British Columbia's carbon tax: Greenhouse gas emission and economic trends since introduction

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Abstract

In 2008, the Canadian province of British Columbia introduced a carbon tax starting at CAD$10 per tonne of carbon dioxide equivalent (CO_2e) and rising by CAD$5/tonne CO_2e/year to a 2012-2013 value of CAD$30/tonne CO_2e. In the current work, we find no clear evidence over the short post-tax period of record that unequivocally links British Columbia's carbon tax to significant reductions in provincial greenhouse gas emissions. There are indications the implementation of this tax may have negatively impacted British Columbia's economic performance relative to the rest of Canada. A longer post-tax period of record is likely necessary in order to reliably determine what, if any, economic and environmental effects have been generated from British Columbia's carbon tax.

Keywords:
Carbon tax, Climate change, Greenhouse gas emissions, Economic impacts, British Columbia

Introduction

The Canadian province of British Columbia introduced a carbon tax on July 1, 2008 with the goal of reducing greenhouse gas (GHG) emissions. The tax was initially set at CAD$10 per tonne of carbon dioxide equivalent (CO_2e), rising by CAD$5 per tonne CO_2e each subsequent year up to its current (2012-2013) rate of CAD$30 per tonne CO_2e. The economic and environmental impacts of the tax have been controversial. Some have argued [1–4] there is evidence that British Columbia's carbon tax did not negatively impact the provincial economy while helping to reduce emissions. However, the data is not clear in this regard for two primary reasons. First - and most importantly - the available data record since enactment is generally very short. In some cases, indicators only have reliable data up to the end of 2009, or 1.5 years post-carbon tax implementation. Second, pre-existing time trends are evident in various indicators with non-stationary slopes (i.e., $\partial^2 I/\partial t^2 \neq 0$ where 'I' represents a generic time-resolved economic or environmental indicator value and 't' is time) both before and after tax implementation. Thus, differentiating carbon tax induced changes in the post-implementation trendings (e.g., by econometric techniques) will be difficult (and potentially unreliable).

Furthermore, even when econometric techniques are employed, it will be problematic to determine correlation-causation directionalities and to ensure that all appropriate input variables are considered. For example, carbon taxation can lower per capita transportation fuel usage by two mechanisms (which can act together): (1) making personal transportation more expensive while not harming the general economy, thereby shifting consumer behavior towards less discretionary travel and/or more efficient modes of transportation; and/or (2) by directly harming the general economy, which leads to a subsequent reduction in per capita fuel consumption since consumers have less financial resources (both in terms of quantity and quality) to spend on transportation and because of a reduced need for such fuel consumption in a less vigorous economy. Mechanism (1) is preferred, but the capacity to clearly distinguish between which of these mechanisms is operative (if either) is challenging in the short term. One must also consider that non-carbon tax related factors may be the primary drivers behind any trends in consumer behavior and economic indicators over time. That said, where changes in trends correspond with the timing of carbon tax introduction, it becomes less likely that trendline alterations are due to non-carbon tax related factors.

Figures 1 and 2 show total and per capita [5] annual greenhouse gas (GHG) emissions [6], respectively, in British Columbia since 1990 for the following sectors: all sectors ("total"; including afforestation and deforestation), energy, and transportation. Although GHG emission targets are typically based on total emissions, population changes over time place the emphasis on per capita behavior as a superior policy indicator. Total and energy related GHG emissions in British Columbia reached a maximum during 2001 and have been in subsequent decline. Transportation related GHG emissions peaked in 2004 and have been in

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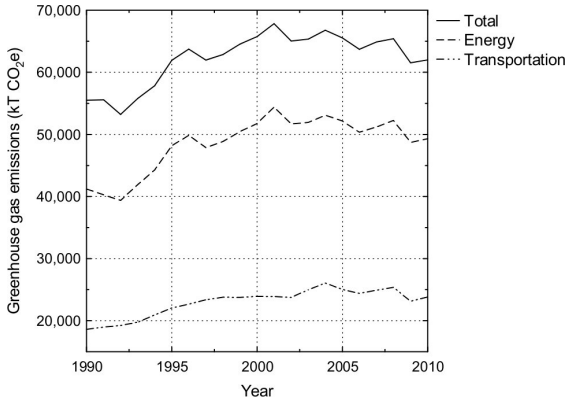

Figure 1: Annual greenhouse gas (GHG) emissions in British Columbia by sector between 1990 and 2010 (latest year for which reliable data is available).

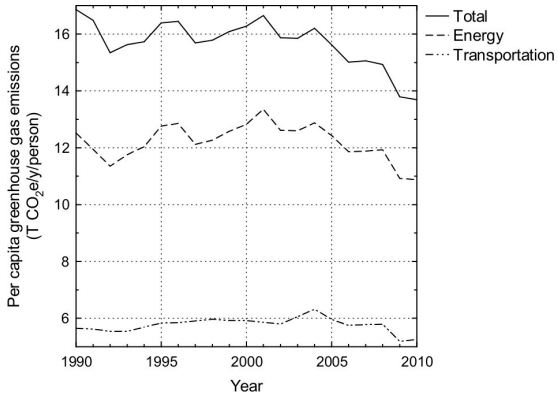

Figure 2: Per capita annual greenhouse gas (GHG) emissions in British Columbia by sector between 1990 and 2010 (latest year for which reliable data is available).

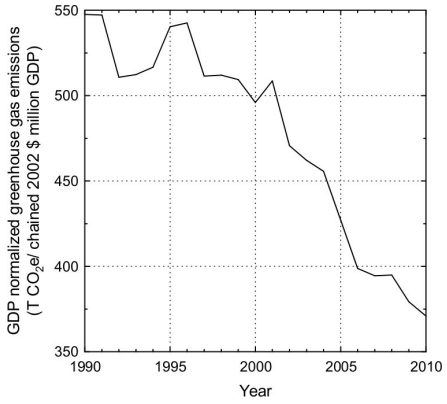

Figure 3: Gross domestic product (GDP) normalized annual greenhouse gas (GHG) emissions in British Columbia between 1990 and 2010 (latest year for which reliable data is available)

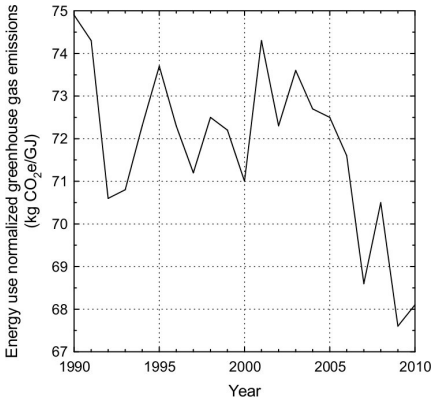

Figure 4: Final demand energy use normalized annual greenhouse gas (GHG) emissions in British Columbia between 1990 and 2010 (latest year for which reliable data is available)

subsequent decline. Per capita emissions in all three sectors were either stable or increasing up to 2004 and have been in subsequent decline. Rigorous regression trending cannot be conducted on the post-carbon tax period because only two data points are available (i.e., 2009 and 2010), and 2008 was a year in which the first half was untaxed while the second half was taxed. Furthermore, the pattern of increasing GHG emissions in each of the three sectors considered herein was not linear before the respective maxima. Thus, the post-maxima declines may or may not be linear. With the limited dataset set available, it is not possible to determine what modeling equation(s) would be most suitable.

Similarly, a plot of gross domestic product (GDP) normalized GHG emissions [6] (Figure 3) reveals no clear impacts of carbon tax introduction. Normalizing British Columbia's GHG emissions to final demand of energy use [6] (Figure 4) also reveals no clear carbon tax induced change in behavior. Consequently, there appears to be no unequivocal evidence that the introduction of British Columbia's carbon tax is leading to more GHG emission efficient economic production or to the use of less-GHG emission intensive energy sources beyond the temporal trends that were existing prior to carbon tax implementation. Passenger transport energy intensity in British Columbia [6] (Figure 5) declined sharply between 1990 and 1995 and has exhibited a steady - but slower - rate of decline since the early 2000s. Data is only available up to 2009, making it impossible to assess any carbon tax related effects on the corresponding time trends. Freight transport energy intensity [6] (Figure 6) has been increasing steadily since 2004, including between 2008 and 2009 (a 4.7% increase), after a prolonged period of significant decline between 1990 and 2004. As well, the residential building emission intensity [6] (Figure 7) has been in general decline since 1990, and no clear 2008-2009 carbon tax related impact is evident.

Net per capita [5] gasoline and diesel oil sales [7] also show no apparent impacts of British Columbia's carbon tax implementation, either when presented in absolute (Figures 8 and 9) or normalized (Figures 10 and 11) formats. British Columbia's per capita net sales of gasoline began to decline in 2004, and the rate of decline appears unchanged

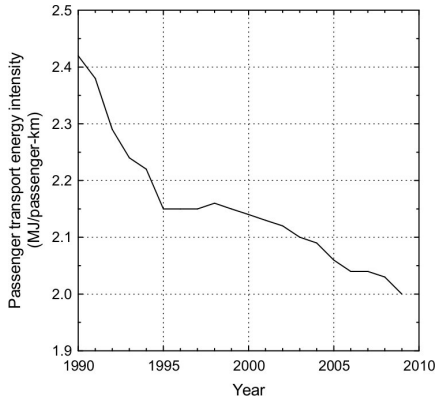

Figure 5: Passenger transport energy intensity in British Columbia between 1990 and 2009 (latest year for which reliable data is available).

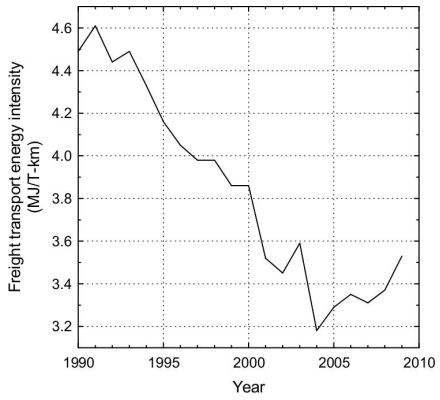

Figure 6: Freight transport energy intensity in British Columbia between 1990 and 2009 (latest year for which reliable data is available).

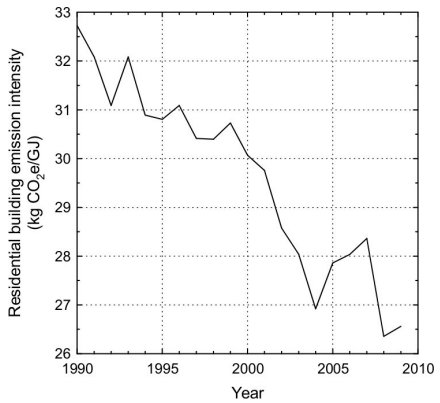

Figure 7: Residential building greenhouse gas (GHG) emission intensity in British Columbia between 1990 and 2009 (latest year for which reliable data is available).

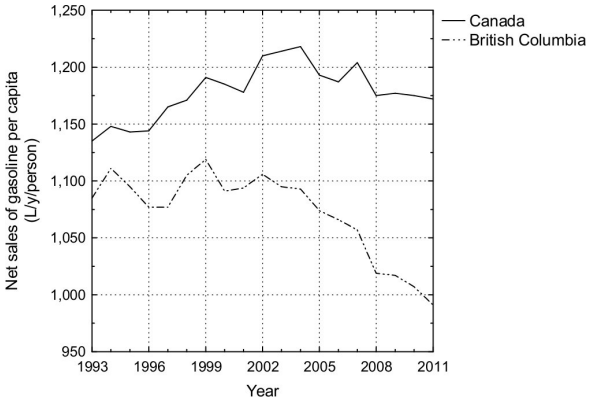

Figure 8: Per capita net sales of gasoline for road motor vehicles in British Columbia and Canada between 1993 and 2011.

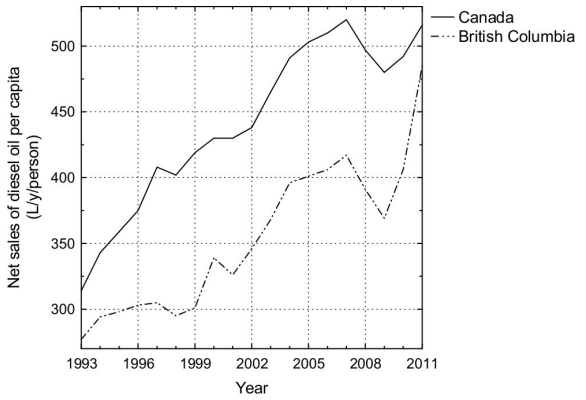

Figure 9: Per capita net sales of diesel oil for road motor vehicles in British Columbia and Canada between 1993 and 2011.

by introduction of the carbon tax in mid-2008. In contrast, British Columbia's per capita net sales of diesel oil have been generally increasing since 1993, and the rate of increase appears to have accelerated since 2009. Between 2007 and 2011, Canada's per capita net sales of diesel oil were effectively unchanged (-0.8% decrease), whereas British Columbia experienced a 16.4% increase. Despite claims to the contrary, this absence of clear reductions in GHG emissions and related carbon-based energy use indicators due to carbon tax implementation in British Columbia are consistent with the experience of various European nations which introduced carbon taxation during the 1990s. Denmark (1992), Finland (1990), the Netherlands (1990), Norway (1991), and Sweden (1992) have all had carbon taxes in place for two decades [8] (Figures 12 [9] and 13 [10]). No clear general changes in GHG emissions trendings either when compared to other developed nations without a federal carbon tax (e.g., Canada) or when compared to pre-carbon tax trendings are evident, although some have interpreted these European trends differently [11].

When basic economic indicators are considered, British Columbia's introduction of a carbon tax may have nega-

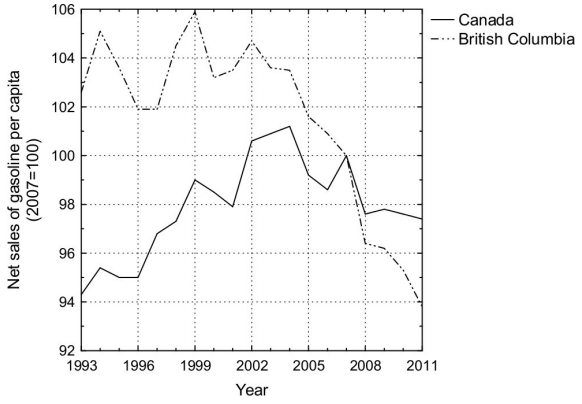

Figure 10: Normalized per capita net sales of gasoline for road motor vehicles in British Columbia and Canada between 1993 and 2011.

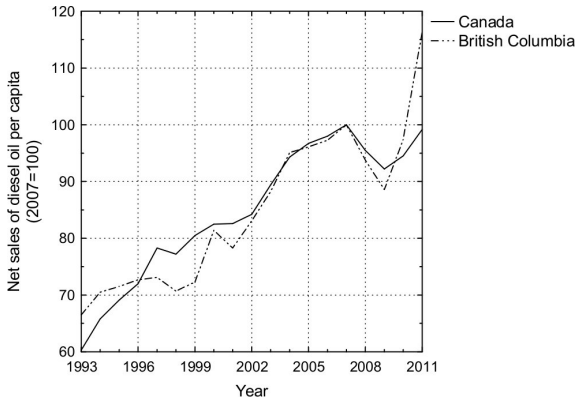

Figure 11: Normalized per capita net sales of diesel oil for road motor vehicles in British Columbia and Canada between 1993 and 2011.

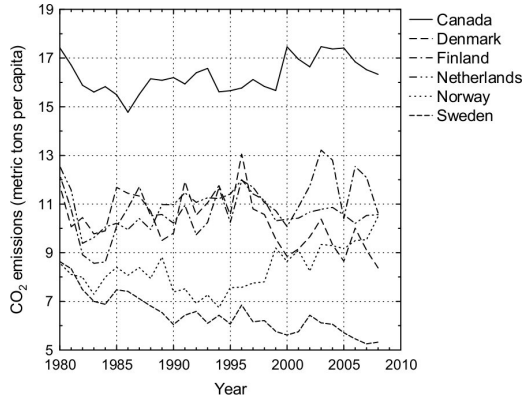

Figure 12: Per capita emissions of carbon dioxide (CO_2) in Canada, Denmark, Finland, the Netherlands, Norway, and Sweden between 1980 and 2008.

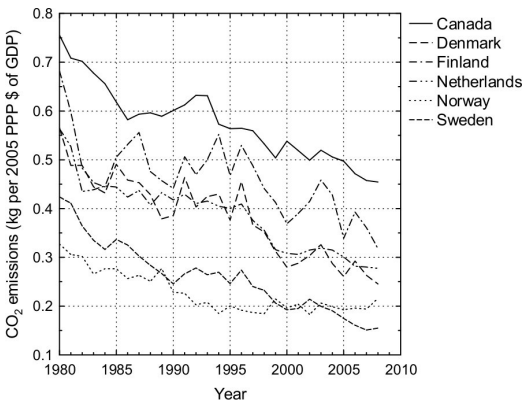

Figure 13: Emissions of carbon dioxide (CO_2) normalized to gross domestic product (GDP) on a purchasing power parity (PPP) basis (constant 2005 international dollars) in Canada, Denmark, Finland, the Netherlands, Norway, and Sweden between 1980 and 2008.

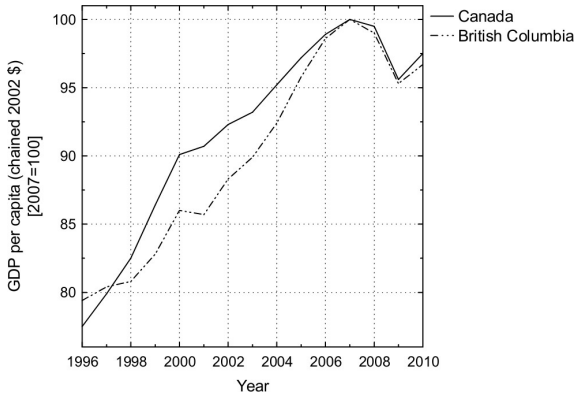

Figure 14: Normalized annual per capita gross domestic product (GDP) for British Columbia and Canada between 1996 and 2010 (latest year for which reliable data is available).

tively impacted the provincial economy. Since 2008, British Columbia has underperformed compared to the Canadian economy with regard to per capita GDP [12] (Figure 14), per capita personal income [12] (Figure 15), and per capita personal disposable income [12] (Figure 16), unemployment rate [13] (Figure 17), and employment rate [13] (Figure 18).

Consequently, there appears to be no clear evidence over the short post-tax period of record demonstrating that the introduction of British Columbia's carbon tax led to significant reductions in GHG emissions. Furthermore, there are suggestions that the implementation of this tax may have negatively impacted the province's economic performance relative to the rest of the nation. These findings in no way can be construed as suggesting that measures to reduce GHG emissions should not be undertaken. Rather, our conclusions call for the need to wait until longer term post-tax analysis periods are available before reaching any broad conclusions regarding the possible environmental and/or economic impacts of British

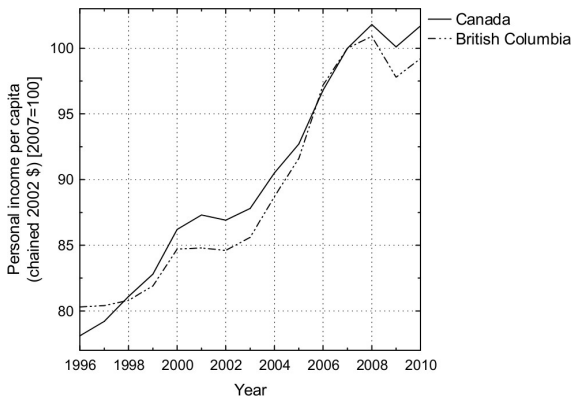

Figure 15: Normalized annual per capita personal incomes for British Columbia and Canada between 1996 and 2010 (latest year for which reliable data is available).

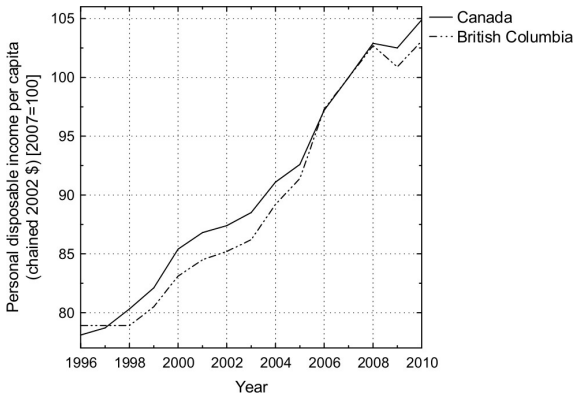

Figure 16: Normalized annual per capita personal disposable incomes for British Columbia and Canada between 1996 and 2010 (latest year for which reliable data is available).

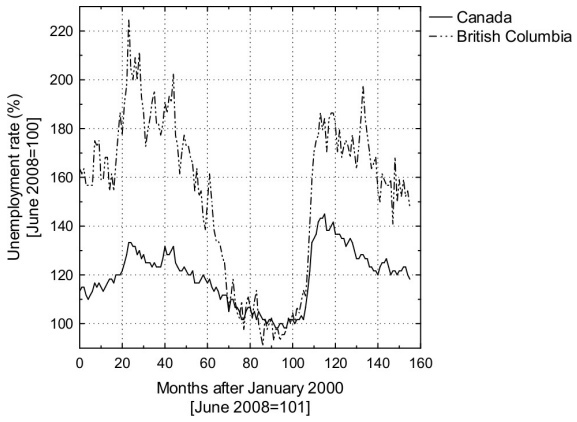

Figure 17: Normalized seasonally adjusted monthly unemployment rates (15 years and over; both sexes) for British Columbia and Canada between 2000 and 2012.

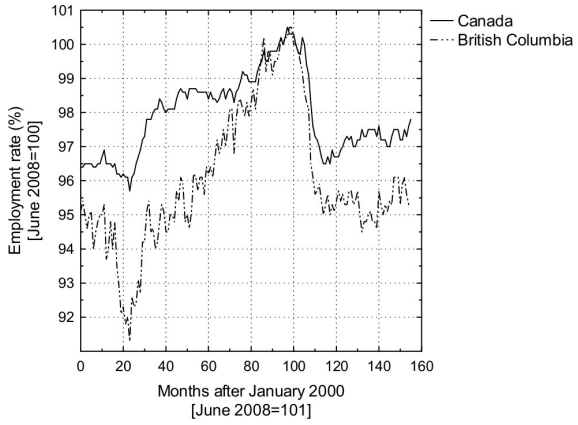

Figure 18: Normalized seasonally adjusted monthly employment rates (15 years and over; both sexes) for British Columbia and Canada between 2000 and 2012.

Columbia's carbon tax, as well as the requirements to accept potential net negative impacts of carbon taxation and/or higher tax rates in order to achieve measurable environmental objectives.

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