax reform proposal by the Government Climate Change Office in December 2010 stated that the country's CO_2 tax revenue could increase by up to a factor of ten if such a reform is carried out between 2030 and 2045 (Vivid Economics, 2012). After much public debate on the proposed long term carbon strategy, in 2011, the government-appointed working party presented the conclusion that while environmental tax levels in Slovenia are high, tax revenues are too unpredictable to support increasing their share (Ecological Institute, 2014). This is in contradiction with the findings of the EC, which argued that "energy tax revenue is highest in Slovenia [...]. This is due, however, not to high tax rates as such but to the high level of final energy consumption." (Umanotera, 2013). After the discussion on greening Slovenia's economy being revived in 2016, the government pledged to form a new working party on green fiscal reform in 2017 (Republic of Slovenia Ministry of Finance, 2017).

A seminal paper by Kešeljević and Koman (2014) analysed the potential outcomes of implementing an ETR in Slovenia, by modelling an annual carbon tax increase of 15 EUR per tonne of CO_2 in the period 2012–2030. The authors found that while in the short run GDP would react negatively, with the strongest decrease of 0.3 % relative to the baseline occurring in 2013, in the long run, economic agents will adjust to the higher level of fuel prices. Similar trends were detected for manufacturing output and employment, while greenhouse gas emissions were found to continue to steadily decrease even in the long run. In terms of revenues, the tax would bolster annual tax receipts by up to 160 million EUR. Allocating these revenues exclusively towards budget deficits was found to have a lower positive effect than when some of the revenues are used for decreasing the labour tax burden, with reductions of employee SSC by 0.6 percentage points identified as the best revenue recycling method for the Slovenian economy. Overall, the authors emphasize the ability of the Slovenian export sector to relatively quickly neutralize the negative effects the carbon tax might have on competitiveness and for households to adjust their behaviour, however warn that the negative effects will initially be much more pronounced than in the long run and hence Slovenia needs a reform that will "introduce the extra carbon tax gradually, transparently, and predictably" (Kešeljević & Koman, 2014).

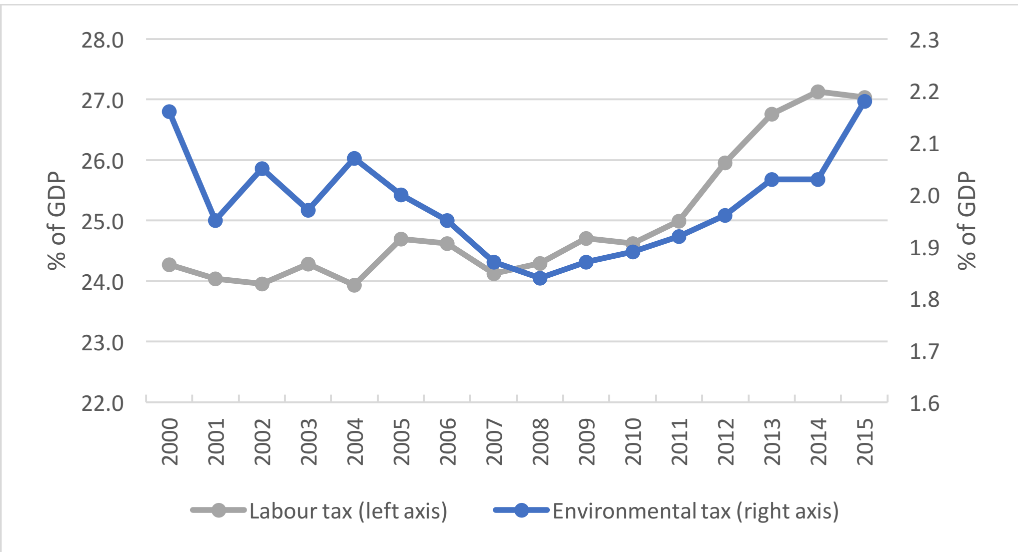
2.2.2 Country that failed to implement ETRs

2.2.2.1 France

France is an example of an old EU member state that has failed to overcome political obstacles in pushing forward an ETR. France first engaged with the notion of reducing labour taxation at the expense of environmental taxes in 1999, when it implemented a tax on pollutants known as *Taxe Générale sur les Activités Polluantes* (hereinafter: TGAP). This policy aimed to simplify existing fees on oils, waste, air pollution, and noise, while in addition created taxes on gravel extraction and detergents. The revenue from the TGAP was used to reorganize and shorten the working time to 35 hours, de facto reducing labour taxation. The use of TGAP revenues for the 35 hour programme was, however, deemed unconstitutional by the Constitutional court in 2001, and the government later failed to introduce a new ETR proposal despite promises to do so in 2002 (Speck, 2008).

Moreover, environmental taxes, particularly the CO_2 tax have proved to be particularly controversial for France. Following the legal commitment in *Grenelle de l'environnement* to re-examine environmental taxes in mid 2009, the French government submitted a proposal to tax sectors excluded from the EU ETS. The tax was to be set at 17 EUR per tonne of CO_2 in 2010, and follow scheduled annual increases to reach 100 EUR per tonne of CO_2 by 2030. At the end of December 2009, the French Constitutional Court annulled the carbon tax proposal which was set to come into force only weeks later, on January 1st 2010, deeming it unconstitutional. The court cited too many tax exemptions and discounts, given the proposed tax design exempted 93 % of industrial emissions. Furthermore, planned compensation schemes for households were found to be in breach of the principle of tax equality (Senit, 2012). Ultimately, after scraping all plans of a carbon tax in March 2010, the French prime minister said that the country will only consider adopting such a tax if it will be a part of the EU level energy taxation directive, arguing that otherwise the potential of damaging industry competitiveness is too large of a risk (Ekins & Speck, 2011). Despite failing to implement a carbon tax, France managed to introduce 44 environmental taxes and charges as part of the *Grenelle de l'environnement* process (Cottrel et al., 2010), which supports the rise of environmental tax revenues in terms of GDP observed in Figure 16.

Figure 16. Labour and environmental taxation in France, 2000–2015



Source: Eurostat, *Environmental taxes,* 2017a; OECD, *Green Growth Indicators*, 2017a.

Alongside rising environmental revenues, France also began to collect higher levels of labour taxes following the financial crisis of 2008. Nonetheless, the main discernable trend in comparison to ETR countries is the volatility of environmental taxes between 2000 and 2007 along with fairly constant labour taxation levels observed during the same time period.

2.3 Principal component analysis

The previous section introduced the complexity and dynamics of environmental and taxation policy in the EU, and presented the limited real life evidence that exists on the impacts of ETR. Policies that simultaneously intend on influencing multiple economic variables through the transmission of behavioral incentives significantly increase the difficulty of isolating meaningful effects, and the ability to extract relevant information about specific instruments. This section aims to provide a better understanding of ETR through principal component analysis (hereinafter: PCA). Ideally, the PCA will identify the economic variables that best account for the differences between countries that have implemented an ETR and those that did not, shedding light on which characteristics offer the best basis for ETR implementation.

2.3.1 Theoretical overview

The PCA is a statistical technique applied to examining interrelations among a set of variables and provides insight into the underlying structure of those variables. It is a method of data reduction, re-expressing multivariate data in fewer dimensions. More formally, it applies an orthogonal transformation to a set of correlated variables in order to convert them into linearly uncorrelated variables, also known as principal components (Shlens, 2003). The first component is said to be comprised of a variable system that explains the greatest variance in the data, the second component the second greatest variance, and so on. The association between the original variables and the components are called eigenvalues or component loadings in multivariate space. Both provide a value, akin to correlation coefficients, of how much variable variation is explained by the component (Ledesma & Valero-Mora, 2007). A common criterion to determine the number of principal components to use in analysis is the Kaiser rule (1960), which states that eigenvalues must be greater than one for reliable components (i.e. if below 1 the component has negative reliability). The PCA relies on three core assumptions (Shlens, 2003):

1. Linearity: the data set is assumed to be a linear combination of the variables
2. Mean and covariance importance: the directions of maximum variance are not guaranteed to contain good features for discrimination
3. Important dynamics in large variances: components with larger variance are assumed to correspond with interesting dynamics, and lower variance with noise

Economists find the main limitation of PCA to be its non-parametric nature, as the user is not able to control for a priori known dynamics, which can dominate the findings (Shlens, 2003). Alternatively, this can also be seen as a strength, as the analysis offers an un-inhibited real world summary of a given dataset.

2.3.2 Methodology

In this thesis, the PCA is performed in the manner of an exploratory analysis using the statistical software STATA. The sample size is comprised of the 28 member states and an average value for EU28, while the variables considered are listed in Table 2.

Table 2. List of variable labels and their descriptions

Label	Description
GDP	Real GDP per capita
EMPL	Share of active population (15–64) that is employed
L_ITR	Ratio of employed labour income taxes and social contributions to total employee compensation and payroll taxes
EMPRt	Income from employment paid by employers, as % of total taxation
EMPEt	Income from employment paid by employees, as % of total taxation
C_ITR	Ratio of all consumption tax revenues to the final household consumption expenditure
E_ITR	Energy taxes in EUR per tonne of oil equivalent
ENVt	Total environmental tax receipts as % of total tax revenues
Et	Energy tax receipts as % of total tax revenues
TRt	Transport tax receipts as % of total tax revenues
PRt	Pollution and resource tax receipts as % of total tax revenues
GHG	Tonnes of CO_2 equivalent per capita
INTE	Gross inland consumption of energy, in thousand tonnes oil equivalent
RENW	Share of renewable energy in gross final energy consumption
RD	Total R&D expenditure by all sectors in EUR per inhabitant
PAT	Patent application to the European Patent Office per billion EUR of business enterprise expenditure on R&D

These variables were selected to provide a well-balanced representation of socio-economic indicators, resource productivity, and environmental policy developments, and are identified as key Green Growth Indicators by the OECD (2017a). Due to data availability issues for certain countries, the analysis is not able to include variables linked to quality of life, which would have provided insights on welfare improvement.

To gain a better understanding of these variables across EU countries, several combinations of the variables will be analysed and their sampling adequacy assessed via the Kaiser-Meyer Olkin (hereinafter: KMO) Test. This test returns a value between 0 and 1, with 1 indicating the sampling is adequate and anything below 0.5 deemed inadequate (Smith, 2002). By exploring KMO values of different combinations, variables that are highly correlated between EU countries (i.e. have a low KMO score) will be dropped and deemed relatively unimportant in terms of distinguishing between member states.

In an attempt to best capture the influence of ETR, a comparison will be made between the years 2002 and 2014. The PCA for the year 2002 will capture the dynamics following the first wave of ETR while the 2014 analysis is intended to shed light on the second wave of ETRs as well as the influence of post-economic crisis measures.

2.3.3 Results

After performing exploratory PCA on different combinations of the above described variables, it quickly became evident that certain variables are closely correlated in EU countries and hence reduce the adequacy of using factor analysis. By dropping variables pollution and resource taxes, transport taxes, and patents, the overall KMO score increased from 0.3103 to 0.5168 for 2014 data and from 0.4554 to 0.5989 for 2002 data, as visible from Table 3. Hence, forthcoming analysis will only include variables included in the dataset of the highest KMO.

Table 3. Kaiser-Meyer Olkin test values

Variation 1			**Variation 2**		
Variable	2002	2014	Variable	2002	2014
GDP	0.5704	0.4555	GDP	0.5895	0.6421
EMPL	0.4650	0.2659	EMPL	0.6036	0.3355
L_ITR	0.3620	0.1773	L_ITR	0.4110	0.2701
E_ITR	0.5300	0.3857	E_ITR	0.5873	0.3292
C_ITR	0.7909	0.3018	C_ITR	0.7840	0.8501
INTE	0.4600	0.3178	INTE	0.3764	0.3793
RD	0.6350	0.4932	RD	0.7207	0.7441
RENW	0.5806	0.2490	RENW	0.5874	0.4288
GHG	0.5514	0.4586	GHG	0.4658	0.4182
EMPR_t	0.6998	0.3170	EMPR_t	0.6236	0.3983
EMPE_t	0.6096	0.5281	EMPE_t	0.6753	0.5244
ENV_t	0.3182	0.3067	ENV_t	0.6634	0.6341
E_t	0.1291	0.2940	E_t	0.2733	0.6566
TR_t	0.3234	0.2283			
PR_t	0.1003	0.0882			
PAT	0.4083	0.1771			
Overall	0.4554	0.3103	Overall	0.5989	0.5168

It is also interesting to note the difference between the two years in terms of which variables appear to be highly correlated for the sample. Most notably, one could deduce that differences in energy taxation are less correlated in 2014 than they were in 2002. This makes sense intuitively as in 2002 most governments relied heavily on these taxes for fiscal income and to lower emissions, however these days countries are using a wider variety of policy instruments, and hence environmental tax structure can vary significantly between countries.

2.3.3.1 PCA for the year 2002

The PCA generated four components with eigenvalues above 1 that explain 76.69 % of the variation between countries in 2002. The first component alone accounted for 34.75 % of the variation. Table 4 shows the breakdown of these five components. The first component places the most weight on GDP and R&D expenditure, followed by implicit tax rates on energy and consumption, as well as how income taxation burdens are distributed between employers and employees. The second component mainly addresses taxation differences between countries in terms of labour and environment, while the share of renewable energy is also considered. For descriptive statistics of the variables and full STATA tables, refer to Appendix B.

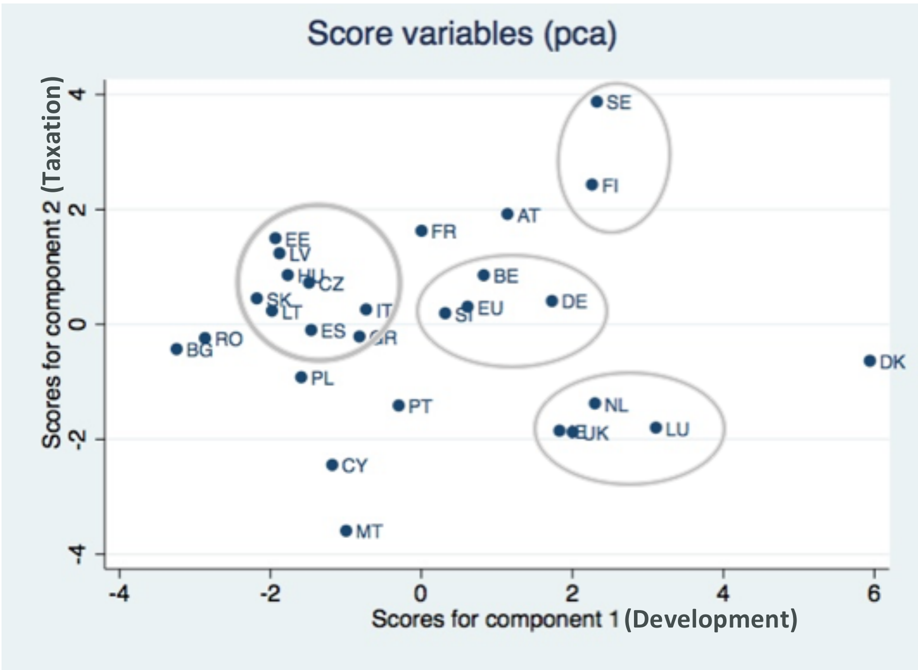
Table 4. PCA components 2002

Variable	Comp 1	Comp 2	Comp 3	Comp 4	Unexplained
GDP	0.4119				.0854
EMPL					.4377
L_ITR		0.5460			.2420
E_ITR	0.3737			0.3450	.2125
C_ITR	0.3535				.2470
INTE				0.8354	.1143
RD	0.4086				.1051
RENW		0.4412	0.3910		.2231
GHG			-0.3881	-0.3068	.2107
EMPR_t	-0.3029	0.4188			.1106
EMPE_t	0.3636				.2882
ENV_t		-0.4212	0.4863		.1163
E_t			0.4203		.6380

Together, the first two components will allow us to plot the countries against variables that have theoretically been very closely related to ETR. For ease of interpretation, component 1 can be defined as the development component given the pronounced weight of GDP and R&D variables, while component 2 can be termed the taxation component due to its focus on labour and environmental taxation variables.

At first glance, we can roughly identify four groups of countries from the score plot in Figure 17, and see that Denmark is a clear outlier with respect to component 1. We can see that all countries that have implemented an ETR during the first wave score very highly in the development component, while there is much more variation in the tax focused component 2. In turn, prior to implementing an ETR, Estonia and Czech Republic are clustered together with other Eastern European countries. Slovenia plots very close to the EU average, and scores similar in the taxation component as Germany. It is also interesting to note that Ireland and the UK score almost identically despite Ireland not implementing an ETR, while Finland and Sweden have distinctive taxation component scores, alluding to differences in their tax structure.

Figure 17. Score plot for 2002



2.3.3.2 PCA for the year 2014

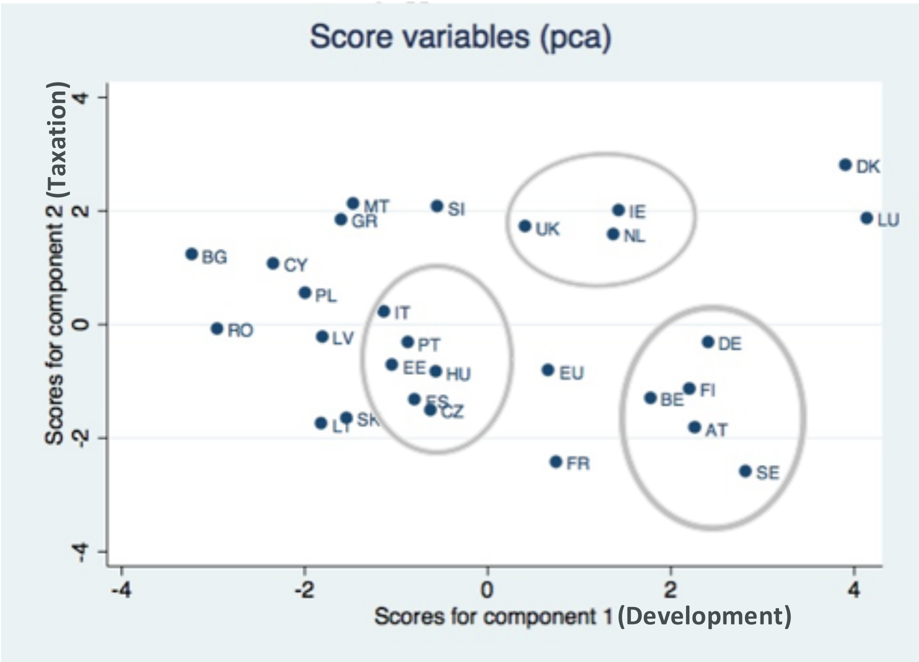
Applying the same method to data from 2014 resulted in the PCA generating five components that explain 81.03 % of the variation between countries, with the first component accounting for 31.73 % of the variation. For a description of the variables and full STATA tables, refer to Appendix C. As seen in Table 5, the component structure varies only slightly from 2002, with the first component no longer containing implicit tax rates and the second component omitting renewables being the most notable changes. Hence, akin to the 2002 analysis, component 1 will be regarded as the development component and component 2 as the taxation component.

Table 5. PCA components 2014

Variable	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Unexplained
GDP	0.4346					.1254
EMPL			0.3584		-0.5792	.1424
L_ITR		-0.3379			0.6814	.0779
E_ITR		0.3248		0.4250		.3105
C_ITR				-0.3500		.2660
INTE				0.5519		.4367
RD	0.4707					.0550
RENW			0.6666			.1021
GHG				-0.5380		.2350
EMPR_t	0.3532	-0.5477				.1493
EMPE_t						.3000
ENV_t		0.4521	0.3006			.0732
E_t	-0.3419					.1922

Compared to 2002, the countries appear to be much more dispersed in Figure 18. Luxembourg now joins Denmark as an outlier by scoring high in both the development and taxation components, alluding that these two countries significantly outperform the rest particularly in terms of GDP and/or R&D investments.

Figure 18. Score plot for 2014



Denmark's significant deviation from other ETR countries can intuitively be related to the country's bold target of being carbon neutral by 2050. The UK and Ireland still score similarly as the Netherlands, however Ireland is now much closer to the Dutch score in terms of the development component, which could be associated with Irish policies in response to the crisis discussed further in section 3. Austria and Belgium are in 2014 even closer to the scores of Finland and Germany, with Sweden continuing to differ in terms of taxation system. Overall, Western economies score higher in terms of the economic development component due to their relatively high levels of GDP per capita and investments into R&D, while no such inference can be made in relation to the taxation component. Furthermore, ETR implementation in Estonia and Czech Republic appeared to distinguish these countries from previously closely related Latvia, Lithuania and Slovakia. The two countries are now closer in score with other non-ETR countries such as Hungary, Spain, and Portugal. Bulgaria and Romania, however, remain at significantly negative values of the development component.

2.3.4 Implications

This analysis is admittedly a very rough attempt at gathering additional information about variable dynamics across the EU. The main limitation of this study is that low KMO scores persist even in the best case scenario where several variables were dropped. However, this analysis provides a good starting point for further deep dives and research. There are certainly some discernable trends that intuitively correspond to the qualitative analysis. The PCA showed that ETR can be applied in countries with different taxation systems, particularly in terms of labour income distribution between employers and employees, as well as levies on energy and general environmental taxation. Furthermore, GDP and R&D investments can be seen as a common factor amongst the first wave ETR countries, suggesting that countries might be more inclined to implement an ETR if their economy is strong and already open to technological development. High levels of R&D expenditure allow countries to better respond to an ETR, as an existing pipeline can help produce abatement technologies and support a transition towards a low carbon economy, while strong levels of GDP make potential negative economic effects less politically threatening. According to this inference, Austria and Belgium emerge as viable candidates to successfully implement an ETR. Denmark’s position as an outlier, particularly in terms of high levels of R&D, further reiterates the country’s leadership in green growth, despite recent cuts to ETR programmes.

Estonia and Czech Republic, from the second wave of ETR, can be interpreted as two countries that tried to boost their GDP and R&D through the ETR mechanism. However, despite efforts to jump start an economic transition, the relative small scale of such reforms maintains the difference between Western and CEE economies, with marginal improvements detected.

3 FUTURE OF ETR AS A POLICY INSTRUMENT

3.1 ETR as an austerity mechanism

The recent economic and financial crisis left European economies reeling and searching for budget balancing strategies that would be least detrimental for long term growth prospects. Economic literature suggests that some tax systems are more conducive to growth, in particular those relying on consumption, environmental, and property taxation. More specifically, empirical research has found that in times of economic crises, carbon taxation is the least damaging form of taxation (Vivid Economics, 2012). When energy taxes are compared with direct taxes, the latter are found to be twice as damaging to GDP, while VAT is linked to having the most pronounced negative impact on employment.

A study by the German led European Climate Forum (Jaeger, Paroussos, Mangalagiu, Kupers, Mandel, & Tabara, 2011) identified combating climate change as an opportunity for Europe to revitalize its economy post-crisis. The report argues that since the financial crisis, emissions have fallen due to lower levels of production, and hence the original goal of reducing emissions by 20 % by 2020 compared to 1990 levels is too weak of an incentive to mobilize innovations and spur green growth. Instead, by ambitiously pursuing emission reductions of 30 %, EU countries can: increase economic growth by 0.6 % per annum, create 6 million new jobs, boost gross investments from 18 to 22 % of GDP, and increase GDP by up to 6 %. The authors identify substantial additional investments as a key mechanism to achieve revitalization, as they induce learning-by-doing across the economy, which in turn increases competiveness, stimulating economic growth and improving investor expectations. The major downside of this scenario is however, that carbon prices would have to increase by 65.3 %, requiring significant annual increases that have thus far proved politically challenging.

European authorities have also recognized the potential of ETR as a key policy instrument to address austerity needs and sluggish economic growth. The EC presented a formative paper with evidence suggesting that increasing efficiency of the taxation framework rather than relying on consolidating the budget expenditure can garner behavioural change that jointly addresses environmental and fiscal needs (EC, 2011). In relation to reforming environmental taxation, this also includes strategies to reduce environmentally harmful subsidies that are oftentimes in the form of tax refunds and exemptions, as they represent an inefficient drain on fiscal budgets.

Furthermore, the Europe 2020 Strategy explicitly articulates the need for countries to raise good quality revenue and to ensure the quality of their tax system, reinforcing the idea that not all revenue to the budget is created equal: "the revenue side of the budget also matters and particular attention should also be given to the quality of the revenue/tax system.

Where taxes may have to rise, this should, where possible, be done in conjunction with making the tax systems more "growth-friendly". For example, raising taxes on labour, as has occurred in the past at great costs to jobs, should be avoided. Rather Member States should seek to shift the tax burden from labour to energy and environmental taxes as part of a "greening" of taxation systems" (EC, 2010).

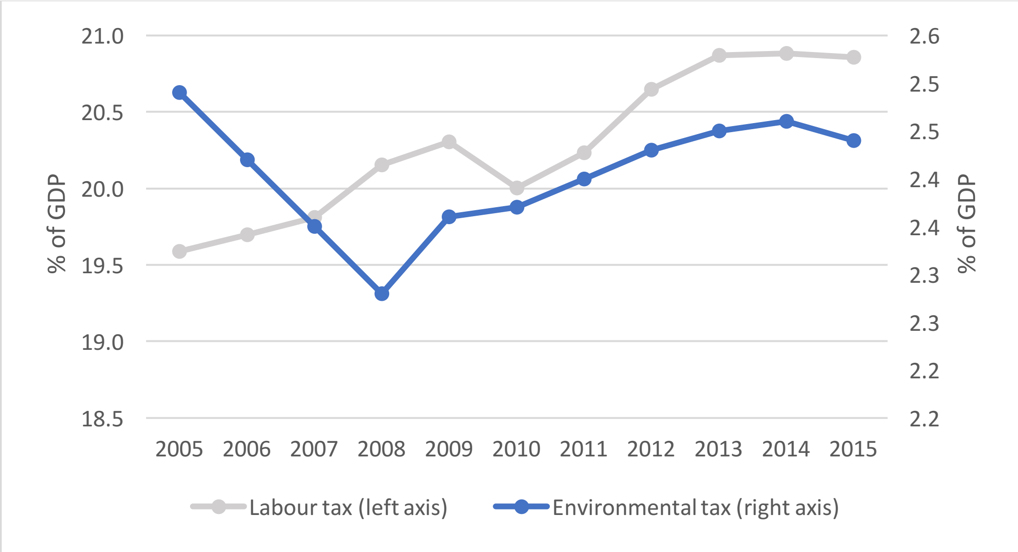
This view that environmental taxes are a good source of revenue and should be increased was further echoed in a study by Heine, Norregaard, and Parry (2012), which found that compensation schemes are better apt in addressing potential competitiveness concerns and protecting vulnerable households than lowering the levels of environmental taxation and providing downstream tax exemptions for favoured sectors. One of the recommended compensation schemes is based on recycling revenues towards output subsidies for vulnerable firms and tax cuts for low-income households, essentially an ETR mechanism.

Perhaps the best opportunity to reverse the low and relatively small scale engagement in environmental taxation reform is to use the EU-wide ETS. Tightening the cap on emissions covered in the EU ETS would raise the carbon price across Europe, and could additionally raise an estimated 30 billion EUR (0.20 % of EU GDP in 2013), more than the 25 billion shifted annually by all local ETRs (Vivid Economics, 2012; Andersen, 2010). However, given that fiscal and environmental policy are still decided upon at the national level, there is no guarantee that the revenue would be recycled back to the economy, or at least not at a significant scale. The largest reforms thus far, implemented by Sweden, Denmark and Germany, have managed to shift only up to 1.1 % of GDP (Andersen, 2010).

Despite several empirical studies demonstrating the unequivocal benefit of restructuring the tax system away from labour and towards environmental taxes, most EU countries reacted in the opposite way. As illustrated in Figure 19, environmental tax receipts were significantly reduced in 2008, as the share reached its lowest level despite the absolute value of GDP also falling (i.e. if taxes would have remained the same, revenues as a share of GDP would have increased). A notable exception is the Greek government, which bolstered its revenues between 2008 and 2011 by increasing excise duties on petrol fuel by 91 % and 40 % for diesel (Schlegelmilch, 2012).

While some of the increase in the share of labour taxation in 2008 can be attributed to the mentioned GDP decline, there is evidence than on average EU countries raised their level of income taxation, particularly between the years 2010 and 2013. In 2016, the average implicit tax rate on labour was 6.4 percentage points higher than in 2009 (EC, 2017).

Figure 19. Labour and environmental taxation trends in the EU, 2005–2015



Source: Eurostat, *Environmental taxes,* 2017a; OECD, *Green Growth Indicators*, 2017a.

A country that explicitly demonstrated the merit of ETR as a crisis time policy was Ireland. Facing the highest relative budget deficit in the euro zone (18.75 billion EUR in 2010), Ireland introduced a CO_2 tax rate of 15 EUR per tonne in 2010 and intended on doubling the rate by 2014 (Vivid Economics, 2012). As the majority of the 1.48 billion EUR raised from carbon taxes between 2010 and 2013 went towards offsetting the treasury's shortfall, Ireland was not able to implement a major reduction in labour taxes but rather focused on preventing any increases (Convery, Dunne, & Joyce, 2013). By focusing on raising revenues with less distorting taxes, the country was able to recover from the crisis earlier, since as soon as carbon tax revenues were not used for repaying government debt and recycled back into the economy, the policy instrument became revenue neutral and fostered employment and GDP growth.

In conclusion, Ireland has confirmed the viability of ETR in a recessionary setting and furthermore its potential to be a key policy instrument to boost budgetary revenues in a non-distortionary manner. However, it is important to realize that labour taxes represent a significantly larger share of tax receipts than environmental taxes, and hence a minor increase in income taxes is often seen as less politically controversial as implementing additional environmental taxes and significantly increasing existing rates.

3.2 Behavioural implications

Perhaps an element that has been most absent from ETR evaluations is linked to behavioral economics and the need to understand the intended and unintended consequences of behaviorally inspired policies. Environmental taxes are after all such a mechanism, providing fiscal incentives to change existing production and consumption patterns towards more ecologically sustainable behaviour. However, devices from classic economic theory fail to account for several behavioural responses arising from these policy instruments.

Framing is undoubtedly one of the main challenges of complex environmental policy instruments. The manner in which a tax is presented has been found to significantly influence societal response. For instance, a study by Hardisty, Johnson, and Weber (2010) showed that consumers are more likely to purchase products if the reason for the higher price is a carbon offset rather than a carbon tax. If carbon taxes are only levied on industry, they are less salient to consumers because they fail to connect higher levels of consumer prices with the tax. Furthermore, framing is also an important factor when consumers engage in mental accounting, the practice of separating income and spending into different 'wallets'. Some forms of taxation can be more salient than others depending on which 'wallet' they will be financed from, with 'out of pocket' tax payments carrying more weight than taxes that tend to be paid automatically. Additionally, the time horizon of taxes needs to be considered, with taxes on income considered more distant, and hence less salient liabilities than taxes on consumption. In Denmark, France, the UK and Norway, the public generally deemed recycling environmental tax revenues through labour costs reductions as unwarranted and confusing, as it combined two categories that consumers tend to separate. Using revenues from an environmental tax for purposes other than to improve the environment was interpreted as a 'trick' (Dresner, Jackson, & Gilbert, 2006; Klok, Larsen, Dahl, & Hansen, 2006).

Prospect theory, which studies decision making under uncertainty, shows that people measure an outcome against a reference point (and not in absolute terms), and when they are loss averse will regard losses (taxes), relative to the reference point, as greater than equivalent gains (subsidies) (Kahneman & Tversky, 1979). Financial incentives are over time incorporated into the reference point, and hence in order to stay effective, tax rates need to be changed frequently to garner a significant behavioral response. If an ETR preserves, or even improves the ex post economic position of taxpayers, the tax incentive can potentially be rescinded (OECD, 2010).

Another aspect relevant for policymakers is the role of defaults, and the reluctance to change. While 'green' defaults can significantly boost environmentally friendly choices such as green electricity (Pichert & Katsikopoulosa, 2008), if market defaults are far from environmentally optimal, regulation and economic incentives of environmental policy will have to be extremely pronounced in order to motivate change. Several countries, such as carbon-intensive Estonia, implemented carbon taxes that failed to provide consistent price signals to warrant change (OECD, 2017b).

The need to consider real life interpretations and responses to policies was perhaps best summarized by the Policies for Ecological Tax Reform Assessment of Social Responses project (hereinafter: PETRAS) (2002), a large scale assessment of the social responses to ETR policies in Europe. Researchers found that the understanding of ETR was very one sided, as the policy name 'environmental tax reform' led people to believe it was an environmental reform addressing environmentally damaging behavior, with no relation to reforming the labour market. The environmental component was pronounced by the salience of experiencing higher energy and fuel costs, which overwhelmed any information people had about the recycling mechanism. Most were not able to understand the connection between increasing energy taxes and lowering employment taxes, regarding it as "pointless moving of money around", stating that these two policy areas should be addressed separately. This was linked to the issue of low visibility of reductions in labour related taxes, particularly social insurance contributions, as only few people were aware of the decrease, while almost all felt an increase in costs from environmental taxes. For example, only 1 out of 50 focus group participants in Denmark was aware of the revenue recycling component. People and businesses were also inherently mistrusting of the government's promise of what the revenues will be used for, calling for more transparency in tax revenue allocation and suggesting a government independent body overseeing revenue distribution, or better yet the entire ETR, would boost its credibility.

In a surprising result, all German business representatives aware of the double dividend premise said they did not believe in its employment effects. Similarly to consumer focus groups, there was a general perception that taxes are a means of raising revenue rather than incentives. Most saw the rising environmental taxes as punishment rather than incentive to change behavior. ETR was viewed as another tax, increasing the already high levels of taxation. Interestingly, international competitiveness appeared to be of more importance to the interviewed policy makers than businesses, confirming Kahneman's focusing illusion claiming government regulators often focus on one aspect of regulation and tend to disregard the rest (Kahneman, Krueger, Schkade, Schwarz, & Stone, 2006).

Ultimately, one can conclude that low acceptance rates of ETR policies are closely linked to significant shortcomings of communication and marketing. It is normal that policy instruments cannot garner desired results if none of the stakeholder groups understand their basic premise and intent. While the ECB for instance has constant, identifiable and well communicated monetary policy goals, one struggles to carve out comparable targets from the European environmental policy, which in 2010 included 860 policies and measures to address greenhouse gas emissions alone (OECD, 2010). Henceforth, if green taxation reforms wish to achieve the same level of credibility, concrete targets such as increasing economic growth by 0.5 % and decreasing the rate of unemployment in Europe by 2 % must be created and outwardly committed to (Jaeger et al., 2011).

3.3 Political implications

Politicians have in practice been found to often lack the long term strategic view needed to support implementation of ETR, with no guarantees of success (contrary to very salient downsides) and opposition of industry making it a risky and unpopular policy to stand behind. As demonstrated in the country analysis, transitions between governments can prove particularly detrimental, as incoming governments are looking to implement policies that will have quick and visible effects to solidify stakeholder support and approval ratings. The most extreme example in recent history is Denmark, where a complete ideology reversal occurred with the new government in 2011 and led to a de facto counter ETR. By 2013, the political agenda was entirely focused on revitalization of the economy, which the government understood as lowering environmental taxes to the lowest levels prescribed with the EU Energy Tax Directive to help boost the competitiveness of industry. Similarly, income taxes were raised to help finance the fallout of environmental taxes and to address budget deficits, another politically popular argument for ending greening reforms.
Additional instances that proved difficult for governments to uphold ETR instruments were times of high global oil prices, as energy taxation is a key revenue source in these policies. For instance, public unrest ensued in the UK in 2000 when high oil prices were even further exacerbated by the FDE, resulting in the government being forced to ultimately abandon this progressive tax scheme. Actions of freezing or diminishing energy taxation schemes were also temporarily implemented during the so-called 2000s energy crisis, as prices climbed from 60 dollars (hereinafter: USD) per barrel in 2005 to 147.3 USD per barrel in July of 2008 (Siegel, 2011).

In order for ETR to overcome these obstacles and become a mainstay in fiscal policy, a compelling narrative that can achieve political consensus needs to be developed. The first proposition must be linked to the difficulties in reaching 2020 greenhouse gas emission targets without an effective mechanism in place. Since energy use increases with income, energy efficiency is not sufficient but rather absolute reductions are needed to achieve the targets. This will require strong measures that will increase energy prices, but also promote renewables, demand reduction, and innovation of abatement technologies. Furthermore, oil shocks should be treated as an incentive to reduce the economy's dependency on price movements in the oil market and an opportunity to develop low-carbon substitutes. The best time to gain political backing for increasing energy taxes is deemed to be when energy prices are low or dropping (Ekins, 2015).

The second proposition must emphasize the mechanisms in place to protect vulnerable households and economic sectors. Energy intensive sectors tend to have strong political influence, and no ETR will be implemented without addressing competitive concerns. Thus far, protection measures have been focused on tax exemptions and reductions, however by implementing schemes that allow sectors with high trade and energy intensities (but low market power) to improve their energy efficiency, can more than offset the effects of taxation and motivate a low-carbon industrial transition (Porter, 1991). Furthermore, such schemes are gaining in appeal due to the EU significantly curbing the allowance of special tax provisions as part of their crackdown on user discrimination and state aid. Similar incentives also need to be vocalized for vulnerable households, to help them increase their housing energy efficiency and limit the regressive impacts of higher environmental taxation.

Finally, the third proposition most convince the voters in the merits of ETR and environmental taxes in general, as people were found to dislike green taxes more than other taxes and generally misunderstood the tax shifting element of ETR (Ekins, 2015). Clear messages need to be delivered, both in terms of political agenda and people's own awareness on their polluting activities and energy usage.

Since the 1990s, 19 different Green Tax Commissions have been established in Europe, and are slowly gaining momentum as a government body that can ensure consistent and transparent reform. These commissions can uphold the above mentioned propositions as they are largely independent from government, have a broad stakeholder representation, are focused on addressing key concerns by holding debates, and generate relevant expert outputs. A paper by Mori, Ekins, Speck, Lee, and Ueta (2013) identifies a key area of unexplored potential to be in existing commissions establishing links with one another to allow for better evidence sharing on the implementation and consequent effects of green taxes. Furthermore, they argue there is a need to develop a better understanding of attitudes towards taxes in earlier stages and for the Commissions to ensure quality communication that is targeted to different audiences. Hence, the establishment of credible national Green Tax Commissions has the potential to significantly elevate and stabilize the role of ETR in fiscal and environmental discussions, particularly if national commissions are connected at the EU level, however ultimately complete government independence is unfeasible and the implementation of such policies remains in the hands of politicians.

CONCLUSION

Economic theory on how to best address negative externalities such as emissions dates back to Pigou and his awareness that consumption and production of certain goods and services can lead to environmental degradation and consequent economic costs. Societies have been levying taxes on goods that we deem 'bad' for decades, however only recently has the focus shifted from these instruments raising revenue to providing an incentive to change behaviour towards more sustainable growth paths. Environmental taxation become a key policy area in the 1990s, when several European countries recognized that there is no such thing as a high-carbon, high-growth scenario in the future. The duality between the goals that environmental taxation aims to achieve is today most often associated with an ETR, a policy instrument that was first introduced in 1991 by Sweden and has since been applied in 7 other countries, with Estonia and Czech Republic being the only new EU member states to commit to such a policy.

With the exception of Germany, ETR programmes and their real-life impacts have been relatively poorly researched in other countries. This can be identified as a potential reason for the absence of larger scale application of this policy instruments, as it makes an already politically challenging reform even harder to implement without convincing evidence of positive gains. The two key concerns that persist throughout the discussion on green reforms are competitiveness and equity. Empirical evidence has shown that potential downsides of rising environmental taxes for most vulnerable sectors are significantly overstated, and that eliminating several tax exemptions, which have become a de facto component of ETR, would not harm the competitiveness of these firms but on the other hand drastically improve the efficiency of the reform. The regressive tendencies of ETR design were also successfully curbed in most countries by applying appropriate compensation schemes for lower-income households.

By employing the PCA, the differences between ETR and non-ETR countries were overshadowed by characteristics of Western versus CEE economies, particularly in terms of GDP and expenditure in R&D. The latter is seen as a characteristic that could indicate high potential for ETR implementation, particularly as a vehicle for a transition towards a low-carbon and environmentally sustainable economy as envisaged by the Porter hypothesis.

ETR allows countries to raise budget revenues through less distortionary means, with carbon taxation identified as the least distorting form of taxation. This has been recognised by the EC as a sustainable instrument in the wake of the financial crisis and successfully implemented by Ireland to help combat its budget deficit. Nonetheless, this thesis found the potential of ETR to replace traditional austerity measures and become a mainstay in policymakers' toolboxes significantly limited until there is a better understanding of the instrument amongst all stakeholders, including the general public.

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APPENDIXES

LIST OF APPENDIXES

Appendix A: Summary of ETRs in the EU

Table 1. Implemented ETR packages

Country	Taxes cut	Taxes raised on	Magnitude	Results
Sweden (1991)	PIT	CO_2 SO_2 VAT on energy purchases	2.4% of total tax revenue	Reduced emissions by 9%, economic growth 48%, employment increase 0.5%
Denmark (1994)	PIT SSC	Various (gasoline, water, waste, electricity, cars) CO_2 SO_2 Capital income	3% of GDP, 6% of total tax revenue in 2002	Reduced CO_2 emissions by 25%, reduced cost of labour by 1.4 ppts
Netherlands (1999)	CPT PIT SSC	CO_2	0.7% of GDP in 2001	Created 9000 new jobs, no regressive tendencies, 15% of revenues for energy efficient household appliances
United Kingdom (1996)	SSC	Landfill tax Climate Change Levy Aggregates tax	~0.1% of GDP in 2010	No negative impact on GDP or employment, positive trend in innovation and energy efficiency, reduced emissions by 25%
Finland (1997)	PIT SSC	CO_2 Landfill	0.3% of GDP or 0.5% of total tax revenue in 1999	No employment effect, slightly regressive
Germany (1999)	SSC	Petroleum products	Around 1% of total tax revenue in 1999 or 0.9% of GDP in 2003	Reduced CO_2 emissions by 2-2.5%, created 250.000 jobs, GDP growth increase of 0.5ppts between 1999- 2003, reversed trend of growing pension contributions
Estonia (2006)	PIT	CO_2 Pollution Natural resource	Reduced marginal PIT levels by 3ppts between 2006-2009	Expected to raise employment by 1%
Czech Republic (2008)	PIT CPT SSC	Solid fossil fuels Electricity Natural gas for heating	CPT reduced by 3ppts, 15% flat rate PIT, SSC reductions of 1.5% for employers & employees	

Source: adapted from B. Bosquet, *Environmental tax reform: does it work? A survey of the empirical evidence*, 2000, p. 21.

Appendix B: STATA tables for PCA in 2002

Table 1. Descriptive statistics, 2002

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP	29.00	18631.03	13080.63	2200.00	56200.00
EMPL	29.00	68.47	5.39	58.50	79.60
L_ITR	29.00	34.79	6.76	22.29	43.75
E_ITR	29.00	134.20	76.07	36.23	367.05
C_ITR	28.00	20.32	4.37	14.55	33.75
INTE	29.00	121905.60	328072.40	825.10	1767632.00
RD	29.00	318.57	338.46	8.40	1183.05
RENW	29.00	11.71	10.14	0.10	38.70
GHG	29.00	11.17	4.42	4.75	27.12
EMPR_t	29.00	19.70	7.23	1.08	32.97
EMPE_t	29.00	24.30	5.92	14.57	40.77
ENV_t	29.00	7.69	1.66	4.87	11.09
E_t	29.00	5.31	1.16	2.88	7.25

Table 2. PCA Eigen values, 2002

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp 1	4.5169	1.9922	0.3475	0.3475
Comp 2	2.5247	0.7414	0.1942	0.5417
Comp 3	1.7833	0.6391	0.1372	0.6788
Comp 4	1.1442	0.2838	0.0880	0.7669
Comp 5	0.8605	0.1087	0.0662	0.8330
Comp 6	0.7518	0.3177	0.0578	0.8909
Comp 7	0.4341	0.0850	0.0334	0.9243
Comp 8	0.3491	0.0573	0.0269	0.9511
Comp 9	0.2918	0.1303	0.0224	0.9736
Comp 10	0.1616	0.0692	0.0124	0.9860
Comp 11	0.0923	0.0271	0.0071	0.9931
Comp 12	0.0652	0.0407	0.0050	0.9981
Comp 13	0.0245	-	0.0019	1.0000

Table 3. PCA full components, 2002

Variable	Comp 1	Comp 2	Comp 3	Comp 4	Unexplained
GDP	0.4119	-0.0436	-0.2763	-0.0809	0.0854
EMPL	0.2951	0.1591	0.2408	-0.0386	0.4377
L_ITR	0.0107	0.5460	-0.0332	0.0491	0.2420
E_ITR	0.3737	-0.0777	0.0535	0.3450	0.2125
C_ITR	0.3535	0.2105	0.1629	-0.1603	0.2470
INTE	0.0472	0.0387	-0.2029	0.8354	0.1143
RD	0.4086	0.2165	-0.1037	-0.0535	0.1051
RENW	0.0191	0.4412	0.3910	-0.0994	0.2231
GHG	0.2774	-0.1611	-0.3881	-0.3068	0.2107
EMPR_t	-0.3029	0.4188	-0.1341	0.0039	0.1106
EMPE_t	0.3636	0.0370	0.2207	0.1463	0.2882
ENV_t	0.0551	-0.4212	0.4863	-0.0181	0.1163
E_t	-0.0714	-0.0338	0.4203	0.1355	0.6380

Appendix C: STATA tables for PCA in 2014

Table 1. Descriptive statistics, 2014

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP	29	26175.86	17355.29	5900.00	89500.00
EMPL	29	72.03	4.48	63.90	81.50
L_ITR	29	34.61	5.79	23.16	43.88
E_ITR	29	214.21	87.17	111.00	456.00
C_ITR	28	21.80	4.40	15.22	31.26
INTE	29	110879.10	298121.40	885.00	1607754.00
RD	29	498.86	449.59	28.00	1411.00
RENW	29	19.12	11.56	4.50	52.50
GHG	29	8.83	3.56	5.00	21.00
EMPR_t	29	18.78	6.82	1.43	31.77
EMPE_t	29	24.06	5.20	13.81	33.85
ENV_t	29	7.38	1.84	4.44	10.60
E_t	29	5.47	1.51	2.61	8.36

Table 2. PCA Eigen values, 2014

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp 1	4.1250	1.6465	0.3173	0.3173
Comp 2	2.4785	0.9268	0.1907	0.5080
Comp 3	1.5517	0.2469	0.1194	0.6273
Comp 4	1.3048	0.2305	0.1004	0.7277
Comp 5	1.0743	0.2271	0.0826	0.8103
Comp 6	0.8472	0.1853	0.0652	0.8755
Comp 7	0.6619	0.2569	0.0509	0.9264
Comp 8	0.4049	0.1306	0.0311	0.9576
Comp 9	0.2743	0.1655	0.0211	0.9787
Comp 10	0.1088	0.0368	0.0084	0.9870
Comp 11	0.0721	0.0141	0.0055	0.9926
Comp 12	0.0580	0.0195	0.0045	0.9970
Comp 13	0.0385	-	0.0030	1.0000

Table 3. PCA full components, 2014

Variable	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Unexplained
GDP	0.4346	0.1169	-0.1475	-0.1226	-0.0877	0.1254
EMPL	0.2489	-0.1085	0.3584	0.1007	-0.5792	0.1424
L_ITR	0.1842	-0.3379	-0.0058	-0.0118	0.6814	0.0779
E_ITR	0.1848	0.3248	0.0361	0.4250	0.2147	0.3105
C_ITR	0.2937	0.1130	0.2610	-0.3500	0.2745	0.2660
INTE	0.0573	-0.0952	-0.2867	0.5519	0.0466	0.4367
RD	0.4707	-0.0420	0.1227	0.0498	-0.0137	0.0550
RENW	0.0663	-0.2694	0.6666	0.0854	0.0286	0.1021
GHG	0.2149	0.1880	-0.2574	-0.5380	-0.0781	0.2350
EMPR_t	-0.1235	-0.5477	0.0143	-0.1776	0.0528	0.1493
EMPE_t	0.3532	0.2301	0.0910	0.1303	0.1331	0.3000
ENV_t	-0.2501	0.4521	0.3006	0.0211	0.1411	0.0732
E_t	-0.3419	0.2571	0.2714	-0.1371	0.1465	0.1922