Apples to Apples

Making Valid Cost-Benefit Comparisons in Climate Policy

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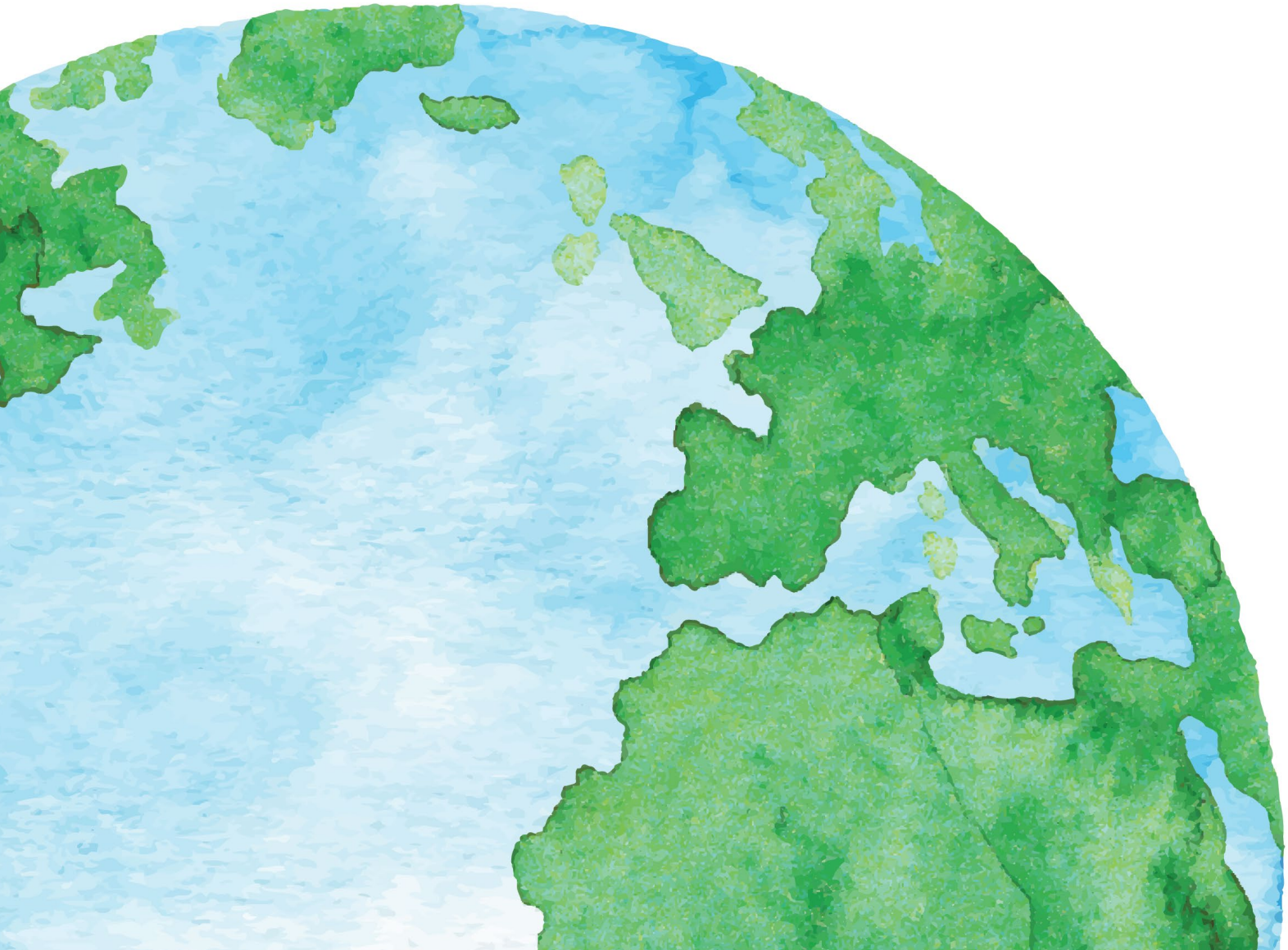
Ross McKitrick



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by Ross McKitrick

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Executive Summary

Climate change represents a major policy challenge and the measures being considered or enacted in Canada and around the world are potentially very costly. A basic principle in public policy analysis is that the benefits of a proposed action should exceed the costs. Ensuring that this condition holds requires that the things being evaluated are truly comparable.

The tools of cost-benefit analysis help ensure that such comparisons are valid. For example, discounting is a way to ensure that a stream of benefits in the future can be meaningfully compared to up-front costs today. Unfortunately, there are two basic errors in discussions of costs and benefits that arise regularly and bias the discussion in favour of overly stringent emission-reduction policies. This publication explains what the errors are and how they can be remedied.

The first error discussed is the *total-versus-marginal* error, which arises when someone compares the total benefit of eliminating all effects of climate change past and future to the marginal cost of a small emissions-reduction policy. For example, if one person comments on the high cost of a proposed policy and someone retorts that it is a small amount compared to the costs of climate change, this is a fallacy because the two are not alternatives. We cannot trade off the marginal cost of a policy against the benefit of eliminating the total costs of all climate change because the policy will not achieve anything on that scale. The proper comparison is between the cost of the policy and the benefits attributable only to that policy.

The *social-versus-private* error arises when a policy target is proposed based on equating the private marginal costs of compliance to the social marginal benefits. Instead, the correct target would be the point where the marginal social cost of emission reduction equals the marginal social benefits. As a practical matter, this implies that the correct price to charge emitters of greenhouse gases is not the so-called *Social Cost of Carbon* (or marginal social damages of emissions); instead it is the Social Cost of Carbon deflated by the Marginal Cost of Public Funds (a measure of the excess burden of the tax system). In some parts of Canada, this means scaling down the Social Cost of Carbon by at least half.

Both of these errors are common in discussions of climate policy. This publication explains how both arise and how they can be remedied by careful application of economic concepts in cost-benefit analysis.

Introduction—Two Common Errors

Climate change represents a major policy challenge. Governments are considering or enacting some very costly measures that could have large effects on economies worldwide. Here in Canada, the issues of carbon taxation and the development of the energy sector are intertwined with climate-change policy goals, leading to major debates and conflicting views about how best to proceed.

A basic principle in the analysis of public policy is that the benefits of a proposed action should exceed the costs. To make the benefit-to-cost comparison valid, each side of the ledger must be measuring comparable things. This is a challenge since benefits and costs are often in very different units. A public investment in, say, local playground equipment involves comparing intangible recreational benefits for the users to measurable financial costs for the municipality. Such comparisons are unavoidable in policy decisions but economics provides analytical tools to help ensure that, as much as possible, the comparisons have theoretical validity. For instance, if (as in the playground-equipment example) a policy imposes large costs up front and a stream of benefits stretching many years in the future, the benefits have to be discounted to the present to determine if they outweigh the costs. This study will discuss two common errors that arise in cost-benefit comparisons of climate policy. The point here is not to argue for one policy over another, but to highlight errors in reasoning that get in the way of sound policy analysis.

1. Total-versus-marginal error

In this error, the total costs of climate change from all emissions past and future are compared to the marginal cost of a small emission-reduction policy, ignoring the fact that the policy will only have a small effect on emissions and, therefore, will not prevent the damages. Unlike a properly configured comparison, this biases the analysis in favour of a proposed plan for reducing emissions. The proper comparison is between the costs of a marginal emission-reduction policy and the beneficial effects attributable only to that policy.

2. Social-versus-private error

This is a subtler error, in which the social benefits of emission reduction are compared to the private, rather than social, costs of abatement. This again biases the analysis towards favouring overly stringent emission-reduction policies.

1. Total-versus-Marginal Error

According to a CBC news report, after the Ontario government enacted a plan to put stickers on gasoline pumps saying "the federal carbon tax will cost you 11¢/litre [by] 2022", the Green Party of Ontario responded by producing stickers that said "Climate change will cost us more", followed by the elaboration, "Climate change could cost us over $91 billion annually by 2050" (Crawley, 2019). This is an often-heard type of comparison. If someone points out the cost of a proposed climate policy, the rejoinder takes the form of saying that climate change will be even costlier, based on estimates of damages from extreme weather or other climate-related phenomena.

The flaw in this reasoning is that the two contingencies are not alternatives. To the extent current and future weather disasters can be attributed to concentrations of greenhouse gases, they depend on the global average concentration, which depends on total world-wide historical and future global emissions, which are barely responsive to variations in local emissions. Whether or not a carbon tax is implemented in Ontario will not have any effect on past emissions and will, on its own, have only very small effects on future total global emissions. Therefore, the gasoline purchaser does not have a choice between paying the carbon tax or experiencing climate change. The latter will happen as a result of a large set of decisions and contingencies that are not affected by the carbon tax. The comparison should, therefore, be between not paying the carbon tax and experiencing climate change, or paying the carbon tax and experiencing almost exactly the same climate change, with (if possible) account taken of whatever future changes in climate will result from introducing the carbon tax.

In practice, computing such minuscule changes is nearly impossible. Canada currently represents about 2% of global carbon-dioxide emissions, and any unilateral domestic policy, including a national carbon price, will only yield a small reduction in emissions. If the tax reduces Canadian emissions by, say, 5%, on its own that means global emissions will fall by at most 5% of 2%, which is 0.1%. That, in turn, will have exceedingly small effects on the global carbon-dioxide concentration. Such changes would, in principle, affect the future path of climate change, but the effects would be too small and uncertain to compute, especially after taking account of leakage effects (in which emitting activity migrates away from regulated jurisdictions to unregulated ones).

In fact, full global implementation of policies like the Paris Treaty will have very small effects on worldwide emissions and, therefore, the global climate. Lomborg (2017) showed that, if every country that made commitments under Paris does everything they have promised, global average temperatures will only be 0.2° lower by 2100 than they would be under business as usual. This echoes a similar finding by Wigley (1998) about the Kyoto Protocol. Supposing that the changes scale in a linear way, and that current emission proportions hold through the century, implementing a policy that permanently reduces Canada's emissions by 5% would reduce the global average temperature in 2100 by 0.1% of 0.2°, or 0.0002° (two ten-thousandths of a degree). The effect of such a tiny reduction on the world's climate would be impossible to compute in a reliable or credible way. But if, for illustrative purposes, we say that annual weather disasters attributable strictly to greenhouse gases cost $100 billion per year, and they are reduced in direct proportion to the reduction in global average temperatures, the savings would be $20 million. This is the amount that needs to be compared to the annual cost of paying the new carbon tax. These costs would include the increase in the total cost of all gasoline purchased, plus the indirect burden of higher transportation and manufacturing costs of all other goods and services. For an economy the size of Canada's, this will typically be measured in the hundreds of millions or billions of dollars.

To summarize: the *total-versus-marginal* error involves contrasting the total cost of a potential harm (such as current and future extreme weather under climate change) to the marginal cost of an emissions policy that will not prevent the harm, but only, at most, reduce it by a very small amount. The fact that the former exceeds the latter does not mean that the policy would pass a benefit-cost test. A proper comparison would be between the cost of the policy and the benefit just of the policy itself.

2. Social-versus-Private Error

This is a subtler error, in which the social benefits of emission reduction are compared to the private costs of abatement. This again biases the analysis towards favouring overly stringent emission reduction policies by prescribing the wrong price level. But, in order to understand this issue we first need to clear up a point of confusion about the term "social".

Most of the actions that take place in the market involve private costs and private benefits. If you purchase a chair, the amount you pay covers the costs of making and retailing the item, and the benefits of ownership accrue to you personally since it resides in your home. Consequently, the private costs and the private benefits are the relevant ones to compare when deciding if it is a worthwhile purchase.

Private costs are also called *internal* costs by economists. Some actions in the market have more than just private or internal costs. If you drive a car, the fuel you use gives rise to tailpipe emissions that affect other people, and your presence on the road adds to congestion for other drivers. So while you incur private costs to use the car, other people incur costs associated with your use of the car. Economists call these *external* costs.

It is at this point that the term "social costs" appears, but is used inconsistently, even by economists. Technically it means internal plus external costs. Continuing with the car example, the following table explains the different concepts.

Table 1: Example of "social costs" applied to ownership of a car

Private costs (or Internal costs) =	car purchase, fuel, insurance, maintenance, etc.
External costs =	tailpipe emissions, addition to traffic congestion, noise
Social costs =	Internal + External costs

We will be making use of the term "Social Cost of Carbon". Unfortunately, this is where confusion arises because people use "social" in this case to mean only the external costs of emissions. To avoid this inconsistency, when I use the word "social" (lowercase) I mean internal plus external costs. When I use "Social" (capitalized) it is only with reference to the Social Cost of Carbon, and refers to the external cost of actions that give rise to carbon dioxide emissions.

Distinguishing private and social costs

The distinction between marginal social and private costs lies at the heart of the motivation for climate policies like carbon taxes. If someone consumes enough gasoline to release a tonne of carbon dioxide emissions, the private cost of purchasing and using the fuel does not equal the social cost of its usage, even if the purchase price of the fuel fully reflects the marginal cost of producing it. The marginal external costs of the emissions must also be considered. These are tabulated under the heading of the Social Cost of Carbon (SCC). The idea of carbon pricing, either through permits trading or carbon taxation, is to bring the private cost of fuel use into line with the social cost, by building into the fuel purchase price the estimated marginal external damages of the emissions, or SCC.

The pricing policy creates an incentive for fuel users to reduce emissions up to the point where their marginal abatement costs (that is, the private cost of incremental emission reductions) just equal the marginal external costs of emissions. Emission abatement efforts up to that point yield reductions that society values more than the costs of achieving them. Emission reductions that go deeper cost more than they are worth. By comparing marginal abatement costs to the carbon price and choosing what amounts to a cost-minimizing emissions level, fuel users help identify and implement the socially least-cost emission abatement options.

Based on this logic, many commentators and even many economists erroneously argue that the SCC should be added to the cost of fuel in the form of a carbon tax. This is incorrect. The problem is that emitters react to the tax by comparing it to their private costs of emission abatement. But, just as there is a gap between private and social costs of fuel use, there is a gap between the private and social costs of government actions such as taxation and regulation.

What needs to be equalized are the marginal social costs of emissions and the marginal *social* costs of abatement. The failure to recognize the gap between the private and social costs of fuel consumption is what caused excessive emissions in the first place, giving rise to the need to price emissions. But failing to recognize the distinction between the private and social costs of abatement would give rise to excessive emission reductions.

Distinguishing private and social of policy

Continuing with the example of a carbon tax, when a tax of any kind is introduced, it imposes greater costs on society than the value of the revenue raised by the government. Taxes drive wedges between the prices received by the seller and those paid by

the buyer. As prices for the consumer rise, people buy less; and as the revenue of sellers drops, producers produce less. Changes in market quantities induced by a new tax will cause losses in consumer surplus and producer surplus that by necessity exceed the revenue generated by the tax. This principle is explained in any introductory economics textbook.

For example, if the government were to impose an income tax of 95%, they would not collect revenue equal to 95% of current income, because the tax would affect the amount people are willing to work. Faced with a 95% tax rate, most people would withdraw most of their labour from the market, and the government would collect very little revenue. The largest losses in the economy would be the income losses to households, and the lost profits of firms from the cessation of productivity among the workers who stopped showing up to work.

These secondary losses arise even when tax policies are implemented on a much smaller scale. Economists refer to them as "welfare losses", referring not to welfare in the sense of income support for poor people, but to social welfare in the sense of utility. Welfare losses are measured on the consumer side (where they are called lost consumer surplus) and the producer side (where they are called lost producer surplus), noting that the latter ultimately accrues to the former through payments to the owners of firms. Taken together they constitute the so-called *excess burden* of taxes. The marginal excess burden of the least-costly new tax is called the *Marginal Cost of Public Funds* (*MCPF*). It measures the value of lost economic welfare required to raise an additional dollar of new funds for the government. If the *MCPF* is, for instance, $1.50, it means an economy loses $1.50 in private welfare to yield another one dollar of revenue for the public sector.

One of the important lessons of the economics of taxation is that introducing a new tax in an economy not only creates excess burdens associated with that tax, but it also exacerbates the marginal burdens of existing taxes. For this reason, when a new tax is proposed by governments, economists strongly recommend taking a revenue-neutral approach. Revenue from the new tax can be used to fund reductions in a burdensome tax elsewhere and, if the tax swap is constructed properly, the marginal excess burden alleviated by the reduced taxes may completely offset those associated with the new tax. Alternatively, if the aim is to increase government revenue, the new tax should be one with the minimum marginal excess burden. Since excess burdens vary widely across different taxes, the choice of fiscal instrument matters acutely.

Implications for carbon pricing

Returning to the policy issue of carbon taxes, pursuing emission abatement through a carbon tax means there will be excess burdens created, as would be the case with any tax.[1] How should this affect the implementation of the carbon tax?

This question was considered many years ago by economist Agnar Sandmo in a 1975 paper in the *Swedish Journal of Economics*. He was not looking specifically at carbon taxes but at any emissions tax tied to consumption of a specific commodity, which is applicable to the case of carbon taxes. Sandmo analyzed a theoretical general equilibrium model in which a burdensome tax system is already in place and the government introduces a new tax to put a price on a pollution externality. He worked out that, using the terminology of climate policy, the optimal tax rate should be the Social Cost of Carbon (*SCC*) divided by the Marginal Cost of Public Funds (*MCPF*):

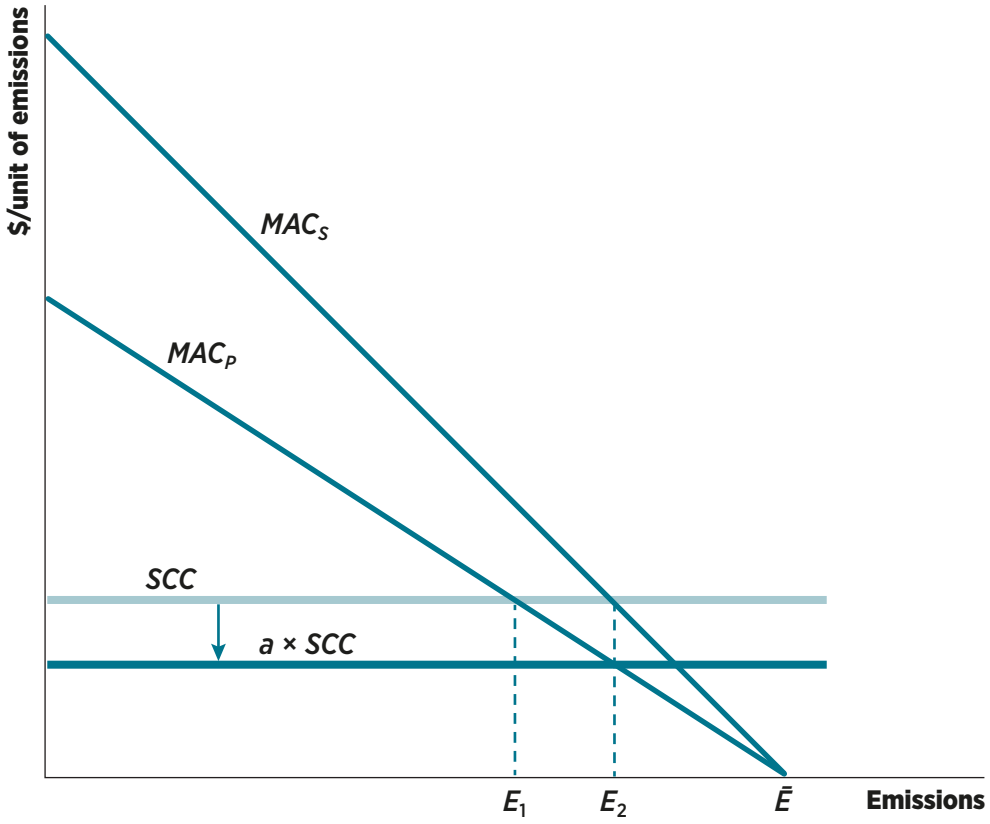
$$\text{Optimal Carbon Tax Rate } T = \frac{\text{Social Cost of Carbon}}{\text{Marginal Cost of Public Funds}}$$

This result has since been confirmed many times by subsequent authors (e.g., Bovenberg and Goulder, 1996; Parry, Williams III, and Goulder, 1999; Schöb, 2003). The intuition is that, by adjusting the emission tax rate in this manner, the marginal social benefits of emission reductions will be equated to the marginal social costs.

The point can be illustrated graphically in figure 1. The horizontal axis shows emissions increasing from left to right, and the vertical axis shows dollars per unit of emissions, that is, marginal costs and benefits. The horizontal line labeled *SCC* shows the external cost of carbon, which we assume to be constant across the entire range of emissions. This can also be thought of as the social benefit of each unit of emission reduction. The downward-sloping line labeled MAC_P represents the private marginal costs of reducing emissions. Starting at the unregulated emissions level $\bar{E}$, as emissions are reduced the private marginal cost of further cuts goes upward. If emitters are charged a tax at the rate *SCC*, they will reduce emissions until the marginal cost of doing so just equals the tax rate, bringing emissions down to the level E_1.

1. It is important to note that excess burdens are created by any type of emission policy, including traditional command regulations. The emission tax, however, yields revenues that can fund tax reductions elsewhere, offsetting some of the welfare losses resulting from excess burdens. Controlling emissions using regulations, or rebating emission-tax revenues via lump-sum transfers, negates these offsetting benefits and greatly increases the overall macroeconomic cost of climate policy (Bovenberg and Goulder, 1996).

Figure 1: Taking account of the difference between private and social costs of abatement policy



But at this point, the *private* marginal costs of emission reduction have been equated to the marginal social benefits of emission reduction, and this does not take into account the excess burden of the carbon tax. A point frequently made in the literature about optimal emission taxes is that even under revenue neutrality an emission tax will generate positive marginal excess burdens because it is more narrowly focused than the major alternative taxes for which it might be swapped.[2] Consequently, the marginal social costs of abatement exceed the marginal private costs, as shown by the line labeled MAC_S in figure 1. This is the quantity that should be equated to the *SCC*, which occurs at emissions level E_2.

2. While it might be possible in principle to find a particularly inefficient tax already in place, namely one with a higher marginal excess burden than a new emission tax, the economics literature works on the assumption that an efficient tax authority would already have identified and swapped out such instruments. The comparison is made to major taxes such as income and sales taxes so as not to create an artificial advantage for the emission tax by assuming the government is arbitrarily inept at designing tax policy.

Since E_2 exceeds E_1, we need to set a tax rate below *SCC*. As shown in the diagram, the appropriate rate is the fraction *a* times *SCC* where $0 < a < 1$. The result of the Sandmo analysis is that *a* equals the inverse of the *MCPF*. Applying this rule we get the formula written above, namely:

$$\text{Optimal Carbon Tax Rate } T = a \times SCC = \frac{\text{Social Cost of Carbon}}{\text{Marginal Cost of Public Funds}}$$

The size of the adjustment to account for the Marginal Cost of Public Funds can be substantial. Ferede and Dahlby (2016) presents recent computations of the *MCPF* across Canada. Provincial personal income taxes have estimated *MCPF* rates ranging from 1.41 (Alberta) to 6.76 (Ontario), which imply *a*-weights of 0.7 to 0.15. The first implication is that emission tax rates should not be the same across the county: they should be lower in regions with high marginal costs of public funds. The Ontario adjustment factor would have an especially large effect ($1 \div 6.76 = 0.15$). It implies that an estimated *SCC* ranging from $20 to $50 per tonne would yield optimal carbon-tax rates from $2.96 to $7.40.

If for simplicity we use a single national average *MCPF* of, say, 2.0, which would be a conservative estimate based on the results in Ferede and Dahlby, the implication is that the optimal carbon tax should only be half the estimated Social Cost of Carbon.

Conclusions

This note has considered two common errors in the discussion of costs and benefits regarding climate policy. Comparing total benefits to marginal costs, for instance the total cessation of weather disasters compared to the cost of paying a carbon tax, yields an exaggerated estimate of net benefits. Second, failing to distinguish between private and social costs of abatement policy leads to an overestimate of the appropriate rate for carbon taxes, because account is not taken of the need to deflate the Social Cost of Carbon by the Marginal Cost of Public Funds. Considering the interest of Canada and many other countries in finding economically efficient approaches to climate policy, paying attention to these errors will help ensure valid application of benefit-cost analysis.

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About the Author

Ross McKitrick

Ross McKitrick is a Professor of Economics at the University of Guelph, where he specializes in environment, energy, and climate policy; and a Senior Fellow of the Fraser Institute. He has published widely on the economics of pollution, climate change, and public policy. His book, *Economic Analysis of Environmental Policy*, was published by the University of Toronto Press in 2010. His background in applied statistics has also led him to collaborative work across a wide range of topics in the physical sciences including paleoclimate reconstruction, malaria transmission, surface-temperature measurement, and climate-model evaluation. Professor McKitrick has made many invited academic presentations around the world, and has testified before the US Congress and committees of the Canadian House of Commons and Senate. He appears frequently in the media, and his research has been discussed in many prominent outlets including the *New York Times*, *Nature*, *Science*, *Economist*, and *Wall Street Journal*.

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