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Carbon taxation in Ireland: Distributional effects of revenue recycling policies

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CARBON TAXATION IN IRELAND. DISTRIBUTIONAL EFFECTS OF REVENUE RECYCLING POLICIES[1]

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ABSTRACT

We calculate the impact of an increase in carbon taxation on carbon emissions and on income inequality. Carbon emissions reduce by 3.94 per cent for a carbon tax increase of €30 per tonne, and 10.24 per cent for an increase of €80 per tonne. Carbon taxation is found to be regressive, with poorer households spending a greater proportion of their income on the tax than more affluent households. However, returning the carbon tax revenues to households reverses this regressive effect, and the net policy effect is progressive. A 'carbon cheque' that distributes the revenues equally to every household leads to small changes in income inequality, while a targeted mechanism that directs more of the revenues towards less affluent households is more progressive, and actually reduces income inequality. The targeted mechanism resembles recycling the revenues through the tax and welfare system, and thus has lower administrative costs than a 'carbon cheque'.

1. INTRODUCTION

Carbon pricing or taxation has been endorsed by many as an important tool in combatting climate change by reducing carbon emissions in the most cost-effective manner, while inducing minimal distortions in other markets (Nordhaus, 1993). The general principle of carbon taxation as an appropriate mechanism to reduce carbon emissions enjoys broad support amongst economists.[2]

However, significant public concerns over carbon taxation remain. Energy affordability is an important consideration for citizens, as is the extent to which carbon taxes impact on income inequality (Kolstad et al., 2014). Because poorer households spend a greater share of their income on energy, carbon taxes can impact on both energy affordability and income inequality. The impact of carbon taxation on rural households is also of concern. Finally, the ability of carbon

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[2] See for example www.econstatement.org

taxation to bring about a decrease in emissions, particularly if households are unable to readily switch to alternative fuels, is sometimes questioned (Patt and Lilliestam, 2018; Vasilakou, 2010).

At least some of these concerns can be addressed by appropriate recycling of the revenue raised by carbon taxation. If the revenue is returned to households, either directly or via the tax and welfare systems, concerns over energy affordability can be addressed. Assuming the revenue received by each household is at least as great as the household expenditure on carbon tax, there is no net effect on energy affordability. Furthermore, appropriate targeting of the recycled revenues can leave income inequality unchanged, or even reduced. Klenert et al. (2018) provide a thorough review of the range of the various revenue recycling mechanisms that can be employed by policymakers.

The choice of recycling mechanism is very important because a poorly designed instrument could exacerbate rather than attenuate an increase in income inequality caused by the tax itself (see Williams, 2016). The cost of implementing the policy itself should also be taken into consideration. For example, the administrative cost of recycling revenue through a direct transfer is likely to be higher than that of changing taxation and social welfare payment rates and thresholds. This higher administration cost reduces the total amount of revenue available for distribution amongst households.

In Ireland, carbon is seen as a core element of the transition to a sustainable economy (DCCAE, 2017) and a carbon tax was introduced in 2010, which applies to the non-ETS (Emissions Trading Scheme) sector only. There is broad political agreement that this tax should be increased (Committee on Climate Action, 2019). New research on the implications of increased carbon taxes for emissions, affordability and inequality is therefore warranted and is the focus of this research.

Research on carbon taxation in Ireland has been carried out since as early as 1992 (FitzGerald and McCoy, 1992). Several of the studies take a macroeconomic perspective and model the economy as a whole. As a result, these can calculate the impact of carbon taxation on various sectors of the economy as well as on households (Bergin et al., 2004; Wissema and Dellink, 2007; Conefrey et al., 2013). They can also calculate the changes in behaviour induced by carbon taxation and the resulting reduction in emissions. These papers cited above consider the impact of the introduction of a carbon tax, however (de Bruin & Yakut, 2019) develop and use the I3E model to consider the impact of a carbon taxation increase. They find that a carbon tax can reduce emissions and that recycling carbon tax revenues to households sees the nominal income of households rise, although the real income falls, due to an increase in inflation. The CGE models reviewed above cannot, however, take account of individual household characteristics and behaviour, and do not consider how different categories of household are affected by carbon taxation, which requires the use of microdata. Research on carbon taxation that does rely on Irish microdata includes Scott and Eakins, 2004 and Callan et al., 2009. Carbon taxes are found by each of the above papers to be regressive, but this literature also finds that the regressive effects can be reversed if the revenue raised from the tax is recycled appropriately back to households. However these models are unable to account for behavioural changes as a result of the tax, and instead assume that household carbon emissions continue unabated after the tax is introduced. While this may be a plausible short-run assumption, it is unlikely to apply in the long run.

This research represents a significant advance on the state of the art by examining the impact of increased carbon taxation on both carbon emissions and household income and equality. Carbon taxation mainly affects household expenditure on energy-related commodities like fuel and transport, as these goods become more expensive. However, carbon taxation also affects expenditure on non-energy-related commodities by shifting the share of the household budget that is spent on each type of commodity. In order to estimate the effects of carbon taxation on expenditure on both energy- and non-energy-related commodities, we use microdata from the Household Budget Survey of Ireland (HBS). This research also considers the impact of recycling the carbon revenue back to households, using both a flat allocation and a targeted allocation.

Our results show that carbon taxes are an effective means of reducing both CO_2 emissions and income inequality when the tax revenue is properly allocated and targeted to protect vulnerable households.

2. METHODOLOGY AND DATA

2.1 Demand system estimation

We employ the Exact Affine Stone Index demand system (EASI, see Lewbel and Pendakur, 2009) to model household behaviour. A demand system is a method of determining how consumer behaviour responds to changes in prices. Consumption decisions are represented as a system of equations which depend on prices, consumption budgets, and observed as well as unobserved household characteristics. Unlike previous models of household demand, the EASI allows for a flexible representation of the relationship between household expenditure on a particular commodity and the household's total disposable income. Demand systems have been used to study households' energy use and carbon emissions

(Creedy and Sleeman, 2006; Pashardes et al., 2014; Tovar Reaños and Wolfing, 2018), but, to our knowledge, this study which employs the EASI demand system to examine the distributional implications of carbon taxation, taking revenue recycling into account, is unique in the literature. It is also the first study to apply the EASI to Irish data. The outputs of the model can be used to estimate a household expenditure function, which represents the quantities of each commodity consumed by a household, given that the household faces a budget restriction. Changes in the price of one commodity, for example increasing energy prices due to a carbon tax, means households will choose a different bundle of commodities in response: in other words, their expenditure on all commodities will change, not just energy-related commodities. We quantify the cost to households from carbon taxation, by determining the adjustment in household income needed to accept a different commodity bundle.[3] This cost will in turn change income distribution and consequently income inequality. We used Atkinson's inequality index to measure these changes in income inequality (see Tovar Reaños and Wolfing, 2018).[4]

To apply the model, data on household expenditure on different commodities, commodity prices and other socioeconomic variables are needed. Using the Household Budget Survey (HBS) from the Central Statistical Office (CSO), we use the following waves from the HBS to estimate our demand system; 2015-2016, 2009, 2004, 1999 and 1994. We group consumption goods into six categories: food, housing, heating and lighting, transport, education and leisure, and other goods and services.[5] A similar approach has been used in Tovar Reaños and Wolfing (2018) and by Bohringer et al. (2017). The grouping largely follows the Classification of Individual Consumption According to Purpose (COICOP). As in Baker et al. (1989) we do not include purchase of vehicles and big appliances such as washing machines, dryers, etc. as part of the commodity bundles. Instead, dummy variables for ownership of these commodities are included in the analysis. Energy is comprised of expenditure on electricity, natural gas, liquid fuels and solid fuels. Transport expenditure comprises petrol and/or diesel, vehicular maintenance, insurance and public transport. Because carbon taxes affect the prices of both heating and fuels for private transportation,[6] we can estimate the changes in income distribution for both groups.

3 After estimating an expenditure function we are able to estimate Hicks' equivalent variation.

4 We follow King (1983) to estimate equivalent income and inequality.

5 This aggregation maximises the use of the data because it considerably reduces the number of households reporting zero expenditure in any given category.

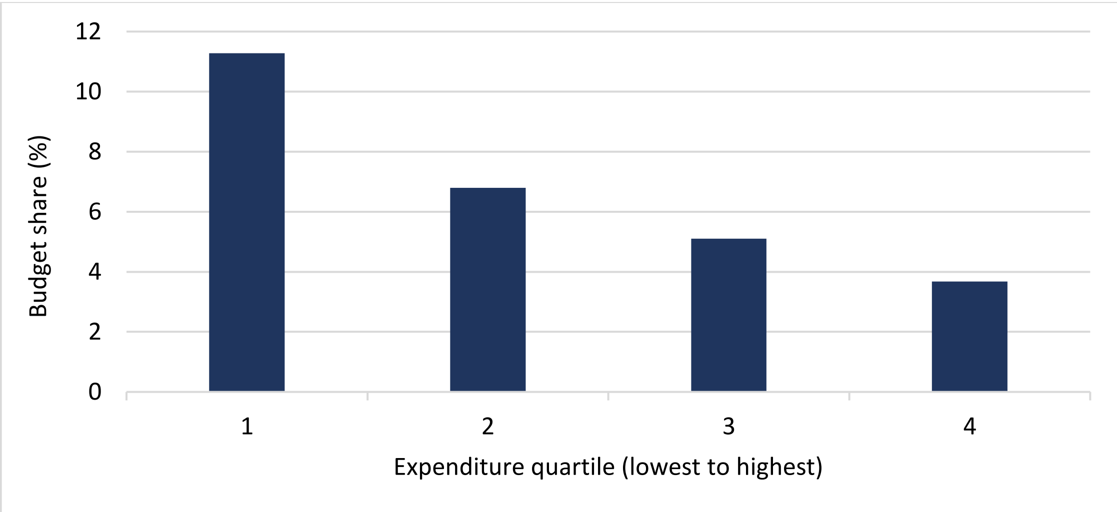
6 While expenditure on electricity is included in the HBS dataset and in our model, carbon taxes do not apply to electricity consumption because electricity generation is covered by the European Union's Emissions Trading Scheme (ETS). Therefore a change in carbon tax changes the prices of heating and transportation fuels, but not of electricity.

A potential caveat is that the parameters for transportation include both public and private transport. However, once we compared our results with a model that only includes private transport, our results are slightly higher, and the general conclusion found in this report holds.[7] Full details of the model can be found in Tovar Reaños and Lynch, 2019.

2.2 Energy consumption with no carbon taxation increase

Figure 1 shows that low income households spend the largest share of their budget on residential energy. The consumption in this sector comprises electricity and fuels for heating. Similar patterns are found for the expenditure on private transportation as shown in Figure 2. This shows that higher energy prices (via a carbon tax or otherwise) will potentially harm low income households disproportionally. This tallies with results from previous research.

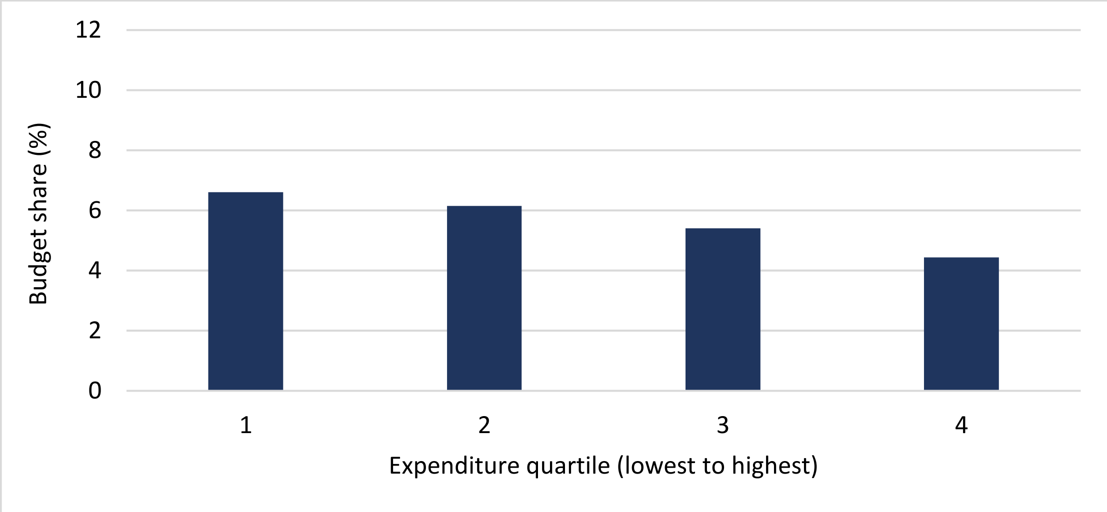
FIGURE 1 BUDGET SHARE OF EXPENDITURE ON HEATING AND LIGHTING USED IN THE RESIDENTIAL SECTOR ACROSS EXPENDITURE QUARTILES



Source: Own estimation based on the HBS.

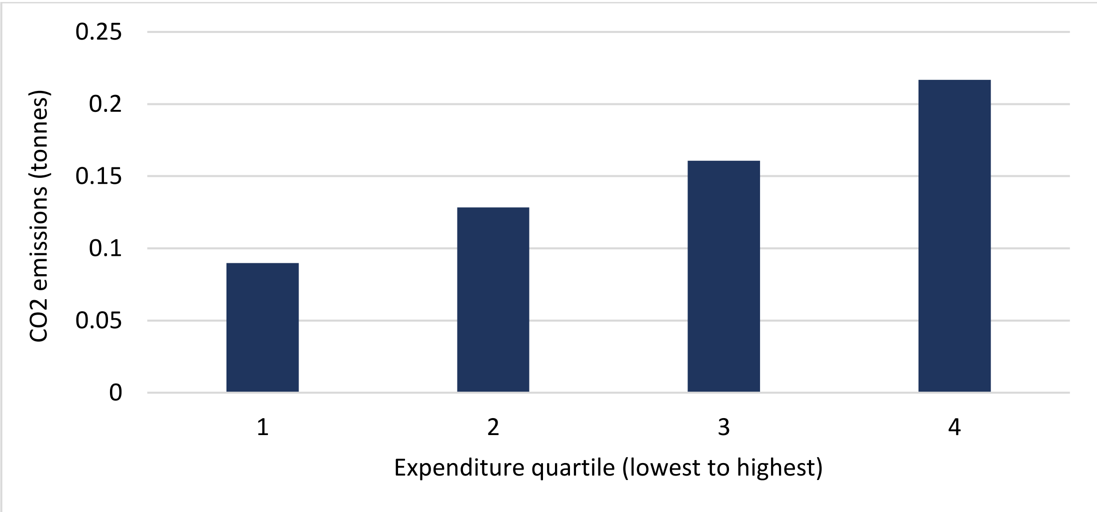
[7] We use a Heckman correction to estimate a demand system for only vehicle owners as in West and Williams (2007). For full details of this estimation see Tovar et al., 2019.

FIGURE 2 BUDGET SHARE OF EXPENDITURE ON DIESEL AND PETROL USED IN PRIVATE TRANSPORTATION ACROSS EXPENDITURE QUARTILES



Source: Own estimation based on the HBS.

FIGURE 3 CARBON EMISSIONS BY INCOME QUARTILE (TONNES)



Source: Own estimation based on the HBS.

Figure 3 shows the carbon emissions per household. More affluent households have higher emissions. This calls for the implementation of a progressive policy instrument where carbon taxes increase with income.

3. MICROSIMULATION

Having determined the expenditure of each income quartile on fuels and transportation, we now determine the impact of a change in carbon taxation on behaviour. This is the major contribution of this piece of research. For this exercise, we use only the 2015-2016 wave of the HBS because it has the most recent data.

In addition, we use emission factors and prices of energy commodities provided by the Sustainable Energy Authority of Ireland (SEAI).[8] As in Callan et al. (2009), we only consider direct emissions.

It is important to note here that the model is a partial equilibrium model, and consequently it is not able to estimate changes in labour supply or in the supply of commodities purchased by households as a result of carbon taxes. This will be the focus of future research.

4. SCENARIOS

We analyse two carbon tax scenarios, where we consider an additional carbon tax of €30 and €80 per tonne respectively. When combined with the existing carbon tax of €20 per tonne, total carbon taxes come to €50 and €100 per tonne. In the baseline scenario, households pay the current carbon tax (i.e. €20 per tonne).

Furthermore, we analyse two mechanisms for recycling the additional carbon tax revenue; a flat allocation and a targeted allocation. The flat allocation scenario resembles the green cheque, which has been advocated by some policymakers; an equal cash transfer is given to every household, the sum total of which is equal to the total carbon tax revenue. Under the targeted scenario, the revenue is distributed amongst households in inverse proportion to the households' share of aggregate income, according to the following equations:

$$\frac{\sum_h^H X_h}{X_h} = r_h$$

$$Share\ X_h = \frac{r_h}{\sum_h r_h}$$

where X_h is each household's total expenditure and $Share\ X_h$ calculates the share of the total carbon tax revenues that accrue to each household h. The first equation calculates the inverse of each household's share of aggregate expenditure, and the second equation normalises this in order to ensure that the sum of all the shares to adds to one.

This allocation mechanism is designed to resemble social welfare transfers, which broadly accrue to households in inverse proportion to income (with some exceptions).

8 Emission factors can be found at www.seai.ie/resources/publications/Energy-Emissions-2017-Final.pdf

5. RESULTS[9]

5.1 Initial incidence

5.1.1 Household level

Table 1 displays how the cost of increasing the carbon tax by an additional €30 per tonne falls on the household types with the largest incidence across the income quartiles as a proportion of total expenditure. Every household bears some cost, but the cost is greatest for the poorest households. Comparing the first and fourth quartiles indicates that poorer households (1st quartile) suffer disproportionately more from carbon taxes. In addition, single households with children are the most affected by this policy.

It should be noted here that this table includes no assumption on how the revenues from carbon taxes are utilised. In essence, the table shows the cost of increasing the carbon tax but assumes that the revenue raised from so doing exits the economy entirely. We relax this assumption further on. Note that our metric measures the cost of the policy as the extra income that the household would require, were they to choose their original bundle of commodities, but at the new set of energy prices.

TABLE 1 HICK'S EQUIVALENT VARIATION RELATIVE TO HOUSEHOLD INCOME

	1st_quartile	2nd_quartile	3rd_quartile	4th_quartile
Single_no_children	-0.83	-0.41***	-0.34***	-0.23***
Single_+65	-0.94	-0.58	-0.41	-0.16***
Single_with_children	-1.01***	-0.67***	-0.45	-0.37
All_households	-0.88	-0.59	-0.48	-0.39

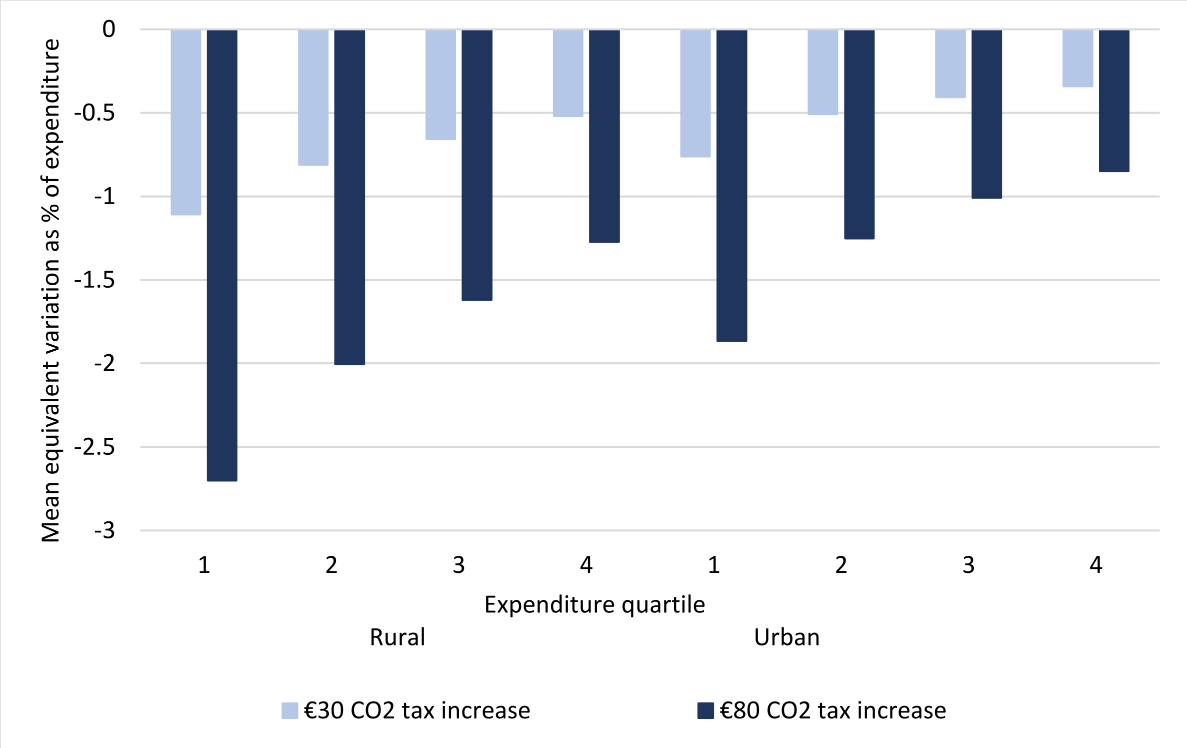
Source: Authors' own estimation.
Notes: Statistically significant with respect to the sample mean in each quartile *p<0.10, **p<0.05, ***p<0.01.

The following graph shows how the tax burden is distributed across different expenditure quartiles. In addition, the graph is broken down by rural and urban households.[10] One can see that rural households are disproportionally more affected, particularly rural households in the lowest income quartile.

9 Own-price, cross-price and expenditure elasticities can be found in Tovar et al., 2019.

10 Rural and urban households are defined by the CSO regarding population size and proximity with aggregated town areas (see www.cso.ie/en/releasesandpublications/ep/p-cp1hii/cp1hii/bgn).

FIGURE 4 DISTRIBUTIONAL EFFECTS OF CARBON TAX FOR URBAN AND RURAL HOUSEHOLDS



Source: Authors' own estimation.

Table 2 shows the average cost per week of carbon taxation on different household types in monetary terms. Households living in older dwellings and low skilled workers have larger costs. Callan et al. (2009) used a different approach and estimated an average cost per week of more than €4 for an additional carbon tax of €20 per tonne. Our results are at the lower bound of this estimate, which is inevitable as our model includes the behavioural effects of carbon taxation. We can simulate the extent to which households will reduce their carbon consumption as a result of the tax, thereby reducing the tax that they pay (as well as reducing total emissions).

TABLE 2 CARBON TAX COST (€/WEEK). OWN ESTIMATED HICK'S EQUIVALENT VARIATION

	Tax_+30	Tax_+80
Dwelling_1980	-3.037***	-7.467 ***
Low_skill	-3.126 ***	-7.726 ***
All_households	-2.772	-6.841

Source: Authors' own estimation.
Notes: Values have been equalised to consider household size. Statistically significant with respect to the sample mean in each quartile. *p<0.10, **p<0.05, **p<0.01.

5.1.2 *Aggregated level*

The cost of the policy faced by households estimated in the previous section will also have distributional effects at aggregate level. Table 3 shows the changes in income inequality, total expenditure per capita and CO_2 emissions as a result of the carbon tax. In the absence of revenue recycling, income inequality, as measured by the Atkinson index, increases. This is due to the regressive nature of carbon taxation. In addition, after paying for the carbon tax, the total expenditure of households declines by between 0.46 per cent and 1.14 per cent. A tax increase of €30 and €80 per tonne decreases CO_2 emissions by 3.94 per cent and 10.24 per cent respectively, due to the behavioural changes made by households in response to the tax.

TABLE 3 CHANGES IN INEQUALITY, EXPENDITURE AND EMISSIONS IN %

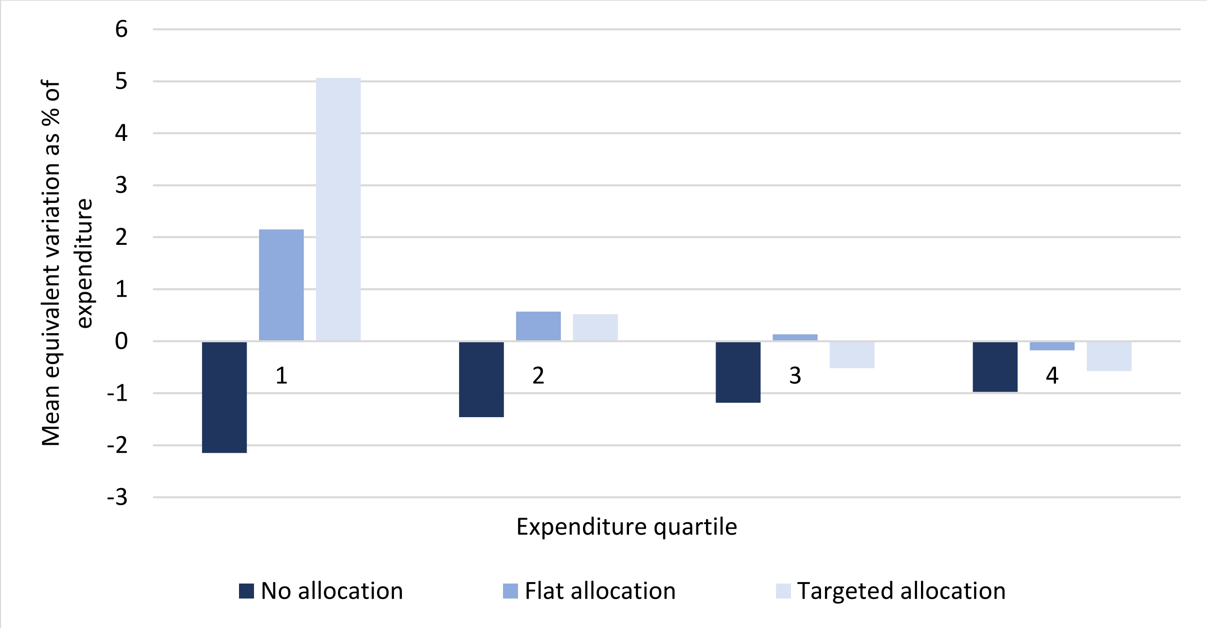
Tax	Inequality %	Expenditure %	Emissions %
+€30	0.40	-0.46	-3.94
+€80	1.04	-1.14	-10.24

Source: Authors' own estimation.

5.2 Revenue recycling

We now consider the effects of recycling carbon tax revenue to households. Figure 5 shows how the cost of an additional €80 per tonne changes when the flat and targeted allocations described above are used. A flat allocation, while equal in monetary terms for each household, is larger in comparison to total expenditure for poorer households than for richer households. For this reason, the flat allocation compensates poorer households more than richer households as a proportion of expenditure. However, a more targeted measure benefits the poorest households far more than the flat measure. The targeted measure is therefore more progressive, which is appropriate given that higher income households emit higher levels of carbon.

FIGURE 5 DISTRIBUTIONAL EFFECTS OF DIFFERENT REVENUE RECYCLING MECHANISM



Source: Authors' own estimation.

Administrative costs are not included in this analysis, but it should be noted here that the administrative cost of the targeted scenario is likely to be lower than that of the flat allocation. This is due to the fact that the flat allocation would most likely have to be achieved by implementing a new mechanism in which a cash payment is delivered to each household, and there is currently no national register of households in the State. In contrast, the targeted mechanism proposal is along the lines of that proposed in Callan et al. (2009), in which the revenues are recycled through the existing tax and welfare system. It is unlikely that the targeted mechanism proposed here could be replicated with 100 per cent accuracy via the existing tax and social welfare mechanisms, but the general principle of a targeted mechanism being preferable to a flat allocation has been established.

In order to evaluate the general effects of the policies, Table 4 shows the effects of the tax increase and revenue recycling on inequality and expenditure. A flat allocation can reduce inequality and increase the average expenditure available for households. Recycling mechanisms can thus not only reverse the regressive effects of carbon taxation, but can actually reduce rather than increase income inequality. The targeted mechanism has even larger effects, potentially doubling the benefits obtained by the flat allocation mechanism.

The degree to which recycling mechanisms can reduce income inequality increases as carbon taxation increases. This is because higher carbon taxes yield higher revenues, and so if appropriate recycling mechanisms are chosen, the reductions in inequality are greater.

TABLE 4 CHANGES IN INEQUALITY, EXPENDITURE. DISTRIBUTIONAL EFFECTS OF TWO RE-ALLOCATION MECHANISMS

Flat allocation		
Carbon tax	Inequality %	Expenditure %
+€30	-0.46	0.16
+€80	-1.05	0.41
Targeted allocation		
Carbon tax	Inequality %	Expenditure %
+€30	-1.23	0.16
+€80	-2.78	0.41

Source: Authors' own estimation.

6. CONCLUSION

This work examined the impact of increased carbon taxation in Ireland, and quantified the impact of same on carbon emissions using Irish microlevel data for the first time. Our results find a 3.94 per cent reduction in carbon emissions if carbon taxes are increased by €30 per tonne, and an 10.24 per cent reduction in emissions if taxes are increased by €80 per tonne. The evidence suggests that carbon taxation is a valid and important part of climate policy.

Results from previous research, which find that carbon taxes are regressive, are repeated here. The impact on rural households is particularly evident. However, the fact that appropriate revenue recycling can reverse these regressive effects diminishes the validity of distributional issues as an argument against increasing carbon taxation. In fact, carbon taxation coupled with revenue recycling has the potential to be a useful tool for mitigating income inequality, independent of climate policy. In our scenario, the flat allocation mimics the carbon cheque, which has been proposed as a potential revenue recycling mechanism in Ireland. While this re-allocation mechanism can reduce inequality, our alternative scenario of the targeted mechanism can bring larger reductions in income inequality.

Our model does not estimate the overall macroeconomic cost of policy reforms because it is a partial equilibrium model. In the same line, our changes in CO_2 emissions are direct emissions and do not consider the overall changes in emissions. Further research is needed to have a macro and micro vison of the cost of the policy reform. Finally, it should be noted that our results simulate behavioural changes based on historical data, which are influenced by the climate, energy and other policies in place at the time the data were collected. Future climate and energy policies, independent of carbon taxation, have the potential to shift behaviour even further. For example, measures such as improved public transportation or congestion charging in city centres could reduce the level of carbon taxation at which commuters move away from private motorised transportation and towards public transport and/or walking or cycling. In other words, these policies would increase the price-responsiveness of commuters to carbon taxation, resulting in even greater emission reductions for a given level of carbon taxation. The interplay between carbon taxation and other climate and energy policies should therefore be taken into consideration by policymakers.

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