A CARBON TAX FOR IRELAND

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Introduction

The *Programme for Government 2007-2012* states that "[a]ppropriate fiscal instruments, including a carbon levy, will be phased in on a revenue-neutral basis over the lifetime of this Government."[2] The terms of reference[3] of the *Commission on Taxation* repeats the commitment "to introduce measures to further lower carbon emissions and to phase in on a revenue neutral basis appropriate fiscal measures including a carbon levy over the lifetime of the Government" and invites the *Commission* to "[i]nvestigate fiscal measures to protect and enhance the environment including the introduction of a carbon tax." This paper presents our thoughts and considerations about such a carbon tax. We discuss selected design issues, and present a preliminary impact assessment for what we think is a reasonable design. More specifically, we address ten questions:

1. Why impose a carbon tax?
2. What level should the tax be?
3. Who should be taxed?
4. What is the expected revenue?
5. What to do with the revenue?
6. What are the macro-economic implications?
7. What are the effects on emissions?
8. What are the effects on income distribution?
9. How to tax internationally traded goods and services?
10. What about fuel tourism?

On some of these questions, we present reasonably strong arguments and evidence. Other questions call for further research. Aspects of some questions can only be answered by the *Dáil Éireann*.

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[1] We are grateful to Kelley Ann Kizzier, Seamus McGuinness, and Frances Ruane for constructive comments.

[2] http://www.taoiseach.gov.ie/attached_files/Pdf%20files/Eng%20Prog%20for%20Gov.pdf

[3] http://www.taxcommission.ie/TermsofReference.html

Why impose a carbon tax?

The cheapest way to meet any emission target is to set the marginal cost of emission equal for every source.[4] The easiest way to establish a uniform price for emissions is to impose the same emission tax on all sources (Baumol, 1972; Pearce, 1991). This implies that the marginal cost of emission reduction is equal across the economy. If marginal costs are not equalised, total economic costs are higher than necessary.[5] For example, if it were cheaper to reduce an additional tonne of carbon in the electricity sector than in the transport sector, then emissions should be reduced further in power generation and less far in transport – total emission reduction should stay the same. This way national reduction costs are minimised. A uniform tax also adheres to the basic notion of fairness that like cases should be treated alike. As there is no difference between a tonne of carbon dioxide emitted by power generation and a tonne emitted by transport, it is fair to tax emissions from both at the same level.

What level should the tax be?

The desirable level of the carbon tax is a complicated issue. Some would argue for cost-benefit analysis, and thus set the tax equal to the social cost of carbon – if that can be estimated (Tol, 2005). Others would argue that the tax should be set at a level that is sufficiently high to meet the emission target with reasonable certainty (den Elzen *et al.*, 2007). Yet others would argue that the carbon tax should not exceed the level that is acceptable to the electorate (Li *et al.*, 2004).

We think that this debate is interesting, but beside the point. Ireland's emissions are a tiny fraction of global emissions. A carbon tax in Ireland will not stop climate change – indeed, it is unlikely to have a measurable direct impact on global warming. A carbon tax is important because it signals Ireland's commitment to international climate policy. A carbon tax also gives the important signal to companies and households that climate policy is serious and here to stay.

Above, we argued for a uniform carbon tax. In fact, some 45% of Ireland's carbon dioxide emissions (and 30% of greenhouse gas emissions) are already regulated by a price mechanism. The EU Emissions Trading System (ETS) sets a price on the emissions of carbon dioxide from power generation and the production of cement and alumina along with other sectors. The carbon tax should be set equal to the permit price. In that way, the price of emissions is uniform.[6]

The EU ETS spot price of carbon dioxide emission permits varies daily.[7] A carbon tax is constant for a budget period, or varies according to a fixed schedule. However, there is

[4] This follows immediately from the structure of the cost minimization problem. As there is a single, economy-wide constraint on emissions, there is a single shadow price that is faced by every emitter. See, for example, Montgomery (1972).

[5] This is not the case if there are market imperfections and prior tax distortions, and the carbon tax interacts with these imperfections and distortions (Baumol and Bradford, 1972). Our understanding of these matters in an Irish context is incomplete.

[6] We would in fact prefer to replace the ETS with a carbon tax, or extend the ETS to cover all emissions. Neither option appears politically feasible.

[7] See for example the *Carbix* on http://www.eex.com/en

also a futures market for emission permits. Prices are less volatile in the futures market. The carbon tax of the following year would be announced in the Budget, and could be set equal to the futures price of the final trading day in November.[8] In that case, at least in expectation, the carbon tax equals the permit price.

The proposed rule – carbon tax equals futures price of tradable permits – is fair and economically efficient as every source pays the same per emitted tonne. The proposed rule has a third advantage. Climate change is a long term problem. The transition to a zero-carbon economy will take a century. Investment and research cycles are much longer than electoral cycles. For these reasons, climate policy should not be subject to the short-term considerations of the economic or political cycle. Reminiscent of the Central Bank's situation, the proposed rule makes the carbon tax independent, to some degree, of day-to-day political and economic issues.

Who should be taxed?

A uniform carbon tax should be applied to all emission sources. If some sources are exempt, then the carbon tax is no longer uniform because, for all practical purposes, a tax exemption equals a zero tax. While there is still debate in academic circles about which substances contribute to climate change and how much (Fuglestvedt *et al.*, 2008; Kandlikar, 1996; Manne and Richels, 2001; Smith and Wigley, 2000), international law is unambiguous: The United Nations Framework Convention on Climate Change recognises six greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphurhexafluoride (SF_6)[9] and it specifies that the Global Warming Potentials of the *Second Assessment Report* of the Intergovernmental Panel on Climate Change (Schimel *et al.*, 1995) be used for converting emissions to their carbon dioxide equivalents. So, the carbon tax should be applied to all sources of each of these gases.

There is one exception. Carbon dioxide emissions from power generation[10] and several other sectors are already regulated by the EU ETS. These emissions should be exempt from the carbon tax. As a matter of principle, double regulation should be avoided. In this particular case, imposing a domestic tax on sectors subject to European regulation would be ineffective and expensive. A domestic tax on emissions in the EU ETS would reduce emissions in Ireland, but because the emission cap is Europe-wide, every tonne reduced in Ireland would be emitted elsewhere. The net effect on emissions would be zero. Furthermore, because the domestic tax would distort the market for emission permits, the costs of emission reduction would increase, particularly in Ireland (Tol, 2007).

The proposed taxation of methane, nitrous oxide, and halocarbons is discussed below. Carbon dioxide emissions not regulated by the EU ETS by and large come from fossil

[8] The exact carbon tax of January would only be announced in December. This is not a problem, if the carbon tax equals the futures price as a rule. Futures prices for carbon permits are public knowledge, and the futures price in early June (say) is similar to the futures price in late November.
[9] Note that HFCs and PFCs are in fact groups of gases. HFCs and PFCs together are referred to as halocarbons, and SF_6 is often but incorrectly included. We follow this practice here.
[10] Including power generation by bodies other than electricity utilities.

fuel combustion. The carbon tax is therefore best administered as a duty on fuels. The duty should be proportional to the carbon content of the fuel.[11]

What is the expected revenue?

The expected revenue of a carbon tax depends on the level of the tax and its scope. Table 1 has some illustrative numbers. According to the latest *Medium-Term Review* (Fitz Gerald *et al.*, 2008), emissions in 2010 are likely to be 48 million tonnes of carbon dioxide, 20 $MTCO_2$ of which is regulated under the EU ETS. If the carbon tax is €20/tCO_2, revenue would be €550 million.[12] If emission permits were to be auctioned, there would be additional revenue of €400 million.[13] If methane and nitrous oxide emissions were taxed too, revenue would increase by another €400 million. A tax on halocarbon emissions would yield a modest €20 million. Under these assumptions, total revenue could be €1,400 million per year.

Table 1 also shows emissions and revenue in 2020. The uncertainty about these estimates is considerably larger. The carbon tax is assumed to rise to €38/tCO_2 in 2020,[14] a 6.6% increase per year. Revenue would grow faster. If the tax applies to carbon dioxide emissions only, revenue would grow by 8.2% per year – considerably faster than the economy and the total government budget. If permits are auctioned and the carbon tax covers all greenhouse gas emissions, revenue would grow by 7.2% per year.

If we accept the projections in Table 1, then a carbon tax would finance further reductions in other taxes as time progresses.

Table 1. Projected greenhouse gas emissions and revenue from a €20/tCO_2 tax in 2010 rising to €38/tCO_2 in 2020.

	Emissions ($KTCO_{2eq}$)		Revenue (mln €)		Growth
	2010	2020	2010	2020	%
CO_2, ETS	20,355	20,259	407	770	6.6
CO_2, non-ETS	27,564	31,983	551	1,215	8.2
CH_4	12,679	12,079	254	459	6.1
N_2O	8,103	7,002	162	266	5.1
Halocarbons	1,034	2,223	21	84	15.1
Total	69,735	73,546	1,395	2,795	7.2

Source: After Fitz Gerald *et al.* (2008).

[11] The carbon content of fuels is readily available from Sustainable Energy Ireland. These numbers are also used for Ireland's emission accounting, which follows internationally agreed rules under the UN Framework Convention on Climate Change.
[12] Note that the emission projections assume a carbon tax of €20/tCO_2, that is, the effect of the tax on emissions is included in these calculations.
[13] If emission permits continue to be grand-parented, there would be a subsidy of €400 mln to the relevant companies. The workings of the EU ETS are beyond the scope of this paper. To date, emission permits have been grand-parented. Although the European Commission is currently in favour of a gradual shift towards auctioning permits, there is an intense business lobby against this.
[14] In constant prices; the nominal carbon tax would be €56/tCO_2.

What to do with the revenue?

As indicated above, the revenue of the proposed carbon tax is substantial. Careful consideration should be given to how it is used. Although there are some facts that should be taken into account, the appropriate use of the tax revenue depends on political priorities and a judgement on the state of the economy.

The carbon tax should not be hypothecated (Brett and Keen, 2000). It is tempting to earmark the carbon tax revenue for, say, subsidies on energy efficiency. This temptation should be resisted. The benefits of earmarking are small and transient, as contributions to the same cause from the general budget would fall. Earmarking reduces the flexibility of the overall government budget. If a cause cannot argue its case for subsidies on its own merit without the protection of an earmarked tax, then that cause is not worthy of government support.

Many economists would argue that the main problem facing the Irish economy at the moment is that wages are rising faster than labour productivity (e.g., Barrett *et al.*, 2007). Therefore, the revenue of the carbon tax would perhaps be best used for policies that deliver increases in net wages without adversely effecting labour costs and, thus, competitiveness. Within this context, some policy levers that could be considered include reductions in the rates of income tax or pay-related social insurance (PRSI).

Assuming that such policies are implemented, research suggests that while the impact on labour costs would be less than in the past, in the medium term quite a high proportion of any reduction in taxes on labour would still be passed through as lower labour costs to business (Fitz Gerald *et al.*, 2008). Part of the tax relief would be used for purposes other than a moderation of labour costs. If income taxes are reduced, employees would still bargain for an increase in gross wages so that their gain in net wages (and consumption) is higher still. If social insurance rates are reduced, shareholders would argue for higher profits dividends instead of passing the lower costs on to customers in the form of lower sale prices – but this would only happen in competitive industries. The exact outcome depends on the structure of the labour and capital markets, and will differ between economic sectors and companies. However, the revenue arising from a carbon tax should make it possible to have an increase in net wages with constant labour costs, and the social partners should be able to reach an agreement that is beneficial to all.

A carbon tax would increase the cost of living. An income tax reduction would compensate for that – but it would compensate only those that have a taxed income. Part of the carbon tax revenue should therefore be used to increase social welfare payments.

Our calculations below suggest that it is possible to use 25% of the carbon tax revenue (excluding auctioning of ETS permits) to finance higher benefits and 40-55% for lowering income taxes such that most households would be equally well off with and without this tax reform package. That implies that 20-35% of the carbon tax revenue is left for other purposes. This can be used to further reduce labour costs or increase benefits. It can also be used to increase government consumption or investment, to reduce government debt, or to purchase CO_2 emission permits from abroad. The "extra" revenue can be used to stimulate energy efficiency and fuel switching. For example, a targeted programme of home insulation could alleviate fuel poverty. But the "extra" revenue can also be used to reduce other taxes.

Government consumption and investment have increased rapidly in recent years – at the moment, the priority seems to be to improve how government money is spent, rather than spending more. Government debt is on a sustainable trajectory already. A reduction of other taxes would complicate the tax reform. One candidate is to lower VAT, but this would stimulate demand which is probably not the fiscal stimulus that the Irish economy needs at the moment. We argue that the Irish economy would be best served by lowering labour costs. Using 25% of the carbon tax revenue for increased benefits, 40% for lower income taxes, and 35% for lower PRSI may strike a reasonable balance between maintenance of equity and improving economic efficiency.

What are the macro-economic implications?

The macro-economic effects of a carbon tax consist of two components. First, a carbon tax increases the price of energy. This means that firms are less competitive on international markets,[15] while households have less money to spend on other consumption. The economy slows down as a result. However, a second effect is that the revenue from a carbon tax can be used to compensate households and companies, and to stimulate the economy. A priori, it is impossible to say which effect is stronger. We therefore use the HERMES model to explore the macro-economic implications.

In the *Medium-Term Review 2008-2015* (Fitz Gerald *et al.*, 2008), we assumed a carbon tax of €20/tCO_2 in 2010 rising to €38/tCO_2 in 2020, and recycled the revenue through a reduction in income taxes. We found that the economic stimulus of lower income taxes is greater than the drag on the economy of higher energy prices. This is no surprise. Energy is a small part of the production costs in Ireland, and labour is a large part. In this paper, we run almost the same scenario, and reach the same conclusion: A carbon tax plus a lower income tax leads to a slightly higher growth rate of the economy. In this particular case, GNP is 1.1% higher in 2020 with a carbon tax than without.[16] See Figure 1 and Table 2. Figure 2 shows that employment would increase too because of the lower income tax. Fitz Gerald and McCoy, Fitz Gerald *et al.* (2002) and Bergin *et al.* (2004) reach the same conclusions.

Figures 1 and 2 also show the implications of alternative ways to recycle the carbon tax revenue. These results are summarised in Table 2. A reduction in social insurance contributions has almost the same macro-economic implications as a reduction in income taxes.[17] A lump sum transfer to households – a cheque in the post – also stimulates the economy, but by far less than a reduction in income tax or social insurance. The effect on employment is smaller still. A reduction in government debt does little for economic growth in the early years, and has a weak but positive effect in the second half of the

[15] Unless, of course, trading partners levy a similar tax.
[16] In the MTR, we compared the case with both a carbon tax and the EU ETS to the case with neither; the difference in 2020 GNP is 1.3% under those conditions. The difference with the results here is that, in the MTR, we assumed that emission permits in the EU ETS will be auctioned and that the auction revenue will be used for lowering income taxes as well. In this paper, we do not assume auctioning.
[17] In theory it should prove more beneficial in terms of growth to recycle revenue from carbon taxes through reducing social insurance contributions because all the benefits would accrue to those in the labour market. However, in practice the HERMES model was not sufficiently detailed to distinguish between the effects of a change in social insurance contributions and a change in income taxes.

decade. Employment falls because labour and energy are complements, and energy would be more expensive. Using the carbon tax revenue to purchase emission permits abroad[18] has a similar effect on employment, but the effect on economic growth is negative throughout the decade – because essentially money is spent on intangible benefits.

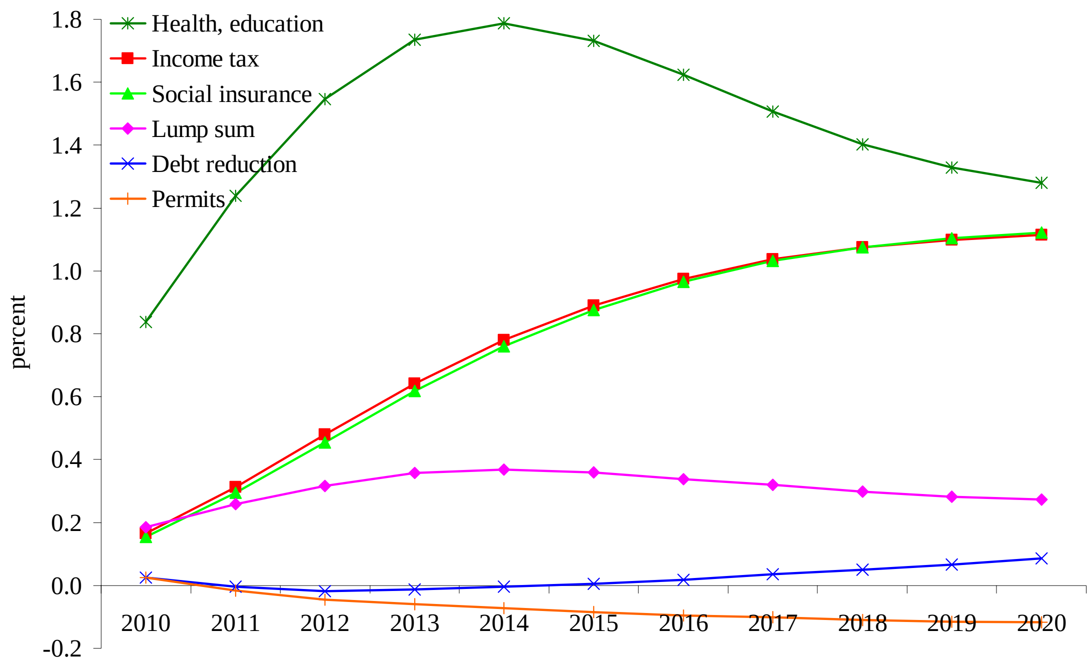

Figure 1. GNP with a carbon tax of €20/tCO_2 in 2010 rising to €38/tCO_2 in 2020 relative to the case without a carbon tax, for six recycling scenarios.

The largest positive effect on GNP and employment is found when using the carbon tax revenue to increase government spending on health and education. While this may seem attractive at first sight, Figure 3 shows the effect of the same six scenarios on the output of the private sector. See also Table 2. The patterns in Figure 3 are the same as in Figures 1 and 2 – except for the increased spending on health and education. The private sector is first stimulated by the extra demand of the public sector and its workers, but the private sector is crowded out in the second half of the decade. Figures 1 and 2 confirm this: Increased government spending has substantial positive effects in the short term, but this wears off after a few years.

Table 2 also shows the effects on carbon dioxide emissions in 2020. Total emission reduction is very similar across the recycling alternatives, but slightly larger for the scenario with slower economic growth. Increased spending on health and education again stands out – even though economic growth would accelerates most in this scenario, the expansion of the economy would be concentrated in most energy-extensive sectors.

[18] Note that this scenario is of academic interest only. Ireland's imports are unlikely to much affect the price of permits, so the purchased permits roughly equal the non-ETS CO_2 emissions – that is, zero emissions (on paper).

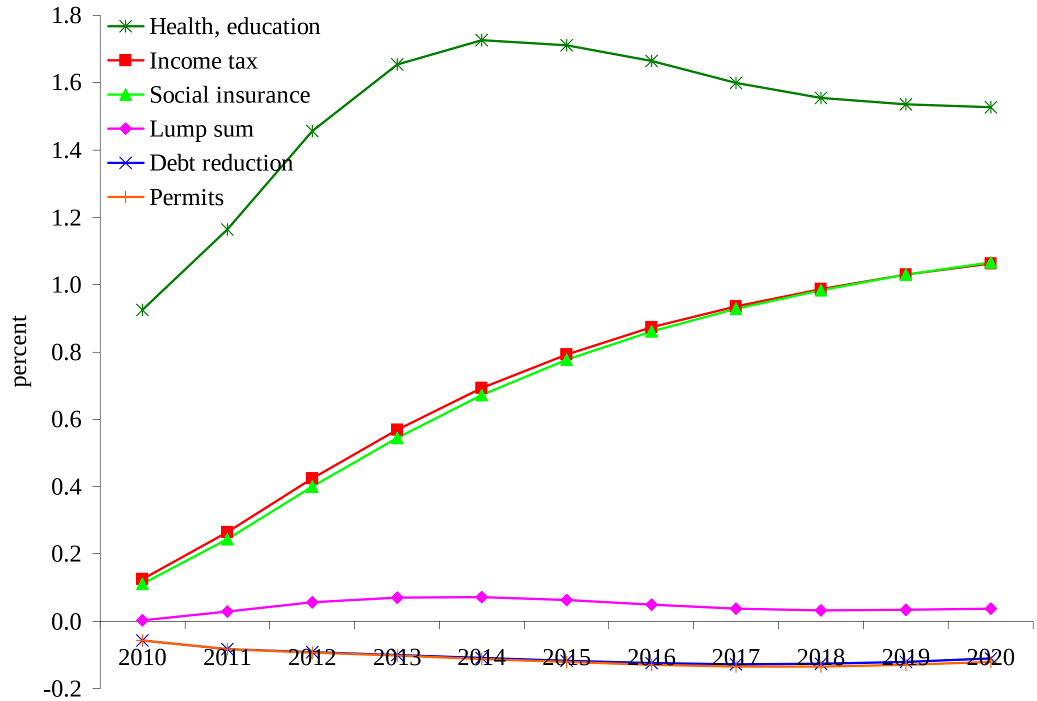

Figure 2. Employment with a carbon tax of €20/tCO_2 in 2010 rising to €38/tCO_2 in 2020 relative to the case without a carbon tax, for six recycling scenarios.

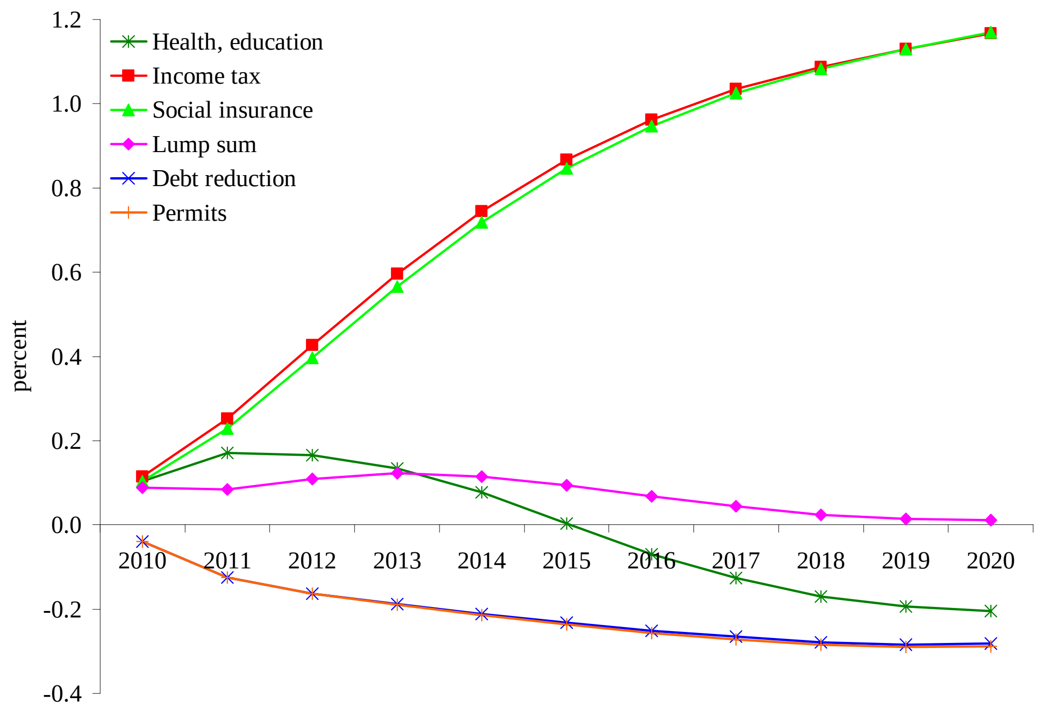

Figure 3. Output of the private sector with a carbon tax of €20/tCO_2 in 2010 rising to €38/tCO_2 in 2020 relative to the case without a carbon tax, for six recycling scenarios.

Table 2. The effects of a carbon tax on GNP, output of the private sector, employment and non-ETS carbon dioxide emissions in 2020 for six recycling scenarios; all impacts expressed in percent of the 2020 value without a carbon tax.

	GNP	Private sector	Employment	CO_2
Income tax	1.11	1.17	1.06	-1.23
Social insurance	1.12	1.17	1.07	-1.25
Lump sum	0.27	0.01	0.04	-1.58
Debt reduction	0.09	-0.28	-0.11	-1.73
Health, education	1.28	-0.20	1.53	-1.36
Permits	-0.12	-0.29	-0.12	-1.77

Source: Own calculations.

What are the effects on emissions?

Table 3 shows the effects of carbon tax on carbon dioxide emissions. We assume that the carbon tax equals the permit price in the EU ETS; specifically, we set the carbon tax equal to €20/tCO_2 in 2010, rising to €38/tCO_2 in 2020. We assume that the revenue of the carbon tax is used to reduce income taxes. The economy develops as in the Benchmark Forecast of the latest *Medium-Term Review* (Fitz Gerald *et al.* 2008).

Table 3 shows the carbon dioxide emissions with and without climate policy. Without climate policy, carbon dioxide emissions in 2020 would be 10% higher. Most of the emission reduction is realized in electricity, where emissions fall by 34%. This compares to a target of 20%. In the rest of the economy, emission reduction is only 1%. This compares to a target reduction of 39%.[19]

Table 3. The impact of climate policy on 2020 carbon dioxide emissions (000 tCO_2)

	No policy	Tax + ETS	Difference		Target
CO_2 from power generation	15,307	10,074	5,232	-34%	-20%
CO_2 from other sources	42,273	42,680	532	-1%	-39%
Total CO_2	58,049	52,285	5,765	-10%	-27%

Source: After Fitz Gerald *et al.* (2008).[20]

These results highlight the inefficiencies induced by the ETS/non-ETS split imposed on Irish climate policy by the European Union.[21] Power generation companies will be exporting emission permits while other companies and households emit too much. It would be wise, therefore, to argue at European level that EU ETS emission permits may be used as offsets outside the EU ETS. Practically, this could mean that the Irish government is allowed to buy ETS permits which are counted against non-ETS emissions.

[19] The target is 80% of emissions in 2005, which is 61% of projected emissions in 2020.
[20] In Fitz Gerald *et al*. (2008), emission permits are assumed to be auctioned; in this paper, emission permits are assumed to be grandparented.
[21] See Boehringer *et al.* (2005, 2006) for a more general assessment.

A carbon tax has two counteracting effects. On the one hand, a carbon tax would induce people and companies to use less and different energy. On the other hand, if properly recycled, a carbon tax stimulates economic growth and this offset the reduction in energy use. The 532 kTCO2 emissions avoided by a carbon tax consist of an increase in emissions of 345 kTCO2 due to faster economic growth, and a reduction of 878 kTCO2 due to energy efficiency and fuel switching. That is, 39% of the gains in carbon efficiency of the economy (bar electricity) are negated by faster economic growth. If the revenue were not recycled through lower labour taxes but used instead to repay debt the reduction in emissions would be significantly greater because of the resulting fall in domestic output (GDP) – see above.

Figures 4 and 5 show a sensitivity analysis on the level of the carbon tax. We set the carbon tax equal to 0x, 1x, 2x, 4x, and 8x the permit price in the EU ETS. For every doubling of the carbon tax, emissions fall further but by less than twice as much. Even if the carbon tax is 8 times the permit price, that is, €160/tCO_2 in 2010 rising to €300/tCO_2 in 2020, emissions fall by only 7% -- far from the 39% target.[22] Recall that a carbon tax is the cheapest way to reduce emissions. Other policy instruments may achieve similar or larger emission reductions, but necessarily at a higher cost.

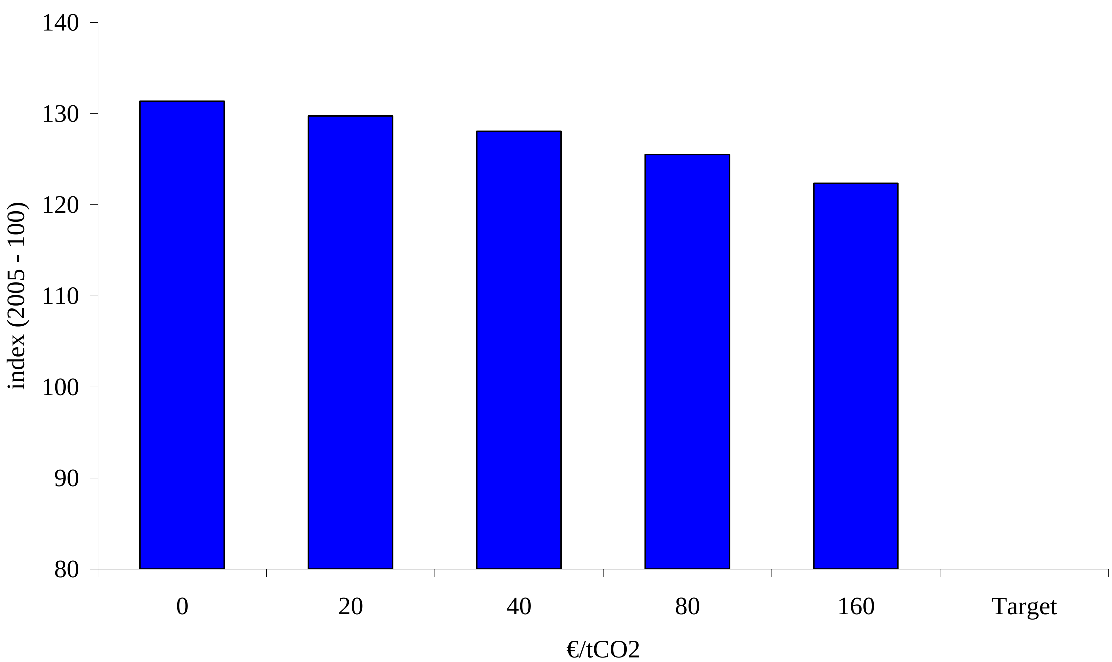

Figure 4. Non-electric carbon dioxide emissions (2020 indexed to 2005) as a function of the carbon tax. The EU target is shown for comparison.

[22] Extrapolating from this, the 2010 carbon tax should be in the order of €5,000/tCO_2 to meet the target.

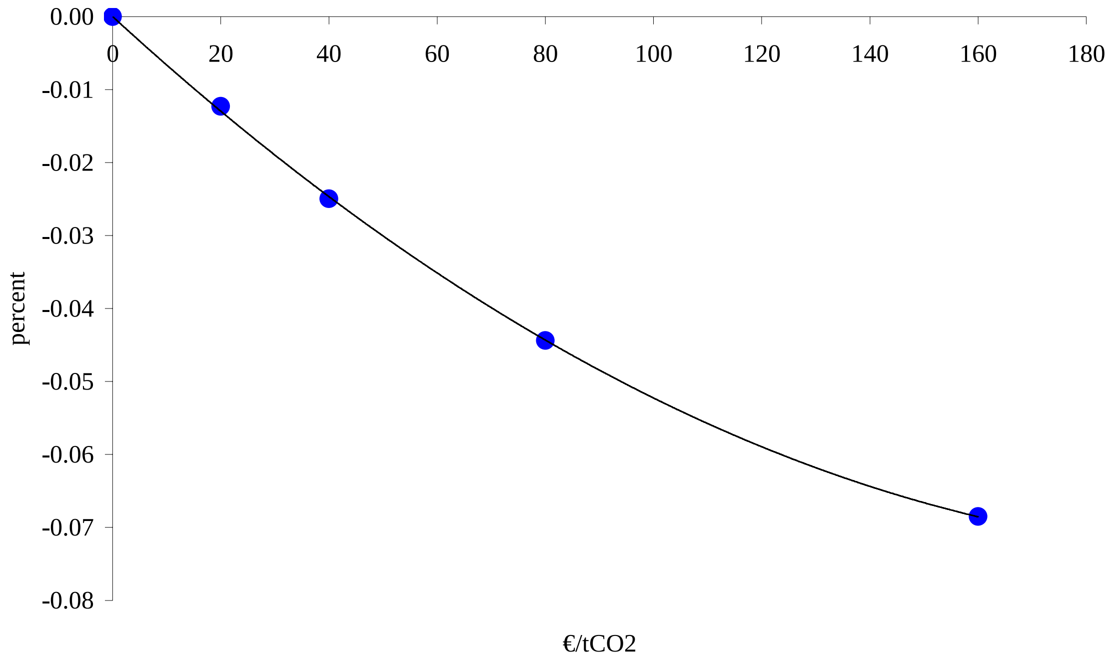

Figure 5. The reduction in 2020 in non-electric carbon dioxide emissions (relative to baseline emissions) as a function of the carbon tax.

Note that a carbon tax of €160/tCO_2 would take the model far outside its normal range. While the model would suggest very substantial positive effects on growth from recycling this revenue, these may not be realistic. This is because of the fact that firms and individuals may well be able to absorb a significant increase in the cost of carbon up to a certain threshold, while facing much greater difficulty for a sudden very large increase in price. This is particularly the case if the price of carbon in Ireland were to be significantly different than in its neighbour countries.

In the long run the biggest impact from a carbon tax (and permit price) will be to incentivise research into new technologies (Fischer *et al.*, 2003; Fischer, 2007). It is only with such development that major reductions in emissions will be possible. However, the time scale on R&D is measured in decades.

If the carbon tax is limited to Ireland, the incentives to do R&D and develop new technologies will be very weak. However, if the price of carbon is similar across the EU, a very large market, substantial R&D will take place and new technologies will be developed. If the increase in the price of carbon was world wide (as with oil prices) the effect on R&D would be even greater. However, whatever the effect on R&D, as shown here, it is likely to have a limited effect on emissions in the first decade. It is only really in the second decade after the price rise that major change would be seen with the introduction of new technologies developed because of the carbon tax.

This means that the HERMES results should be seen as lower bound effects on emissions reduction in the long run. They should be really only used out a decade ahead. Thereafter the effects of R&D could be expected to change the modelled relationships at an increasing rate.

What are the effects on income distribution?

A carbon tax is a tax on energy use, that is, a tax on a necessary good. One would expect that a carbon tax is regressive. Figure 6 shows that this is the case. A carbon tax would thus further skew the income distribution. Fuel poverty is considered a problem in Ireland (Healy and Clinch, 2002, 2004). We estimate that in 2005 15% of households spend over 10% of their income on energy. Given that energy prices have risen faster than incomes, the number would be 19% in 2008.

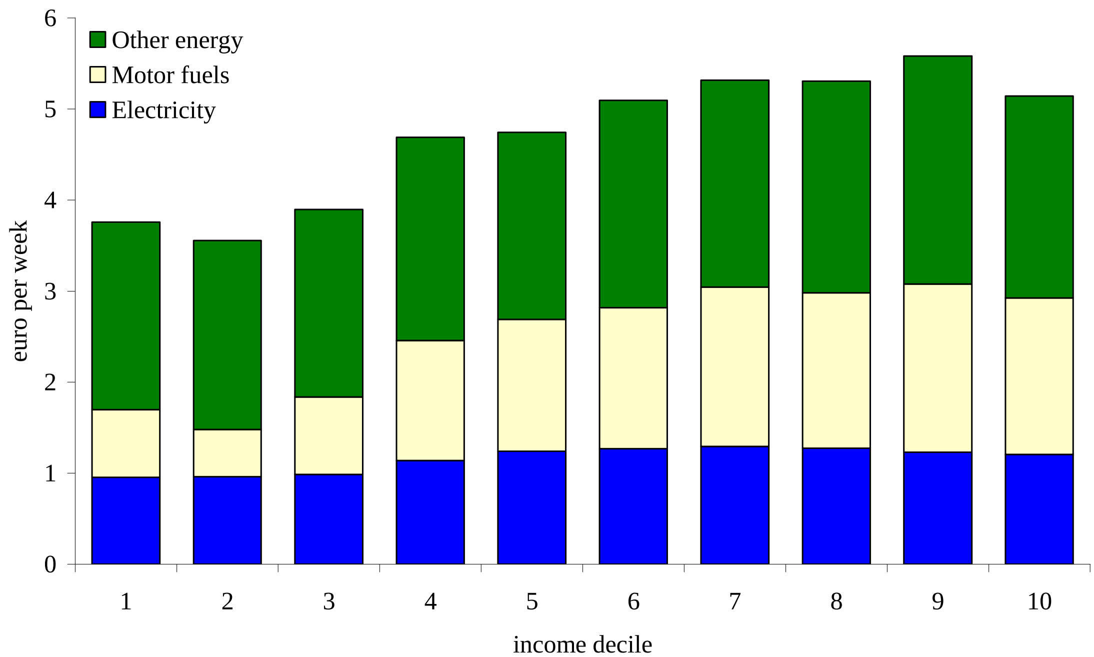

Figure 6. The impact (euro per household per week) of a €20/tCO_2 carbon tax per income decile, split between electricity, motor fuels and other energy.

The data in Figure 6 are based on the *Household Budget Survey 2004-5* (CSO, 2008), using the micro-data on quantities of energy used for home heating, quantities of electricity used, and expenditures on motor fuels.[23] Price data and emissions coefficients are taken from SEI[24] and Scott and Eakins (2004). Note that we include direct emissions only. Indirect effects – for example, retailers passing on their carbon taxes to consumers – are not included.

Figure 6 shows that the richest households emit only 37% more carbon dioxide than do the poorest households – while the equivalised disposable income[25] of the richest

[23] Note that we do not have data per income decile on fuel used in international travel, but aviation emissions will be regulated under the EU ETS.
[24] Prices are from http://www.sei.ie/index.asp?locID=1017&docID=-1; emission factors are derived from data in SEI's online publications *Energy in Ireland, Comparison of Energy Costs for Domestic Fuels: Explanatory and Guidance Notes* and *Energy Map*.
[25] Households differ in size across the income distribution. The distribution of simple household income therefore gives a distorted picture. Equivalisation corrects for that by expressing the household income as income per adult equivalent, and rescaling to the national average household size. All figures of deciles are formulated on this basis.

households is eight times that of the poorest. Figure 6 also shows that electricity, already regulated under the EU ETS, is only a small part of the total burden of climate policy.[26] Figure 6 further shows that electricity use is rather flat across the income distribution: The top decile use only 26% more electricity than do the bottom decile. The distribution of "other energy", mostly for home heating, is even flatter: The top decile use 8% more than the bottom. The big difference between income deciles is in motor fuels: The top decile use 132% more than the bottom one.

Figure 7 splits the implications of the carbon tax for rural and urban households. Because in the countryside houses are bigger, distances are longer and more transport is by car, rural households tend to use more energy and more (carbon-intensive) solid fuels than urban households in the same income decile. Therefore, a carbon tax would weigh more heavily on rural households – but the absolute difference is small: less than one euro per household per week in the lower income deciles.

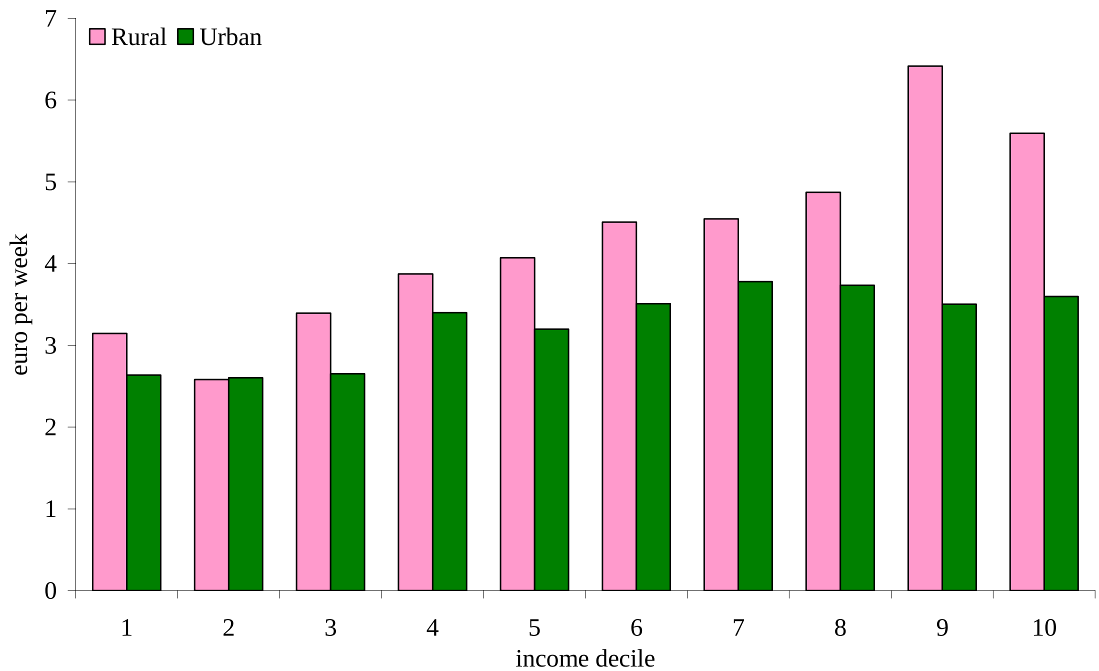

Figure 7. The impact (euro per household per week) of a €20/tCO_2 carbon tax per income decile, split between urban and rural households; non-electric energy only.

Figure 8 shows the carbon tax per person and per household, as a function of household size and Figure 9 repeats this for each household type. Energy is a common good within a household. This is obvious for space heating, but it also, to a lesser extent, for transport. Children add somewhat to the energy use of a household, but relatively little.[27] Therefore, a carbon tax would hit people in a smaller household harder – but the absolute differences are small.

[26] The EU ETS has raised the price of electricity since 2007. This has been included in the relevant price indices that are used for setting benefits and in wage negotiations. We will therefore not consider it further.
[27] The difference between the average married couple with two children and three children is due to income. Richer families tend to be larger.

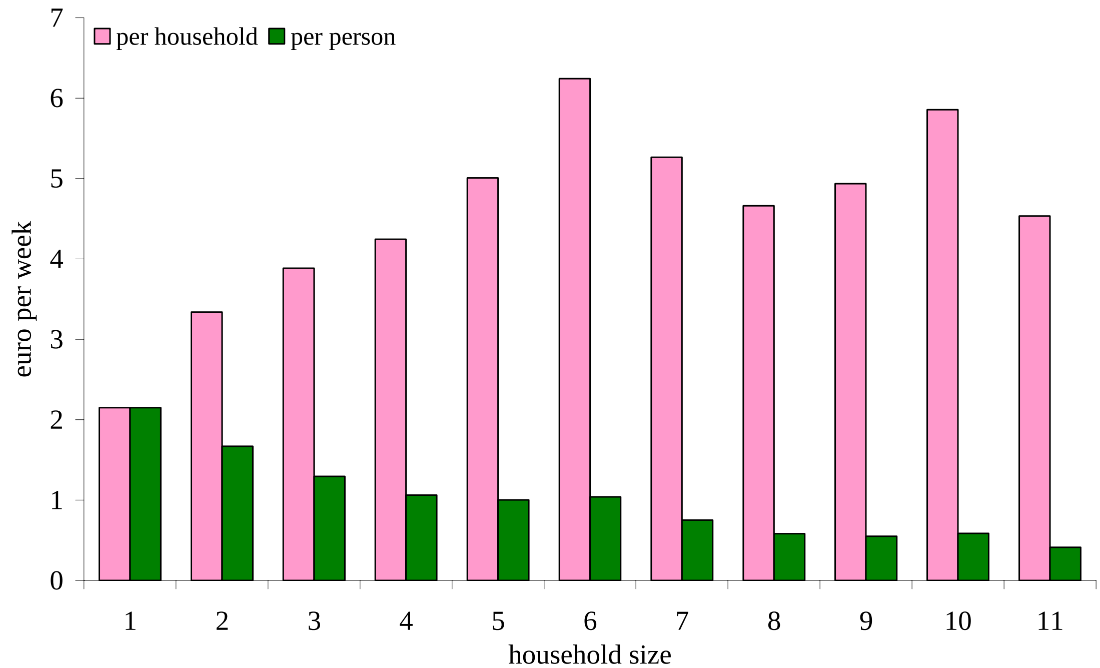

Figure 8. The impact (euro per household per week, and euro per person per week) of a €20/tCO_2 carbon tax per household size; non-electric energy only.

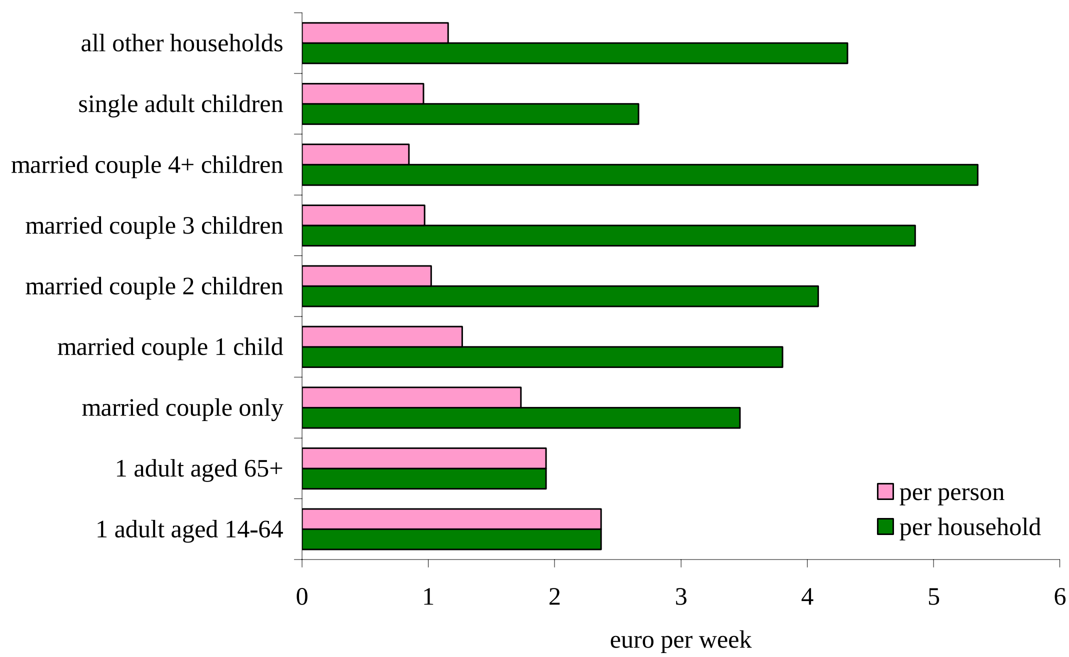

Figure 9. The impact (euro per household per week, and euro per person per week) of a €20/tCO_2 carbon tax per household type; non-electric energy only.

Figure 10 shows the carbon tax relative to the total benefits received and the total direct taxes paid (before revenue recycling; all data for 2005). The crucial insight of Figure 10 is that the carbon tax is measured in euros per week, while benefits and taxes are measured in hundreds of euros per week. For the bottom four deciles of the income distribution, the carbon tax is at most 2.0% of total benefits. For the top four deciles, the carbon tax is at most 2.6% of total direct taxes. Therefore, one can compensate for the impact of a carbon tax with a relatively small increase in benefits, and a relatively small decrease in income taxes.[28]

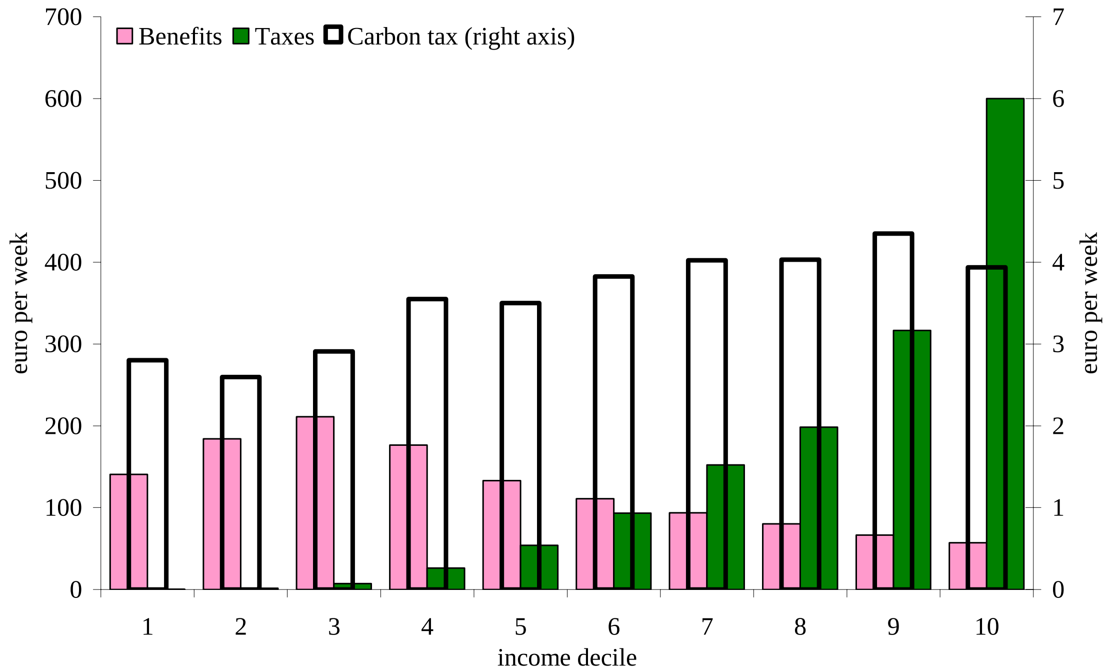

Figure 10. The impact (euro per household per week) of a €20/tCO_2 carbon tax (right axis), and total benefits received and total direct taxes paid (left axis) per income decile; non-electric energy only.

We use the SWITCH model (Callan *et al.*, 2008) to study the distributional implications of revenue recycling. We increased social welfare, and decreased taxes. The social welfare package involves a €2 increase in personal rates for *all* social welfare payments (pensions, unemployment compensation, short-term illness and long-term disability, one parent families). The qualified adult allowance (QAA) is also increased by €2 per week. Optionally, a further €0.80 per week is allowed in respect of each qualifying child of a social welfare recipient. For income taxes, we consider two scenarios. In the first, the basic personal tax credit is increased by €104 per year. Tax credits for one-parent families are adjusted in line with this. In the context of compensation for carbon taxes, a tax credit increase is more suitable than a tax rate cut, as the amount of carbon tax paid by taxpayers is broadly constant, whereas compensation via tax rate cuts would be

[28] In the middle parts of the income distribution, people would benefit from both higher benefits and lower taxes.

concentrated towards the top of the income distribution. Nonetheless, in the second scenario, we reduce the tax rate in the lower band from 20.0% to 19.5%.

Figures 11 and 12 show the results, per income decile, of higher benefits and higher tax credits. The increase in social welfare payments benefits households in the lower half of the income distribution, and the increased tax credit benefits households in the upper half (Figure 11). Subtracting the carbon tax, there are gains across the income distribution[29] – but the gains are minimal for deciles 1, 4, and 10. Figure 12 adds an increase in the qualified child allowance for social welfare recipients, which has clear benefits for the lower incomes.

Figures 13 and 14 show the results of higher benefits and a lower tax rate. Again, there are gains across the income distribution, but minimal ones for deciles 1 and 4. Rich households gain more (Figure 13). Figure 14 adds an increase in the qualified child allowance for social welfare recipients. As this mainly benefits households at the bottom of the income distribution, the distribution of gains is more equitable.

Note that SWITCH estimates suggest that about 35,000 households in the bottom 3 deciles (and about 55,000 in total, all in the bottom half of the income distribution) would not be assisted by the tax/welfare compensation package. Some of these would be households with a low self-employment income, subject neither to tax nor eligible for social welfare payments.

Table 4 shows the effects on the government budget. The increase in social welfare would cost €122 million per year, or €138 million if child benefits are raised too. An increase in tax credits would cost the exchequer €222 million, and a decrease in the lower tax rate would cost €301 million. This compares to a carbon tax revenue of €551 million, €266 million of which would come directly from households. Overall, the tax and benefit reform in Figure 12 would bring €191 million net to the exchequer, and the reform of Figure 14 would yield €112 million net. This money could be used for further tax reform, for example a reduction in social insurance.

Table 4. Budget implications a carbon tax reform.

Description	Budget
Carbon tax, non-ETS, €20/tCO_2	+€551 mln
of which on households	+€266 mln
Social welfare increase, €2/person/week	-€122 mln
Child benefit increase, €0.80/child/week	-€16 mln
Tax credit increase, €104/person/year	-€222 mln
Tax rate decrease, to 19.5%	-€301 mln
Package Figure 12	+€191 mln
Package Figure 14	+€112 mln

Source: Own calculations.

[29] Recall that we exclude the indirect effects of carbon taxes on the income distribution.

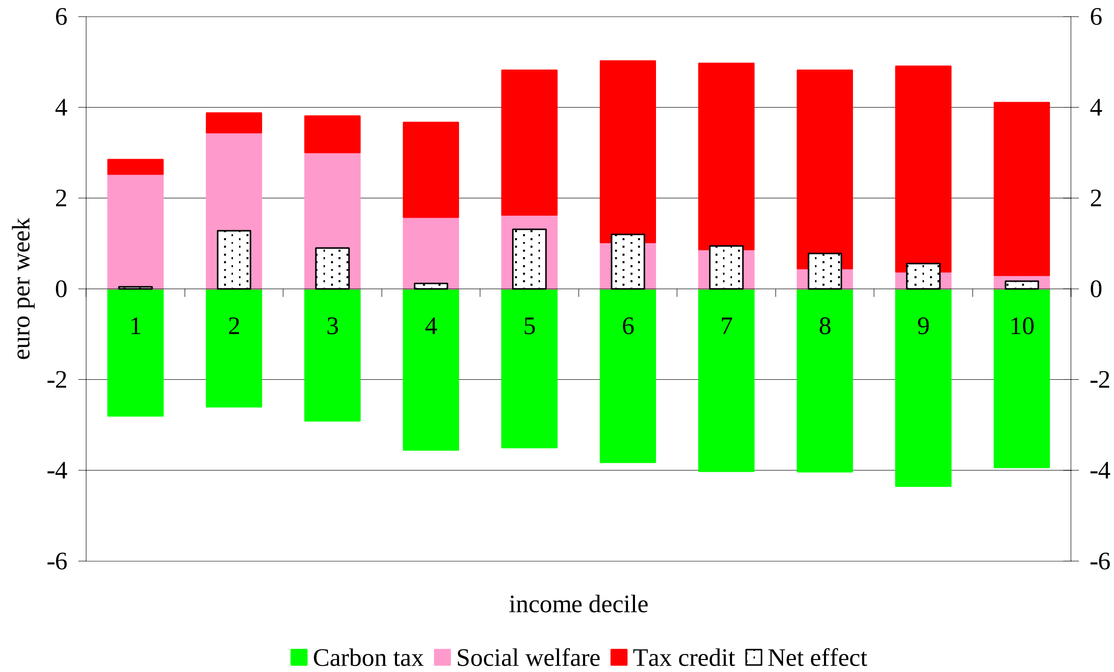

Figure 11. The effect of a carbon tax, social welfare increase, and tax credit increase per income decile, in euro per household per week; the net effect is also shown.

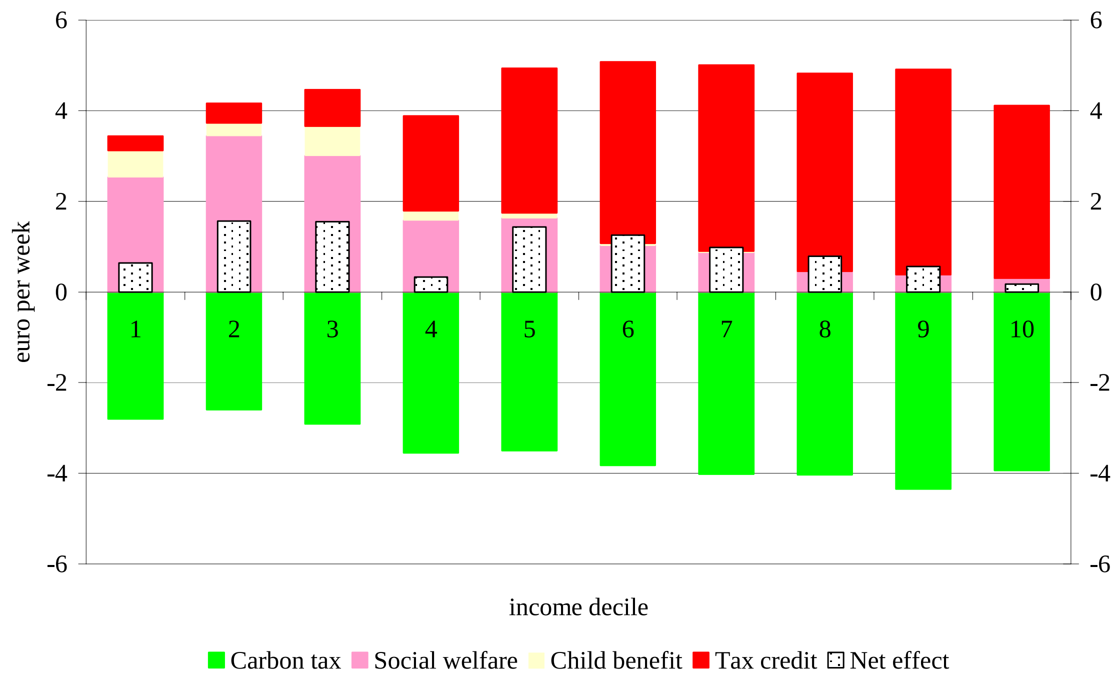

Figure 12. The effect of a carbon tax, social welfare increase, child benefit increase, and tax credit increase per income decile, in euro per household per week; the net effect is also shown.

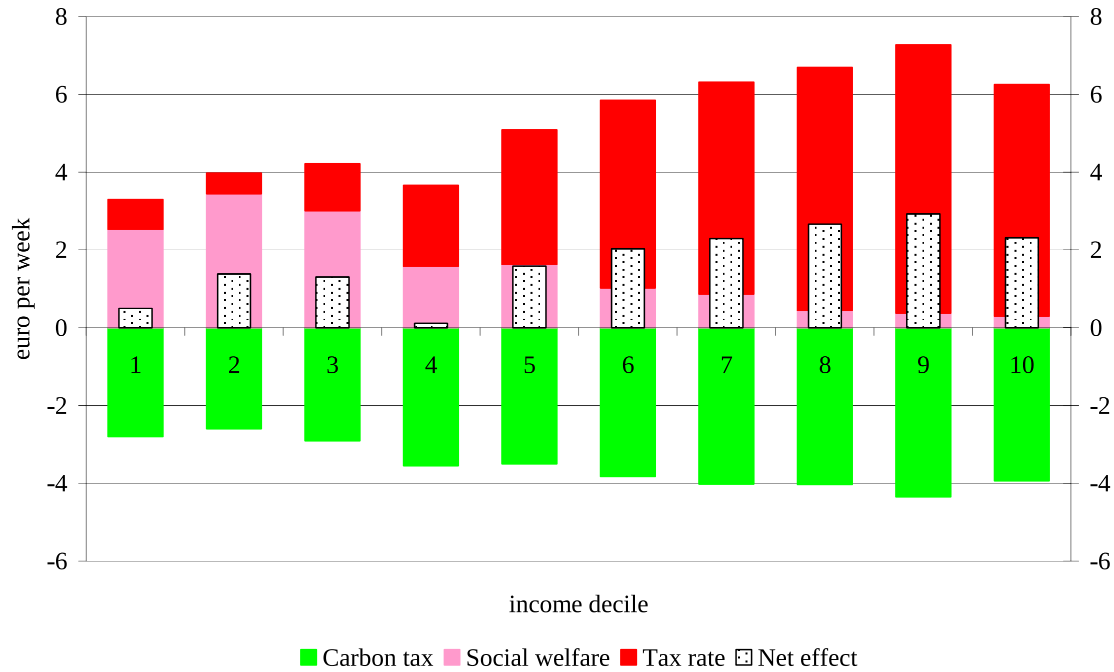

Figure 13. The effect of a carbon tax, social welfare increase, and tax rate reduction per income decile, in euro per household per week; the net effect is also shown.

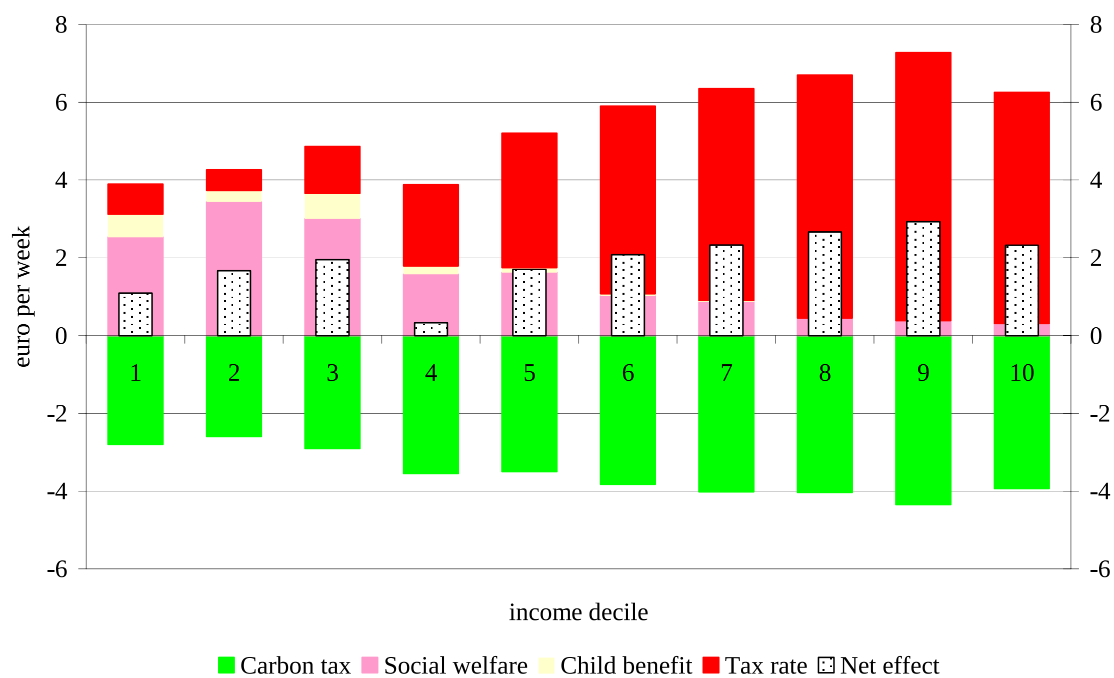

Figure 14. The effect of a carbon tax, social welfare increase, child benefit increase, and tax rate reduction per income decile, in euro per household per week; the net effect is also shown.

How to tax internationally traded goods and services?

Ireland has a small open economy. Many of the goods consumed in Ireland are produced abroad, and many of the goods produced in Ireland are consumed abroad. This is also true for motor fuel and electricity. The Republic of Ireland is a net importer of electricity from Northern Ireland, and there are plans to build an interconnector to Wales that would bring electricity imports from Great Britain as well (Malaguzzi Valeri, 2008). This is not an issue for climate policy, because power generation in the United Kingdom is regulated by EU ETS just like power generation in the Republic of Ireland. Motor fuels are treated differently at each side of the border; we discuss the issue of fuel tourism below.

Besides trade in energy, there is also trade in products that have a high energy- or carbon-content. That is, such products entail substantial greenhouse gas emissions in their production. Climate policy would therefore substantially change the cost of production, and hence international competitiveness (cf. Fitz Gerald *et al.*, 2007). Cement and aluminium are two such products, but both are covered by the EU ETS, so climate policy only affects exports to countries outside the European Union.[30]

There are two export-oriented activities that could be affected by domestic climate policy, as in both cases there are no plans for regulation by the European Union or by international treaty. The first such sector is agriculture, the main source of emissions of methane and nitrous oxide. Methane accounts for some 19% of all greenhouse gas emissions, and most of that methane comes from the dairy and beef herds. Halocarbons are only 1% of total emissions, but have grown much faster than any other emissions: 20% per year between 1990 and 2005, compared to 3% for carbon dioxide and 0% for methane and nitrous oxide. Halocarbons are industrial gases, used to produce pharmaceuticals and computer parts. Both industries produce mostly for export. However, it is not well understood how a carbon tax would affect these companies.

The situation in agriculture is better known. Above, we assumed a carbon tax of €20/tCO_2 rising to €38/tCO_2 in 2020. Using the EPA emission coefficients and the UNFCCC global warming potentials, this corresponds to an annual tax of €45 per dairy cow, rising to €86 in 2025; for beef cattle, this is €22/head rising to €43/head. Unless farmers in other countries are taxed at a similar level, Irish farmers would have to accept a lower income, although some would be forced out of business. Lower beef or milk production in Ireland would reduce methane emissions in Ireland, but as global emissions are driven by meat and dairy consumption rather than the location of production, emissions elsewhere would increase by about the same amount. The effect on global emissions would be minimal.

One could exempt methane emissions from the carbon tax, but that would imply non-uniform taxation and it would mean that the emission reduction effort would fall on the other sources. One could also rebate the carbon tax when the product is exported, but the administration would be complicated. Because the bulk of the output of the cattle sector is exported, exemption would probably be more efficient than the introduction of a complicated rebating scheme – or perhaps a partial exemption based on the average export rate. Domestically, the carbon tax would discriminate against Irish dairy and meat

[30] Base chemicals are energy-intensive products outside the EU ETS, but not produced at a large scale in Ireland.

products. Tariffs on imports from other EU countries are illegal, while taxing imports from non-EU countries would require the consent of all other EU Member States and would be illegal under the rules of the World Trade Organization.

Another solution is to tax the consumer rather than the producer. That is, a duty would be put on dairy products and meat that is proportional to the average amount of methane emitted per volume or weight. Products for exports would be automatically exempt (rather than taxed and rebated), while imported products would be treated like domestic products. Retailers collect VAT and excise duties already, and could collect the carbon tax as well without additional administrative burden.

For example, in 2005, there were 1.1 million dairy cows in Ireland, producing 4.9 billion litres of milk. This makes for 4,500 litres of milk per cow per year. The above carbon tax would thus be equivalent to a "methane duty" of 1.3 cent per litre of milk in 2010, rising to 2.4 cents in 2020. In 2005, Irish consumers bought 520 million litres of milk. The tax revenue would thus be some €5 million. Similar duties could be placed on other dairy products, on meat and, arguably, on selected electronic and pharmaceutical products. We do not have the data in hand to compute illustrative methane duties.

Whatever the environmental benefits of a methane duty on food, one should consider the implications for health as well. Reducing milk consumption may be good for the environment, but it is bad for health – while reducing the consumption of red meat is good for both health and environment. The introduction of environmental duties on food could perhaps best be done together with a reform of health duties, which are currently limited to tobacco and alcohol.

Another drawback of a carbon tax on consumption, and particularly one based on average emissions, is that it does not incentivise emission reduction. Returning to the example of milk, the easiest way to reduce methane emissions is probably through food additives.[31] Internationally competitive research and development in this area should be subsidised, as should the additives already on the market.[32] This can be financed by the proceeds of the methane duty.

A tax on feed would give incentives to reduce methane, particularly if that tax is differentiated according to its effects on the digestive system of ruminants. It would also increase the time that animals spend outdoors, and grass-fed cattle emit less methane than fodder-fed ones. However, such a tax would reduce the international competitiveness of Irish farming unless it is done in the form of a budget-neutral feebate (Johnson, 2006) – that is, climate-friendly feed should be subsidised and climate-unfriendly feed should be taxed, and the total tax revenue should equal the total subsidy outlay.

[31] Methane emissions would fall if biomass and forestry were treated like agriculture under the provisions of the CAP. If prices for agricultural products reflected the true market price, with a rising price of carbon, farmers may begin to switch from carbon emitting cattle production to carbon sequestering biomass (for heating or power generation) or timber production. The market should be allowed to work allowing farmers to choose their profit maximising mix of outputs. This could be expected to lead to a gradual reduction in methane emissions (in Ireland) and an increase in biomass production, reducing carbon emissions (globally) from the use of fossil fuels.

[32] Environmental economists generally dislike input subsidies as they stimulate production. This is not true for a subsidy on food additives, as production costs would not be substantially affected.

What about fuel tourism?

Fuel tourism is the amount of fuel bought in Ireland but consumed abroad. As fuel is cheaper in the Republic of Ireland, consumers from Northern Ireland drive across the border to tank up. Other drivers, particularly of lorries, fill up just before getting on the ferry. There is probably also significant illegal trade in fuel.

In the *Medium-Term Review* (Fitz Gerald *et al.*, 2008), we estimate that in 2005 between 5 and 9% of total petrol sales in Ireland were consumed abroad. The figure for diesel is 15 to 20%. These estimates (and estimates by others) are based on model simulations rather than on sales data. More work is needed to measure fuel tourism with more precision. We can, however, get an idea of the effect of changes in taxation on fuel tourism and revenue entries. Adopting a carbon tax equal to €20/tonne of CO_2 in Ireland with no change in taxation in the UK would reduce fuel tourism and associated carbon emissions by about 285 tonnes of CO_2 in 2005, which is about 0.5% of total carbon dioxide emissions. However, emissions elsewhere, particularly in the UK, would increase by almost the same amount, so that the net effect on climate change is virtually zero.

The decrease in fuel tourism would reduce the amount of excise taxes paid by non-residents to the Irish revenue by about €26 million. The non-residents who continue buying fuel in Ireland pay the carbon tax, thereby increasing Irish revenues by €14 million. On balance, the Irish revenue loses approximately €12 million by imposing a €20/tonne of CO2, or 0.03% of total tax revenue.

Further research

We identified a number of issues for further research that would help to give better informed answers to the questions addressed in this paper:

1. Replication of the results with other models.
2. Sensitivity analysis on parameter and scenario assumptions.
3. Alternative designs of the carbon tax and revenue recycling.
4. Interactions between carbon taxes, pre-existing taxes, and market structure.
5. Implications for wages and profits of reductions in income taxes and social insurance.
6. Indirect effects of carbon taxes on income distribution.
7. Implications of carbon taxes on fuel poverty.
8. Policy options to reduce greenhouse gas emissions from agriculture, including the implications for human diet and health.
9. Implications of a carbon equivalent tax for the electrical and electronic goods and pharma-chemical sectors.

Conclusions

In this paper, we discuss ten questions. The answers are as follows:

1. A uniform carbon tax should be imposed because it is the cheapest way to reduce emissions.
2. The carbon tax should equal the futures price of emission permits in the EU Emissions Trading System.
3. All sources of emissions of all greenhouse gases should be taxed, with the exception of emissions already regulated by the EU Emissions Trading System.
4. The expected revenue of a €20/tCO_2 on carbon dioxide emissions is €550 million per year. If permits in the EU Emissions Trading System are fully auctioned and if other greenhouse gases are taxed too, the expected revenue is €1,400 million. Between 2010 and 2020, the revenue of a carbon tax is likely to grow substantially faster than the overall government budget.
5. The revenue of the carbon tax can probably be best used to mitigate the distributional implications of the carbon tax and to reduce labour costs.
6. If the revenue of the carbon tax is used to reduce income taxes and social insurance, then Gross National Product and employment would grow slightly faster.
7. A carbon tax would reduce emissions by a modest amount in the coming decade. An attempt to meet the EU target for 2020 by domestic emission reduction would be very expensive. However, if introduced today and if the tax or a similar instrument were used elsewhere in the EU, the long-term effects would be much larger as new technology was developed and implemented.
8. A carbon tax is mildly regressive, but a relatively modest increase in benefits and reduction in income tax would offset this.
9. Emissions of methane, nitrous oxide and halocarbons originate from internationally exposed sectors with no international or even European regulation in sight. Therefore, the equivalent carbon tax could be placed on the final consumer (rather than on the producer), as this would automatically exempt products for export and treat domestic and imported products in the same way. For food, environmental duties should not be introduced without considering the implications for health. For agriculture, feebates for feed are another option.
10. A carbon tax would reduce fuel tourism. Ireland’s emissions would fall by perhaps 0.5%, but emission increases elsewhere would negate all climate gains. The effects on revenue are minimal.

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