The Carbon Tax Effect on British Columbia Economy and Carbon Emission

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Abstract. A carbon tax is the most common carbon emission control policy widely used. British Columbia is the first Canadian province to use a carbon tax and implementing a carbon tax will impact British Columbia's environment and economy. This paper analyzes the scale of the carbon tax, energy consumption, GHG emission, and government revenue in British Columbia to evaluate the effect of the carbon tax. This paper finds that a carbon tax has no impact on dramatically reducing GHG British Columbia emissions, but it can help the government get more revenue. Although the carbon tax has little effect on reducing carbon emissions in British Columbia, the carbon emissions in British Columbia have been significantly reduced compared to other provinces. Therefore, we believe that the British Columbia carbon tax has a significant impact on controlling CO2 emissions, and the value of carbon emissions can be further controlled by increasing the carbon tax.

Keywords: CO2 emissions; British Columbia; Carbon tax.

1. Introduction

Global climate disasters occur more frequently due to rising temperatures brought on by increased greenhouse gas emissions. Countries and regions will develop policies and objectives to decrease the emissions of greenhouse gas. Also, in the year of 2050 the emissions of country become net-zero, Canada must comply with the Paris Agreement's requirement that its greenhouse gas emissions be reduced by 40 to 45 percent from 2005 levels by 2030 [1]. Canada's Environment and Climate Change, 2022 Canada has two tiers of both the federal and provincial governments. Provincial governments may create regional policies. As a result, different Canadian provinces have distinct carbon policies. For instance, cap and trade are used in Quebec and Nova Scotia, whereas carbon tax schemes are used in British Columbia and the northwest. Carbon emission legislation will impact the local economy and the way of life of the populace. One of the most popular and commonly utilized methods of reducing carbon emissions is the carbon price.

A carbon tax operates as a price tool that can raise the cost of using fossil fuels and hence decrease the usage of fossil fuels. As a by-product of burning fossil fuels, carbon dioxide is a significant greenhouse gas. Annual increases in the Earth's CO2 content have some effects, including ocean acidification, glacier melting, and global warming. It is challenging to generate effective carbon emissions by depending on competitive markets because problems like climate change are nonexcludable. The microeconomic theory states that the government imposes a carbon tax to equal the social benefit and social cost of CO2 emissions by adding the social cost of CO2 emissions to users. The government must revise the carbon pricing according to inflation as a price mechanism. A tool that automatically accounts for inflation is the tradable permit. This strategy is based on the Coase theorem, which places a boundary on carbon emissions, and is used by provinces like Quebec. The market exchanges licenses and, in the end, efficiently distributes the amount of carbon emissions. Both strategies effectively internalize externality and resolve the CO2 emissions-related climate issue.

A carbon price can decrease the use of fossil fuels, but it might also change how energy is produced. Increased production costs and decreased profitability in the manufacturing, industrial, and power sectors may result from increasing energy costs. The success of carbon tax policies and their effects on the economy must therefore be assessed. This paper analyzes the scale of the carbon tax, energy consumption, GHG emission, and government revenue in British Columbia to evaluate the effect of the carbon tax.

The outline of this paper is as follow: the review of the earlier research on the efficiency of carbon prices conducted by economists are presented after the introduction. Section 3 evaluate the effectiveness of the carbon tax on British Columbia and its effects on the economy and analyze the carbon tax policy and its implementation in B.C. province.

2. Literature Review

To slow down global warming and climate change, it is urgent to decrease the emissions of greenhouse gas, and the carbon tax has become an essential tool for implementing emission reduction measures. According to the Paris Agreement, by 2030, Canada wants to cut greenhouse gas emissions by 30%. In order to achieve emission targets, the Canadian federal and provincial governments have separately formulated carbon emission policies. In 2008, British Columbia implemented a carbon tax. British Columbia was ripe for a carbon tax because of its considerable hydropower potential, increased attention to climate change, leaders' strong commitment tom reducing emissions, and support from the business community [2]. Although the carbon tax will increase personal expenses, it will cause the ruling party's support to decline in the early stage of carbon tax implementation. However, with the carbon tax implementation, support gradually recovered, and supporters doubled as opponents. That is why British Columbia's carbon tax is sustainable.

The initial carbon tax rate was $10/ton, and it was later raised by $5 annually., reaching $30/ton in 2012 [2]. The carbon tax price remained at $30/ton for five years. On April 1, 2022, B.C. carbon tax increased from $45/ton to $50/ton. A carbon tax applies to the purchase and use of fossil fuels, based on a carbon tax of $50/ton, the tax rates for different fuels are: Gasoline 11.05 ¢/litre, Diesel (light fuel oil) 13.01 ¢/litre And Natural gas at 9.79 ¢/cubic meter [3].

The carbon tax hurts the use of Diesel, and the average annual diesel emission reduction after the carbon tax was about 1.3% of the diesel emissions in 2008 [4]. Eduardo, in the New York times in 2016, points out that the carbon tax has resulted in better-than- expected results for British Columbia. B.C.'s economy is growing faster than neighboring provinces, and greenhouse gas emissions have fallen. As a result of the carbon tax, rising gasoline and natural gas prices encourage people to drive less and heat more reasonably. The opposition rate of the carbon tax has also gradually decreased, and the support rate of both individuals and enterprises has increased, indicating that the carbon tax is an effective carbon policy and that the market has a good carbon policy [5].

Pretis used machine learning methods to study the impact of the carbon tax on B.C.'s economic and environmental effects [6]. The results suggest that existing carbon taxes may be too low to induce effective emissions reductions. Meanwhile, the carbon tax has no significant negative impact on GDP, but it can significantly increase tax revenue [7]. The carbon tax became an essential part of B.C. government revenue.

Revenues from carbon taxes can help governments cut other taxes and increase government spending. By leveraging carbon tax revenue, government spending can further support greenhouse gas emissions, mitigate climate hazards, subsidize the economic burden of consumers and generators, and finance public utilities [8]. Yamazaki studies the impact of a carbon tax in B.C. on employment. A carbon tax is not conducive to industries with high carbon intensity, so the carbon tax causes employment in the industry to decline while employment in the clean energy industry increases, which drives the increase in renewable energy. New employment directions will be created with the adjustment of the industrial structure and the reallocation of resources. From 2007 to 2013, the employment rate in B.C. increased by 0.74% per year.

3. Analysis

Carbon tax is established under the Greenhouse Gas Pollution Pricing Act (GGPPA), which consists of two parts:

Fuel producers, distributors and specific users pay fuel fees for 21 types of fuels and combustibles

For large emitters, use an output-based pricing system (OBPS) to levy a carbon tax.

Positive aspects of the analysis

Carbon tax on energy production and consumption

The carbon tax has limited ability to control fuel producers. Figure 1 shows the 1995-2020 energy production in BC. We can see that crude oil production decreased slightly in 2008 and 2009, but crude oil production returned to the 2008 level in 2010. Thus, the carbon tax did not reach the purpose of limiting crude oil output. Before the carbon tax implementation, natural gas production started to decline in 2006, and it is difficult to judge that a drop in natural gas has resulted from the carbon tax's performance.

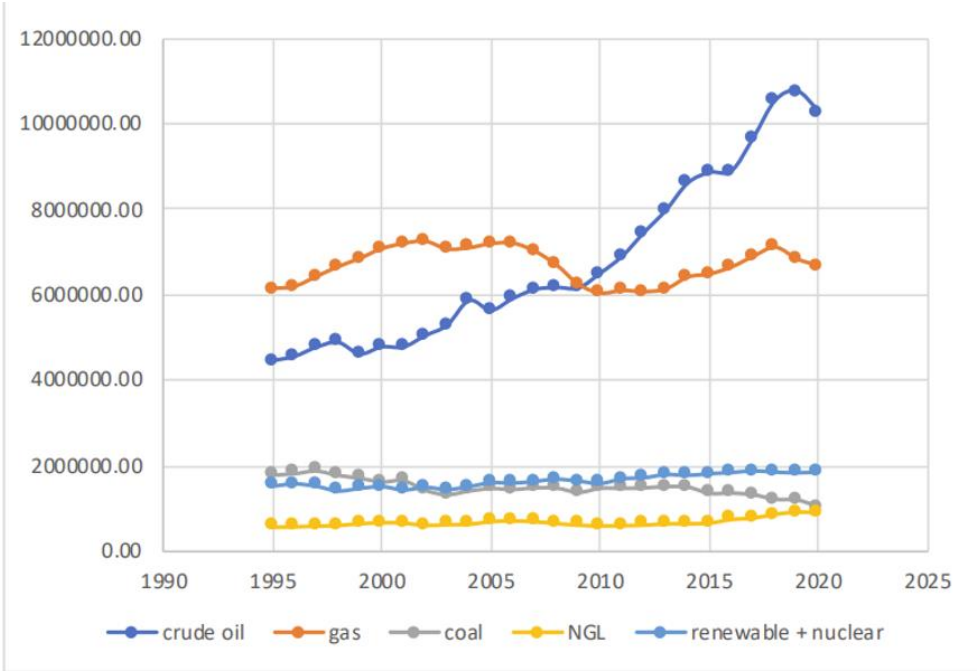

Fig 1. Energy production in BC. [3]

Examine and further study on the effect of the carbon tax on energy production, this report also does regression analysis, and the results are shown in Table 1. As the carbon tax increase, crude oil, NGL, and renewable + nuclear energy production increases, while the coal production reduces, and the carbon tax does not affect natural gas.

Table 1. Carbon tax effect on energy production

	curde oil	natural gas	coal	NGL	renewable+nuclear
(Intercept)	5027082.855	6812308.829	1616816.628	640429.43	1528801.312
	(204307.597)	(106881.024)	(41630.355)	(19652.463)	(16448.172)
carbon.tax	123732.283	-10080.928	-8753.823	3398.016	8442.925
	(10001.297)	(5232.056)	(2037.896)	(962.03)	(805.173)
N	26	26	26	26	26
R2	0.864	0.134	0.435	0.342	0.821
LogLik	-388.123	-371.277	-346.762	-327.246	-322.618
AIC	782.246	748.544	699.524	600.491	651.236

Since Coal is a high carbon emission energy source, a carbon tax can inhibit its consumption. Low-carbon emission energy, such as renewable energy and nuclear energy, benefited from the carbon tax and increased significantly after the carbon tax policy. However, the carbon tax cannot limit crude oil and natural gas production because these two energy sources are highly related to GDP and have a high proportion of energy consumption. According to energy's trilemma, both the economy

and the environment are critical, and the government will pay more attention to economic growth than the environment nowadays.

Carbon taxes have different effects on energy consumption varies across industries. Figure 2 shows petroleum trends in different industries. Following the carbon tax implementation in 2008, petroleum demand fell significantly in 2009 but rebounded to 2008 levels in 2010. Transportation has the highest proportion of the use of petroleum, and its trend is similar to that of petroleum demand. Carbon tax increases have little effect on inhibiting the consumption of oil.

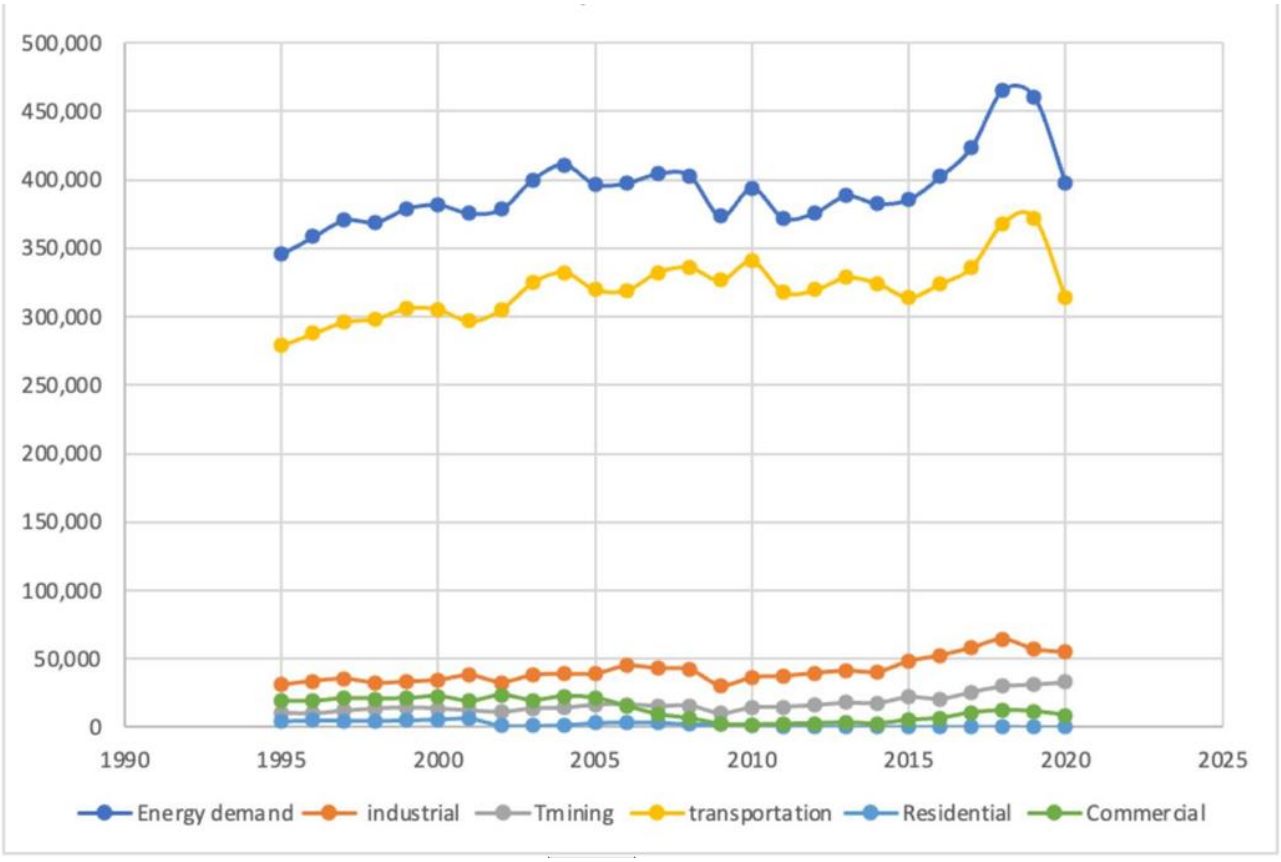

Fig 2. Refined petroleum consumption in BC. [3]

Table 2 uses the regression method to analyze the effects of the carbon tax on petroleum. In industrial, mining and transportation markets, the carbon tax has not inhibited the use of petroleum. In residential and commercial markets, the carbon tax can reduce petroleum consumption. However, the proportion of residential and commercial petroleum consumption is too small to have little impact on overall carbon emissions.

Table 2. Effect of carbon tax on energy consumption

	Energy.demand	industrial	mining	transportation	Residential	Commercial
(Intercept)	380897.45	35669.879	12661.056	309330.851	3760.827	18065.86
	6503.97	1810.961	1107.622	4794.75	327.456	1397.109
carbon.tax	805.679	419.186	322.868	782.747	-107.651	-384.273
	318.355	88.65	54.22	234.713	16.03	68.392
N	26	26	26	26	26	26
R2	0.211	0.482	0.596	0.318	0.653	0.568
LogLik	-298.439	-265.253	-252.47	-290.568	-220.786	-258.507
AIC	602.986	536.506	510.94	587.136	447.572	523.014

3.1 Carbon Tax on GHG Emission

The carbon tax did not inhibit energy production and consumption from previous figures, and The carbon tax's impact on GHG emissions is also limited. British Columbia emissions have risen from 59.2 Mt in 2015 to 65.7 Mt in 2019, an 11% increase in four years. Figure 3 shows the GHG emissions changes in B.C. the total GHG emission decreased in 2009 and 2010, but after that, it had an increasing trend, especially after 2015. According to the current trend of total GHG emission, the B.C. 2025 emission target will be impossible to achieve.

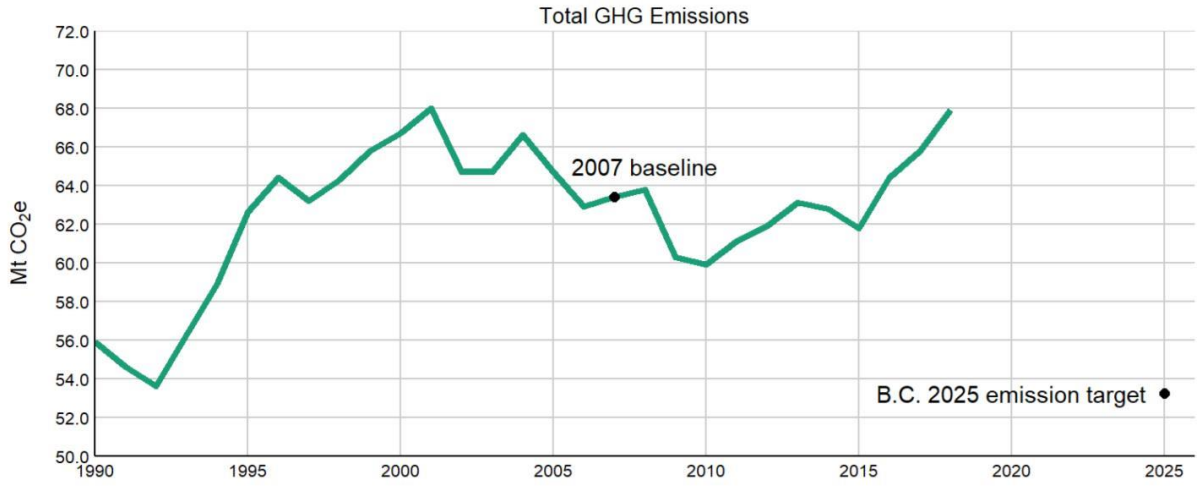

Fig 3. Total GHG emission in B.C. [3]

The total GHG emission did not decrease significantly because of the increasing energy consumption in B.C., but energy consumption efficiency had been significantly improved. Figure 4 shows the trend of GHG emissions per person. It can be seen that GHG emission per person has had a downward trend since 2004. The decrease in GHG emissions per person after the carbon tax implementation is hard to say because of the carbon tax effect.

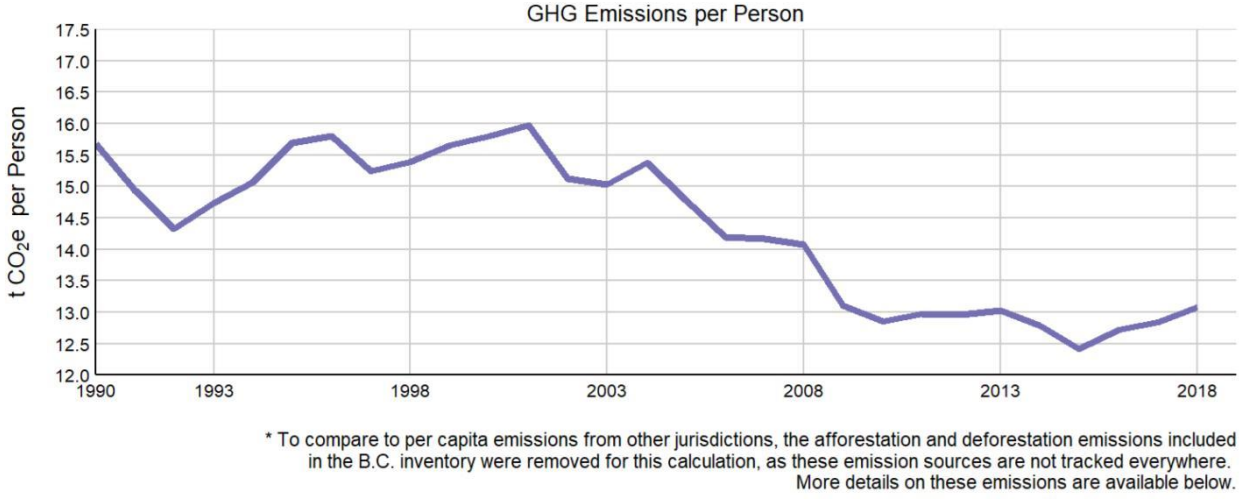

Fig 4. GHG emission per person in B.C. [3]

Compared with other regions in Canada, implementing a carbon tax in B.C. effectively reduces GHG emissions. Figure 5 shows the average change in pre-tax and post-tax GHG emissions. Total carbon emissions in B.C. from 2008 to 2013 decreased by 6.1% compared to 2000 to 2007, while

other regions increased by 3.5%. Emission per capita fell by 12.9%, while other regions fell by 3.7%. Emission per GDP fell by 20.5%, while the rest of the region fell by 8.1%. The carbon emission of B.C. province after the introduction of the carbon tax policy has a significant inhibitory effect compared with other regions.

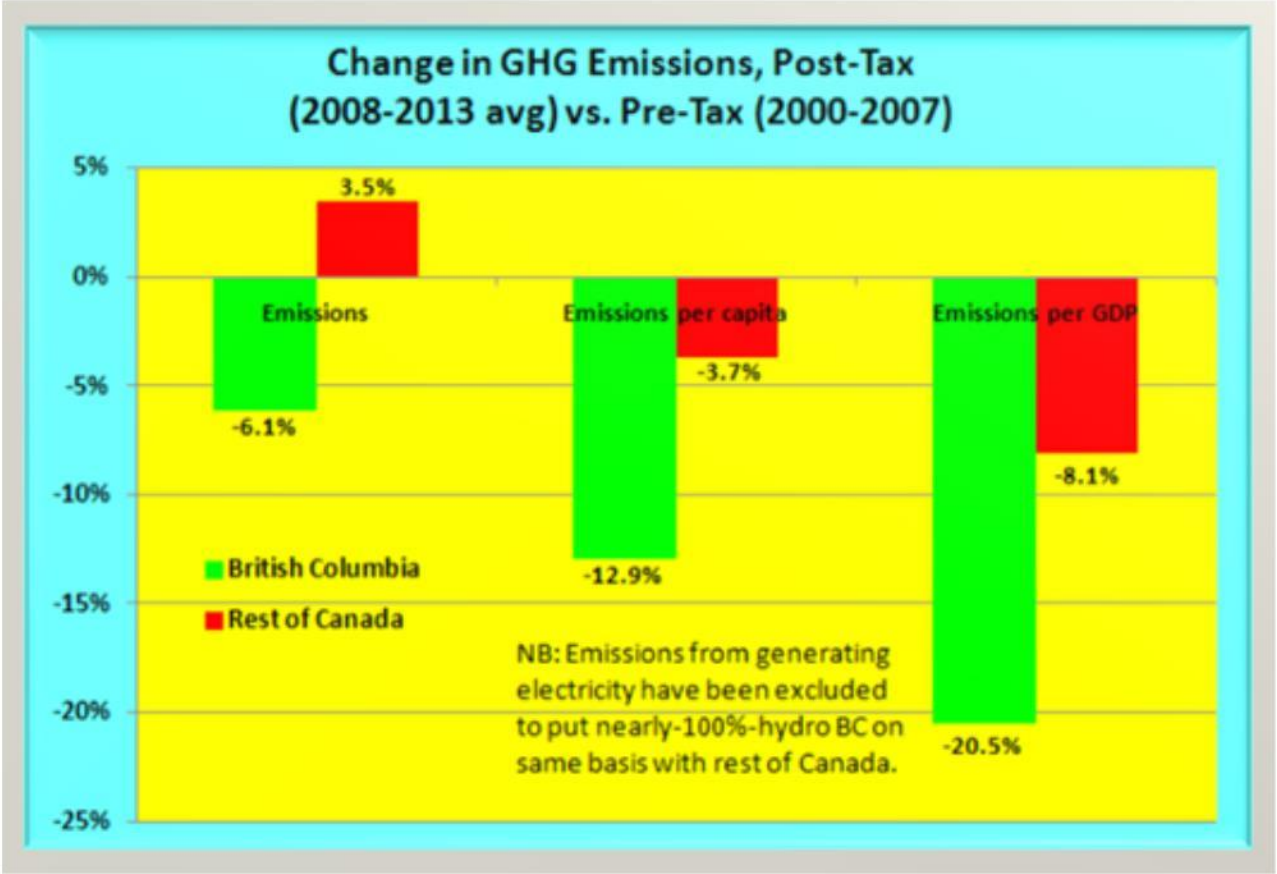

Fig 5. Carbon tax effect in B.C. [3]

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3.2 Carbon Tax on Government Revenue

B.C. government revenue in 2021 is 70.2 billion [9], of which carbon tax is 2 billion [10]. Carbon tax accounts for 3% of government revenue. As of 2021, carbon tax has paid 14 billion to B.C. Province carbon tax, but the reduction effect achieved is not obvious. The government uses carbon tax proceeds to encourage companies and organizations to participate in the R&D and promotion of a low-carbon economy, such as the clean BC industrial plan launched in 2019, to encourage the industry to remain competitive in terms of innovation and emission reduction.

4. Limitation of the Analysis

The OLS method used in this paper to study the relationship between carbon tax and energy production and consumption lacks causality. The OLS method cannot eliminate the influence of the omitted variable bias on the estimation results, resulting in bias in the estimated effect of carbon tax. Many factors affect the energy market, such as interest rates, exchange rates, COVID-19, etc. Even if OLS introduces the above variables, it cannot guarantee a causal analysis of carbon tax on the energy market can be obtained. Secondly, there is an obvious correlation in the data, because variables such as GHG emission, energy consumption, production belong to the time series. There is a

correlation between the data of adjacent years, which leads to the conclusion that the analysis obtained by the OLS method is no longer valid.

The amount of data collected is small, resulting in a large error in the estimated carbon tax effect. According to econometrics, the larger the sample size, the greater the power. The amount of annual data used in this paper is too small, with only 26 observations. The implementation of the carbon tax does not take effect at the end of the year, and the use of the annual data cannot capture people's reactions to the carbon tax after the carbon tax takes effect. Therefore, to improve the accuracy of carbon tax effect estimation, we can use monthly data to increase the sample size.

5. Policy Implications

As a whole, B.C.'s carbon tax has been poorly implemented. Two primary purposes of the government's carbon tax are to reduce carbon emissions and collect tax revenue. Since the government's carbon tax revenue is not significant, the government may consider increasing the tax burden and changing the intervention methods [11].

According to microeconomic theory, when the demand curve is inelastic, the tax has little effect on the quantity. When people's demand for fossil fuels is inelastic, the percentage change in price causes a minor change in consumption. Even if the government imposes a carbon tax, the impact on carbon consumption is negligible.

To strengthen the policy and meet the objectives of increased tax revenue and decreased carbon emissions, the government may consider a more severe carbon tax policy. For example, the government could raise the carbon tax to twice its current level, which would help further reduce carbon emissions and increase government revenue.

Furthermore, the government can learn from Quebec's policy. Currently, Quebec uses the Cap-and-Trade method to control carbon emissions. According to Coase's theorem, unless the boundaries of the property rights are clearly stated, and there are no transaction costs, the market can efficiently allocate carbon emissions. The government sets a cap on carbon emissions and issues a corresponding number of permits, and the permits can be traded among different companies. In this way, companies with high costs buy permits from companies with low costs in case of insufficient permits. The market would lead to an equilibrium price. The advantage of this is that the government directly controls the cap on carbon emissions and is thus able to reduce carbon emissions to a satisfactory level directly.

Since lowering carbon emissions increases costs for consumers and reduces benefits for producers, the government also has to weigh the distribution of benefits. On the one hand, the government can use public opinion polls to avoid options that reduce people's support. On the other hand, the government can transfer the carbon tax collected to subsidize the low-income people to increase social welfare.

6. Conclusion

Humankind must combat climate change for its survival. The leading cause of climate change is the burning of fossil fuels, and a carbon tax can reduce the use of fossil fuels. Many papers have discussed the importance of a carbon tax to reduce carbon emissions, and data from B.C. shows that the carbon tax is not strong enough and therefore has limited effect.

Through the previous study, the B.C. carbon tax will hardly reach its target by 2025 and does not contribute enough tax revenue to the government. For this reason, the government could raise the carbon tax or consider using a Cap-and-trade approach. The limitation of this paper is that the OLS approach, while indicating a small effect of the carbon tax on GDP and unemployment, does not show a causal relationship. Also, the limited sample of data collection will constrain the accuracy.

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