

REVIEW FOR *ECONOMICS OF* “THE SOCIAL COST OF CARBON: TRENDS, OUTLIERS AND CATASTROPHES”

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1. INTRODUCTION

Economics is needed to evaluate whether current climate policy is too stringent or too loose, and whether we are responding too quickly or too slowly to the climate risks that make front page headlines. An estimate, however rough, of how much damage is done through the emission of one tonne of carbon equivalent into the atmosphere—known as the Social Cost of Carbon (SCC)—is useful for economic evaluation of climate policy. If carbon prices created by policies such as the European Emissions Trading Scheme (EU ETS) are much above the SCC, this suggests to economists that policy is too fast and/or too strict. On the other hand, if policies create carbon prices well below the SCC, we may not be moving quickly enough to reduce climate risks.

As such, periodic evaluation of the “state-of-the-art” concerning SCC estimates is a useful input into the policy process. Tol (2005) was such an input. Tol (2007) represents an update on previous work. Unfortunately, as Tol notes, the “state-of-the-art” in the area has not changed a great deal in the last decade and remains rather poor. Many studies rely heavily on regional or global extrapolation from particular case studies, ethical aggregation issues are still hotly contested, valuation methods are still questioned, and many studies ignore a wide range of (possibly nasty) climate impacts and second-order environment-economy interactions. As such, a great deal of caution is warranted with any SCC estimate, and this caution applies similarly to this meta-analysis.

Nevertheless, Tol (2007) seeks to draw four significant conclusions from his analysis:

1. There is a downward trend in SCC estimates;
2. The estimates by Stern et al. (2006) are “outliers”;
3. It’s the tails that count: uncertainty in the SCC estimates is critical;
4. The implicit carbon tax would “bankrupt” many countries.

Importantly, the paper further claims that the meta-analysis shows that current climate policy efforts should be intensified. However, this claim is based on a calculation error and is not justified by the analysis.¹

No practitioner or observer in this area will find the third conclusion to be surprising. Yohe (2007) has already commented on the first and the fourth claims. Here, I review what is new, consider some important and relevant issues that were omitted, discuss some methodological issues, briefly compare the results from this meta-analysis with the last study (Tol, 2005), examine the literature in comparison with Stern et al. (2006), and finally address the claim that climate policy should be intensified.

¹ See section 7 below.

2. WHAT IS NEW?

Of the roughly 100 more new estimates included since Tol (2005), the majority are from two studies, namely Ceronsky et al. (2005) and Guo et al. (2006). Both studies employ the FUND model. So while the number of SCC estimates has indeed doubled, the number of underlying integrated assessment models has not expanded quite so rapidly. While important updates have been made to some of these integrated assessment models, there is often nothing like a fresh pair of eyes, and Tol (2007) is correct to welcome “quality research by newcomers in the field”.

On a related matter, it is noteworthy that estimates from FUND account for over 50% of all observations (112) in the meta-analysis. It would be interesting to see a plot of the distribution of the results of the meta-analysis according to the underlying integrated assessment model. The large number of estimates from FUND is a testament to the energy and industriousness of its author. It does, however, also raise the issue of whether there is enough truly independent research from different models to make robust claims about the appropriate SCC from a meta-analysis at this stage of development in the literature.

3. OMITTED ISSUES

Differences in SCC estimates may be driven by several factors unconnected with the underlying scientific and economic model. There are at least four important such areas.

First, valuing climate impacts involves deep and controversial ethical questions. Even *before* considering “equity weighting” or “discounting”, assumptions must be made about the underlying normative framework. Economists almost invariably adopt a consequentialist, welfarist, and utilitarian framework, but this is not the only (or necessarily the most compelling) ethical approach. This assumption goes unacknowledged in most of the research in the area, and is similarly unacknowledged in this meta-analysis. And yet, using a normative framework that philosophers find more compelling could lead to very substantial shifts in recommended climate policy.

Second, climate change is a non-marginal phenomenon. As such, each SCC estimate is a function of the assumed future pathway. Most SCC estimates are (implicitly) “business as usual” estimates. There are exceptions — Stern et al. (2006) for instance express SCC estimates as an explicit function of different future pathways and concentration stabilisation levels.

Third, the process of valuing climate impacts involves estimating “utility losses” in different world regions and the converting these losses back into monetary terms, normalised to a particular income level. It is obviously important for any comparison that all studies are normalised to the same income level (Anthoff et al. 2006). It is my understanding, but this is not explicit, that all the studies in the meta-analysis have had climate impacts normalised to the same level, probably mean world income.

Fourth, SCC estimates can also vary trivially because they are expressed with different numeraire years — US\$ in 1990 is different to US\$ in 2005. A frustrating feature of the literature, and also of both meta studies, is that numeraire years are often not stated.

4. METHODOLOGICAL ISSUES AND INDEPENDENCE

Tol (2007) employs a system of scoring papers based on whether they are ‘independent’ estimates, use the ‘correct’ estimation method and have a ‘realistic’ climate-change scenario. Some measure of ‘quality’ of different papers is a necessary evil. However, it inevitably generates two potential concerns. First, given that the scoring system is somewhat subjective, Tol (2007) should provide a fuller explanation and justification of the particular values given to different studies. Second, this subjectivity is potentially problematic given that Tol himself is the author of more than 50% of the estimates in the meta-analysis. One suspects that if authors of other integrated assessment models were asked to choose the quality indicators, the allocation of ‘1’s and ‘0’s may well be reversed. Ideally, of course, the results of a meta-analysis would not depend upon its author. That said, we do not have a meta-analysis by an independent scholar who is not scoring his or her own model. In the absence of an independent analysis, this paper is certainly better than nothing.

5. RESULTS AND TRENDS

Tol (2007) finds a downward trend in the mean estimates of the SCC since the studies in the early 1990s. Interestingly, however, compared with the meta-analysis in Tol (2005), Tol (2007) finds *higher* SCC estimates. For instance, the mean SCC over all studies in Tol (2005) was \$93/tC, while in the present meta-analysis it is now \$127/tC (see Table 1). Could this be an indication, as Yohe (2007) suggests, that SCC estimates are hooking upwards?

Table 1: Comparison of results for all studies

	Median	Mean	95 th percentile
Tol (2005)	\$14/tC (\$3.8/tCO ₂)	\$93/tC (\$25/tCO ₂)	\$350/tC (\$95/tCO ₂)
Tol (2007)	\$74/tC (\$20/tCO ₂)	\$127/tC (\$35/tCO ₂)	\$453/tC (\$124/tCO ₂)

The same trend is observed when the meta-analysis is restricted to peer-reviewed studies only, shown in Table 2. The mean SCC estimate in Tol (2005) was \$50/tC, while in Tol (2007) the estimate is \$71/tC.

Table 2: Comparison of results for peer-reviewed studies

	Median	Mean	95 th percentile
Tol (2005)	\$14/tC (\$3.8/tCO ₂)	\$50/tC (\$14/tCO ₂)	\$245/tC (\$67/tCO ₂)
Tol (2007)	\$48/tC (\$13/tCO ₂)	\$71/tC (\$19/tCO ₂)	\$231/tC (\$63/tCO ₂)

6. COMPARISON WITH STERN ET AL. (2006)

Tol (2007) shows that one of the estimates from Stern et al. (2006) — the “business as usual” (BAU) estimate shown in Table 3 — is an “outlier” when compared with previous estimates. As noted above, the SCC estimates in Stern et al. (2006) are explicitly pathway specific. This is an important feature of the analysis. For instance, the SCC along pathways towards stabilisation at 450PPM, is lower than the SCC along a “business as usual” pathway, which assumed to lead to concentrations of over 650PPM.

Table 3: Comparison with Stern et al. (2006)

Pathway	450PPM	550PPM	BAU (> 650PPM)
Stern et al. (2006)	\$92/tC (\$25/tCO ₂)	\$110/tC (\$30/tCO ₂)	\$314/tC (\$85/tCO ₂)

The Stern SCCs at 450PPM and 550PPM are not “outliers”, but this comparison is inappropriate if the other estimates are equivalent BAU estimates. The fact that the BAU estimate in Stern et al. (2006) is higher than previous studies, of course, does not necessarily mean that it is wrong. Results in quantum physics might similarly have been described “outliers” when compared with Newtonian priors. It does, however, mean that the onus is upon Stern et al. (2006) to explain why their results are different. The Stern Review states:

It should be remembered that this model is different from its predecessors, in that it incorporates both explicit modelling of the role of risk, using standard approaches to the economics of risk, and makes some allowance for catastrophe risk and non-market costs, albeit in an oversimplified way. In our view, these are very important aspects of the social cost of carbon, which should indeed be included in its calculation even though they are very difficult to assess...Nevertheless, we are keenly aware of the sensitivity of estimates to the assumptions that are made.

Other assumptions that are important in explaining the Stern Review results include the use of equity weighting (the elasticity of marginal utility is unity) and, of course, the approach to discounting. The consumption discount rate used by Stern et al. (2006) is endogenous to the particular path, growth rate and model run of each world region. However, after 2100 a relatively low long-term consumption discount rate of 1.4% (real) is employed, which is based on a pure time discount rate of 0.1% to accounts for extinction risk. Stern et al. (2006) depart from previous work in so far as the discount rate does not reflect “today’s marketplace” (Nordhaus, 2007), but is instead based on explicit ethical considerations. Many philosophers find it incredulous that some economists believe that questions of global and intergenerational justice should be answered by reference to “today’s marketplace”.²

Other differences between the approach of Stern et al. (2006) and previous studies have been more than adequately set out in the vigorous debates following the Stern Review.

7. IS CLIMATE POLICY TOO WEAK?

An important claim by Tol (2007) is that the meta-analysis makes the case for intensifying climate policy. This is said to be because even the lowest SCC estimates exceed current and forward carbon prices on the EU ETS.³

Certainly, the spot EU ETS (Phase 1) carbon price is near-zero, and no-one could seriously claim that Phase 1 was too stringent. However, on the forward EU ETS carbon price, Tol (2007) has unfortunately made a simple calculation error. Prices for 2008 delivery of

² For a critical overview of some of the ethical issues in the Stern Review, see Beckerman and Hepburn (2007).

³ These lower estimates are derived using a 3% pure time preference rate that most philosophers and a majority of professional economists consider to be too high. The latter is shown by the fact that the median *consumption* discount rate in Weitzman’s (2001) survey was 3%, implying a median pure time discount rate of at most 2%, based on reasonable assumptions.

European allowances under the EU ETS, at the time of writing, were above €20/tCO₂, or \$30/tCO₂, which is equivalent to \$110/tC (not \$8/tC as claimed) after accounting for the fact that there is 12tC in every 44tCO₂.⁴

So does the EU ETS Phase 2 actually pass a cost-benefit analysis? On the basis of Tol's meta-analyses, the answer is "possibly not". Current EU ETS prices for 2008 delivery, at \$110/tC, are higher than peer-reviewed mean SCC estimates of \$50/tC (Tol, 2005) and \$71/tC (Tol, 2007). Only when the grey literature results are included, leading to a mean SCC estimate of \$127/tC (Tol, 2007), does the EU ETS appear to pass the test.

Of course, this is not to say that the EU ETS is necessarily economically unsound. Clearly, the EU ETS is deemed cost effective if the Stern et al. (2006) 550PPM estimates are employed. Moreover, as noted in the introduction, an enormous amount of caution is warranted in evaluating and using *any* SCC estimate. Additionally, as noted by sections 3 and 4 above, the estimates aggregated by Tol (2007) are based on a series of methodological and ethical assumptions which may, or may not, be considered to be appropriate. Finally, there are reasons why the SCC estimates might be too low—risk and ambiguity aversion premia, omitted impacts *might* lead to underestimates, rather than overestimates, of the SCC—in addition to reasons why developed country climate policy should be *more* stringent than that implied by an SCC normalised to world income levels.

8. CONCLUSION

While this meta-analysis does provide an update on the work of Tol (2005), it unfortunately suffers from several shortcomings. These are:

- A majority of the new estimates are from FUND, which also provides a majority of all estimates aggregated in Tol (2007);
- While measures of estimate 'quality' are helpful, the subjectivity of these measures implies that results would almost certainly differ if an author of a competing model conducted the meta-analysis;
- Several important issues are not addressed (e.g. relevance of ethical framework, path dependence, income normalisation, numeraire year etc);
- The fact that the BAU estimate by Stern et al (2006) might be considered as an "outlier" does not mean that the estimates are "dodgy" or wrong;
- An error is made in claiming that the meta-analysis justifies the intensification of climate policy.

This is not to say that meta-analyses in this area are not useful (although it might be debated whether there is enough genuinely independent research in the area to warrant another update). Indeed, estimates, however rough, of the costs of climate change are essential to the economic analysis of climate change policy.

⁴ Incidentally, errors of this type do suggest a more scholarly tone might be advisable in places, and reference to the work of the IPCC and the Stern Review as "dodgy" and the claim that countries are attempting to "cook the books rather than do serious analysis" may be unwise. The charge that other academics and policy makers have published results in bad-faith is serious and potentially unhelpful (unless it can be shown to be true) in an area that is already excessively politicised.

Nevertheless, a great deal of caution is warranted in this area, given that a long list of caveats still applies to the “state-of-the-art”. Caveats range widely, from fundamental ethical issues through to specific economic questions and modelling choices. In my assessment, the paper, as currently drafted, does not yet exhibit the requisite degree of cautiousness, and would benefit from revisions accordingly.

7. REFERENCES

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