THE SOCIAL COST OF CARBON: TRENDS, OUTLIERS AND CATASTROPHES

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Abstract

211 estimates of the social cost of carbon are included in a meta-analysis. The results confirm that a lower discount rate implies a higher estimate; and that higher estimates are found in the gray literature. It is also found that there is a downward trend in the economic impact estimates of the climate; that the Stern Review’s estimates of the social cost of carbon is an outlier; and that the right tail of the distribution is fat. There is a fair chance that the annual climate liability exceeds the annual income of many people.

Key words

Climate change, social cost of carbon

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1. Introduction

Estimates of the social cost of carbon (dioxide emissions), or the marginal damage cost of climate change are an essential ingredient to any assessment of climate policy. The social cost of carbon (SCC) is a first estimate of the Pigou tax that should be placed on carbon dioxide emissions. Indeed, if the SCC is computed along a trajectory in which the marginal costs of emission reduction equal the SCC, the SCC is the Pigou tax. Few would argue that climate policy should be set by cost-benefit analysis alone, but most economists would feel queasy if climate policy would drift too far from its optimum. This paper presents a meta-analysis of over 200 estimates of the SCC.

In Tol (2005), I also presented a meta-analysis of the SCC. There are four reasons for the current update. Firstly, the number of estimates has roughly doubled. Tol (2005) was part of a larger study that led to many new estimates, but other studies were published as well – and my attention was drawn to a handful of estimates I had previously overlooked. See Table A1. Secondly, the Stern Review (Stern *et al.*, 2006) was published, provoking renewed interest in cost-benefit analyses of climate policy (Anderson, 2007; Byatt *et al.*, 2006; Carter *et al.*, 2006; Dasgupta, 2007; Dietz *et al.*, 2007a,b; Hamid *et al.*, 2007; Mendelsohn, 2006; Nordhaus, 2007; Spash, 2007; Stern and Taylor, 2007; Tol, 2006; Tol and Yohe, 2006, 2007a; Yohe, 2006; Yohe and Tol, 2006; Yohe *et al.*, 2007; note that these are the published papers only – various journals are preparing special issues). The Stern Review also published an estimate of the SCC. Although many newspapers publicised the Stern Review as entirely novel, its estimate is in fact number 211 in chronological order. A number of people argued that the Stern Review is an outlier. This paper formally tests this assertion. Thirdly, the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) was published (Schneider *et al.*, 2007). It argues that economic estimates of the impact of climate change have become more pessimistic since the previous report of 2001. This paper formally tests this assertion as well. Fourthly, Weitzman (2007) argues that climate economics has unduly focussed on the middle of the probability distribution, and should have focussed on the tails. This paper supports that argument. Fourthly, I estimate the risk premium and the fraction of people that would be able to afford the estimated carbon tax.

Although there are now over 200 estimates of the SCC, research in this area is still less developed than one would wish. The 200 estimates of the *marginal* costs of climate change are based on a dozen of estimates of the *total* costs of climate change (Cline, 1992; Fankhauser, 1995; Maddison, 2003; Mendelsohn *et al.*, 2000; Nordhaus, 1991, 1994, 2006; Nordhaus and Boyer, 2000; Nordhaus and Yang, 1996; Rehdanz and Maddison, 2005; Tol, 1995, 2002).[1] The total cost estimates omit some impacts of climate change; they tend to ignore interactions between different impacts, and neglect higher order effects on the economy and population; they rely on extrapolation from a few detailed case studies; they often impose a changing climate on a static society; they use simplistic models of adaptation to climate change; they often ignore uncertainties; and they use controversial valuation methods and benefit transfers.

Unfortunately, this list of caveats has not changed much since Fankhauser and Tol (1996). The proximate reason is that few people work in this area, and none full time, as funding is difficult to get. The ultimate reasons are, firstly, that the issues are complex and uncertain, and require broad multidisciplinary knowledge and, secondly, that the results are unpopular with climate policy makers.

However, climate change is climbing the international policy agenda again – and certain countries do require a cost-benefit analysis on any major policy decision. Some countries prefer to cook the books rather than do serious analysis (e.g., Clarkson and Deyes, 2002; Pearce, 2003; CEC, 2005a,b; Tol, 2007), but other countries try to use the best available

[1] Note that Nordhaus and Mendelsohn are colleagues; that Fankhauser, Maddison and Tol worked with David Pearce and each other in the formative stages of their careers; and that Rehdanz used to be a PhD student of Maddison and Tol.

knowledge. In this paper, I present that – but the reader should be aware that “best available” does not mean “good” in this case.

In Section 2, I present the data and methods. Section 3 shows the results for the monetary estimates, while Section 4 estimates the risk premium and distributional implications. Section 5 concludes.

2. Data and Methods

211 estimates of the SCC were gathered from 47 studies. See Table A1. The studies were grouped in those that were peer-reviewed and those that were not. Note that some of the more recent studies are currently under peer-review, but they are counted as gray literature until published. Some studies are based on original estimates of the total costs of climate change, while other studies borrow total costs estimates from other studies. Most studies use incremental or marginal calculus to estimate the SCC, as they should, while a few others use average impacts or an unspecified method. Some studies assume that climate changes but society does not, while other studies include a dynamic model of vulnerability. A few studies use entirely arbitrary assumptions about future climate change, while most studies are based on internally consistent scenarios. These classifications are used as quality indicators. Specifically, the sum of the values in Table A1 is the “quality” of the study. More recent studies receive a higher weight – publication year minus 1980 over 10 – so that age contributes up to one-third of the total quality weight. Many of the studies report multiple estimates. Most of the estimates are sensitivity analyses around a central estimate, and some estimates are only included to (approximately) reproduce an earlier study. The quality weight of a study is distributed over the alternative estimates in that study on the basis of my assessment of what the author thinks are more and less credible assumptions. Tol (2005) reports a sensitivity analysis, and finds that the results are robust.

The 211 estimates are classified as follows. Most estimates use the Ramsey discount rule – $\delta = \rho + \eta g$ – but some estimates use a constant consumption discount rate rather than a constant utility discount rate. A few recent studies use a *declining* discount rate (inspired by Gollier, 2002, and Weitzman, 2001), a few studies fail to report what discount rate was used, and a few studies include the discount rate in the uncertainty analysis. Some studies use equity weighting (Fankhauser *et al.*, 1997), but most studies simply add the regional dollar values. The discount rate and the age of the study are used to split the sample.

I adjust three alternative kernel density estimators to these data points. Essentially, a kernel density estimator assigns a probability density function to each data point, and the kernel estimator is the weighted sum of these PDFs. As always, the standard choice is the Gaussian distribution. The 211 estimates provide the modes. Only a few of the studies provide an estimate of the uncertainty. Therefore, either the standard deviation or the coefficient of variation is set equal to the sample standard deviation or the sample coefficient of variation. However, the uncertainty in the sample is right-skewed and fat-tailed. Therefore, the Fisher-Tippett distribution is also used, with the modes equal to the best guesses and the standard deviations equal to the sample standard deviation. The coefficient of variation of the Fisher-Tippett distributed is bounded from above at about

1.7, which is smaller than the sample coefficient variation. However, the Fisher-Tippett distribution is the only distribution that is right-skewed, fat-tailed, and defined on the entire real line.

3. Results

Table 1 shows selected characteristics of the kernel distributions for the whole sample and selected sub-samples. Figure 1 shows the probability density functions.

Unsurprisingly, the Fisher-Tippett kernel has fatter tails and therefore higher means and medians than the Gauss kernel. The modes are about the same. Using the Gauss kernel with the sample coefficient of variation rather than the sample standard deviation has mixed effects. The estimates near zero get higher weight, and this pulls the mode and median down. However, the high estimates are spread thinly over a wide range, and this implies fatter tails and a higher mean.

Splitting the sample by discount rate used has the expected effect: A higher discount rate implies a lower estimate of the SCC and a thinner tail. Table 1 also shows that estimates in the peer reviewed literature are lower and less uncertain than estimates in the gray literature. This confirms the findings of Tol (2005).

Splitting the sample by publication date, shows that the estimates of the SCC published before AR2 (Pearce *et al.*, 1995) were larger than the estimates published between AR2 and AR3 (Smith *et al.*, 2001), which in turn were larger that the estimates published since. Note that these differences are not statistically significant if one considers the means and standard deviation. However, the kernel distribution clearly shifts to the left. Therefore, AR4 (Schneider *et al.*, 2007) were incorrect to conclude that the economic estimates of the impact of climate change have *increased* since 2001. In their words (p. 781): “There is some evidence that initial new market benefits from climate change will peak at a lower magnitude and sooner than was assumed for the TAR, and it is likely that there will be higher damages for larger magnitudes of global mean temperature increases than was estimated in the TAR.” It is unclear how Schneider *et al*. (2007) reached this conclusion, but it is not supported by the data presented here.

The SCC estimate by Stern *et al*. (2006) is almost an outlier in the entire sample (excluding, of course, the Stern estimate itself). Depending on the kernel density, the Stern estimate lies between the 90th and the 94th percentile. It fits in better with estimates that use a low discount rate and were not peer-reviewed – characteristics of the Stern Review – but even in comparison to those studies, Stern *et al*. (2006) are on the high side. The Stern estimate also fits in better with the older studies. This is no surprise, as the PAGE model (e.g., Hope, 2006) is updated only with great delay – that is, after the literature reviews by the IPCC (Pearce *et al.*, 2005; Smith *et al.*, 2001). It does fly in the face, though, of the assertion by Stern *et al*. (2006) to have used the latest research.

4. Catastrophic liability

Weitzman (2007) argues that the uncertainty about climate change may be so profound that the expected welfare loss is unbounded. See also Tol (2003) and Tol and Yohe (2007b).

Figure 2 has a different take on this. It plots the cumulative kernel density estimate (Fisher-Tippett), and the fraction of the world population for whom the “liability of climate change” (i.e., the SCC times their emissions) exceeds their per capita income. See Tol and Verheyen (2004) for a discussion on liability and impacts of climate change.

For a rising SCC, first the countries with high emission intensity (CO_2 emissions per gross domestic product) would be “bankrupted” – that is, the annual carbon tax (if paid without reducing emissions) would exceed the annual income for the average person. Using 2002 data, the Ukraine would be the first country to which this would happen. A carbon tax of $418/tC would be too much. The probability that the SCC exceeds $418/tC varies between 5% and 7%. See Table 2. This is a high probability for an “infinite” loss – but such a high tax would trigger emission reduction, other countries may come to the assistance of the Ukraine, and it is unlikely to impose such a high tax in the first place.

Table 2 also shows the SCCs that would “bankrupt” 1%, 5%, and 10% of the world population, and the associated probabilities. Obviously, the SCCs are higher, and the probabilities smaller – but there is still a probability of 1-2% that the SCC is larger than $1385/tC, which would “bankrupt” more than 10% of the world population. For all three kernel distributions, there is a positive probability that more than 60% of the world population is “bankrupted”. The expected fraction of the world population that goes “bankrupt” lies between 0.6% and 1.1%.

Finally, Table 2 shows the risk premium of the SCC for the average person on Earth. The risk premia vary between 15% and 27% -- for the average. For over 60% of the world population, the risk premium is infinite.

This confirms Weitzman’s (2007) claim that climate policy analysis is dominated by the tails of the distribution – and it highlights that climate is an equity problem.

5. Discussion and conclusion

This paper presents an update of an earlier meta-analysis (Tol, 2005) of the social cost of carbon. Besides more data and more advanced statistical analysis, this paper offers four results. Firstly, there is a downward trend in the estimates of the social cost of carbon – even if the IPCC (Schneider *et al.*, 2007) would like to believe the opposite. Secondly, the Stern Review (Stern *et al.*, 2006) is an outlier – and its impact estimates are pessimistic even when compared to other studies in the gray literature and other estimates that use low discount rates. Thirdly, the uncertainty about the social cost of carbon is so large that the tails of the distribution may dominate the conclusions (Weitzman, 2007) – even though many of the high estimates have not been peer-reviewed and use unacceptably low discount rates. Fourthly, if everyone were to pay a carbon tax equal to the social cost of carbon (but not reduce emissions), there is a fair chance that annual taxes would exceed annual income for many people.

There are three implications. Firstly, greenhouse gas emission reduction today is justified. The median of the Fisher-Tippett kernel density for peer-reviewed estimates with a 3%

pure rate of time preference and without equity weights, is $20/tC. This compares to a future price of carbon permits of $8/tC in the European Union (and a spot price of ¢3/tC). The case for intensification of climate policy can be made with conservative assumptions. One does not have to rely on dodgy analysis as in Schneider *et al*. (2007) and Stern *et al*. (2006). Secondly, the uncertainty is so large that a considerable risk premium is warranted. With the conservative assumptions above, the mean equals $23/tC and the certainty-equivalent $25/tC. More importantly, there is a 1% probability that the social cost of carbon is greater than $78/tC. This number rapidly increases if we use a lower discount rate – as may well be appropriate for a problem with such a long time horizon – and if we allow for the possibility that there is some truth in the scare-mongering of the gray literature. Thirdly, more research is needed into the economic impacts of climate change – to eliminate that part of the uncertainty that is due to lack of study, and to separate the truly scary impacts from the scare-mongering. Papers often conclude with a call for more research, and often this is a call for funding for the authors or a justification for further papers by the authors. In this case, however, quality research by newcomers in the field would be particularly welcome.

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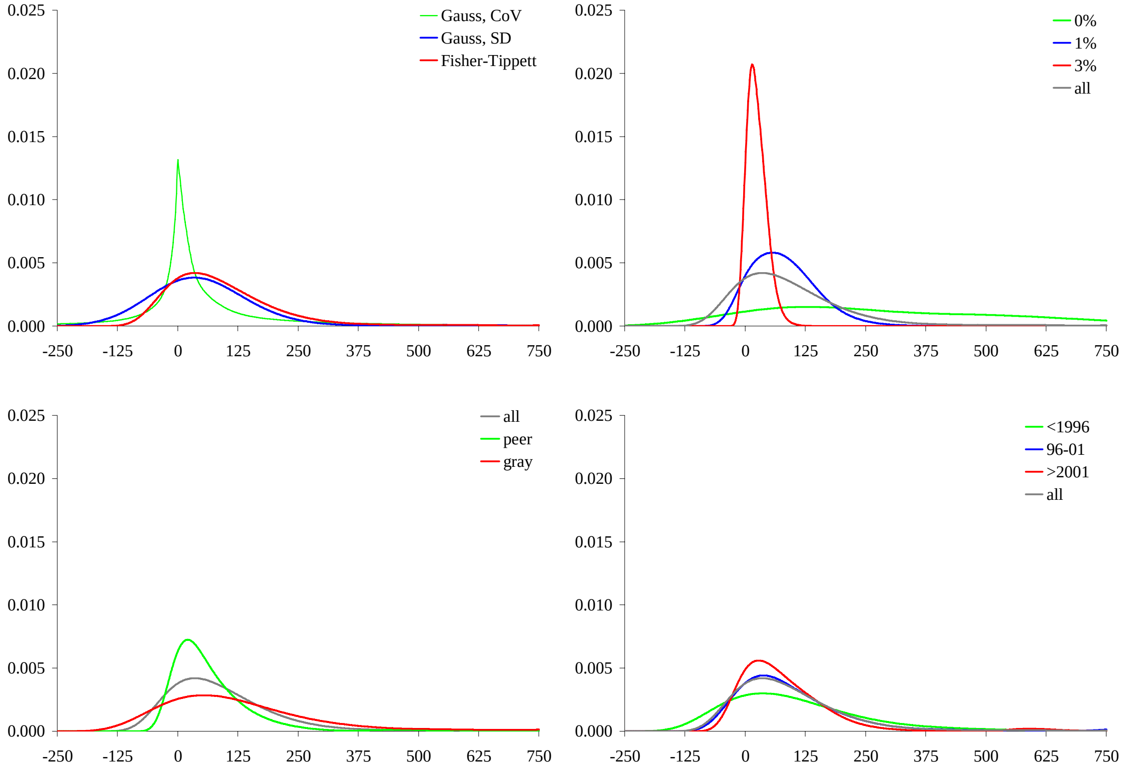

Figure 1. The kernel estimate of the probability density function of the social cost of carbon; top left: alternative distributional assumptions; top right: sample split according to pure rate of time preference; bottom left: sample split according to review; bottom right: sample split according to age of study. The Fisher-Tippett distribution is used throughout (except top left).

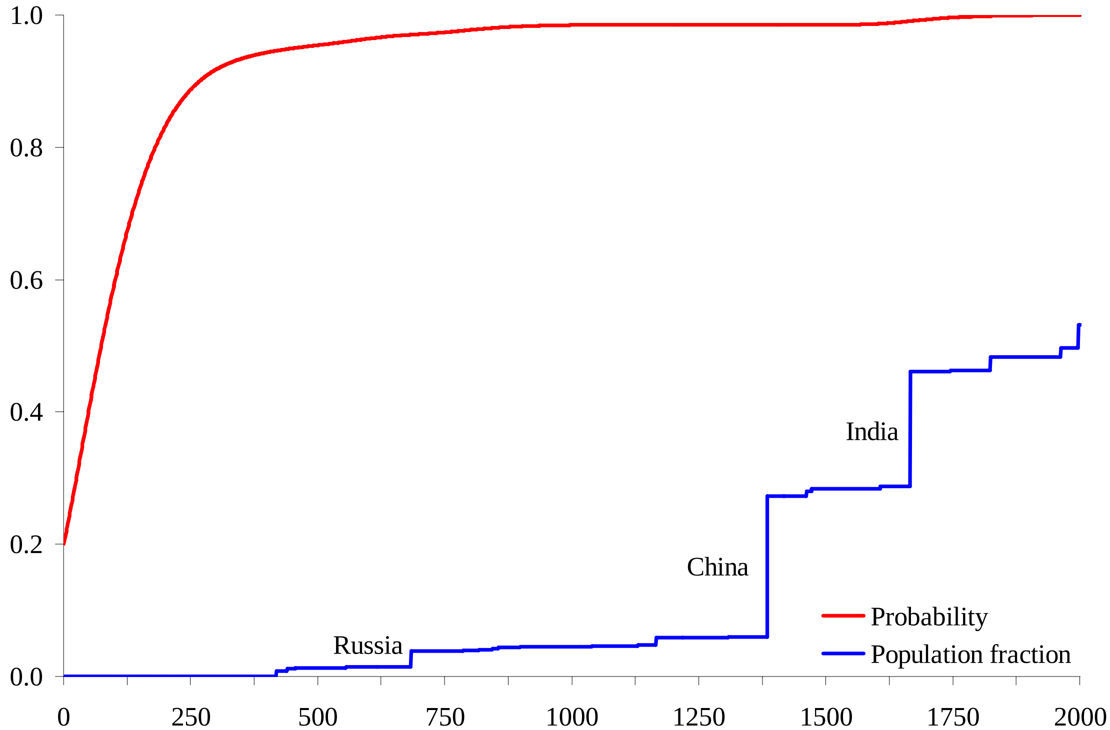

Figure 2. The cumulative kernel density function of the social cost of carbon (in \$/tC) and the fraction of the world population for whom the total "carbon tax" exceeds income. Population, per capita income, and per capita CO_2 emissions are for year 2002 from http://earthtrends.wri.org.

Table 1. Selected characteristics (mode, mean, standard deviation, median, 90-percentile, 95-percentile, 99-percentile, percentile of the Stern estimate) of the joint probability density of the social cost of carbon for the whole sample (all) and selected subsamples (pure rate of time preference, review process, and publication date).

	All	PRTP			Review		Publication date		
		0%	1%	3%	peer	gray	<1996	96-01	>2001
Fisher-Tippett, sample standard deviation									
Mode	35	129	56	14	20	53	36	37	27
Mean	127	317	80	24	71	196	190	120	88
St.Dev.	243	301	70	21	98	345	392	179	121
Median	74	265	72	21	48	106	88	75	62
90%	267	722	171	51	170	470	397	274	196
95%	453	856	204	61	231	820	1555	482	263
99%	1655	1152	276	82	524	1771	1826	867	627
Stern	0.92	0.56	1.00	1.00	0.97	0.84	0.86	0.92	0.96
Gauss, sample standard deviation									
Mode	33	136	46	14	21	46	32	35	29
Mean	88	220	55	16	49	135	131	83	61
St.Dev.	243	298	70	21	98	345	392	178	121
Median	47	194	53	16	33	65	49	50	42
90%	213	626	146	44	142	350	298	221	164
95%	371	747	172	52	201	766	1453	428	219
99%	1623	953	221	67	503	1734	1782	843	610
Stern	0.94	0.65	1.00	1.00	0.97	0.89	0.91	0.94	0.97
Gauss, sample coefficient of variation									
Mode	0	19	5	2	3	0	4	5	0
Mean	102	225	55	16	55	144	125	100	68
St.Dev.	351	342	69	20	186	437	424	323	223
Median	15	107	34	10	14	18	14	16	17
90%	304	676	151	43	159	407	360	264	210
95%	596	989	195	58	310	891	808	537	361
99%	2025	1502	285	89	885	2420	2411	1841	1127
Stern	0.90	0.76	0.99	1.00	0.95	0.87	0.89	0.92	0.94

Table 2. The social cost of carbon for which 1% / 5% / 10% of the world population would be "bankrupted by a carbon tax", and their exceedance probability according to three alternative kernel densities (Fisher-Tippett with sample standard deviation; Gauss with sample standard deviation; Gauss with sample coefficient of variation). Also shown are the SCC that triggers the first bankruptcy and its exceedance probabilities; the expected fraction of the population that faces "bankruptcy" (exp); and the risk premium (RP).

	SCC	Probability		
	$/tC	FT	G (SD)	G (Cov)
1st	418	5.4%	4.7%	7.3%
1%	440	5.1%	4.5%	6.9%
5%	1166	1.5%	1.4%	2.4%
10%	1385	1.4%	1.4%	2.0%
Exp.		0.7%	0.6%	1.1%
RP		15%	18%	27%

Table A1. Estimates of the social cost of carbon (SCC), and characteristics of the study (PR: peer-reviewed; IE: independent estimate; ME: correct estimation method; DM: dynamic model of vulnerability; SC: realistic scenario; CDR: consumption discount rate; PRTP: pure rate of time preference; EW: equity-weighted).

Author	year	weight	SCC	PR	IE	ME	DM	SC	CDR	PRTP	EW
Nordhaus	1982	1.000	146.7	1	1	0	0	0	NA	1.0	0
Ayres & Walter	1991	1.000	119.0	1	1	0	0	0	3.0	1.0	0
Nordhaus	1991	1.000	26.8	1	1	0	0	0	3.0	1.0	0
Haradan	1992	1.000	7.3	1	1	0	0	0	4.0	2.0	0
Cline	1992	1.000	64.9	0	1	1	0	1	NA	NA	0
Hoymeyer & Gaertner	1992	1.000	1666.7	0	1	0	0	1	0.0	-2.0	0
Haradan	1993	0.250	1.9	1	0	0	0	0	4.0	2.0	0
	1993	0.500	3.0	1	0	0	0	0	4.0	2.0	0
	1993	0.250	8.8	1	0	0	0	0	4.0	2.0	0
Nordhaus	1993	1.000	5.0	1	0	1	0	1	5.0	3.0	0
Peck & Teisberg	1993	1.000	10.0	1	0	1	0	1	5.0	3.0	0
Reilly & Richards	1993	0.500	14.3	1	0	1	0	0	5.0	3.0	0
	1993	0.500	21.2	1	0	1	0	0	5.0	3.0	0
Fankhauser	1994	1.000	20.3	1	1	1	0	1	NA	NA	0
Nordhaus	1994	1.000	5.3	0	1	1	0	1	5.0	3.0	0
Azar	1994	0.250	50.0	1	0	0	0	0	NA	0.0	0
	1994	0.500	200.0	1	0	0	0	0	NA	0.0	0
	1994	0.250	500.0	1	0	0	0	0	NA	0.0	0
Maddison	1995	1.000	16.5	1	0	1	0	1	5.0	3.0	0
Schauer	1995	0.500	8.3	1	1	1	0	1	4.9	2.3	0
	1995	0.500	112.5	1	1	1	0	1	4.9	2.3	0
Plambeck & Hope	1996	0.300	3.0	1	1	1	0	1	5.0	3.0	0
	1996	0.100	8.0	1	1	1	0	1	5.0	3.0	0
	1996	0.100	8.0	1	1	1	0	1	5.0	3.0	0
	1996	0.300	21.0	1	1	1	0	1	5.0	3.0	0
	1996	0.100	46.0	1	1	1	0	1	4.0	2.0	0
	1996	0.100	440.0	1	1	1	0	1	2.0	0.0	0
Azar & Sterner	1996	0.044	85.0	1	0	1	0	1	2.0	0.0	0
	1996	0.089	200.0	1	0	1	0	1	2.0	0.0	0
	1996	0.033	75.0	1	0	1	0	1	2.1	0.1	0
	1996	0.067	140.0	1	0	1	0	1	2.1	0.1	0
	1996	0.022	32.0	1	0	1	0	1	3.0	1.0	0
	1996	0.044	33.0	1	0	1	0	1	3.0	1.0	0
	1996	0.011	13.0	1	0	1	0	1	5.0	3.0	0
	1996	0.022	13.0	1	0	1	0	1	5.0	3.0	0
	1996	0.089	260.0	1	0	1	0	1	2.0	0.0	1

	1996	0.178	590.0	1	0	1	0	1	2.0	0.0	1
	1996	0.067	230.0	1	0	1	0	1	2.1	0.1	1
	1996	0.133	410.0	1	0	1	0	1	2.1	0.1	1
	1996	0.044	95.0	1	0	1	0	1	3.0	1.0	1
	1996	0.089	98.0	1	0	1	0	1	3.0	1.0	1
	1996	0.022	39.0	1	0	1	0	1	5.0	3.0	1
	1996	0.044	39.0	1	0	1	0	1	5.0	3.0	1
Downing et al.	1996	0.500	53.5	0	1	0	1	1	0.0	-2.0	0
	1996	0.500	18.3	0	1	0	1	1	0.0	-2.0	0
Hohmeyer	1996	1.000	800.0	0	0	0	0	1	0.0	-2.0	0
Hope & Maul	1996	0.100	7.0	1	1	1	0	0	4.0	2.0	0
	1996	1.000	24.0	1	1	1	0	0	4.0	2.0	0
	1996	0.800	5.0	1	1	1	0	1	4.0	2.0	0
	1996	0.100	29.0	1	1	1	0	0	4.0	2.0	0
Nordhaus & Yang	1996	1.000	6.2	1	1	1	0	1	5.0	3.0	0
Nordhaus & Popp	1997	0.900	11.6	1	0	1	0	1	5.0	3.0	0
	1997	0.100	6.3	1	0	1	0	1	5.0	3.0	0
Cline	1997	1.000	88.0	0	1	1	0	1	NA	NA	0
Eyre et al.	1999	0.500	170.0	0	0	1	1	1	1.0	-1.0	1
	1999	0.500	70.0	0	0	1	1	1	3.0	1.0	1
	1999	0.500	160.0	0	0	1	1	1	1.0	-1.0	1
	1999	0.500	74.0	0	0	1	1	1	3.0	1.0	1
Tol	1999	0.250	60.0	1	1	1	1	1	3.0	1.0	1
	1999	0.050	62.0	1	1	1	1	1	3.0	1.0	1
	1999	0.050	23.0	1	1	1	1	1	3.0	1.0	0
	1999	0.050	66.0	1	1	1	1	1	3.0	1.0	1
	1999	0.050	65.0	1	1	1	1	1	3.0	1.0	1
	1999	0.050	56.0	1	1	1	1	1	3.0	1.0	1
	1999	0.050	317.0	1	1	1	1	1	0.0	-2.0	1
	1999	0.010	243.0	1	1	1	1	1	0.0	-2.0	1
	1999	0.010	142.0	1	1	1	1	1	0.0	-2.0	0
	1999	0.010	360.0	1	1	1	1	1	0.0	-2.0	1
	1999	0.010	348.0	1	1	1	1	1	0.0	-2.0	1
	1999	0.010	288.0	1	1	1	1	1	0.0	-2.0	1
	1999	0.050	171.0	1	1	1	1	1	1.0	-1.0	1
	1999	0.010	172.0	1	1	1	1	1	1.0	-1.0	1
	1999	0.010	73.0	1	1	1	1	1	1.0	-1.0	0
	1999	0.010	192.0	1	1	1	1	1	1.0	-1.0	1
	1999	0.010	187.0	1	1	1	1	1	1.0	-1.0	1
	1999	0.010	156.0	1	1	1	1	1	1.0	-1.0	1
	1999	0.100	26.0	1	1	1	1	1	5.0	3.0	1

	1999	0.020	26.0	1	1	1	1	1	5.0	3.0	1
	1999	0.020	9.0	1	1	1	1	1	5.0	3.0	0
	1999	0.020	28.0	1	1	1	1	1	5.0	3.0	1
	1999	0.020	28.0	1	1	1	1	1	5.0	3.0	1
	1999	0.020	25.0	1	1	1	1	1	5.0	3.0	1
	1999	0.050	6.0	1	1	1	1	1	10.0	8.0	1
	1999	0.010	6.0	1	1	1	1	1	10.0	8.0	1
	1999	0.010	2.0	1	1	1	1	1	10.0	8.0	0
	1999	0.010	6.0	1	1	1	1	1	10.0	8.0	1
	1999	0.010	6.0	1	1	1	1	1	10.0	8.0	1
	1999	0.010	6.0	1	1	1	1	1	10.0	8.0	1
Roughgarden & Schneider	1999	1.000	40.4	1	1	1	0	1	5.0	3.0	0
Nordhaus & Boyer	2000	1.000	5.9	0	1	1	0	1	NA	NA	0
Tol & Downing	2000	0.100	26.1	0	0	1	1	1	3.0	1.0	1
	2000	0.100	3.5	0	0	1	1	1	3.0	1.0	0
	2000	1.000	45.8	0	0	1	1	1	3.0	1.0	1
	2000	0.800	5.1	0	0	1	1	1	3.0	1.0	0
Clarkson & Deyes	2002	1.000	101.5	0	0	1	0	1	3.0	1.0	1
Tol	2002	0.083	19.9	0	1	1	1	1	2.0	0.0	0
	2002	0.167	16.1	0	1	1	1	1	2.0	0.0	1
	2002	0.167	3.8	0	1	1	1	1	3.0	1.0	0
	2002	0.333	6.6	0	1	1	1	1	3.0	1.0	1
	2002	0.083	-6.6	0	1	1	1	1	5.0	3.0	0
	2002	0.167	-0.5	0	1	1	1	1	5.0	3.0	1
Newell & Pizer	2003	0.100	5.7	1	0	1	0	1	4.0	2.0	0
	2003	0.200	10.4	1	0	1	0	1	NA	2.0	0
	2003	0.200	6.5	1	0	1	0	1	NA	2.0	0
	2003	0.050	21.7	1	0	1	0	1	2.0	0.0	0
	2003	0.100	33.8	1	0	1	0	1	NA	0.0	0
	2003	0.100	23.3	1	0	1	0	1	NA	0.0	0
	2003	0.050	1.5	1	0	1	0	1	7.0	5.0	0
	2003	0.100	2.9	1	0	1	0	1	NA	5.0	0
	2003	0.100	1.8	1	0	1	0	1	NA	5.0	0
Pearce	2003	1.000	23.5	1	0	1	0	1	3.0	1.0	1
Uzawa	2003	1.000	160.7	0	1	0	0	0	NA	NA	NA
Mendelsohn	2003	1.000	1.5	0	1	0	0	0	5.0	3.0	0
Hope	2003	1.000	19.0	0	0	1	0	1	NA	3.0	0
Link & Tol	2004	0.165	79.0	1	1	1	1	1	NA	0.0	0
	2004	0.165	170.0	1	1	1	1	1	NA	0.0	1
	2004	0.165	25.2	1	1	1	1	1	NA	1.0	0
	2004	0.165	94.1	1	1	1	1	1	NA	1.0	1

	2004	0.165	5.1	1	1	1	1	1	NA	3.0	0
	2004	0.165	45.1	1	1	1	1	1	NA	3.0	1
	2004	0.002	75.6	1	1	1	1	1	NA	0.0	0
	2004	0.002	167.8	1	1	1	1	1	NA	0.0	1
	2004	0.002	24.4	1	1	1	1	1	NA	1.0	0
	2004	0.002	93.6	1	1	1	1	1	NA	1.0	1
	2004	0.002	5.0	1	1	1	1	1	NA	3.0	0
	2004	0.002	45.0	1	1	1	1	1	NA	3.0	1
Hohmeyer	2004	0.500	32.0	0	0	1	0	1	NA	1.0	0
	2004	0.500	590.0	0	0	1	0	1	NA	0.0	1
Cline	2004	0.900	128.0	0	0	1	0	1	NA	NA	0
	2004	0.050	450.0	0	0	1	0	1	NA	NA	0
	2004	0.050	10.0	0	0	1	0	1	NA	NA	0
Manne	2004	0.050	300.0	0	0	1	0	1	NA	NA	0
	2004	0.950	12.0	0	0	1	0	1	NA	NA	0
Hope	2005	1.000	21.0	0	1	1	0	1	NA	3.0	0
Ceronsky et al.	2005	0.238	58.0	0	0	1	1	1	NA	0.0	0
	2005	0.238	11.0	0	0	1	1	1	NA	1.0	0
	2005	0.238	-2.3	0	0	1	1	1	NA	3.0	0
	2005	0.238	18.0	0	0	1	1	1	NA	NA	0
	2005	0.001	54.0	0	0	1	1	1	NA	0.0	0
	2005	0.001	11.0	0	0	1	1	1	NA	1.0	0
	2005	0.001	-2.5	0	0	1	1	1	NA	3.0	0
	2005	0.001	17.0	0	0	1	1	1	NA	NA	0
	2005	0.001	54.0	0	0	1	1	1	NA	0.0	0
	2005	0.001	13.0	0	0	1	1	1	NA	1.0	0
	2005	0.001	-0.1	0	0	1	1	1	NA	3.0	0
	2005	0.001	20.0	0	0	1	1	1	NA	NA	0
	2005	0.001	54.0	0	0	1	1	1	NA	0.0	0
	2005	0.001	10.0	0	0	1	1	1	NA	1.0	0
	2005	0.001	-2.5	0	0	1	1	1	NA	3.0	0
	2005	0.001	17.0	0	0	1	1	1	NA	NA	0
	2005	0.001	55.0	0	0	1	1	1	NA	0.0	0
	2005	0.001	11.0	0	0	1	1	1	NA	1.0	0
	2005	0.001	-2.5	0	0	1	1	1	NA	3.0	0
	2005	0.001	18.0	0	0	1	1	1	NA	NA	0
	2005	0.001	58.0	0	0	1	1	1	NA	0.0	0
	2005	0.001	12.0	0	0	1	1	1	NA	1.0	0
	2005	0.001	-2.3	0	0	1	1	1	NA	3.0	0
	2005	0.001	18.0	0	0	1	1	1	NA	NA	0
	2005	0.001	73.0	0	0	1	1	1	NA	0.0	0

	2005	0.001	16.0	0	0	1	1	1	NA	1.0	0
	2005	0.001	-1.6	0	0	1	1	1	NA	3.0	0
	2005	0.001	24.0	0	0	1	1	1	NA	NA	0
	2005	0.001	94.0	0	0	1	1	1	NA	0.0	0
	2005	0.001	21.0	0	0	1	1	1	NA	1.0	0
	2005	0.001	-0.7	0	0	1	1	1	NA	3.0	0
	2005	0.001	30.0	0	0	1	1	1	NA	NA	0
	2005	0.001	330.0	0	0	1	1	1	NA	0.0	0
	2005	0.001	89.0	0	0	1	1	1	NA	1.0	0
	2005	0.001	17.0	0	0	1	1	1	NA	3.0	0
	2005	0.001	100.0	0	0	1	1	1	NA	NA	0
	2005	0.001	1500.0	0	0	1	1	1	NA	0.0	0
	2005	0.001	360.0	0	0	1	1	1	NA	1.0	0
	2005	0.001	75.0	0	0	1	1	1	NA	3.0	0
	2005	0.001	270.0	0	0	1	1	1	NA	NA	0
	2005	0.001	2400.0	0	0	1	1	1	NA	0.0	0
	2005	0.001	580.0	0	0	1	1	1	NA	1.0	0
	2005	0.001	120.0	0	0	1	1	1	NA	3.0	0
	2005	0.001	360.0	0	0	1	1	1	NA	NA	0
Hope	2005	0.167	43.0	0	0	1	0	1	NA	3.0	1
	2005	0.167	35.0	0	0	1	0	1	NA	3.0	1
	2005	0.167	31.0	0	0	1	0	1	NA	3.0	0
	2005	0.167	46.0	0	0	1	0	1	NA	3.0	1
	2005	0.167	37.0	0	0	1	0	1	NA	3.0	1
	2005	0.167	32.0	0	0	1	0	1	NA	3.0	0
Downing et al.	2005	1.000	50.8	0	0	0	0	0	NA	NA	1
Guo et al.	2006	0.016	58.0	1	0	1	1	1	NA	0.0	0
	2006	0.016	11.0	1	0	1	1	1	NA	1.0	0
	2006	0.016	-2.3	1	0	1	1	1	NA	3.0	0
	2006	0.143	18.0	1	0	1	1	1	NA	NA	0
	2006	0.008	6.6	1	0	1	1	1	3.5		0
	2006	0.143	88.0	1	0	1	1	1	NA	NA	0
	2006	0.008	2.1	1	0	1	1	1	4.0		0
	2006	0.214	88.0	1	0	1	1	1	NA	NA	0
	2006	0.008	2.1	1	0	1	1	1	4.0		0
	2006	0.036	185.0	1	0	1	1	1	NA	0.0	0
	2006	0.036	29.0	1	0	1	1	1	NA	1.0	0
	2006	0.036	-1.3	1	0	1	1	1	NA	3.0	0
	2006	0.036	85.0	1	0	1	1	1	NA	0.0	0
	2006	0.036	15.0	1	0	1	1	1	NA	1.0	0
	2006	0.036	-2.1	1	0	1	1	1	NA	3.0	0

	2006	0.214	35.0	1	0	1	1	1	NA	NA	0
Wahba & Hope	2006	0.200	19.0	1	0	1	0	1	NA	3.0	0
	2006	0.200	14.0	1	0	1	0	1	NA	3.0	0
	2006	0.100	47.0	1	0	1	0	1	NA	2.0	0
	2006	0.100	145.0	1	0	1	0	1	NA	1.0	0
	2006	0.100	30.0	1	0	1	0	1	NA	2.0	0
	2006	0.100	91.0	1	0	1	0	1	NA	1.0	0
	2006	0.100	29.0	1	0	1	0	1	NA	3.0	0
	2006	0.100	21.0	1	0	1	0	1	NA	3.0	0
Hope	2006	1.000	19.0	1	0	1	0	1	NA	3.0	0
Stern et al.	2006	1.000	314.0	0	0	1	0	1	NA	0.0	1

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