A rural myth? Sources and implications of the perceived unfairness of carbon taxes in rural communities

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A B S T R A C T

Since British Columbia’s carbon tax was implemented in 2008, local interest groups and municipal politicians have claimed that the tax places an unfair burden on rural communities. We investigate the sources of this perception of unfairness and its implications for policymaking. We examine the distributive effects of British Columbia’s carbon tax using a computable general equilibrium model of the Canadian economy. We find that the rural population would indeed have experienced a disproportionate burden had the carbon tax been introduced without redistributive measures, but that the revenue recycling program introduced in parallel with the tax was sufficient to balance the inequity. Hence, the Northern and Rural Homeowner Benefit Program, a transfer program introduced later in response to public protests, was unnecessary. Additionally, analysis of polling data shows that the new program failed to increase support for the carbon tax in rural communities, despite making these households better off on average than households in large urban centers. We therefore conclude that this ongoing opposition is based on a rural myth. Policymakers should carefully investigate distributive impacts of carbon policies and address evidential inequities. Yet, before overcompensating groups that still feel disadvantaged, policymakers should address the myth of unfairness at its source.

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1. Introduction

It is a common perception that carbon or fuel taxes hit rural households harder compared to households living in urban communities, mainly due to the greater dependence of rural households on car travel and their increased fuel needs to heat their typically larger and more remotely located homes. As a result, support for such policies in rural communities is often lower than in urban areas. Yet empirical evidence of the distributional effects of fuel taxation on rural versus urban households is scarce and in the absence of supporting evidence it is not clear whether the perceived injustice is merely a ‘rural myth’. Several questions arise: Do rural communities indeed carry a disproportionately larger share of the costs resulting from a carbon tax? If yes, what can government do to offset the burden on households in rural communities? If not, why do rural people perceive a disadvantage and should policymakers respond to these perceptions?

We investigate these questions using the carbon tax policy in British Columbia as a case study. In 2008, British Columbia became the first jurisdiction in North America to introduce a carbon tax to meet its emission reduction target. The tax is now $30/t CO₂,¹ and applies to almost all fossil fuel combustion in the province. The tax is designed to be revenue neutral by law, which means that the government must fully recycle carbon tax revenues to households and businesses through other tax cuts and targeted benefit payments. The policy has received overall positive responses yet there has also been a popular belief that the policy’s costs are allocated unevenly across the province (Lee and Sanger, 2008). In particular, rural households in the Northern part of the province have claimed that they have been disproportionally burdened by the carbon tax. These communities suggested that their consumption of heating fuels and gasoline was inherently higher and more difficult to be substituted than that of households in the urban centers of the province’s South. Protests effected the announcement of the Northern and Rural Homeowner Benefit Program in the 2009 Budget as a mechanism for carbon tax revenue recycling. The program has been available to eligible households since the 2011 tax year, apportioning 6–7% of the total carbon tax revenue.

The introduction of the homeowner benefit program can be seen as part of a general trend, whereby an increasing amount of British Columbia’s carbon tax revenue is directed away from broad cuts of distorting labor and capital taxes towards more specific lump sum...
payments and tax incentives to specific interest groups. This trend raises concerns about the policy’s cost effectiveness, and in particular its capacity for triggering double dividend effects. Initially, British Columbia’s carbon tax has been considered a textbook model for efficient carbon legislation including uniform prices across fuels and emitters, full revenue recycling mainly through broad cuts of other distortionary taxes and only very few exemptions. There is a risk that going forward, political conflicts and the exemptions and concessions granted to appease these conflicts may gradually compromise the policy’s effectiveness and efficiency as vocal lobby groups achieve exemptions and benefits under the carbon tax revenue recycling program (Harrison, 2013).

We use a static computable general equilibrium model (CGE) of the Canadian economy to investigate the welfare implications of the British Columbia carbon tax and revenue recycling measures on rural as compared to urban households in 2012. To do so we disaggregate British Columbia households by location; we distinguish rural, small urban and urban households. We also decompose welfare impacts to identify some mechanisms behind the different experiences of households in different locations. Specifically, we investigate the impact of the groups’ varying transportation patterns on tax incidence and thus respond to a central argument put forward by opponents to the tax. We find the following. First, had the British Columbia carbon tax been introduced without any revenue recycling measures in place (i.e., if revenue had been retained by government), rural households in British Columbia would indeed have experienced the largest welfare loss due to the carbon tax. However, in contrast to the common belief, we find no evidence that the limited availability of public transport in remote areas has any significant impact on tax incidence. We do find, however, that the expenditure share of transportation fuels for rural households is larger than that for urban households, and this is an important driver of the incidence of the policy. Second, our results indicate that the revenue recycling program introduced in parallel with the tax in 2008 (not including a transfer program specifically targeted at rural households) was sufficient to generate a welfare gain for all household groups.3 While rural households still benefit the least from the policy, compared to households in urban and small urban areas, the differences are trivial in size. It follows that, according to our analysis, there was no need for the introduction of the homeowner benefit program following the implementation of the tax. Third, we find that the introduction of the program significantly overcompensated rural households, such that these households are net beneficiaries from the carbon tax and associated revenue recycling mechanisms, relative to urban households. Finally, we also make use of polling data to document that rural opposition to the carbon tax was maintained (and actually significantly increased) following the introduction of the benefits, which seems to indicate that the program failed to address the concerns.

We conclude that the evidence base of perceived unfairness of carbon taxes to rural communities should be analyzed carefully before policy actions are taken. If such analysis does not support these perceptions, governments can focus on uncovering and effectively addressing the underlying sources of this ‘rural myth’ instead of using carbon tax revenues to “buy” support from rural constituencies, which may put at risk the economic efficiency of the policy, and which does not seem effective at garnering support from the targeted groups anyway.

The organization of the remainder of this paper is as follows. Section 2 describes key design features of the British Columbia carbon tax regime. Section 3 discusses existing research on the social acceptability of a carbon tax and the urban–rural divide in perception of the fairness of such a policy. Section 4 presents the CGE model and data that we use for the analysis of distributional impacts. Section 5 outlines the simulation experiments, and reports the results. Section 6 explores how support for the carbon tax differs in urban and rural communities. Section 7 concludes and suggests policy implications.

2. Overview of the British Columbia carbon tax

British Columbia aims to reduce GHG emissions by 33% below 2007 levels by 20204 and the carbon tax was introduced as the central measure for achieving this goal. An estimated 77% of British Columbia’s total GHG emissions are covered by the tax, including all emissions from burning fossil fuels, tires and peat, and other materials to generate energy or heat.5 In the first five years of its existence the tax rate increased annually in $5/tonne steps, from its starting level at $10/tonne in 2008 to its current level at $30/tonne. No further increases are planned. The tax applies to all fuels used or purchased in British Columbia, and is calculated based on their carbon content. Greenhouse gases other than carbon dioxide are included and weighted according to 100-year global warming potentials. The initial idea was to treat all sectors and activities the same, but the provincial budgets from 2012 and 2013 introduced partial exemptions for the greenhouse sector and the rest of the agriculture sector (Rivers and Schaufele, 2014).

A key design feature of the British Columbia carbon tax policy is revenue neutrality, i.e. the full recycling of all carbon tax income to British Columbia residents by means of other tax reductions and lump-sum payments (British Columbia, 2012). Each year, British Columbia’s Minister of Finance develops a 3-year plan for how to redistribute the anticipated gross carbon tax revenues. This plan is brought to the Legislative Assembly together with the provincial budget. The forecasts are revised as new information becomes available. To date, the British Columbia government has not only ensured revenue neutrality but implemented rebates and tax cuts slightly larger than the revised carbon tax revenues. Each year from 2008 to 2012, the granted tax cuts and transfer payments exceeded carbon tax payments by roughly 10%. As shown in Table 3 total carbon revenue in fiscal year 2011/12 (the analysis year for this paper) equaled $959 M but recycling measures amounted to $1141 M (British Columbia Ministry of Finance, 2013).

In fiscal year 2011/2012, nearly 60% of revenue measures targeted businesses and 40% went to households. Carbon tax revenue in British Columbia has been recycled back to businesses through two channels: (a) personal tax reductions and transfers to households and (b) business tax rate reductions and corporate tax credits.

Revenue recycling measures to households comprise of personal income tax rate reductions and lump-sum transfers, both primarily targeted at low income households. In 2008/09 the government cut the income tax rates for the two bottom brackets by 5% (i.e. for annual taxable income up to $70,000) using carbon tax revenues. In fiscal year 2011/12, $220 M or 47% of the total personal tax measures were used to fund this personal income tax cut. In terms of direct transfers, the largest program is the British Columbia Low Income Climate Action Tax Credit that was introduced with the carbon tax in 2008. In 2011/12 the program received $184 M in support which corresponds to 39% of total revenues redistributed to households.6 The third largest recycling measure to support households is the Northern and Rural Homeowner Benefit program, which was introduced in the 2009 budget (for the

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4 Interim mitigation targets have been set at 6% in 2012 and 18% in 2016.
5 The remaining emissions are mainly related to agriculture, land-use change, and industrial processes.
6 Eligibility for the Climate Action Tax Credit depends on net household income and household size. The maximum receivable amount equals $115.50 per adult and $34.50 per child. In 2011, the net income threshold for singles households was at $31,711 and at $36,997 for married couples or single parents. Households with net income exceeding these thresholds may still be able to claim a reduced credit.
2011 tax year) in response to vocal opposition to the carbon tax policy by municipalities in the northern interior of the province. The program grants support of up to $200 to homeowners located outside of three relatively urban regional districts in the South of the Province. Eligibility for the homeowner benefit is linked to property value and additional criteria related to age and income. In 2011/12, the revenue allocated through the homeowner benefit program amounted to $66 M, or 14% of the total amount redistributed to households.

3. The urban–rural divide on carbon and fuel taxes

3.1. Regional perception of the carbon tax in British Columbia

The rural population in northern interior British Columbia has been particularly vocal in their rejection of the carbon tax. At the 2008 annual meeting of the North Central Municipal Association members almost unanimously supported a resolution claiming the policy was unfairly burdensome to northern communities. The main concerns raised were related to the inherently greater fuel consumption of households living in the rural north compared to urban households in the south resulting in a disproportionately larger carbon tax burden (Harrison and Peet, 2012). It is claimed that the geographical remoteness and cold temperatures of northern communities raise demand for space heating and require people to buy larger cars and drive longer distances to work, shops, and medical care. The absence of public transit options, such as buses and trains, is seen to imply that reducing carbon emissions is not a matter of choice for people living in the north and that fuel consumption is not a matter of lifestyle but a necessity (Austin, 2008). Therefore, municipal representatives from northern towns claimed the carbon tax was putting citizens in rural northern towns at a disadvantage compared to the urban population of the south, where transport infrastructure is better and heating needs are less.

Looking closer at the sources of the rural population’s perception of unfairness, there are indications that the carbon tax was considered a sign of political disempowerment and of discrimination against northern voters. At the 2012 hearings of the Select Standing Committee on Finance and Government Services in Northern communities one witness stated (Legislative Assembly British Columbia, 2012): “No doubt people who are in favor of the carbon tax probably live in Vancouver and Victoria where they enjoy subsidized public transit and a warmer climate where their heating and fuel bills are a fraction of ours.” Another witness claimed: “This [the increased heating costs] is a northern issue. […] That’s [the carbon tax] a southern policy. It doesn’t fit with what we need in the north.” From these statements that emphasize the ‘otherness’ of the urban south, it becomes clear that opposition to the carbon tax is closely linked with the perceived own identity of northern British Columbia citizens—an identity that is separate and different from people in the south of British Columbia. Harrison and Peet (2012) describe this northern identity to consist of “cold weather, vast distances, and a resource-based economy.” These parts of northern identity are vulnerable to the introduction of the carbon tax. Harrison and Peet (2012) further argue that the introduction of the policy touched some deep and longstanding regional tensions between people in the rural North and the urban South of the province. These tensions are related to the political and economic history of British Columbia (Brownsey et al., 2010). Historically, communities in the north have made their livelihoods from supplying the corporations based in the south with natural resources, creating a relationship of economic dependence. At the same time, voters in the north have typically been vastly outnumbered by the much more populated Lower Mainland (Markey et al., 2007). As a result, the north has developed the perception of being economically disempowered and politically marginalized (Harrison and Peet, 2012). This perception of fundamental power inequality helps explain the specific regional patterns of opposition to the carbon tax: Northern citizens considered the tax as yet more proof that their needs and their existing vulnerabilities are not being recognized by those in power.

Previous research on the social acceptability of carbon taxes and other environmental levies similarly shows that individuals’ opinions are driven largely by social norms (Schade and Schlag, 2003), political ideology (Thalmann, 2004) and misunderstanding (Dresner et al., 2006a, 2006b) rather than informed reasoning about the policy implications. Citizens’ perception of fairness of a policy is necessarily subjective and many times not equivalent to what theoretical and empirical analysis suggest.

3.2. Existing studies on the effects of carbon taxation on urban vs. rural households

The broader literature on distributional impacts of carbon taxation and revenue recycling on households is too large to be fully reviewed here. Existing partial or general equilibrium studies commonly investigate effects on households grouped by income and/or geographical region and come to different conclusions about carbon tax incidence. This is partly because the extent to which carbon taxes are found to be regressive (progressive) significantly depends on the analysts’ choice of measurement, methodology, and key parameter assumptions (Dinan, 2012; Dissou and Siddiqui, 2014; Fullerton and Heutel, 2010). Recent studies in the Canadian context, suggest that a federal carbon tax has progressive impacts at lower tax levels but the opposite effect at higher levels (Dissou and Siddiqui, 2014) and that the British Columbia carbon tax is mildly progressive (Beck et al., 2015).

Only few analyses specifically investigate impacts on households differentiated by location in terms of community size. These studies tend to conclude that rural households are disproportionately burdened by carbon and fuel taxes. For example, Vennemo et al. (2009) use a dynamic CGE model of the Chinese economy to investigate the distributional impacts of abatement commitments on households with varying incomes and in different regions. The authors find that poor rural households in regions with large dependence on mining and heavy industry experience the highest welfare losses. Vennemo et al. (2009) recommend redistribution by means of revenue recycling.

Looking more specifically at mechanisms that drive the uneven tax incidence, Bureau (2011) uses a partial equilibrium model to investigate alternative scenarios of carbon taxes on car fuels in France. Results indicate that the poorest households that live in peri-urban or rural areas lose up to 90% more in welfare due to the introduction of a carbon tax than the richest households. The reason is that peri-urban and rural households drive more mileage than urban households and at the same time have a lower elasticity of fuel demand, which Bureau (2011) explains through their reduced availability of alternative transport options. Bureau (2011) also considers alternative schemes for redistributing carbon tax revenues but no scenario includes a targeted compensation for rural households.

Findings by Bureau (2011) support earlier results by Blow and Crawford (1997) on the distributional impacts of fuel taxes based on UK household data differentiating households across income and location. Blow and Crawford (1997) suggest that the tax raises the cost of living slightly more in rural as compared to urban areas. The explanation is that rural households are more likely to own a car and have higher mileage than urban households. Results also show that the availability of a frequent bus and rail service helps reducing mileage driven.

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7 Capital Regional District, Greater Vancouver Regional District, and the Fraser Valley Regional District
8 The submission’s argument against the tax and the included citizens’ comments indicate that two other major concerns are the burden the tax puts on British Columbia’s small businesses and their resulting inability to compete with businesses in other jurisdictions as well as the perceived lack of environmental effectiveness of the carbon tax (Bateman, 2012).

9 Rausch et al. (2010) provide a more extensive overview.
and that the lower the real cost of bus travel the greater the reduction in car mileages.\textsuperscript{10} In contrast to these results, Kallbekken and Saalen (2011) use survey data from Norway to investigate the factors driving people’s attitudes towards fuel taxes and find that the variable ‘availability of alternative transport’ did not have significant predictive power.

Regarding the urban–rural tax incidence in British Columbia, the provincial Budget from 2008, when the tax was first introduced, contained one exemplary illustration of the financial effects of the carbon tax on a rural household, and finds that the gains from tax cuts exceed tax payments (British Columbia Ministry of Finance, 2008). Later studies on the equity impacts of the British Columbia carbon tax, in particular in the context of a 5-year tax review in 2012, do not explicitly touch on the urban–rural divide. The information provided by the British Columbia government on the official review process does not address regional equity issues (British Columbia Ministry of Finance, 2013), Lee (2011) and Lee and Sanger (2008) use micro-simulation analysis to estimate the impact of the carbon tax on household energy expenditures by income level, but not by location. Beck et al. (2015) use a CGE model to examine carbon tax incidence in British Columbia across income groups but, again, do not distinguish households by location.

This study complements the existing literature reviewed here in at least two important ways. First, this paper is different from existing studies in that we analyze an implemented rather than a hypothetical policy scenario. Key parameter choices that drive findings about carbon tax incidence, e.g. tax rate and revenue recycling, are observed rather than chosen by the analyst. Second, we explicitly focus on the location of residence as the critical variable for household disaggregation rather than income and geographic region as done by other studies. Our analysis relates to previous research in that rural households concentrated in the North of British Columbia, are systematically poorer than urban households but goes beyond it by specifically isolating some of the suggested mechanisms behind the distributional effects on rural populations, including fuel expenditures and public transport choices.

4. The model

4.1. Overview

We use a static, multi-region, multi-sector, multi-household computable general equilibrium model of the Canadian economy. A general equilibrium model is useful for assessing the incidence of tax changes because it allows the incidence of the tax to emerge in response to properties of the model, rather than to be imposed as an assumption (Fullerton and Metcalf, 2002). A number of studies show that it is important to account for general equilibrium effects in the context of assessing the incidence of environmental policies (Fullerton and Heutel, 2007, 2010; Rausch et al., 2011). In addition, the CGE model provides a comprehensive and theoretically consistent framework for assessing the incidence of environmental policies (Fullerton and Metcalf, 2002). A number of studies show that it is important to account for general equilibrium effects in the context of assessing the incidence of environmental policies.

The model includes 10 regions (one for each province, with Prince Douglas). The model includes 10 regions (one for each province, with Prince Douglas). The model distinguishes 19 production sectors in the economy, including 5 energy sectors (coal, natural gas, crude oil, refined oil products, and electricity) and 6 manufacturing sectors (pulp and paper, primary metal, chemical, cement, vehicle, and other). In each sector, output is produced by perfectly competitive firms combining labor, capital, and intermediate inputs (including energy).\textsuperscript{11} As is common, we employ nested constant elasticity of substitution production functions. Elasticities and the nesting structure of production functions are drawn from Okagawa and Ban (2008), and detailed in Böhringer et al. (forthcoming) and Beck et al. (2015).

Households jointly choose labor supply, savings, and consumption to maximize utility subject to a budget constraint that requires total income equals total expenditure. First, households allocate income between current full consumption and future consumption (saving) using a Cobb–Douglas specification that implies that households save a constant fraction of total income.\textsuperscript{12} The current consumption aggregator is composed of leisure and material consumption. The elasticity of substitution between these inputs is chosen such that the labor supply elasticity matches empirical estimates. Households supply capital (including sources) and labor to firms. Firms accounts (i.e., profits, firm re-investment) are incorporated into household accounts.

Markets for all factors are assumed to clear perfectly. Labor is treated as perfectly mobile between sectors, but immobile between regions (i.e., no inter-regional migration). The capital stock is divided into two equal parts: one part is treated as immobile between sectors and regions, and the other is mobile both between sectors and regions. In our static model, capital stock is fixed while the rental rate on capital is endogenously determined.

Consumption by households is made up of a bundle of all the goods produced in the model (the bundle of goods is distinct for each household, as described below). Households consume a mix of domestic and foreign variants of each good, with the mix dictated by relative prices of each variant. Households can substitute between goods as relative prices change. The nature of substitution is given by the constant elasticity of substitution function represented in Fig. 1. Consumption is allocated among three distinct bundles – transport, energy, and other goods – according to their relative prices and the elasticity of substitution $\sigma^T$, which is set to a value of 1 (i.e., Cobb–Douglas).

Within the transport nest, consumers choose between public and private modes. Public transport is a produced good, while private transport requires the combination of vehicles and refined petroleum products. We impose a zero elasticity of substitution between vehicles and petroleum products (i.e, Leontief), which corresponds to a short-run simulation where vehicle efficiency remains unchanged. In the base run, the elasticity of substitution between private and public transport, $\sigma^{PN}$, is set to 0.3 for households in large urban areas, and set to zero for households in small urban areas and rural areas. Thus the price elasticity of demand for public transport in large urban areas is 0.36.\textsuperscript{13} This is similar to empirical estimates of short-run public transport demand elasticity summarized in Litman (2004) and Pauley et al. (2006), who report studies with values around 0.2 to 0.4. We experiment with alternative values of this parameter for households in rural and small urban areas in the results.

Consumption of non-transport energy is a constant elasticity of substitution aggregate of natural gas and electricity. The elasticity of substitution within this nest is $\sigma^{LE}$, which is set to a value of 0.25. All other non-energy and non-transport goods are grouped into the remaining nest. Households substitute between these goods according to a constant elasticity of substitution function with elasticity $\sigma^P$, which is set to a value of 0 (i.e., Leontief). However, in the experiments we conduct, price changes for non-energy and non-transport goods are minimal, and so even with a positive elasticity of substitution there would be limited substitution between these goods in final consumption. The model includes 10 regions (one for each province, with Prince Edward Island and the Territories combined into one region). Regions trade with one another and with the rest of the world while the current

\textsuperscript{10} The effects of rail costs, however, are found to be insignificant (Blow and Crawford, 1997).

\textsuperscript{11} In extractive sectors, a fixed factor is used to ensure an upward-sloping supply curve.

\textsuperscript{12} This is a reasonable approximation; for Canada, investment has fluctuated between about 18 and 23% of income over 40 years, despite large changes in relative prices.

\textsuperscript{13} The price elasticity of demand for public transport is derived from the cost function and is equal to $\frac{\partial Q^P}{\partial P} = \frac{\sigma^{PN}}{\sigma^{PN} - \sigma^T} = \frac{\partial Q^{PN}}{\partial P}$, where $Q^{PN}$ is the share of public transport out of total transport and $\partial Q^{PN}$ is the share of total transport in total consumption.
account of each region is fixed. We adopt the Armington assumption to capture heterogeneity in goods from different regions. Benchmark bilateral trade values by commodity are based on data in the System of National Accounts.

The model includes regional governments in each region as well as a federal government. Real government expenditures are fixed in each region in the simulation experiments in this paper. To fund expenditures and transfers, governments tax output, consumption, investment, intermediate goods, and primary production factors. Tax rates are calculated from provincial economic accounts.

The model is calibrated to the economic transactions of the benchmark year – 2007 – as compiled in Statistics Canada’s System of National Accounts (Statistics Canada, 2008a, 2008b). Additional details on the distribution of income, taxes, and public expenditures are based on the Public Accounts. To investigate the impacts of BC’s carbon tax, which has reached its full level of $30/t CO2 in 2012, we construct a counterfactual benchmark of 2012 where no carbon tax applies. Using Environment Canada projections of sector output by province and energy demand, we create the benchmark scenario by conducting forward-calibration of the 2007 base year data set.14

4.2. Household disaggregation

In order to conduct analysis of the distributional effects of the British Columbia carbon tax on rural vs. urban population, we disaggregate households according to location of residence. Our disaggregation methodology closely follows Beck et al. (2015), but includes differentiation by household location as well as income.

We base our household disaggregation on data from the Survey of Household Spending (SHS), an annual survey which collects information on household expenditures, income, and demographics. In the 2007 version of the SHS, which we use, the sample included more than 21,000 households across all provinces. Using this data, we group households according to household income and location. Publicly accessible SHS data provides only limited information on household location within a province, by grouping households according to the size of the population centre in three categories (1) urban area of 100,000 people or greater, (2) urban area of 1000 to 99,999 people, (3) rural area of less than 1000 people.15 Within each of these groups, we allocate respondents in the SHS into 10 deciles of equal size, based on income. Thus, in total, we group households into 30 categories, differentiated by both income and location of residence.16

Within each household category, we calculate total expenditure by category and income by source. We scale expenditure and income from the SHS to ensure that it is consistent with the System of National Accounts, upon which the CGE model is based. We use the same procedure as detailed in Beck et al. (2015) and therefore do not detail it here. We then include each of the households as individual representative agents in the CGE model, to determine how changes in price induced by the British Columbia carbon tax and associated measures affect well-being.

Tables 1 and 2 show the resulting breakdown of income into sources and expenditure into shares for each of the three geographically-distinct household categories. Households in large urban areas are wealthier than other households, followed by households in small urban areas and rural areas. Households in large urban areas derive a larger portion of their income from labor and a lower amount from government transfers than households in small urban or rural areas, which largely reflects differences in incomes (see Beck et al. (2015)).17 Households in urban areas also derive a larger portion of total income from investments than rural households.18 Households in rural areas spend a slightly smaller share of total expenditures on natural gas compared to urban households, but a slightly larger share on electricity and a much larger share on refined petroleum products (primarily gasoline and diesel). Urban households’ spending on public transport is double the share of rural household spending, reflecting the increased public transport availability in urban areas. Overall, rural household expenditure on carbon intensive goods (energy and public transport) is somewhat higher than that of households in both small and large urban centers. This is the primary reason for the perception of unfairness of the carbon tax to these households.

14 The forward calibration is explained in Böhringer et al. (2009), and this same technique is used in the previous papers, such as Böhringer et al. (forthcoming) and Beck et al. (2015).

15 Statistics Canada defines a ‘rural’ resident as one living outside a centre with a population of at least 1000 people and in a region with a population density of less than 400 people per square kilometer.

16 When reporting the results in the following section, we aggregate all households over income categories and focus only on differences in households by location. We use the disaggregation by income within the model in order to properly account for revenue recycling provisions adopted with the carbon tax, which are income-dependent.

17 The data we use does not allow us to further disaggregate labor income by source (e.g., skill level or occupational category). As a result, we treat labor as a homogeneous good, consistent with the treatment in many other models of this type. However, it is possible that including labor market heterogeneity would affect our calculations of tax incidence.

18 The Survey of Household Spending reports annual investment income, rather than total capital ownership. We assume that household capital ownership is proportional to investment income. Total capital ownership is roughly 40% of income, while investment income reported by households is only about 3% (the difference reflects depreciation of assets, re-investments within firms, and corporate income tax). The effects of a policy on welfare are impacted both by total capital ownership as well as investment income.
5. Scenarios and results

To simulate the distributional effects of the tax we impose a $30/t CO₂ tax on all combustion-related greenhouse gases in the province of British Columbia. As described earlier, this is the level reached by the tax in July 2012, and it has remained constant at this level since that point. With the carbon tax imposed, we conduct a number of simulations to reveal the impact of the tax on different household groups, the impact of associated revenue recycling schemes, and the mechanisms that generate these impacts.

We begin with a simulation that imposes the carbon tax, in which revenue from the carbon tax is used to reduce the provincial government deficit. This simulation allows us to examine the pure impact of the carbon tax on household welfare, absent any revenue recycling mechanisms. The results are shown in the leftmost columns in Fig. 2. These results confirm the contention of rural and northern households in British Columbia — the tax appears to affect rural households more than urban households. In particular, absent any return of the revenue to households, households in rural areas experience a roughly 0.53% loss of welfare, while households in urban areas experience only a 0.42% loss of welfare and households in small urban areas experience about a 0.45% loss in welfare.

The other columns in Fig. 2 explore some mechanisms behind the differences in the welfare experienced by households in different locations. In particular, the second set of columns in Fig. 2 imposes an alternative transport elasticity for rural households, by setting \( e^{RTN} = 0.3 \) for all households in the model. This scenario is aimed at capturing one of the key concerns of rural residents following the tax, which is that they had no viable alternatives to private transport to reduce emissions. In particular, the concern was that while urban residents have the flexibility to mode switch to public transit following an increase in gasoline prices caused by the carbon tax, rural residents had no such option. The results in Fig. 2 suggest that this concern has a negligible impact on overall welfare impacts of the tax by household (i.e., the welfare estimates are unchanged). This is relatively intuitive: the elasticity of substitution is a second-order property of the consumer utility function, and therefore has a small effect on utility in response to small price changes. Additionally, cost shares for public transport are low for both rural and urban households as are elasticities of substitution, suggesting that the carbon tax likely had a minimal impact on mode choice even in urban areas. The third set of columns imposes identical expenditure shares for transportation fuels across all households. This allows us to determine the importance of differences in transport fuel expenditure in contributing to differences in welfare. Welfare across households in this simulation becomes more similar, suggesting that differences in cost shares of transport fuel are a key determinant of differences in the incidence of the tax.

We also conduct additional decomposition analyses (not shown) in which we impose identical expenditure shares and income source shares sequentially, as in Beck et al. (2015) and Rausch et al. (2010). The results of the decomposition exercise suggest that both heterogeneity in income shares and heterogeneity in expenditure shares by household location serve to make rural households more severely impacted by the tax than urban households. Relative to urban households, rural households have higher expenditure shares on energy-intensive goods (which increase in price due to the carbon tax) as well as a larger share of full income from labor (which falls in price by about 1% due to the carbon tax), both of which exacerbate welfare losses. This is in contrast to other studies that examine the incidence of a carbon tax on different income groups, where differences in household income sources are a key factor in explaining heterogeneous welfare impacts from a carbon tax, and work in an opposite direction to differences in spending (Rausch et al., 2010; Beck et al., 2015).

Fig. 3 shows the impact of the revenue recycling programs that were implemented in conjunction with the carbon tax. The first set of columns is identical to the leftmost columns in Fig. 2, and is a simulation of the carbon tax alone, with no revenue recycling scheme (all revenue is used to reduce the provincial government deficit, which offers no welfare benefit to households in our static model). The second set of columns imposes the cuts to personal income tax and corporate income tax that accompanied the carbon tax. These cuts are detailed in Section 2 of this paper. The cuts significantly improve the welfare of all households in British Columbia. However, they do not change the overall incidence of the tax, which is still largest for rural households. The third set of columns adds the low income tax credit. This is an income-contingent credit which is available to households with incomes less than about $37,000, as described in Section 2. With this scenario, we model the revenue-recycling system that was originally implemented with the tax in 2008. In this scenario, welfare for all households is positive although the government deficit is somewhat increased (by 0.12% of income) in this scenario, which transfers welfare from future households to today’s households in our static model. Additionally, the incidence of the policy is affected. In particular, households in small urban areas appear to be most positively affected by the tax, followed by households in large urban and rural areas. This is a result of the low income tax credit being received disproportionately by households in rural and small urban households (who have lower

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**Table 1**

Benchmark household income source, tax and net saving shares. Calculated by reconciling data from System of National Accounts with data from Survey of Household Spending as described in text. Note that the table includes only the portion of income from capital that is reported as investment income by households. Other components of capital income (re-investments within firms, corporate income tax, royalties, and depreciation) are included in the model but not in this table.

<table>
<thead>
<tr>
<th>Household group</th>
<th>Average income</th>
<th>Labor income share</th>
<th>Investment income share</th>
<th>Transfer income share</th>
<th>Tax share of income</th>
<th>Net saving share of income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban large</td>
<td>72792</td>
<td>0.828</td>
<td>0.036</td>
<td>0.136</td>
<td>0.190</td>
<td>0.028</td>
</tr>
<tr>
<td>Urban small</td>
<td>60719</td>
<td>0.788</td>
<td>0.024</td>
<td>0.188</td>
<td>0.171</td>
<td>−0.027</td>
</tr>
<tr>
<td>Rural</td>
<td>55272</td>
<td>0.722</td>
<td>0.006</td>
<td>0.272</td>
<td>0.138</td>
<td>−0.045</td>
</tr>
</tbody>
</table>

**Table 2**

Benchmark household consumption shares. Calculated by reconciling data from System of National Accounts with data from Survey of Household Spending as described in text.

<table>
<thead>
<tr>
<th>Household group</th>
<th>Natural gas share</th>
<th>Refined petroleum products share</th>
<th>Electricity share</th>
<th>Public transportation share</th>
<th>Other consumption share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban large</td>
<td>0.009</td>
<td>0.038</td>
<td>0.007</td>
<td>0.008</td>
<td>0.939</td>
</tr>
<tr>
<td>Urban small</td>
<td>0.009</td>
<td>0.045</td>
<td>0.009</td>
<td>0.005</td>
<td>0.933</td>
</tr>
<tr>
<td>Rural</td>
<td>0.007</td>
<td>0.061</td>
<td>0.011</td>
<td>0.004</td>
<td>0.917</td>
</tr>
</tbody>
</table>

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19 It is important to note that welfare in this simulation is reduced as a result of using the revenue from the carbon tax for reducing the deficit (which offers no welfare benefit in our static model). The simulation is useful because it shows the relative effect of the tax on households absent any revenue recycling schemes.

20 Recall that Table 1 shows shares of income including only the portion of capital income that is reported in the household survey. Welfare impacts are calculated based on full income. See footnote 18.
Table 3
Revenue recycling strategy in tax year 2011/2012 ($ M) (%).

<table>
<thead>
<tr>
<th>Revenue recycling measures</th>
<th>2011/2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon tax revenue</td>
<td>959</td>
</tr>
<tr>
<td>Personal tax measures (total)</td>
<td>470 (41%)</td>
</tr>
<tr>
<td>British Columbia Low income climate action tax credit</td>
<td>184</td>
</tr>
<tr>
<td>Reduction of 5% in the first two personal income tax rates</td>
<td>220</td>
</tr>
<tr>
<td>Northern and Rural Homeowner Benefit of up to $200</td>
<td>68</td>
</tr>
<tr>
<td>Business tax measures (total)</td>
<td>671 (59%)</td>
</tr>
<tr>
<td>General corporate income tax rate reduction</td>
<td>381</td>
</tr>
<tr>
<td>Small business corporate income tax rate reduction</td>
<td>220</td>
</tr>
<tr>
<td>Industrial property tax credit</td>
<td>68</td>
</tr>
<tr>
<td>School property tax reduction</td>
<td>2</td>
</tr>
<tr>
<td>Total revenue measures</td>
<td>1141</td>
</tr>
</tbody>
</table>

Table 4
Difference in difference analysis of support for carbon tax. Standard errors in brackets. The effect of the Northern and Rural Homeowner Benefit Program (NRHBP) on rural communities is calculated from the coefficient on rural + NRHBP. For probit models, the effect is calculated from $\Phi(\beta_1 + \beta_2 + \beta_3 + \beta_4 X)$ - $\Phi(\beta_1 + \beta_2 + \beta_4 X)$ where $\Phi(\cdot)$ is the standard normal distribution. For logistic models, the effect is calculated from $1/(1 + \exp(\beta_1 + \beta_2 + \beta_3 X)) - 1/(1 + \exp(\beta_1 + \beta_2 + \beta_X))$. According to the size of the urban area in which they are located, which is the best alternative based on the SHS data available for public use. In our model, we consider all households outside of large urban areas to be eligible for the homeowner benefit. This is an imperfect way to model eligibility for the program, since there are some small urban areas and rural areas in the Fraser Valley Regional District, and there is one large urban area (Kelowna) that is outside the three excluded areas listed above. However, despite these differences, we believe that this method of allocating revenue in the model offers a good representation of the impact of the homeowner benefit program on the distribution of welfare impacts from the policy. As shown in the figure, we find that this significantly improves the welfare of rural and small urban households relative to large urban households. The program appears to be much more generous to these households than would be required from an analysis of the incidence of the carbon tax.

While we see the positive welfare impact of the carbon tax with the full revenue recycling in Fig. 3, this is partly because the deficit of the provincial government increased somewhat relative to the benchmark simulation (more revenue was rebated than was collected in carbon taxes). To correctly evaluate the welfare effect from the policy in our static model, we should evaluate the policy in a deficit-neutral scenario. Thus, in Fig. 4, we consider the carbon tax with all of the revenue recycling programs while we maintain the government deficit at its original level. We consider four different ways of maintaining the level of the deficit. In the first case, we balance the government deficit using lump sum transfers to all households in proportion to benchmark income. Since the spending pattern is different between households, this lump sum transfer is not perfectly welfare neutral. Nevertheless, it is still more or less welfare neutral. In other words, comparing to the last columns in Fig. 3, every household loses welfare by a similar percentage. In a second simulation, we balance the government deficit relative to the benchmark scenario using a corporate income tax increase. In this case, large urban households experience a slightly larger welfare loss because they have larger share of investment income. The third alternative is to increase the personal income tax, which leads to large urban and small urban households experiencing larger welfare losses than rural households because their share of labor income is larger. The fourth alternative considered is a lump-sum payment purely based on population size (i.e., a per person transfer to reduce the deficit to its benchmark level). Since in this case every household has to pay the same amount, rural households suffer most heavily because their

Table 4
<table>
<thead>
<tr>
<th>Dependent variable: opposetax</th>
<th>OLS (1)</th>
<th>OLS (2)</th>
<th>OLS (3)</th>
<th>Probit (4)</th>
<th>Logistic (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>post2011</td>
<td>-0.152**</td>
<td>-0.151**</td>
<td>-0.156***</td>
<td>-0.397***</td>
<td>-0.637****</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.035)</td>
<td>(0.035)</td>
<td>(0.089)</td>
<td>(0.144)</td>
</tr>
<tr>
<td>Rural</td>
<td>0.005</td>
<td>0.004</td>
<td>-0.005</td>
<td>-0.013</td>
<td>-0.021</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td>(0.034)</td>
<td>(0.034)</td>
<td>(0.088)</td>
<td>(0.140)</td>
</tr>
<tr>
<td>Rural × post2011</td>
<td>0.084</td>
<td>0.087**</td>
<td>0.052**</td>
<td>0.235**</td>
<td>0.378**</td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
<td>(0.053)</td>
<td>(0.053)</td>
<td>(0.135)</td>
<td>(0.216)</td>
</tr>
<tr>
<td>Effect of NRHBP in rural communities</td>
<td>0.084</td>
<td>0.087</td>
<td>0.052</td>
<td>0.093</td>
<td>0.094</td>
</tr>
<tr>
<td>Income</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Gender</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Age</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Observations</td>
<td>1484</td>
<td>1484</td>
<td>1484</td>
<td>1484</td>
<td>1484</td>
</tr>
<tr>
<td>R²</td>
<td>0.016</td>
<td>0.022</td>
<td>0.027</td>
<td>0.027</td>
<td>0.027</td>
</tr>
<tr>
<td>Log likelihood</td>
<td></td>
<td></td>
<td></td>
<td>-1008.273</td>
<td>-1,008.252</td>
</tr>
</tbody>
</table>

* p < 0.1.
** p < 0.05.
*** p < 0.01.
average income is lower than that of urban households. Hence, the same payment means larger welfare loss for lower-income households. We consider this an unrealistic mechanism, but include it for comparison purposes. Even in this case, the welfare loss to large urban households is larger than for rural households.

We conduct a number of sensitivity analyses to estimate the effect of modeling assumptions on the results. In particular, we test alternative functional forms for production sectors (nesting capital and energy as opposed to capital and labor), alternative empirical estimates of production function elasticities, alternative assumptions about capital mobility, alternative assumptions about labor supply elasticities, and alternative assumptions about trade elasticities. These differences in assumptions and parameters do not have significant effects on the main results and conclusions that we draw above, and so we do not report them in detail here.

6. The effect of the homeowner benefit on support for the carbon tax

Our modeling results suggest that prior to the introduction of the homeowner benefit program, households outside of large urban areas were slightly more negatively impacted by the carbon tax than households in large urban areas. As we discussed above, there was significant opposition to the tax during this period, which precipitated the introduction of the program. Our analysis shows that on average, this targeted grant was sufficient to significantly overcompensate rural households: whereas prior to the homeowner benefit program, households in rural areas were worse off by roughly $5–10/year as a result of the carbon tax, the program provided a $200/year benefit to rural homeowners. One reason for the introduction of the benefit program was to reduce rural opposition to the tax. According to the literature on environmental taxation, the introduction of appropriately designed revenue recycling measures can help significantly raise public acceptance of the carbon tax (see Dresner et al., 2006a, 2006b; Schade and Schlag, 2003; Pearson, 1995; Bristow et al., 2010).

In this section, we test whether the homeowner benefit program succeeded in securing rural support for the carbon tax. We use polling data from a series of six public opinion polls that were implemented between 2008 and 2014 by the polling firm Environics. In each case, the polls were conducted by telephone using a national sample of about 1000 or 2000 households (with a British Columbia sample of 150 to
400 in each polling wave). In total, we have survey responses for nearly 1500 British Columbia residents over the period 2008 to 2014. The polls asked a number of questions about demography and geography as well as about support for the carbon tax in British Columbia:

As you may know, British Columbia now has a tax on all carbon-based fuels used by consumers and businesses in the province, as a way to encourage reductions in greenhouse gas emissions generated in the province. This tax is “revenue neutral” which means the same amount raised through this tax each year is refunded by law to taxpayers in the form of lower personal income and corporate taxes. Do you strongly support, somewhat support, somewhat oppose or strongly oppose this carbon tax for B.C.?

Our analysis focuses on whether the homeowner benefit program changes the opposition to the tax in British Columbia. Accordingly, we create a dummy variable (which we call opposetax below) that is equal to one if a respondent indicates they somewhat or strongly oppose the tax, and equal to zero if they somewhat or strongly support the tax (we drop observations that did not respond to this question or that indicated they didn’t know or had no opinion). The polling firm recorded the size of the community for each respondent. We categorized communities with 100,000 or more residents as urban and those with less than 100,000 as rural. Rural communities are eligible for the Northern and Rural Householder Benefit Program, so if the program succeeded in reducing opposition to the carbon tax, we would expect to see a differential impact in these communities.

Fig. 5 shows how opposition to the carbon tax changed over time, in both urban and rural communities. Upon its introduction in 2008, opposition to the carbon tax was high in both urban and rural communities, with about 60% opposed to the policy. Opposition was reduced over time in both urban and rural areas. The homeowner benefit program was made available in 2011. Polls taken prior to 2011 show a relatively similar level of opposition to the carbon tax in urban and rural areas. In contrast, polls taken after 2011 suggest a split between rural and urban perception of the tax, with rural areas more likely to oppose the tax. This suggests that the program did not succeed at reducing rural opposition to the tax. Rather, it may have backfired.

We conduct a more formal analysis of the tax, using a difference-in-difference approach that is suggested by Fig. 5. We model opposition to the tax as a function of household demography and availability of the homeowner benefit program, as follows:

\[
\text{opposetax} = \beta_0 + \beta_1 \text{post2011}_i + \beta_2 \text{rural}_i + \beta_3 (\text{post2011}_i \times \text{rural}_i) + \beta_4 X_i + \epsilon_i
\]

where opposetax, is a dummy variable that is equal to one if the respondent indicates they somewhat or strongly oppose the carbon tax, post2011, is a dummy variable that is equal to one if the poll is taken after April 2011, when the homeowner benefit program became available, rural, is a dummy variable that is equal to one if the respondent is in a rural area (less than 100,000 people), and \(X_i\) is a set of demographic characteristics. The coefficient \(\beta_1\) captures the average difference in support for the carbon tax after 2011 as compared to prior to 2011. As shown in the figure, opposition to the carbon tax decreases over time, and so this coefficient is negative. The coefficient \(\beta_3\) captures the average difference in support for the carbon tax in rural communities compared to urban communities. We focus on the interaction term, \(\beta_3\), which captures the change in opposition to the carbon tax in rural areas compared to urban areas following the introduction of the program, conditional on observed demographic characteristics. This term reflects the effect of the homeowner benefit program on rural opposition to the carbon tax. A positive value suggests that the program increased opposition to the tax, while a negative value suggest the opposite.

Results are given in Table 4. The first column uses a linear probability model (ordinary least squares) and does not include any demographic controls. Consistent with the figure, the results suggest opposition to the tax was lower after the homeowner benefit program was introduced in 2011: overall opposition was 15% lower after 2011 compared to prior to 2011. The results also suggest that opposition to the tax is not significantly different in urban as compared to rural areas on average. Rather, it appears that a vocal rural minority was responsible for the opposition to the tax by rural areas that we document above. And interestingly, the results suggest that opposition to the tax in rural areas increased following the introduction of the homeowner benefit program, although without demographic controls, the effect is not statistically significant. The second and third columns add demographic controls (for income, gender, and age) to the specification in column 1. Again, the homeowner benefit program appears to be associated

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23 Polls were conducted by telephone, and are stratified to ensure representation by geography, age cohort, gender, and community size.

24 Income and age are categorical and enter as a series of dummy variables. Income and age terms are jointly significant (although many of the individual dummy variables are not) and the gender dummy variable is significant.
with an increase in opposition to the carbon tax in rural areas. The coefficient is significant at the 90% level, and suggests that opposition to the tax in rural areas increased by about 9 percentage points (from about 50% to about 60%) as a result of the program. The fourth and fifth columns are the same as the third column, but use a probit and logistic specification to account for the discrete dependent variable. These produce marginal effects that are nearly identical to those in the third column: opposition to the carbon tax appears to increase following the introduction of the homeowner benefit program, by about 9 percentage points.

Our analysis of the polling data shows that the homeowner benefit program appears to have worsened support for the carbon tax in rural communities that received the transfer. However, it does not explain the mechanism generating the increased opposition to the carbon tax in rural households associated with the program. One reason may be that the introduction of the benefit program created a new awareness for the carbon tax and its distributional effects among the eligible households. People from rural communities that had not perceived the carbon tax as unfair prior to the introduction of the homeowner benefit program may have changed their opinion about the tax after its introduction because they may interpret the government’s initiative to offset the inequity created by the tax as a clear sign that this inequity existed in the first place. In other words, by trying to fix the distributional problem caused by the carbon tax, the government implicitly admitted that there was a problem to start with. If this explanation holds true, such signaling effect of the homeowner benefit program provides yet another reason for governments to conduct careful analysis of distributional effects before responding to perceptions of unfairness.

7. Conclusion

Our results indicate that, had the British Columbia carbon tax been introduced in the absence of any revenue recycling measures, rural households would have indeed experienced a slightly larger burden from the carbon tax compared to households in small and large urban communities. This result is in line with Bureau (2011) and the common perception of uneven regional tax incidence. However, our decomposed results contradict previous arguments in that we do not identify limited alternative transportation options as the key driver of the extra burden on the rural population. Instead, we find that the larger share of income of rural households that is spent on transportation fuels causes the increased exposure to the tax burden. Again, this finding confirms results by Bureau (2011) and also Blow and Crawford (1997). The model results further indicate that the initial revenue recycling scheme that the government introduced together with the tax in 2008 (excluding the homeowner benefit program) was sufficient to balance the initial disadvantage of rural households and, in fact, make all households better off on average. With revenue recycling rural households are still found to experience the smallest net gain after revenue recycling compared to households in small and large urban areas but the differences between groups are trivially small. Hence, our results imply that by introducing the homeowner benefit program the British Columbia government substantially overcompensated northern rural households and responded to a ‘rural myth’ that was sustained by northern municipal leaders and interest groups rather than evidence on tax incidence. After the implementation of the benefit program, the results indicate that rural households that are eligible for the benefit experience a significantly larger increase in welfare than urban households if government deficit is assumed endogenous and significantly smaller welfare loss if the government deficit is assumed fixed.

In line with previous studies on the social acceptability of environmental taxes, our findings suggest that individuals’ attitudes towards carbon tax are often not based on analysis of incidence but rather driven by pre-existing beliefs, political ideology and conceptions of identity (Schade and Schlag, 2003; Dresner et al., 2006a, 2006b). In British Columbia specifically, Harrison and Peet (2012) argued that lack of supporting evidence of injustice did not prevent municipal politicians and rural constituencies from perceiving and criticizing – as if by default – the unfair distributive effects of the carbon tax. Even the implementation de
benefit program may even have contributed to increasing opposition from rural households to the tax because its introduction could be interpreted as a signal that the tax did create inequity in the first place. We draw the following general implications from the British Columbia case study. First, the regional distributional effects of carbon taxation need to be analyzed carefully for each individual case, in particular if interest groups perceive rural communities to be systematically disadvantaged. The categorical assumption that remote communities are inherently disadvantaged requires scrutiny. Any inequities identified in this analysis can be effectively addressed by adequate revenue recycling measures. However, if the analysis shows that perceived injustice is merely a ‘rural myth’, more research into the ideational sources of popular opposition to environmental taxes is warranted in order to develop adequate policy responses (Schade and Schlag, 2003). Simply granting financial concessions to opposing groups, even if they overcompensate the initial tax burden, do not automatically represent an effective strategy to address such concerns. In fact, revenue recycling strategies specifically aimed at appeasing protesting voters may not only fail to do so (as the true source of the perception of injustice lies somewhere else) yet ultimately compromise the scheme’s overall cost-effectiveness.

Acknowledgments

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