

# Carbon Tax: Theory and Experiment

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# Reducing GHG to manageable levels is behavior-limited

Limiting factor in mitigating climate change at any predefined goal is not technical

- The technology may not be cheap or optimal, but it does exist

Limiting factors are economic and behavioral

Even if economic barrier is inconsequential (which it is), there are daunting behavioral barriers

- Pushback from powerful potential losers
- Inertia / procrastination
- Future benefits vs. immediate costs; discounting

# Policies to guide desired behavior

## "Command and Control"

- Regulations limiting amount of CO<sub>2</sub> emissions allowed

## Incentives

- Rebates / subsidies for purchase of equipment that reduces CO<sub>2</sub> emissions

## Carbon tax

## Carbon emission cap-and-trade

# Carbon tax

Favored solution by Nordhaus and many economists

- Efficient, easy to implement, and utilizes normal market function to achieve goal

Revenues from carbon tax reduce other tax rates, so overall tax burden is unchanged

Ultimate cost is (appropriately) borne by those benefiting from goods and services produced by carbon-emitting energy sources

- As it is now, emitting carbon is "free goods"; those doing so are, in effect, receiving a subsidy paid from future damages - how fair is that?

# Carbon tax

Amount of carbon tax based on target of maximum temperature

DICE model suggests \$25/ton to limit to 2.5°

Range of rates from other models from  $\frac{1}{2}$  to 2x that amount

Tax would rise gradually to damp down CO<sub>2</sub> emissions due to increasing population and wealth

But won't that cause household expenses to rise dramatically?

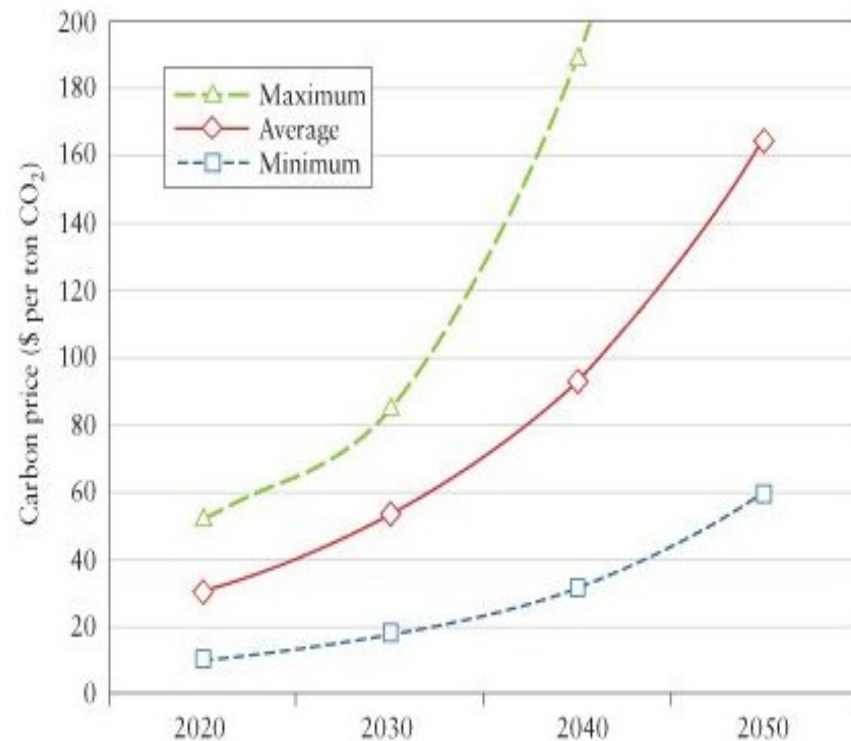


Figure 33. Illustrative carbon prices needed for a 2½°C temperature limit. This figure shows target price paths for CO<sub>2</sub> that would lead to a maximum temperature rise of around 2½°C. These results are from a group of thirteen models and show the central tendency as well as

# Effect of carbon tax on consumers

Carbon tax set at \$25/ton CO<sub>2</sub>, for example

Greatest impact is on electricity prices, due to their reliance on coal (20% increase)

Driving (8%) and flying (6%) next most affected

Some behaviors will be modified - e.g., taking vacations near home rather than foreign travel

However, overall household consumption cost only affected 1%

Table 9. Impacts of a \$25 per ton CO<sub>2</sub> price.

Example	Tons of CO <sub>2</sub>	Increase in spending due to \$25 CO <sub>2</sub> price	Increase in spending (%)
Year's electricity use	9.34	\$233.40	19.45
Year's driving	4.68	\$116.90	7.79
Economy class transcontinental flight	0.67	\$16.80	5.61
One year's household communication services	0.01	\$0.36	0.04
One year's household financial services	0.02	\$0.41	0.04
One year's household consumption	29.48	\$737.00	0.92

# Effect of carbon tax on prices

Carbon tax set at \$25/ton CO<sub>2</sub> initially and rising gradually over decades

Temperature limited to 2.5°

Cost as % of GDP never more than 1.25%

Table 10. Economic impacts of proposed carbon tax, United States, 2010–2030.

Year	Tax rate (2005 \$/ton CO <sub>2</sub> )	Emissions (billion tons CO <sub>2</sub> )	Revenues (2005 billion \$)	Revenues (% of GDP)
2010	0	6.3	0	0.00
2015	25	5.9	147	0.96
2020	30	5.5	168	0.97
2025	42	5.4	225	1.14
2030	53	5.2	277	1.25

# Comparing methods of reducing emissions

Carbon tax or cap-and-trade achieve substantial reductions at low cost

Other taxes, regulations, standards, rebates and subsidies are partial solutions at higher cost per ton of CO<sub>2</sub> avoided

Policy	Effect (as % of 2010–2030 emissions)	Cost (\$ per ton of CO <sub>2</sub> )
Gasoline tax	1.8	40
Building codes	0.1	51
Tighter auto standards	0.6	85
Liquid natural gas trucks	1.5	85
Weatherization tax credits	0.3	255
Federal interest subsidy	0.0	71,075
Cap and trade/Carbon tax	10.2	12



# British Columbia's Carbon Tax

Implemented in 2008

Electorate with strong environmental views, special interest in climate change

Provincial Premier Gordon Campbell made passage of carbon tax a signature issue

Right-center majority government - credible with business

Political institutional structure giving power to leader of the majority party

Hydro power generation of electricity predominates - relatively little impact on electricity price

Tax designed for revenue-neutrality

# Evaluation of B.C. Carbon Tax



SP

Sustainable  
Prosperity



uOttawa

Institut de l'environnement  
Institute of the Environment

Working Paper

NI WP 15-04

May 2015

[www.nicholasinstitute.duke.edu](http://www.nicholasinstitute.duke.edu)

British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest  
"Grand Experiment" in Environmental Policy

Brian C. Murray\* and Nicholas Rivers\*\*

# Provisions of B.C. carbon tax: sources

## Covered

- Fossil fuels (FF) used in the province

## Excluded

- Exported fuels; notably coal
- Fuel for ships/planes to/from B.C.
- Non-fuel GHG emissions - industrial process, landfill, agriculture, forestry
- Fugitive emissions (methane) during FF production and transmission

70-75% of all GHG emissions in province covered

# Provisions of B.C. carbon tax:

## Rates

C\$10 / tCO<sub>2</sub> at 2008 initiation

Increase C\$5 / tCO<sub>2</sub> annually x 4 yrs

C\$30 / tCO<sub>2</sub> from 2012 forward

C\$30 ≈ US\$24

# B.C. carbon tax rate vs. other jurisdictions

**Table 3. British Columbia carbon tax level compared to other carbon prices**

Region	Program	Domestic price (2015) <sup>a</sup>	US\$/ton <sup>b</sup>
British Columbia	Carbon tax	C\$ 30/ton	24.00
Alberta	Emission intensity target (fee for exceedance)	C\$ 15/ton	12.00
California-Quebec	Cap and trade (economywide)	US\$12.21/ton <sup>c</sup>	12.21
Northeastern United States	Cap and trade (electric power sector)	US\$ 5.41/short ton <sup>d</sup>	6.06
European Union	Cap and trade (economywide)	€ 6.80/ton <sup>e</sup>	7.34
France	Carbon tax on transport fuels and domestic heating fuels	€ 14.50/ton (rising to €22 in 2016)	15.66

<sup>a</sup> Nearest quote to April 8, 2015.

# B.C. carbon tax rate by fuel

**Table 2. Selected carbon tax rates by fuel**

Fuel type	Tax unit	Tax rate (in 2015)	Tax % of final fuel price (2014)
Gasoline	C¢/liter	6.67	4.4%
Diesel (light fuel oil)	C¢/liter	7.67	5.1%
Natural Gas	C¢/cubic meter	5.7	33.9%
Propane	¢/liter	4.62	7.1%
Coal high-heat value	C\$/ton	62.31	54.7%
Coal low-heat value	C\$/ton	53.31	46.8%

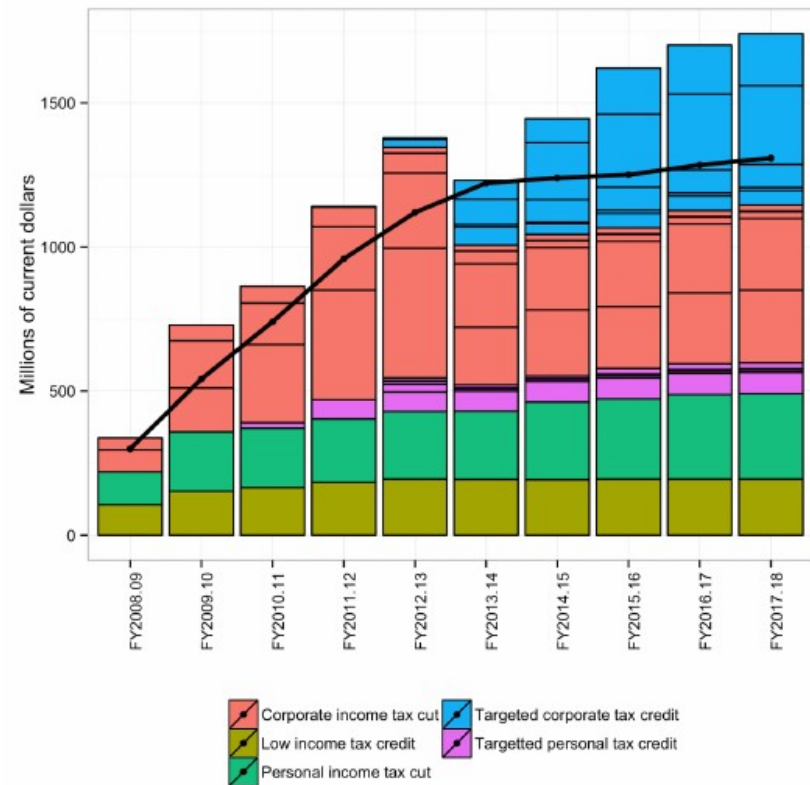
# B.C. carbon tax: Use of revenue

Tax credits to low income, rural citizens

Reduced personal income tax rates in lower two brackets

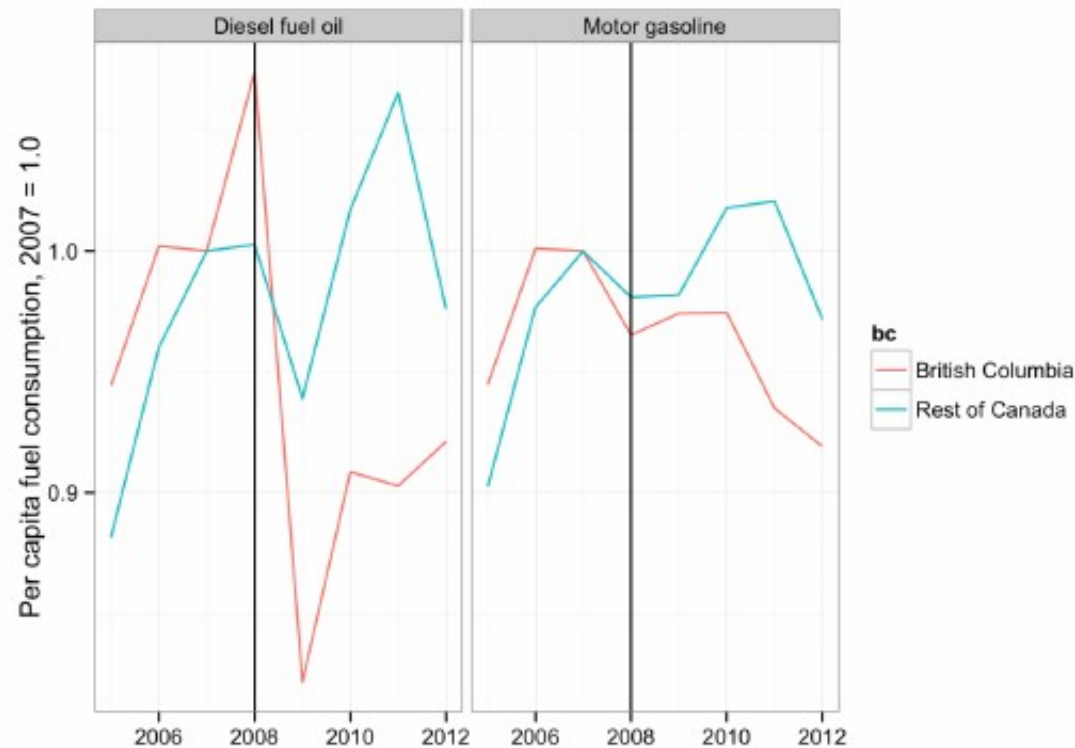
Reduced corporate income tax

Figure 1. Distribution of uses of BC carbon tax revenues, 2008–2018



# Effect of B.C. carbon tax on gasoline and diesel consumption

Figure 2. Trends in gasoline and diesel fuel oil sales in British Columbia and the rest of Canada, 2005–2012





# Effect of B.C. carbon tax on FF consumption

10% lower gasoline consumption

15% lower residential NG consumption

67% lower commercial NG consumption

Table 4. Summary of studies that estimate the effect of British Columbia's carbon tax on GHG emissions and fuel consumption

Source	Method	Results
British Columbia (2008)	Numerical simulation model with technological detail	5% reduction in GHG emissions
Beck et al. (2015)	Computable general equilibrium model	8.5% reduction in GHG gas emissions
Elgie and McClay (2013)	Difference-in-difference with no additional controls	18.8% reduction in per capita sales of petroleum fuels subject to the tax
Elgie and McClay (2013)	Difference-in-difference with no additional controls	9% reduction in per capita GHG emissions (data to 2011 only)
Rivers and Schaufele (2012)	Difference-in-difference with controls	11–17% reduction in per capita gasoline sales
Gulati and Gholami (2015)	Difference-in-difference with controls	15% reduction in residential natural gas demand; 67% reduction in commercial natural gas demand
Bernard, Guenther, and Kichian (2014)	Time series analysis	7% reduction in per capita gasoline sales

# Effect of B.C. carbon tax on GHG emissions

"It is reasonable to claim that the effect of the tax was to reduce ... GHG emissions 5-15% in B.C." - authors

The reductions were estimated by statistical modeling

- Compare actual emissions with a scenario estimating emissions in the absence of the tax

# Effects of B.C. carbon tax on economy: Expectations

## Simple

- Damages due to CC avoided
- Income taxes reduced
- Revenue neutral → minimal impact on economy
- Losers: those with livelihood tied to FF consumption
- Winners: All others - "windfall"

# Effects of B.C. carbon tax on economy: Expectations

## “Double dividend” hypothesis

- Income tax produces price distortions, reducing economic output
- Income tax reductions due to carbon tax weakens distortions, stimulates more economic output
- Resultant net positive impact on economy

# Effects of B.C. carbon tax on economy: Observed

Evidence based on a limited number of studies suggests little net impact in either direction

Possible negative effects in emission-intensive sectors (e.g., cement)

Positive effects in other sectors compensate

Adjustments made mid-course to reduce possible negative impacts to agriculture competitiveness (though no reduction of ag trade flows was seen)

# Effects of B.C. carbon tax on lower income (LI) citizens

Energy consumes a greater proportion of LI  
budget

Tax on energy is therefore regressive

# Response to potential regressive aspects of carbon tax

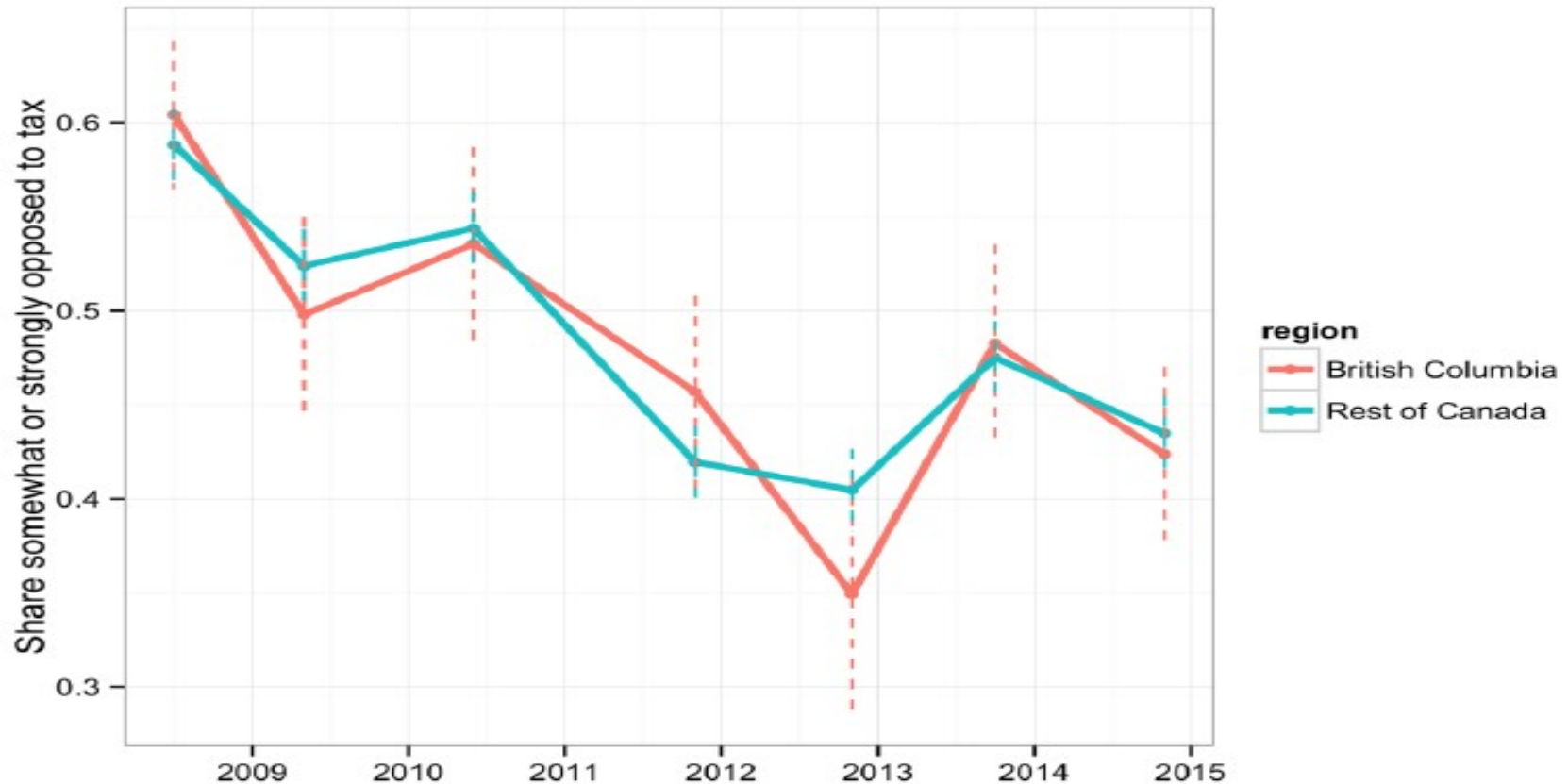
Inequity of tax to lower income addressed

Revenue recycling allocated mostly to LI

- LI Climate Action Tax Credit - \$115/adult, \$34/child
- 5% reduction in income tax rate in two lowest tax brackets
- Tax credits for Northern and rural residents

# Public reaction to B.C. carbon tax

Figure 4. Polling results on the BC carbon tax, 2008–2014



Initial opposition 60% in 2008, falling to 45% by 2013 on



# Public reaction by sector

Multifactorial analysis of polling data

Those more opposed:

- Older
- Lower income
- Small communities
- Male

Older, male, low income, rural (70% opposed) vs.  
younger, female, higher income, urban (40% opposed)

# B.C. carbon tax: Summary

Tax started low (C\$10/t) and rose over 4 years to C\$30/t

## Equitable

- Surplus recycled to be revenue neutral, favoring disproportionately affected lower income individuals

GHG reduction: ~ 10%

## Economic impacts

- No overall adverse effect detected
- Weak evidence for positive "double dividend"
- Carbon-intensive sectors negatively effected; offset by benefits to others

Public acceptance: Initially 60% opposed, improved substantially to less than 50% opposed with actual experience

# Questions to ponder

Are these results unique to British Columbia, or would they likely occur elsewhere?

What modifications might make carbon tax more palatable or effective in the U.S.?

... in the rest of the world?

How can those likely to be adversely affected (e.g., coal miners) be made whole?