Student Working Paper Series

Axe the Tax? An Analysis of the Effectiveness of BC's Carbon Tax in Reducing GHG Emissions

Ashley McDougall

WP 2024 - 01
August 2024

University of the Fraser Valley
Department of Economics
Abbotsford, British Columbia, Canada

Axe the Tax? An Analysis of the Effectiveness of BC's Carbon Tax in Reducing GHG Emissions

Ashley McDougall

August 14, 2024

Abstract

This paper evaluates the effectiveness of British Columbia's carbon tax in reducing greenhouse gas (GHG) emissions. Multiple regression analyses, including difference-in-differences methods, are conducted using data from Canada's official greenhouse gas inventory and other economic data. The results are robust and indicate that the BC carbon tax has not significantly reduced overall GHG emissions, potentially due to contradictory overlapping policies. Policy recommendations include streamlining environmental policies and advocating for the renegotiation of the Paris Accord to account for Canada's forest sinks. This paper highlights the need for coherent environmental policies to achieve meaningful reductions in GHG emissions for Canada and globally.

Keywords: carbon tax, greenhouse gas emissions, British Columbia, environmental policy, policy effectiveness.

JEL Codes: H21, H23, H71, Q58.

1 Introduction

The carbon tax is a historically contentious policy and remains a major point of debate in British Columbia (BC) and across Canada. Although proponents of the carbon tax are confident in its potential to meet environmental goals, critics argue that it is both ineffective and regressive. Carbon tax policies are supported by the BC New Democratic Party (NDP) and the federal Liberal government, and have faced significant criticism from both the BC and federal Conservatives, who have popularized the ”axe the tax” slogan. The aim of this paper is to analyse the effectiveness of the carbon tax in reducing greenhouse gas (GHG) emissions.

On July 1, 2008, BC became the first jurisdiction in North America to implement a carbon tax. The tax was initially set at CA$10 per tonne of GHG emissions, measured in tonnes of carbon dioxide equivalent (t CO2 eq), with a plan for it to increase until 2012, when it reached CA$30 per tonne. In April 2022, the tax rate was raised from CA$30 to CA$50 per tonne, and on January 1, 2023, it further increased to CA$65 per tonne. As of April 1, 2024, BC's carbon tax rate stands at $80 per tonne. The provincial government's plan is to continue raising the tax annually, aiming for CA$170 per tonne by 2030 (Carbon Tax Center, 2024). The BC carbon tax is levied on the purchase and consumption of fossil fuels, which make up approximately 80% of the province's GHG emissions (Ministry of Environment and Climate Change Strategy, 2024).

Prior to the introduction of the BC carbon tax in 2008, environment and climate change had been polling as the number one concern for British Columbians in 2007. However, in the spring of 2008, gasoline price hikes led to growing public concern about the new policy. Following this, the opposition BC NDP launched an ”axe the tax” campaign at that time, which resulted in declining public support for the BC Liberals and the carbon tax policy (Harrison, 2019).

By 2009, in the wake of the global recession, British Columbia's public opinion had shifted. Opinion polls at that time revealed that British Columbians had the lowest level of support for a carbon tax in the country, despite being the only province with such a tax at the time, with just 40% backing the measure (The Canadian Press, 2009). Today, as the costs of food and housing continue to rise, nearly half of Canadians now support the elimination of the carbon tax. According to a 2023

Angus Reid poll, 42% of Canadians favor completely abolishing the carbon tax, 25% believe it should remain at its current rate without further increases, 17% advocate for a reduction over the next three years, and only 15% support maintaining the current approach (Woodside, 2023).

It's important to examine the trends of support for the carbon tax in the context of affordability. When life becomes unaffordable, people are less likely to support or be able to afford extra taxation. The fluctuation in public support for the carbon tax highlights how economic pressures can influence attitudes towards environmental policies. If individuals are struggling with the cost of living, they will prioritize financial relief over environmental goals. In April 2022, Canada experienced an inflation rate of 6.8%, the highest in 31 years. A recent survey also revealed that 1 in 5 Canadians are reducing their food intake to cope with increased costs and manage their expenses (Unifor, 2022). These affordability issues significantly impact support for the carbon tax, as people facing financial difficulties are less inclined to support additional up-front expenses.

As BC approaches a provincial election in October of 2024, British Columbians must decide which party to support, with the carbon tax being a central issue in the election. BC's political parties offer various perspectives on the carbon tax. The BC NDP and BC Greens support maintaining the current carbon tax structure with incremental increases, while the BC United supports maintaining the tax with no increase, and the BC Conservative Party supports eliminating the carbon tax altogether.

Existing literature provides varying perspectives on the carbon tax. Studies indicate mixed results on the effectiveness of the BC carbon tax, with some noting insufficient tax rates causing ineffectiveness of the carbon tax in reducing GHG emissions, and others noting a significant decrease in per capita fuel consumption as a result of a carbon tax policy. In this paper, we find that the BC carbon tax is not effective in reducing GHG emissions. This is likely due, in part, to the fact that the potential effectiveness of the carbon tax is being undermined by the presence of a multitude of conflicting policies, which create mixed signals in the market. With such diverse perspectives on a controversial subject, the objective of this paper is to provide a timely and well-informed analysis on whether British Columbia should consider "axing the tax."

The remainder of this paper is structured as follows: Section 2 offers a review of related literature. Section 3 reviews the data utilized in the analysis. Section 4 outlines the methodology. Section 5 presents the results of the analysis. Section 6 discusses policy implications and conclusions.

2 Literature Review

The following section reviews literature on carbon tax systems applied in BC, Canada, and globally.

2.1 BC Carbon Tax

Several studies have examined the BC carbon tax for its impacts on GHG emissions and the economy. Pretis (2022) found that while the tax has reduced transportation emissions, it has not led to significant reductions in overall GHG emissions, suggesting that current tax rates are unable to generate a substantial impact. Elgie and McClay (2013) reported a 19% decline in per capita fuel consumption in BC compared to the rest of Canada, with no adverse effects on economic growth. Murray and Rivers (2015) noted that the tax, set at C$30 per tonne by 2012, covers a significant portion of emissions and had reduced them by 5% to 15% at that time. They also note that some sectors faced economic challenges due to the tax, but overall economic impacts were minimal. Olale et al. (2019) focus on the impact of BC's carbon tax on agriculture, finding it associated with a decline in farm income-to-receipts ratios and increased production costs. This highlights the need to consider specific sectoral impacts in evaluating carbon tax policies. Sileci (2023) shows that the BC carbon tax reduced GHG emissions and benefited air quality, but noted that these benefits were unevenly distributed. The conflicts in these findings suggest that further analysis is needed to properly evaluate the effectiveness of the BC carbon tax in reducing GHG emissions.

2.2 Carbon Tax in Canada

Several studies examine the application of a carbon tax in Canada. The study by Snodden and Tombe (2019) highlights that increasing carbon tax revenues could impact provincial fiscal capacities and the distribution of equalization payments, especially given the uneven distribution of

GHG emissions across provinces. The role of the federal backstop in provinces without stringent carbon pricing further complicates matters, as these revenues are currently excluded from the equalization formula. In Saskatchewan, a study by Liu et al. (2018) using a Computable General Equilibrium (CGE) model shows that while a carbon tax reduces GHG emissions, it also contracts the economy, especially in resource-intensive sectors like coal and petroleum. Future research will focus on dynamic CGE models and exploring carbon tax revenue recycling mechanisms to optimize benefits. Mildenberger et al. (2022) find that recycling revenue through lump-sum dividends might reduce public resistance to carbon taxes; however, their study indicates low public awareness and significant underestimation of rebate amounts in Canada as well as Switzerland. Accurate rebate information had limited impact on public support, suggesting that perceptions are influenced by partisan identities. Harrison (2012) explores the political dynamics of carbon tax proposals in BC and at the federal level, noting that while BC's carbon tax succeeded due to economic focus during a recession, carbon tax proposals generally remain unpopular, highlighting the political risks of environmental policies broad electoral support.

2.3 Carbon Tax Globally

This sub-section reviews carbon tax literature from countries outside of Canada. Fremstad and Paul (2019) show that while a carbon tax can be a straightforward solution to reducing GHG emissions, it should be complemented by significant research and development (R&D) to foster new technologies and address market failures related to pollution. Williams III et al. (2014) estimate the effects of an initial incidence of a carbon tax across U.S. states, which shows geographic differences driven by income sources and energy use patterns, with revenue use playing a crucial role in determining the impact. Another study by Dumortier and Elobeid (2021) assesses the economic and environmental effects of a U.S. carbon tax on agriculture, finding increased production costs and altered trade patterns, which lead to a slight global increase in GHG emissions from land-use changes. Agostini et al. (1992) examine the effects of carbon taxes in OECD-European countries, highlighting the importance of country-specific coordinated environmental policies to stabilize emissions, with high tax rates being necessary for significant reductions. Hajek et al. (2019) evaluate the environmental effectiveness of carbon taxes in the energy industries of selected EU countries, finding that increased tax rates significantly reduce GHG emissions. Carson et al. (2015) compare the cost of carbon tax policies in China and the U.S., finding that the welfare costs are lower in developing countries like China than those in developed countries such as the U.S. for emissions reductions up to 12%.

3 Data

Data on road transportation emissions from Canada's official GHG inventory was used, which summarizes anthropogenic GHG emissions by measuring consumption of fuels (excluding the biogenic CO2 emissions from ethanol and biodiesel) by vehicles licensed to operate on roads (Environment and Climate Change Canada , 2024). Data from the following Canadian provinces is used in the analysis: British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Newfoundland and Labrador, and Prince Edward Island. GHG emissions from Canadian territories are too small to influence the analysis and results and therefore are not included.

Canada's GHG inventory is developed in accordance with the Enhanced Transparency Framework of the Paris Agreement, using the 2006 Intergovernmental Panel on Climate Change (IPCC) methodological guidance. GHG emissions are estimated by multiplying activity data, such as the annual amount of fuel burned, by emission factors, which are average rates of emissions for given activities. Emissions are reported in kilotons of carbon dioxide equivalents (kt CO2 eq), calculated by multiplying the emissions of a specific GHG by its global warming potential (GWP). The data collection principles focus on improving estimates of key categories, enhancing data quality iteratively, and ensuring continuous improvement through regular review and agreements with data suppliers. The Government of Canada collects data on GHG emissions on an annual basis, which is submitted to the United Nations on April 15 yearly (Environment and Climate Change Canada , 2023a).

Gases measured are carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF6) and nitrogen trifluoride (NF3). These GHGs trap heat in the atmosphere, creating a greenhouse effect and contributing to the

Table I: Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
GHG Emissions (kt CO2 eq)	11,601.54	12,730.85	418.19	48,461.59
GDP (Millions)	$169,052.30	$204,513	$3,683	$874,981
Population	3,255,801	3,838,380	130,369	14,842,488

warming of the earth. It is estimated that 80% of GHG emissions globally result from burning fossil fuels and industrial processes. These emissions contribute to increasing annual temperatures, sea level and precipitation level increases, and increased heat waves. In 2021, approximately 22% of Canada's GHG emissions came from transport. GHGs have varying GWPs and lifespans. Methane (CH4) and hydrofluorocarbons (HFC) are considered to be short-lived climate pollutants that are highly potent. Long-lived pollutants include perfluorocarbons (PFC), sulfur hexafluoride (SF6) and nitrogen trifluoride (NF3), which remain in the atmosphere for a longer period of time (Government of Canada, 2024).

Lastly, Statistics Canada data on annual population and gross domestic product (GDP) by province from 1990 to 2021 was used. Population estimates are recorded annually on July 1 and GDP data is measured annually in chained 2017 dollars at market prices (Statistics Canada, 2024).

Table I presents descriptive statistics of the data.

4 Methods

This section outlines the methods used in the analysis. We specifically focus on the application of four linear regression models, including difference-in-differences techniques. The GHG data, GDP data, and population data were transformed using logarithms, allowing us to interpret the estimated coefficients in the regressions as elasticities. The following section details the specific methodologies used to construct these regression models.

The first regression model tests whether the BC carbon tax is correlated with reducing GHG emissions in British Columbia. Models 1 and 2 uses a restricted sample, focusing only on BC. Focusing these analyses on the province with the longest-standing carbon tax allows us to examine a more extended period of treatment exposure, which allows for a clearer observation of the policy's long-term effects. Model 1 is specified as:

$$\log GHG_t = \beta_0 + \beta_1 CarbonTax_t + \beta_2 \log GHG_{t-1} + e_t \tag{1}$$

where $CarbonTax_t$ is a binary variable indicating the presence of the BC carbon tax (0 if the year is < 2008, 1 if the year is ≥ 2008), $logGHG_{t-1}$ is the logarithm of GHG emissions, lagged at year $t-1$, and e_t is the error term at year t. The coefficient β_1 in equation (1) represents the elasticity of GHG emissions with respect to the BC carbon tax policy. If β_1 is negative, it implies that the introduction of the BC carbon tax is associated with a reduction in GHG emissions. If β_1 is positive, it suggests that the BC carbon tax is correlated with an increase in GHG emissions. A zero coefficient would indicate no correlation between the BC carbon tax and GHG emissions. The magnitude of β_1 indicates the strength of this relationship: a larger absolute value means a stronger impact of the BC carbon tax on GHG emissions, whereas a smaller absolute value means a weaker impact. The coefficient β_2 is lagged logarithmic GHG emissions, which is included to account for the potential of autocorrelation. Pretis (2022) discusses the need to include the lagged logarithmic GHG emissions because of the persistence of GHG emissions' impact on current and future emission quantities.

The second regression includes additional variables to control for GDP and population size, aiming to reduce omitted variable bias and provide a more accurate estimate of the BC carbon tax's effect on GHG emissions. Equation (2) also uses a restricted sample focusing solely on British Columbia. As well, the model includes lagged data for GHG emissions, GDP and population to model delayed effects and enhance the robustness of the analysis. The model is specified as:

$$\log GHG_t = \beta_0 + \beta_1 CarbonTax_t + \beta_2 \log GHG_{t-1} + \gamma_1 \log GDP_{t-1} + \gamma_2 \log Population_{t-1} + e_t \tag{2}$$

where $logGHG_{t-1}$ is the logarithm of lagged GHG emissions at year t for BC, and $\gamma_1 \log(GDP_{t-1})$ and $\gamma_2 \log(Population_{t-1})$ are logarithmic GDP and population, lagged at year $t-1$. γ_1 is the output elasticity of GHG and γ_2 is the population elasticity of GHG. γ_1 measures the percentage change in GHG for every one percentage point increase in GDP in the previous period. γ_2 measures the percentage change in GHG for every one percentage point increase in population in the previous period.

The estimated effect of the policy in (1) and (2) is correlational only and cannot be considered causal. To evaluate the causal impact of the BC carbon tax, we employ a difference-in-differences approach in models 3 and 4. This model compares the changes in GHG emissions over time between BC (the treatment group) and other provinces (the control group). The model is specified as:

$$\log GHG_t = \beta_0 + \beta_1 CarbonTax_t + \beta_2 \log GHG_{t-1} + \beta_3 Treated_i + \beta_4 CarbonTax_{it} \times Treated_i + e_t \quad (3)$$

where $Treated_i$ is a binary variable indicating the presence of the carbon tax policy (1 if i is BC, 0 if i is not BC) and $CarbonTax_{it} \times Treated_i$ is the interaction term and difference-in-differences (DID) estimator. The coefficient β_3 captures the causal effect of the carbon tax policy by comparing changes in GHG emissions over time between BC (the treatment group) and other provinces (the control group). This approach helps isolate the impact of the carbon tax from other confounding factors. The final regression model extends the DID approach by including GDP and population information to further control for other factors, thereby controlling for omitted variable bias. The model is specified as:

$$\begin{aligned} \log GHG_{it} = \beta_0 + \beta_1 CarbonTax_{it} + \beta_2 \log GHG_{i,t-1} \\ + \beta_3 Treated_i + \beta_4 CarbonTax_i t * Treated_i + \gamma_1 \log GDP_{i,t-1} + \gamma_2 \log Population_{i,t-1} + e_t \quad (4) \end{aligned}$$

These four regression models provide a comprehensive framework for analyzing the effectiveness of the BC carbon tax on reducing GHG emissions.

The parallel trends assumption is crucial to the difference-in-differences analysis. It requires the assumption that in the absence of the treatment (CarbonTax), the treated and control groups would have followed the same trend over time. This assumption enables us to attribute any post-treatment differences in GHG emissions between the groups to the BC carbon tax.

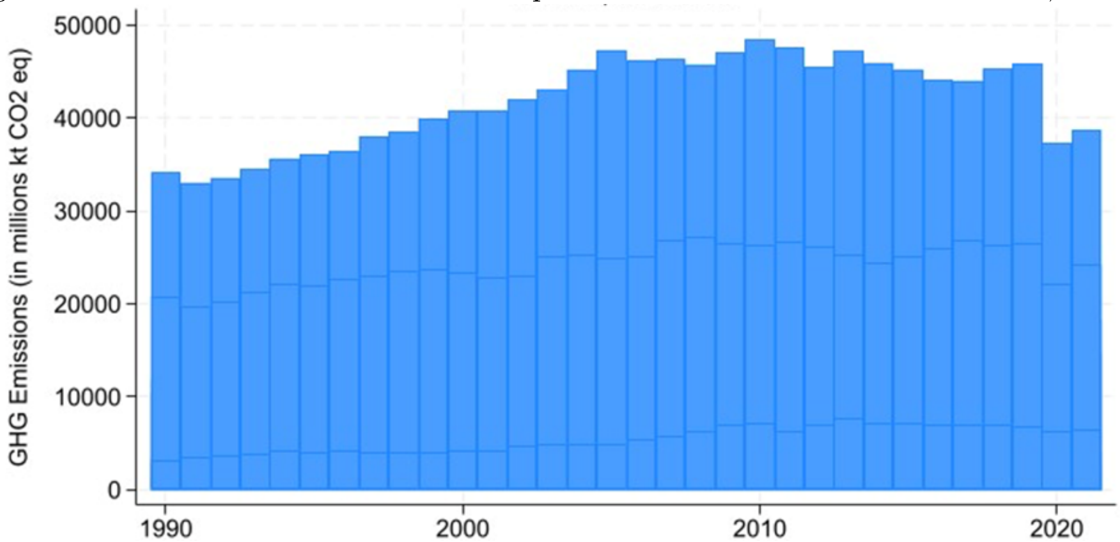
5 Results

5.1 Trends in GHG Emissions

Figure 1 illustrates the annual mean GHG emissions (in kt CO_2 eq) for Canadian provinces from 1990-2021. The 1990's saw steady, but substantial growth in road transportation emissions across Canadian provinces. During the 1990s, Canada experienced significant urbanization, which had an impact on GHG emissions from road transportation. As cities expanded outward, urban residents increasingly moved to suburban areas, which is also referred to as urban sprawl. This shift led to longer commuting distances and times, as people traveled greater distances between their homes and workplaces. The reliance on personal vehicles grew due to public transportation infrastructure in these areas not keeping pace with the population growth, further exacerbating the rise in emissions. The increased vehicular traffic contributed to higher fuel consumption and GHG emissions. As a result, urbanization during this period was a key factor in the growth in road transportation emissions in Canada (Rahdari, 2021). From 2000-2010, this trend continued, with GHG emissions continuing to grow with growing urbanization. There was a dip in GHG emissions in 2008 with the financial crisis occurring at that time, resulting in less road transportation and therefore less GHG emissions. Despite this periodic dip, emissions continue to rise from 2008-2010. From 2010 to 2021, GHG emissions from road transportation continued to rise, though at a slower rate compared to previous decades. This may be partially due to electric vehicles (EVs) becoming more common, though they still remain a small proportion of total vehicles in Canada. The COVID-19 pandemic led to a temporary reduction in road transportation emissions in 2020 due to lockdowns, reduced economic activity, and changes to road transportation behaviours.

Figure 2 illustrates provincial GHG emissions from road transportation by year. The majority of provinces exhibit an overall increase in GHG emissions from 1990 to 2021, with some variations

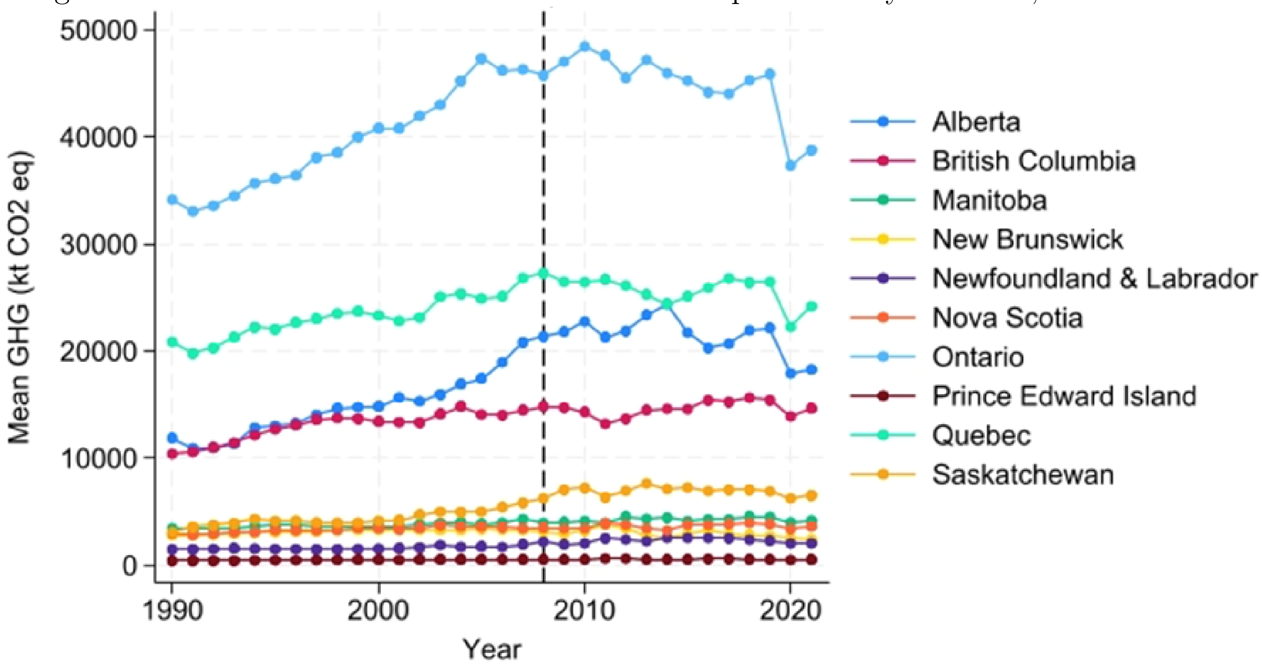
Figure 1: Total Annual GHG Road Transportation Emission Trends in Canada, 1990-2021



in the rates of increase. Most provinces show a steady or slightly increasing trend in GHG emissions from 2000 onwards, with some provinces experiencing increases and decreases during this period.

BC's emissions show a gradual increase, peaking slightly around 2004-2008 before declining briefly, possibly temporarily influenced by the implementation of the BC carbon tax in 2008, before a large increase after the implementation of the BC carbon tax. Emissions in Saskatchewan also show an increasing trend, peaking around 2015 before a slight decline. Ontario and Quebec are Canada's highest GHG emitting provinces, though both display mostly stable emissions with minor fluctuations. Quebec, in particular, shows a slight decreasing trend. Alberta also consistently exhibits high GHG emissions, which reflects its significant reliance on fossil fuel industries. Other provinces such as British Columbia, Manitoba, and Saskatchewan show relatively stable emission trends over the years, with lower overall emission levels compared to Alberta. Manitoba and maritime provinces (Manitoba, New Brunswick, Nova Scotia, Newfoundland & Labrador, and Prince Edward Island) have lower emissions compared to the larger provinces. They exhibit less pronounced trends, with minor fluctuations over the years.

Figure 2: Annual GHG Emissions from Road Transportation by Province, 1990-2021



5.2 Impact of the Carbon Tax on GHG Emissions

The first regression model examines the impact of British Columbia's carbon tax policy on the logarithm of GHG emissions. This model also considers the effect of the lagged logarithm of GHG emissions. As presented in Table 2, column (1), the coefficient for the lagged variable log(GHG) (0.809) is highly significant at the 1% level (p = 0.000), indicating a strong positive autocorrelation, where past emissions strongly predict current emissions. The coefficient for $CarbonTax$ is positive (0.006) but not statistically significant (p = 0.733), suggesting that the BC carbon tax policy does not have a significant immediate effect on reducing GHG emissions. The constant term, significant at the 10% level (1.831), represents the base level of emissions when all other variables are zero. . The R-squared value of 0.860 indicates that 86% of the variation in GHG emissions is explained by the model

In the second model, the lagged logarithm of GDP and population are included as additional variables. The results in Table 2, column (2), show that the coefficient for lagged log(GHG) remains positive (0.655) and significant (p = 0.000). The $CarbonTax$ coefficient is negative (-0.017) but still not significant (p = 0.527). The coefficients for log(GDP) and log(Population) are

-0.006 and 0.234, respectively, with neither being statistically significant ($p = 0.927$ and $p = 0.482$). The constant term is also not significant ($p = 0.944$). The R-squared value slightly increases to 0.869, indicating that the inclusion of population and GDP as variables does not substantially affect the variability of GHG emissions outcomes. Both models suggest that past GHG emission levels are the strongest predictors of current and future emissions. Despite the $CarbonTax$ coefficients being insignificant, it is noteworthy that they are inconsistent between the two models. Model 1 indicates a small positive impact on GHG emissions, while Model 2 indicates a small negative impact. Model 2's $CarbonTax$ coefficient is also inconsistent with the observed increase in GHG emissions over time, despite the BC carbon tax policy being in place since 2008.

5.3 Difference-in-Difference Regressions

The difference-in-differences (DID) models, 3 and 4, aim to provide a causal estimate of the BC carbon tax's impact by including the interaction term $CarbonTax \times Treated$. Table 2 column (3) shows that the coefficient for lagged log(GHG) increases significantly to 0.898, which shows that previous emissions have an even stronger predictive power when the DID variable is introduced. The $CarbonTax$ coefficient (-0.002) is negative but still not significant, indicating that the BC carbon tax does not show a statistically significant impact on emissions reduction. The constant term is positive and highly significant (0.896). The R-squared value of 0.998 suggests that this model explains nearly all the variability in greenhouse gas emissions.

The final model shows lagged log(GHG), $CarbonTax$, and $CarbonTax \times Treated$ coefficients which are only slightly different from model 3, showing that incorporating GDP and population as variables does not have a large effect on GHG outcomes. This points to the conclusion that the largest indicator for GHG emissions outcomes is past GHG emission levels. Table 2 column (4) shows that the coefficient for lagged log(GHG) remains very high and significant (0.859), reinforcing the strong dependence on past emissions levels. The $CarbonTax$ coefficient (-0.014) is still not significant. The log(GDP) variable becomes significant at the 10% level (0.086), suggesting a small but positive impact on emissions. The interaction term $CarbonTax \times Treated$ is negative but not significant (-0.005), implying that the impact of the BC carbon tax is not significant. The constant term (1.518) is significant at the 10% level. The model retains an R-squared value

Table II: Regression Results

Dependent variable: $\log(GHG_{i,t})$	1	2	3	4
$\log(GHG_{i,t-1})$	0.809***	0.655***	0.898***	0.859***
	-10.25	-4.71	-33.99	-25.17
$CarbonTax_{i,t}$	0.006	-0.017	-0.002	-0.014
	-0.34	(-0.640)	(-0.270)	(-1.320)
$\log(GDPi_{i,t})$		-0.006		0.086*
		(-0.04)		-2.33
$\log(Population_{i,t})$		0.234		-0.088
		-0.71		(-1.52)
$CarbonTax_{i,t} \times Treated_{i,t}$			-0.003	-0.005
			(-0.160)	(-0.220)
Constant	1.831*	-0.2	0.896***	1.518*
	-2.45	(-0.070)	-3.94	-2.19
Observations	31	31	310	310
R squared	0.86	0.869	0.998	0.998

Notes: *** significant at 1%, ** significant at 5%, * significant at 10%.

of 0.998, maintaining its high explanatory power and further proving the dependence of GHG emissions on past GHG emissions.

6 Policy Discussion

6.1 Policy Explanations to Regression Results

McKitrick (2016) argues that multiple overlapping environmental policies can lead to inefficiencies and reduced effectiveness. This perspective is reflected in the regression results and is evident in analyzing the multitude of policies present in BC which are aimed at reducing GHG emissions. While the BC carbon tax aims to reduce GHG emissions by making fossil fuel use more expensive, its effectiveness can be undermined if it is implemented alongside other conflicting policies. McKitrick (2016) highlights that such redundancy can create economic inefficiencies and deadweight loss without achieving additional environmental benefits.

In addition to the carbon tax, British Columbia and Canada have implemented several other overlapping environmental policies. For instance, the federal government has introduced the Clean Fuel Standard, which mandates a reduction in the carbon intensity of fuels (Environment and Climate Change Canada , 2023b). BC has its own Low Carbon Fuel Standard with similar objectives, which also imposes a credit-based emissions trading system. Additionally, there are various subsidies and incentives for renewable energy projects, electric vehicles, and energy efficiency improvements at both the provincial and federal levels. The Greenhouse Gas Industrial Reporting and Control Act in BC requires large industrial emitters to meet specific emissions targets or pay into a technology fund (Province of British Columbia, 2024). These overlapping policies lead to regulatory confusion and administrative burdens for businesses. They may also result in double counting of emissions reductions or conflicting signals about the most effective ways to reduce GHG emissions. Addressing these overlaps requires careful policy coordination to ensure that the combined impact of these measures maximizes environmental benefits without imposing unnecessary economic costs.

Low adoption of electric vehicles (EVs) is another example of an inefficiency created through the use of overlapping policies. Despite significant subsidies and incentives, EV adoption remains limited, suggesting that existing policies promoting their adoption may not be effectively designed to achieve lower GHG emissions, which is the intended outcome. The conflicting results observed in our regression models further highlight the need for a more streamlined approach to environmental policy. For example, while Model 1 suggests an association between the BC carbon tax and increased GHG emissions, Model 2 shows a reduction in GHG emissions when GDP and population are accounted for. However, the coefficients for the $CarbonTax$ variable in both models are not statistically significant. This inconsistency points to potential issues with policy overlap, reinforcing McKitrick's argument for more targeted and efficient policy design. Table 3 shows Electric and Non-Electric vehicle registration in Canada from 2017-2022, including EV registration growth. Since 2019, growth in EV registration has been declining, while year-to-year demand for non-electric vehicles has maintained stable growth between 2018-2022. This further highlights the lack of efficiency when multitude of environmental policies are implemented.

Another key element of the policy explanation for these results is the issue of inadequate funding for public transit investments. Canada could increase public transit ridership through targeted investments in transit operations, housing density near transit, and incentives for faster transit services. These measures could cut 65 million tonnes of carbon emissions from 2024 to 2035. However, current public transit is underutilized due to unreliable services and lack of adequate

Table III: Electric Vehicle Registration in Canada, 2017-2022

	2017	2018	2019	2020	2021	2022
Non-electric	3,268,655	3,327,929	3,381,707	3,369,266	3,512,196	3,615,356
Electric	48,789	59,210	79,823	101,311	134,331	173,594
Percentage of EV to total M.V.R.	1.50%	1.80%	2.40%	3.00%	3.80%	4.80%
EV growth year-to-year		19%	33%	27%	27%	26%
Non-electric growth year-to-year		2%	2%	0%	4%	3%

funding. Despite significant federal investment in transit infrastructure, insufficient funding for day-to-day operations leaves many buses idle (Environmental Defence, 2024). Investing adequately into transit services is crucial for improving ridership, reducing GHG emissions, and making public transit a viable climate solution.

6.2 Policy Recommendations

In order for environmental policies to be effective, BC and the rest of Canada should adopt a more streamlined approach. McKitrick's argument for reducing policy overlap and redundancy is particularly important here. Multiple overlapping policies can lead to inefficiencies, increased financial burdens, and economic inefficiencies without necessarily providing environmental benefits. Instead, focusing on a single, well-targeted policy can generate more productive and substantial outcomes, while also being less burdensome on consumers and the economy.

If a carbon tax is to be implemented, it should be the only environmental policy targeting GHG emissions. This would allow for a clearer signal in the market, reducing confusion and enabling businesses and consumers to make better decisions that are less burdened by a multitude of policies. By concentrating resources and efforts on one policy, be it the carbon tax or another policy, its effectiveness can be maximized and would ensure that it sufficiently creates reductions in emissions. This focused approach is more likely to yield better environmental and economic results.

Pretis (2022) argues that carbon pricing at current rates alone is insufficient for major GHG emission reductions. The absence of a statistically significant effect of carbon taxes on aggregate emissions is likely due to the tax being too low to prompt changes, given the varied GHG emissions elasticities across sectors. Pretis also argues that carbon taxes are not the only way to reduce emissions and that other measures like command-and-control approaches and mandated efficiency improvements can significantly lower emissions.

Another viable policy solution may be for Canada to advocate for a renegotiation of the Paris Accord to account for its large forest sinks. Research shows that forest-related emissions reported in national inventories may be lower than global estimates, due to differences in how anthropogenic forest carbon sinks are counted. For instance, Canada's National Inventory Report shows a discrepancy between actual forestry-related emissions and reported figures. While carbon emissions from wildfires are considered natural, carbon removals from commercially mature forests are deemed anthropogenic. This inconsistent reporting approach can lead to an emissions account that is not truly reflective of Canada's emissions (Bysouth et al., 2024).

Canada's forests, especially its boreal forests, are crucial carbon sinks, absorbing significant amounts of greenhouse gases and playing an important role in the global carbon balance. These forests are a major contributor to climate mitigation by sequestering more carbon than they emit, which helps offset emissions globally (Harris et al., 2021). This raises important questions about whether Canada, with its considerable natural carbon sinks, should bear the same burden of climate mitigation through policies like the carbon tax, which impose direct costs on consumers and the economy. Instead, greater responsibility should be placed on nations that are larger polluters, as they contribute more substantially to global carbon emissions. Renegotiating the Paris Accord to recognize the unique contributions of heavily forested nations like Canada could lead to a more effective global strategy for addressing climate change, one that accurately reflects each country's carbon balance and directs responsibility towards the major emitters.

The health and management of Canada's carbon sinks are critical for maintaining the environmental benefits they provide. There is a need for further research on the emissions of unmanaged forests in order to better understand and accurately account for carbon dynamics and potential carbon sinks in unmanaged forests. These forests play a crucial role in carbon emissions and deficits, yet they are often excluded or underrepresented in national inventories. Recognizing their contribution is important in order to create a more accurate and comprehensive picture of a country's carbon balance, particularly for a nation like Canada with extensive unmanaged forests. Furthermore, other countries with significant forest cover, such as Brazil, Russia, and countries in central Africa share similar challenges and opportunities with large forests (Harris and Gibbs, 2021). These nations could become key allies for Canada in advocating for a renegotiation of the Paris Accord. This collaboration could aim to ensure that the carbon sinks provided by large, forested areas is properly acknowledged within international climate agreements. These countries can push for an international framework that more accurately reflects the contributions of forested nations to global carbon sequestration. This approach would recognize a more equitable distribution of responsibilities in combating climate change.

7 Summary and Conclusion

This paper analyzes the effectiveness of the BC carbon tax in reducing GHG emissions. Data from Canada's official GHG inventory, along with provincial population and GDP data, were analyzed using multiple regression models and difference-in-differences techniques. The findings reveal that the BC carbon tax has not significantly reduced overall GHG emissions, likely due to contradictory overlapping policies and insufficient tax rates. We examine possible solutions for the future direction of environmental policy in BC and the rest of Canada.

The study highlights the mixed impact of the carbon tax, with some models indicating a slight positive or negative correlation with GHG emissions, but none showing significant results. Policy recommendations include streamlining environmental policies to reduce overlap and focusing on a single, well-targeted measure like an appropriately set carbon tax. As well, we suggest that Canada should advocate for a renegotiation of the Paris Accord to account for its vast forest sinks. We also emphasize the need for further research on unmanaged forests' emissions in Canada, as well as other densely forested countries.

This paper contributes to existing carbon tax literature by providing an analysis of the BC carbon tax's effectiveness. Through highlighting the inconsistencies and limited impact of the carbon tax, the study contributes to the ongoing debate on the best ways to approach to environmental policy in Canada by showing the BC carbon tax to be statistically ineffective. These findings highlight the importance of policy coherence and clarity of direction in the market when it comes to environmental and carbon pricing policy. Future research should explore the benefits of employing only a single environmental policy as well as the potential benefits of renegotiating the Paris Accord to recognize forest sinks accurately. This approach could lead to more effective climate policies globally.

References

Agostini, P., Botteon, M., and Carraro, C. (1992). A carbon tax to reduce co2 emissions in europe. *Energy Economics*, 14(4):279–290.

Bysouth, D., Boan, J. J., Malcolm, J., and Taylor, A. R. (2024). High emissions or carbon neutral? inclusion of anthropogenic forest sinks leads to underreporting of forestry emissions. *Frontiers and Global Change*, 6.

Carbon Tax Center (2024). Canada's federal carbon pricing program. https://www.carbontax.org/where-carbon-is-taxed-overview/canada-british-columbia/. Accessed: 2024-07-29.

Carson, R., Jacobsen, M., and Liu, A. (2015). Comparing the cost of a carbon tax in China and the United States. *American Economic Association Conference*.

Dumortier, J. and Elobeid, A. (2021). Effects of a carbon tax in the united states on agricultural markets and carbon emissions from land-use change. *Land Use Policy*, 103.

Elgie, S. and McClay, J. (2013). BC's Carbon Tax Shift Is Working Well after Four Years. *Canadian Public Policy*, 39:1–10.

Environment and Climate Change Canada (2023a). National Inventory Report 1990-2021. https://energy-information.canada.ca/en/subjects/greenhouse-gas-emissions-national-inventory-report-nir. Accessed: 2024-05-20.

Environment and Climate Change Canada (2023b). What are Clean Fuel Regulations. https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations/about.html#toc3. Accessed: 2024-05-20.

Environment and Climate Change Canada (2024). Canada's official greenhouse gas inventory. https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/inventory.html?utm_campaign=not-applicable&utm_medium=vanity-url&utm_source=canada-ca_ghg-inventory. Accessed: 2024-05-10.

Environmental Defence (2024). New Report: Expanding Public Transit Service Can Double Ridership and Cut Emissions by 65 Million Tonnes. https://environmentaldefence.ca/2024/02/27/expanding-public-transit-can-double-ridership-and-reduce-polluting-emissions-report/#:~:text=Combined%20with%20electrification%20of%20bus,produced%20by%2020%20million%20cars. Accessed: 2024-06-20.

Fremstad, A. and Paul, M. (2019). The Impact of a Carbon Tax on Inequality. *Ecological Economics*, 163:88–97.

Government of Canada (2024). Greenhouse gas emissions: drivers and impacts. https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions-drivers-impacts.html. Accessed: 2024-06-20.

Hajek, M., Zimmermannova, J., Helman, K., and Rozensky, L. (2019). Analysis of carbon tax efficiency in energy industries of selected EU countries. *Energy Policy*, 134.

Harris, N. and Gibbs, D. (2021). Forests Absorb Twice As Much Carbon As They Emit Each Year. https://www.wri.org/insights/forests-absorb-twice-much-carbon-they-emit-each-year. Accessed: 2024-06-20.

Harris, N., Gibbs, D. A., Baccini, A., Birdsey, R. A., de Bruin, S., Farina, M., Fatoyinbo, L., Hansen, M. C., Herold, M., Houghton, R. A., Potapov, P. V., Suarez, D. R., Roman-Cuesta, R. M., Saatchi, S. S., Slay, C. M., Turubanova, S. A., and Tyukavina, A. (2021). Global maps of twenty-first century forest carbon fluxes. *Nature Climate Change*, 11.

Harrison, K. (2012). A Tale of Two Taxes: The Fate of Environmental Tax Reform in Canada. *Review of Policy Research*, 29(3):383–407.

Harrison, K. (2019). Lessons Learned from British Columbia's Carbon Tax. *Policy Options*.

Liu, L., Huang, C., Huang, G., Baetz, B., and Pittendrigh, S. (2018). How a carbon tax will affect an emission-intensive economy: A case study of the Province of Saskatchewan, Canada. *Energy*.

McKitrick, R. (2016). A Practical Guide to the Economics of Carbon Pricing. *SPP Research Papers*, 9(28).

Mildenberger, M., Lachapelle, E., Harrison, K., and Stadelmann-Steffen, I. (2022). Limited impacts of carbon tax rebate programmes on public support for carbon pricing. *Nature Climate Change*, 12:141–147.

Ministry of Environment and Climate Change Strategy (2024). British columbia's carbon tax. https://www2.gov.bc.ca/gov/content/environment/climate-change/clean-economy/carbon-tax. Accessed: 2024-07-14.

Murray, B. and Rivers, N. (2015). British Columbia's revenue neutral carbon tax: A review of the latest grand experiment in environmental policy. *Energy Policy*, 86:674–683.

Olale, E., Yiridoe, E., Ochuodho, T., and Lantz, V. (2019). The Effect of Carbon Tax on Farm Income: Evidence from a Canadian Province. *Environmental and Resource Economics*, 74:605–623.

Pretis, F. (2022). Does a Carbon Tax Reduce CO2 Emissions? *Environmental and Resource Economics*, 83:115–144.

Province of British Columbia (2024). Credit market. `https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/renewable-low-carbon-fuels/credits-market`. Accessed: 2024-06-20.

Rahdari, M. (2021). Measuring and monitoring urban sprawl in Canada from 1991 to 2011. `https://spectrum.library.concordia.ca/987639/1/PouraliRahdari_MSc_S2021.pdf`. Accessed: 2024-07-14.

Sileci, L. (2023). Carbon pricing with regressive co-benefits: evidence from British Columbia's carbon tax. *London School of Economics and Political Science*.

Snodden, T. and Tombe, T. (2019). Analysis of Carbon Tax Treatment in Canada's Equalization Program. *Canadian Public Policy*.

Statistics Canada (2024). Population estimates on July 1, by age and gender. `https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=1710000501`. Accessed: 2024-06-20.

The Canadian Press (2009). Canadians barely support carbon tax; don't like BC version, poll finds. `hhttps://thetyee.ca/Blogs/TheHook/BC-Politics/2009/05/10/CarbonPoll/`.

Unifor (2022). Understanding and Addressing Canada's Affordability Crisis. `https://www.unifor.org/sites/default/files/documents/Understanding%20and%20Addressing%20Canada%E2%80%99s%20Affordability%20Crisis.pdf`. Accessed: 2024-07-20.

Williams III, R., Gordon, H., Burtraw, D., Carbone, J., and Morgenstern, R. (2014). The initial incidence of a carbon tax across US states. *National Tax Journal*, 67(4).

Woodside, J. (2023). Public Support for Carbon Tax Waning Quickly. *Canada's National Observer*.