Distributional incidence of climate change policy in Canada

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STATE OF KNOWLEDGE REPORT

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1.Introduction

Significantly reducing Canada's energy-related greenhouse gas emissions will likely require aggressive policies to encourage energy efficiency, low carbon secondary energy generation (from renewables, nuclear, or fossil with carbon capture), and/or fuel switching. There is much support amongst academics, as well as considerable momentum in the policy process, towards market-based approaches to implementing these policies, which involve directly or indirectly imposing a price on carbon emissions, either using a tax on emissions or an emission cap with tradable emission permits [Stavins, 2001]. Given the scale of transformation envisioned - the federal government, for example, has endorsed a 17 percent reduction in emissions from 2005 levels by 2020, followed by more significant reductions in later years – the price on carbon emissions probably has to rise to quite high levels [National Roundtable on the Environment and the Economy, 2007].

Figure 1 summarizes the results from some recent Canadian studies that examine the level of carbon price that might be required to meet varying levels of emission reductions. To reduce emissions by 25 percent from business as usual levels is likely to require a price on carbon of between $50-150/t CO_2, and possibly higher.[1] As an illustration, a $100/t CO_2 policy would increase the price of retail gasoline by about 25 percent and the price of household natural gas by about 50 percent. Clearly, a market-based carbon policy designed to achieve large cuts in emissions is likely to have noticeable impacts on price.

A policy that imposed a substantial financial penalty on carbon emissions could be accompanied by significant distributional impacts - that is, it could concentrate costs in certain regions or income or demographic groups. An understanding of the distributional impacts of climate policy is important, for two key reasons [Oladosu and Rose, 2007]. First, from a normative perspective, policymakers are concerned with notions of fairness or equity in policy application. For example, guidelines for application of environmental policy issued by Canada's Department of Finance highlight "fairness" as a key criteria in judging between alternative policies [Department of Finance, 2005]. Second, from a pragmatic perspective, a policy that creates a disproportionately negative impact on certain demographic or income groups is less likely to be viable, since concentrated impacts can be a cornerstone around which opposition to the policy can be mobilized [Olson, 1971].

[1] Note that because of on-going growth in emissions as a result of economic expansion and structural change, the current federal target to reduce emissions by 17 percent from 2005 levels by 2020 likely corresponds to a reduction of 25 percent or more from business as usual levels in 2020.

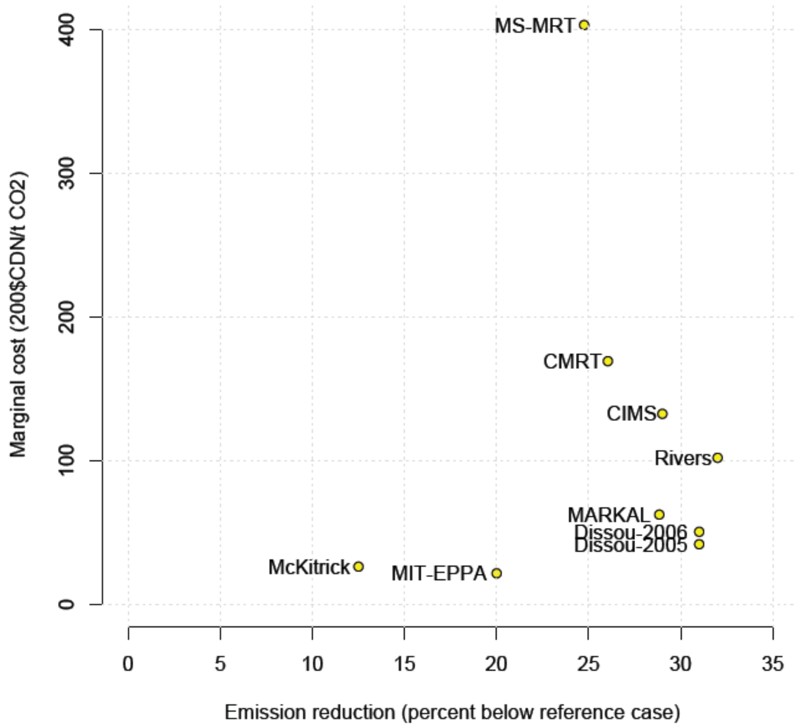

Figure 1: Model simulations of marginal abatement costs in Canada

Source: McKitrickis from [McKitrick, 1997]; MIT-EPPA is from [Morris et al., 2008]; MARKAL and CIMS are from [Jaccard et al., 2003]; Dissou are from [Dissou, 2005] and [Dissou, 2006]; Rivers is from [Rivers and Jaccard, 2010], CMRT is from [Snoddon and Wigle, 2007]; and MS-MRT is from [Wigle, 2001].

Notes: All dollar values are converted to 2005 Canadian dollars for comparability. Where possible, all reported values correspond to scenarios in which all revenue from carbon pricing is returned to households in lump sum. In all models, the time frame from policy implementation until the emission target is reached is about 10 years.

Previously proposed and implemented market-based climate change policies in Canada have taken distributional consequences into account in policy design, underscoring the importance of a well-developed understanding of distributional impacts of environmental policies. For example, the introduction of British Columbia's carbon tax was accompanied by a “Low Income Climate Action Tax Credit” paid to individuals and families defined as low income [British Columbia, 2008].[2] Following lobbying by rural municipalities, British Columbia's government also initiated a “Northern and Rural Homeowner Benefit”, valued at up to $200 per year and starting in the 2011 tax year [British Columbia, 2010]. Similarly, the `Green Plan' 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. These measures included 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. Like the British Columbia carbon tax, the proposed federal carbon tax also included support for

[2] The tax credit of $100 per adult and $31.50 per child applies to families earning less than $35,843 in 2010.

Northern and rural Canadians in the form of a Green Credit valued at $150 annually per household [Liberal Party of Canada, 2008]. Clearly, distributional concerns are of primary concern to policymakers considering implementing market-based carbon policies.[3]

This primary objective of this report is to outline previous literature and theory relating to the distributional impacts of carbon policies, with a particular focus on the Canadian context. Throughout the paper, the focus is on intra- rather than inter-regional distribution of a carbon policy's impacts. That is, the paper does not examine how carbon policies might concentrate impacts on certain provinces within Canada, but instead outlines how such policies might impact households across demographic groups that are common to all provinces. The regional incidence of carbon policies is of critical importance, however, and is addressed in other publications ([Snoddon and Wigle, 2009, Snoddon and Wigle, 2007]).

2. Previous literature

2.1 Tax incidence theory

When economists measure the distributional incidence of a policy, they are attempting to measure who bears the economic burden of the policy, or how the policy differentially affects the welfare of individuals throughout society. Analysis of the distributional incidence of policy changes - particularly taxes - is a fundamental area of research in public economics. Analysis of the distributional impact of carbon policies can therefore build upon a rich literature that has emerged from previous studies of the corporate income tax, payroll taxes, and excise taxes [Kotlikoff and Summers, 1987] and [Fullerton and Metcalf, 2002] provide excellent summaries of the economic literature on the incidence of taxes).

A carbon policy can influence an individual's welfare through several avenues. First and most obviously, by raising the prices of fossil fuels, it most penalizes those individuals that consume large amounts of fossil energy, and for whom there are no close substitutes for this consumption. Figure 2 shows the expenditures on fossil energy per household by expenditure quintile as a proportion of current household expenditure. On average, households in Canada devote about 5 percent of their total household budget to fossil fuels. However, there is some variation across different expenditure levels. The poorest households spend about 4.7 percent of household budget on fossil fuels, while middle income households spend more than 5 percent, and the wealthiest households spend under 4 percent.

[3] Interestingly, for policies where the statutory incidence falls on business, like Alberta's Specified Gas Emitters Framework or Quebec's carbon tax, the issue of distributional incidence appears less important to policy makers and the public, and as a result there have not been measures taken to reduce or eliminate undesirable distributional impacts. To economists, however, the statutory incidence of the policy does not dictate the economic incidence.

A policy that raised the price of fossil energy might therefore be expected to impact somewhat more severely on middle income households than high-income or low-income households.[4]

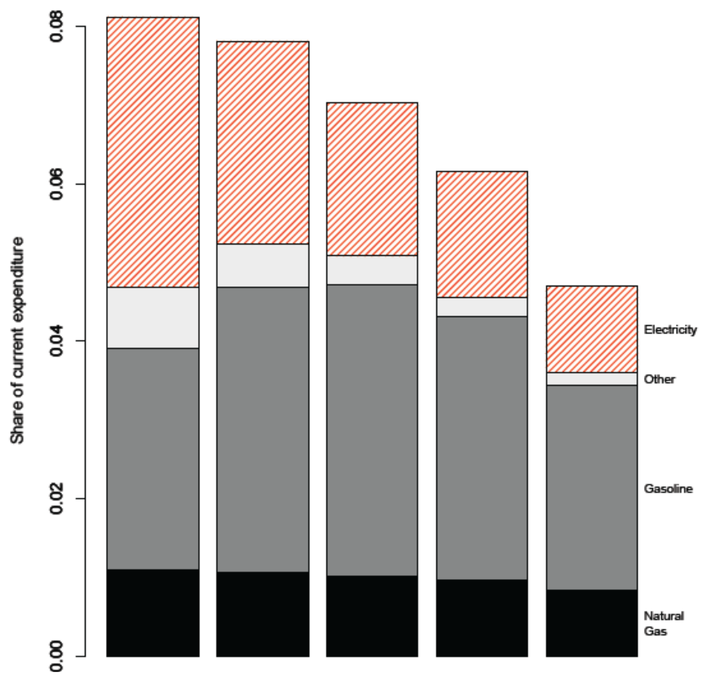

Figure 2: Household budget shares for energy, 2005

Source: Author's calculations using data from Statistics Canada, Survey of Household Spending, 2005.

Notes: Expenditures on fossil fuels are shown as solid boxes in greyscale. Expenditure on electricity is shown as hatched boxes. Households are grouped according to expenditure quintile. The first quintile covers all households with an annual expenditure (including income taxes, gifts, and contributions to charity) of less than about $27,000, followed by $45,000 for the second quintile, $66,000 for the third quintile, $95,000 in the fourth quintile. The fifth quintile includes all households with an annual expenditure greater than $95,000.

[4] I show expenditures on fossil energy as a proportion of total current expenditure rather than as a proportion of income because analysis by Poterba and others has suggested that using annual income as a basis for tax incidence calculations can be misleading if one is actually interested in the lifetime burden of the tax [Poterba, 1989]. Since individuals move between categories throughout their lives, and since individuals can borrow or save to smooth their consumption profiles over time, current-year income may be a poor proxy for lifetime income. As an example, a student pursuing a degree in medicine might have very low current-year income, but very high expected lifetime income. Because of difference in lifetime and current income, measuring the incidence of a policy using current-year income would give a poor measure of the impact of the policy over the life of the doctor. Similarly, for a retired individual, current-year income might be substantially below average lifetime income, even though the individual might be wealthy as a result of accumulated savings. While understanding the lifetime impact of a policy might be desirable, measuring lifetime income is difficult. Poterba, however, suggested that current- year expenditure is a reasonable proxy for lifetime income, because individuals can borrow or save when annual income deviates from annualized lifetime income, to smooth their consumption profile. As a result, it is conventional in studies of tax incidence to compare individuals according to current-year expenditure rather than current year income.

A second way in which a carbon policy could influence an individual's well-being is by changing the prices of other goods and services purchased by the individual. For example, if the carbon policy increases the cost of producing certain goods, and if producers of these goods pass cost increases on to consumers, then consumers will experience increased prices not just for fossil energy, but for these other goods as well. An obvious example is electricity. Production of electricity produces over 100 million tonnes of greenhouse gas emissions annually in Canada, as a result of burning coal and natural gas in fossil-fired power plants. A market-based policy that increased the cost of these fuels would therefore likely lead to increased cost of electricity generation, and increased electricity prices for consumers. Since individuals consume different amounts of electricity as shown in Figure 2, this opens up the possibility for differential impacts of the policy between households. As the figure shows, households with low overall expenditure tend to spend a much greater proportion of their total budget on electricity than households with high total expenditures. Increases in the price of electricity might therefore exacerbate income inequality in Canada. The indirect price impact of carbon policies is not limited to the electricity market. Since almost all products require energy during production, increases in the prices of fossil fuels can have ripple effects in seemingly unrelated products (some of these might increase inequality, and others might reduce inequality).

A third avenue via which a carbon policy can differentially impact the welfare of individuals is by changing their incomes. Incomes can change as a result of a carbon policy because firms may not fully shift the burden of the carbon policy onto consumers through higher product prices. Instead, some of the burden of the carbon policy may be absorbed by the firm, and reflected in lower wages to its employees or lower profits to its owners. When this occurs, economists say that the burden of the tax has been "shifted backwards" ([Yohe, 1979, Fullerton and Heutel, 2007]).

The degree to which a tax is shifted backwards depends on the characteristics of each particular market in which the policy applies. If consumer demand for the product is inelastic, such that the quantity of demand by consumers does not change substantially when the price changes, then the burden of the policy will be shifted forwards onto consumers and reflected in higher consumer prices, with distributional consequences as described above. In contrast, if consumer demand for the product is elastic, as is the case when close substitutes for the product are available, then the burden of the policy will be shifted backward onto producers and reflected in lower incomes for owners and workers of firms.[5] Additional complications arise if the market in which the policy applies is made up of a small number of firms with power to set prices. In this case, the amount that the tax is shifted forward depends on the supply and demand elasticities as well as the number of firms in the market. When firms have market power, it is theoretically possible for them to "overshift" a tax, so that consumer prices rise by more than the full amount of the tax. The degree to which firms shift the burden of a policy forward onto consumers compared to backward onto owners and workers is clearly important in determining

[5] Formally, in a competitive market the incidence of the tax is determined by the relative elasticities of supply and demand. [I don't know if it's just my program, but it looks like the equations in the text below have all disappeared.] Given equilibrium of supply and demand at the consumer price p, and a tax on supply denoted by τ , equilibrium is given by: $D(p) = S(p-\tau)$. This expression can be differentiated to give the change in consumer price with respect to the tax rate: $dp = \eta s \frac{\eta s}{\eta s - \eta D} d\tau$, where $\eta i,\ i = (S, D)$ is the elasticity of supply or demand. If the absolute value of the demand elasticity is large relative to the supply elasticity, the consumer price remains unchanged, and the producer bears the burden of the tax. If the absolute value of the demand elasticity is small relative to the supply elasticity, the consumer price changes by the full amount of the tax.

the ultimate incidence of the policy. When a policy is shifted forward onto consumers, it impacts different consumers according to their consumption of the regulated good and their ability to substitute away from that good, as described above. When a policy is shifted backward, it lowers the return on capital earned by owners of the firm and potentially also the wage rate paid to the firm's workers. Since ownership of firms is concentrated in wealthy households, and since labour supply is different depending on household composition, this “backward shifting” of carbon policy can itself have important distributional consequences.

2.2 Previous studies

With the rising prominence of market-based approaches to climate change mitigation, there have been a number of attempts to quantify the distributional impacts of such policies. Table 1 summarizes several of these attempts, and groups them according to method of analysis. As shown in the table, most previous studies use an input-output model in combination with a consumer expenditure survey. The input-output model is used to propagate price impacts resulting from carbon pricing, which manifest themselves in higher fossil fuel prices, into indirect price impacts on goods consumed by consumers. Subsequently, these indirect price changes, along with direct price changes for fossil fuels consumed by consumers, are used with data from a consumer expenditure survey to estimate incidence of the carbon price.

In general, this type of study finds that the absolute incidence of carbon taxes in developed countries is regressive, meaning that poorer households experience a larger loss in relative income or consumption as a result of a carbon tax than wealthier households.[6] In contrast, in less developed countries, analysis often suggests that the absolute incidence of carbon taxes can be progressive. These results arise directly from the shares of expenditure on carbon goods by households in consumer expenditure surveys. Since (in wealthy countries) poor consumers spend a larger fraction of their income on carbon goods, it follows that carbon taxes will be shown to be regressive using this modelling approach. Using current year expenditure as a proxy for lifetime income, as suggested by Poterba [Poterba, 1989], can dilute or even reverse this trend; see for example [Dinan and Rogers, 2002]. Additionally, most studies suggest that while the absolute incidence of a carbon tax falls relatively heavily on poor consumers, the amount of revenue generated by the carbon tax is sufficient to offset this regressivity using targeted tax measures or lump-sum recycling; see for example [Callan et al., 2009]. As a result, the differential incidence of carbon taxes has the potential to be progressive.

This modeling approach, however, misses some important elements that can have significant impacts on the incidence of the policy. First, in this modeling approach neither consumers nor producers are able to respond to price changes by substituting among inputs. Since the purpose of a carbon price is

[6] Three types of modeling studies are used to assess the incidence of a tax. In an absolute incidence analysis, revenues from the tax are ignored, so that only the incidence of the tax itself, and not the subsequent use of revenue, is assessed. In a balanced budget analysis, it is assumed that the revenue raised by the tax is spent by government. Since certain government programs and transfers can have a distributional impact themselves (by changing prices in various markets), this complicates the analysis of incidence (but makes it more realistic). Finally, in a differential analysis, it is assumed that the revenue is used to lower some other tax, which again complicates the simple estimates from absolute studies. See [Fullerton and Metcalf, 2002].

to cause shifts in how products are produced and consumed, and since the ease of substitution among inputs impacts the welfare implications of a price change, this seems like a problematic assumption.

Second, these studies assume that all costs of the tax are borne directly by the consumer, and that none of the incidence of the policy is shifted backwards. Since it is unlikely that consumer demand is perfectly inelastic or that producer supply is perfectly elastic, this is a problematic assumption. A better understanding of the incidence of a carbon policy would come from a model that explicitly accounted for the possibility for producers to pass taxes backward to factors as well as forward to consumers.

Table 1: Summary of literature findings on distributional impacts of environmental policies

Study	Finding
Input output model with consumer expenditure survey	
[Metcalf, 1999]; package of various environmental taxes in US	Absolute incidence: regressive; Differential incidence: neutral or progressive
[Brenner et al., 2007]; carbon tax in China	Absolute incidence: progressive; Differential incidence: highly progressive
[Dinan and Rogers, 2002]; carbon tax in US	Absolute incidence: regressive; Differential incidence: potentially progressive
[Hamilton and Cameron, 1994]; carbon tax in Canada	Absolute incidence 'moderately regressive'
[Callan et al., 2009]; carbon tax in Ireland	Absolute incidence: regressive; Differential incidence: neutral
[Lee and Sanger, 2008]; carbon tax in BC	Absolute incidence: mildly regressive; Differential incidence: potentially progressive
Econometric estimation of consumer demand system	
[Tiezzi, 2005]; carbon tax in Italy	Absolute incidence: progressive
[West and Williams, 2004]; gasoline tax in US	Absolute incidence: regressive; Differential incidence: potentially progressive (with lump sum distribution)
[West and Williams, 2004]; carbon tax in Australia	Absolute incidence: regressive
Computable general equilibrium model	
[Parry, 2004]; various environmental policies in US electricity (partial equilibrium model)	Differential incidence: highly regressive (with grandfathered permits) or mildly regressive (with lump-sum allocation to households)
[Heerden et al., 2006]; carbon tax in South Africa	Differential incidence: progressive
[Araar et al., 2008]; carbon policies in Canada (CGE model with stochastic dominance analysis)	Differential analysis: mildly regressive
[Oladosu and Rose, 2007]; carbon tax in Susquehanna River Basin	Absolute incidence: slightly progressive; Differential incidence: highly progressive (with lump-sum permits allocation to households)

A second approach to exploring the distributional aspects of environmental policy, shown as the middle group of studies in Table 1, explicitly recognizes the ability of consumers to change decisions in response to changing prices, through the estimation of a consumer demand system. Both Tiezzi and West and Williams estimate an almost ideal demand system based on a time series of household expenditure data disaggregated across household types, in Italy and the United States respectively [Tiezzi, 2005,West and Williams, 2004]. Cornwell and Creedy estimate a linear expenditure system based on similar data for Australia [Cornwell and Creedy, 1997]. Using this approach, they are able to model consumer response to the price changes from a carbon or gasoline tax, and measure welfare change using a true cost of living index. Tiezzi finds that the absolute impact of a carbon tax in Italy is mildly progressive, West and Williams find the opposite for a gasoline tax in the US, as do Cornwell and Cready for a carbon tax in Australia. These studies offer a significant improvement in some respects over the fixed-coefficient studies described above. By allowing consumers to respond to price changes by altering their consumption basket in a way that matches observed behaviour, they more closely capture the welfare impacts of price changes. However, as with the input-output approach, these studies do not capture the imperfect ability of firms to pass taxes forward onto consumers, and so assume consumer income is fixed in response to policy changes. Further, these studies ignore producer response to environmental policies, which can be important in mitigating their ultimate impact.

Computable general equilibrium models, which allow the burden of a tax to be passed forward onto consumer prices or backward onto factors, and also model the process of adjustment to a policy by both producers and consumers, should offer a closer approximation of the welfare changes resulting from an environmental policy. A small number of CGE studies have been conducted to assess distributional consequences of climate change policy; these are summarized in the bottom part of Table 1.

Heerden et al. analyze a variety of environmental taxes in South Africa, with the aim of finding a combination of tax and revenue recycling scheme that simultaneously reduces poverty rates, increases economic output, and reduces emissions [Heerden et al., 2006].Their model suggests that a carbon tax coupled with food tax reductions could achieve these goals. Importantly in this context, the model results are driven partly by dynamics in factor markets; by reducing food taxes, food production is encouraged. This sector has a large demand for elastically supplied unskilled labour, and so increasing output helps to reduce unemployment and also poverty rates.

Oladosu and Rose use a regional CGE model to assess the distributional impact of carbon taxes in the Susquehanna River Basin in the US [Oladosuand Rose, 2007]. They conduct a balanced budget analysis and find that a carbon tax is slightly progressive. Again, dynamics in factor markets are an important component of their results: they find carbon-intensive industries are skilled labour intensive, such that carbon taxes reduce the skilled wage rate, which is paid predominantly to high-income households.

Araar et al. use a Canadian CGE model to measure changes in factor and commodity prices following a carbon policy [Araar et al., 2008]. Subsequently, they undertake a stochastic dominance analysis by combining the price changes with data from a consumer expenditure survey containing over ten thousand households. They find that using proceeds from a carbon tax to reduce consumption taxes has a lesser impact on poverty rates than using proceeds to reduce labour taxes, and that either of these is superior to an output-based recycling scheme.

3. Discussion and conclusions

Several key points emerge from the theoretical and empirical studies that have attempted to estimate the distributional consequences of market-based climate change policies.

- Carbon policies can impact the welfare of households in three primary ways:

    1. By increasing the consumer price of fossil fuels.
    2. By affecting the consumer price of other goods and services.
    3. By affecting the incomes of consumers.

- For an accurate understanding of the distributional impacts of carbon policies, it is important to consider all three of these avenues. Additionally, it is important to recognize that both consumers and producers adjust when carbon policies are applied by changing the types of goods they purchase. This can help to mitigate the economic impact of a carbon policy, and should be considered in modeling studies that aim to assess the distributional impact of such policies. Currently, many empirical studies do not consider all three avenues through which carbon policies can influence consumer welfare, and do not consider the process of adjustment that takes place by consumers and producers when a carbon policy is applied.

- Most studies in developed countries find that the absolute incidence of a carbon policy is regressive, such that low-income households are impacted relatively more than high-income households. This conclusion holds in three studies conducted in Canada that were reviewed for this paper. However, this conclusion is dependent on the metric used. When households are grouped according to current-year expenditure rather than current-year income, carbon policies are usually found to be much less regressive. Economists often recommend grouping households according to current-year expenditure rather than income, to capture consumption-smoothing that occurs throughout the lifetime of individuals.

- Even where the absolute incidence of a carbon policy is found to be regressive, nearly all research suggests that the differential incidence of a carbon policy need not be regressive. In fact, most studies suggest that a `cap-and-dividend' approach, where carbon revenues are distributed to households on an equal per-household basis, is likely to be highly progressive. In contrast, some studies suggest that when revenues from the carbon policy are used to lower pre-existing personal or corporate income taxes, the distributional incidence will be regressive.

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