

## Ward,RE

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**From:** Ward,RE  
**Sent:** 18 March 2014 08:33  
**To:** 'Otrok, Christopher M.'  
**Subject:** RE: Errors in Tol (2013)  
**Attachments:** Tol 2002.pdf; Nordhaus 1994a.pdf; Nordhaus 2006.pdf

Dear Chris,

Many thanks for your message. I am glad that Professor Tol has admitted at least one of the errors in his paper, which I assume is to correct the value attributed to Hope (2006) to -0.9 instead of +0.9 in Table 1. However, you should also note that Figure 1 plots Hope (2006) as +0.9, so it will also need to be amended to make it consistent with Table 1.

This amendment also casts doubt on the commentary in Tol (2013) in section 2.1 on 'Impact of climate change on welfare', which states:

"Second the initial benefits of a modest increase in temperature are probably positive, followed by losses as temperatures increase further. Fig.1 illustrates this pattern. The initial benefits arise partly from CO<sub>2</sub> fertilization, and partly from reduced heating costs and cold-related health problems in temperate zones."

In fact, of the 17 estimates included in Table 1 and plotted in Figure 1 of Tol (2002), only one study (Tol, 2002) finds significant net benefits from warming. That single study by Tol (2002), a copy of which I have attached, notes on pages 63-64 that it omitted a "long list" of impacts, including on amenity, recreation, tourism, extreme weather, fisheries, construction, transport, energy supply and morbidity. Hence the claim that "the initial benefits of a modest increase in temperature are probably positive" is based on just a single study which acknowledges that it omits many impacts of climate change.

On the other errors in Tol (2013), I am disappointed that Professor Tol has sought to convince you that they do not need correcting. However, I think it is relatively straightforward for you to verify that they are indeed errors. I have attached copies of two of the relevant papers which Professor Tol has used.

The Nordhaus (1994a) paper on 'Expert opinion on climate change', published in 'American Scientist', shows on page 48 in Figure 2 that a rise of 3°C in global average temperature by 2090 would result in a loss of between 0 and 21 per cent of gross world product, with a mean value of 1.9 per cent and a mode of 3.6 per cent. However, Table 1 of Tol (2013) indicates that the paper found a loss of between 0 and 30 per cent, with a mean of 4.8 per cent. In fact, these figures correspond exactly to the results in Figure 3 of the Nordhaus (1994a) paper, which provides the estimates of the likelihood of a high-consequence event from global warming.

The Nordhaus (2006) paper on 'Geography and macroeconomics: new data and new findings', published in the 'Proceedings of the National Academy of Sciences', states on page 3516 that the scenarios are drawn from the IPCC TAR and "have been rescaled to correspond to a 3°C global average equilibrium increase". However, Table 1 and Figure 1 of Tol (2013) wrongly represents the Nordhaus (2006) paper as relating to a warming of 2.5°C.

I am unable to attach a copy of Nordhaus (2008), which is a book entitled 'A Question of Balance: Weighing the Options on Global Warming Policies'. However, it states on pages 13-14 that the DICE model was used to estimate that global warming of 3.1°C by 2100 would "increase damages by almost 3 percent of global output in 2100" "increase damages by almost 3 percent of global output in 2100". However, Table 1 of Tol (2013) wrongly indicates that Nordhaus (2008) found that global warming of 3.0°C would have an impact on global GDP of -2.5 per cent.

Given these errors, which you are able to verify for yourself, I believe it is reasonable for the journal to require Professor Tol to make available the calculations he performed to aggregate other authors' work for inclusion in Table 1 and Figure 1, so that I and other readers of the journal can attempt to replicate the results.

I understand that Professor Tol may be reluctant to promptly correct the errors in his paper, so I would be willing, if you feel it is necessary, to submit a short paper to the journal, identifying the errors in the paper and discussing how they affect the discussion and conclusions.

Best wishes,

Bob

Bob Ward

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**From:** Otok, Christopher M. [mailto:otrokc@missouri.edu]  
**Sent:** 17 March 2014 21:13  
**To:** Ward,RE  
**Subject:** RE: Errors in Tol (2013)

Dear Bob

I have now corresponded with Professor Tol on these issues. The 2<sup>nd</sup> part of your email is speculative so I will respond to the first part. Prof Tol has responded that you have had a past correspondence on this where he has explained in detail your errors. From my reading of the results it seems that the only error in the paper is that a minus sign was dropped from Table 1. I will look into having this noted/changed/add an erratum in the online version of the paper to fix this.

Regards

Chris

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**From:** [R.E.Ward@lse.ac.uk](mailto:R.E.Ward@lse.ac.uk) [mailto:R.E.Ward@lse.ac.uk]  
**Sent:** Tuesday, January 28, 2014 9:48 AM

**To:** [etace@wiwi.uni-bielefeld.de](mailto:etace@wiwi.uni-bielefeld.de); [Tony.He-1@uts.edu.au](mailto:Tony.He-1@uts.edu.au); [paul\\_klein\\_2@sfu.ca](mailto:paul_klein_2@sfu.ca); Otrok, Christopher M.  
**Subject:** Errors in Tol (2013)

Dear Professor Dawid, Professor He, Professor Klein, and Professor Otrok

My apologies for writing to you collectively as editors of the 'Journal of Economic Dynamics & Control' - the journal's website sadly lacks any information about how to notify Elsevier staff of errors in one of the journal's papers.

I am writing to draw your attention to a number of small but significant errors in a paper which was published by the 'Journal of Economic Dynamics & Control' in 2013. I believe they require not only prompt correction but also action by the author to make available details of the calculations he carried out so that the rest of his data may be replicated and verified. The paper is now being cited in the media and in policy debates, including as a key reference in the forthcoming 'Contribution of Working Group II of the Intergovernmental Panel on Climate Change to the Fifth Assessment Report', so the errors could be causing quite widespread damage.

The paper is 'Targets for global climate policy: An overview', by Richard S. J. Tol, which was published in volume 37, pages 911-928. The errors occur in Table 1 on page 914 and Figure 1 on page 912, as well as in the accompanying commentary in the text of the paper.

Specifically, Table 1 purports to compile the results published by other authors, but contains three clear mistakes in the column labelled 'Impact (% GDP)', which are also wrongly plotted in Figure 1. These are:

1. The Nordhaus (1994a) paper, which is listed in the references as 'Expert opinion on climate change' and published in 'American Scientist', found that a rise of 3°C in global average temperature by 2090 would result in a loss of between 0 and 21 per cent of gross world product, with a mean value of 1.9 per cent and a mode of 3.6 per cent, as shown in Figure 2 in the paper. However, Table 1 of Tol (2013) indicates that the paper found a loss of between 0 and 30 per cent, with a mean of 4.8 per cent. In fact, these figures correspond exactly to the results in Figure 3 of the Nordhaus 1994a paper, which provides the estimates of the likelihood of a high-consequence event from global warming. It seems that Tol (2013) accidentally mixed up the two, and used the wrong numbers.
2. The Nordhaus (2006) paper, which is listed in the references as 'Geography and macroeconomics: new data and new findings' and published in the 'Proceedings of the National Academy of Sciences', presents an estimate of impacts from two scenarios, one which considers warming only and one which includes mid-continental drying as well. On page 3516 of the paper, Nordhaus states that the scenarios are drawn from the IPCC TAR and "have been rescaled to correspond to a 3°C global average equilibrium increase". However, Table 1 of Tol (2013) wrongly lists the Nordhaus 2006 paper as relating to a warming of 2.5°C.
3. The Nordhaus (2008) paper, which is listed in the references as 'A Question of Balance: Weighing the Options on Global Warming Policies' and published by Yale University Press, used the DICE model to estimate that global warming of 3.1°C by 2100 would "increase damages by almost 3 percent of global output in 2100" (pages 13-14). However, Table 1 of Tol (2013) wrongly indicates that Nordhaus (2008) found that global warming of 3.0°C would have an impact on global GDP of -2.5 per cent.

In addition, another likely mistake occurs in the column labelled 'Impact (% GDP)'. It is:

1. The Hope (2006) paper, which is listed in the references as 'The marginal impact of CO<sub>2</sub> from PAGE2002: an integrated assessment model incorporating the IPCC's five reasons for concern' and published in 'The Integrated Assessment Journal', estimates the marginal impacts of a 10 per cent reduction in carbon dioxide emissions. These are calculated from the PAGE2002 model which incorporates regional impact factors listed in Table 5 on page 24 as percentage GDP loss due to global warming of "2.5°C above the tolerable level in each impact sector in the EU, with regional multipliers for other regions". Apart from the EU, regional weight factors are provided for seven other regions, with mean values ranging from -0.35 for Eastern Europe and the Former Soviet Union (the only regional impact factor implying a positive change in GDP) to 2.5 for India. It is important to note that nowhere in the paper does Hope (2006) provide an estimate of the global impact of global warming relative to present day or pre-industrial levels. However, Table 1 of Tol (2013) indicates that Hope (2006) found that the range of global impact on GDP of global warming of 2.5°C was 0.9 per cent, with an "uncertainty" of -0.2 to 2.7. This result obtained from the calculations of Tol (2013) is unlikely to be accurate, given the information provided in the Hope (2006) paper.

I note that most of these mistakes also appeared in earlier papers by the same author which were published in the 'Journal of Economic Perspectives' in 2009 and 'Environmental and Resource Economics' in 2012.

I have been able to verify that six other values (for Nordhaus (1994b), Fankhauser (1995), Tol (1995), Nordhaus and Boyer (2000), Tol (2002a), and Bosello et al. (2012)) listed in Table 1 and plotted in Figure 1 of Tol (2013) are correct. However, the six remaining data points (for Nordhaus and Yang (1996), Plambeck and Hope (1996), Mendelsohn et al. (2000), Maddison (2003), Rehdanz and Maddison (2005), and Maddison and Rehdanz (2011)) were derived by Tol using his own calculations based on the other authors' work, so I have been unable to verify their accuracy.

I exchanged e-mail messages with Professor Tol in October 2013 about these issues and he eventually confirmed that each represented errors in Table 1 and Figure 1 of Tol (2013). However, he has still not expressed any intention of providing a corrigendum to correct these small errors. Nor has he responded to my request for him to make available the details of his calculations so that I might verify the other data he presented in the paper. Therefore, I have been left with no other choice but to write to you at the 'Journal of Economic Dynamics & Control'.

I suggest not only that Professor Tol correct these small errors without any further delay, but also that he makes available immediately the details of his own calculations used to derive the unverified results for the five studies, so that their accuracy can be checked. The curves fitted to the data in Figure 3 will also need to be re-plotted, and the commentary in the text will need to be amended to reflect the updated analysis. Although these small errors appear to be the result of sloppiness rather than a concerted effort to misrepresent other authors' work, I note that the effect of correcting the data would be that only one data point indicates any significantly positive impact of global warming on global GDP.

Finally, I would point out that Professor Tol's reluctance to correct these basic errors in his work is in stark contrast to the positive attitude adopted by Carmen Reinhart and Kenneth Rogoff when they recently learned of similarly sloppy mistakes in their 2010 paper on 'Growth in a Time of Debt'. I do hope that Professor Tol can be persuaded to adopt a more constructive approach to addressing the mistakes in his paper, which are having an impact not just on his reputation but also that of the 'Journal of Economic Dynamics & Control'.

Yours sincerely,

Bob Ward

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