

Comments on *The Social Cost Of Carbon And The Shadow Price Of Carbon: What They Are, And How To Use Them In Economic Appraisal In The UK*

David Newbery
University of Cambridge
31 August 2007¹

Clearly DEFRA has to respond to the *Stern Review* and prepare for e.g. the Climate Change Bill, and has to set out how to value climate change mitigation efforts and to clarify the various senses of the words price and cost, and is to be commended on bravely tackling a task that many of us would quail before. The document starts with an intelligent discussion of the possible meanings of the “cost” of carbon (actually CO₂), but, perhaps inevitably in a policy-oriented text (in contrast to the carefully argued but extremely long *Stern Review*) sweeps a number of important distinctions under the carpet – which might not matter if they did not bear so directly on the magnitude of the resulting shadow price of carbon derived to guide policy.

The *social* cost of carbon, SCC, as its name implies, measures the *social* cost of the damage caused by releasing a tonne of CO₂. Its magnitude depends sensitively the choice of the social welfare function (SWF) and its implied social weighting scheme (which is that adopted by the *Stern Review* and the Government *Green Book*) and on the rate of pure time preference, which Stern takes as 0.1 of 1% p.a. The SWF implies that £1 of damage to a Bangladeshi now counts the same (roughly) as £15 damage to a UK citizen, and according to which we would be willing to spend £15 to create a benefit of £1 in Bangladesh now.² If this were set out in such stark terms I suspect there would be queries (at the very least) about consistency with our aid policy (a target of 0.7 of 1% of GDP which we are far from achieving), and some skepticism that “society should, in theory, be willing to pay” such an amount in such a case. (There are other interesting questions about whether richer countries than us would accept a higher SCC, as they should on this logic.)

The value of the SCC is also critically dependent on a very low rate of discount, which again is inconsistent with other investment decision making, notably in infrastructure investment. The idea that “society should, in theory, be willing to pay” this particular SCC thus glosses over a large number of problematic issues, which Stern might have been able to sustain on the basis of his ethical arguments, and where DEFRA should perhaps point out that if Stern’s conclusions are to be accepted, then the *social* values are what they are, but they cannot be immediately accepted as a guide to UK policy in isolation.

The arguments surrounding this also make some strong and not well-substantiated implicit claims. For example the claim on p3 that the “tighter the emissions target, the lower the SCC will be, since there will be less damage from climate change” holds given the social welfare function (SWF) – implicitly the degree to which we value harm to others. But if a lax international regime leads to high climate change damages we might conclude that others do

¹ I am indebted to Karsten Neuhoff for comments without implicating him in the final outcome.

² The Social Welfare Function used is additive logarithmic in consumption per head – $\sum_h \log c_h$. Social weights attached to household h are then equal to the marginal social welfare, or $1/c_h$.

not reciprocate and therefore have less claim on our good will, and so should count less in our SWF, hence downgrading the distributional weights in and level of the SCC. Much depends on whether we view the SWF as an absolute ethical imperative or part of a social contract with other countries (and people at different dates).

The distinction between SCC and the *shadow price* of carbon, SPC, is explained thus:

“... the SCC is essentially exogenous – that is, determined purely by our understanding of the damage caused and the way we value it; the SPC is endogenous, in the sense that it can adjust to reflect the policy and technological environment.”

The distinction is not quite so straightforward, as the SCC will depend on the abatement actually achieved, as does the SPC, and so the SCC is not really exogenous. The SPC is a shadow price in that it is the marginal abatement cost (MAC) to reach a target concentration,³ although that choice of target concentration depends on *social* valuation. Even here, a sensible level for the SPC depends on a reasonably high degree of collective action, and in turn agreement both on the physics/economics of climate change *and* on the social valuation (what we collectively want to aim for including, critically, the relative extent to which rich countries will support poorer countries).⁴ Then the SPC might be measured by price that we *might* agree should be the carbon (dioxide) price that all (or most) countries would set internally (via taxes or cap and trade mechanisms) and which ought then to be equal to the MAC. A subset (OECD?) of countries might agree that investment decisions should be guided by an agreed SPC but there would need to be some pretty explicit agreement about how it should be determined and on what ethical basis. Without actual or expected success in reaching a wider international agreement on pricing carbon, leadership roles involving high SPC are likely to be both costly and ineffective. Thus “adopting a value at the top of the range should be sufficient to generate abatement compatible with moving into the 450-550ppm optimal range” is only true if (almost) everyone adopts that value. This is explicitly recognized on p3: “In order to conclude that it is worth acting, each country needs to be confident that enough other countries are committed to a similar goal.”

Even here there are some points that need clarification. The claim is that “the SCC associated with the stabilization goal and the MAC needed to achieve it may not be equal.” If that is the case then the goal is presumably wrong (since the optimal goal is where they are equal), and we need to know why the goal is “wrong”. If the target is all that countries will accept, because they do not agree on the SCC or on the actions needed to implement the “right” target, then the SPC is indeed the MAC to achieve what we have agreed, accepting that the UK would have liked to achieve more. Individual UK action in setting the UK SPC > the agreed SPC = MAC to deliver the agreement or Protocol would mean that we inefficiently spent more reducing the marginal tonne than other countries without having

³ Note that even the concept of “the” MAC implies either a degree of efficiency in targeting or an actual market price to guide decisions if the MAC is to be the same in different mitigation activities.

⁴ The need for collective action is brought out more clearly on p3 for the SPC but not for the SCC, where our willingness to attach high weights to poor countries is likely to depend on collective action.

much affect (2%) on the outcome (unless it is part of a strategy to successfully shame others into raising the agreed SPC).

It then does not follow that the SPC=MAC is lower the tighter the target just because the SCC is lower – instead the MAC will be higher the tighter the target, but still below the SCC (otherwise we could use the SCC=MAC on the grounds that an ideal international agreement had been reached).

Some of the confusion might be removed by starting from the agreed international target (including an agreement on how to achieve it), and computing the least cost acceptable path and the implied MAC at each date, which can then become the SPC. This MAC will increase over time as deferring costly options makes sense if the future is discounted. With some iteration on objectives and means, the international agreement might aim to determine a starting value of the SPC or MAC and then on the rate at which it should increase.⁵

The suggested SPC

The suggested price of £25/tCO₂ = 40 Euros/t CO₂ = £92/tC = \$150/tC seems high,⁶ compared to forward EU ETS prices of 19 Euros/t CO₂ (Dec 2008, = £13/t CIO₂) and compared to UK coal prices into power stations in June 2007 of \$102/t (itself almost twice the normal price), particularly as it rises at 2% p.a. One test is whether a sufficient number of countries would accept this as a carbon price or tax on the basis of which to take key decisions on e.g. the choice of electricity generation technology (which will be influenced by the time path of the SPC over the 25-60 year life of the station). Certainly nuclear power ought to be commercial at this price in most developed countries unless they have very cheap coal that cannot be exported profitably (e.g. brown coal in Australia). It appears that even the more expensive carbon capture and storage (CCS) becomes economic at world coal prices on this price trajectory. The MIT study *The Future of Coal* estimates the levelised cost of marginal CO₂ reduction via CCS on pulverized coal stations as about \$35-40/t CO₂, which is equivalent to a carbon price starting at \$31 (roughly the DEFRA suggested starting level) and escalating at 2% p.a., assuming no future learning cost reductions from CCS.⁷ Using (as yet commercially unproven) integrated coal gasification the marginal CO₂ cost is about half, suggesting that CCS might (eventually) only require half the DEFRA price. The MIT study shows global CO₂ emissions stabilizing by around 2015 at about 28 GT CO₂ under their high price assumption of an initial price of \$25/t (1997 prices)⁸ rising at 4% p.a. from 2015 onwards, close to the 2015 DEFRA price (although thereafter rising more rapidly, but without the benefit of a positive carbon price until 2015).

There is the additional question of what is the net cost to the UK of adopting unilaterally a higher price than other countries – on the one hand harming our energy-

⁵ As in the US National Energy Commission's carbon price projections cited in the MIT *The Future of Coal*, p9.

⁶ Using the long-run exchange rate of \$1.61 = £1.

⁷ Discounting at 8% real the levelised equivalent of \$31 escalating over 40 years is \$38 and at 3.5% is \$42.

⁸ Or \$32 in 2007 prices.

intensive export industries or over-encouraging imports from under-pricing countries (and thereby weakening their resolve to properly price carbon, unless we impose border tax adjustments), while on the other stimulating the development of low carbon technologies for export (where we would likely be competing with the much better endowed US).

The document's claim that the carbon price should rise over time is correct (judging from the Hope PAGE2002 model) but the reasoning given is less convincing. Bear in mind that temperature is a *log* function of concentration, so that a unit increase in CO₂ concentrations (e.g. from 550 ppm to 560 ppm) leads to a successively *lower* increase in temperature, so even if damage rises more than proportionately to temperature it is not obvious that damage rises more than proportionately to concentrations. Hope's model actually shows the SCC relatively insensitive to the emissions path, in contrast to the model that Stern built from Hope's PAGE2002 version. That said announcing the time path of the SPC is critical for investment decisions.

The SPC is intended to guide decisions, and will only do so outside the public sector if incorporated into a market price – i.e. as a tax or allowance price, with rebates for other carbon pricing instruments (like the EU ETS). This is not spelled out (and is presumably off the policy agenda). Usage decisions as well as investment will be guided by market prices, and only by shadow prices in the public sector (and then probably only for those investment decisions made on the basis of CBA – which leaves out most infrastructure, except those projects that for other reasons the Government wishes to encourage).

An interesting test case might be to examine road-rail decisions, where there is a high fuel tax element for road transport (way higher than even the SPC) but nothing comparable for diesel-powered rail (electricity is at least paying the ETS price). It might be helpful to provide a worked example to illustrate how such investment decisions should be made, thereby illustrating the points made on p10 about avoiding double counting. The main failure at the moment is the unwillingness to confront domestic consumers with the full carbon price of non-electrical fuels. (Electricity at least pays the ETS price at the margin, even if it is subsidized via the lower VAT rate.)

A further test case might be whether the government were willing to write a long-term option on the carbon price for new low carbon (and typically high capital cost) investments (wind, tidal stream, CCS, nuclear power, etc) at anything like these levels, such that the holder would be entitled to receive the difference between the actual carbon price (which would need careful definition in the context of possible carbon taxes and various climate change instruments as well as the ETS) and the strike price (and would be obligated to pay if the actual carbon price exceeded the strike price). My understanding is that the government would be most reluctant to do that without a comparable long-term commitment by the EU and possibly other competitors. If so, what would be the logic of investing long term in projects that are only justified at the deemed SPC, committing the country to the difference in costs of these and alternatives preferable at the expected actual future carbon price?

The discussion on p9 of the discount rate is rather confusing – the SPC will guide marginal investment decisions, and if there is an intention to actually use the *Green Book* rate of 3.5% (at which a vast number of road investments have a B/C ratio above 5), then that rate

should presumably be used to determine the SPC and that in turn will lower the SCC and SPC. The choice of discount rate will also affect the rate of growth of the SPC.

The claim that “improving technology over time is likely to lead to a falling marginal abatement function over time” is true but could be misleading – it does not mean that the MAC in equilibrium will fall, rather than the MAC schedule will shift down and abatement will increase in line with the rising SPC meeting the shifted MAC schedule further to the right, and this might be clarified with a diagram.

Cost effectiveness: here one might discuss a different approach to setting the SPC. If the international horse-trading over climate change policy is over the prices to set then the approach suggested would be anchored in the outcomes of these agreements. At present negotiations are over emissions per period, from which it would normally follow that the SPC should be the shadow price of that constraint, and would be determined in quite a different way (and would be different by country without trading). Again, much is being swept under the carpet (perhaps for quite understandable reasons) in the acceptance of an SPC so unhinged from current forms of international agreement.

In short, the paper is wrestling with several unresolved problems – the most important of which is how to set national policies posited on international agreement on what should be done to mitigate climate change well in advance of any discussion on how such agreements might be implemented. Even within the UK it faces an inconsistency in domestic policy where some projects and policies (those justified with this SPC) would be financed by the government but where others that might have a claim on government resources (carbon options for new nuclear and CCS) or which materialize as new taxes (on domestic heating) are rejected.

Finally, there is a reasonable case for making an assessment of what future negotiations (ETS post-Kyoto, etc) might deliver in terms of a carbon price (which could be well above the forward ETS price) and announcing that as the target to guide policy and support mechanisms (such as carbon options, feed-in tariffs, etc), but it is not clear that one would start from the *Stern Review* SCC. DEFRA has in this document responded to the challenge – now the task is to make the case more watertight.