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**"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"**

Comments by Alex Bowen[1] on DEFRA draft dated 10/08/07

**Introduction**

This report, in my opinion, provides a generally clear exposition of how to use a shadow price of carbon in economic appraisal. However, the analytic framework could be laid out more fully and some of the explanations of concepts are somewhat confusing.

My comments are organised below by draft heading. The main points are:

- The differences between the social cost of carbon and the shadow price of carbon need to be clarified.
- The role of the marginal cost of abatement is not adequately explained.
- The efficiency benefits of uniform carbon pricing could be emphasised more as a motivation for the whole exercise.
- The choice of price index for deflating nominal values should be revisited.
- The role of the social rate of time preference appears to be misunderstood and the advocacy of a standard discount rate of 3.5% does not entirely convince.

**"What is the social cost of carbon?"**

I would have found it helpful if this section had explained more fully some of the terms of art used throughout the report. Thus, for example, it would be useful to explain the concept of an externality and its relevance in this context, as well as the relationship of the externality to social cost. In general, some or all of social cost may be reflected in market prices, and it is important to be clear about why that is not the case here.

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The concept of the shadow price of carbon should also be introduced and explained here, not least because the distinction between the social cost of carbon (SCC) and shadow price of carbon (SPC) is not always transparent in the report. The shadow price in a given period should equal the change in the policy-maker's objective function for a (very small) reduction in carbon emissions in the same period. It can differ from the SCC, broadly for two reasons. First, it is calculated for the optimal level of emissions given the objective function and the various constraints. The SCC can be calculated away from the optimum. Second, the policy-maker's objective function may differ from that assumed in calculating the SCC. That might be the case, for example, because additional factors may influence the policy-maker that are not included in the social welfare function on which the SCC is based – such as a desire to set a good example to other countries. This seems to be what the report is saying later (pp 2-5).

It would be helpful to acknowledge that estimates of the SCC, SPC, and indeed marginal abatement cost (MAC) all depend on ethical judgements within a particular ethical framework – of 'expected utility' – and cannot be determined by purely technical means.

Footnote 3 introduces the notion of a representative consumer. This is not an easy concept to explain in a setting where consumption opportunities are unequally distributed and distributional equity matters to the policy-maker. Is it necessary?

**"How should we use the SCC to determine a stabilisation goal?"**

The optimum stabilisation goal entails equality between the MAC and SCC through time. The current text could be read to mean that only the current values need to be equalised. It could also be noted that the SCC and MAC should both be calculated taking into account the ranges of uncertainty about climate-change damages and abatement costs. Expected utility theory allows one in principle to derive single numbers for the SCC and MAC, even though the costs and benefits are uncertain. This point is developed later (pp10-12), but the fact that this framework entails decision-making under uncertainty is worth making up front. The role of the MAC as a guide to the appropriate SPC is not explored.

Footnote 4 could usefully be brought into the main text (thus also satisfying the statement in the second paragraph of p3 better).

**"Why use a shadow price of carbon, rather than simply the social costs?"**

As noted above, the SPC should be defined earlier. It is not strictly true to say that the SCC is essentially exogenous. It depends crucially on the presumed range of emission paths, which in turn depends on policy measures and technology.

**"Choosing the appropriate shadow price of carbon for the UK"**

If a global concentration target is tighter because the estimates of climate change damage from any given concentration are higher (and marginal abatement costs over time unchanged), the SCC will be higher. In the third paragraph, the initial statement needs to be clarified. The current text is describing a trade-off for a *given* view of the probability distribution of damages through time.

The SPC is associated with a constrained optimum, as noted above. At the optimum, under certain conditions, SPC=SCC=MAC. In that sense, the SPC – the basis for policy – could be said to be based as much on the MAC as on the SCC. As flagged above, this merits further discussion of how MAC estimates can be used to guide the setting of a SPC. The paragraph does not make clear at the beginning that it is considering the circumstances in which setting the SPC equal to the SCC will reach the desired outcome.

The description of what is prudent at the end of the third paragraph could be contentious. The upside risks to the size of climate change damages are already factored into the choice of range. Choosing the top of the range in order to err on the side of having too high a SPC risks excessive abatement costs. That is not necessarily prudent (especially if it risks undermining public support for the policy).

Somewhere in this section it would be helpful to rehearse the efficiency argument in favour of a single world carbon price – achieving any given stabilisation target at least

cost. (This is, of course, subject to the caveat that a uniform price can only be justified if it can be assumed that measures are taken to ensure that the incidence of abatement costs under chosen policies does not alter income distribution and equity.)

I find the discussion under the heading 'the value of leadership' a little confusing. The text starts off saying that this is one reason why the SPC might not equal the SCC, but then says that the appropriate SPC does not allow explicitly for the value of leadership per se. The fourth bullet on p5 seems to be consistent with the first argument, not the second.

On p6, the second bullet suggests using both a GDP deflator and the UK's CPI inflation target. This seems odd, as there can be persistent differences between the inflation rates calculated using the two measures. Some measure of inflation for consumers would be consistent with the consumption-based utility framework underlying the SCC approach, so *either* the CPI or the consumption deflator would be appropriate.

**"How should the shadow price of carbon be applied?"**

Under 'innovation market failures', a point could be added about the need to tackle the co-ordination difficulties that can arise if innovation is left to private agents. Public action may be needed, for example, to establish confidence in new networks (of fuel stations, electricity distribution, etc).

On the discount rate, the Stern Review argument was that there does not exist a single discount rate that can be used to make non-marginal decisions under uncertainty. But the social rate of time preference, as an underlying concept, remains highly relevant for climate-change policy decisions.

In the penultimate paragraph on p9, the use of the standard 3.5 percent discount rate is advocated. This may be convenient, but it does not follow from the logic of the Stern Review's non-marginal expected utility analysis. A project entails costs through time. The impact on utility depends on the path the economy is on, which is uncertain. For example, a project costs more in terms of foregone utility on bad paths. In principle,

an individual project's costs could be evaluated like marginal climate-change costs. In addition, one should consider the likelihood of the project being stopped by exogenous circumstances and the covariance of future project returns with consumption generally.

On p 11, the list of 'very substantial uncertainties' should include those about abatement costs, because they will affect the emissions path followed by the economy under any given set of policies, the growth rate of the stock of greenhouse gases and, therefore, the SCC.

At the bottom of p11, there is a discussion of the benefits of flexibility. The corollary of that is the potential benefit of delaying lumpy investment in relatively inflexible projects, if more information is expected to become available in the future (as suggested by so-called 'real option' theory).

On p12, a definition of cost-effectiveness analysis would have been helpful. Judging by the text, it is only appropriate to discrete projects, the scale of which it is difficult to vary in small steps. If scale can be varied, then marginal, not average unit, costs are the appropriate concept for decision-making.

**"What about other greenhouse gases?"**

The problem with using global warming potentials (GWPs) is that they are not an economic concept. Two emissions of the same GWP can have a different impact on welfare depending on their time profiles. For example, one gas might have an intense but short-lived impact compared with another; the former would have a relatively lower SCC associated with it than relative GWPs would suggest.