The Shadow Price of Carbon: Response of Government Economists to Academic Peer Review Comments[1]

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January 2008

As part of the process of developing its new guidance on the Shadow Price of Carbon (SPC), Defra invited comment from expert academics in this area. Defra received 6 sets of peer review comments on an early draft of the explanatory note describing the proposed approach.

Defra would like to thank all those who took part in the peer review process for their constructive comments, which have helped us to explain the new approach more clearly and to clarify our thoughts on how the guidance should be developed going forward. The note that has now been published has been amended to take on board many of the points raised.

This document summarises the major points raised by respondents and outlines the response of government economists to them, indicating where they have and have not been incorporated in the new guidance. The focus is not on those comments that relate directly to the Stern Review[5] (which has been debated extensively since its publication) but rather on how the work of the Review and other pieces of economic evidence and analysis are incorporated into the new guidance.

While for the most part the reviewers recognised that the new guidance is an improvement and an important contribution to climate change policy, the focus in the response below is on those comments that were challenging of the draft reviewed and / or suggested areas for improvement.

1. What questions are the SCC/SPC trying to answer?

Response of government economists:

The Shadow Price of Carbon (SPC) is the value that will be placed by government on carbon impacts when evaluating policy options. The new framework will ensure that the carbon impacts of policies – whether negative

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[5] The Stern Review: The Economics of Climate Change. Available at: http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm

or positive - will be taken into account systematically and consistently across government.

The revised estimate of the SPC reflects the damages caused by an incremental carbon emission. Defra will consider revising guidance to follow a MAC –based approach in the coming year. Under this approach, the SPC would represent the price necessary to induce sufficient investment to reach a given target. Estimates of the social cost of carbon would still be important – alongside data on marginal abatement costs, these estimates should inform international negotiations and the setting of targets.

2. A recurring theme from reviewers was that the early draft reviewed was insufficiently clear as to the exact approach that Defra has pursued – namely, whether the new SPC is based purely on the damage cost of an incremental emission of GHG, or whether allowance is made for the prevailing marginal abatement cost (MAC) and its relation to any targets we might have in place. Further, several of the reviewers strongly advocated taking the latter approach – namely adopting a SPC which is consistent with bringing forward the necessary abatement of emissions in order to meet a set target.

Response of government economists:

In relation to the first point, the paper that has now been published has been clarified in order to prevent any confusion. Defra has chosen a figure for the SPC that is based upon the social cost of carbon (SCC) at an atmospheric stabilisation concentration of 550 ppm CO2e.[6] *As such, the new guidance is currently based purely on estimates of the damage costs of climate change impacts.*

In relation to the second point, we agree that there is merit in considering a move towards a MAC-based approach to calculating the SPC, and we therefore intend to review the guidance within the next year. This review will consider the case for moving from an approach based purely on the damages from climate change to a figure that is based upon UK and global emissions reductions targets and information on prevailing and future MACs. Initial evidence reviewed in the explanatory note suggests that the current proposed figure is broadly in line with UK and global targets, dependent on the level of abatement required to take place within UK borders, but considerable further analysis is needed.

[6] It is necessary to assume a stabilised atmospheric concentration level as the damages from climate change impacts depend upon atmospheric concentration – the higher the concentration, the higher the SCC. Choosing an SCC for the UK therefore involves making assumptions about the future policy of the rest of the world. As discussed below, 550 ppm is at the upper end of the suggested stabilisation range from the Stern Review. This figure has been chosen in order to be more certain the UK will undertake sufficient abatement to reach the suggested Stern stabilisation range. Please see main paper for further details.

3. Several reviewers highlighted the considerable uncertainty surrounding estimates of the SCC. One reviewer suggested that the SCC derived by Stern is an underestimate as second-order impacts such as socially contingent effects are excluded. However, another reviewer suggested that choosing the top of the range in order to err on the side of caution risked incurring excessive abatement costs.

Response of government economists:

Defra recognises the uncertainty surrounding estimates of the SCC. It is also correct to observe that certain socially contingent effects are not included in the Stern modelling. However, it is not possible to conclude from this that the Stern estimates we have used are systematically too low, since there are several other, potentially countervailing, uncertainties regarding, for example, the relationship between emissions and climate change and between climate change and economic costs. Despite these uncertainties, we believe that the SCC values calculated by Stern are the best estimates currently available and that it is therefore appropriate to use them to form the basis of the guidance for now. To be prudent, we have used the SCC corresponding to the top of the suggested Stern stabilisation range as the basis for the current SPC figure.

Defra is undertaking significant research on two fronts to reduce the uncertainty attached to the SPC in the future. First, we are undertaking a major programme of research to improve our understanding of the impacts and costs of climate change. The Met Office Hadley Centre provides in-depth information to the government on climate change issues, including the Integrated Climate Programme. This will develop state-of-the-art climate models which (i) help detect and attribute current climate change, and (ii) predict future global and regional climate viability and change, on decadal to century timescales. Government will also continue to draw on the results of further work by the Committee on Climate Change, the Intergovernmental Panel on Climate Change and the wider academic community on the SCC and damage cost estimates. This will include taking account of Integrated Assessment Models which can be used to further examine the impacts of assumptions about the economics of risk, uncertainty, catastrophic and irreversible events, and approaches to equity on the SCC and damage costs, and also taking account of results from other detailed models about the socio-economic impacts of climate change and their valuation.

Second, as mentioned above, within the coming year Defra will consider the case for calculating the SPC on the basis of the marginal abatement costs that would need to be incurred to meet a given emissions reduction target. This will involve detailed research into marginal abatement costs in the UK and globally. A particular focus of this work will be on the extent to which the policy regime allows for the delivery of abatement at least cost and on the potential for technological improvements in the future.

4. The use of a single value across government (in order to promote consistency of application) was considered a positive move by some, but not by others. The uncertainty surrounding the SCC was suggested as a reason to consider adopting a range, at least for decisions where carbon emissions are a key factor.

Response of government economists:

Defra recognises the uncertainty around the SCC, but the importance of consistent application across Government must also be emphasised. In the guidance, Defra states that carbon benefits should be treated similarly to any other parameters in the application of sensitivity range and suggest an indicative range to be used of +20%, -10% of the total present value (PV) of carbon. As noted, the research referred to above should help to reduce the uncertainty surrounding the SPC.

5. Some reviewers requested clarification and a consistency check on the use of different discount rates – the Stern Review has a lower discount rate than that which will apply to the carbon impacts of individual projects.

Response of government economists:

As stated in the main paper, we believe it is necessary for the climate change problem on the whole to be treated differently from everyday, marginal policy decisions. The Stern Review takes a specific ethical approach to discounting the climate change impacts, based on the belief that it is unfair to discriminate against somebody purely because they are born in a later time period. As such, the Green Book social rate of time preference (SRTP) is not applicable to the climate change problem as a whole, hence the SPC is the relevant figure to use in appraisals as a measure of the carbon impacts. The SPC is dependent to a certain extent on the ethical framework set by the Stern Review. However, individual policy decisions will (generally) have a marginal impact on welfare, hence it is appropriate to continue to use the SRTP to discount all benefits and costs in appraisals. Please see the main paper published alongside this document for further information.

6. The convention and extent of 'uprating' was also questioned by some reviewers.

Response of government economists:

Damage is a function of the cumulated stock (which is rising), so one extra tonne in the future will have a higher associated damage than an extra tonne released now. Additionally, as incomes grow, so the monetary value of damage is likely to increase, owing to an associated higher willingness to pay

to avoid warming damage[7]. Therefore, it is right not just to uprate the value of the SCC for inflation (in order to preserve its real value), but also to uprate for the expected increase in damages from the incremental carbon emission. Should the guidance adopt an approach based on MACs, then we would not uprate at a pre-determined 2% per annum in real terms, but would regularly review our SPC figure in order to produce a figure that is consistent with the target that we are aiming to reach.

7. There was some disagreement amongst reviewers as to whether 550ppm CO2e is a reasonable target to aim for. While it was recognised that 550ppm CO2e is broadly in line with current Government policy (and a reasonable assumption to make regarding a possible international agreement), it was also suggested that we aim for a stabilisation target towards the lower end of the suggested range due to the small probability of large temperature increases even at concentrations of 550ppm CO2e.

Response of government economists:

Stern suggests aiming for a stabilisation range of 450-550ppm CO2e. Defra has adopted the social cost of carbon from the Stern Review which is consistent with a stabilisation scenario of 550ppm CO2e. This however, does not imply acceptance of 550ppm CO2e as a target.
Within the Stern range, the tighter the emissions target, the lower the SCC will be, since there will be less damage from climate change. Thus in Stern's suggested range, the SCC is highest for 550ppm CO_2e. Care is therefore needed in selecting the specific target on which to base the UK's SPC. If the SCC exceeds the required MAC for the given goal, this will lead to over-achievement of the target. However, if the SCC is below the MAC for the expected stabilisation goal, then decisions taken on the basis of the SCC will fail to reach the expected goal – too little investment will take place. For this reason, and in order to be more certain that the UK is undertaking sufficient abatement to help achieve the stabilisation goal, we believe it is prudent to adopt a SPC based on the SCC at the top of the 450-550ppm CO_2e range. Please see the explanatory note (pp3-6) for further information.

Equally, initial investigation into the McKinsey global MAC curve would suggest that the new SPC is roughly in line with the price required to reach (globally) a 450ppm stabilisation scenario.[8] However, this relies upon comprehensive international action and perfect exploitation of abatement potential globally. If this is not the case, the actual MAC required may be substantially higher than this figure. Again, the rationale for considering the MAC associated with the bottom of the stabilisation range is to ensure that the abatement generated is compatible with moving towards the 450-550ppm proposed range. This is essentially the same reasoning that led to the choice

[7] David Pearce "The Social Cost of Carbon and its Policy Implications" *Oxford Review of Economic Policy*, 2003. Vol 19:3, pp 362-384
[8] Although it should also be noted that the McKinsey UK MAC curve suggests a higher price would be required to reach UK 2020 targets.

of an SCC value at the top of the stabilisation range. Please see the explanatory note (pp6-7) for further information.

8a. It was noted that the SPC should really be the price that is required to reach agreed (international) targets, and that international agreements would currently suggest a lower SPC (such as in the EU ETS). It was suggested that such agreements are more credible than Government policy/targets.

Response of government economists:

The carbon price experienced in Phase I of EU ETS reflected the fact that this phase was a learning period, for participants as well as cap-setters – there was not sufficient information for the cap to be set with any certainty with regard to bringing forward a price within a sensible range, and the cap-setting process erred on the side of caution as a result. However, caps will become progressively tighter over time, as demonstrated by the robust current price in Phase II of EU ETS. In the longer term, we would expect the market price of carbon to reflect more closely the SPC as international agreements progress towards a comprehensive, global approach to emissions reductions. It would be short-sighted to base our SPC on shorter term agreements which are not a comprehensive response to the problem at hand. Such a choice could also have the effect of "locking-in" higher abatement costs in the future. Further to this, the Climate Change Bill should provide greater credibility (and hence certainty for business) relating Government targets, and as such investment decisions will begin to price in carbon with greater certainty.

8b. A closely related point regarding the relation of the market price to the social cost of carbon was raised – adopting the new SPC across government will clearly only affect decision-making in the public sector, but the decisions of private agents will still be guided by the market price (the forward EU ETS price is lower than the SPC, and CDM credits might also be used to reach policy goals). Is the market price the correct price to consider?

Response of government economists:

It is true that public sector decisions will be guided directly by including the new SPC within cost benefit analysis. Defra intends a more rigorous and comprehensive application of the SPC across public sector decision-making, even where carbon impacts are not major. In addition, policies influencing the private sector will be heavily informed by the SPC–. For example, in the formulation of a policy to act on a particular sector, the level of incentive provided would be informed by the new SPC, and as such government is able to project social valuations onto private decision-makers.

As noted above, the current market price is not based on the comprehensive global agreement that will be required to reach a stabilisation goal within the

Stern range. However, the Government is working hard towards achieving such an agreement. Further, should government move towards a MAC approach in future, then the market price of carbon would explicitly be used to inform the SPC. Its exact level would be determined by the availability of abatement options at home and abroad and would also depend on any supplementarity conditions imposed.

9. One reviewer noted that previous SCC modelling has suggested that the SCC is not in fact path-dependent. This contrasts with the Stern Review modelling which finds large differences in the SCC between different atmospheric concentration paths.

Response of government economists:

(With thanks to Simon Dietz for clarifying this issue): The clearly visible path dependency of the SCC demonstrated in the Stern Review, and the inconsistency of this with previous SCC modelling can be explained. The Stern Review used an endogenous discount rate[9], whereas earlier studies had discounted exogenously. By utilising an endogenous discounting regime, differences in the SCC on different paths emerge. The reason for this is that on BAU pathways, the damages from climate change are much greater, and thus growth is lower. With endogenous discounting, this leads to a lower discount rate compared to an, e.g. 550 ppm CO2e stabilisation concentration which will have lower climate change damages and a higher growth and thus discount rate. Therefore the present value of damages will be higher on a BAU trajectory.

These differences emerge more under low discounting regimes (such as that used by Stern), as the differences in damages tend to happen far in the future. In addition, as GHG emissions have increasing marginal damages the higher is the accumulated stock (damages are convex), then the marginal damages on higher atmospheric concentration pathways must be higher – this effect must outweigh the falling effect of an incremental emission on atmospheric concentrations in order for the SCC to be higher at higher atmospheric concentrations, all else equal.

10. Several reviewers noted that the use of Global Warming Potential (GWP) figures in order to convert non-CO2 GHGs into a CO2 equivalent measure (so that the SPC can be applied across GHGs) is not an entirely accurate conversion. As GWPs are not an economic concept, two emissions with the same GWP can have a very different welfare impact depending upon their time profiles. In addition, the GWPs are based on 1995 values rather than the most recent 2001 values.

[9] This means that the discount rate used in the analysis was determined by the actual growth rate predicted by the model, taking climate damages into account. Exogenous discounting applies a pre-determined discount rate based on an assumed rate of growth.

Response of government economists:

The GWPs used in the guidance are indeed 1995 values. These are in line with UNFCCC reporting requirements, and hence are the appropriate figures to use in appraising options across different GHGs in order to comply with our international agreements. We recognise that these are not entirely accurate in terms of the social costs of different gases as a result of different time profiles of the actual GWP of different gases. However, in order to ensure policy consistency with international obligations, and as a result of the lack of available information regarding the actual social costs of different gases, the guidance will continue to use the 1995 figures. It may be desirable for modelling to be done in order to reflect more accurately the social costs of different gases, in which case guidance could be updated to reflect this.