Carbon Tax Literature Review

Briefing material prepared for the Saskatchewan Chamber of Commerce Environment Committee

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Disclaimer:

This is a non-exhaustive, non-authoritative literature review produced by Saskatchewan Chamber of Commerce Environment Committee Volunteer and founder and President of 5Spheres Consulting Inc., Jim Heffernan.

The purpose of this paper was to advance the Environment Committee's discussion on the issue of carbon pricing. It does not represent a definitive determination on the subject and should solely be used as a general information source.

This paper does not represent the formal position of the Saskatchewan Chamber of Commerce with regard to carbon pricing.

Purpose and Methods:

This literature review was completed for the Saskatchewan Chamber of Commerce' Environment Committee to help address, if not answer, the question "What is the right carbon tax rate?"

A non-exhaustive literature review was conducted to identify, present, and discuss matters relevant to the design and implementation of a carbon tax and so advance the Committee's discussion of this matter. This review focused on literature available to the public for free. Most of the literature citations include links to the full publications. Links to free abstracts are included for those publications that are only available in full at cost.

Background and Recommended Reading:

The concept of using environmental taxes to advance social welfare is often credited to Pigou's book "The Economics of Welfare" (published in both 1920 and 1938). The concept is now widely embraced within the field of environmental economics and environmental taxes are often described as Pigouvian instruments/taxes. Therefore, much of the literature on carbon taxes makes reference to Pigou's theory and/or Pigouvian instruments/taxes.

Pigouvian taxes are intended to "internalize externalities" (Metcalf and Weisbach 2009). They are taxes added to the price of a commodity (or product) to account for the social costs of consuming the commodity (or product). Climate change resulting from consumption of fossil fuels is a "classic externality" (Marron and Toder 2014). The price of fossil fuels in most jurisdictions does not reflect the costs of anthropogenic climate change resulting from fossil fuel consumption.

The concept of the social cost of carbon (SCC) is a direct result of applying Pigouvian principles to the problem of anthropogenic climate change. Marron and Toder (2014) note that human activities release carbon dioxide and other greenhouse gases into the atmosphere which change the climate and impose a variety of harms on the global public. They state:

"Taxing greenhouse gas emissions is one way to reduce those harms. But how big should the tax be? The Pigouvian tradition offers one answer: the optimal tax on carbon dioxide, the most important greenhouse gas, should be equal to the marginal social cost of carbon emissions. A tax at that level would internalize the externality and maximize conventional measures of social welfare."

The publications of Metcalf and Weisbach (2009) and Marron and Toder (2014) mentioned above both provide a broad-based discussions of issues relevant to the design of a carbon tax. Metcalf and Weisbach (2009) is lengthy at approximately 60 pages and discusses these issues in depth. In contrast, Marron and Toder (2014) is brief at 6 pages but is superficial in some respects. Metcalf and Weisbach (2009) is recommended for those who are not familiar with carbon taxes while Marron and Toder (2014) will suffice for those who simply want to refresh their memories. The publication of Tol (2013) provides up-to-date comments on many of the challenges facing those trying to estimate the SCC. Tol (2013) is relatively brief at 18 pages but contains details on the mathematics of estimating the SCC and the statistical analyses involved in reviewing estimates of the SCC that may be beyond some readers.

Challenges and Issues:

Uncertainty:

Marron and Toder (2014) express the challenge of dealing with uncertainty in estimating the SCC concisely:

"Estimating the marginal social cost of carbon thus requires complex modeling and assumptions about the trajectory of carbon emissions, climate sensitivity, and the impacts of any climate changes, all of which are uncertain. The cost may depend critically on controversial assumptions, such as what value to place on low-probability, catastrophic outcomes and what discount rate to apply in valuing damages far in the future."

Most people will probably have a sense of the challenge in assigning value to "low-probability, catastrophic outcomes". In contrast, the idea of discounting the value of "damages far in the future" may not be as readily appreciated. However, the application of a discount rate in valuing future damages is fundamental to estimates of the SCC. The higher the discount rate, the higher the discount placed on the price of climate change costs payable in the future. This discount rate, also called the pure rate of time preference, remains a topic of much debate as differences in setting the discount rate are responsible for much of the variation in estimates of the SCC.

Carbon Taxes Are Regressive:

Grainger and Kolstad (2010) used historic American data on consumption, emissions, and the structure of the American economy to estimate how a carbon tax would be distributed across income groups. They found that the burden of a carbon tax, as a percentage of income, would be higher among low-income consumers than among high-income consumers. They conclude that a carbon tax within the United States would be "regressive by nature" as polluting, energy-intensive goods "take up a large percentage of a low-income person's budget".

The potential for carbon taxes to be regressive is a common concern among those interested in their design (Metcalf and Weisbach 2009, Marron and Toder 2014). Both Metcalf and Weisbach (2009) and Marron and Toder (2014) note that the regressive effect of a carbon tax could be at least partially offset by reductions in income or payroll taxes. Further, Marron and Toder (2014) state that tax credits earmarked for low-income consumers will also serve to offset a regressive carbon tax.

Public Acceptance:

Kallbekken et al. (2011) conducted a market-based experiment "to explore the issue of support for Pigouvian taxation". Participants traded in a fictitious good within a fictitious market for a period of time and then subsequently under a fictitious Pigouvian instrument. The questions investigated included:

- Does explaining the purpose, function, and utility of the Pigouvian instrument (i.e. "understanding") affect the acceptance of the Pigouvian instrument within the market?
- Does how the Pigouvian instrument's revenues are redistributed (i.e. "lump-sum" redistribution to all v. "targeted" redistribution to polluters or victims of pollution) affect the acceptance of the instrument within the market?

Kallbekken et al. (2011) observed behaviour consistent with "tax aversion" within their participants. They found that "understanding" of the Pigouvian instrument had no effect on participants' acceptance of it. However, they also found that the manner in which revenues were redistributed did have an effect

on acceptance of the instrument. "Targeted" redistribution of revenues to polluters (i.e. industries likely to be adversely affected by the instrument) and victims of pollution (i.e. members of the public likely to be adversely affected by polluting industries) both increased participants' support for the instrument.

Kallbekken et al. (2011) concluded that earmarked redistribution of the revenues generated by a Pigouvian instrument may be critical in obtaining acceptance for the instrument.

Estimates of the Social Cost of Carbon (SCC):

Reviews of Published Estimates:

Several reviews of past published estimates of the social cost of carbon have been completed by Tol (2005, 2008, 2009, 2013). These reviews are discussed due to Tol's lengthy history with the topic. Table 1 lists some of the findings of these reviews.

Table 1. Measures of central tendency (mean and median), variability (standard deviation), and the number of estimates examined (sample size) in statistical analyses of published estimates of the social cost of carbon in the reviews of Tol (2005, 2008, 2009, 2013).

Review	Mean	Median	Standard Deviation	Sample Size	Valuation[1]
Tol 2005	$93	$14	not provided	103	1995 $US per metric ton of carbon
Tol 2008[2]	$127	$74	$243	211	$US per metric ton of carbon
Tol 2008[3]	$88	$47	$243	211	$US per metric ton of carbon
Tol 2009	$105	$29	not provided	232	$US per metric ton of carbon
Tol 2013[4]	$196	$135	$322	588	2010 $US per metric ton of carbon
Tol 2013[5]	$296	$247	$309	not provided	2010 $US per metric ton of carbon
Tol 2013[6]	$25	$23	$22	not provided	2010 $US per metric ton of carbon

[1]Valuations of the social cost of carbon are all expressed in $US, although not always with a specific year given for the currency.

[2]Tol (2008) used two different statistical methods to fit the data set to a probability distribution function. Values reported here relied on the use of a Fisher-Tippett distribution in the statistical analyses.

[3]Tol (2008) used two different statistical methods to fit the data set to a probability distribution function. Values reported here relied on the use of a Gaussian distribution in the statistical analyses.

[4]Measures in Tol (2013) presented here are those from all data regardless of discount rate.

[5]Measures in Tol (2013) presented here are those from the subset of the data - the estimates calculated using a discount rate of 0% per annum.

[6]Measures in Tol (2013) presented here are those from the subset of the data - the estimates calculated using a discount rate of 3% per annum.

Tol's efforts were intended to gain insight into the probable social cost of carbon (SCC) by examining the 100s of published estimates of the SCC collectively. As the published estimates are derived from a variety of mathematical models and differing underlying assumptions, Tol relied on statistical analyses to make inferences about the probable SCC. The measures that appear in Table 1 are but a fraction of those generated in Tol's publications. Table 1 reveals how estimates of the probable SCC vary with both the statistical methods Tol used and with the discount rate assumptions made by authors that published the estimates.

Tol (2013) noted that the 588 estimates of the social cost of carbon exhibit a highly skewed distribution. The mean estimate of the SCC was highly influenced by a relatively few high estimates of the SCC. These high estimates of the SCC were often those from the "grey" literature (i.e. those SCC estimates not subject to peer review) and/or those that were based upon discount rates at or near zero. The skewness of the distribution is visible in the findings (Table 1) where median estimates of the SCC are much lower than the mean estimates. Tol (2013) eliminated many of the SCC estimates from the "grey" literature and all of those SCC estimates that rely on discounts rates at or near zero by analyzing only those SCC estimates based upon a 3% discount rate. The resulting mean SCC estimate was $25 (2010 USD). Further, the resulting mean and median estimates of the SCC were nearly equivalent, suggesting diminished influence of extreme SSC estimates.

Tol (2013) concluded that the expected value of a carbon tax, calculated based upon a 3% discount rate (that typical of public investments), is $25 (2010 USD)/tonne of carbon and should increase at 2.3% per year. The current (2016) value of this carbon tax would be almost $38 CDN per tonne of carbon based upon an American inflation rate of 2% (2010-2013), the tax growth rate of 2.3% (2013 and beyond), and an assumed exchange rate of $1 CDN/$0.75 USD. This carbon tax would then exceed $50 CDN per tonne of carbon by 2029, assuming the exchange rate remains constant.

Existing Carbon Taxes:

Globally:

There are currently 16 jurisdictions utilizing direct carbon taxes: British Columbia; Chile; Costa Rica; Denmark; Finland; France; Iceland; Ireland; Japan; Mexico; Norway; South Africa; Sweden; Switzerland; and the United Kindom (World Bank Group 2016). These carbon tax rates vary from $2 US per tonne of carbon dioxide equivalents ($7.34 US per tonne carbon) in Japan to greater than $100 US per tonne of carbon in Sweden.

British Columbia:

British Columbia's recent experience with a carbon tax is informative. Elgie and McClay (2013) discussed the origin of the carbon tax in British Columbia (BC) and examined changes in fuel use, greenhouse gas emissions (GHG), and gross domestic product (GDP) within the province relative to the rest of Canada through the first five years of the tax's implementation. They noted the following:

- The tax was initially controversial.
- BC's carbon tax was introduced at the rate of $10 per tonne of carbon dioxide equivalent in 2008 and increased annually by $5 up to the current value of $30 per tonne of carbon dioxide equivalent in 2012. It has remained at that rate since then.
- Per capita consumption of fuels subject to the tax in BC declined by approximately 19% relative to the rest of Canada during the period examined.
- Per capita GHG emissions in BC declined by approximately 9% relative to the rest of Canada during the period examined.
- GDP measures suggest that BC's economy slightly outperformed the rest of Canada during the period examined.
- The carbon tax is revenue neutral. The tax is described as being a "tax shift". Revenue from the carbon tax is returned to the economy through reductions in personal income tax, payroll tax, low-income tax credits, and rebates for northern and rural BC homeowners.
- They conclude the BC carbon tax appears to have been highly effective during the period examined.

BC's Liberal Party has evidently not suffered too greatly as a result of the carbon tax as they were re-elected in both 2009 and 2013. However, Harrison (2012) noted that in matters related to the economy, BC's Liberal Party has benefited politically from having "no opposition on its right".

Lastly, independent review of the BC carbon tax by Beck et al. (2015) indicates that tax has been progressive, not regressive.

Reviewer's Opinion:

Uncertainty underpins the estimation of the social cost of carbon and any attempt to set a carbon tax. Arguably, the best that can be expected is that the initial rate be 'in the right ballpark' and that the tax be reviewed periodically as new information comes along. It's worth noting that the Federal Government's proposal is a tax that begins at $10 per tonne of carbon in 2018 and increases to $50 a tonne of carbon in 2022 while Tol (2013), after reviewing 588 estimates of the SCC, recommended a carbon tax that would be roughly $38 CDN per tonne of carbon today, increasing by 2.3% annually, and surpassing $50 CDN per tonne of carbon in 2029. Since it would be extremely difficult to portray Tol as being 'extremist' or 'left wing', it seems that the Federal Government' proposed carbon tax is at least 'in the right ballpark'.

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