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PROVINCIAL CARBON PRICING AND HOUSEHOLD FAIRNESS

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EXECUTIVE SUMMARY

Well-designed carbon pricing policy must consider the costs imposed on households of different incomes, and ensure overall fairness. Recycling revenue generated from the policy back to the economy is the central way to design fair policy. This paper assesses the extent to which a carbon price—on its own, *without* considering revenue recycling—could be unfair for lower-income households. It then identifies the share of carbon revenue required to address these concerns.

A carbon price can affect household budgets in different ways. It increases the prices of emission-intensive goods and services, which represent a larger share of expenditure for lower-income households. A carbon price can also reduce household employment or investment income, which are more important income sources for higher-income households. Assessing the overall fairness of carbon pricing on households therefore requires looking at these two effects together.

Economic modelling for Alberta, Ontario, Manitoba, and Nova Scotia suggests that carbon pricing would impose small overall costs on households, and the impact could be slightly regressive or slightly progressive, depending on the income measure used to assess relative costs. In either case, our analysis finds that the costs imposed on lower-income households can be entirely offset by using a relatively small proportion of the revenues generated by carbon pricing policies.

In addition, analysis of the impact of carbon pricing on households residing in areas of different sizes for the four provinces suggests that carbon costs for households do not vary significantly across rural and urban areas.

Finally, the estimates presented in this report should be viewed as overestimates of the true costs for households. As discussed, they do not consider the benefits for households from recycling carbon pricing revenues back to the economy. They also exclude changes in household and firm behaviour in response to the carbon price, which will reduce the overall household cost.

Carbon pricing policies implemented in Canadian provinces should certainly be designed to be fair across households of different incomes. However, the analysis here suggests that concerns for household fairness need not preclude policy action, given that smart recycling of revenue can significantly improve the fairness of carbon pricing policy in all provinces.

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1. Introduction

Policies that attach a price to greenhouse gas (GHG) emissions can reduce those emissions in a cost-effective manner. A "carbon price" increases the relative prices of emissions-intensive goods and services, creating powerful economic incentives to shift consumption and production patterns toward lower-carbon alternatives. Different policy instruments, whether a carbon tax or a cap-and-trade system, can price carbon successfully (Canada's Ecofiscal Commission, 2015a).

A carbon pricing policy should not only be designed to reduce GHG emissions at the lowest possible economic cost, but should also be designed to be fair across households of different incomes. In particular, widespread political support for the policy likely requires that lower-income households not bear a higher share of the costs.

This report examines the impact of provincial carbon prices on household income and expenditures. In particular, it explores the extent to which lower-income households might be disproportionately affected by carbon costs. When considering the scale of the impact in each province, we examine several issues. To what extent will a broad carbon price increase the cost of household expenditures or reduce incomes? Will lower-income households feel a greater impact than higher-income ones? Are there notable differences across provinces and, if so, why? Are there important differences between the impacts on rural and urban households?

We focus on the analysis of carbon pricing in four provinces: Alberta, Manitoba, Ontario, and Nova Scotia. We examine these provinces to show the implications of different provincial energy mixes and different income distributions for carbon pricing and household fairness. Alberta is a resource-intensive province with a coal-based electricity system. Manitoba and Ontario both have low-carbon electricity systems. Nova Scotia is a small province with a coal-based electricity system. These provinces also vary considerably in terms of average income and, as such, provide a useful cross-section of provincial contexts within Canada.

For any province, the key to addressing the fairness of a carbon price is "revenue recycling"—using some fraction of the revenue generated by the policy to return to households. The approach we examine is analogous to current Canadian policy regarding the GST/HST: the federal government provides a refundable tax credit in the form of quarterly cash payments to lower-income individuals and families (CRA, 2015). British Columbia's carbon tax uses this approach to improve the fairness of its policy.

The main goal of this report is to determine the impact of a $30/tonne carbon price—before recycling any revenue—on households of different incomes. Once these impacts are known, we can then estimate the scale of revenue required to address potential fairness concerns, thus informing our broader analysis on revenue recycling (Canada's Ecofiscal Commission, 2016).[1]

We find that provincial carbon pricing imposes a slightly greater cost on lower-income households than higher-income ones—when the cost is measured as a fraction of household income. In other words, the carbon price is mildly *regressive* when the impact is measured in this way. In contrast, if the cost is measured as a share of household expenditure, carbon pricing is either proportional or mildly progressive, indicating that the cost of the policy is slightly larger for higher-income households. In either case, we find that the costs imposed on lower-income households can be entirely eliminated by using a relatively small fraction of the revenues generated by the carbon pricing policies to offset these costs.

1 Our main analysis on revenue recycling is contained in our latest report, *Choose Wisely: Options and Trade-offs in Recycling Carbon Pricing Revenue.*

The remainder of this report is structured as follows: Section 2 explores the various channels through which carbon pricing can affect households, defines what we mean by "fair" carbon pricing policy, and looks at how the relative importance of the various channels can affect the overall fairness of the policy. Section 3 uses a tax-modelling analysis to estimate the impacts of provincial carbon pricing on households of different income levels. It also explores how these impacts vary across the four provinces, as well as the different impacts on rural and urban households. Section 4 examines several additional factors not included in our analysis, but which nonetheless deserve consideration by governments designing carbon pricing policies. Finally, Section 5 examines the scale of carbon pricing revenue required to eliminate the costs imposed on lower-income households.

2. What Is "Fairness" in the Context of Carbon Pricing?

We begin by describing the various channels through which carbon pricing can affect a household's income or expenditures. Next, we deem as unfair a policy that is *regressive*, a term commonly used in discussions of tax policy but one that nonetheless needs to be defined clearly for our purposes. We then consider how different channels will tend to be more or less regressive for households. The next section uses economic modelling to determine the fairness of carbon pricing in specific provinces.

Carbon pricing affects households in different ways

A household is a convenient unit for examining the impact of policy. For the purposes of this report, a household is defined as a group of people living together in the same residence. In what follows, we will group households by their levels of income. For now, however, consider how all households are the same in one important respect: their budget is composed of 1) various possible sources of incomes, such as employment, investment, and transfers from government; and 2) several types of expenditures, such as fuels, electricity, housing, food, and clothing.

Figure 1 illustrates the different channels through which a provincial carbon price can affect households within and outside that province. There are three distinct channels, as discussed below.

"Direct carbon costs" increase fuel prices. First, a carbon price directly raises the prices of fuels consumed by households. We refer to these as the *direct carbon costs* of the policy, and they are based on the GHG emissions that households produce through the combustion of fuels for transportation and home heating, such as gasoline, diesel, and natural gas. The prices of these fuels will increase as a result of the carbon price, by an amount that depends on the carbon content of the specific fuel.[2] If all provincial carbon prices were equal, the effect on fuel prices would be the same for all households in all provinces. Direct carbon costs thus affect the expenditure side of household budgets.

"Indirect carbon costs" raise other prices and reduce incomes. Households also consume many goods and services that do not directly emit GHGs, but have emissions associated with their production processes. Electricity, housing, food, and clothing all fall into this category. In other words, GHG emissions occur upstream in the supply chain of these products, and the *indirect carbon costs* incurred from pricing these emissions must be borne by someone—either in the form of higher prices or lower incomes.

Electricity generation is an important example of a product that involves an indirect carbon cost, and it differs significantly across Canadian provinces. In Alberta, Saskatchewan, and Nova Scotia, most electricity is produced with coal-fired facilities. Electricity generators in these provinces would directly see higher carbon costs under a carbon pricing policy, which they will tend to pass on to businesses and households in the form of higher electricity prices. Such significant price increases would not occur in British Columbia, Manitoba, and Quebec, however, because electricity in these provinces is generated with far lower GHG emissions, mostly from large-scale hydro facilities.

Not all indirect carbon costs can be passed on to consumers in the form of higher prices. The extent of pass-through depends on characteristics of the product market. For example, firms that produce globally traded commodities, such as oil or base metals, face global prices beyond their control and which are unaffected by the provincial carbon price. In such cases, the carbon costs associated with production will reduce corporate profits or workers' wages, or both. In contrast, a seller of a highly differentiated product, such as branded advanced electronics or highly skilled professional services, will generally be able to pass some fraction of its carbon costs on to its consumers in the form of a higher price. But the pass-through will generally be incomplete; in this case, the carbon cost would lead to both higher consumer prices and lower incomes.

2 Following a body of empirical research (Rivers, 2012), we assume that fuel suppliers pass the full carbon cost through to domestic consumers in the form of higher prices.

Figure 1: The Transmission of a Provincial Carbon Price to Households

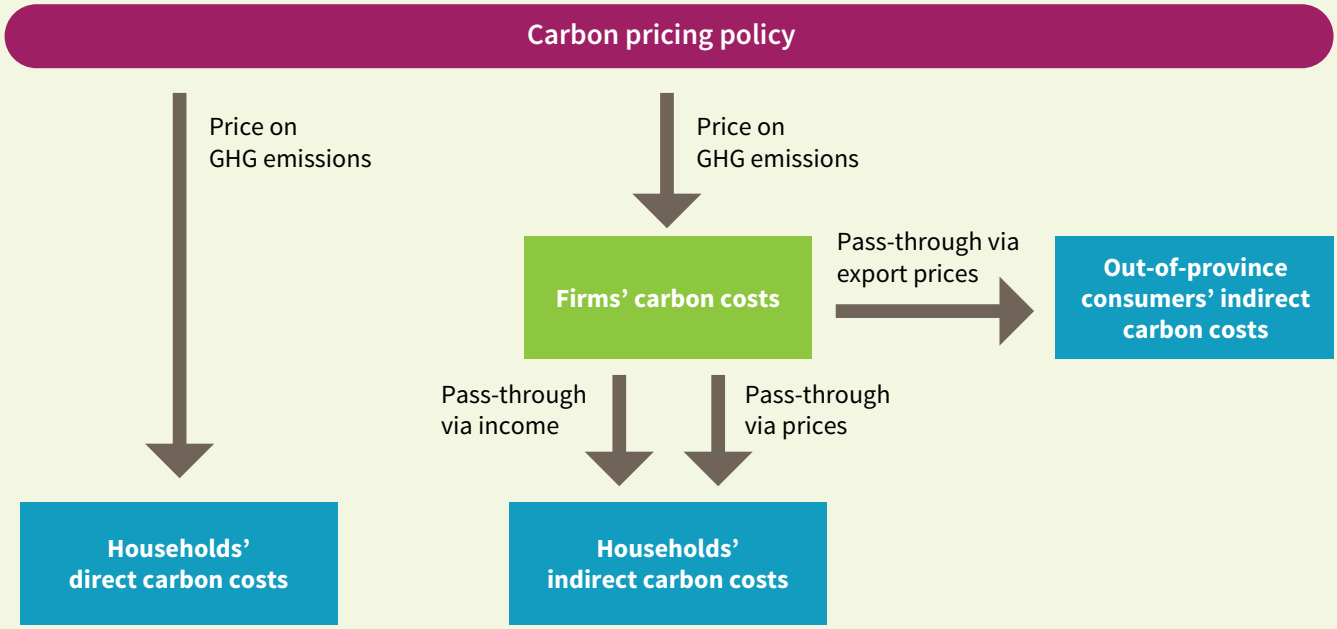

Figure 1 illustrates how costs created by a carbon price can pass through an economy to household budgets. Impacts can either be through increases in prices of goods and services or through reductions of incomes. Direct carbon costs raise prices of fuels; indirect carbon costs are passed through firms to households via a combination of higher prices and lower incomes. Some fraction of the indirect carbon costs associated with exported products is borne by out-of-province consumers and thus reduces the overall domestic cost of the policy.

Source: Canada's Ecofiscal Commission.

Note that any part of indirect carbon costs that does not lead to higher prices must affect household incomes. Any reduction in firm profits will result in a reduction in shareholders' income, which ultimately appears as a fall in household investment income. Similarly, any reduction in workers' wages will result in a decline in household employment income.[3] Because financial capital is more mobile than labour across jurisdictional boundaries, the burden of the carbon price is more likely to fall on workers through lower wages.[4] Whether the carbon cost is borne by labour or capital, however, there is a negative effect on household income within the province.

Some indirect costs are borne by out-of-province consumers. Finally, some indirect carbon costs will be borne by out-of-province consumers who face higher prices for provincial exports. Just as indirect carbon costs are partially passed on to domestic households, they are also passed on to out-of-province consumers through higher prices. Again, however, the magnitude of this effect depends importantly on market details.

Some firms will not be able to increase the prices charged to out-of-province consumers. A cement producer, for example, will face carbon costs related to its manufacturing processes, but it likely cannot influence the price it charges for its undifferentiated

3 Carbon pricing will naturally lead to increases in demand for some products, and wages and profits in these parts of the economy will rise. But for the overall economy, which is a net user of carbon-based inputs, there will be a reduction in income if carbon costs are not fully reflected in higher prices.

4 Owners of financial capital can generally shift their funds to other jurisdictions if the domestic rate of return is below the rate available elsewhere. However, "home bias" of investors and the limited access to international markets for small firms can explain why some of the burden of the carbon price could be borne by owners (Crisan et al., 2015).

product in global cement markets. Instead, its carbon costs will result in lower wages or profits, thus reducing income for domestic households.[5] But sellers of differentiated products have some market power and are thus able to raise their selling prices at least partly in response to their carbon costs. In this case, some of the carbon cost will be borne by out-of-province consumers.

For exported products, therefore, the total carbon cost borne by domestic households depends on a provincial economy's ability to pass indirect carbon costs through to final consumer prices. Indeed, if exporting firms are able to pass on costs to final prices, then a portion of these costs will be borne by out-of-province consumers instead of domestic owners or workers.

Different channels have different effects on fairness. To summarize, the costs created by a provincial carbon pricing policy will be transmitted through three distinct channels, all shown in Figure 1. First, consumer prices for fuels will rise directly. Second, the indirect carbon costs associated with the production of a wide range of goods and services will be divided between an increase in prices and a reduction in income. These first two effects combine to generate a cost for households within the province. The third channel is through the prices of exported products; to the extent that these prices increase, a portion of the policy's cost is borne by out-of-province consumers rather than by domestic households.

As we will see below, these three channels play an important role in determining the fairness of a carbon pricing policy. Households of different income levels have systematic differences in *expenditure patterns*, and are thus differentially affected by the direct versus indirect carbon costs. In addition, households of different income levels have systematically different *sources* of income, especially the split between government transfers, employment income, and investment income. The implication of these differences in expenditure patterns and income sources is that lower-income and higher-income households are differentially affected by the carbon price.

Finally, how governments use the revenue generated from a carbon pricing policy can reduce the overall impact on households. One of the benefits of implementing carbon pricing as opposed to relying exclusively on direct government regulations to reduce GHG emissions is that it has the potential to raise revenue. As a result, the way carbon revenue is recycled back to the economy—for example, through reductions in taxes or investments in infrastructure—can significantly reduce the overall costs of carbon pricing on households. The recycling of carbon pricing revenue is the focus of our most recent report (Canada's Ecofiscal Commission, 2016).

Fairness is about carbon costs in proportion to household budgets

Economists consider fairness in the context of tax policy along two dimensions: horizontal equity and vertical equity.

Horizontal equity requires that households with similar incomes and demographic compositions be treated equally. For example, if two equal-sized households each earn $50,000 per year, they should pay the same amount of income tax, even if they have different sources of income. The pursuit of horizontal equity suggests that all types of income should be taxed similarly.

Designing a carbon price to achieve horizontal equity largely corresponds with applying the carbon price as broadly as possible across the economy, thereby including the largest possible share of total GHG emissions. In this way, specific sectors or regions of the economy will not be excluded from the policy. Given the benefits for cost-effectiveness that follow from such a broadly applied policy (Canada's Ecofiscal Commission, 2015a), our modelling analysis in the next section assumes a broad approach to carbon pricing and therefore achieves horizontal equity.

Vertical equity requires that households with greater incomes be taxed more heavily because of their greater ability to pay. For example, a household that earns $100,000 per year should pay more in taxes than an equal-sized household that earns only $50,000 per year. One could argue further, and many economists do, that vertical equity demands that higher-income households pay a *higher proportion* of their income in taxes than lower-income households.

Our focus is on the policy's implications for *vertical* equity, which can be characterized in three ways. A policy is *regressive* if low-income households face greater carbon costs as a share of their income than do higher-income households. For example, if the household carbon cost is 2% of household income for lower-income households but only 1% for higher-income households, the carbon price is regressive. Note that the *dollar amount* of the carbon cost may well be lower for the lower-income households; but it is the higher *proportional* cost that identifies the policy as being regressive.

A policy is *proportional* if all households face the same carbon costs as a share of their income (although in this case, it would certainly be true that the dollar amount of the carbon cost would be higher for higher-income households). Finally, a policy is *progressive* if the carbon cost as a share of income rises as household income rises.

Achieving vertical equity requires—at a minimum—that the carbon pricing policy have a proportional impact, thus affecting

5 Some owners of domestically located firms reside outside the home province; as a result, not all of the reduction in profit will be borne by domestic households.

all households by a similar percentage of income. As we suggested above, however, many economists would argue further that vertical equity requires the carbon price to have a clearly progressive impact on households.

In this report, we will identify a carbon pricing policy as fair if the impact on households is not regressive, and we will examine the amount of carbon revenue required to entirely offset the impact on lower-income households, thereby making the overall policy clearly progressive.

Increases in prices tend to be regressive; decreases in income tend to be progressive

We have examined the channels through which carbon pricing can affect household budgets. Simply put, carbon costs can affect households by raising prices or by reducing incomes. We have also explained what we mean by a fair carbon pricing policy, and have emphasized the importance of considering carbon costs as a proportion of household income. We now examine how the different channels help to determine the fairness of the overall carbon pricing policy.

To assess fairness more formally, we group households into five equal subsets, called quintiles, each containing 20% of total households. Income levels define the quintiles: the first quintile contains the lowest-income households, the second contains the second-lowest-income households, and so on.

Price increases tend to be regressive. Carbon costs that increase the prices of goods and services tend to increase the regressivity of carbon pricing. Table 1 shows, for each of the income quintiles, average total household expenditure as well as the share of expenditure in each of the broad categories—energy, food, housing, and other. Households are assigned into income quintiles based on their total annual income before taxes in 2013. Not surprisingly, households in lower-income quintiles spend a greater share of their expenditures on energy, food, and housing than do those with higher incomes. The higher-income households spend a greater share on other categories, which include products such as travel, entertainment, and clothing. Note that Table 1 shows *averages* for each income quintile; there is considerable variation of income and expenditure *within* these quintiles.

Since a carbon price will increase the price of energy-based products more than other products, and since lower-income households spend relatively more of their budget on these products, the price impacts of a carbon pricing policy, when taken alone, tend to be regressive. Research by Barrington-Leigh et al. (2015), Grainger and

Table 1: Household Expenditures by Income Quintile in Canada, 2013

Income quintiles	Average total expenditure	Share of total household expenditure (%)					
		Energy			Food	Housing	Other
		Electricity	Transport fuels	Home heating fuels			
1	$31,417	2.5	3.6	1.0	13.8	26.9	52.2
2	$47,825	2.4	4.0	1.1	13.4	22.8	56.4
3	$66,680	2.0	3.6	1.0	11.4	19.2	62.8
4	$93,005	1.6	3.7	0.9	10.0	17.9	65.8
5	$155,888	1.1	2.5	0.7	7.8	14.8	73.0
All	$79,012	1.7	3.3	0.9	10.1	18.2	65.9

For each income quintile, Table 1 shows the average total expenditure as well as the allocation of expenditure across the four broad categories.

Source: Canada's Ecofiscal Commission, using CANSIM Table 203-0022 (Statistics Canada, 2016a).

Kolstad (2010), Lee and Sanger (2008), and Hamilton and Cameron (1994) confirms this general point.

Reductions in income tend to be progressive. In contrast, the resulting changes in household income tend to increase the progressivity of carbon pricing. Table 2 indicates the share of household income coming from different sources, for five income quintiles in Canada. Households in the lowest-income quintile derive the majority of their income from government transfers, such as Old Age Security, Employment Insurance, Social Assistance, and the Guaranteed Income Supplement. In contrast, households in the higher-income quintiles receive most of their income from employment. The share of income coming from investment returns is low and similar for all income quintiles except the highest. Pension income is most important for the middle-income quintiles.

Since households with different levels of income typically have different primary sources of income, the impact of carbon pricing on incomes can alter the fairness of the policy. Indeed, analyses that take carbon pricing's effects on household income into account tends to find less evidence of regressivity and even some evidence of progressivity (Beck et al., 2015a; Morris & Munnings, 2013). This is because some portion of carbon costs will lead to lower employment and investment income, which are relatively more important income sources for higher-income households.

Our analysis below examines the *overall* impact from carbon pricing policies, combining the separate price and income effects on household budgets in each of the five income quintiles, in four provinces.

Table 2: Share of Household Income by Source and by Income Quintile in Canada, 2013

Income quintiles	Average total income	Average share of total income (%)			
		Employment income	Investment income	Pension and other income	Transfer income
1	$18,867	23.9	3.4	7.5	65.2
2	$40,229	44.8	3.7	15.0	36.5
3	$63,699	64.7	3.6	14.1	17.6
4	$97,325	76.7	3.7	10.3	9.3
5	$204,824	80.0	11.3	5.9	2.9
All	$84,987	71.1	7.3	9.1	12.5

Table 2 presents the average household income for each income quintile, as well as the share of income from each of four sources. Note that the income quintiles in Tables 1 and 2 are slightly different, because they are based on different income datasets. Pension and other income includes spousal support, lump-sum payments from pensions and deferred profit-sharing plans, retirement allowances (including severance pay), scholarships, and death benefits.

Source: Canada's Ecofiscal Commission, using Statistics Canada's Social Policy Simulation Model Version 22.0.

3. What Is the Impact of Carbon Pricing on Canadian Households?

To assess the fairness of carbon pricing in Canada, we use economic models to estimate the impacts of a carbon price on households. To illustrate the implications of different provincial energy mixes and different provincial income distributions, we consider households in Alberta, Manitoba, Ontario, and Nova Scotia. We estimate carbon costs for households at different income levels in each province, which depend on province-specific energy mixes and economic structures.

Economic modelling occurs in two stages. We begin by modelling the impact of a new $30/tonne carbon price in each province using Statistics Canada's input-output model, COMTAX. This model accounts for indirect carbon costs by linking the production of goods and services with their final consumption by households.[6] The second stage uses the outputs from the COMTAX model and feeds them into a separate model to assess the carbon costs for different households. This stage uses Statistics Canada's Social Policy Simulation Database and Model (SPSD/M), with detailed resolution regarding financial interactions between governments and households.[7] The combination of these two models allows us to realistically estimate the absolute household costs, and their distribution across income levels, generated by the carbon price within each province.

For our modelling scenario, we assume that all direct costs of the carbon price (i.e., on fuels) are passed through to consumers in the form of higher prices. However, as reflects our discussion in Section 2, we assume that only a fraction of the indirect carbon costs are passed on in the form of higher prices; the remainder leads to reductions in household income. For income reductions, we assume employment income is reduced, whereas investment income is unaffected, in keeping with the view that highly mobile financial capital is unlikely to bear a large burden of the carbon price.[8]

We define province-specific pass-through of indirect carbon costs based on findings from our recent report on business competitiveness. Sectors most vulnerable to competitiveness pressures are those that are both emissions intensive and trade exposed. Within each province, we identify each sector as being either "more exposed" or "less exposed" to these pressures (Canada's Ecofiscal Commission, 2015b). For the current report, we assume that the more exposed sectors pass none of their carbon costs on through higher prices, and thus all of the costs fall on labour income. In contrast, we assume that the less exposed sectors pass all of their carbon costs on through higher prices (and none through lower wages). This assumption is clearly an imperfect one, but consistent with a rule of thumb that carbon costs are mostly passed on to consumers through higher product prices for local products and through lower wages for globally traded products (Coady, 2006).

Figure 2 presents the estimated household impacts given these pass-through assumptions. It shows the total household carbon cost by income quintile for each of the four provinces, and includes both the direct and indirect costs. Panel A presents the carbon cost as a share of current household income. For an alternative measure of the incidence of carbon pricing, Panel B presents the carbon cost as a share of current household expenditure. (There is some debate regarding the correct measure to gauge incidence, for reasons discussed in Box 1.) In both cases, the data are scaled by the "adult-adjusted equivalent size" of household.[9]

Household impacts are relatively small. Several main findings emerge from Figure 2. First, the *level* of the curves indicates the magnitude of the total carbon costs for households. In all cases, the carbon costs associated with a $30/tonne carbon price represents a very small share of total income or expenditure. The carbon cost is always less than 2.1% of household income or expenditure, and

6 In our analysis, emissions within the public sector do not generate net revenue for government. Also, the carbon costs associated with investment in physical capital do not get passed on immediately to consumers in the form of higher prices. In reality, these costs would be passed on to consumers in the future, but are omitted by our analysis, which is based on a snapshot in time. Emissions associated with exported products are included in our analysis, although some fraction of the associated carbon cost is borne by out-of-province consumers.

7 We use the model version 22.0. For a detailed description of the model, see Crisan et al. (2015).

8 The reductions in employment income are allocated to the five income quintiles based on the share of provincial employment income in each quintile. Average per-household employment income in each quintile is then given by the allocation to each quintile divided by the number of households in each quintile. Employment income is the sum of employment and self-employment income.

9 The carbon cost for a household is scaled to permit a comparison of households that differ by size and composition. The scaling approach puts more weight on adults than children and accounts for economies of scale within households (e.g., doubling the size of a household increases the cost of living by less than a factor of two). With this scaling approach, a single adult household has an equivalent size of 1.0, a household with two adults is scaled as 1.4, and one with two adults and two children has a scale of 1.7. Since lower-income households are systematically smaller than higher-income households, the absence of such scaling overstates the fairness of carbon pricing.

Box 1: What Is the Appropriate Measure of Household Income?

To assess the fairness of carbon pricing, we have related carbon costs to household incomes. Do the costs represent a larger proportion of the incomes of richer households than poorer ones? To make this comparison accurately, we need to have a good measure of household income.

The most obvious measure is a household's *current annual income*. For example, for a household's annual income of $50,000 and an annual carbon cost of $600, the ratio would be 1.2%. Several studies assessing carbon pricing and fairness have used this approach, including Hamilton and Cameron (1994), Lee and Sanger (2008), and Barrington-Leigh et al. (2015).

This may not be the best measure to use, however, because many households have incomes that vary from year to year, while the carbon cost tends to be much more stable. An important source of income variation is patterns in lifetime earnings. For example, while both a university student and an unskilled worker might have low current incomes, they have different expectations regarding their future incomes. More generally, young households tend to spend more than their income and incur debts; middle-aged households spend less than their income while repaying debts and accumulating savings; and older households often spend more than their current incomes, financing their expenditures by drawing from their accumulated savings.

Some economists argue that if we want to accurately compare the real burden of carbon pricing across different households, we should compare what they pay not with their current annual incomes but with their *expected lifetime incomes*. The problem is that it is not easy to measure such a concept. But fortunately, there is a reasonably good proxy: each group's *current expenditure*. Why is this?

Consider again the case of unskilled workers and current university students. Though they may have similarly low current incomes, they likely have very different expectations regarding their future incomes. The first group will tend to have low spending to match their low long-term income expectations; in contrast, those in the second group will tend to spend well in excess of their current incomes to match their higher lifetime expectations. If we measure the burden of the carbon cost as a percentage of current income, both groups will be deemed to be facing the same burden. From the perspective of lifetime income, however, it seems clear that the burden is greater on those with lower expected future incomes than on those with higher expectations.

If we instead measure the cost as a fraction of their *current expenditure*, we will, for the reasons just mentioned, come closer to their lifetime income expectations than by using current incomes. Now the burden will be seen to be a higher proportion of the first group's expenditure than of the second group's, and we will more accurately observe the different burdens.

The bottom line is that the precise measure of household income matters for assessing the fairness of carbon pricing. This is why we examine household carbon costs using both approaches.

Figure 2: The Impact of Carbon Pricing on Canadian Household Budgets

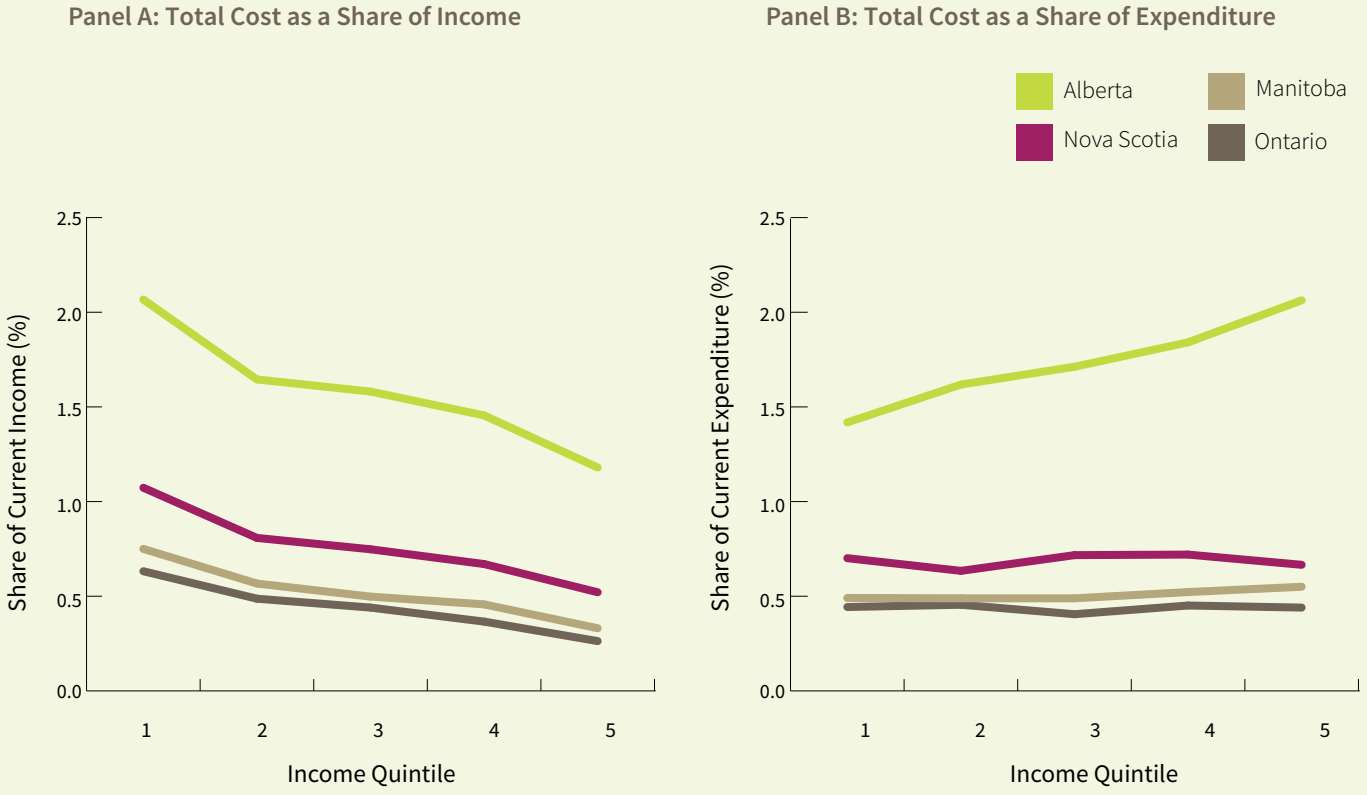

Figure 2 presents the total household impact assuming that a fraction of indirect carbon costs are passed on to consumers through higher prices; the remaining costs result in lower employment income. The rate of pass-through is based on the share of emissions identified as vulnerable to competitiveness pressures. Panel A shows the carbon cost as a share of current household income; Panel B shows the carbon cost as a share of current household expenditure. Data in both panels are scaled by the adult-adjusted equivalent size to account for varying numbers of people per household.

Source: Canada's Ecofiscal Commission, using Statistics Canada's Social Policy Simulation Model Version 22.0.

for most provinces and income quintiles, it is less than 1%—and in many instances, less than 0.6%. It is worth recalling at this point that these estimated costs are *before* beneficial effects of revenue recycling are considered.

We also assume here that households maintain their current expenditure patterns in the presence of carbon prices. A more realistic assumption, especially over the longer run, is that households will adjust their expenditure patterns by substituting away from goods and services whose prices increase because of the carbon pricing policy. For this reason, even our small estimated household costs should be viewed as an overstatement of the true costs.

The extent of regressivity is sensitive to measurement. The second important point is that the *slope* of the curves is the key indicator of the policy's regressivity. The more steeply the curve declines as income rises, the more regressive is the carbon pricing policy—because it means that lower-income households are bearing a larger proportionate burden than higher-income households. The opposite is true as well: the more steeply the curve inclines with higher income (see Panel B), the more progressive is the policy. When household costs are considered as a share of current income, carbon pricing appears to be regressive for all four provinces—but only slightly. Yet when considering the cost as a share of current

expenditure, carbon pricing is mildly progressive in Alberta and almost exactly proportional in the three other provinces.

There is a simple explanation for why carbon pricing is more regressive when carbon costs are expressed as a share of current income than as a share of current expenditures. For lower-income households, expenditure is typically greater than income, the excess being financed by borrowing. The opposite is true for higher-income households, which regularly save a considerable fraction of their income. The arithmetic result of this difference is that carbon costs are a higher fraction of income than of expenditure for lower-income households, but the difference is much smaller for higher-income households. Thus, the measure used for household income affects the estimated regressivity of the policy (see Box 1).

Alberta stands out from the rest. The household carbon cost is higher in Alberta than elsewhere, and it also varies more across income quintiles. These differences exist for three reasons. First, the carbon intensity of Alberta's electricity system is greater than that of other provinces, which means that electricity prices will rise more there than in either Manitoba or Ontario, both of which have low-emissions electricity systems. Second, on average, Albertans tend to consume more fuel relative to other provinces.[10] Third, the share of sectors vulnerable to competitiveness pressures is significantly greater in Alberta than in other provinces—in particular, the emissions-intensive oil and gas sector (Canada's Ecofiscal Commission, 2015b). As a result, more indirect carbon costs cannot be passed on to consumers through higher prices and are instead passed on through lower employment income. This explains both a higher carbon cost and one that is more progressive (since employment income is relatively more important for higher-income households).

The total household impacts in Nova Scotia are less than in Alberta but greater than in Ontario and Manitoba. As in Alberta, coal-fired electricity in Nova Scotia is highly emissions intensive, and electricity generators pass the direct carbon costs on to consumers in the form of higher prices for goods and services.[11] But unlike Alberta, Nova Scotia lacks a significant share of its industry that is emissions intensive and trade exposed; this explains why household carbon costs are less in Nova Scotia than in Alberta, despite their similar electricity systems. For Ontario and Manitoba, it is *both* their low-emissions electricity systems and their small share of vulnerable sectors that explain their very low household carbon costs.

Household carbon costs can be expressed in dollar terms. For the four provinces considered, the average annual carbon cost varies from $207 for households in the first income quintile to $543 in the middle quintile and $1,141 for households in the highest quintile. There are, of course, differences across provinces due to both differences in the carbon costs and differences in income levels. The annual carbon cost ranges from $140 for the lowest-income households in Ontario to about $5,000 for the highest-income households in Alberta. For each province considered, the carbon costs in dollar terms always increase with income quintiles. Also, for reasons discussed earlier, these values should be viewed as overestimates of the true costs, as they do not include changes in household and firm behaviour in response to the carbon price. These household impacts also ignore the beneficial effects from the recycling of carbon pricing revenues.

Finally, our findings are consistent with those of Beck et al. (2015a). They assess the impacts of British Columbia's carbon tax by looking at the combined effects on consumer prices and household income, and find that the carbon tax is progressive even before considering the impacts of revenue recycling. Their finding of progressivity suggests that the impacts on income are more important for households than the impacts on product prices. This is because B.C.'s electricity is mostly generated from low-carbon hydroelectricity (and hence indirect carbon costs are low) and because fuel spending in the province is roughly proportional across different income groups. The progressivity of the policy is therefore driven by the negative impacts on employment and investment income—sources of income that are more important for higher-income households.

Rural versus urban differences in household impacts are very small

In addition to examining the impact of carbon pricing on households of different incomes, our model can be used to assess the differences in the carbon costs for households residing in areas of different size.

10 On a per capita basis, Albertans consumed 30% more gasoline for road transport than the Canadian average in 2014 (Statistics Canada, 2016b, 2016c).

11 The importance of coal-based electricity in Alberta and Nova Scotia has implications for the long-term carbon costs generated by carbon pricing policies in these provinces. The model here is static and thus cannot account for the actions that emitters take, especially over time, in response to carbon pricing. In response to a carbon price, it is highly probable that electricity generators in both provinces will gradually phase out their coal-fired facilities and replace them with ones using less-emitting natural gas. Over a longer period, even those facilities are likely to be replaced with renewable power sources. This shift will (gradually) reduce the carbon costs borne by households.

The size and density of urban areas might matter for the fairness of carbon pricing. Those residing in rural areas might drive more frequently and for longer distances, given their limited access to public transportation. Or they might have greater home-heating costs if more remote areas have lower average temperatures. In these cases, rural households could face larger carbon costs than households in urban areas. In British Columbia, rural communities have voiced these exact concerns regarding the implementation of that province's carbon tax (Beck et al., 2015b).

To what extent do the data identify such different impacts of carbon pricing? Figure 3 presents the total household carbon cost in the four provinces, for areas of three different sizes. It shows the carbon costs separately for households in large urban areas (those with a population of more than 100,000), households in small urban areas (those with a population of less than 100,000), and households residing in rural areas.

The analysis suggests that for any individual province, and for both the income and expenditure measures, household carbon costs do not vary significantly across areas of different size. This is broadly consistent with the findings of Beck et al. (2015b) that rural households bear only a slightly larger burden of British Columbia's carbon tax than do households in large urban areas. They also find, however, that the revenue-recycling scheme implemented by the province is sufficient to compensate these households and that the additional Northern and Rural Homeowner Benefit program is therefore unlikely to be necessary.

Figure 3: Total Carbon Costs for Rural and Urban Areas

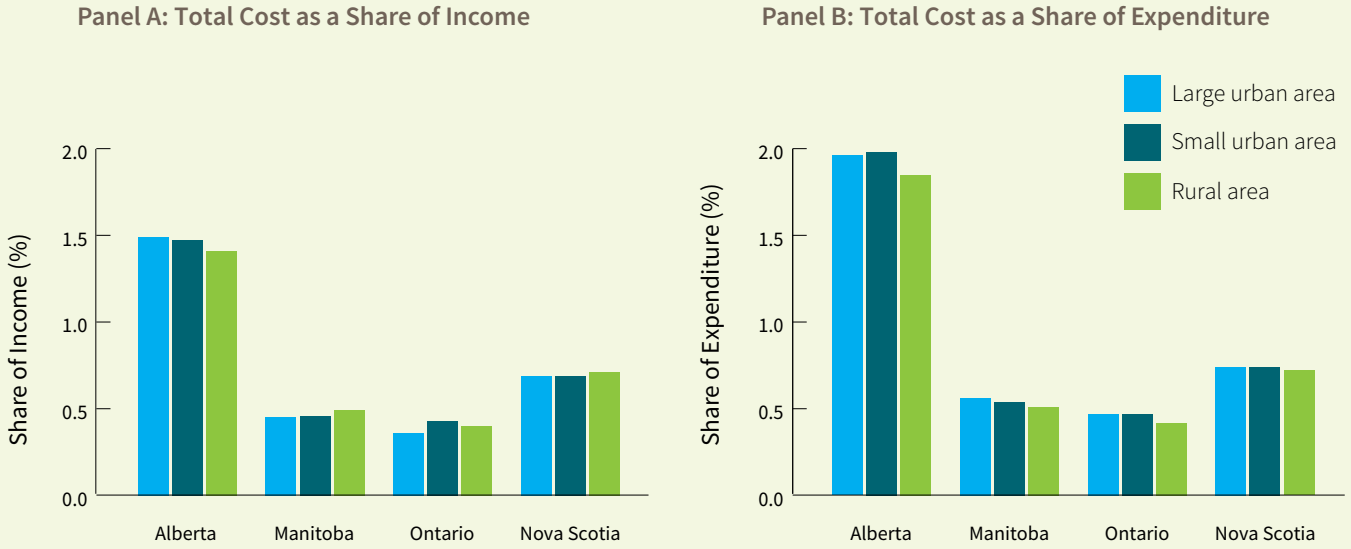

Figure 3 presents the total carbon costs for households in different-size areas. Panel A shows the cost as a share of current household income; Panel B shows the cost as a share of current household expenditure. Both are scaled by the adult-adjusted equivalent size.

Source: Canada's Ecofiscal Commission, using Statistics Canada's Social Policy Simulation Model Version 22.0.

4. What's Missing From This Analysis?

This report considers the fairness of a $30/tonne carbon price in Canadian provinces *before* revenue recycling is considered. We have examined the total (direct plus indirect) carbon costs for households by income quintiles, in four provinces. The results are based on economic modelling that assesses the impacts of carbon pricing on product prices and household incomes. We have found that carbon pricing policies would generate small costs for households and that the impact would be slightly regressive under some conditions. The total cost as a share of annual household income is slightly larger for lower-income households than for higher-income households; when costs are expressed as a share of annual household expenditure, however, this regressivity disappears.[12]

Our modelling approach likely *overstates* the level of household carbon costs and the estimated regressivity for three reasons.

First, the model captures household carbon costs only as a snapshot in time. It does not consider how households respond to the carbon price by adjusting their behaviour to save money and reduce costs. Over short periods, households might make small adjustments in response to price increases—they might drive less or take public transit more often, for example. In the longer run, however, households can respond more strongly to the carbon price by purchasing more efficient furnaces or vehicles. As a result of such adjustments, the overall household cost will fall over time. It follows that for all income levels, our estimates of carbon costs should be viewed as upper bounds of the true costs.

Our analysis also does not consider the implications of broader changes elsewhere in the economy in response to the carbon price. Industrial and commercial emitters throughout the economy will respond to the price by improving their emissions performance and, as a result, the indirect costs will decline. In the long run, decarbonized electricity generation in Nova Scotia and Alberta, for example, will lead to less regressive impacts of carbon pricing policies in those provinces. Additionally, on the income side, potential growth in the low-carbon sector could increase household wages and returns on investments in these industries as a result of carbon pricing.

Second, our modelling does not incorporate the fact that increases in the nationwide price level will lead to increases in government transfers to households. As carbon pricing leads to higher prices of specific goods and services, it will also increase the overall price level, as measured by the Consumer Price Index (CPI). A rise in the CPI leads to an increase in all government transfers indexed to inflation. For example, the Guaranteed Income Supplement to low-income seniors and Old Age Security to all seniors are payments to households whose value will increase as a result of widespread price increases caused by carbon pricing policies. Since these income sources are more important for lower-income households, this effect would reduce the regressivity of the overall policy.

Third, and most importantly, our analysis does not consider the implications of revenue recycling for household fairness. If the policy is designed to use some portion of carbon pricing revenues to return to households, especially the lowest-income households, the regressivity of the policy can be reduced or even eliminated altogether. We return to this point below.

12 Our analysis focuses on averages for each of the five income quintiles and does not consider the differential impacts of carbon pricing within the various income quintiles. The most vulnerable households, for example, are likely those in the bottom 5% to 10% of households (the bottom half of the first income quintile). More detailed analysis is needed to determine the significance of differences within income quintiles. When identifying the most vulnerable, an important additional dimension ignored in this analysis would be family type (such as married with or without children, elderly or unattached non-elderly households). Interacting family types with different income levels could provide critical information for governments looking to identify the most vulnerable households. Hamilton and Cameron (1994) conduct such an analysis for a hypothetical carbon tax in Canada and find low-income married couples to be the most heavily impacted.

5. What Are the Implications for Policy?

Based on the analyses in this report, three main implications emerge for the design of provincial carbon pricing policies.

1. Concerns for household fairness should not preclude policy action.

We find that carbon pricing policies in Canadian provinces would generate only small household impacts. The carbon cost associated with a $30/tonne carbon price is always less than 2.1% of household income or expenditure, and for most provinces and income quintiles, it is less than 1%—and in many instances, less than 0.6%. When carbon costs are expressed as a share of household income, the impacts are slightly regressive. When we consider the costs as a share of current expenditure, carbon pricing is proportional or even slightly progressive.

Concerns regarding the fairness of policy are nonetheless entirely legitimate. As we discuss below, however, whatever unfair household impacts might exist can be addressed relatively easily through revenue recycling.

2. Impacts on household fairness are different across provinces.

Both the overall household burden and the distribution of this burden across income quintiles can differ significantly between provinces. In particular, the nature of a province's electricity system and the size of its emissions-intensive sector are key determinants of both the total household carbon cost and the extent to which low-income households bear a greater burden than higher-income households.

3. Smart recycling of revenue can increase the fairness of carbon pricing policy.

Even if the effects of a carbon price (on product prices and household incomes) are regressive, the net impact on households can be altered significantly if revenues from the policy are returned to households, especially to those with the lowest incomes.

Several approaches to revenue recycling can offset the regressive effects of policy. For example, to offset all or part of the GST/HST paid by lower-income individuals and families, the federal government currently provides non-taxable quarterly cash payments, through the refundable GST tax credit. Other approaches include income-tax cuts targeted to lower-income groups or eliminating other federal or provincial taxes.

When designing carbon pricing policies, one principle is to "do no harm" for lower-income households (Stone, 2015), meaning that carbon pricing should neither make poor households poorer nor push households into poverty. In practice, following this principle requires that some fraction of carbon pricing revenues be returned to lower-income households so as to leave their post-transfer incomes unaffected by the policy.

Table 3: Share of Carbon Pricing Revenues Required to "Do No Harm"

	Percentage of carbon pricing revenues required to fully compensate households	
Province	First income quintile	First & second income quintiles
Alberta	3.2	9.5
Manitoba	4.4	12.6
Ontario	3.9	11.6
Nova Scotia	4.0	11.8

Table 3 presents the share of provincial carbon pricing revenues required to completely offset the carbon costs to all households in the first income quintile, as well as the first and second income quintiles.

Source: Canada's Ecofiscal Commission, using Statistics Canada's Social Policy Simulation Model Version 22.0.

Such a rebate could be carefully designed to target the most vulnerable households without creating additional labour-market distortions.[13] We take an illustrative approach, and consider transfers based on income quintiles. Table 3 presents the share of total provincial carbon pricing revenues required to do no harm to all households (on average) in the first income quintile, and the first and second income quintiles. Offsetting the full cost of policy to the first income quintile requires less than 5% of total carbon pricing revenue in all four provinces. The revenue required to offset the cost to the first two income quintiles is less than 13% of provincial carbon revenue. The clear implication is that governments can fully eliminate the regressivity of their carbon pricing policies and still retain most of the associated revenues for other policy objectives.

6. What Comes Next?

Carbon pricing in Canadian provinces would impose small costs on households, and the impact could be slightly regressive or slightly progressive, depending on the precise measures used. Carbon pricing also generates challenges for the competitiveness of businesses that face carbon costs that business rivals in other jurisdictions do not face. It is essential for provincial governments designing and implementing carbon pricing policies to recognize these two challenges; it is equally important to recognize that these challenges can be dealt with successfully, and thus why these two challenges need not be obstacles for carbon pricing.

The key to addressing both the fairness and competitiveness challenges from carbon pricing is the recycling of carbon revenues. The latest major report from Canada's Ecofiscal Commission, *Choose Wisely: Options and Trade-offs in Recycling Carbon Pricing Revenue*, examines the cases for and against several options for revenue recycling, aimed not only at addressing the fairness and competitiveness challenges, but also at achieving broader environmental and economic objectives.

13 Abrupt thresholds for eligibility defined by a specific income level would create perverse incentives for households to maintain or reduce their income by working less or evading taxes. To avoid this problem, governments could design the transfer with gradually declining benefit levels or claw-back rates.

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8. Appendix

Table 4 presents detailed information about the households and the impact of a $30/tonne carbon price in each of the four provinces. The bullets below describe the data in each column of the table:

- The first column groups provincial households in five equal-sized sets, called quintiles. Each quintile contains 20% of total households, ordered from lowest income to highest income.
- The second column presents the current income ranges that define each quintile.
- The third column shows the average current income for households in each quintile. Current income represents the total annual income received by households in 2013 from employment, investment, pension, government transfers and other sources.
- The fourth column shows the average current expenditure for households in each quintile. Current expenditure represents the total expenditures on goods and services by households in 2013.
- The fifth column describes the average adult-adjusted equivalent size of households in each quintile. This scaling method allows for comparison between households that differ by size and composition by putting more weight on adults than children.
- The sixth column describes the total number of households in each quintile and in the province as a whole. As should be expected, the number of households per quintile is roughly the same.
- The seventh column presents employment income as a share of total income for each quintile (other sources of income include government transfers and investment income). We use this metric to allocate domestic indirect carbon costs to households through lower incomes as opposed to higher prices.
- The eighth column shows households' carbon costs (before revenue recycling and before behavioural responses, both of which will lower total impacts) by income quintile. These values include both indirect and direct carbon costs and account for the fact that not all carbon costs are passed through to prices.
- The last two columns are households' carbon costs divided respectively by current income and current expenditure. These metrics allow us to assess the fairness of carbon pricing. Both of these shares are also standardized by the adult-adjusted equivalent size. Because lower-income households are systematically smaller than higher-income ones, not scaling for adult-adjusted equivalent size would make carbon pricing seem unduly progressive. As a result, the metrics presented in the last two columns should not be viewed as per capita measures, but rather a synthetic metric that allows for the assessment of the incidence of carbon pricing on households.

Table 4: Descriptive Statistics and Household Impact of a $30/tonne Carbon Price in Four Provinces (2013)

Income quintile	Income range	Average current income	Average current expenditure	Adult-adjusted equivalent size	Total number of households (thousand)	Share of employ-ment income (%)	Average carbon cost per household	Equivalent carbon cost as a share of income (%)	Equivalent carbon cost as a share of expenditure (%)
Alberta									
1	Min-$37,502	$24,181	$35,248	1.16	324.9	2	$580	2.1	1.4
2	$37,503-$65,674	$51,662	$52,529	1.33	327.6	7	$1,130	1.6	1.6
3	$65,675-$97,914	$81,825	$75,577	1.46	322.8	15	$1,889	1.6	1.7
4	$97,915-$149,080	$122,767	$97,071	1.56	325.3	25	$2,787	1.5	1.8
5	$149,081-Max	$269,679	$154,257	1.61	324.7	51	$5,123	1.2	2.1
All	Min-Max	$109,950	$82,892	1.42	1625.3	100	$2,301	1.5	2.0
Manitoba									
1	Min-$29,402	$18,832	$28,783	1.1	102.1	2	$155	0.7	0.5
2	$29,403-$49,829	$39,437	$45,732	1.29	102.5	7	$288	0.6	0.5
3	$49,830-$76,085	$61,818	$62,872	1.43	102.4	14	$440	0.5	0.5
4	$76,086-$114,351	$94,269	$82,468	1.56	102.2	27	$672	0.5	0.5
5	$114,352-Max	$181,434	$109,045	1.63	102.5	51	$978	0.3	0.6
All	Min-Max	$79,193	$65,796	1.4	511.7	100	$507	0.5	0.6
Ontario									
1	Min-$31,083	$19,277	$27,472	1.15	1091.3	1	$140	0.6	0.4
2	$31,084-$52,923	$41,593	$44,478	1.35	1088.5	6	$273	0.5	0.5
3	$52,924-$82,949	$67,098	$72,896	1.46	1090	14	$431	0.4	0.4
4	$82,950-$124,087	$101,639	$82,514	1.57	1089.9	25	$584	0.4	0.5
5	$124,088-Max	$212,152	$127,132	1.68	1089.9	54	$939	0.3	0.4
All	Min-Max	$88,346	$70,894	1.44	5449.6	100	$473	0.4	0.5
Nova Scotia									
1	Min-$26,998	$17,016	$26,033	1.09	82	1	$199	1.1	0.7
2	$26,999-$45,932	$36,336	$46,300	1.32	81.7	6	$387	0.8	0.6
3	$45,933-$68,265	$57,021	$59,543	1.41	81.7	14	$602	0.7	0.7
4	$68,266-$106,775	$84,326	$78,456	1.5	82.2	26	$847	0.7	0.7
5	$106,776-Max	$163,239	$127,710	1.63	81.8	52	$1,386	0.5	0.7
All	Min-Max	$71,582	$67,603	1.39	409.4	100	$685	0.7	0.7

Table 4 presents summary statistics as well as total carbon costs for households in each of the four provinces: Alberta, Manitoba, Ontario and Nova Scotia. The first two columns describe the income quintiles. Columns 3 to 5 are respectively the average of current income, current expenditure, and adult-adjusted equivalent size per quintile. Column 6 represents the total number of households per income quintile, and column 7, the share of total provincial employment income of each quintile. The last three columns describe the impact of a $30/tonne carbon price on households in each province. It is shown first in dollar terms, then respectively as a share of income and expenditure. Data in the last two columns are scaled by the adult-adjusted equivalent size.

Source: Canada's Ecofiscal Commission, using Statistics Canada's Social Policy Simulation Model Version 22.0.

Table 5 provides information on additional parameters used to estimate the overall costs of carbon pricing on households. The bullets below describe each column of the table:

- The first column lists the four provinces considered in our analysis.
- The second column presents the estimated total provincial carbon revenue that would be generated if the province had implemented a $30/tonne carbon price in 2013. It is estimated using detailed provincial energy-use data from Statistics Canada and corresponding GHG emissions factors.
- The third column presents the share of total carbon revenue (or costs) that is borne by the government sector. These values are outputs of the input-output modelling of carbon pricing using Statistics Canada's COMTAX model. Because the government is paying itself, we remove this dollar value from the total revenue to determine the effective total provincial revenue.
- The fourth column presents the share of total carbon costs that would be borne by exports, based on the input-output modelling of carbon pricing using Statistics Canada's COMTAX model. We use these values to allocate a share of export-related carbon costs back to domestic households through lower employment income instead of assuming that these costs are passed on to out-of-province consumers.
- The last column presents the share of indirect carbon costs that can be passed on through higher prices in each province. These values are based on the share of provincial GHG emissions from sectors exposed to carbon competitiveness pressures as defined in Canada's Ecofiscal Commission (2015b) report.

Table 5: Additional Parameters for Analysis

Province	Total carbon revenue (million)	Share of total carbon cost borne by government (%)	Share of costs borne by consumers of exports (%)	Price pass-through of indirect costs (%)
Alberta	$6,350	7	43	44
Manitoba	$392	8	24	48
Ontario	$4,272	9	26	64
Nova Scotia	$453	10	28	55

Table 5 presents key parameters used for the analysis for each of the four provinces. Column 2 presents an estimate of 2013 total provincial carbon revenue for a $30/tonne carbon tax using provincial energy-use data. Through COMTAX modelling, columns 3 and 4 present the share of the total carbon revenue (or cost) that is borne by the government sector and out-of-province consumers of exports. For our analysis, we remove government costs from the total revenue and add a share of export costs back into our analysis. The last column presents province-specific pass-through of indirect carbon cost based on findings from Canada's Ecofiscal Commission (2015b).

Source: Canada's Ecofiscal Commission, using CANSIM 127-0004, CANSIM-128-0017, Statistics Canada's COMTAX model, and Canada's Ecofiscal Commission (2015b).

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