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Policy Forum: The Distribution of Costs of a Carbon Tax Among Canadian Households

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KEYWORDS: ENVIRONMENT ■ CARBON TAXES ■ INCIDENCE ■ HOUSEHOLDS ■ FAIRNESS ■ POLICY

CONTENTS

INTRODUCTION

The idea of a carbon tax enjoys broad support among economists because it can efficiently motivate households and firms to reduce emissions of the greenhouse gases (GHGs) that are responsible for climate change. However, despite the economic appeal of a carbon tax, the idea of such a policy has proved controversial in Canada (and other countries), in part because of concerns that a carbon tax might exacerbate patterns of income inequality among Canadian households. The logic behind this concern is the observation that low-income households spend a relatively large proportion of their income on fossil fuels, so that a tax that raised the price of these goods could be regressive. Study of the issue is important, for at least two

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reasons.[1] First, from a normative perspective, fairness in policy design is important, and is actively pursued by policy makers. For example, Department of Finance guidelines for the application of environmental policy in Canada highlight fairness as a key criterion in judging the merits of alternative policies.[2] Second, from a pragmatic perspective, a policy that has a disproportionately negative impact on a certain demographic or income group is less likely to be viable, since concentrated impacts can be a cornerstone around which opposition can be mobilized.[3]

This article evaluates the distributional incidence of a carbon tax applied in Canada. The analysis does not include a formal econometric or simulation model, but instead highlights the key issues that must be considered in determining the incidence of a carbon tax, using a simple static model and descriptive statistics to make some calculations of distributional burden. Because of the lack of a complex modelling framework, the results are best seen as "first-order" impacts, in that they do not take into account how firms and households might change their behaviour as prices change. Nonetheless, they are likely a useful guide to the short-run incidence of a carbon tax on Canadian households.

The findings suggest that the incidence of a carbon tax is affected by income-side as well as expenditure-side impacts, and that the choice of income measure is an important determinant of the fairness of a tax. Overall, a carbon tax appears regressive if households are sorted by annual income. Implementation of a tax of $30 per tonne of carbon dioxide (tCO_2) equivalent emissions tax[4] would reduce the net income of the lowest-income households by 2.2 percent, while leaving the net income of the highest-income households virtually unchanged. However, the same tax appears progressive if households are sorted by annual expenditure (which may serve as a closer proxy for lifetime income). The analysis also suggests that existing indexing of transfer payments would help to reduce the regressive impact of a carbon tax, and that the policy could be made progressive by using a portion of the revenue that would be raised from the carbon tax to offset distributional impacts. Similar conclusions in a Canadian context have been reached in earlier studies using somewhat different methods.[5]

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1 Gbadebo Oladosu and Adam Rose, "Income Distribution Impacts of Climate Change Mitigation Policy in the Susquehanna River Basin Economy" (2007) 29:3 *Energy Economics* 520-44.

2 Canada, Department of Finance, 2005 Budget, Budget Plan, February 23, 2005, at annex 4.

3 Mancur Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups* (Cambridge, MA: Harvard University Press, 1965).

4 Carbon taxes can be levied on CO_2 emissions or total GHG emissions from combustion, measured in CO_2 equivalents. The difference between the two measures is small, and in this article I will refer to tonnes of CO_2, even though the analysis would apply equally if the base for the tax were total combustion GHG emissions.

5 Kirk Hamilton and Grant Cameron, "Simulating the Distributional Effects of a Canadian Carbon Tax" (1994) 20:4 *Canadian Public Policy* 385-99; and Abdelkrim Araar, Yazid Dissou, and Jean-Yves Duclos, "Household Incidence of Pollution Control Policies: A Robust Welfare Analysis Using General Equilibrium Effects" (2011) 61:2 *Journal of Environmental Economics and Management* 227-43.

The rest of the article is organized as follows. First, I describe the likely price impacts of a carbon tax on both fossil fuels and other commodities. Next, I explore how these price impacts are likely to affect households at different points in the income distribution, on the basis of their different expenditure patterns. I then explain how a carbon tax might affect not only prices of consumer goods but also household income, and show how household income might be affected at different points in the income distribution. Finally, I consider the policy implications of the results and present some brief concluding comments.

PRICE IMPACTS OF A CARBON TAX

Direct Price Increase

By design, a carbon tax increases the price of goods with embodied carbon emissions. For fossil fuels, the magnitude of the price increase is readily determined on the basis of the carbon content of fuels. Table 1 shows the impact of a $30/tCO_2$ tax, which is the upper end of the price of allowances in the European Union's emission trading scheme during the past several years, and is equal to British Columbia's carbon tax as of July 2012. It is also close to the federal government's recent estimate of the social cost of carbon (the damage from an additional tonne of CO_2 emitted to the atmosphere).[6] The price impact varies substantially depending on the type of fuel, as shown in table 1. For example, a $30/tCO_2$ tax is equivalent to a 5.8 percent tax on the consumer price of gasoline, a 7.0 percent tax on diesel, a 17.7 percent tax on natural gas, and a 108 percent tax on coal, assuming reference prices given in the table.[7] In the discussion that follows, I show how this tax might affect households at different levels of income.

There are two elements that complicate the analysis, however. First, the carbon tax might be transmitted to the consumer price of other, non-fuel products. Second, as with other tax changes, the tax may or may not be fully passed on to final consumers. I address each of these considerations before turning to the question of the distributional consequences of price changes attributable to the carbon tax.

6 For example, the central estimate for the social cost of carbon in recent federal regulatory impact analysis statements (that is, cost-benefit analyses) for renewable fuel standards, light-duty vehicle regulations, and coal-fired power plants is between $25 and $30/tCO_2$. See the regulatory impact analysis statement accompanying "Renewable Fuel Regulations" (2010) 144:18 *Canada Gazette Part II* 1673-1739; "Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations" (2011) 145:35 *Canada Gazette Part I* 2779-2842; and "Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations" (2010) 144:21 *Canada Gazette Part II* 1871-1915.

7 Price increases are linear in the carbon price, so a doubling of the carbon price from $30 to $60/tCO_2$ would result in a doubling of the price increase, from 5.8 to 11.6 percent for gasoline, for instance.

TABLE 1 Direct Impacts of a Carbon Tax

	Composite greenhouse gas content (tCO_2/TJ)	Energy content	Unit tax at \$30/tCO_2 (\$)	Baseline commodity price (\$)	Equivalent ad valorem tax on commodity (%)	Baseline delivered price[a] (%)	Equivalent ad valorem tax on delivered good (%)
Motor gasoline.	70.68	35.0 MJ/L	0.074/L	0.65/L	11.4	1.29/L	5.8
Diesel fuel	73.80	38.3 MJ/L	0.085/L	0.65/L	13.0	1.22/L	7.0
Natural gas.	59.95	38.0 MJ/m^3	0.068/m^3	0.132/m^3	51.9	0.39/m^3	17.7
Coal	90.00	na	2.70/GJ	2.50/GJ	108.0	2.50/GJ	108.0

tCO_2 = tonnes of carbon dioxide
TJ = terajoule
MJ/L = megajoules per litre
MJ/m^3 = megajoules per cubic metre
GJ = gigajoule

[a] Delivered price includes tax, storage, transport, and distribution margins. In cases where these are fixed charges (natural gas), the calculation reflects an average cost for delivered energy.

Sources: Natural Resources Canada, Analysis and Modelling Division, *Canada's Energy Outlook: The Reference Case 2006* (Ottawa: Natural Resources Canada, 2006); MJ Ervin fuel prices from www.kentmarketingservices.com/dnn/PetroleumPriceData.aspx; natural gas prices from the National Energy Board at www.neb-one.gc.ca/clf-nsi/rnrgynfmtn/prcng/cndnnrgprcngtrndfct2011/cndn.nrgprcngtrndfct-eng.html, figures 6 and 7; coal prices from the US Energy Information Administration at www.eia.gov/forecasts/aeo/.

Transmission of Carbon Tax to Other Commodities

Although the direct impact of a carbon tax on fuel prices is the most clearly observable consequence of such a policy, a carbon tax is also likely to affect the price of other goods consumed by households. Most obviously, about one-quarter of total electricity in Canada is produced from fossil fuels, primarily coal and natural gas; most of the remainder is produced from hydro and nuclear power. As the price of these fossil fuels increases as a result of the carbon tax, household electricity prices will also increase. A similar mechanism will result in price changes for other goods consumed by households. For example, to the extent that food production uses fossil fuel inputs (for agricultural production, for transporting food from producers to distributors and retail outlets, and for storage), increases in the price of these inputs will increase the end price of food products. Moreover, there can be second-order (and higher-order) impacts of the price change. For example, since steel production uses electricity as an input, the cost of producing steel will rise as a function of increases in the cost of electricity attributable to the carbon tax; industries that use steel as an input will therefore also experience increased prices.

Figure 1 shows the results of a series of calculations that project the transmission of increased fossil fuel prices, as shown in table 1, to other commodities.[8] Although the greatest increases to consumer prices are likely for goods with significant fossil fuel content (gasoline, natural gas, and electricity), the carbon tax is likely to show up in the price of other goods as well. For example, the calculations suggest that a \$30/tCO_2 tax would increase the price of food and non-alcoholic beverages by 1.2 percent. Later in the article, I use the results of these calculations to estimate changes in overall household expenditures.

Economic Incidence Versus Statutory Incidence

Depending on relative flexibility in producer supply and consumer demand, a tax may be partially or fully passed on to consumers or borne entirely by the firm.[9] Specifically, when consumer demand is inelastic relative to producer supply, firms will be able to pass the tax on to consumers, whereas when consumer demand is elastic relative to producer supply, firms will absorb the price increase, and the consumer price will remain relatively unchanged. In the case of the carbon tax considered here, full

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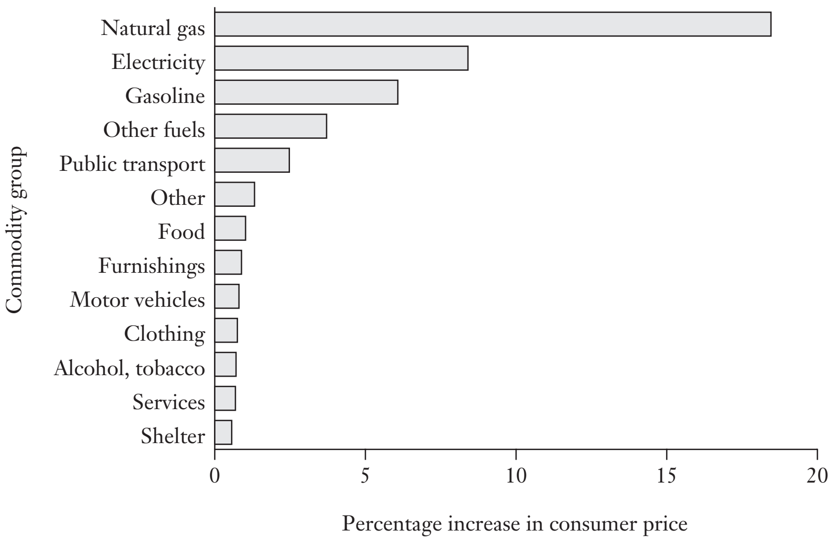
8 A description of the methods used in these calculations is available from the author upon request, or from www.sites.google.com/site/nicholasjrivers/home/research. The model assumes no substitution by firms as relative prices change, such that the results likely overstate the price increase attributable to the carbon tax; therefore, the projected price increases are best viewed as a short-run effect of the tax. Similar calculations have been used in the United States: Terry Dinan and Diane Lim Rogers, "Distributional Effects of Carbon Allowance Trading: How Government Decisions Determine Winners and Losers" (2002) 55:2 *National Tax Journal* 199-222.

9 Under conditions of imperfect competition, a tax can be "overshifted" to consumers, such that a 1 percent tax implies a larger than 1 percent increase in the consumer price.

FIGURE 1 Projected Changes in Consumer Prices in Response to a Carbon Tax, by Commodity Group



Note: Assuming a tax of $30 per tonne of carbon dioxide equivalent emissions.
Source: Author's calculations (available from the author upon request).

passthrough would result in an increase in consumer fuel prices associated with a $30/t$CO_2$ price as calculated in table 1, while less than full cost passthrough would imply a lower price increase. In the case of incomplete passthrough, the tax would be borne partly by investors in the firm and partly by employees of the firm (as well as partly by consumers of the firm's products).

Limited empirical evidence exists on passthrough of energy taxes. In the United States, Choinard and Perloff[10] find that state gasoline excise taxes are borne almost entirely by the consumer, but that federal gasoline excise taxes are borne by the consumer and the wholesaler in roughly equal proportions. (The authors' empirical conclusions match their theoretical model, which suggests that gasoline supply is more elastic at the state level than at the federal level, since taxes imposed by US states can reasonably be taken to have no effect on world oil prices, while the same assumption cannot be made for the United States as a whole.) These findings on the incidence of state gasoline taxes are echoed by other researchers,[11] but Marion and

10 Hayley Choinard and Jeffrey M. Perloff, "Incidence of State and Federal Gasoline Taxes" (2004) 83:1 *Economics Letters* 55-60.

11 James Alm, Edward Sennoga, and Mark Skidmore, "Perfect Competition, Urbanization, and Tax Incidence in the Retail Gasoline Market" (2009) 47:1 *Economic Inquiry* 118-34; and Justin Marion and Eric Muehlegger, "Fuel Tax Incidence and Supply Conditions" (2011) 95:9-10 *Journal of Public Economics* 1202-12.

Muehlegger[12] also report findings suggesting nearly full passthrough of federal gasoline and diesel taxes. There is no empirical evidence on the incidence of coal or natural gas taxes. (These commodities are generally not subject to excise taxes.)

Simulation models also contribute some evidence on passthrough of carbon prices. For example, Bovenberg and Goulder[13] and Metcalf et al.[14] find that around 90 percent of a coal tax is passed through to consumers, with the remainder being borne by suppliers. Using a similar model, Rausch et al.[15] also find that 90 percent of a coal tax, but only about 75 percent of a natural gas tax, is passed through to final consumers. (The authors' model also suggests a passthrough of about 80 percent for a federal gasoline tax.)

Thus, although the evidence is incomplete, it appears that federal fuel taxes are incompletely passed on to final consumers, such that the increase in retail fuel prices is likely to be somewhat (though not substantially) less than that calculated in table 1. In the calculations below, I assume full passthrough of the tax to consumers, but also test the implications of a 90 percent passthrough rate, consistent with the limited evidence above.

Having estimated the price increases attributable to the assumed carbon tax, I now turn to the question of how these price impacts might affect the well-being of Canadians throughout the population. I begin by discussing price impacts on the expenditure (uses) side, and then move to discussing impacts on the income (sources) side.

DISTRIBUTIONAL IMPACTS ON THE EXPENDITURE SIDE

Figure 2 uses Statistics Canada data collected in the annual Survey of Household Spending to document household expenditure on energy goods as a percentage of annual income according to income vigntile.[16] The figure indicates that there is some variability in spending profiles across the income distribution. The households in the lowest income vigntile spend on average slightly more than 20 percent of their annual

12 Marion and Muehlegger, supra note 11.

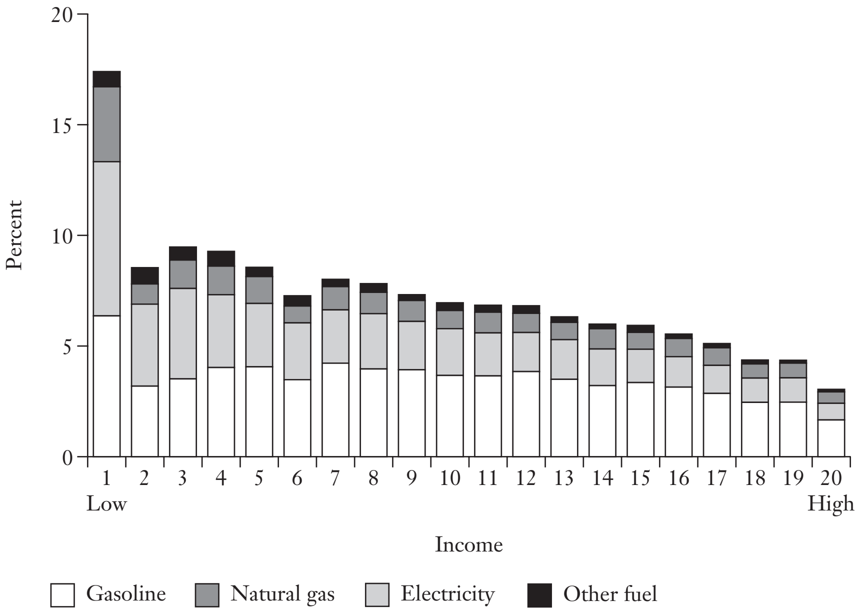
13 A. Lans Bovenberg and Lawrence H. Goulder, "Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does It Cost?" in Carlo Carraro and Gilbert E. Metcalf, eds., *Distributional and Behavioral Impacts of Environmental Policy* (Chicago: University of Chicago Press, 2001), 45-89.

14 Gilbert E. Metcalf, Sergey Paltsev, John M. Reilly, Henry D. Jacoby, and Jennifer Holak, *Analysis of a Carbon Tax To Reduce U.S. Greenhouse Gas Emissions*, MIT Joint Program on the Science and Policy of Global Change Report no. 160 (Cambridge, MA: MIT Press, April 2008).

15 Sebastian Rausch, Gilbert E. Metcalf, John M. Reilly, and Sergey Paltsev, *Distributional Impacts of a U.S. Greenhouse Gas Policy: A General Equilibrium Analysis of Carbon Pricing*, MIT Joint Program on the Science and Policy of Global Change Report no. 182 (Cambridge, MA: MIT Press, November 2009).

16 The microdata files used in the analysis were top-coded to protect respondent confidentiality, so results for the top income quintile likely underestimate total income.

FIGURE 2 Annual Household Expenditure on Energy as a Percentage of Income, by Income Vigntile



Source: Statistics Canada, *Survey of Household Spending 2009* (Ottawa: Statistics Canada, 2010).

income on energy goods, with the bulk of this being spent on electricity and gasoline. Household expenditure on energy goods declines almost monotonously with rising income, such that at the highest income vigntile, households spend only about 2.5 percent of their annual income on energy. This pattern suggests that a carbon tax is likely to be regressive, and exacerbate existing income inequalities. It is this pattern that is highlighted as a concern by advocates for low-income individuals.[17]

However, there is some risk in determining the distributional incidence of price changes by looking at expenditures as a percentage of annual income. Because the incomes of individuals usually vary widely at different stages of their lives, annual income may not be a good proxy for lifetime income. For instance, a wealthy retiree drawing down earnings on invested savings may have a low annual income, and thus fall into the same income vigntile as a medical student who borrows to pay for medical school. However, for both of these individuals, lifetime income will presumably be much higher, so determining incidence on the basis of annual income can be misleading. Several authors have noted that annual expenditure more closely reflects

17 Marc Lee and Toby Sanger, *Is BC's Carbon Tax Fair? An Impact Analysis for Different Income Levels* (Vancouver: Canadian Centre for Policy Alternatives, BC Office, October 2008).

lifetime income than annual income (because individuals borrow and save to smooth consumption over their lifetimes).[18] If we are concerned about the lifetime incidence of the tax change, looking at expenditures on fossil fuels as a percentage of annual expenditure rather than annual income may be more appropriate.

Figure 3 shows energy expenditures as a percentage of total annual expenditure. This figure suggests that increases in energy prices would be much less regressive than suggested in figure 2. The pattern of steady decline in figure 2 is seen to be mostly due, not to differences in the share of energy goods in total expenditures, but to the ratio of household expenditure to income: high-income households have incomes that exceed expenditures (that is, they are savers), while the reverse is true for low-income households (that is, they are borrowers). In figure 3, the expenditure share on energy follows an inverted U distribution, with middle-income households spending the greatest share of their budget on energy (around 7 percent) and with low- and high-expenditure households spending a smaller percentage. If annual expenditures are a good proxy for lifetime income, then there seems to be less cause for concern that increases in energy prices will prove regressive.

By multiplying the changes in the prices of energy and other consumer goods that result from a carbon tax (figure 1) by household expenditure shares on energy and other goods (figure 2), I determine to a first-order approximation the changes in expenditure by households attributable to the carbon tax. (I refer to this as a first-order approximation because I assume that quantities demanded do not change as a result of price changes.) The results are presented in figure 4. Using annual income as the denominator, a carbon tax appears regressive on the expenditure side, imposing an additional cost of slightly more than 3 percent of annual income on the lowest-income households, compared with only 0.6 percent for the highest. As above, the pattern is almost perfectly consistent, such that as income rises, the cost impact declines.

DISTRIBUTIONAL IMPACTS ON THE INCOME SIDE

In addition to the differences in household expenditures documented above, households at different points in the income distribution derive income from different sources. Figure 5 shows that in the lower 40 percent of the income distribution in Canada, transfers from government make up about half of total income. In contrast, in the upper portion of the income distribution, transfer payments make up only a very small portion of total income. The wealthiest households derive most income from earnings, but also derive a relatively large share (compared with the population as a whole) from investments. Private pensions make up a sizable portion of income for households in the middle of the income distribution.

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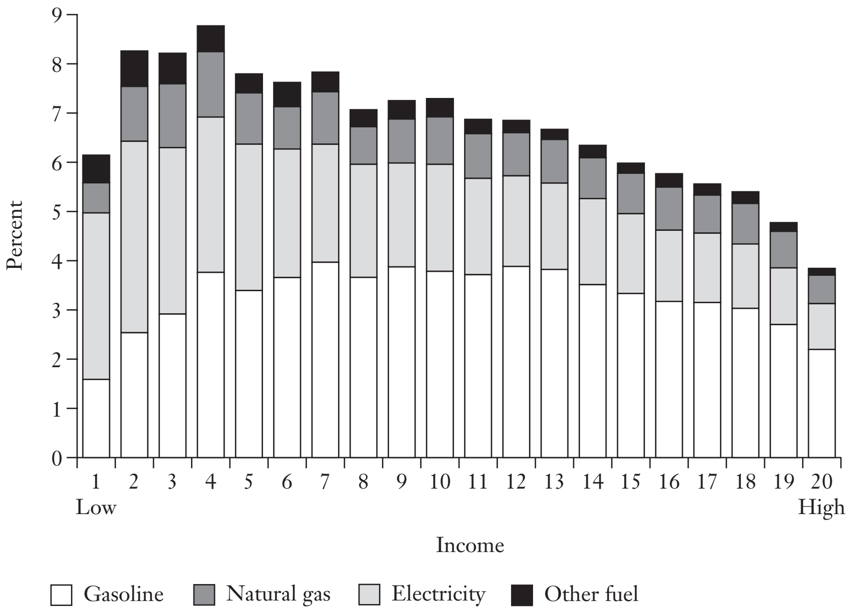
18 See, for example, James M. Poterba, "Lifetime Incidence and the Distributional Burden of Excise Taxes" (1989) 79:2 *American Economic Review* 325-30.

FIGURE 3 Annual Household Expenditure on Energy as a Percentage of Total Expenditure, by Income Vigntile



Source: Statistics Canada, *Survey of Household Spending 2009* (Ottawa: Statistics Canada, 2010).

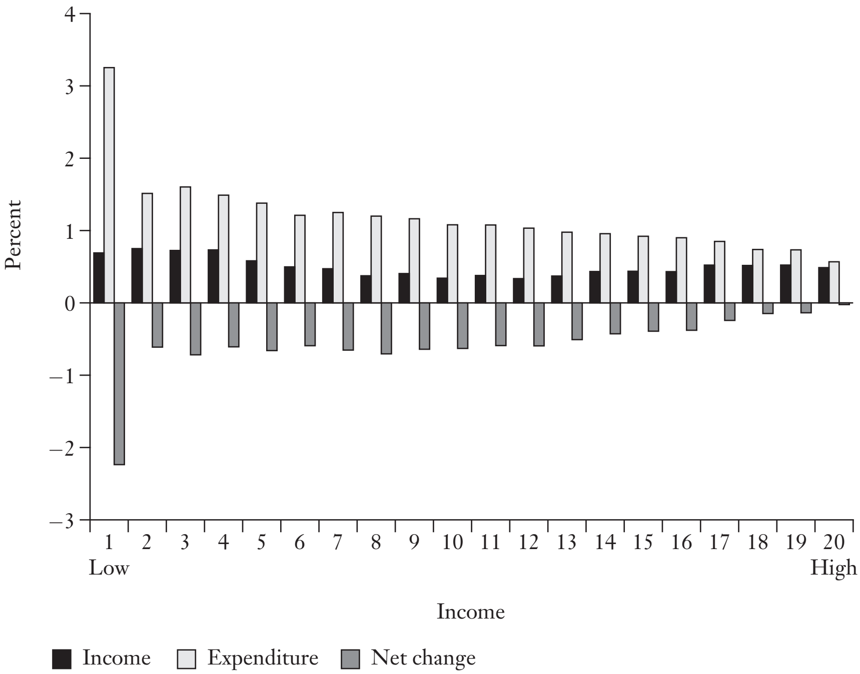
Because the sources of income differ systematically across the income distribution, if a carbon policy affects one source of income more than another, there is potential for carbon policies to have impacts through this channel, in addition to the expenditure channel described above. In the following sections, I describe the potential changes in transfer, wage, and investment income.

Indexing of Transfer Income

Indexing of government transfers can help to reduce the regressivity of increases in energy prices. When government transfers are indexed to changes in consumer prices, as reflected in the consumer price index (CPI), policy-driven increases in energy costs that increase the CPI will result in increased transfer payments. Although this can help to mitigate impacts of higher energy prices on low-income households, it is unlikely to exactly compensate, for several reasons.

First, although transfer payments make up a sizable portion of total income for low-income households, other sources of income that are not directly indexed to the CPI also contribute substantial amounts, as shown in figure 5. This implies that for households that derive around 50 percent of their income from transfer payments, the remaining 50 percent is not adjusted for changes in consumer prices.

FIGURE 4 Projected Changes in Household Income and Expenditures, and Net Change, as a Result of a Carbon Tax, by Income Vigntile

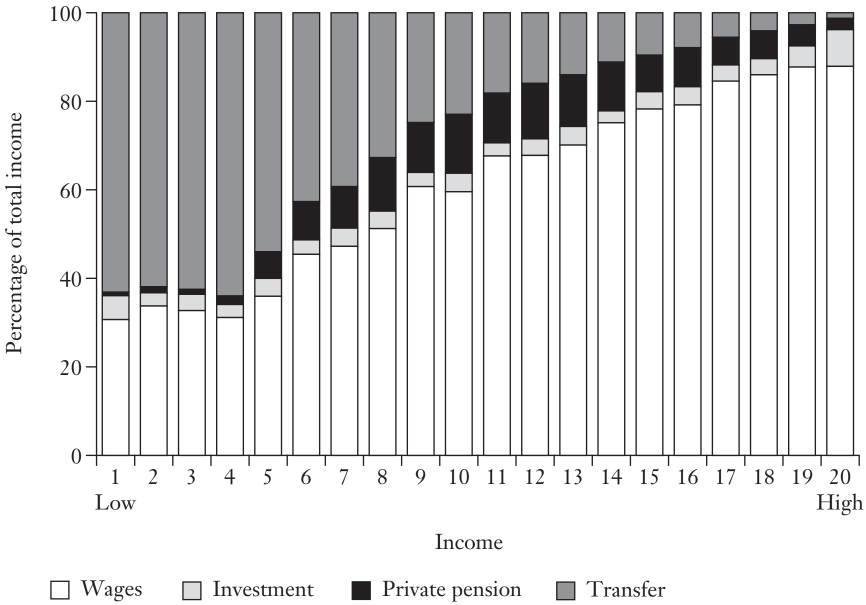


Note: Assuming a tax of $30 per tonne of carbon dioxide equivalent emissions.
Source: Author's calculations.

Second, the CPI is weighted according to average expenditure shares in Canada. To the extent that average expenditure shares do not reflect expenditure shares in the low-income population, indexing transfer payments using the CPI will not reflect actual changes in required expenditure resulting from the policy. Figure 3 shows that the lowest-income households allocate a smaller-than-average share of total expenditures to energy, such that, on average, indexing of government transfers resulting from energy price increases is likely to somewhat overcompensate these households. To illustrate, if the CPI weight for energy goods is 8 percent and a low-income household spends 6 percent of its budget on energy, a doubling of energy prices will lead to an 8 percent increase in the CPI, but only a 6 percent increase in the cost of living for that household.

Third, not all transfer payments are indexed. As table 2 shows, most government transfer income is indexed to changes in the CPI. For example, benefit payments through the Canada/Quebec Pension Plan and old age security programs, which together accounted for nearly half of all direct government transfers to individuals, are updated regularly (every year or quarter) to reflect changes in the CPI. As the table

FIGURE 5 Household Income by Source and Income Vigntile



Source: Statistics Canada, *Survey of Labour and Income Dynamics* (Ottawa: Statistics Canada, 2009).

shows, about two-thirds of total government transfers are directly tied to the CPI. The major transfer payment not directly tied to changes in the CPI is the employment insurance program, which makes up about 17 percent of total transfer payments.

These three factors taken together suggest that indexing government transfers to the CPI will help, but not totally insulate low-income households from policy-driven changes in the price of energy. Analysis by Fullerton et al.[19] confirms this result in the US context. In contrast, analysis by Rausch et al.[20] finds that indexing government transfers is sufficient to raise the consumption of the lowest-income groups when carbon-pricing policies are applied.

Return on Investments and Wages

The earlier discussion on the incidence of a carbon tax suggested that passthrough to consumer prices might be incomplete, such that a portion of the tax would be

19 Don Fullerton, Garth Heutel, and Gilbert E. Metcalf, "Does the Indexing of Government Transfers Make Carbon Pricing Progressive?" (2012) 94:2 *American Journal of Agricultural Economics* 347-53.

20 Sebastian Rausch, Gilbert E. Metcalf, John M. Reilly, and Sergy Paltsev, "Distributional Implications of Alternative U.S. Greenhouse Gas Control Measures" (2010) 10:2 *BE Journal of Economic Analysis & Policy*.

TABLE 2 Indexing of Government Transfers to Changes in the Consumer Price Index

	Percentage of total transfer	Indexed?
Child benefits (Canada child tax benefit, national child benefit supplement, children's special allowances)	8.7	Yes
Canada/Quebec Pension Plan	28.3	Yes
Guaranteed income supplement	5.9	Yes
Goods and services tax/harmonized sales tax credit	2.7	Yes
Provincial sales tax credit	1.7	Ad hoc by province
Social assistance	7.9	Ad hoc by province
Universal child care benefit	2.0	No
Employment insurance	17.3	No
Workers' compensation	4.9	Partly
Old age security	19.7	Yes
Other government transfers	0.9	na

Source: Author's calculations based on data from Statistics Canada, *Survey of Labour and Income Dynamics* (Ottawa: Statistics Canada, 2009).

shifted back and borne by the firm. When the tax is shifted back, rates of return for factors used by the firm will fall commensurately.

Harberger[21] developed an early model for considering the impact of a tax on returns to factors of production, and suggested that the relative impact on factor prices is determined both by the ability of a firm to substitute one factor of production for another and by the relative intensity of use of different factors by the firm. Recent calculations by Fullerton and Heutel[22] using a similar model to Harberger's show that because firms that produce carbon-intensive goods tend to be capital-intensive, backward-shifting of carbon taxes is likely to reduce the rate of return on capital relative to labour. (Fullerton and Heutel find that the relative ease of substituting capital and labour for carbon plays a small role in determining the incidence of a carbon tax.) Their calculations suggest that in the US context, the return on capital is likely to fall by about 1 percent,[23] while the wage rate is likely to increase by about 0.75 percent (compared with a "clean good" with no embodied carbon). Repeating their calculations for Canada suggests a similar outcome.

Because of the different profile of wage and investment income in different households, these changes in rates of return are likely to exert a heterogeneous effect on households. High-income households, for which most income is earned, are likely to benefit from the increased wage rate. Middle-income households, which obtain

21 Arnold C. Harberger, "The Incidence of the Corporation Income Tax" (1962) 70:3 *Journal of Political Economy* 215-40.

22 Don Fullerton and Garth Heutel, "Analytical General Equilibrium Effects of Energy Policy on Output and Factor Prices" (2010) 10:2 *BE Journal of Economic Analysis & Policy*.

23 Note that this is a percent, not a percentage point. Thus, if the original return on capital was 5 percent, a 1 percent change would imply a decrease to 4.95 percent.

a substantial share of income from pensions and investments, are likely to suffer somewhat as a result of a relative fall in the return on investment.[24] Low-income households will be less affected by trends in wage and rental income because they derive most of their income from transfers.

Overall Change in Income

As with calculations on the expenditure side, I multiply changes in rates of remuneration for various endowments by endowments, to come up with a profile of impacts on the income side. Changes in income resulting from changes in transfer payments as well as wage and investment income are shown in figure 4.

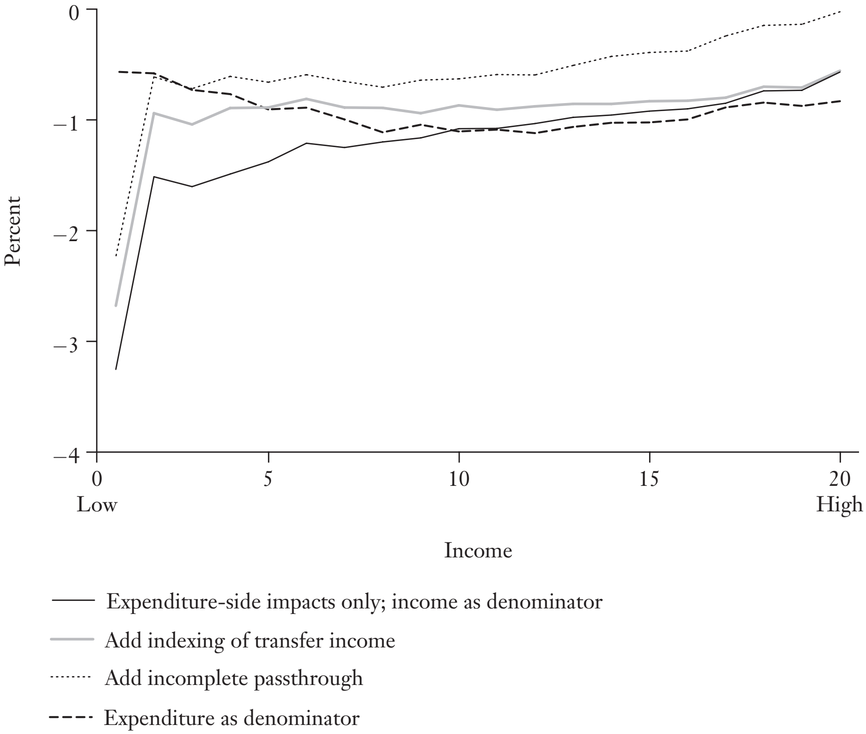
According to the calculations, household income for low-income households would increase by about 0.7 percent, primarily as a result of increases in transfer payments to reflect an increase in the CPI. This increase is larger than for households in the middle of the income distribution, which see incomes increase by around 0.3 percent. High-income households are projected to have incomes increase by 0.5 percent, such that the income-side impacts of the carbon tax favour low-income households.

Figure 4 also shows the net change in household incomes, given as the percentage change in income minus the percentage change in expenditure, and using annual income as the denominator. Negative values indicate a reduction in net household income. As shown in the figure, based on the calculations described above, net household income is projected to fall by the largest amount—roughly 2.2 percent—for the lowest-income group. Changes in net income for other households are much smaller. Although the pattern is not perfectly consistent between the lowest- and highest-income groups, the findings suggest that carbon taxation—absent any other measures—is likely to be regressive (when households are classified according to income, rather than annual expenditure).

Figure 6 repeats the above calculations for different assumptions about passthrough, indexing of transfers, and the use of annual expenditure as a proxy for lifetime income. When only expenditure-side impacts are considered and annual income is used as the denominator, the carbon tax appears quite regressive: the lowest-income households experience a loss of 3 percent of annual income, compared with a loss of just 0.6 percent for the highest-income households. When indexing of government transfers or incomplete passthrough of the tax is assumed, the regressivity of the tax is reduced by not eliminated completely. However, using annual expenditure rather than annual income as a proxy for lifetime income has a major impact on the calculations. In this case, the carbon tax appears progressive: the impact is equivalent to about 0.5 percent of annual income for the lowest-income households, compared with about 1 percent for middle-income and high-income households.

24 I assume that changes in the rate of return on investment are passed on to private pension holders.

FIGURE 6 Projected Change in Net Household Income Under Varying Assumptions, by Income Vigntile



Note: Assuming a tax of $30 per tonne of carbon dioxide equivalent emissions.
Source: Author's calculations.

REVENUE RECYCLING AND POLICY IMPLICATIONS

The preceding analysis has considered the incidence of a carbon tax, and has concluded that the results of a simple analysis that considers only the expenditure-side impacts of the tax and uses annual income as a proxy for lifetime income can be reversed when income-side impacts are included and when annual expenditure is used as a proxy for lifetime income. However, the analysis so far is incomplete, since it has not considered the use of revenue generated from carbon taxation. Total combustion-related GHG emissions in Canada are about 600 million tonnes of CO_2 equivalent,[25]

25 Environment Canada, *National Inventory Report 1990-2008: Greenhouse Gas Sources and Sinks in Canada* (Ottawa: Environment Canada, 2010).

so the \$30/tCO_2 tax considered here would raise approximately \$18 billion per year.[26] A portion of this revenue could be used to offset any regressive impacts of the carbon tax on the lowest-income households. This could be accomplished through lump-sum cash transfers, such as existing goods and services tax credits (which are designed for a similar purpose).

It is straightforward to calculate the amount of revenue that would be required to make the carbon tax policy revenue-neutral to low-income households, using information from figure 4. For example, to ensure that no household in the lowest income vigntile experienced a net reduction in income as a result of the carbon tax would require \$48 million per year, or 0.27 percent of the revenue raised by the tax. (These calculations use annual income as the denominator, but also consider indexing of transfer income and incomplete passthrough.) To ensure that no household with an income below \$36,000 experienced a net decline in income as a result of the carbon tax would require \$1.7 billion per year in transfers, or 9.4 percent of the revenue raised from the tax. Similarly, to fully protect households with incomes below \$54,000 would require about 23 percent of the revenue raised from the tax. Clearly, by ensuring that targeted income transfers accompany a carbon tax, it is possible to implement such a policy without an adverse effect on the income distribution. These calculations suggest that doing so would require only a small portion of the total revenue from the tax, leaving a substantial amount available for other purposes.

This type of transfer often accompanies tax-based policies aimed at reducing carbon emissions. For example, a low-income climate action tax credit accompanied the introduction of British Columbia's carbon tax for families defined as low income.[27] Similarly, the "Green Shift" proposed by the Liberal Party during the 2008 federal election included a carbon tax accompanied by measures designed to address possible distributional impacts of the policy. Among those measures were a boost to the guaranteed income supplement, a new guaranteed family supplement, and a low-income family child benefit supplement, together valued at over \$1.5 billion per year. Similar support has been included in proposed US climate change policies. For example, the Waxman-Markey bill of 2009,[28] would have allocated 15 percent

26 Given that there is likely to be a behavioural response to carbon taxation, the actual revenue raised will be somewhat lower than this amount; model-based assessments suggest that a carbon tax of this magnitude would reduce emissions by 10 to 20 percent (Christa Clapp, Katia Karousakis, Barbara Buchner, and Jean Chateau, *National and Sectoral GHG Mitigation Potential: A Comparison Across Models* (Paris: Organisation for Economic Co-operation and Development and International Energy Agency, 2009)), so the revenue figure is overstated by this amount. As with the rest of the analysis in this article, however, I focus on short-run response, where I assume no change in consumer or firm behaviour resulting from an increase in price.

27 The tax credit of \$100 per adult and \$31.50 per child applied to families earning less than \$35,843 in 2010.

28 HR 2454, American Clean Energy and Security Act of 2009, 111th Cong., 1st sess. (2009). The bill was passed by the US Congress but not by the Senate.

of all allowances in the cap-and-trade scheme to low-income households, to mitigate negative impacts on this vulnerable population.

CONCLUSIONS

Analysis of the impact of carbon taxes on fairness that focuses on the percentage of consumer income spent on energy goods typically concludes that such a tax would substantially increase inequality. This conclusion should be qualified, for a number of reasons. First, passthrough of a carbon tax would likely be incomplete, such that part of the tax burden would be experienced by factors of production employed by energy firms, not directly by consumers. Second, indexing of transfer payments could help to mitigate the impact of the tax on lower-income consumers. Third, measuring tax incidence by examining trends in annual expenditure may be more appropriate than measuring according to annual income. Incorporating these qualifications makes it more difficult to draw strong conclusions about the incidence of a carbon tax. Particularly if annual expenditures are used as a proxy for lifetime income, there seems to be little need for concern about the economic incidence of carbon taxes.

No matter how the economic incidence of a carbon tax is measured, the revenue from a carbon tax is much greater than would be necessary to fund a scheme of transfers to ensure no adverse impacts for low-income households. Such a scheme is simple to implement, and can alleviate most concerns about inequality associated with a carbon tax. In sum, concern over the unequal incidence of a carbon tax should not be a reason to avoid its implementation.