



ANALYSIS

What Factors Drive Inequalities in Carbon Tax Incidence? Decomposing Socioeconomic Inequalities in Carbon Tax Incidence in Ireland

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ABSTRACT

Carbon taxes increase the cost of necessary household energy expenditures. In many developed countries, carbon taxes are regressive as they comprise a greater proportion of a poorer household's income. Certain socioeconomic groups are more negatively affected by these impacts than others. While inequality of incidence by income group has received great attention in the literature, a gap exists to quantify the inequality associated with socioeconomic characteristics. This information is policy-relevant as it may inform the most effective means to offset negative welfare impacts through changes to taxes and/or social transfers. This paper provides this contribution. First, the inequality of carbon tax incidence across the income spectrum is quantified using the concentration index methodology. A subsequent multivariate decomposition quantifies the contribution each socioeconomic factor makes towards this inequality of incidence. This is carried out for electricity, motor fuel and all other home fuels to elicit variation of socioeconomic incidence by source. While income contributes a great deal towards inequality of incidence for other home fuels, other socioeconomic characteristics are the primary determinants of electricity and motor fuel-related carbon tax incidence. The relative importance of each characteristic in determining regressive impacts is quantified and this varies by carbon tax source.

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1. Introduction

International environmental agreements have motivated binding national targets to reduce CO₂ emission (e.g. European Commission, 2009; Kyoto Protocol to the United Nations Framework Convention on Climate Change; UNFCCC, 2015). Around 40 countries and more than 20 cities, states and provinces have either implemented or are planning to implement a carbon tax or similar carbon pricing scheme (Farrell and Lyons, 2016; World Bank, 2014a; World Bank, 2014b). In many developed economies, a carbon tax has been found to be regressive, having a proportionally greater impact on the incomes of poorer households than richer households (Callan et al., 2009; Farrell and Lyons, 2016). Understanding the distribution of incidence has been the subject of much analysis to date (e.g. O'Donoghue, 1997; Kerkhof et al., 2008; Callan et al., 2009; Rausch et al., 2011).

Within the carbon tax literature, revenue 'recycling' via the tax-benefit system is commonly suggested as a means to offset regressive impacts. Generally, redistribution is considered in the context of achieving a progressive distribution of incidence, measured according to changes in burden for aggregated income groups (e.g. O'Donoghue, 1997; Kerkhof et al., 2008; Callan et al., 2009; Rausch et al., 2011). While the distribution is progressive in aggregate, low income households that benefit from the redistribution policy are not necessarily those households that lose out due to the imposition of the carbon tax. Indeed, it is the progressive distribution of the total tax-benefit system that is of greatest importance, as 'losers' may be compensated elsewhere in the tax-benefit system (Mirrlees and Adam, 2011). However, as carbon taxes grow through time (Tol, 2013; van den Bergh and Botzen, 2015), potentially replacing more traditional forms of taxation, these regressive impacts may grow in magnitude. Offsetting the regressive impacts specific to carbon taxation will therefore be of increasing importance going forward. This paper provides the evidence base to inform any policy amendments required to ensure a progressive tax-benefit policy, post-carbon tax incidence. This is carried out by decomposing measures of inequality of carbon tax incidence by socioeconomic determinant, identifying the cohorts affected by regressive impacts and thus informing

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revenue redistribution policy. Measures of income inequality are a quantifiable indicator of pro-rich or pro-poor distributive burden, giving insight into whether the burden of carbon tax falls disproportionately on poor households.

This paper addresses a methodological gap offered by commonly employed techniques. Microsimulation-type analyses show the distribution of burden by income group or between socioeconomic cohorts (e.g. comparing the burden imposed on urban vs. rural dwellers or large vs. small households). This identifies the distributional outcome, but does not give insight into the factors driving this result. It is therefore difficult to compare the influence each factor plays in the overall regressive impact. While traditional regression-based analyses (e.g. Büchs and Schnepf, 2013) can isolate the expected influence that each socioeconomic factor plays in carbon consumption, the regressivity of this relationship is not accounted for. One must combine information on the propensity to consume carbon with the gradient of this consumption across the income distribution to elicit this information. This paper provides this contribution by carrying out a multivariate decomposition of the concentration index, a method commonly employed to decompose socioeconomic inequalities in health outcomes (Walsh and Cullinan, 2015; van Doorslaer et al., 2004; Yiengprugsawan et al., 2009; Wagstaff et al., 2001).

This analysis of this paper is applied to an Irish case study and the results are threefold. First, this paper has quantified the incidence of carbon tax expenditure. For the considered Irish case study, electricity and 'other'¹ fuel-related carbon taxes have the greatest pro-poor distribution of incidence. In terms of magnitude, less wealthy households spend a greater proportion of their income on 'other' fuel and motor fuel-related carbon taxes. Second, the determinants of carbon tax expenditure are identified. Location, occupation and household structure are important for motor fuel-related carbon tax expenditure. Education, location, household structure and home heating method influence 'other' fuel-related carbon tax expenditure, while dwelling type, household structure and appliance ownership are important determinants of electricity-related carbon tax expenditure.

Third, the extent to which each socioeconomic determinant affects inequality has been quantified for each carbon source. Most notably, income is associated with a large proportion of 'other' fuel-related inequality in Ireland, however, it is found to be of lesser importance for electricity or motor fuel-related carbon tax incidence. For motor fuels, location and occupation are important determinants. In particular, farmers and own account workers are associated with regressive effects. Household size, structure and appliance ownership is important for electricity-related carbon tax incidence. While a greater number of inhabitants increases the household's carbon tax cost, this impact is only regressive in relation to the number of children present. This is especially true for electricity-related carbon tax incidence.

Potential channels that may offset negative distributional effects have also been identified in this paper. When considering methods to counteract the regressivity associated with electricity-related carbon taxes, adjusting housing-related taxes and transfers may be effective. Income dominates regressivity associated with 'other' fuels and income-based redistribution measures such as cash transfers or incentives to support less carbon-intensive heating technologies or energy efficiency upgrades may be most appropriate.

In providing these contributions, this paper proceeds as follows. Section 2 reviews the previous literature in the field of carbon taxation, concentration indices and decomposition analysis, highlighting the gap addressed by this paper. Section 3 outlines the data

and methodology employed. Section 4 presents the results. First, the regressive impact of each carbon tax is explicitly quantified using the concentration and Kakwani indices. Next, regression analyses are presented to identify the determinants of carbon tax consumption. Following the methodology of Wagstaff et al. (2003), the total regressive impact is decomposed according to constituent socioeconomic drivers. Presenting the results in this fashion allows for more complete insight into how carbon taxes affect the income distribution, while emphasising the benefit of adopting the decomposed concentration index methodology. Section 5 offers insight into the important policy implications of these findings. Section 6 offers some concluding comments.

2. Literature Review

Callan et al. (2009) have comprehensively reviewed the literature analysing the distribution of carbon tax incidence amongst households. Microsimulation-based methods are most-often used to analyse the incidence of cost relative to income. Most analyses to date focus on changes in income as a result of direct emission of CO₂ (Poterba, 1991; Safirova et al., 2004; Pearson and Smith, 1991; O'Donoghue, 1997; Scott and Ekins, 2004; Callan et al., 2009). Tax-benefit microsimulation models have been used to consider the distributional impact relative to the full tax and benefit system (Callan et al., 2009; O'Donoghue, 1997). Advances in this field have generally focussed on incorporating further sources of emission or incorporating a behavioural response to price changes. Indirect consumption of CO₂ embedded in goods and services has been incorporated through integration with an input-output or CGE model (Beck et al., 2015; Cornwell and Creedy, 1996; Ekins et al., 2011; Hamilton and Cameron, 1994; Labandeira and Labeaga, 1999; Lyons et al., 2012; Verde and Tol, 2009; Wier et al., 2005). Kerkhof et al. (2008) analyse the distributional effects of taxing multiple greenhouse gases. They find that the tax is less regressive and more cost-effective than taxing carbon alone. Analyses by Brannlund and Nordstrom (2004), Labandeira and Labeaga (1999) and Tiezzi (2001) include a system of demand equations to incorporate demand response to carbon tax-induced price changes, with these studies also finding regressive impacts.

Despite the wide range of methodological developments, the literature to date has not decomposed regressive impacts by socioeconomic determinant. A number of methods have been applied to approximate these impacts. Büchs and Schnepf (2013) use a regression-based analysis to elicit the determinants of carbon tax emission. Comparing the socioeconomic determinants of carbon emission with the determinants of income gave qualitative insight into distributional impacts. However, quantification of distributional effect and ranking of importance is not facilitated by this analysis. This is important information to effectively offset negative income effects through social transfer design.

Presenting incidence by income or socioeconomic cohort (Callan et al., 2009; Ekins et al., 2011; Grainger and Kolstad, 2010) gives intuitive insight into incidence amongst population groups. However, it is difficult to compare between-factor impacts in this manner, such as comparing the influence of education vs. social class in determining the regressivity of a carbon tax, as determinants are confounded in such analyses. Indeed, when such an analysis is extrapolated out over a number of determinants, easy comparison, quantification of effect and ranking of importance is difficult. Such information may be important when designing an effective suite of social transfer policies.

To address this deficiency, this paper quantifies the contribution each socioeconomic factor makes towards unequal carbon tax incidence using regression-based decomposition methods. Regression-based decomposition methods have been used by Fields (2003), Morduch and Sicular (2002) and Yun (2006) to quantify the

¹ The 'other' fuel category is comprised of fuels primarily used for home heating and cooking, except for electricity.

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