Canada's Climate Policy Options

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1 Introduction

Thank you for the invitation to speak once again to the Ottawa Economics Association and the Canadian Association for Business Economics. I spoke to this audience five years ago, on the same topic. Back then, the government of the day was strongly enthusiastic about the Kyoto Protocol, although there was growing concern that it did not really intend to regulate Canadian greenhouse gas emissions. Today, the government is strongly skeptical about the Kyoto Protocol, although there is growing concern that they really do intend to regulate Canadian greenhouse gas emissions. On balance I think I prefer the old arrangement. We had to endure a bit of posturing and self-congratulatory rhetoric, but there was less chance of a costly policy blunder.

The economics of climate change has always been very simple. In the first part of my talk I will explain why, and what our current knowledge implies regarding the optimal policy strategy. That portion of my talk could have been written ten years ago: nothing of any real substance has changed since then. But, as you are aware, the climate policy debate has been interminably complicated, and in the second part of my talk I will try to explain why it is so, and why it will remain so. To anticipate that discussion somewhat, the complexity arises because of a combination of things: the underlying scientific issues are complex; policy goals are often distorted and disconnected from the ends we thought we were trying to accomplish; and the issue is routinely muddled with air pollution policy, a conflation that only messes up the discussion further.

But I begin with the simple economics.

2 Economic Issues

2.1 Optimal emissions and the price-quantity choice

We can illustrate an externality problem using simple tools from environmental economics: a Marginal Damages (MD) line and a Marginal Abatement Cost (MAC) line. We put emissions on the horizontal axis and money on the vertical axis, as in Figure 1.

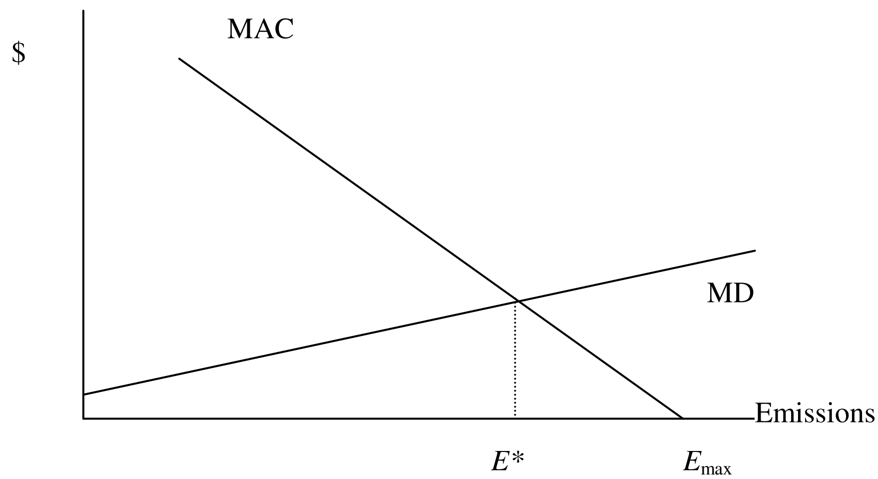


FIGURE ONE

We have in mind industrial processes that generate emissions of carbon dioxide, and household preferences that imply a desire for lower emissions. The MAC line is like a factor demand curve (see, e.g. McKitrick and Collinge 2000). Mathematically, its derivation is just like the derivation of the labour demand curve, only the productive input in this case is the right to emit. If emissions are unregulated the firm goes to E_{max}, where the price for the right to emit is \$0. If emissions must be reduced, then for every possible emissions target there is a corresponding price, or marginal cost. That represents the amount the firms would be willing to pay, at the margin, for the right to increase emissions a little; alternatively it can be interpreted as the cost of reducing emissions further, assuming policy has been targeting the lowest cost emissions first. That's not usually a realistic assumption but we'll use it for now.

A key point to stress is that the MAC pairs prices and quantities. Regulators can pick the quantity or the price, but not both. A lot of the fighting over climate policy arises when regulators think they can go off the demand curve, or in this case the Marginal Abatement Cost curve.

The MD line is like a supply curve. At a given emissions level, the MD curve tells us how much the victims of the externality would have to be compensated in order to be willing to accept, or "supply", one more unit of emissions. In other words it's the marginal cost to the public of emissions; or – reading from right to left – the marginal benefit of reducing emissions.

In Figure 1, the optimal emissions level is *E**. Higher emissions generate more damages than they are worth, where we count the "worth" by the willingness-to-pay on the part of potential emitters. Lower emissions cost more to abate then they are worth, where "worth" is measured by the amount victims would be willing to accept as compensation. Since emissions are paired with prices, it implies that there is a price *P** corresponding to the optimal emissions level.

The optimal policy in Figure 1 could take several forms. The simplest is to impose a tax of *P** on emissions, and let firms figure out how to respond. They will collectively reduce emissions as long as doing so is cheaper than paying the tax. So emissions will fall to *E**, and just as importantly, they will share the burden of abatement activity among firms in the most efficient way possible, without the regulator having to negotiate a burden-sharing arrangement. The mathematical demonstration of this is in any environmental economics textbook under the heading of the "equimarginal rule."

Another option is to require firms to hold permits for the right to emit, and to auction off precisely *E**. The market price will be *P** and once again the abatement burden will be shared efficiently.

The outcome in this case is symmetrical: pick either the price or the quantity and the outcome will be the same. The symmetry breaks down pretty quickly once we add in some specific details, but we never get the option of moving off the MAC curve. We can pick the price or the quantity, but not both.

2.2 The case of carbon dioxide

Turning to the case of carbon dioxide, which should we choose? It turns out, as I will explain, that the uncertainty over quantities guarantees that any mistakes we make will be very costly. But the uncertainty about the price guarantees that mistakes will not be costly. In other words, if we try to pick an emissions target we will risk making very costly mistakes. If we pick a price, we can't go wrong. There is a large literature now on the economics of carbon dioxide emissions, and it all comes to this conclusion: think of the issue in terms of an optimal social cost, not an optimal emissions target.

Figure 2 illustrates the situation. The first thing to note is that the MD line is horizontal. To the extent that carbon dioxide poses any problems, the damages are determined by the global concentration in the atmosphere, not the local emissions. Over the entire range of domestic emissions that are relevant to policy planning, any quantity target we pick gives us virtually no control over the global concentration of CO_2. Right now, CO_2 concentrations are just over 370 ppm. This number will evolve over the next century pretty much regardless of whether our emissions go up or down by the amounts being discussed. So the damages that can be associated with the first unit of Canadian emissions is the same as the damages that can be associated with the last unit.

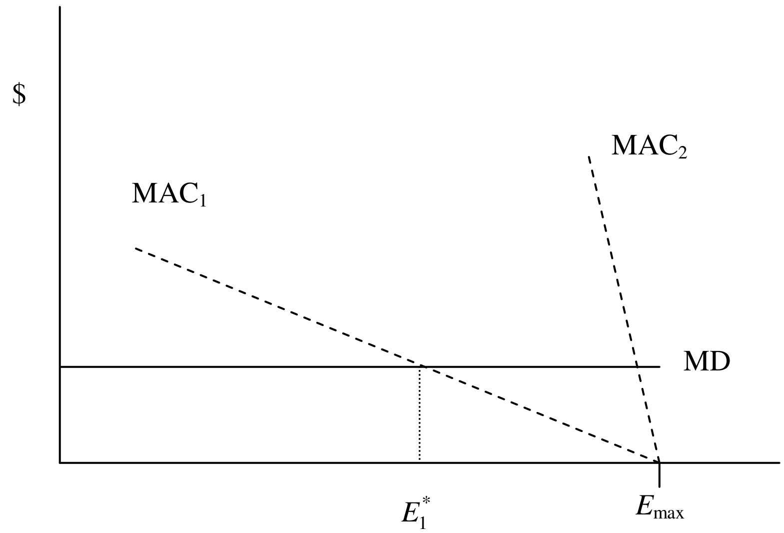


FIGURE TWO

I mentioned that the price uncertainty is very limited. In a recent paper, Richard Tol (2005) canvassed over 100 studies that have looked at the marginal damages of carbon dioxide emissions. While there was variability regarding the methodologies and assumptions, they had in common that they took climate forecasts more or less at face value and attached dollar values to the global consequences of emissions. They differed in how they valued those effects, but the overall results were surprisingly clustered. Figure 3, reproduced from Tol's paper, shows the overall distribution. There is a huge modal concentration between $0 and $10 (US) per tonne. Tol's diagram had to cut off the spike in the middle, so I have re-drawn it in rather crudely in Figure 3.

The mode is $2/tonne, the median is $14/tonne and the mean is $93/tonne. The mean is overstated because Tol initially includes some gray literature suggesting implausibly large costs, up to $800 per tonne. If the sample is confined to peer-reviewed literature, the mean falls to $43 and the mode falls to $1.50 per tonne; Tol reports the latter number is robust to many configurations of quality-weighting. Besides removing non peer-reviewed studies, if we confine attention to papers that use a 3% pure rate of time preference, to avoid tweaking the damage costs upwards by failing to discount the future, the median falls to about $6/tonne (Tol, 2005, Fig. 5). In other words, half the peer-reviewed studies put the costs at or below $6/tonne.

So there is not a lot of uncertainty on the price axis. The social cost of carbon dioxide emissions, at the global level, is almost certainly less than $50/tonne, very likely less than $15/tonne, and likely less than $10/tonne (I'm using the probability qualifiers arbitrarily). If we pick a price of, say, $10/tonne (Cdn) for the price axis in Figure 2, we have probably set it too high, but we won't be more than $10-15 off either way.

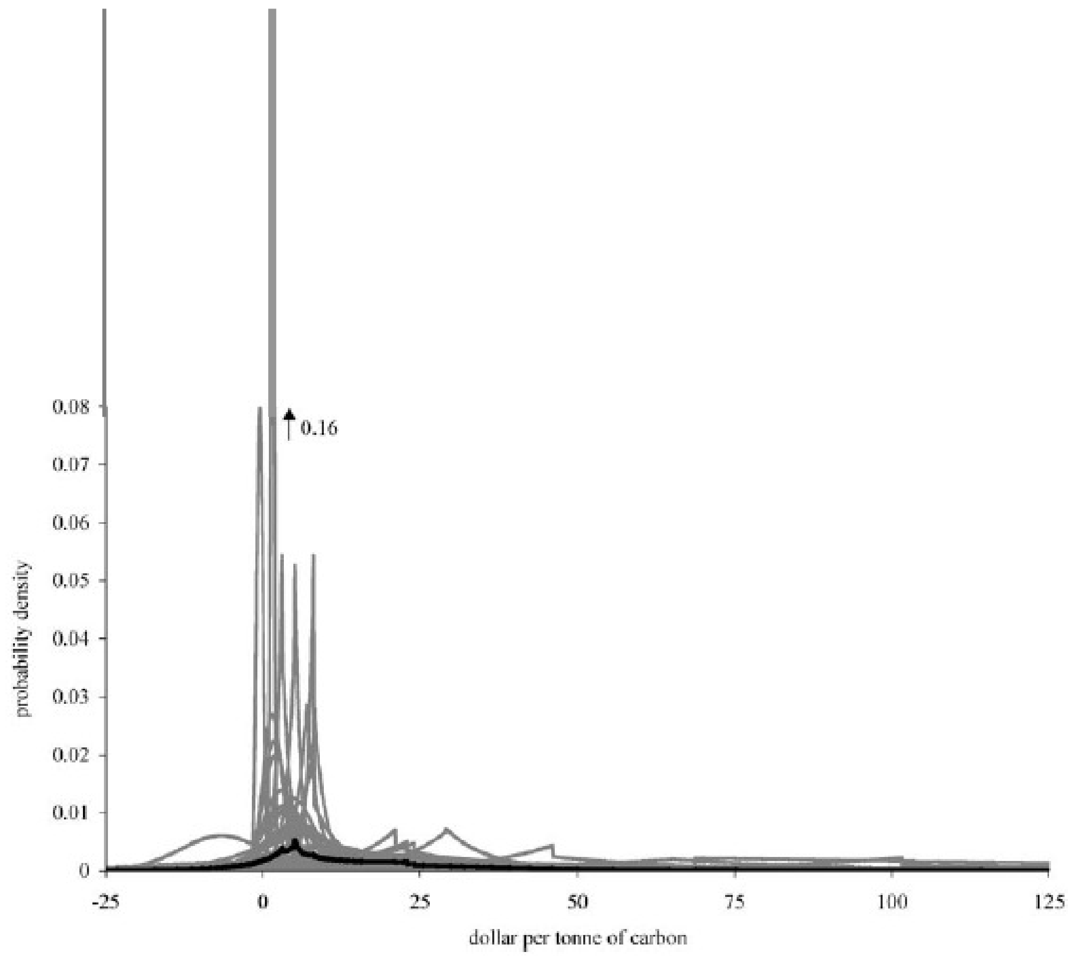


FIGURE THREE
Source: Tol (2005), histogram mode added

What if we try to pick a target on the quantity axis? In Figure 2 I have drawn two possible MAC's. MAC_1 is the "optimist" estimate. It suggests that large reductions could be accomplished at low total and marginal costs. The total cost of abatement is the area under the marginal abatement curve. MAC_1 rises slowly, and suggests that at a given price, the quantity of emissions would fall quickly. If firms had to pay even a low cost per unit of emissions, they would cut their emissions dramatically.

MAC_2 is the "pessimist" curve. It suggests that emission reductions would cost a lot, and the costs would rise quickly. Firms facing even a high charge per unit of emissions would no cut emissions much at all.

Suppose we try to pick a quantity target rather than a price target. Let's go with the optimists and aim for an emissions cap of E_1^*, which implies a cut of about 40-50%. If we side with the optimists and they turn out to be wrong, i.e. MAC_2 turns out to be the correct line, the resulting economic costs will be pretty catastrophic. The market price for permits will be far higher than expected and the costs incurred by emitters will be as well. Most of the abatement that occurs will be at a cost far above any associated benefits.

If we go with the pessimists, we would not bother with any emission reductions. It would be possible to justify a small cut in emissions on theoretical grounds, but once we factor in all the policy costs, including administration, tax interaction effects (Parry 2003) etc., the fixed costs of implementing the policy would not justify the small welfare gain. But if we made that decision, and the pessimists were wrong, the welfare costs (arising from the failure to reduce emissions) would be rather large. They would be determined by the area below the MD line and above the MAC_1 line, to the right of E_1^*.

In other words, whichever estimate we go with, if it is wrong, we are guaranteed to make a big mistake. But now go back to the price axis. If we pick a number for the emissions tax, say $10, we do not need to decide in advance whether the optimists or the pessimists are correct regarding the MAC. The emitters will respond to the tax by cutting emissions up to the point where further abatement costs more than $10 per tonne. In doing so they will reveal where the MAC is. There is no need to negotiate with them about emission targets, no need to assess whether they are exaggerating their abatement costs, etc. If they are paying the estimated marginal damages of $10 per tonne, and if MAC_1 is the correct line, emissions will fall to E_1^*, and, given our estimates of marginal damages that will be the right outcome.

2.3 On not having it both ways

However, if we decide that the marginal social cost of CO_2 is $10/tonne, and if the pessimists are right, then we need to steel ourselves for the inconvenient truth that the optimal emissions level is only slightly less than the unregulated emissions level. In other words, sound public policy should not attempt to reduce carbon dioxide emissions by much, if any. Acknowledging that the MAC line is steep but seeking deep emission cuts anyway amounts to trying to have it both ways.

I am a pessimist with regards to the MAC line, and I think the MD line is somewhere around $0, ±$2. People whose views I respect think the MD line is placed higher, but not by much. Even if it goes up to $15/tonne, that still implies only very small CO_2 emission reductions, hardly worth the bother.

Much of the tail-chasing in Canadian climate policy over the past few years has begun with politicians or policy advocates trying to find an outcome off the MAC line. It usually goes like this. A policy advocate (elected or not) conceives of an arbitrary emissions reduction target, say 30% below business-as-usual.

Policies are proposed, usually involving some variant of tradable permits, that might constrain emissions down to that level. Industry and other observers object to the costs that would be entailed, and bring forth well-crunched numbers pointing to permit prices of $100 per tonne or so. The policymaker doesn't want the permit price to go that high, so the policy is tweaked to put a cap on firms' costs at, say, $15 per tonne, by allowing either international permits purchases or a tax-based backstop on the permits price. Then the policy advocate boasts that the policy will not cost more than a few cents per barrel of oil (or some equivalent). But it is immediately retorted that neither will the policy reduce domestic emissions: firms will just buy foreign credits. At this point nobody is happy: firms are facing emission charges, emissions won't be reduced, and Canadian money will be spent on hot air credits overseas. So then the policy advocates look to develop ideas for domestic emission reduction measures, and around we go again.

There is no breaking out of this loop until the discussion of climate policy gets put on realistic foundations, chiefly by dispensing with the hope that we can pick an outcome off the MAC line. The following options are open.

- If the optimists are right, a carbon tax that internalizes the estimated global social costs of carbon dioxide emissions will suffice to move Canada to Kyoto-style emission reductions. There is no need in that case for additional regulations or emission reduction targets.

- If the pessimists are right, a carbon tax that internalizes the estimated global social costs of carbon dioxide emissions will lead to almost no emission reductions. Augmenting it with Kyoto-style emission reduction targets will have a large negative economic effect and will make us worse off, even after accounting for the benefits of reduced carbon emissions.

2.4 Revenue recycling and rate revisions

Thus far the economics is simple: put a price on carbon emissions of, at a generous estimate, $10 per tonne, and go home. The market will respond, the chips will fall where they will, and the outcome will be the best for all concerned, approximately. But there is the question of what to do with the money raised. This again is simple. It should go into general government revenues, to be used for cutting income taxes or some other tax with high marginal excess burden. At $10 per tonne, full revenue recycling can pretty much guarantee emissions control policy comes in at zero overall economic cost (e.g. McKitrick 1997), though bear in mind that emissions will not likely go down much.

One thing that should *not* be done is to dump the proceeds into a 'green technology fund'. This, unfortunately, is what Alberta has decided to do. They put a $15/tonne tax on large emitters this year, and they are using the proceeds to fund emission reduction projects. But consider how this will work.

In response to the $15/tonne tax, Alberta firms will search out every scheme and contraption that can cut CO_2 emissions for less than $15/tonne. The private sector will thereby exhaust all the cheapest abatement options. So when the government goes looking for projects to dump green technology fund money on, the list of eligible projects will *only* include those that were too inefficient to be undertaken by the private sector. They will, by design, be projects that cost a lot and yield relatively feeble emission reductions. If they were more efficient then they would have been adopted by firms already. By dumping money on them, the Alberta government will waste money and foul the efficiency properties of the underlying emissions tax. There is any number of things that could be done with the tax money that would preserve the basic efficiency of the policy. There is only one thing that could be done that would effectively destroy the policy design, and Alberta is doing it, unfortunately.

If the option of general revenue-recycling is not politically feasible, another possibility is to return the money to firms using an output-based recycling rule. Firms are grouped according to SIC-codes into clusters with similar outputs. The total payments within a cluster are pooled, then paid back to the contributors with each firm's share determined by its share of the total value of output in its cluster. This is how Sweden has controlled NOx emissions from its power plants. The effect of the tax is to punish firms with high emissions and low output, and reward firms with low emissions and high output. Since the money stays within a sector, the overall effect on competitiveness is minimized. Also, firms that took early action on emission reductions are not penalized, since they start out with a higher chance of getting a net contribution from their competitors.

Another point to remind ourselves of is that adjustments to the emissions charge must not arise simply from consideration of the quantity reduced. It is not valid to put on an emissions charge of $10 on the belief that this is the social cost of emissions, then hike it to $30 because there were hardly any emission reductions. If the social cost is $10 then that's that. Having an arbitrary target in mind along the quantity axis only leads to calls for unwarranted revisions to the policy, that will tend to overshoot the appropriate target.

3 Why the Climate Debate is So Complicated

3.1 Because the underlying science is complicated

It is impossible to canvass the issue of climate change without noting that the underlying complexities of the science hold an abiding and intense fascination for the public. The powerful reaction to every little bit of scientific news about climate change is a clue to an important element of the policy debate. The public has been led to believe that, as Al Gore put it during his testimony last week in Washington, there is a "planetary emergency" akin to a baby's crib being on fire, in response to which it would be irrational to quibble about whether there is a problem. The analogy is alarmist, of course, and also misplaced. A crib fire is a visible emergency with an immediate, low-cost and wholly effective solution: grab the baby. Global warming is not visible in the conventional sense, it is not an emergency, there is no immediate solution and whatever is being proposed is both highly expensive and largely ineffective. Of course Mr. Gore doesn't believe the analogy anyway, since when it comes to policy proposals he reverts to standard clichés about energy conservation and solar panels. These are trifling and irrelevant measures if the goal is to reduce the atmospheric concentration of greenhouse gases.

The alarmist hypothesis implies that economic growth and prosperity is basically incompatible with the continued habitability of the planet. Senior public figures in the world of science warn that vast regions of the world will be wiped out, Sir Nicholas Stern has warned that global warming will erase 20 percent of the world's GDP, people hear warnings about 20-foot sea level rises, the sudden melting of Greenland and Antarctica, hurricanes, flooding of US coastal cities, etc. If all this is true, then dealing with it is obviously going to have to be our top priority for the coming decade. If this really is what we face then let's stop talking about minuscule measures like Kyoto, we have to take down half the world's industrial activity before the decade is out. If we really need to reduce atmospheric CO_2 or even cap it at current levels, policy discussion has to go big, or go home.

But if it is not true—if these terrible disasters do not come to pass in the next few years—then given the number of highly placed experts either repeating these claims or nodding in silent approval as they are made, a large fraction of the scientific establishment will have done serious damage to its credibility. They are taking quite a gamble.

Amidst all this anxiety, the public retains an abiding willingness to entertain the arguments of those plucky few who periodically stand up to deliver the unpopular message that carbon dioxide may not be much of a menace after all. I can attest, from much personal experience, both to the unpopularity of the message, and to the willingness of the public to consider it. This receptiveness to information, combined with the fact that relevant new information continues to accumulate, means that, for the foreseeable future, the public will not support plans that involve serious economic consequences from greenhouse gas abatement.

The capacity of information to change minds was illustrated by a recent debate in New York City hosted by *Intelligence Squared* (http://www.intelligencesquaredus.org/), a classy group of thinkers who bring together top experts for Oxford-style debates in front of an educated, paying audience. On March 14 2007 they debated the resolution "Global warming is not a crisis." Three experts spoke on each side. Prior to the debate, the audience voted 57% to 30% – almost two to one – *against* the motion (i.e. in support of the idea that global warming is a crisis). After the debate the audience had swung sharply, and the motion was supported 46% to 42% – a small majority now rejected the claim global warming is a crisis. The undecided portion had stayed roughly the same (about 12%) each time. The information presented during the debate added about 16% to the crisis-deniers column, enough to reverse the vote outcome.

This does not surprise me. I am very aware that the information available to someone who passively consumes the media is pretty one-sided in favour of alarmism. But when people go looking for information, assuming that they aren't simply trolling for any old factoids to confirm the position they already hold, they are soon confronted with information against the standard popular view of global-warming-as-a-crisis that they find unexpectedly persuasive.

Let me give a few examples. When people begin investigating climate change they are often surprised to find out how much of the basic temperature data come from weather stations located on the ground. People instinctively understand that data collected in or near cities will have a bias towards showing warming. This instinct is correct. But when they look for the response of the Intergovernmental Panel on

Climate Change (IPCC) and compare it to the available literature they find the IPCC's position hopelessly dogmatic and unpersuasive.

Even more surprising is the fact that nearly half the world's weather stations were closed between 1990 and 1993.

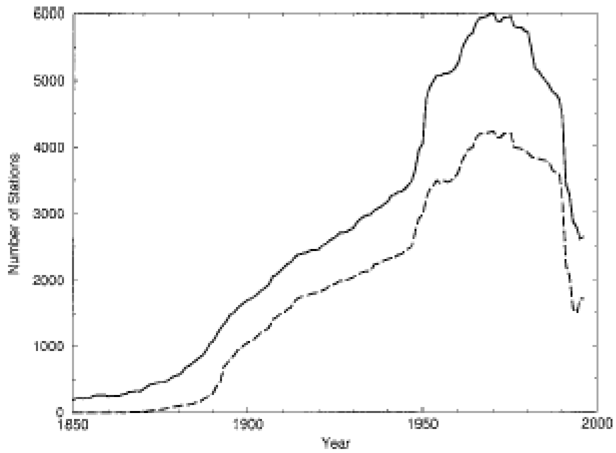


FIGURE 4: Number of Active Weather Stations in GHCN Archive. Solid: reporting mean T. Dashed: reporting daily Max/Min. Source: Peterson and Vose (1997).

It was after 1990 that the global average temperature seemed routinely to be hitting new highs. So there is a confounding problem in the data. The people who use the basic thermometer data group it into grid cells to try and minimize the impact of the sudden change in the sample. Maybe their adjustments are adequate. But maybe they are not, in which case the different behaviour of the mean after 1990 may be partly or wholly attributable to the major discontinuity in the sample. You will search in vain through the recent IPCC report for a discussion of this problem. Indeed you would be hard pressed to find any publications on this subject in climate journals, and the few papers out there raise important doubts about the continuity of the data. Moreover, the loss of stations was not evenly spread around the world. The former Soviet countries (including Russia) ceased a lot of their data collection after 1990, as did many African and South American countries. So the sample is now smaller and less evenly-spread out. I have serious doubts that the surface-measured average is a continuous index across the 1990-divide. And the fact that people learn about this important problem from books and weblogs, rather than from the IPCC, diminishes the IPCC's claim to be a comprehensive source of information.

Another confounding issue is the evidence that solar output is now exceptionally high in the context of the past 7,000 years. The role of the sun in climate change is a complex and fiercely-debated point. If the sun has a somewhat stronger role than is assumed in standard climate modeling exercises, then the 20th century climate change can be largely or wholly attributed to recent increased solar flux.

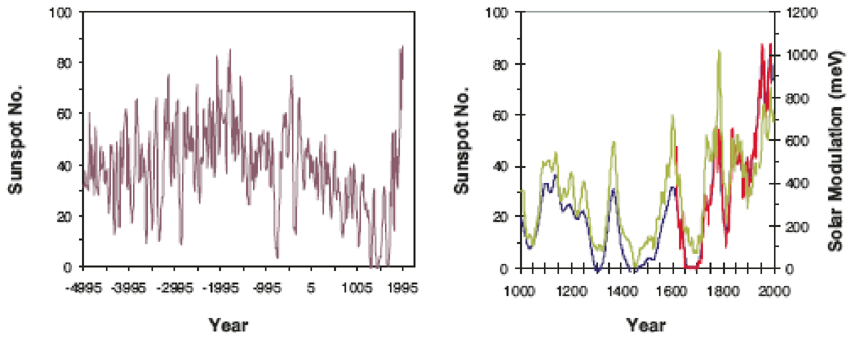


FIGURE 5: left, solar flux reconstruction over past 7,000 years; right: over past 1000 years. Sources: See McKitrick et al. (2007) Fig. ISPM-4.

Turning to climate models, another item quickly learned by people digging into details is that, if greenhouse gases are driving climate change, then there will be a distinct 3-dimensional pattern to it. The trends ought to be strongest at the North Pole, in the tropical troposphere and at the South Pole. The poles are rather small regions; the tropical troposphere (30N to 30S, 1—10 km up) is half the world's lower atmosphere.

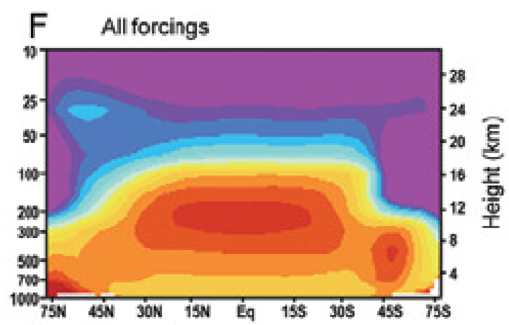


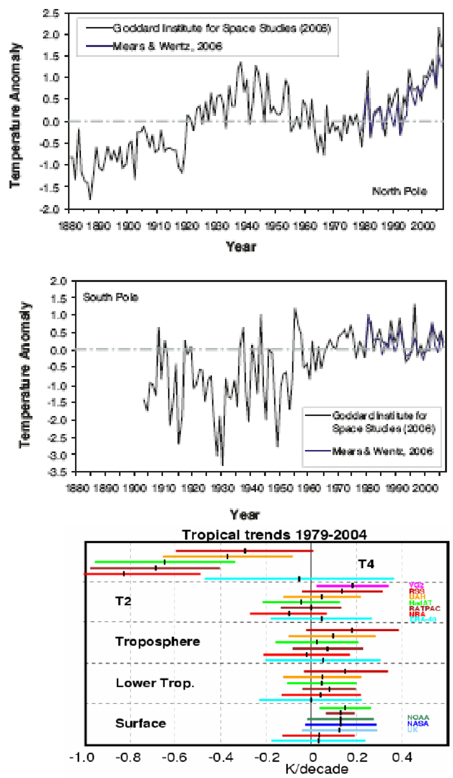
FIGURE 6: Representative climate model simulation of 1958-1999 temperature trends assuming dominant greenhouse gas forcing. Horizontal axis: latitude, Antarctic region to Arctic region. Vertical axis: height through atmosphere, pressure on left, km on right. Source: US CCSP report Fig. 1.3F, page 25. See similar graphics in IPCC AR4 Fig. 10.3.4, 10.3.5.

The data on these items are easy to obtain. No matter who collects the data (and there are multiple independent teams) they all agree on the following.

- Over the 20th century the Arctic behaved cyclically with a slight upward trend in the average temperature. Some teams find the current mean higher than in the 1930s, but not all. A recent analysis (Soon et al. 2005) found it highly correlated with 20th century solar flux.

- Since 1979 there are only small and statistically insignificant trends in the tropical troposphere, whether measured using weather satellite data (regardless of who processes it) or weather balloon data (IPCC AR4 Figure 3.4.3). Almost all data show the measured warming trends to be higher at the surface than in the mid-troposphere, opposite to the model projections.

- Since 1970 there has been no trend up or down in the Antarctic temperature average.



Arctic average temperature anomaly

Antarctic average temperature anomaly

Tropospheric trends in the tropics

FIGURE 7: Trends in averaged temperature data. Top: Arctic; Middle: Antarctic; Bottom: Tropical troposphere/surface. Sources: Top and Middle, see McKitrick et al. (2007) Fig. ISPM-8; Bottom graph is IPCC AR4 Fig. 3.4.3.

These latter two are not minor discrepancies. The major greenhouse gas-driven warming trends are supposed to begin, and remain strongest, in the troposphere and at the poles. *If* greenhouse gases are driving the process, that is. Anyone who wants to claim that greenhouse gases are driving a major climate change needs to explain why nothing is happening in the tropical troposphere beyond what can be attributed to natural variability. He or she needs to show the reader graphs of the vertical profile of warming predictions from climate models, compared to corresponding graphs of data, and discuss the discrepancies openly and honestly. Major reports from groups like the IPCC and the US Climate Change Science Program contain this information, but it is buried. The highly-promoted Summaries do not acknowledge these things, and Government web sites never discuss them either. Readers who discover it for themselves tend to become skeptical thereafter about the intentions and reliability of these institutions.

3.2 Because the policy goals get muddled

The next reason the climate policy debate is interminable and complicated is that people keep losing track of what the goals are. What is it we want to accomplish? Here are some stated or implied answers that you can hear if you listen to the discussion.

a) Stop climate change.
b) Stop climate chaos.
c) Stop global warming.
d) Implement the Kyoto Protocol.
e) Prevent dangerous anthropogenic interference with the climate system.
f) Cut greenhouse gas emissions.
g) Conserve energy.

These are all muddled answers. The first three are just baffling. The climate naturally changes on all known time scales. If it didn't, we would likely still be in the middle of an ice age. And the coupled ocean-atmosphere system is nonlinear and chaotic. Trying to stop chaotic behaviour of the climate makes as much sense as trying to change the orbit of the Earth.

A more generous interpretation of (a—c) would be to say that the goal is reduce the concentration of greenhouse gases in the atmosphere. But the reality is that a lot of emissions growth is coming from countries outside the Kyoto framework, including China and India, and even full implementation of the Kyoto Protocol would merely slow down (by a small amount) the accumulation of CO_2 in the atmosphere. The level of CO_2 we reach in 2100 might, under Kyoto, be delayed by a few years. So in assessing the benefits of emission reductions, bear in mind that all we are talking about doing is delaying the climate change, not actually averting it.

Item (d) represents the rut that policy got into after 1997, when countries came home from Kyoto with an unworkable treaty, and thereafter began a pointless decade-long charade of pretending to support it while quietly gutting it with loopholes or simply ignoring it. Implementing Kyoto is not an end in itself, but only a possible means to some other ends. In this case the means are fatally flawed, whatever the perceived ends are.

Item (e) has a policy connection through the UN Framework Convention on Climate Change, which binds signatories to reduce emissions to a level that would prevent dangerous interference with the climate system. "Dangerous" is undefined, of course, so the provision is pretty meaningless. And humans have an effect on the climate system through large-scale land-use changes, but nobody is proposing we turn all the farms back to forest and unbuild all the cities, even if it could be shown that all this land-use change had a ‘dangerous’ impact on the climate. So we are selective in the kinds of interference we want to scale back. And in any case, the activities that potentially change the climate carry benefits as well as costs. *Reducing* those activities can be dangerous, if doing so prevents needed development or causes economic hardship. Regarding industrial development, we take the rough with the smooth. If we commit ourselves to avoiding potentially dangerous courses of action, we might just as easily find ourselves arguing against Kyoto as for it.

(f) is a catch-all that covers a lot of policies that sound angelic must still be critically assessed. A few years ago the government published a list of so-called ‘Targeted Measures’ as part of their Options Paper (Canada 2002). Items included: re-surfacing Canada’s highways with concrete, retraining truck drivers to keep their tires properly inflated, retrofitting twenty percent of Canadian business buildings and houses, strictly enforcing speed limits, putting on road tolls, etc. The list went on for 20 pages.

Should any such policies be enacted? Probably not, but the real question has to be, not whether it would reduce emissions, but would it do so at a low-enough cost to yield a net benefit *in light of the estimated marginal damages of carbon dioxide*. Releasing a tonne of CO_2 is not the end of the world. It may carry a social cost, but not an infinite one. Avoiding the emission is, likewise, not of infinite value. By current data, emission reductions should cost less than about \$10 per tonne.

For example, should the government subsidize ethanol production? Here is the thought experiment. Suppose a charge of \$10 per tonne is applied to carbon dioxide emissions. Now sit back and watch how the market responds. Fuel costs would rise, but a refinery could potentially limit the price rise (thereby getting a competitive advantage) by blending in ethanol. However, whether or not they do so would depend on whether the reduction in the fossil carbon content of the fuel would yield sufficient tax savings to cover the ethanol production costs. Eventually the numbers would be crunched and a decision would be made. Maybe some ethanol production would be induced by this policy. Maybe a lot would. It is hard to tell without the detailed data and objective analysis that would only be done once firms were faced with a clear price signal. In any case, subsidies would not be needed. The government should not try to circumvent the process by rushing in with subsidies or arbitrary production targets.

In the same way, the question of whether Alberta should build a CO_2 pipeline depends on how much the abatement would cost per tonne at the margin. It is not enough to observe that piping CO_2 from the oil sands down to the old gas fields would reduce CO_2 emissions. The goal is not simply to reduce emissions, but to do so only insofar as net benefits are created.

The other odd aspect of making non-specific emission cuts the goal is that revisions to the business-as-usual assumptions do not seem to affect the policy target. If we project global emissions of 30 Gigatonnes of carbon as of 2050, and we decide we should keep it to a maximum of 25 Gigatonnes, what would it mean if new information came along showing that business-as-usual emissions will not exceed 20 Gigatonnes by 2050? It should imply that the need for policy just vanished. But instead, the target simply gets revised to 15 Gigatonnes. If emission reductions is the goal, we will never get there, since there will always be more reducing to do.

(g) is also a catch-all term under which even more ill-advised ideas are filed. Ontario is considering following Australia's lead in banning incandescent bulbs. What is the purpose of such a policy? If the idea is to eliminate incandescent bulb purchases, a ban might work, though it might simply create a black market. It is, frankly, hard to picture the RCMP opening a special division to break up international lightbulb smuggling rings. And it is hard to picture courts sending someone's grandfather to prison for using an old 60-watt bulb in his porchlight, not to mention changing his neighbour's light bulb for her, thereby making himself a bulb dealer.

But nobody cares about incandescent bulbs. The issue is greenhouse gases. Would banning incandescent bulbs reduce these emissions? Possibly, though it is easy to overstate the effectiveness of such measures, and of course the cost per tonne would likely be far greater than any benefits due to the emission cuts. It would be especially pointless to ban incandescent bulbs at the same time as the province plans to shut its coal-fired power plants. Having reduced the carbon content of fuels, the energy used by light bulbs is that much less tied to CO_2 emissions. The final irony is that this policy is being proposed as a means of reducing energy consumption in a province that still subsidizes electricity rates.

The recent federal policy to tax 'gas guzzlers' and give purchasers of 'fuel-efficient' cars a subsidy is another example of an idea that gets justified on the grounds of energy conservation, without reflecting on its lack of connection to what we are supposedly interested in, not to mention the redundancy with other current policies.

New cars and light trucks in Canada are subject to stringent controls on several emission types. US federal rules (which we copy here) prescribe maximum allowable levels (in grams per mile) of Volatile Organic Compounds (VOC's), NOx and carbon monoxide. Since 1966, those regulations have been tightened by, respectively, 99%, 98% and 96% (see McKitrick 2007). For the 2007 model year, a brand new SUV would have to be driven 50 miles to generate the same amount of NOx as a new light truck generated in one mile back in 1966. Consumers pay for all these emission controls in the purchase price. They also pay for meeting the fuel efficiency requirements, as well as the particulate and other exhaust regulations prescribed by provincial regulations.

But now, on top of these emission controls, a superfluous and punitive tax has been imposed on 'gas guzzlers'. What is it supposed to accomplish? We don't really care about whether people buy large cars or vans. Nor do we care if they are driven a lot (and the one-time tax wouldn't affect the daily driving decision anyway). We supposedly care about the emissions from the tailpipe, but that is already the subject of longstanding regulation. A pointless tax like this would never be justified except that 'energy conservation' is considered to be a sufficient rationale with little further thought.

3.3 Because air pollution is different

The final thing that makes this issue so complicated is the confusion with air pollution policy. There is currently no regulation of carbon dioxide emissions in Canada, except for the new Alberta targets. The federal government has implied that its new Clean Air Act fills a gap by bringing in regulations on air pollution. But air pollution is already heavily regulated in Canada, and moreover the regulations have been quite effective in improving Canadian air quality (see McKitrick 2007 for a review). But because we do not regulate CO_2 emissions, it is sometimes said that Canada has comparatively poor performance on 'emissions' relative to other OECD countries. But that is simply muddying the distinction between two very difference things. On conventional air pollution we have extensive regulations in place and concentrations of most contaminants in urban air have been cut substantially since the 1970s.

The distinction between CO_2 and air pollution is also important because CO_2 is much more difficult to control than particulates, sulphur dioxide, etc. Ordinary air pollution can be treated with end-of-pipe abatement. But there is no scrubber for CO_2. Sulphur was reduced in the 1990s by switching to low-sulphur coal from western North America. But there is no such thing as low-carbon coal. Using fossil fuels does not necessarily imply releasing NOx or particulates: these can be substantially decoupled from consumption with existing technology. But it does imply releasing carbon dioxide. With the exception of carbon capture and storage, which is a limited and costly option applicable in rather few places, burning fossil fuels implies releasing carbon in the form of carbon dioxide.

4 Conclusions

What are Canada's policy options? There is no shortage of people peddling ideas that fit into the list of muddled goals: energy conservation plans, ad hoc greenhouse gas reduction plans, plans to implement this or that treaty, etc. But stripped down to its clearest form, we have two options. We can pick a price or a quantity. The analysis I have presented, which I suggest reflects the mainstream views of economists on this topic, is that picking a price is a better strategy. The appropriate price is rather low, and implies only minor emission reductions. We probably do not have the option of picking a low price and getting a lot of emission reductions. The optimists may turn out to be right, but we should not go picking quantity targets on the assumption they are.

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