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THE ENVIRONMENTAL IMPACT OF FISCAL INSTRUMENTS

EDGAR MORGENROTH, MARTIN MURPHY AND KYLE MOORE

epa Environmental Protection Agency

ESRI ECONOMIC & SOCIAL RESEARCH INSTITUTE

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The fiscal system constitutes an important mechanism by which firms and individuals are incentivised. Taxes discourage and subsidies encourage activities. It is therefore not surprising to find that in developed countries a wide range of fiscal measures have been enacted. These are usually assessed in terms of their fiscal implications as, for example, a reduced tax rate or an allowance reduces the amount of tax revenue collected. The effect of fiscal measures on their targeted activity is also often assessed. For example, the employment creation effects of investment incentives have been analysed. Likewise, the environmental effects of some measures aimed at achieving environmental goals have been assessed. However, the environmental effects of fiscal measures that are not specifically aimed at achieving environmental objectives are not regularly quantified.

In common with other developed countries, a range of fiscal measures have been adopted in Ireland. These include reduced tax rates, tax exemptions, tax allowances and direct subsidies. However, as many of the measures that had been enacted in the past decade resulted in significant reductions in tax revenue and had questionable effects, the number of tax expenditures has been reduced significantly over recent years.

This report seeks to assess the environmental impact of existing and potential fiscal instruments in Ireland. This is achieved by first conducting a simple assessment of potential environmental impacts of a large number of existing and potential fiscal instruments. This considers the incentives that a particular measure sets, the likely resulting behaviour and the consequent expected environmental impact. In total, 142 measures are considered. The environmental impacts considered cover the main domains of climate change, air quality, water quality and land; 246 impacts are identified, which implies that on average measures impact on more than one domain. The most widespread impact is on climate change emissions, with 98 measures having impacts. The least common impact is on water, with just 23 measures. Just over half the measures were assessed to have a likely positive impact.

The initial assessment of environmental impacts of the 142 measures does not identify the size of the environmental impact. It also does not provide a definitive assessment of the effects. To achieve this, a more thorough analysis is necessary. Such an analysis would require knowledge of the extent of the benefit and the likely behavioural response, and if conducted

for all measures would be a significant research task, which is beyond the scope of this report. Therefore a number of case studies are considered to assess the impact of some measures further. These are the difference in excise rate between petrol and diesel, the zero value added tax (VAT) rate on fertiliser, the rebate scheme on diesel excise for the haulage industry and the possible introduction of an air passenger duty. While the analysis might suggest that the impact of each measure is relatively small, together they have a significant negative impact on the environment. The combined negative impact of the transport measures when compared to counterfactuals where the favourable treatment is removed or a new measure is introduced suggests that total Irish CO_2 emissions could be reduced by 1.1 per cent, NO_X emissions could be reduced by 1.34 per cent and PM_{10} emissions could be reduced by 1.47 per cent. The absolute reduction of emissions in tonnes is quite large on each of the three pollutants.

CHAPTER 1

Introduction

Fiscal measures such as taxes, tax expenditures[1] and subsidies are important policy tools. By changing prices, they affect behaviour of firms and individuals. It is therefore not surprising that the use of fiscal instruments as a corrective measure for externalities[2] has been proposed by Pigou (1920), and his initial insights have spawned a considerable academic literature, which focuses on the role of taxation in achieving environmental goals. Likewise, it is not surprising to see fiscal instruments to achieve environmental objectives implemented in many countries. For example, Cansino et al. (2010) find that 16 of the EU-27 member states promote green electricity using tax incentives along with other measures.

In common with other countries, a range of fiscal measures with a wide range of objectives is in place in Ireland, but, with the exception of those directly aimed at achieving environmental goals, their impact on the environment is not normally assessed. Fiscal measures may contribute either positively or negatively towards environmental outcomes in Ireland, and it is likely that changes to them may yield environmental improvements. This report seeks to assess the environmental impact of existing and potential fiscal instruments in Ireland. The analysis encompasses an initial assessment of expected environmental impacts of a large number of existing and potential fiscal instruments. The environmental impacts considered cover the main domains of climate change, air quality, water quality and land.

Environmental taxes and subsidies are applied to reinforce the Polluter Pays Principle, which states that:

> *the polluter should bear the expenses of carrying out the above-mentioned measures decided by public authorities to ensure that the environment is in an acceptable state ... the cost of these measures should be reflected in the cost of goods and services which cause pollution in production and/or consumption.* (OECD, 1974)

The key reason why governments need to get involved in dealing with

[1] The more favourable tax treatment of certain groups, products or activities, through allowances, reduced tax rates or rebates.

[2] Externalities are costs or benefits that are imposed on some through the actions of others. Examples include pollution or visual disamenities.

externalities is that they tend to affect many individuals and are difficult for individuals on their own to address. For example, individuals might struggle to assert property rights which would allow them to seek compensation for negative externalities, e.g. for air pollution. If the true cost of the externalities were properly reflected in the decisions of potential polluters, they might take actions to avoid creating the externality in the first place. Fiscal instruments should therefore correct the prices faced by polluters such that environmental externalities are avoided or at least reduced.

The impact of fiscal measures that are directly aimed at achieving environmental benefits are regularly analysed in terms of their effectiveness in achieving their stated environmental aims, costs and wider effects. For example, Martin et al. (2014) found that the introduction of a carbon tax in the UK reduced energy intensity significantly in manufacturing plants. A car scrappage scheme in the USA whereby consumers could get a rebate on the purchase of new and presumably more efficient cars, which cost $3 billion, was evaluated by Li et al. (2013). They found that approximately 45 per cent of the expenditure under the scheme was deadweight, i.e. would have occurred without any government intervention. Energy taxes and the EU emissions trading system (ETS) were found to increase productivity, decrease employment and have a mixed effect on investment, although the effects differed significantly across industries (see Cummins et al., 2011). In the USA tax expenditure accounts for three-quarters of federal support for energy policy, and in so far as this is aimed at increasing the share of renewables in the fuel mix, it was found to come at a relatively high cost (Metcalf, 2008).

In Ireland the changes in vehicle taxation enacted in 2008 have been shown to have significantly altered the composition of the national car fleet with respect to fuel type (see Hennessy and Tol, 2011).

While fiscal measures that are specifically targeted at environmental objectives are regularly analysed, the effect of the broader fiscal system on the environment is analysed less frequently. However, many measures that are not specifically aimed at the environment may have an impact on the environment by incentivising behaviour. In the Irish context this was first pointed out by Barrett et al. (1997).

Since July 2013 an Essential User Fuel Tax Rebate is available to haulage firms, which allows these firms to reclaim some taxes spent on fuel purchased in Ireland, and constitutes a tax expenditure. This might have

encouraged greater fuel usage as the rebate effectively lowers the price of fuel. This could arise either through increased mileage, the operation of older, less efficient vehicles or deferred investment in new, more efficient vehicles (see Hyland and Morgenroth, 2012).

Importantly, while the revenue implications of fiscal instruments are typically identified in detail, the actual environmental impacts of these are often not assessed. Thus, for example, the introduction of the Essential User Fuel Tax Rebate was estimated to cost the Exchequer €70 million per annum, while the environmental implications of this new policy were not quantified. Thus, fiscal instruments play a part in determining environmental outcomes. While a comparison of environmental indicators for Ireland with those across the EU shows that Ireland generally scores well, there are a number of measures where Ireland needs to improve.

Perhaps the most pressing issue is in relation to climate change, where Ireland's greenhouse gas (GHG) emissions are likely to exceed binding limits under an existing measures scenario (Environmental Protection Agency (EPA), 2016a; Climate Change Advisory Council (CCAC), 2017). In addition, there are some other environmental indicators where Ireland needs to improve. For example, Ireland did not meet World Health Organisation (WHO) air quality guideline limits in relation to particulate matters in a number of recent years (EPA, 2016b). There has also been a decline in high environmental status rivers over a longer period.

The European Commission's recently published report *The Environmental Implementation Review* (2017), which details each member state's environmental challenges, displays Ireland in a positive light. In particular, a point of excellence for Ireland was the transformation of its waste sector due to reforms such as closing illegal landfills. One worrying aspect, though, is Ireland's fondness for diesel cars. Ireland has the second highest share of diesel cars among new passenger cars in the EU, whereby 73 per cent of new car registrations are diesel, just behind Latvia in 2013 (Eurostat, 2015). Two of the four case studies in this report may provide guidance in policy measures that can potentially move Ireland closer to European norms.

In Ireland, tax expenditures identified by the Revenue Commissioners cost over €3.8 billion in 2015, which is equivalent to just under 8 per cent of tax revenue (Revenue Commissioners, 2017). While the Irish tax system still contains many tax expenditures, it must be noted that many, particularly property-related tax expenditures, have been phased out over recent years. Examples include capital allowances for multi-storey car parks that

would have the effect (at least at the margin) of reducing car parking costs and thus incentivising driving. Over the period 2004 to 2014 the cost of tax expenditures was equivalent to just over 33 per cent of total tax revenue.

In addition to tax expenditures that are explicitly recognised, there are examples where reduced taxes are not listed as tax expenditures, e.g. zero rating of VAT on fertilisers. Furthermore, tax instruments that are commonly used in other countries to address environmental externalities are not applied in Ireland and could thus be considered a missed opportunity to alter behaviour.

This report is organised as follows. Chapter 2 identifies a large set of existing and possible fiscal instruments and assesses their expected environmental effects using a simple approach. This highlights the potential for non-environmentally aimed fiscal instruments to impact on the environment. In Chapter 3 the environmental impact of a number of selected fiscal instruments is assessed more thoroughly and quantified. Chapter 4 summarises the results and offers some conclusions.

CHAPTER 2

Fiscal instruments

2.1 TAXES AND TAX EXPENDITURES IN IRELAND

Taxes not only raise revenue to pay for the activities of governments, they almost invariably affect the behaviour of individuals and firms. These behaviours, in turn, often affect the environment in some way. Indeed, an important rationale for some forms of tax is to deter less environmentally desirable activities by increasing the price of pursuing them (e.g. the plastic bag tax). In cases where markets fail to provide appropriate incentives to protect the environment, environmental taxes may offer an efficient way to sustainability and long-run societal welfare.

Tax expenditures relate to government spending through the tax code. By choosing to exempt some goods or services from taxation or to tax them more lightly than others, a cross-subsidy favouring particular types of expenditures or activities is in effect provided. Many such fiscal instruments are currently used in Ireland.

The first task in this chapter is to identify the fiscal instruments that are to be analysed. The Revenue Commissioners identify 102 tax exemptions in 2012 and just 15 tax expenditures in 2015. Furthermore, the Revenue Commissioners provide details about the VAT treatment of different products and services. Many, such as exempt categories or reduced rates of value added tax (VAT), are explicitly identified in government publications, but others are not as clearly highlighted, such as the zero VAT on fertiliser use.[3] A third category of fiscal instruments are those that are common in other countries but not used in Ireland. For example, taxes on extraction of aggregates are employed in many EU countries but not in Ireland.[4] A case could be made that this is a form of tax expenditure. These and other potential fiscal instruments are more difficult to identify, but a search of the literature and the Internet sites of tax authorities in other countries was used to compile as comprehensive a list as possible.

[3] Reduced VAT rates are not considered a tax expenditure in official records but, given that they impact on behaviour, they are included in the analysis in this report.

[4] Apart from determining fiscal policy, the State also plays an important role through its purchases. In relation to aggregates, the construction of the Irish motorway network and other public capital works significantly contributes to the demand. Introducing an aggregates tax would not make a material difference to this, as the revenue would flow back to the state so that it would not alter prices for central government.

We use the broader term 'fiscal instrument' to encompass both explicit tax expenditures and other fiscal measures that affect the absolute and relative taxation of goods, services and activities. For example, a lower rate of VAT is not included in the official list of tax expenditures but clearly might impact on behaviour.

The second task was to assess the potential environmental impact of each fiscal instrument. Measures could have a range of effects on different aspects of the environment. Here we consider the emission of GHGs, emissions that impact on local air quality, impacts on water and impacts on soils. Noise pollution is not considered here as this is often dependent on the way in which an activity is carried out rather than the activity itself. It is also beyond the scope of this report to assess the resource efficiency implications across the economy of the application of fiscal measures.

The most obvious impact on air quality comes from the combustion of materials through either the operation of combustion engines or the burning of materials for home heating or electricity generation. Water pollution encompasses direct and indirect emissions into water. For example, substances could be directly flowing into a water course or could leach out of surrounding land. Soils could be altered or material could be extracted.

In the case of each type of environmental impact, the effect of fiscal measures could be either negative or positive. One would expect a positive impact from measures that are directly aimed at addressing environmental issues, while measures that are not specifically aimed at the environment are more likely to have negative effects.

The approach here is not to attempt to quantify the potential effect but to conduct an initial assessment of whether a measure might impact on one of the environmental domains. This is accomplished by first determining the likely change in behaviour that a particular measure will give rise to. For example, a tax relief on construction should result in more construction than if the relief did not exist.

The second step is to assess what effect more construction might have on the environmental domains. For example, more construction might use up land if the construction is on a greenfield site, but that would not be the case for brownfield developments. However, additional construction is also likely to give rise to construction waste, which is likely to have an effect on the land domain. Of course, the level of impact may vary

significantly between different projects that are stimulated by the tax incentive. It is also not always certain that the effect is necessarily positive or negative. For example, the Young Farmers Relief incentivises younger farmers to take over farms. This might result in more intensive agricultural practices being used that impact negatively on the environment, but it might also eliminate inefficient and environmentally damaging practices or could result in a young farmer converting to organic methods, which would have a beneficial environmental impact. This means that the analysis in this chapter is only a first rough assessment of the likely impacts and more detailed analysis is necessary to identify the nature and scale of impact.

Furthermore, the scale of impact is likely to vary significantly between instruments; many impacts are likely to be small and may well be acceptable in the context of other aims of the particular measure. For example, while the favourable tax treatment of cars for the disabled is likely to increase the stock of cars marginally and to increase GHGs and impacts on air quality, the social benefits of improving the mobility of the disabled far outweigh the negative environmental impacts.

In total we identify 246 environmental impacts, either positive or negative, for this set of instruments. This list is not exhaustive and probably underestimates the number of fiscal instruments in play. These differ in their type, from benefit-in-kind tax exemptions to excise duty taxes. A full list of the fiscal instruments we have identified, with descriptions, is given in the Appendix.

Some fiscal instruments intentionally affect the environment. Examples are easy to find. The Carbon Tax changes the relative price of fuels, deterring use of fossil fuels that lead to higher carbon emissions and ultimately to climate change. Similarly, the environmental levy on plastic bags aims to deter the purchase of plastic bags, ultimately reducing litter. The Cycle to Work Scheme seeks to encourage the take-up of cycling to work to reduce vehicle emissions and congestion, through a benefit-in-kind from employers.

However, some instruments can have unforeseen environmental consequences and often these are negative. For example, take the system of company car taxation in Ireland. With tax liability calculated on a sliding scale based on total business kilometres driven, it creates the perverse incentive for employees to increase business mileage to reduce their tax payments. This has the unanticipated effect of increased vehicle emissions.

Where measures affect the environment in ways that are intended, it is more likely that data will be collected to allow an assessment of the environmental effects of the measures. Indeed, in some cases ex ante assessments may have been carried out by the government or by researchers. For example, the expected effects of the carbon tax were explored in some detail before it was introduced (e.g. Commission on Taxation, 2009; Callan et al*.,* 2009). In contrast, unintended consequences tend to be harder to identify and to estimate.

2.2 SUMMARY OF ENVIRONMENTAL EFFECTS BY DOMAIN AND DIRECTION OF EFFECT

Here a distinction is made between impacts that affect air quality and those that influence climate change, i.e. local pollutants and global pollutants. Impacts on land include extraction of resources and land-use changes that have negative environmental impacts. Impacts on water include any that reduce water quality, but also those that influence water extraction.

To see how the assessment of impacts was carried out, it is useful to consider a few examples of the measures considered here (the complete set of measures and the assessment are set out in the Appendix). The first measure considered in the Appendix is the Cycle to Work Scheme. This is aimed at increasing cycling and thereby reducing the use of transport modes that use combustion engines. This should reduce GHG emissions and benefit local air quality. In contrast, exemptions from Vehicle Registration Tax (VRT), by reducing the cost of cars for certain individuals, increases the number of cars. However, as this measure is limited to a small number of individuals, the overall effect is likely to be small. The Capital Gains Tax relief on the disposal to a child of a residential dwelling site is expected to have a negative impact on land, as it results in more land being covered with a building. This measure is also more likely to be used more in rural areas, and results in sprawled development patterns, which have wider negative effects. Water and wastewater charges, by making the price of water explicit, will reduce the use of water and thus reduce the production of wastewater.

Table 1 summarises the numbers of likely effects identified under the headings of air, water, land and emissions, divided between those with broadly positive and negative impact.

TABLE 1 ENVIRONMENTAL EFFECTS IDENTIFIED FOR FISCAL INSTRUMENTS IN IRELAND

Domain of effect	Positive	Negative	Total
Air	40	27	67
Water	10	13	23
Land	17	41	58
Emissions	57	41	98
	124	122	246

Source: Authors' calculations; see Appendix.

The total number of positive environmental effects is just greater than the total number of negative effects from the instruments we have identified. The most prevalent domain of effects is emissions, with 98 environmental effects associated with it, of which majority are positive. Land and emissions are associated with the largest number of negative environmental effects, although the majority of land impacts are negative while the majority of emissions effects are positive.

This simple environmental categorisation of instruments takes no account of the varying sizes of the positive or negative effects. In practice, the impact can vary greatly across instruments, particularly in how many economic agents the tax affects. This can range from small (e.g. repayment of VAT for disabled drivers) to substantial numbers (e.g. plastic bag levy). It is not straightforward to quantify the effects of fiscal instruments. There are several challenges. Firstly, the required data may not be available. For example, details that could be used to assess the environmental impact of the tax treatment of company cars, which is likely to have significant negative environmental effects, are not available. Secondly, parameters that measure the responsiveness of behaviour to price changes are required to calculate the potential impact of changing a fiscal measure. Finally, accurate and up-to-date information on emission factors is required in order to put a figure on the damage of an activity.

In the next chapter, we scrutinise selected fiscal instruments in detail, paying special attention to their environmental impact and attempting to quantify it. This approach is intended to help illustrate how such effects can be identified and quantified in general, as well as providing some useful insights into the specific cases discussed.

CHAPTER 3

Case studies

The assessment of fiscal measures in the previous chapter shows that many have a negative environmental impact. Thus, the fiscal measures in place result, for example, in higher emissions. Using four case studies we quantify this negative effect, calculating the positive environmental effect of removing these measures.

Agriculture and transport remain the two largest contributors by sector to overall GHG emissions in 2015, accounting for 33.1 per cent and 19.8 per cent respectively (Environmental Protection Agency (EPA), 2017). Additionally, the two sectors are projected to account for 76 per cent of non-Emissions Trading Scheme (ETS) emissions in 2020 (EPA, 2016b). We select four fiscal measures that that are assessed to negatively affect the emissions from these sectors. These are the difference in excise rate between petrol and diesel, the zero value added tax rate (VAT) on fertiliser, the rebate scheme on diesel excise for the haulage industry and the possible introduction of an air passenger duty (APD).

The selection was heavily influenced by data availability. For example, the tax regime for company cars appears to incentivise higher emissions, but as there are no data on the number of company cars, their characteristics and usage, it is not possible to conduct an analysis of this incentive. The analysis in this chapter provides a more in-depth analysis in order to quantify these negative effects.

3.1 DIESEL–PETROL EXCISE GAP

The taxation regime for vehicles of different fuel types has a significant impact on consumer decisions. For example, the charging of vehicle registration tax and motor tax in Ireland on the basis of CO_2 emissions resulted in a significant switch towards diesel-powered cars (Hennessy and Tol, 2011). There is also a relationship between the relative taxation of fuels and the composition of the vehicle stock. Across EU countries the correlation between the share of the stock of passenger cars that are diesel powered and the favourable tax treatment of diesel relative to petrol is 0.53.[5]

[5] The calculation uses Eurostat data on the stock of passenger cars by fuel type and fuel taxation rates from the EU DG MOVE. The correlation is statistically significant at the 1% level.

The change in the tax system in Ireland has had a significant effect on CO_2 emissions, as it incentivised the purchase of more efficient vehicles. In 2009 just 13 per cent of new cars registered were in the lowest emission category (Category A, less than 120 g CO_2/km). By 2016 this had increased to 78 per cent. The buoyant economy, which resulted in a significant increase in the number of new vehicles purchased, reduced the average age of the Irish car stock, and individuals chose to buy more efficient cars. This, coupled with EU regulations that required car manufacturers to produce more efficient vehicles should have resulted in a significant efficiency improvement.

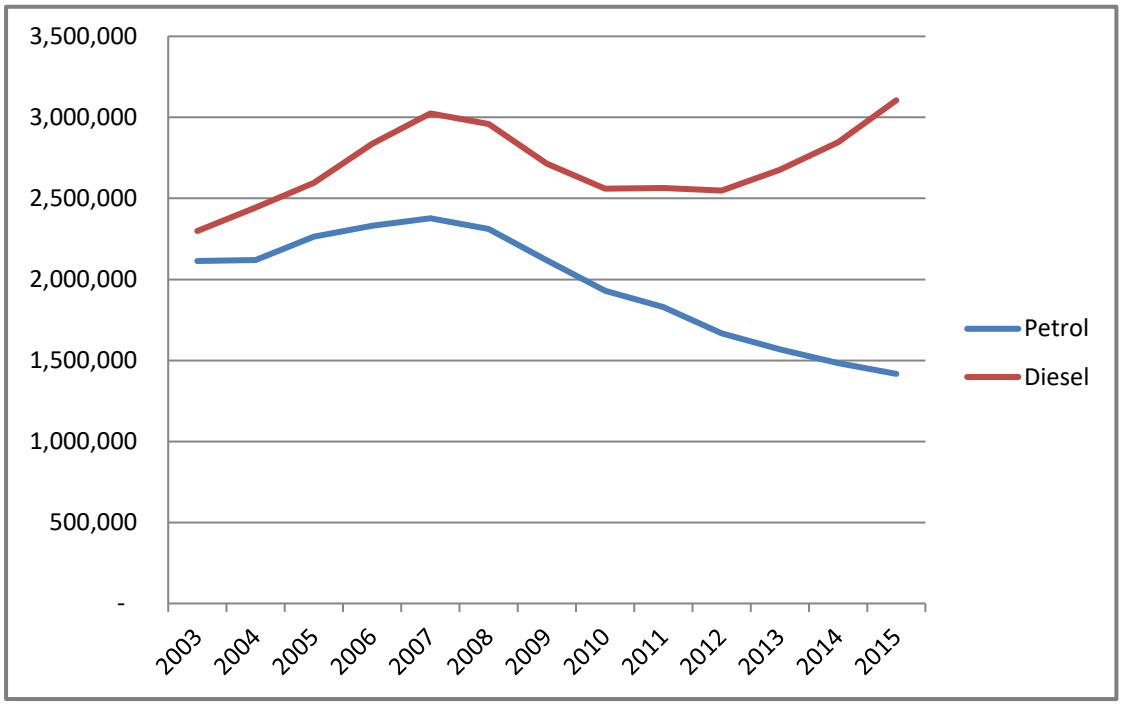
However, the rising stock of new vehicles was accompanied by longer travel distances and somewhat larger cars on average the efficiency improvements have been more modest than one might expect. Daly and Ó Gallachoir (2011) estimated that CO_2 emissions in Ireland have been reduced by 7 per cent. This estimate, however, does not take account of the fact that manufacturers' claimed emissions have been progressively understated. A recent report by the International Council on Clean Transportation (ICCT) (2016; see also Tietge et al., 2017) shows that the deviation between manufacturers' stated emissions and those measured in practical driving situations increased from 9 per cent in 2001 to 42 per cent in 2015. In addition, Leinert et al. (2013) show that dieselisation due to the tax changes introduced in 2008 resulted in lower reductions in nitrogen oxides (NO_X) emissions than would otherwise have been the case.

In Ireland, consumption and excise receipts for diesel surpass those for petrol, and the gap between them is growing. Figures 1 and 2 display the recent trends in observed fuel consumption and receipts.

As a consequence of increasing diesel consumption in Ireland and across the EU, significant air quality issues have arisen as vehicles emit NO_X and particulate matter (PM) as well as CO_2, and diesel vehicles emit more NO_X and PM than petrol vehicles (both emit more CO_2 than electric vehicles).

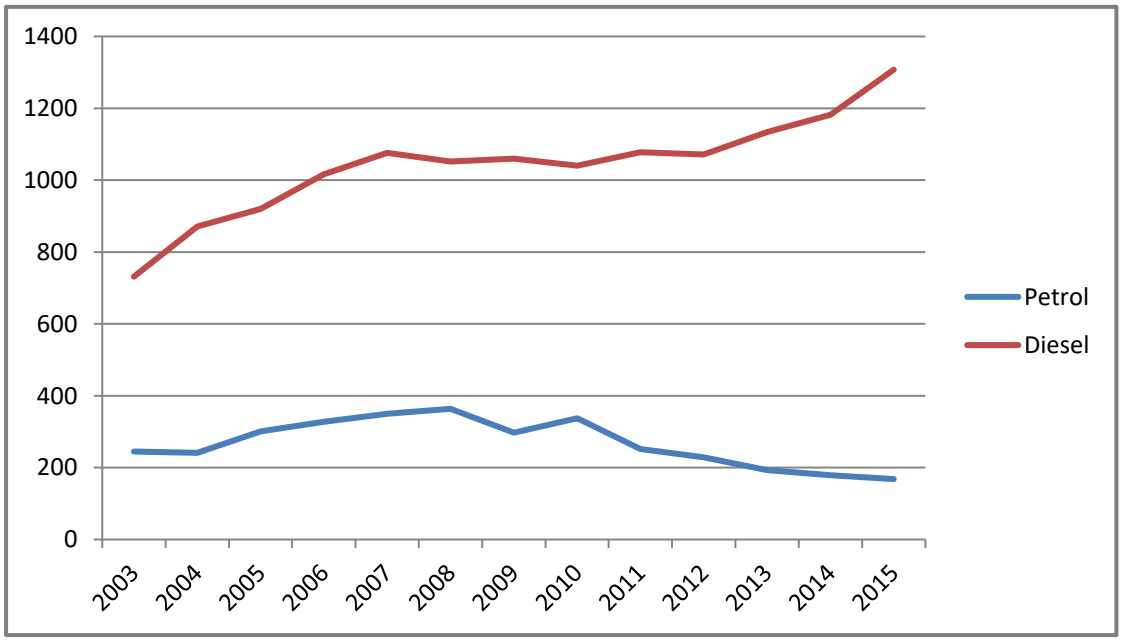
The transport sector is a major contributor to emissions of air pollutants. In 2013, this sector made up 46 per cent of total NO_X emissions and 13 per cent of total PM_{10} (PM 10 µm or less in diameter), emissions in the EU-28. Moreover, of the NO_X emissions emitted by road vehicles, 80 per cent is from diesel vehicles (European Environment Agency (EEA), 2015).

FIGURE 1 FUEL CONSUMPTION ('000 LITRES)



Source: Revenue Commissioners

FIGURE 2 FUEL EXCISE RECEIPTS (€MILLION)



Source: Revenue Commissioners

The vehicle emissions testing process has received greater attention since the Volkswagen scandal in 2015. The emissions during typical operating conditions have been found to far exceed theoretical testing levels. Diesel

vehicles that 'claim' to meet standards under laboratory conditions perform far less well when measured under real driving conditions. For example, on-road fuel consumption, and hence also the CO_2 emissions, can be 20–40 per cent higher than official measurements. Additionally, the levels of NO_X emissions can be up to four or five times higher in reality (EEA, 2015; Tietge et al., 2017). A similar wide disparity in vehicle emission levels under laboratory and real-life testing has not been witnessed for petrol vehicles. While the EU plans to introduce emissions testing procedures that better reflect real on-road driving conditions, it is likely that until then the emission factors used for diesel vehicles will understate their true impact. Thus, caution should be exercised with the emission factors used in this paper.

The higher levels of emissions compared to those claimed by manufacturers combined with growing traffic volumes have resulted in poor air quality in many European cities. As a consequence, and given the need to meet EU air quality regulations, many cities are now considering diesel bans or at least bans of diesel vehicles that do not meet the Euro 6 standard.[6,7]

Currently, diesel fuel benefits from a lower excise rate than petrol in Ireland.[8] This, along with the CO_2-based Vehicle Registration Tax (VRT) and Motor Tax system, incentivises the purchase and use of diesel cars. The lower excise rate on diesel compared to petrol can be considered a tax expenditure. This favourable treatment of diesel vehicles, which was introduced to reduce CO_2 emissions, is likely to result in increased emissions of both NO_X and PM. Here we examine the environmental impact of this favourable tax treatment of diesel cars, by calculating the effect on fuel consumption and emissions if the excise rate on diesel is raised to that of petrol.[9]

[6] The EU sets emission standards for passenger cars and other vehicles setting out maximum permitted emissions of key pollutants. These standards were introduced in 1993, with the original standard being known as Euro 1. They have been progressively tightened and the latest is Euro 6, which was introduced in 2014.

[7] The Bundesrat, the national legislative body that represents the German Federal States, which has significant functions in relation to transport, has proposed a new law that will ban diesel vehicles that do not meet at least the Euro 6 norm.

[8] The excise rates on petrol and diesel are €587.71 and €479.02 per 1000 l, respectively (including the carbon tax component).

[9] Equalising the excise rates is not revenue neutral, so the effect will be a mix of equalisation and of raising the average price of fuel.

3.1.1 Method

The impact of closing the excise gap between the two fuels would come through a price effect, which can be measured using the price elasticity of demand (PED) for fuel (in this case, diesel). A PED measures the responsiveness of demand to a change in price. The equalisation of excise rates is equivalent to a 22 per cent increase in the price of diesel. Multiplying this percentage change in price by the PED of diesel will generate the percentage change in the quantity of diesel demanded. This figure will feed through to changes in consumption, emissions and receipts. These calculations take the current composition of the vehicle stock, which of course is significantly changed from its pre-2008 composition due to the tax changes introduced at that time, as a basis. The results of the calculations would be different if the composition and size of the stock were different.

We also consider the possibility that drivers would switch away from diesel to petrol. In the short run this is likely to be muted, but over time a permanent change in the relative price of fuel would impact on the car technology purchased.[10] We can estimate the magnitude of this switching using a cross-price elasticity of demand (XED) for petrol with respect to diesel. This measures the responsiveness of petrol demand to a change in diesel prices. As diesel and petrol are assumed to be substitutes for each other, we would expect a positive cross-elasticity; that is, as the price of diesel increases, drivers divert their fuel demand towards the substitute of petrol. While many research papers have estimated price elasticities (e.g Dahl, 2012; Labandeira et al., 2017), there is a gap in the literature pertaining to the estimation of cross-price elasticities of demand for diesel and petrol. Further research will be needed to address this shortcoming and ensure that the elasticity used in this report is plausible in an Irish context.

We use emission factors to gauge the environmental impact of a change in the price of diesel. An emission factor gives the average emission rate of a given pollutant for a given source, relative to units of activity. We have opted to use emission factors relative to a litre of fuel instead of using emission factors that give pollutant per kilometre driven, as these correspond to the easily accessible fuel consumption data and this avoids

[10] It is likely that only households with both diesel and petrol vehicles may switch to using their petrol vehicles immediately.

arguments over the relative fuel efficiency of diesel over petrol for distance travelled on a tank of fuel. Transport emission factors are taken from research by AEA Energy & Environment, on behalf of Defra.[11] We opted to use these emission factors over those provided by the Sustainable Energy Authority of Ireland (SEAI), because they are much richer in detail.[12] In particular, they give an estimate of urban and rural emissions, which is a salient issue in Ireland. They provide a rich dataset of emission factors for different types of vehicle engines as well as distinguishing between urban, rural and motorway emissions. We use the emission factors for NO_X and PM_{10}, both rural and urban, for the newest class of diesel and petrol vehicles, which results in a conservative estimate of the environmental impact as newer engines are more efficient than older ones and the gap between new diesel engines and petrol engines is smaller than that for older engines. To measure the difference in emissions between urban and rural Ireland, we use population data from the census to proxy for urban-rural mileage in Ireland.[13]

3.1.2 Results

We have assumed a price elasticity of demand for diesel of –0.19, estimated for Ireland by the National Roads Authority (NRA, 2013). In addition, we have used a cross-price elasticity of demand estimated for petrol of 0.10 in Polemis (2006). Polemis estimates petrol and diesel demand in Greece using a cointegration approach. The figure he finds is reasonable in a theoretical sense, as we expect diesel and petrol to be imperfect substitutes, but considering that few studies have estimated cross-price elasticities between fuels, it would be unwise to place too much faith in the estimate.[14] With these two elasticities, we can simulate what would happen if the diesel excise rate were increased by 22 per cent to bring it in line with the rate for petrol. Table 2 summarises these results and Table 3 computes the net changes for the variables of interest.

[11] AEA Energy & Environment is now called Ricardo Energy & Environment.
[12] We do use the SEAI diesel emission factor for CO_2 emissions, which is 2.68 kg CO_2/l.
[13] 62% of the population of Ireland lived in urban areas (Central Statistics Office (CSO), 2012).
[14] Ofori (2015), another paper we identified, estimated a cross-price elasticity of demand for petrol equal to 0.10 in Ghana. This figure provides greater confidence to the Polemis (2006) estimate used.

TABLE 2 OUTCOMES OF EQUALISING DIESEL AND PETROL EXCISE RATES

	Before	After	Change	Change (%)
Diesel				
Excise duty (€ per 1000 l)	479.02	587.71	108.69	22
Consumption (1000 l)	3,106,000	2,972,000	−134,000	−4.3
Receipts (€m)	1,308	1,747	439	33.6
CO_2 emissions (t)	8,323,000	7,964,000	−359,000	−4.3
Urban NO_X emissions (t)	9,743	9,323	−420	−4.3
Rural NO_X emissions (t)	6,090	5,827	−263	−4.3
Total NO_X emissions (t)	15,830	15,150	−680	−4.3
Urban PM_{10} emissions (t)	597	571	−26	−4.3
Rural PM_{10} emissions (t)	283	271	−12	−4.3
Total PM_{10} emissions (t)	880	842	−38	−4.3
Petrol				
Excise duty (€ per 1000l)	587.71	587.71	0	0
Consumption (kl)	1,417,000	1,449,000	32,000	2.2
Receipts (€m)	768	851	83	10.8
CO_2 emissions (t)	3,344,000	3,420,000	76,000	2.3
Urban NO_X emissions (t)	808	827	19	2.4
Rural NO_X emissions (t)	565	578	13	2.3
Total NO_X emissions (t)	1,373	1,405	32	2.3
Urban PM_{10} emissions (t)	17.6	18.0	0.4	2.3
Rural PM_{10} emissions (t)	10.8	11.0	0.2	2.2
Total PM_{10} emissions (t)	28.3	29.0	0.7	2.3

Notes: *Values are rounded to four significant figures.*
Source: *Authors' calculations*

TABLE 3 NET CHANGES

	Change	Change (%)
Consumption (kl)	−102,000	−2.3
Receipts (€m)	522	25
CO_2 emissions (t)	−283,000	−2.4
Urban NO_X emissions (t)	−402	−3.8
Rural NO_X emissions (t)	−250	−3.7
Total NO_X emissions (t)	−652	−3.8
Urban PM_{10} emissions (t)	−25	−4.1
Rural PM_{10} emissions (t)	−12	−4.1
Total PM_{10} emissions (t)	−37	−4.1

Notes: *Values are rounded to three significant figures.*
Source: *Authors' calculations*

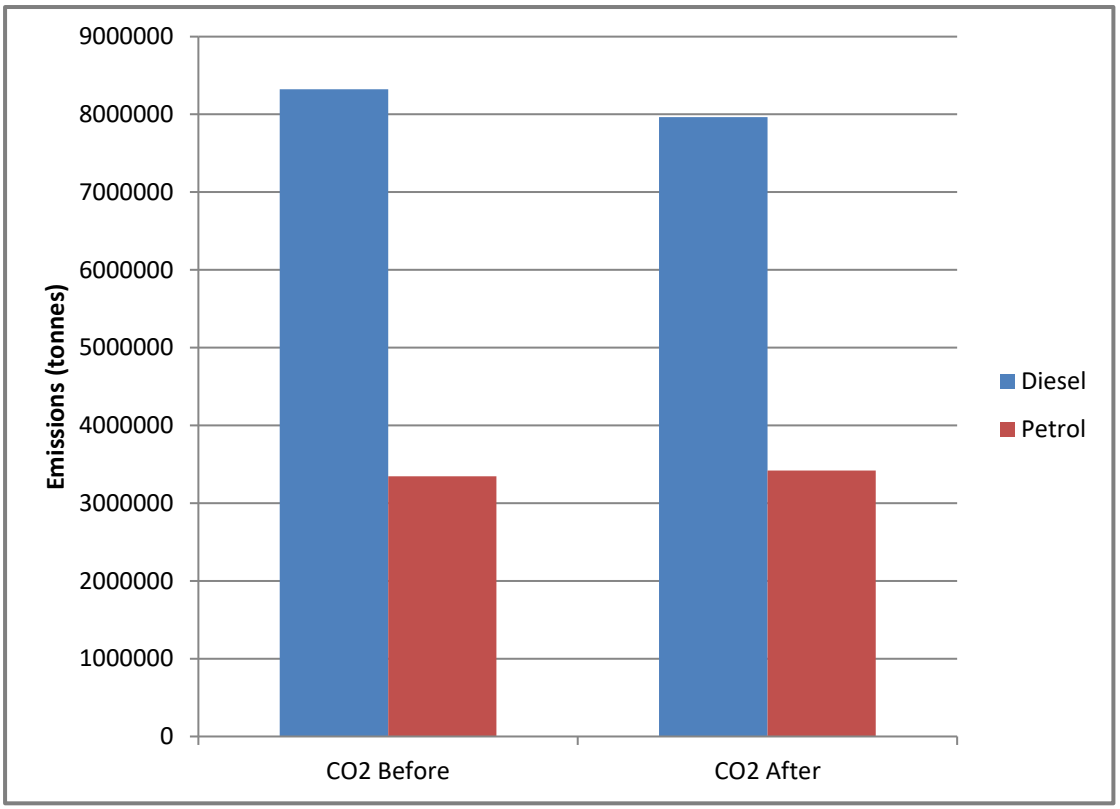
The analysis shows quite broadly that an equalisation of excise rates of petrol and diesel to the current rate for petrol would reduce fuel consumption, drive down vehicle-related emissions and provide a revenue boost to the exchequer. Emissions of all three pollutants fall (see Figures 3, 4 and 5). The reductions are significant, especially given that the change required to achieve them is relatively modest. Importantly, the

equalisation of excise rates would lead to a reduction in CO_2 emissions, i.e. it would not reverse the gains achieved through the tax changes introduced in 2008.

Interestingly, there is a greater reduction in urban areas than in rural areas (see Table 3). The equalisation of excise rates would thus particularly meet the objective to improve urban air quality. This is important, as air quality issues tend to be concentrated in urban areas.

Government receipts are expected to increase from the greater petrol fuel sales and the greater excise duty on each litre of diesel. This revenue boost is to be expected since diesel demand is inelastic (PED is less than 1). This happens because the price effect generated by the higher price of diesel is greater than the quantity effect of a reduction in sales[15].

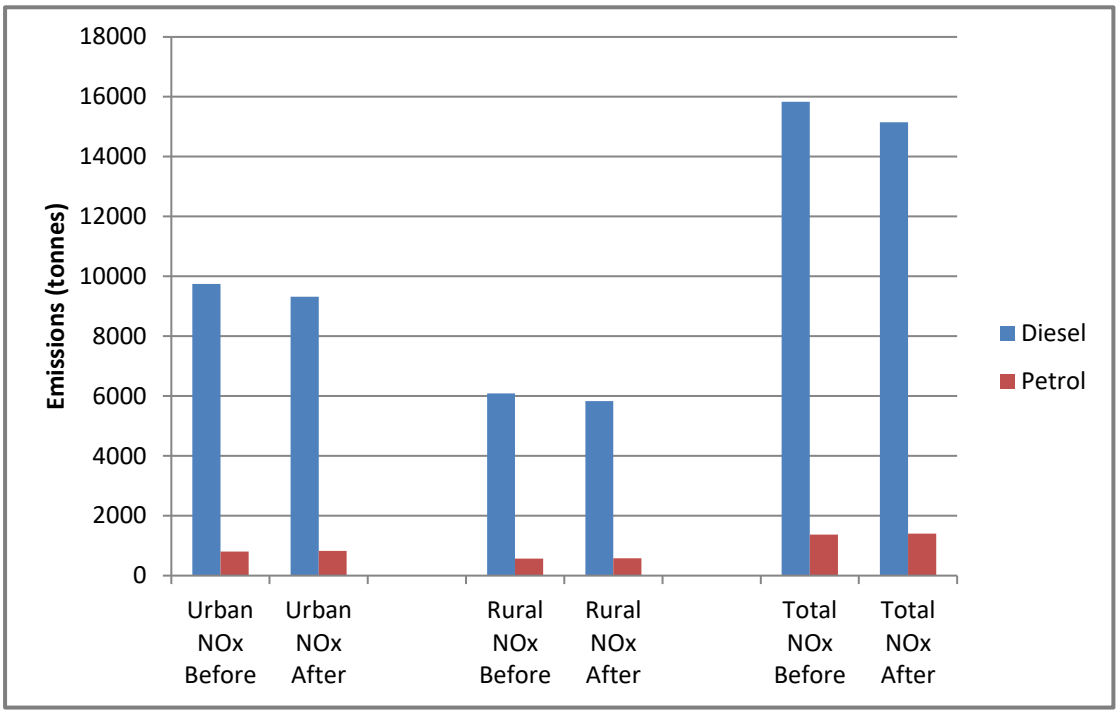
FIGURE 3 CO_2 EMISSIONS



Source: Authors' calculations

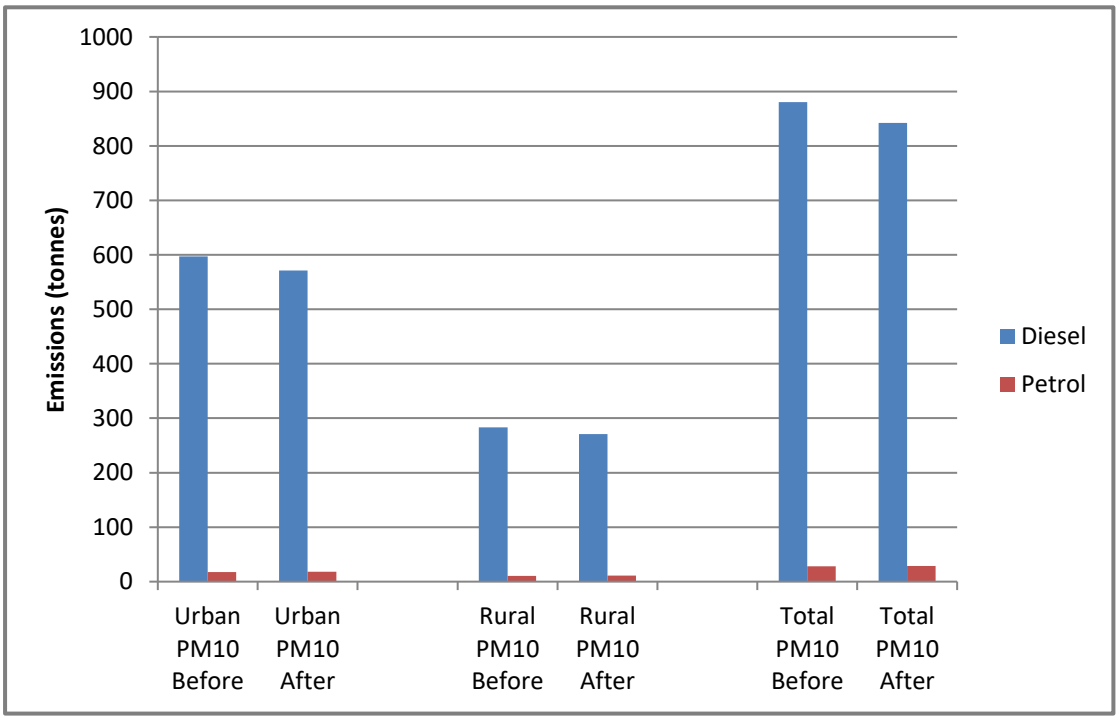
[15] Revenue is likely to fall in the long run as individuals alter their behaviour and switch to more efficient cars, including those with alternative technologies. This highlights the key issue in enacting environmental tax reform, as the intended changed behaviour erodes tax revenues.

FIGURE 4 NO_X EMISSIONS



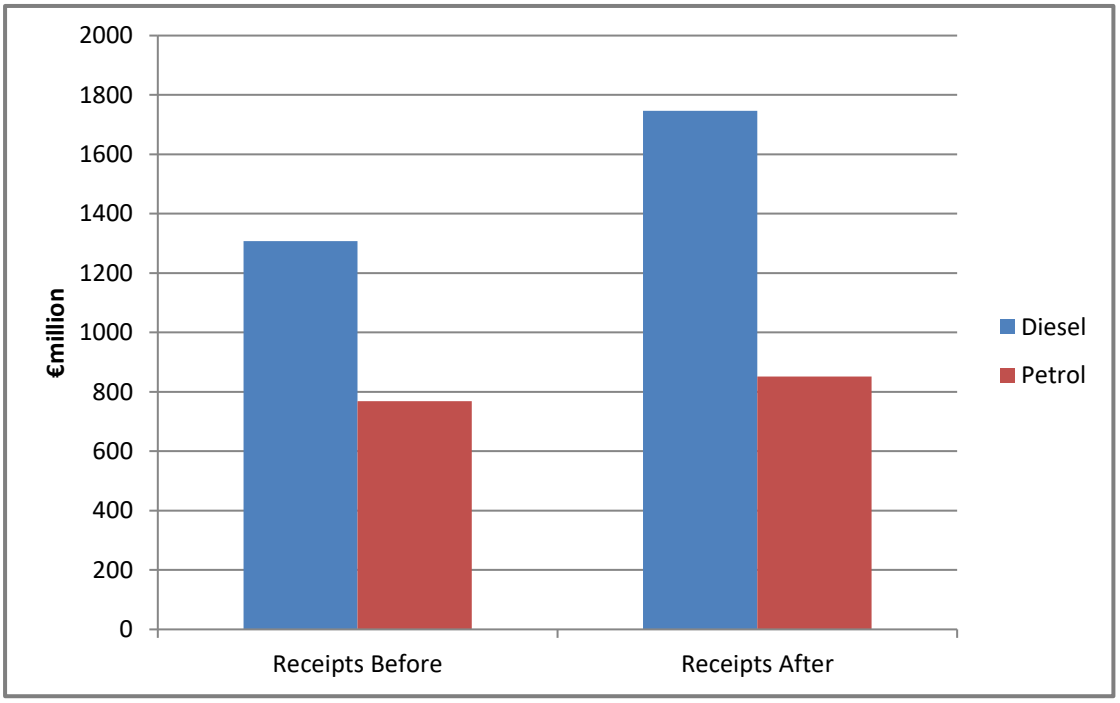
Source: Authors' calculations

FIGURE 5 PM_{10} EMISSIONS



Source: Authors' calculations

FIGURE 6 EXCISE RECEIPTS



Source: Authors' calculations

This case study shows that an increase in the excise rate on diesel can be justified on environmental and fiscal grounds. One point to consider is how the change in the price of diesel in Ireland could impact on the relationship of fuel demand between neighbouring jurisdictions of the UK (NI) and Ireland. An increase in the Irish price of diesel that makes it higher than the NI price may increase the level of cross-border fuel tourism into the UK, which would have a positive effect on Ireland's recorded emissions but a negative impact for the exchequer. Recent research by Kennedy et al. (2017) shows that the price of diesel was 1.2 times higher in the UK than in Ireland in 2016, suggesting that the risk of 'fuel leakage' outside the country is likely to be minimal. However, one should be aware of the impact any increase in the excise rate of diesel may have on the substitution of agricultural diesel. The increase in the price differential between the two types of diesel may incentivise fuel fraud, although sampling by Revenue shows that the selling of agricultural diesel is close to being eliminated in the market, which suggests that this problem may not be as big as first thought (Tax Strategy Group, 2016). Overall, an increase in the excise rate of diesel is likely to reduce environmental damage caused by motor fuels.

3.2 ZERO RATE VAT ON FERTILISER

Nitrate and phosphate leaching causes severe damage to rivers and lakes. A report by the EPA on water quality found that the eutrophication of rivers and lakes continues to be the greatest impact on water quality from agriculture in Ireland, with 88 per cent of nitrates and nearly 50 per cent of phosphates reaching inland waters originating from agricultural sources (EPA, 2015). Additionally, the use of nitrogen fertiliser and manure contributed substantially to the agriculture sector's 32 per cent share of national GHG emissions in 2014 (EPA, 2016a). Controlling nitrogen output by farmers is predicted to lead to environmental benefits, through decreased nitrogen pollution, as well as economic benefits in the form of improved long-term yields (European Commission, 2013). However, in countries where nitrogen taxes have been implemented, the results have been mixed.

In their study of nitrogen control policies on two Ohio farm sites, Hopkins et al. (1996) found that taxes must be set at a relatively high level in order to incentivise farmers to make significantly nitrogen reductions. It was also found that nitrogen pollution and economic impact varied dramatically according to farm type. The tax had a more adverse economic impact on crop than on animal farms, although crop farms had lower emissions than animal farms, because animal farms can substitute from fertiliser to animal manure. This led the authors to conclude that any policies should be targeted towards land and farm type. Schou et al. (2000) undertook a similar study in Denmark, examining the effects of a nitrogen tax on fertilisers compared to both fertilisers and animal feeds. They also found that marginal abatement costs varied significantly by farm type. The single tax scenario had the largest impact on the crop sector, and little impact on the cattle or pig industry, which can substitute animal manure. In the combined tax scenario, activity in the livestock sector shrank. Both scenarios led to a reduction in nitrogen application by 32–40 per cent. However, following a cost-effectiveness analysis it was shown that the single tax scenario was more efficient as the combined tax had severe negative economic impacts for the pig industry. This research confirms the earlier finding that taxes on fertiliser should be addressed in relation to farm type.

In Ireland, fertiliser and animal feed are currently subject to a concessionary 'zero rate' of VAT. This might incentivise the excessive use of artificial nitrogen, which causes an environmental externality in the form of water and land pollution. For example, there is evidence that Irish dairy and tillage farms overuse nitrogen fertiliser in particular (Buckley,

2010). It has also been shown that the reduction of fertiliser use would reduce costs and thus aid economic efficiency (Buckley and Carney, 2013).

3.2.1 Method

Similar to the analysis undertaken in Section 3.1, we can use price elasticities of demand to calculate the negative effect of the favourable tax treatment on fiscal and environmental indicators. That is, what would be the impact of applying the standard 23 per cent rate of VAT on fertiliser?

We can use a price elasticity of demand for fertiliser estimate, taken from Breen et al. (2012), who calculated a figure of −0.39 for Ireland. This suggests that demand for fertiliser is quite inelastic; that is, demand responds slowly to changes in price. This figure is estimated for only one type of fertiliser – calcium ammonium nitrate (CAN). However, as it is one of the most commonly used nitrogen fertilisers, it seems reasonable to extrapolate to two other fertiliser types: urea (nitrogen) and superphosphate (phosphorus). Hence, we assume an elasticity of −0.39 for all three fertiliser types. We use data for the year 2015 from Eurostat (2016) for fertiliser consumption by type, as well as taking an average of fertiliser prices across 2015 from the CSO (CSO, 2016). There is no distinction between the type of nitrogen fertiliser used in these data, so we split consumption equally across the two nitrogen fertilisers, CAN and urea. Additionally, we assume that VAT is applied per tonne of fertiliser used.

3.2.2 Results

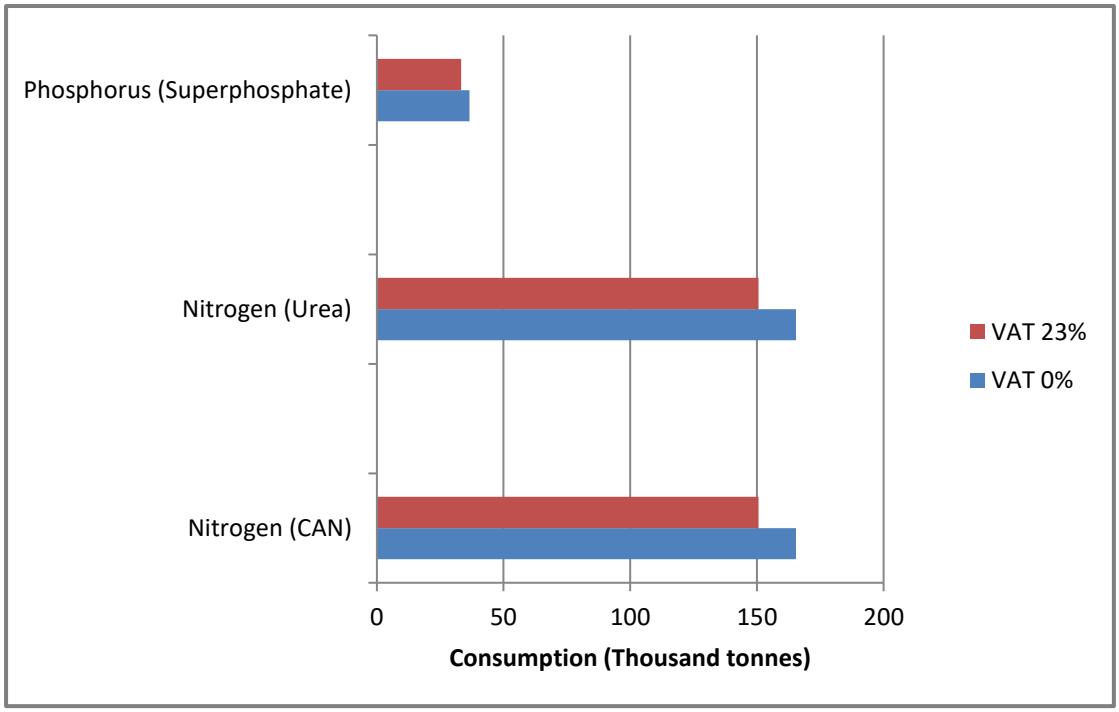
TABLE 4 IMPACT OF RAISING FERTILISER VAT TO STANDARD

	Before (O% VAT)	After (23% VAT)	Change	Change (%)
Nitrogen (urea)				
Price (€/tonne)	410	504	94	23
Consumption (t)	165,500	150,600	−14,900	−9.85
Nitrogen (CAN)				
Price (€/tonne)	320	394	74	23
Consumption	165,500	150,600	−14,900	−9.85
Phosphorus (superphosphate)				
Price (€/tonne)	419	515	96	23
Consumption (t)	36,550	33,270	−3,280	−8.97
Tax revenue (€m)	0	35.14	35.14	N/A

Notes: *Tax revenue is calculated for all fertilisers. Values are rounded to four significant figures.*
Source: *Authors' calculations*

Table 4 displays simulation results if a standard rate of VAT is enforced on fertiliser. We see prices rising and consumption of fertiliser falling (see also Figure 7). In total, across the three types of fertiliser we estimate a reduction of around 33,000 tonnes per year. Applying VAT to a previously unrated good will also have the effect of boosting revenues for the exchequer. This analysis suggests that there will be a tax revenue gain of €35.14m each year.[16]

FIGURE 7 ESTIMATED FERTILISER CONSUMPTION



Source: Authors' calculations

Both environmental and economic benefits can be accrued by making fertiliser subject to the standard rate of VAT. While the greatest benefit to the environment and the exchequer is to bring fertiliser up to the 23 per cent VAT rate, the implementation might be difficult, with a large majority of farmers in Ireland not VAT registered.[17] Also, the heterogeneity of farms in Ireland means that this change in the tax system could disproportionally affect small, struggling farmers, who are likely to be low-intensity users of fertiliser. Perhaps an appropriate solution in Ireland would be to charge a normal rate of VAT on fertiliser, thus removing the effective subsidy, but to refund this on the basis of farm size and type. Thus farmers would only

[16] Urea, CAN and superphosphate provide €17.5m, €13.7m and €3.94m in tax revenues, respectively.
[17] 11,649 of an estimated total 140,000 farms are VAT registered with Revenue; see https://data.gov.ie/dataset/value-added-tax-vat-registrations-by-sector/resource/af5942d0-5939-401f-8fe0-80698fa28dcc

be refunded for using the correct amount of nitrogen used, penalising them for excess usage and rewarding them if they use a lower amount than their allocation (Scott, 1997).

3.3 DIESEL REBATE SCHEME

We saw in Section 3.1 that diesel is taxed more favourably than petrol. However, this is not the only way in which Ireland incentivises the use of diesel over petrol. Ireland is one of eight EU member states that provide a fuel tax relief for commercial vehicles using diesel fuel. The Essential User Fuel Rebate, introduced in 2013, provides tax relief on diesel fuel when the market price of diesel is above a certain threshold. Diesel operators are entitled to a repayment per litre provided that the average price of diesel is above €1.23 per litre. This repayment is made on a sliding scale, where the maximum amount repayable is 7.5c per litre when the price is €1.54 per litre or over (see Table 5).[18]

TABLE 5 DIESEL REBATE SCHEME (AMOUNT REPAYABLE)

Price (VAT incl.)	Price (Vat excl.)	Repayment (cent/litre)
1.54	1.25	7.5
1.50	1.22	6.6
1.45	1.18	5.4
1.40	1.14	4.2
1.35	1.10	3.0
1.30	1.06	1.8
1.27	1.03	0.9
1.23	1.00	0

Source: Revenue Commissioners

The Irish Road Haulage Association argued successfully for government support on the grounds of improving weak profit margins of licensed operators during the economic recovery while simultaneously resulting in a financial gain to the exchequer. However, research casts doubt on this last claim. Hyland and Morgenroth (2012) produced a report for the Department of Transport, Tourism and Sport assessing the prospective impact of introducing the diesel rebate. They found that the scheme was extremely unlikely to accrue a gain for the exchequer, with a minimum estimated loss of €42 million each year. However, one of the main assumptions for these estimates was a rebate of 15c per litre. The

[18] For more information about the scheme, see http://www.revenue.ie/en/tax/excise/diesel-rebate-scheme/

maximum repayment rate in the scheme is 7.5c per litre and has not come into effect due to relatively low diesel prices. Indeed, since the third quarter of 2015, the market price of diesel has not been high enough to trigger the activation of the rebate (see Table 6). Hyland and Morgenroth (2012) produced an addendum to their report more in line with the actual rebate rates by demonstrating an estimated loss of €20 million per year with a repayment rate of 7c per litre.

TABLE 6 DIESEL REBATE SCHEME (REPAYMENT RATES 2013–2016)

Year	Quarter	DRS Rate €
2016	4	0.000
2016	3	0.000
2016	2	0.000
2016	1	0.000
2015	4	0.000
2015	3	0.016
2015	2	0.022
2015	1	0.000
2014	4	0.044
2014	3	0.059
2014	2	0.058
2014	1	0.059
2013	4	0.062
2013	3	0.066

Source: Revenue Commissioners

Data provided by Revenue on the Diesel Rebate Scheme support the figures estimated by Hyland and Morgenroth (2012). The cost of the rebate was about €12m, €22m and €768,000 in years 2013, 2014 and 2015, respectively.[19] These cost figures were affected by the size of the repayment rate over the full year as well as the take-up of the scheme in the number of claims made.[20] Take-up was surprisingly low, with only 204 claims in the first year. This probably contributed to the lower than estimated cost of the scheme, as 2013 had the largest rebate. Additionally, it has been harder to tease out the likely revenue-raising benefits, such as increased excise receipts and fuel tourism from greater diesel consumption, as considered in Hyland and Morgenroth (2012).

The fiscal focus has dominated discussion of the diesel rebate while the environmental significance has been largely neglected. The motivation for

[19] A full breakdown of Diesel Rebate statistics including the national–international and haulage–passenger splits can be requested from Revenue.
[20] The cost in 2016 was zero as the Diesel Rebate Scheme repayment rate was €0 over the whole year.

this research is to highlight and quantify the environmental consequences so, akin to section 3.1, we aim to put an environmental cost figure on the increased diesel consumption as a result of the Diesel Rebate Scheme. Our simulation tries to answer the question: what would the environmental impact have been if the Diesel Rebate Scheme had not been in existence?

3.3.1 Method

Once again, we assume a price elasticity of demand for diesel of −0.19, estimated for Ireland by the NRA (2013). In addition, we use the diesel emission factor for CO_2 from SEAI (2.68 kg CO_2/litre), as well as the motorway diesel emission factors from AEA Energy & Environment for NO_X (6.26 kg NO_X/kl) and PM_{10} (0.29 kg PM_{10}/kl). The reason for using motorway emission factors is that we expect that haulage and passenger operators will use these roads most frequently. Volumes of diesel consumption come from Revenue. Data on diesel prices are taken from the AA Ireland fuel price index, which provides average fuel prices for each month since 1991.[21] Since the Diesel Rebate Scheme has only operated for the years 2013–2016, we take the average of diesel prices across those years as well as the average rebate rate in each year. To assess the impact the Diesel Rebate Scheme has had on diesel consumption, we subtract the average rebate from the average diesel price for each year to give the 'actual' price haulage and passenger operators see when making their fuel decisions. We then use the price elasticity of demand above to estimate the consumption boost the lower diesel price has stimulated. From that, we can use emission factors to provide environmental figures of pollutant emissions.

3.3.2 Results

Table 7 illustrates the environmental consequences of the Diesel Rebate Scheme in Ireland.

[21] See https://www.theaa.ie/aa/motoring-advice/petrol-prices.aspx

TABLE 7 IMPACT OF DIESEL REBATE SCHEME

	Without rebate	With rebate	Change	Change (%)
2013				
Price (€ per 1000 l)	1,556	1,492	−64	−4.1
Consumption (kl)	2,655,000	2,676,000	21,000	0.79
CO_2 emissions (t)	7,117,000	7,173,000	56,000	0.79
NO_X emissions (t)	16,620	16,750	130	0.78
PM_{10} emissions (t)	770	776	6	0.78
2014				
Price (€ per 1000 l)	1,502	1,447	−55	−3.6
Consumption (kl)	2,827,000	2,847,000	20,000	0.70
CO_2 emissions (t)	7,577,000	7,630,000	53,000	0.70
NO_X emissions (t)	17,700	17,820	120	0.68
PM_{10} emissions (t)	820	826	6	0.73
2015				
Price (€ per 1000l)	1,449	1,440	−9	−0.7
Consumption (kl)	3,102,000	3,106,000	4,000	0.12
CO_2 emissions (t)	8,313,000	8,323,000	10,000	0.12
NO_X emissions (t)	19,420	19,440	20	0.10
PM_{10} emissions (t)	900	901	1	0.11

Note: *Values are rounded to four significant figures.*
Source: *Authors' calculations*

The results show that the Diesel Rebate Scheme has encouraged greater consumption of diesel and this has had negative environmental consequences over the length of the scheme. The added impact on emissions of CO_2, NO_X and PM_{10} is significant, with over 100,000 extra tonnes of CO_2 emitted.

Finally, the Irish Road Haulage Association argued that haulage operators had shouldered a large part of Ireland's recovery from recession and that this rebate was to assist in relieving the pressures on the industry. The issue remains as to whether this temporary measure will be retained during economic downturns only or made permanent.

3.4 AIR PASSENGER DUTY

Aviation is responsible for large-scale cross-border environmental externalities, yet it bears disproportionally low charges compared to other areas of transport. For example, it has little or no excise charge compared to diesel or petrol for vehicles. Therefore there is a strong case for increasing taxes on the aviation sector to internalise the externalities caused by air travel. The most efficient method of achieving this is through

levelling a charge on aviation fuel. Gonzales and Hosoda (2016) show that the reduction in aviation fuel taxes charged in Japan that was introduced in 2011 significantly increased fuel use, and that aviation fuel taxes could significantly reduce emissions from aviation.

However, the Chicago Convention, which prevents fuel that is on an aircraft on arrival from another country from being taxed, is often used as a reason to exempt aviation fuel from taxation altogether. The argument is that as the fuel can be 'imported' on the plane without tax, an imposition of a tax in one country would result in more fuel being carried by aircraft destined to that country, which would reduce efficiency. This leaves the second-best option available of charging an air travel tax (or APD) to passengers on international flights (Seely, 2012). An example of this charge is the UK's APD currently levied on domestic and international flights.

However, although the UK's APD makes at least a modest attempt to internalise some of the externalities imposed by aviation, many economists hold the view that it is inefficient and should be updated to be more responsive to changes in distance and environmental damage caused by different flights. APD is a per passenger charge on departure flights from the UK. Currently, it is levied per air ticket and the size of duty depends on the class of travel and distance travelled, although rates are arbitrarily set by distance bands, e.g. band A: 0–2000 miles from London. This can create distortions; for instance, Washington is just less than 4000 miles away and is placed in Band B, yet California is over 5000 miles away and bears no additional charge (Truby, 2010).

Leicester and O'Dea (2008) recommend reforming the tax by making it contingent on the aircraft type and distance travelled, and levied on seats rather than passengers to penalise aircraft that are flown at under full capacity. The changes they propose would have a fixed-charge element to account for externalities attributable to all flights such as noise on take-off, as well as a variable component which would increase in proportion with distance travelled. They give the example of flights to Sudan and Canada. Currently these have the same rate of APD; after the reforms the Canadian ticket would be charged a tax of £31.32 while the ticket to Sudan would be charged over £100. The difference is accounted for by the difference in load factors, with the Canadian flights more often reaching full capacity and the cost shared over all passengers while flights to Sudan are more often flown under capacity and thus the passengers must pay for the externality imposed not just by their own travel but by the empty seats around them.

Mayor and Tol (2007) analysed the impact of the UK's APD on CO_2 emissions and visitor numbers under four scenarios: no APD, original APD, doubling APD and 'Green Miles'. They found little change in aviation emissions across the four scenarios, which they attributed to APD being a boarding tax that approximates badly to an emissions tax. Instead of any of the four scenarios, the authors recommend a carbon tax on emissions rather than the current system of APD, if the aim is to reduce CO_2 emissions.

Krenek and Schratzenstaller (2014) note that the current carbon price is too low to have a meaningful impact on travel behaviour and emissions generated. They model an air tax based on CO_2 emissions with a CO_2 price of €25–35 per tonne. This would increase European prices by 3.5–4.9 per cent and intercontinental flights by 1.7–2.4 per cent. In order to reduce the total numbers of passengers and thus the total aviation externalities, a significantly higher carbon price would be required. These results are similar to those reported by Seetaram et al. (2014), who found that outbound air travel is income elastic and should be taxed as a luxury, in order to break the current 'ideology that air travel should be cheap and accessible to all'.

Taken together, the literature suggests that if Ireland is to introduce an airline passenger duty then it should be based on the aircraft type and distance flown with a fixed component to account for local externalities on take-off and landing. It should be levied per seat rather than on passenger ticket, to encourage airlines to increase their flight load factor and remove unnecessary flights. Such taxes have been avoided in many countries for fear of passengers changing to airports across borders, but Ireland's geographical location as an island with only the UK as a close neighbour means that this kind of substitution is unlikely to occur.

3.4.1 Method

We simulate the impact of Ireland introducing an APD, levied at the same rate as in the UK. We treat this exercise as an impact on consumer expenditure. Due to data restrictions on flight prices, we use data from the Household Budget Survey (HBS; CSO, 2012b) on expenditure on air travel. This means the focus is on the impact of an APD on the consumer decision to undertake air travel. We also include non-residents and tourist expenditure on flights, as a potential APD affects all departure flights from Ireland. These data on overseas travellers' fare receipts are taken from the CSO's Tourism & Travel survey (2013). The HBS classifies spending on air travel into two categories: within the Republic of Ireland and international.

Because of this, instead of the UK's current form of APD which is based on distance bands, we will employ an APD based on domestic and international flights, where domestic flights are subject to the lower rate of APD. Corresponding to the UK APD rates from 1 April 2017, we use a duty of €13 per flight within the Republic and €75 for all international flights. Departure flights and passenger numbers come from the CSO's aviation statistics (2013a).

Once again, to assess the consumer response on a change in price, we utilise a price elasticity of demand. Air travel demand elasticities have a wide variety of results, reflecting the scope of elasticities investigated in the literature; for example, the different markets of air travel such as the type of class, reason for air travel and length of flight. Also, income elasticities may be playing a strong role in the demand for air travel, which was traditionally a luxury type of good. Nonetheless, we use an overall price elasticity with respect to air fares for simplicity. The figure we use is taken from a UK Department for Transport (2009) report which estimates an overall air fare elasticity of −0.46. This seems a perfectly sensible estimate as aviation transport demand is considered relatively price inelastic: passengers, when faced with increased prices, can reduce the cost of their trip by flying to a cheaper destination or downgrading their class rather than forgo the trip entirely. It corresponds to other estimates used in the literature, such as Mayor and Tol's (2007) price elasticity of −0.45 for the UK.

We use emission factors from research by Pearce and Pearce (2000), which details for various types of aircraft the level of emissions during landing and take-off, as well as cruising over distance. To simplify we use the emission factors for the Boeing-737, which is the only aircraft in Ryanair's fleet.[22] For landing/take-off the emission factors are 2591 kg CO_2 and 9 kg NO_X per flight; to account for distance travelled we use 0.02 kg CO_2 per passenger-kilometre. Unfortunately, there is no emission factor for NO_X per passenger-kilometre. One note of caution is that these aircraft emission factors are slightly dated now, and airlines such as Ryanair use newer, less polluting aircraft. Estimated emissions may be slightly amplified as a consequence, but this may be balanced by the understated NO_X mentioned above.

[22] We focus on the two main Irish airlines. Aer Lingus tends to use Airbus A320s. See https://www.aerlingus.com/about-us/fleet/ and https://www.ryanair.com/ie/en/useful-info/about-ryanair/fleet

3.4.2 Results

Table 8 presents the potential impact of introducing an APD in Ireland. All figures are on a yearly basis.

TABLE 8 AIR PASSENGER DUTY SIMULATION

	Before APD	After APD	Change	Change (%)
Within ROI				
Flights	3,100	2,560	−540	−17.4
Passengers	60,200	49,710	−10,490	−17.4
CO_2 emissions (t)	8,390	6,940	−1,450	−17.3
NO_X emissions (t)	28	23	−5	−17.9
International travel				
Flights	98,990	88,410	−10,580	−11.0
Passengers	12,310,000	10,990,000	−1,320,000	−10.7
CO_2 emissions (t)	522,300	466,400	−55,900	−10.7
NO_X emissions (t)	891	796	−95	−10.7

Note: *Values are rounded to four significant figures.*
Source: *Authors' calculations*

The results show that a duty on passengers travelling by air has the outcomes of fewer passengers and reduced flights, and this brings the environmental benefits of lower CO_2 and NO_X emissions each year.

We see that passengers are more responsive to an APD for the decision to undertake travel within Ireland. This is reasonable, as Ireland has strong substitutes such as trains and buses that compete with domestic air travel. However, the big reduction in emissions is driven by the impact the APD has on international flights, which travel greater distances and emit more pollutants. As the number of flights within Ireland is small, and hence the reduction in airline emissions is relatively low, there may be a case for not imposing APD on domestic flights.

Calculations also show that APD could generate around €825m each year in excise duties. This would be a substantial boon to Irish state revenues, but bear in mind that this piece of analysis does not consider the many fiscal repercussions of introducing an APD, such as the effect on employment in the aviation sector. This is because the focus of these case studies is to quantify an environmental impact. Nonetheless, as mentioned earlier, Ireland has a strong position regarding its geographical location. The substitution of passengers away from Irish airports is likely to be minimal, especially as the UK, the only country that has a land border with Ireland, has an APD too. The fear of this 'leakage' is one of the main reasons governments choose not to impose aviation taxes and risk the wider negative economic consequences on GDP.

CHAPTER 4

Conclusion and implications

Developed countries have complex tax systems that incorporate a range of taxes, tax rates and exemptions. Much of the discussion around setting taxes and reforming tax systems focuses on the need to achieve a revenue target, the distributional consequences and their effect, as well as the degree to which the tax system distorts the economy. In recent years there have been calls for environmental tax reform, whereby the burden of taxation is moved from income and profit towards activities that have negative environmental effects in order to reduce negative externalities and thus improve efficiency. While a burgeoning literature considers the feasibility of large-scale revenue-neutral environmental tax reform (e.g. Jorgenson et al., 2013; Chiroleu-Assouline and Fodha, 2014) and the effect of specific environmental taxes (e.g van der Ploeg and Withagen, 2014; Martin et al. 2014), the literature on the environmental effects of tax expenditures is more limited.

This report has examined the effects of fiscal measures on Ireland's environment. Chapter 2 used a simple approach to identifying and classifying fiscal instruments with environmental effects, and estimated the number of such measures in Ireland at present. This showed that a large number of fiscal measures have some effect on at least one environmental domain, and some impact on more than one aspect of the environment. However, for many the impact is likely to be limited. Not all measures have negative effects, and it also needs to be borne in mind that these measures, by and large, are not directly aimed at achieving environmental objectives, and for at least some measures it can be argued that the meeting of other objectives may justify a limited negative environmental impact.

From the large set of measures that were assessed to have negative environmental effects, four were selected for a more detailed assessment of the size of the environmental impact. The choice was made with reference to the fact that transport and agriculture account for the largest shares in GHG emissions and also on the basis of data availability. In relation to transport, the lower excise duty on diesel compared to petrol, the essential fuel user's rebate scheme and the introduction of an air passenger charge as a proxy for a tax on aviation fuel are considered. The regime of company-car-related benefit in kind taxation would make another interesting case study, as the current regime is likely to result in significantly higher emissions than a system based on emissions like that

in the UK. Unfortunately, this could not be pursued here due to lack of data on the number and type of company cars and their annual mileage. The zero VAT rate on fertilisers was analysed in relation to environmental impact from agriculture.

While each measure might be thought of as relatively small, together they have a significant negative impact on the environment. Table 9 shows the negative impact of the transport measures when compared to our counterfactuals where the favourable treatment is removed or a new measure is introduced.[23] The table shows that if only these measures were addressed, CO_2 emissions could be reduced by 1.1 per cent, NO_X emissions by 1.34 per cent and PM_{10} emissions by 1.47 per cent. The absolute reduction of emissions in tonnes is quite large for each of the three pollutants.

TABLE 9 CUMULATIVE ENVIRONMENTAL EFFECTS

	Before	After	Change	Change (%)
CO_2 emissions (t)	35,320,000	34,930,000	−390,000	−1.10
NO_X emissions (t)	72,490	71,520	−970	−1.34
PM_{10} emissions (t)	3,410	3,360	−50	−1.47

Notes: *Values rounded to four significant figures. The measures included in the calculation are the removal of the excise difference between diesel and petrol, the elimination of the diesel rebate and the introduction of an air passenger tax.*
Source: *Authors' calculations*

Overall the analysis shows that the environmental impact of the fiscal system should be studied more carefully, as some measures have significant environmental costs. The appropriate reform of these measures could make a significant contribution to reducing Ireland's GHG emissions and reduce local pollution.

The analysis also shows that many fiscal measures have environmental impacts that have largely been ignored in the design of fiscal measures. Ignoring these can have significant efficiency implications, as negative environmental impacts have costs for individuals and, in relation to climate change, for the state and the world. Similarly, positive environmental effects of fiscal measures should be explicitly acknowledged and considered in decision making. The positive effects should also be assessed *ex post*, to see how significant they really are. In this respect it is important to collect the appropriate data. For example, it is difficult to assess the

[23] Unfortunately, the fertiliser case study only looks at consumption data.

effectiveness of the bike to work scheme, which should have a significant positive environmental effect, if the number of beneficiaries and their travel behaviour is not known.

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APPENDIX

List of fiscal instruments with environmental effects

Policy instrument	Type	Domain of effect								Description
		Air		**Water**		**Land**		**Emissions**		
		+	**–**	**+**	**–**	**+**	**–**	**+**	**–**	
Tax Exemptions:										
Cycle to Work Scheme	Benefit-in-kind	✓						✓		The purpose is to encourage more employees to cycle to and from work. Under the scheme an employer may provide an employee with bicycle and/or cycle safety equipment without the employee being liable for benefit-in-kind taxation, limited to a cost of €1000.
Taxsaver Commuter Scheme	Benefit-in-kind	✓						✓		Allows public transport tickets to be purchased for employees. Companies can save up to 10.75% in PRSI while employees can save 31%–51% in tax, PRSI and USC.
VRT for leased cars	Vehicle Registration Tax (VRT)		✓						✓	
Remissions/repayments of VRT for disabled drivers	VRT		✓						✓	Open to persons who meet the specified medical criteria and have obtained a Primary Medical Certificate to that effect. They can apply for relief as either a driver with a disability or a passenger with a disability. • €10,000 for a driver with a disability where the vehicle has adaptations. • €16,000 for a driver with a disability where the vehicle has more specific adaptations.

Policy instrument	Type	Domain of effect Air +	 –	 Water +	 –	 Land +	 –	 Emissions +	 –	Description
										• €22,000 for a driver with a disability where the vehicle has extensive adaptations. Relief is restricted to a vehicle of engine capacity up to 6000cc. A vehicle that has been admitted to the scheme will also be entitled to an exemption from payment of Annual Motor Tax.
Exemptions from VRT	VRT		✓						✓	
VRT Export Repayment Scheme	VRT		✓						✓	VRT that may be repayable as a vehicle may already have been the subject of VRT remissions/repayments. To qualify for a repayment the vehicle must, among other things, have a value (OMSP) as determined by Revenue for VRT purposes of at least €2000. There is an administrative charge of €100. NCTS fees will also apply.
Relief from VRT for hybrid, plug-in hybrid and electric cars	Vehicle Registration Tax (VRT)	✓						✓		Category A or Category B electric vehicles, which are shown to the satisfaction of the Revenue Commissioners to be series production (i.e. originally manufactured) models of electric vehicles registered before 31 December 2016, are eligible for relief from VRT up to a maximum of €5000. Accordingly, for example, where VRT in the amount of €5750 is payable on the registration of a qualifying electric vehicle, VRT in the amount of €750 (i.e. €5750–€5000) will be due at the time of vehicle registration.
Repayment of excise duty for disabled drivers	Mineral Oil Tax (MOT)		✓						✓	
Diesel Rebate Scheme	MOT		✓						✓	Provides for the repayment to qualifying road transport operators of part of the mineral oil tax paid on the auto-

Policy instrument	Type	Domain of effect								Description
		Air		**Water**		**Land**		**Emissions**		
		+	–	+	–	+	–	+	–	
										diesel purchased within the state by them for use in the course of business. The amount of the repayment will vary in accordance with the average price at which auto-diesel is available for purchase during a repayment period. This will be calculated on a sliding scale.
Repayment of VAT for disabled drivers	VAT concession		✓						✓	
Biofuels Excise Relief Scheme	Ceased/Phasing-out items							✓		A €200 million excise relief scheme for biofuels was introduced in Budget 2006 with the aim of reaching a 2% target for biofuels penetration of the transport fuels market and CO_2 savings of over 250,000 tonnes per annum.
Multi-storey car parks	Ceased/Phasing-out items		✓				✓		✓	Under section 344 TCA1997, a scheme of capital allowances was made available in respect of capital expenditure incurred in the qualifying period on the construction or refurbishment of qualifying multi-storey car parks. The capital allowances available were restricted to a maximum 50% write-off of the capital expenditure incurred.
Park & ride	Ceased/Phasing-out items	✓						✓		Provided for a scheme of tax reliefs aimed at encouraging the establishment of park-and-ride facilities, mainly in larger urban areas. Capital allowances: park and ride facilities and commercial buildings construction or refurbishment, 100% in total. Residential reliefs: Qualifying Residential Buildings Relief.
CGT Retirement Relief	Capital Gains Tax (CGT)				✓		✓		✓	Private Residence: Gains made on the disposal of your home together with its gardens or grounds up to an area

Policy instrument	Type	Domain of effect Air + –	Water + –	Land + –	Emissions + –	Description
						(exclusive of the site of the residence) of one acre may be exempt. Transfer of a site from parent to child: The market value of the site must not exceed €500,000 (€254,000 for disposals prior to 5 December 2007). Retirement Relief: This relief applies where you dispose of certain 'qualifying assets'. These include assets used for the purpose of a trade, profession or farming and shares in certain family trading companies.
CGT Farm Consolidation Relief	CGT		✓	✓	✓	Where a parcel of land is sold by an individual farmer (or, where sold by more than one individual jointly, at least one of the individuals is a farmer); Where the sale and purchase occur within 24 months of each other and the initial sale or purchase of land took place in the period 1 January 2013–31 December 2016; The interaction of the sale and purchase together result in an overall reduction in the distance between parcels comprised in the farm, including land that has been leased for at least 2 years with a minimum of 5 years to run; Thereby leading to a reduction in the fragmentation of the farm and an improvement in the operation and viability of the consolidated farm.
CAT Agricultural Relief	CAT		✓	✓	✓	
Consanguinity Relief	Stamp Duty		✓	✓	✓	Consanguinity relief no longer applies to conveyances or transfers, whether on sale or by gift, of non-residential property other than land, between related persons where the instrument is executed on or after 1 January 2015. The

Policy instrument	Type	Domain of effect Air + –	Water + –	Land + –	Emissions + –	Description
						individual to whom the land is conveyed or transferred must, from the date of execution of the conveyance or transfer – • farm the land for a period of not less than 6 years, or • lease it for a period of not less than 6 years to an individual who will farm the land.
Young Trained Farmer Relief	Stamp Duty		✓	✓	✓	This exemption from stamp duty is to encourage the transfer of farmland to a new generation of farmers with relevant qualifications. The transfer may be by way of gift or sale.
Commercial woodland – duty not chargeable on the value of the trees growing on the land	Stamp Duty			✓		(1) In this section 'trees' means woodlands managed on a commercial basis and with a view to the realisation of profits. (2) This section applies to an instrument, being a conveyance or transfer on sale of land, or a lease of land, where the instrument contains a certificate to the effect that trees are growing on a substantial part of such land. (3) Stamp duty shall not be chargeable on any instrument to which this section applies, in respect of such part of the consideration for the sale or lease as represents the value of trees growing on the land.
Single Farm Payment entitlement	Stamp Duty		✓	✓	✓	The sale/transfer/other disposition of a Single Farm Payment entitlement occurring on or after 1 January 2005 is exempt from Stamp Duty.
Farmers' VAT Treatment	Unregistered VAT repayments		✓	✓	✓	A VAT-registered farmer is entitled to take a credit or deduction (i.e. set off against his/her liability) for VAT properly invoiced to him/her or paid on imports or intra-

Policy instrument	Type	Domain of effect Air +	 –	Water +	 –	Land +	 –	Emissions +	 –	Description
										Community acquisitions in respect of most goods and services used in connection with his/her taxable activities. S/he is not required to pay the supplier before taking the credit.
Woodlands profits & distributions	Personal Tax Credits					✓				Dividends and other distributions paid out of exempt profits/gains from the occupation of certain woodlands are, in the hands of an individual, disregarded for income tax purposes and, in the case of companies, treated as exempt income of the company for corporation tax purposes.
General Stock Relief (section 666)	Personal Tax Credits			✓		✓		✓		Provides stock relief generally at the rate of 50% for farmers who are registered farm partnerships and 100% for certain 'qualifying farmers' within the meaning 667B (often referred to as young trained farmers), who are partners in such partnerships in accounting periods which commence on or after 1 January 2012 and end on December 2015.
Stock Relief for Young Trained Farmer (Section 667B)	Personal Tax Credits			✓		✓		✓		
Rental deductions – leasing of the farmland	Personal Tax Credits			✓		✓		✓		Maximum reduction allowed For leases entered into between 1 January 2007 and 31 December 2014: 5 years or more but less than 7 years = €12,000 7 years or more but less than 10 years = €15,000 10 years or more = €20,000 On or after 1 January 2015 lease term: 5 years or more but less than 7 years = €18,000 7 years or more but less than 10 years = €22,500 10 years or more but less than 15 years = €30,000

Policy instrument	Type	Domain of effect Air + –	Water + –	Land + –	Emissions + –	Description
						15 years or more = €40,000
Rural Renewal	Ceased/Phasing-out items			✓		Provided for a scheme of tax reliefs aimed at invigorating certain areas of rural Ireland on similar lines to the renewal schemes previously available in an urban context. Capital Allowances: Industrial (mill, factory, lab, dock undertaking) and Commercial Buildings Construction or Refurbishment 100% in total. Residential Reliefs: Qualifying Residential Buildings Relief against total Income Section 23 type relief against Irish rental Income only.
Woodlands	Ceased/Phasing-Out Items			✓		
Greenhouse Gas Emissions Allowance	Stamp Duty				✓	
Accelerated capital allowances for energy-efficient equipment	Capital allowance				✓	Accelerated capital allowances of 100% of the capital expenditure incurred (compared with a 12.5% write-off over eight years, which is the normal rule for plant and machinery) on such equipment can be claimed for the year in which the equipment is first provided and used. The scheme has been extended until 31 December 2017.
Licences and leases granted under Petroleum and Other Mineral Development Act, 1960, etc.	Stamp Duty				✓	Stamp duty shall not be chargeable on: (a) a licence granted under section 8, 9 or 19 of the Petroleum and Other Minerals Development Act, 1960, (b) a lease granted under section 13 of that Act, or

Policy instrument	Type	Domain of effect Air + –	Water + –	Land + –	Emissions + –	Description
						(c) an instrument for the sale, assignment or transfer of any such licence or lease or any right or interest in any such licence or lease.
Touring Coaches	VAT Refund Orders	✓			✓	Subject to certain conditions, persons who are engaged in the business of the carriage for reward of tourists by road, under contracts for group transport, may reclaim VAT incurred on the purchase, intra-community acquisition and lease/hire of touring coaches.
CGT principal private residence relief	CGT			✓		Gains made on the disposal of your home together with its gardens or grounds up to an area (exclusive of the site of the residence) of one acre may be exempt. For full relief to apply, you must have occupied the home as your principal private residence throughout your period of ownership or to within 12 months of the date of disposal. Relief may be restricted where the home was not your main residence throughout the period of ownership (other than the final 12 months), where any part of it was used exclusively for the purposes of a trade, business or profession or where it is sold as development land, for example part of the garden.
CGT exemption on disposal of site to a child	CGT			✓		
Dublin Docklands Development Authority	Stamp Duty			✓		Section 12 of the Finance Act, 1895, shall not apply to the vesting in the Dublin Docklands Development Authority of any property or rights transferred under this Act.
Temple Bar Properties Limited	Stamp Duty			✓		Stamp duty shall not be chargeable on any instrument under which any land, or any interest in land, easement, way-leave, water right or any other right is acquired in the

Policy instrument	Type	Domain of effect Air + –	Water + –	Land + –	Emissions + –	Description
						Temple Bar area, that is, 'the area' as described in the First Schedule in the Temple Bar Area Renewal and Development Act, 1991, by Temple Bar Properties Limited, or any subsidiary of Temple Bar Properties Limited.
Housing Finance Agency	Stamp Duty			✓		Stamp duty shall not be chargeable on any agreement or other instrument made for the purposes of, or in connection with, securing the advancement of moneys to housing authorities (within the meaning of the Housing Act, 1966) by the Housing Finance Agency plc.
Housing Finance Agency Limited	Stamp Duty			✓		
Housing Authorities and Affordable Homes Partnership	Stamp Duty			✓		The new section 106B retains the exemption from stamp duty in respect of a conveyance, transfer or lease of a house, building or land to: • a Housing Authority in connection with any of its functions under the Housing Acts 1966 to 2004 or • the Affordable Homes Partnership in connection with the services specified in article 4(2) of the Affordable Homes Partnership (Establishment) Order 2005 as amended.
National Asset Management Agency (NAMA)	Stamp Duty			✓		Stamp duty shall not be chargeable under or by reference to any Heading in Schedule 1 on an instrument: (a) for the sale, transfer, lease or other disposition of any property, asset or documentation to NAMA or a NAMA-subsidiary by NAMA, a NAMA-subsidiary or a participating institution, (b) for the transfer, to a NAMA-subsidiary or a participating institution, of securities issued in accordance with the Act of 2009 for the

Policy instrument	Type	Domain of effect Air +	Air −	Water +	Water −	Land +	Land −	Emissions +	Emissions −	Description
										purposes of section 47(2)(b), 48(2)(b) or 49 of that Act, (c) for the transfer to a NAMA-subsidiary by NAMA or a NAMA-subsidiary of securities issued in accordance with the Act of 2009 for the purposes of section 47(2)(a) or 48(2)(a) of that Act, (d) for the transfer to a participating institution of a bank asset, security or other property by NAMA or a NAMA-subsidiary in connection with section 125 of the Act of 2009, or (e) for the transfer or other disposition to NAMA or a NAMA-subsidiary of any property in settlement or part settlement of an acquired bank asset.
Exemptions	LPT					✓				1. New and previously unused residential properties purchased from a builder or a property developer between 1 January 2013 and 31 October 2019. 2. Certain residential properties purchased in 2013. 3. Residential properties constructed and owned by a builder or developer that remain unsold. 4. Residential properties situated in a specified unfinished housing estate. 5. Residential properties owned by a charity or a public body and used to provide special needs accommodation. 6. Residential properties used by a charity in connection with recreational activities. 7. Registered Nursing Homes. 8. Residential property vacated for an extended period by a person with a long-term mental or physical infirmity.

Policy instrument	Type	Domain of effect Air + –	Water + –	Land + –	Emissions + –	Description
						9. Residential properties fully subject to commercial rates. 10. Residential properties that have been certified as having significant pyritic damage. 11. Residential property purchased, built or adapted to make it suitable for occupation by a permanently and totally incapacitated individual as their sole or main residence.
Deferrals	Local Property Tax (LPT)			✓		Payment of the tax is deferred – meaning that it becomes payable later and carries an interest charge of 4% per annum. The deferred tax remains a charge on the property and will have to be paid to Revenue when the property is sold or transferred to another person.
Home Renovation Incentive	Personal Tax Credit			✓	✓	The Home Renovation Incentive (HRI) Scheme provides for tax relief for homeowners and landlords by way of an Income Tax credit at 13.5% of qualifying expenditure on repair, renovation or improvement works carried out on a main home or rental property by qualifying contractors. The amount of the HRI tax credit depends on the amount spent on qualifying works. Tax relief can be claimed on qualifying expenditure over €4405 (before VAT at 13.5%) per property. This €4405 (before VAT) can be the total from any number of jobs carried out and paid for from 25 October 2013 to 31 December 2016 for homeowners claiming on their main home and on or after 15 October 2014 and up to 31 December 2016 for landlords claiming on their rental property. While there is no upper limit on

Policy instrument	Type	Domain of effect Air +	Air −	Water +	Water −	Land +	Land −	Emissions +	Emissions −	Description
										expenditure on qualifying works, the tax credit will only be given in relation to a maximum of €30,000 (before VAT at 13.5%) per property.
Living City Initiative	Personal Tax Credit					✓		✓		The Living City Initiative is a scheme of property tax incentives which applies in certain 'special regeneration areas' in the centres of Dublin, Cork, Limerick, Galway, Waterford and Kilkenny. The residential element provides tax relief for owner-occupiers by way of a deduction from their total income of 10% per annum of qualifying expenditure over a 10 year period and is only available where the property is the claimant's only or main residence.
Urban renewal	Ceased/Phasing-Out Items						✓			Provided for a scheme of tax reliefs designed to foster urban renewal and improvement. Industrial (mill, factory, lab) and commercial buildings: construction or refurbishment 100% in total. Residential reliefs: relief against total income (owner) Section 23 type relief against Irish Rental Income only (lessor)
Town renewal	Ceased/Phasing-Out Items						✓			Tax relief for developments in certain locations.
Seaside resorts	Ceased/Phasing-Out Items						✓			Tax relief for developments in certain locations.

Policy instrument	Type	Domain of effect								Description
		Air		Water		Land		Emissions		
		+	–	+	–	+	–	+	–	
Student accommodation	Ceased/Phasing-Out Items						✓			Tax relief for the development of student accommodation.
Hotels	Ceased/Phasing-Out Items						✓			Tax relief for the development of hotels.
Nursing homes	Ceased/Phasing-Out Items						✓			Tax relief for the development of a nursing home.
Housing for the elderly/infirm	Ceased/Phasing-Out Items						✓			Tax relief for the development of housing for the elderly/infirm.
Hostels	Ceased/Phasing-Out Items						✓			Tax relief for the development of hostels.
Guest houses	Ceased/Phasing-Out Items						✓			Tax relief for the development of guest houses.
Convalescent homes	Ceased/Phasing-Out Items						✓			Tax relief for the development of convalescent homes.
Qualifying private hospitals	Ceased/Phasing-Out Items						✓			Tax relief for the development of private hospitals.
Qualifying sports injury clinics	Ceased/Phasing-Out Items						✓			Tax relief for the development of sports injury clinics.

Policy instrument	Type	Domain of effect								Description
		Air		**Water**		**Land**		**Emissions**		
		+	**–**	**+**	**–**	**+**	**–**	**+**	**–**	
Buildings used for certain childcare purposes	Ceased/Phasing-Out Items						✓			Tax relief for the development of childcare buildings.
Qualifying hospitals	Ceased/Phasing-Out Items						✓			Tax relief for the development of hospitals.
Qualifying mental health centres	Ceased/Phasing-Out Items						✓			Tax relief for the development of mental health centres.
Taxes										
Livestock rate	VAT				✓		✓		✓	Agricultural rate of VAT – 4.8%. The sale of livestock and greyhounds and the hire of horses are liable. This rate does not apply to non-VAT registered farmers who can avail of the 5.2% flat-rate additions.
Flat-rate compensation percentage for farmers	VAT				✓		✓		✓	
Petrol	Excise Tax	✓						✓		€587.71 per 1000 litres.
Aviation gasoline:	Excise Tax	✓						✓		€587.71 per 1000 litres.
1. Used as a propellant	Excise Tax	✓						✓		€479.02 per 1000 litres.
2. Used for air navigation	Excise Tax	✓						✓		€479.02 per 1000 litres.
3. Used for private pleasure navigation	Excise Tax	✓						✓		€479.02 per 1000 litres.

Policy instrument	Type	Domain of effect								Description
		Air		**Water**		**Land**		**Emissions**		
		+	**–**	**+**	**–**	**+**	**–**	**+**	**–**	
Kerosene used other than as a propellant	Excise Tax	✓						✓		€50.73 per 1000 litres.
Fuel oil	Excise Tax	✓						✓		€76.53 per 1000 litres.
Other heavy oil (including MGO)	Excise Tax	✓						✓		€102.28 per 1000 litres.
Liquefied petroleum gas used as a propellant	Excise Tax	✓						✓		€96.45 per 1000 litres.
Other liquefied petroleum gas	Excise Tax	✓						✓		€32.86 per 1,000 litres.
Substitute fuel used as a propellant instead of unleaded petrol	Excise Tax	✓						✓		€587.71 per 1,000 litres.
Substitute fuel used as a propellant instead of diesel	Excise Tax	✓						✓		€479.02 per 1,000 litres.
Substitute fuel used other than as a propellant:	Excise Tax	✓						✓		€102.28 per 1,000 litres.
1. Measured based on net calorific value	Natural Gas Carbon Tax	✓						✓		€4.10 per megawatt hour.
2. Measured based on gross calorific value	Natural Gas Carbon Tax	✓						✓		€3.70 per megawatt hour.
Coal	Solid Fuel Carbon Tax	✓						✓		€52.67 per tonne.

Policy instrument	Type	Domain of effect								Description
		Air		**Water**		**Land**		**Emissions**		
		+	–	+	–	+	–	+	–	
Peat briquettes	Solid Fuel Carbon Tax	✓						✓		€36.67 per tonne.
Milled peat	Solid Fuel Carbon Tax	✓						✓		€17.99 per tonne.
Other peat	Solid Fuel Carbon Tax	✓						✓		€27.25 per tonne.
Business use	Electricity	✓						✓		€0.50 per megawatt hour.
Non-business use	Electricity	✓						✓		€1.00 per megawatt hour.
Local Property Tax	LPT						✓			
Plastic Bag Levy	Plastic Bag Levy			✓		✓				22c.
Category A vehicles (car/minibus < 12 seats)	VRT		✓						✓	Emissions: (rate, minimum tax) 0–81A1 (14%, €280), 81–100A2 (15%, €300), 101–110A3 (16%, €320), 111–120A4 (17%, €340) 121–130B1 (18%, €360), 131–140B2 (19%, €380), 141–155C (23%, €460), 156–170D (27%, €540), 171–190E (30%, €600), 191–225F (34%, €680), >255g/kmG (36%, €720).

Policy instrument	Type	Domain of effect								Description
		Air		Water		Land		Emissions		
		+	–	+	–	+	–	+	–	
Category B vehicles (car-derived van or a jeep-derived van N1)	VRT		✓						✓	Standard rate 13.5%; minimum rate: €125.
Category C vehicles (tractor or bus)	VRT		✓						✓	Flat rate €200.
Category D vehicles (ambulances/fire engines etc.)	VRT		✓						✓	N/A.
Motorcycles	VRT		✓						✓	Charged per cc of engine: up to 350, €2; >350, €1.
Hybrid electric vehicle	VRT		✓						✓	Maximum amount remitted or repaid depending on age of the vehicle. New: €1500, <2 years old: €1350, >2<3 years: €1200, >3<4 years: €1050, >4<5 years: €900, >5<6 years: €750, >6<7 years: €600, >7<8 years: €450, >8<9 years: €300, >9<10 years: €150, >10 years: nil, pre-July 2008: 50% rebate for some hybrids.
Plug-in hybrid electric vehicle	VRT		✓						✓	Max. amount remitted or repaid depending on age of the vehicle New: €2500, <2 years old: €2250, >2 <3 years: €2000, >3<4 years: €1750, >4<5 years: €1500, >5<6 years: €1250, >6<7years: €750, >7<8 years: €450, >8<9 years: €500, >9<10 years: €250, >10 years: Nil
(Car registered on or after 1 July 2008 or a vehicle registered between 1 Jan 2008 and 30 Jun	Motor Tax		✓						✓	Motor Tax based on CO_2 emissions

Policy instrument	Type	Domain of effect Air +	 –	Water +	 –	Land +	 –	Emissions +	 –	Description
2008 with tax based on CO_2 emissions)										Emissions (annual, half year, quarterly, arrears monthly): A0 0g/km (€120,€66, €33, €12) A1 1–80g/km (€170, €94, €48, €17) A2 80–100g/km (€180, €99, €50, €18) A3 101–110g/km (€190, €105, €53, €19) A4 111–120g/km (€200,€111, €56, €20) B1 121–130g/km (€270, €149, €76, €27) B2 131–140g/km (€280, €155, €79, €28) C 140–155g/km (€390, €216, €110, €39) D 156–170g/km (€570, €316, €161, €57) E 171–190g/km (€750, €416, €211, €75) F 191–225g/km (€1200, €666, €339, €120) G >225g/km (€2350, €1304, €663, €235)
Private cars registered pre 1 Jul 2008 (engine size)	Motor Tax		✓						✓	Engine capacity (annual, half year, quarterly, arrears monthly): Up to 1000 (€199, €110, €56, €19.90) 1001–1100 (€299, €165, €84, €29.90) 1100–1200 (€330, €183, €93, €33) 1201–1300 (€358, €198, €101, €35.80) 1301–1400 (€385, €213, €108, €38.50) 1401–1500 (€413, €229, €116, €41.30) 1501–1600 (€514, €285, €145, €51.40) 1601–1700 (€544, €301, €153, €54.40) 1701–1800 (€636, €352, €179, €63.60) 1801–1900 (€673, €373, €190, €67.30) 1901–2000 (€710, €394, €200, €71) 2001–2100 (€906, €502, €255, €90.60) 2101–2200 (€951, €527, €268, €95.10) 2201–2300 (€994, €551, €280, €99.40) 2301–2400 (€1034, €573, €292,

Policy instrument	Type	Domain of effect Air +	 –	 Water +	 –	 Land +	 –	 Emissions +	 –	Description
										€103.40) 2401–2500 (€1080, €559, €305, €108) 2501–2600 (€1294, €718, €365, 129.40) 2601–2700 (€1345, €746, €379, €134.50) 2701–2800 (€1391, €772, €392, €139.10) 2801–2900 (€1443, €800, €407, €411.30) 2901–3000 (€1494, €829, €422, €149.40) >3000 (€1809, €1003, €511, €180.90) Electrical (€120, €66, €33, €12)
Goods vehicles	Motor Tax		✓						✓	Unladen weight, kg (annual, half year, quarterly, arrears monthly) <3001 (€333, €184, €94, €33.30) 3001–4000 (€420, €233, €118, €42) 4001–5000 (€543, €301, €153, €54.30) 5001–6000 (€753, €417, €212, €75.30) 6001–7000 (€1019, €565, €287, €101.90) 7001–8000 (€1282, €711, €363, €128.20) 8001–9000 (€1584, €879, €447, €158.40) 9001–10000 (€1886, €1046, €532, €188.60) 10001–11000 (€2188, €1214, €618, €218.80) 11001–12000 (€2490, €1381, €703, €249) 12001–13000 (€2792, €1549, €788, €279.20) 13001–14000 (€3094, €1717, €874, €309.40) 14001–15000 (€3698, €2052, €1044, €369.80) 15001–16000 (€4000, €2220, €1130, €400) 17001–18000 (€4302, €2387, €1215, €430.20) 18001–19000 (€4604, €2555, €1300, €460.40) 19001–20000 (€4906, €2722, €1385, €490.60) >20000 (€5195, €2883, €1467, €519.50) Electrical (€92, –, –, €86)

Policy instrument	Type	Domain of effect								Description
		Air		Water		Land		Emissions		
		+	–	+	–	+	–	+	–	
Large PSV/Youth & Community Bus	Motor Tax		✓						✓	Seating capacity (annual, half year, quarterly, arrears monthly): 9–20 (€154, €85, €43, €15.40) 21–40 (€202, €112, €57, €20.20) 41–60 (€403, €223, €113, €40.30) >60 (€403, €223, €113, €40.30)
Trade licences	Motor Tax		✓						✓	Vehicle category (motor cycle, other): Initial trade licence/plate (€59, €353); replacement trade licence/plate (€38, €86)
Miscellaneous vehicles	Motor Tax		✓						✓	(Annual, half year, quarterly, arrears monthly) Off-road dumper (€885, €491, €250, €88.50), general haulage tractor (€333, €184, €94, €33.30), machine/workshop/contrivance (recovery vehicle) (€333, €184, €94, €33.30) island vehicles (€102, –, –, €10.20) agricultural tractor/trench digger and excavator (€102, –, –, €10.20) motor caravan (€102,–, –, €10.20) hearse (€102, –, –, €10.20) dumper and forklift truck (€102, –, –, €10.20) taxi and hackney (€95, –, –, €9.50) school bus (€95, –, –, €9.50) cycles and tricycles electrical (€35, –, –, €3.50) cycles and tricycles ≤75cc (€49, –, –, €4.90) cycles and tricycles 76–200 cc (€67, –, –, €6.70) cycles and tricycles >200cc (€88, –, –,

Policy instrument	Type	Domain of effect								Description
		Air		**Water**		**Land**		**Emissions**		
		+	–	+	–	+	–	+	–	
										€8.80) cycles and tricycles pedestrian controlled vehicle (€88, –, –, €8.80) veteran and vintage motorcycles (€26, –, –, €2.60) veteran and vintage all other vehicles (€56, –, –, €5.60)
EEA Potential New Environmental Taxes:										
Landfill Levy	Environmental tax					✓		✓		Under the Waste Management (Landfill Levy) Regulations (2013), a government levy of €75 is payable per tonne of commercial waste disposed in landfill. This is an additional to the charge by either the local authority or the private landfill owner for use of their facility.
User Charge for effluent and water discharge	Environmental tax			✓						Currently water and wastewater charges only apply to commercial premises and private group scheme members.
Water abstraction levy	Environmental tax			✓				✓		Applying Danish rates and system, whereby pipe leakage could be reduced from 30–40% to 10%.
Aggregates levy	Environmental tax	✓		✓		✓		✓		Sand, gravel, crushed rock. Applying UK rates for reduced volume + 25% recycling.
Tax on packaging	Environmental tax					✓				Applying Danish rates for glass bottles and by weight for other waste streams.

Policy instrument	Type	Domain of effect								Description
		Air		**Water**		**Land**		**Emissions**		
		+	–	+	–	+	–	+	–	
SO_2	Environmental tax	✓						✓		Applying rates applicable in Denmark.
NO_X	Environmental tax	✓						✓		Applying rates applicable in Sweden.
GHG–nitrogen	Environmental tax	✓						✓		€15 per CO_2-eq for N_2O of mineral fertilisers.
Recalibration of VRT and extension to commercial	Environmental tax	✓						✓		Data as to numbers of commercial vehicles etc. Required for more accurate revenue estimates.
Air Travel Tax	Environmental tax	✓						✓		Apply UK rate of €14 for longer flights; lower rate for short flights at €3 per passenger.
HGV vignette scheme	Environmental tax	✓						✓		Applying Germany's approach and rates.
Increasing excise duty on petrol and diesel	Environmental tax	✓						✓		UK levels. Revenues netted out for the expected reduction in tank tourism from N. Ireland and for differences in VAT rates.
CO_2 Tax, non-ETS	Environmental tax							✓		Increase CO_2-tax to level in Sweden of €22/TCO_2

Policy instrument	Type	Domain of effect								Description
		Air		**Water**		**Land**		**Emissions**		
		+	**–**	**+**	**–**	**+**	**–**	**+**	**–**	
CO_2 Tax, offshore	Environmental tax							✓		Apply Norwegian system for taxation of offshore emissions from flaring etc. (€0.05/Nm^3).
Electricity Tax	Environmental tax							✓		Introduce EU minimum rate for domestic sector (€1.3/GJ).
Energy Tax	Environmental tax							✓		Introduce new energy tax with minimum of €1.3 per GJ – similar to EU minimum for electricity.
Land Value Tax	Environmental tax					✓				Applying rates applicable in Denmark.
CSO potentially environmentally damaging subsidies										
Marine Diesel Tax Relief	Mineral Oil Tax (MOT)		✓		✓				✓	VAT paid by unregistered fishermen on the purchase, intra-Community acquisition or importation of marine diesel can also be reclaimed, while mineral oil tax on such marine diesel can be reclaimed by both VAT-registered and unregistered fishermen.
Fuel Allowance	Subsidy		✓						✓	The aim of the scheme is to assist qualified households in receipt of certain social welfare payments with their heating costs. The allowance represents a contribution towards a person's normal heating expenses. It is not

Policy instrument	Type	Domain of effect Air +	 –	 Water +	 –	 Land +	 –	 Emissions +	 –	Description
										intended to meet those costs in full. The rate of basic Fuel Allowance is €22.50 per week.
Electricity Allowance	Subsidy		✓						✓	The Household Benefits Package is a package of allowances that help with the costs of running a household. The package is available to everyone aged over 70 and to people under 70 in certain circumstances. The Electricity Allowance is paid either directly as a cash payment or as a cash credit against an electricity or gas bill each month. (This only applies to Bord Gáis and Electric Ireland customers.)
Gas Allowance	Subsidy		✓						✓	Part of the Household Benefits Package, like the electricity allowance above.
PSO Levy: Electricity Generation from Peat	Subsidy		✓						✓	The Public Service Obligation Levy is a government subsidy that is charged to all electricity customers in Ireland. The money collected from the PSO Levy is used to subsidise peat-burning power plants.
PSO Levy: Security of Electricity Supply	Subsidy								✓	The PSO Levy is also used to secure the Irish electricity supply. The PSO Levy was currently set at €5.90 each month in 2016/2017.

Policy instrument	Type	Domain of effect								Description
		Air		**Water**		**Land**		**Emissions**		
		+	–	+	–	+	–	+	–	
Agricultural Product Subsidies: Cattle	Subsidy						✓		✓	This figure includes the subsidies (defined by Eurostat) used by the CSO in the calculation of operating surplus in agriculture, such as Basic Payments Scheme, REPS, Compensatory Allowances for Disadvantaged Areas and disease compensation payments, but also payments such as the Beef Technology Adoption Programme.
Environmental transfers for heat/energy saving and management										
Better Energy Communities	Grant	✓						✓		An Energy Efficiency Grant Scheme available through the Sustainable Energy Authority of Ireland (SEAI).
Better Energy Homes	Grant	✓						✓		Provides grants to homeowners to improve energy efficiency in their homes. Landlords and owners of more than one property can also apply for a grant under the scheme. It is administered by SEAI.
Local Authority Estate Energy Retrofit	Grant	✓						✓		Under the Department's Social Housing Investment Programme, local authorities are allocated capital funding each year in respect of a range of measures to improve the standard and overall quality of their social housing stock. The programme includes a retrofitting measure aimed at improving the energy efficiency of older apartments and houses by reducing heat loss through the fabric of the

Policy instrument	Type	Domain of effect Air + –	Water + –	Land + –	Emissions + –	Description
						building and the installation of high-efficiency condensing boilers.
Public Sector Energy Efficiency Programme	Grant	✓			✓	SEAI supports Public Sector organisations to meet their energy efficiency targets.
Warmer Homes Scheme	Grant	✓			✓	The Better Energy Warmer Homes scheme (BEWH), administered by the SEAI, funds energy efficiency improvements in the homes of the elderly and vulnerable, making the homes more comfortable, healthier and more cost effective to run.
Environmental transfers for the production of energy from renewable resources						
Bioenergy Scheme	Grant				✓	The Bioenergy Scheme provides establishment grants to farmers to grow willow for the production of biomass suitable for use as a renewable source of energy. The Scheme aims to increase the production of willow in Ireland and to encourage alternative land use options. Aid is payable on 40% of the approved costs associated with establishing the crop, subject to a maximum payment rate of €1040 per hectare, with the balance to be invested by the applicant. Eligible costs include those associated with

Policy instrument	Type	Domain of effect Air +	 –	 Water +	 –	 Land +	 –	 Emissions +	 –	Description
										ground preparation, fencing, vegetation control and the purchase of planting stock and planting.
Electric Vehicles Grant Scheme	Grant	✓						✓		SEAI is offering grants of up to €5000 for a battery electric vehicle (BEV) or a plug-in hybrid electric vehicle (PHEV) purchased and registered in Ireland. In addition, these vehicles qualify for VRT relief of up to €5000 for a BEV and €2,500 for a PHEV, providing a maximum combined subsidy (grant + VRT relief) of €10,000 for BEVs and €7500 for PHEVs.
Ocean Energy Prototype Research and Development Programme	Grant			✓						This development fund is designed to accelerate and enhance support for the research, development, testing and deployment of wave and tidal energy devices.
PSO Levy: Electricity Generation from Renewable Sources	Subsidy	✓						✓		The PSO Levy is also used for the development of renewable electricity.
Environmental transfers for management of natural resources										
Native Woodland Conservation Scheme	Grant					✓				The Native Woodland Conservation Scheme promotes the appropriate restoration of existing native woodland (including the conversion of non-native forest to native woodland), through the provision of financial support to forest holders towards the cost of appropriate works.

Policy instrument	Type	Domain of effect								Description
		Air		Water		Land		Emissions		
		+	–	+	–	+	–	+	–	
Marine Environment Protection Scheme	Grant			✓						A programme aiming to maintain healthy fish stocks while simultaneously developing the marine environment. The national lobster conservation programme is also funded to the tune of €113,000 with a similar investment being made by inshore fishermen.
Rainwater Harvesting Scheme	Grant			✓						The objective of the scheme is to conserve water by maximising the use of rainfall run-off and reduce water costs on farm. This will be achieved by grant aiding support for rainwater harvesting facilities and equipment. This scheme will be targeted, in the first instance, at young trained dairy farmers. The rainwater harvesting facilities and equipment will be grant-aided at 40% up to a maximum grant level.
Rural Environment Protection Scheme (REPS)	Grant					✓		✓		Various schemes have been set up over the years to provide income support for farmers who engage in specified environmental activities.
Corncrake Grant Scheme	Grant					✓				The Corncrake Grant Scheme (CGS) is a grant available for landowners who have corncrakes calling on or near their land. The scheme is available to all landowners who have meadow within 250 m of a calling male corncrake, except for participants in the Agri-Environment Option Scheme (AEOS). Landowners receive a grant/payment if they agree

Policy instrument	Type	Domain of effect Air + –	Water + –	Land + –	Emissions + –	Description
						to delayed mowing of meadows, carry out corncrake friendly (CF) mowing when cutting the meadow and leave an unmown strip of meadow along the side of the plot if required.
The Burren Farming for Conservation Programme	Grant		✓	✓		The primary objectives of the proposed programme are: • To ensure the sustainable agricultural management of high nature value farmland in the Burren. • To contribute to the positive management of the Burren landscape and the cultural heritage of the Burren. • To contribute to improvements in water quality and water usage efficiency in the Burren region.
Green, Low-Carbon, Agri-Environment Scheme (GLAS)	Grant		✓	✓	✓	The scheme is green as it preserves our traditional hay meadows and low-input pastures; low-carbon as it retains the carbon stocks in soil through margins, habitat preservation and practices such as minimum tillage; and agri-environment as it promotes agricultural actions, which introduce or continue to apply agricultural production methods compatible with the protection of the environment, water quality, the landscape and its features,

Policy instrument	Type	Domain of effect Air + –	Water + –	Land + –	Emissions + –	Description
						endangered species of flora and fauna and climate change mitigation.
Cessation of Turf-Cutting Compensation Scheme	Grant			✓		The government has put in place a compensation scheme for those affected by the cessation of turf cutting on raised bog special areas of conservation. This scheme comprises a payment of €1500 per year, index linked, for 15 years or, where feasible, relocation of turf cutters to non-designated bogs where they can continue to cut turf.
Agri-Environment Options Scheme (AEOS)	Grant		✓		✓	The objectives of the scheme are to promote biodiversity, encourage water management/quality and combat climate change as well as contributing to positive environmental management of farmed Natura 2000 sites and river catchments in the implementation of the Birds Directive, Habitats Directive and Water Framework Directive.
Landfill Remediation Scheme	Grant			✓		The Landfill Remediation Grant Scheme was established in 2006 to deal with the specific issue of the remediation of closed, licensed, local authority-operated landfills, and in recognition of the fact that local authorities would not have sufficient resources to fund the full cost of this remediation.

Policy instrument	Type	Domain of effect								Description
		Air		**Water**		**Land**		**Emissions**		
		+	**–**	**+**	**–**	**+**	**–**	**+**	**–**	
Organic Farming Scheme	Grant							✓		The objective of the scheme is to facilitate the development of the organic sector so as to ensure a regular supply of high-quality organic produce to the market.

Source: Revenue data on taxes, reliefs and exemptions.

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