



AN EVIDENCE-BASED APPROACH TO PRICING CO₂ EMISSIONS

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The Global Warming Policy Foundation

GWPF Note

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Foreword

In relation to climate change issues, there is an official policy consensus, subscribed to by governments across the world. The consensus, which reflects received opinion, has been in place for over two decades. It has given rise to a still-growing array of policy initiatives. In thus acting, governments have been guided by scientific advice furnished through the *official expert advisory process*.

Despite its widespread acceptance, official and unofficial, received opinion remains subject to challenge by a varied collection of doubters, sceptics, critics and non-subscribers: I label these collectively as *dissenters*. They continue to be greatly outnumbered by the *upholders* of received opinion.

On both sides of the divide, views come in many shapes and forms: there is a whole spectrum of positions, ranging from (so to speak) dark green to dark blue. Strong dissenters – the dark blues – hold that human-induced global warming, if indeed its extent can be shown to be significant, is not a cause for alarm or concern: hence measures to curb emissions should be eschewed – or discontinued, where they are now in place. In this essay Ross McKittrick, himself a prominent dissenter, presents an alternative approach.

First, he makes the case for the general adoption of a tax on CO₂ emissions, though only given the fulfilment of strict conditions. Second – and this is very much his own special contribution to the debate – he suggests an actual empirical basis for determining the rate at which such a tax should be levied.

McKittrick's argument starts from twin propositions which many economists, including even the strong upholders among them, would be ready to accept, viz.:

- A moderate revenue-neutral tax on CO₂ emissions could well do less harm than the sources of revenue that it displaced: even aside from its effects on emissions, therefore, such a tax may deserve a place within revenue systems – in any country, rich or poor.
- The tax represents the least costly means of curbing emissions.

Actual 'climate change' policies have of course not taken the form of uniform taxes. Everywhere, the measures that are in force or in prospect largely comprise a long and growing list of costly regulatory initiatives. In all such cases, across the world, the adoption of a carbon tax that displaced or precluded such initiatives would constitute a major improvement. As McKittrick rightly notes, however, 'layering a carbon tax on top of a mishmash of other carbon and "green" regulation simply exacerbates the inefficiency of the regulatory system': the Carbon Price Floor which the British government has recently introduced is an example of such counter-productive 'layering'. The case for introducing the 'carbon' tax depends on its being made virtually the sole instrument of policy for curbing emissions.

Alas, there is no government anywhere which shows any sign of taking seriously the

idea of relying solely, or even predominantly, on a uniform CO₂ tax to the exclusion of ill-judged administrative measures. Even so, it is worth setting out the case clearly and accurately, as McKittrick has done here. Moreover, the case is reinforced, and given an important extra dimension, by his specific proposal for giving effect to the tax. He suggests linking the evolution of the tax rate to changes in estimated temperatures in the tropical troposphere, since these are seen as especially responsive to changing concentrations of CO₂ and there are good available data for them.

A clear advantage of this proposal is that the tax would then depend on actual evidence of the extent of global warming. Further, as McKittrick observes, one could think in terms of a futures market 'in which firms could buy contracts to cover the per-tonne emissions cost of the tax': such a market would 'force investors to make the best possible use of information about the future, and to press for improvements in climate forecasting'.

Such improvements are much needed. Contrary to what is widely believed or presumed, the official expert advisory process has shown itself to be seriously flawed: McKittrick has himself been one of its leading critics, as in his report for the Global Warming Policy Foundation on the Intergovernmental Panel on Climate Change.¹ The temperature-based procedure that he outlines in this essay would provide a strong incentive for more thorough and objective analysis of possible future developments in the climate system. His essay thus offers a blueprint for an evidence-based low-cost emissions policy that would also promote the cause of better understanding.

David Henderson

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¹ Ross McKittrick, 'What Is Wrong with the IPCC?: Proposals for a Radical Reform', GWPF Report 4, 2011.

Introduction: three cautions about carbon taxes²

The idea of carbon taxes has been around for a long time, but many questions and misconceptions about them remain. Before going into detail about the concept of a temperature-indexed tax, it is helpful first to spell out some economic fundamentals of carbon taxes in general.

The basic mechanism involves building a tax per tonne of carbon dioxide (CO₂) emissions into the price of all forms of fossil energy (oil, coal and natural gas). CO₂ is uniquely suitable for taxing in this way because in almost all cases there are no abatement options: once burned, the entire carbon content of the fuel ends up as CO₂ in the air. So if we know how much fuel is used, we know how much tax should be paid. Users of the fuels will then economize by reducing the most carbon-intensive forms of energy consumption. Since purchasers in the market are motivated to save money, any emission reduction option that costs less than the tax that would otherwise be paid will be adopted. The result is that the market will discover all the least-costly ways of reducing CO₂ emissions, in the process making use of far more information than would ever have been available to government planners and rule-makers.

Because of this economic mechanism a carbon tax is, theoretically, the most efficient tool for reducing CO₂ emissions. But there are three large caveats attached to this claim.

Instead of, not in addition to

First, the taxes must be used *instead of*, not *on top of*, other regulatory mechanisms. Anyone arguing for a carbon tax without simultaneously arguing for the removal of all other carbon regulations does not understand the concept. Layering a carbon tax on top of a mishmash of other carbon and 'green' regulation simply exacerbates the inefficiency of the regulatory system, it does not introduce any cost-savings. By now, pretty much every country has introduced some form of ad hoc regulation of CO₂ emissions, if not via direct emission controls then via indirect measures like energy efficiency standards or renewable energy programs. Consequently, no country is in a position to derive an efficiency gain from introducing carbon taxes, until it first dismantles the policies the carbon tax would replace. In the absence of a commitment to do so, a carbon tax is likely to do more harm than good, by exacerbating the inefficiencies of other policies while introducing no new efficiencies of its own.

Revenue-neutrality via tax reduction

Second, the case for the efficiency of a carbon tax presupposes that the revenues are not used for anything other than reducing other taxes. Without this condition, the carbon tax can easily become not only a macroeconomic burden but a source of new regulatory inefficiency.

² This essay summarises an idea set out in a number of my earlier publications, including McKittrick (2010) and (2012).

In addition to their role in controlling an emissions externality, carbon taxes are revenue instruments for the government, and need to be analysed as such. But new taxes diminish both the benefits to consumers and profits to suppliers. Because of the way people respond to price changes, the losses to consumers and suppliers always exceed the new revenues raised by the government. This difference is referred to by economists as the 'deadweight loss' or 'excess burden' of the tax. If the revenue pays for reducing another tax rate, and if the reduction in the deadweight loss associated with the other tax exceeds the new deadweight loss from introducing the carbon tax, there will be an overall macroeconomic gain. Many studies have found that the deadweight loss of a small carbon tax would be less than the gains from reducing income and payroll taxes, so there is the prospect of a slight macroeconomic benefit from such a tax switch.

But this only works for low carbon taxes. It can be shown with a bit of mathematics that the excess burden of any one tax goes up with the square of the tax rate. So a rising carbon tax must eventually cause added deadweight losses larger than the benefits from reducing other tax rates. And this effect likely kicks in before the tax has risen to a rate high enough to bring about significant emission reductions. So there is no avoiding the fact that emission reductions, even using revenue-neutral carbon taxes, are likely to be costly.³

Some carbon tax proponents want the revenue used to subsidize emission reduction technology, or green energy, or other such investments. This is *the worst* possible use of the revenue, since it destroys the microeconomic efficiency of the tax instrument. The carbon tax induces the market to identify the least-cost emission reduction options. The ones the market refuses to adopt are the relatively costly and ineffective ones. If the carbon tax revenue is used to subsidize the options rejected by the market, the policy goes from being a cost-minimizing instrument to a cost-maximizing one: it becomes, in effect, a tax on cheap and effective abatement schemes to subsidize the costly and ineffective ones. Proponents of carbon taxes who demand the revenues be turned into a slush fund for green technology are simply rent-seeking, and once again revealing that the discussion has departed from sound economic principles.

Price, not quantity, is the target

Third, it must be recognized that a carbon tax is a *price* instrument, not a *quantity* instrument. The policy works by stipulating the price one pays for emissions, then leaves it up to individuals and enterprises to decide what the quantity of emissions will be. The alternative option is for the policy-maker to determine the quantity of emissions, then let the market determine the price of achieving such cuts.

³ There is another important connection between carbon taxes and the excess burden of the tax system. The usual textbook formula for an emission tax says that the rate should be equal to the marginal value of the damages of the emissions. But this is not correct. In an economy with a pre-existing tax system (in other words, all of them), the optimal emissions tax rate should equal marginal damages reduced by a factor that compensates for the marginal excess burden of the tax system. So the larger the deadweight losses of the existing tax system, the lower will be the optimal carbon tax rate, and the less role it can play in any tax reform. This (obviously quite technical) point was first proven by the Swedish economist Agnar Sandmo in 1977, but involves some intricate mathematics to explain and is typically ignored in modern textbook explanations of carbon taxes. For a full discussion see Chapter 8 of McKittrick (2011).

Economists have long preferred price instruments over quantity instruments for CO₂ reductions. The reason is that, while emission abatement costs vary a lot based on the target, the social costs of emissions do not, since they mix globally. For any one country, its first tonne of CO₂ emissions each year imposes the same social cost at the margin as its final tonne. Hence it is better for policy-makers to try and guess the right price rather than the right quantity.

Policy-makers get into trouble when they try to control both the price and the quantity. Small changes in the allowed quantity can cause enormous price volatility (as has been seen in the EU tradable permits system) whereas even large variations in the price will tend to yield about the same emission reductions. So proponents of a carbon tax must recognize that they cannot simultaneously advocate for an arbitrary quantity target. The point of, say, a \$25 carbon tax is not that emissions will fall by some arbitrarily-chosen amount, but that users will pay \$25 for every tonne they emit. If they do, the policy is a 'success', even if it doesn't yield large emission reductions.

So, prior to asking how the tax rate should be set, we must emphasize these three points. A carbon tax is best seen as a replacement for the existing mix of inefficient climate policies, not an addition to them. The revenues must be earmarked for reducing other taxes, and the 'success' of the policy should be based on whether it enacts a price for emissions, not whether it yields an arbitrary change in the quantity of emissions.

Solving the dynamic rate-setting problem

Proposals for carbon taxes have to answer two questions: what should be the starting rate, and how should the tax rate change over time. Since, as I have said, a low carbon tax coupled with reductions in income taxes would likely be neutral or mildly beneficial at the macroeconomic level, it is conceivable that agreement could be reached in favour of a small carbon tax, even if people are otherwise divided about the underlying seriousness of the global warming issue. The second question, namely what the dynamic rate-setting process should be, is where views get polarized and agreement breaks down. How quickly should the tax rise, or should it go up at all? One side considers CO₂ a great threat to the planet and wants a firm commitment to a rapid rise in the tax rate over the coming decades, to slow down the emissions they believe are causing global warming. The other side does not view global warming as a problem, and would view any plans to increase in the tax as an unnecessary cash grab.

There is no grand scientific answer to this dilemma. Some economists crank up giant computer models that were built on the assumption that we understand all the parameters of the climatic and economic systems, and they print out what they view as the mathematically-optimal tax path based on computations of marginal social damages and so forth. Of course the polarized groups do not believe these models or their printouts, for different reasons, so such plans are usually dead on arrival.

I propose instead that the best way to proceed would be to put a small tax on CO₂ emissions, and tie its subsequent evolution to a suitable measure of atmospheric temperatures. If temperatures go up, so does the tax. If they do not, the tax does not change. In this way everybody will expect to get the policy they think best, and whoever turns out to be right deserves to be so. Sceptics who do not believe in global warming will not expect the tax to go up, and might even expect it to go down. Those convinced we are in for rapid warming will expect the tax to rise quickly in the years ahead. Companies managing factories and power plants will have to figure out who is more likely to be right, because billions of dollars of potential tax liabilities will depend on what is going to happen. Nobody will benefit from using false or exaggerated science: instead the market will identify those who can prove they understand the climate well enough to make accurate forecasts. And policy-makers will be guaranteed that, whatever the tax does in the future, the policy will turn out to have been the right one.

Why it would work

Admittedly the idea sounds a bit unusual, but bear with me: it makes sense. Reductions in greenhouse gas emissions (beyond trivial, symbolic gestures) are extremely costly. Such reductions may eventually turn out to be necessary, but there are valid reasons to think that they will not be. Policy-makers thus confront a choice between imposing an economic catastrophe that might turn out to be for nothing, or doing nothing and risking a planetary catastrophe. Small wonder no one knows how to proceed.

A temperature-indexed tax goes by the formal name of a 'state-contingent externality pricing mechanism'. It is possible to show, with a bit of mathematics, that it allows us to use observable information to construct a very good approximation to the unobservable future path of optimal emission charges that we would have imposed if we had full information about the long term effect of CO₂ emissions on the climate. Understanding the mathematics, however, is not necessary for grasping the intuition of why the idea works.

Consider, as an example, some recent comments by financiers in the *Guardian* newspaper⁴ concerning the existence of a so-called 'carbon bubble'. They were responding to a report by Lord Stern claiming that, as countries begin to impose what he views as an inevitable sequence of anti-fossil fuel policies to deal with the coming global warming, two-thirds of the world's reserves of fossil fuels will become uneconomic and will never be extracted. As a result, investments in fossil energy companies are, in his view, massively over-valued. One financial manager (Jens Peers), with responsibility for €4 billion in investments, agreed with this logic, saying:

'The risk is massive, but a lot of asset managers think they have a lot of time. I think they are wrong.'

⁴ <http://www.guardian.co.uk/environment/2013/apr/19/carbon-bubble-financial-crash-crisis>

Another financier, Jeremy Grantham, said his €106 billion fund would soon divest itself of all coal and unconventional fossil fuel assets:

‘The probability of them running into trouble is too high for me to take that risk as an investor.’

On the other hand most investors viewed the report by Stern with indifference and market prices for fossil energy did not change as a result of its publication. Which side is correct?

The difficulty of deciding is that these investors are betting on a political process, in which they have financial interests and their own statements may influence the outcome. Grantham, for instance, is the financial backer of the Grantham Institute for Climate Change⁵, a UK think tank that claims a mandate to ‘shape decision-making’ around climate policy. The work of the Grantham Institute is strongly critical of fossil energy and supportive of renewables. Thus, when Grantham declares his intent to divest from fossil energy and invest in renewables, he might simply be ‘talking his book’, or trying to induce other investors to make similar decisions since the ensuing price movements would be financially advantageous to him. Likewise, people often worry that owners of major oil and coal-based resource companies support advocacy against stringent climate policy in order to protect their investments, even if they privately believe global warming is a threat.

But consider how the incentives would change if the stringency and cost of future climate policy were determined only by the pace of global warming. If temperatures are going to rise in the near future, the views of Stern, Peers and Grantham would turn out to be justified and they will profit accordingly. If warming should prove to be a non-issue, and fossil energy will remain relatively inexpensive, they will have made the wrong investments and others will profit instead. Either way the outcome would be correct and objective. No one would have an incentive to make investments they privately believed were at odds with the actual progress of global warming and the implied evolution of climate policy. This would be a far better situation than one in which people with massive financial investments in rival forms of energy use their influence to drive policy decisions to their benefit, irrespective of the underlying scientific reality.

Which thermometer to use?

Then comes the question of what temperature measure should guide the future progress of the tax rate. The ideal one should respond quickly to CO₂ emissions, and not be expected to respond much to other changes in the climate system. All climate models in use today predict that, if CO₂ drives climate change, the strongest and most rapid response will be an amplified warming trend in the tropical troposphere: the vast region from near the surface up to 16 km altitude, spanning the tropics 20 degrees

⁵ <http://www3.imperial.ac.uk/climatechange>

North and South. And they predict that temperatures here would not change nearly as much in response to the other things that have caused warming and cooling in other parts of the atmosphere, such as ozone depletion, solar variations and land-use change. So I consider temperature levels in the tropical troposphere to be an ideal place to see the general magnitude of CO₂ emissions on the climate.

There is good quality data for this region of the atmosphere from independent satellites and weather balloons, so it would be easy to implement the idea. Suppose we set the initial carbon tax at about US \$10 per tonne, which is low enough not to do any real economic harm as long as we use all the revenues to pay for income tax cuts. The IPCC predicts a warming rate in the tropical troposphere due to greenhouse gas emissions of between 0.2 to 1.2 degrees Celsius per decade throughout this century. Using a simple adjustment formula, the upper end of warming forecasts would imply the tax could reach over \$200 per tonne of CO₂ by 2100, forcing a major shift towards planning for low-carbon energy sources.

What if no one believes the forecasts? Here is where the concepts really gets interesting. There is no incentive for industry to promote or use wrong forecasts. The greatest benefits will accrue to those who base their plans on the most accurate numbers. Losses will pile up for those who make bad forecasts. In one stroke we will solve the politicisation of climate science by using the market to weed out bad models.

Forward-looking

A colleague of mine (Hsu 2011) has also pointed out that, if a futures market were to be opened in which firms could buy contracts to cover the per-tonne costs of the emissions tax up to, say, 30 years ahead, not only would investors have complete pricing certainty for the coming years, but the futures market would become the world's most accurate climate model. With billions of dollars at stake, investors will ruthlessly sift information sources for an edge in predicting the value of such contracts, thereby bringing all the world's knowledge to bear on the future path of climate.

For example, if a scientist concludes from his analysis that we are nearing a 'tipping point' at which rapid temperature increases are inevitable, he might get frustrated if colleagues or policy-makers keep ignoring his warnings. But under the plan I am describing, if he has a valid analysis, market participants will not ignore him, instead they will objectively assess whether his warnings are credible. Likewise, if Lord Stern believes that global warming will make fossil fuel reserves worthless, owners of such reserves who accept his argument will have a strong incentive to invest in carbon tax futures to hedge against the risk to their assets. Hence, futures prices will reflect objective forecasts of future temperatures. Indeed if a scientist (or Lord Stern) believes his own forecast of the coming climate tipping point, he could earn significant profits by investing his pension in carbon tax futures while they are still cheap. And if he does not trust his own science enough to bet his pension on it, then he can hardly blame

others for ignoring it too.

I have received some criticisms of this idea that need to be addressed. First, it seems to be backwards-looking, because it is based on current and past temperature levels. But choosing the tropical troposphere as our metric means we are using the atmosphere's own 'leading indicator' - the warming there is supposed to be earlier and stronger than warming at the surface. And, more crucially, the policy is forward-looking because investors are forward-looking. A firm building a heavy oil upgrader or a pulp mill would not care what the tax rate is today, much less last year; instead it will want to know what the rate is likely to be 10 years from now when the operation is at full capacity. The market will force investors to make the best possible use of information about the future, and to press for improvements in climate forecasting in the process. So the policy is the most forward-looking one we can possibly implement.

Second, the tax I propose starts small, since we are unlikely to get agreement on a large tax. Environmentalists will object that a low tax will not force emissions down. That is correct, since most CO₂ control measures are very expensive on a per-tonne basis, so market participants will tend to prefer to pay the tax and continue burning fossil fuels. The point, however, is that if the environmentalists are correct, the tax will not stay low for long. Anyone who complains that the tax will never go up, and therefore would be useless in the fight against global warming, would, I hope, see the flaw in their position.

Finally, taxes can only be imposed at the national level, but CO₂ emissions have a global effect, so it might seem this cannot provide a global response. But this is a limitation of all policy proposals. All policies are nationally-implemented, not just taxes. No one supposes a globally-imposed policy on climate is likely to be accepted anytime soon. But this idea does not need to be globally adopted to be globally beneficial. In fact, it would only require one country to implement it, for everyone else to benefit from the emergence of the market for tax futures that would reveal optimal forecasts of global warming. And any country that implements it, even on its own, gets the benefit of knowing that it is pursuing the right policy path, even without knowing in advance what the path looks like.

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