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MEMORANDUM **DRAFT**

TO: Distribution

SUBJECT: Nordhaus's arguments against strict action.

Executive Summary and Key Findings

- Nordhaus finds that the optimal policy, given the current state of knowledge and ignoring uncertainty, is to do very little in the short term (a $6/ton tax in 2005) and only marginally more in the long term. While his mild long-term policy suggestion helps to inform the basis of his short term recommendations, Nordhaus only intends to propose a short-term strategy and emphasizes that policies should change as we learn more.
- Recognizing wide-ranging uncertainties and the possibility of calamity, Nordhaus investigates optimal policy choices over a reasonable distribution of possible states of the world. He shows that while the median optimal carbon tax is on the order of $6/ton in 2005, the mean optimal carbon tax is somewhat larger, at $18/ton in 2005.
- His conclusions are viewed with skepticism by some critics, who believe some or all of the following: he overstates control costs, he understates control benefits, and his choice of a positive pure rate of time preference is indefensible. Others find his results and methodology more robust.

Introduction

In a 1994 book1, Nordhaus calculates an optimal policy response to the problem of climate change. A distinguishing feature of this work is that it aims to uncover a truly optimal policy — that is, one that maximizes *net* benefit as opposed to one that merely minimizes the cost of achieving an *ad hoc* CO_2 concentration target.

Basic Results

Ignoring uncertainty and with a best guess of costs and benefits (based on a wide purview of existing studies) Nordhaus finds that the optimal policy is to do close to nothing. With the optimal policy, carbon taxes rise from $6 per ton in 2005 to $20 per ton (1989 dollars) in 2100. Global average temperature under this policy increases 3.2°C — only 0.2°C less than in the baseline case. On net, the world economy under this scenario enjoys a small net benefit relative to the baseline case. See Table 1.

Restricting emissions of greenhouse gases to 1990 levels, on the other hand, inflicts relatively large net costs. Carbon taxes rise to $400/ton in 2100, and the increase in global average temperature is limited to only 2.4°C — a full degree less than in the baseline.

Given that the optimal policy is much closer to doing nothing than to restricting to 1990 levels, it appears that literally doing nothing in the short term is superior to current proposals oriented on 1990 emissions levels.

Table 12

	Global Net Benefit3			Carbon Tax ($/ton)		
	NPV ($billions)	Annualized ($billions)	NPV as % of PV of baseline output	2005	2055	2105
Optimal Policy (no uncertainty)	271	11	0.04	6	15	21
Restrict to 1990 levels	- 7,069	- 283	- 0.98	50	230	400
Stabilize at 1.5°C increase	- 40,980	- 1,639	- 5.94	200	700	800

It is worth emphasizing that Nordhaus's result is not simply a matter of delaying controls. While the typical *cost-minimization* exercise also shows that carbon emissions should be allowed to follow a near-baseline path at first, Nordhaus's result goes further: he finds that relatively little should be done even over the long term. In his optimal scenario, carbon concentrations are allowed to grow without apparent bound.

Incorporating uncertainty, Nordhaus's results change though the basic message of modest short-term measures does not.

- Nordhaus examines how the optimal policy changes when key parameter values vary from his best guess and finds that the mean optimal policy calls for higher carbon taxes than he finds for the best-guess case. The mean optimal policy calls for a carbon tax of $18/ton in 2005 and $53/ton in 2045.

- The "mean" result differs from the "best guess" result because the distribution of outcomes is skewed so that favorable climate change scenarios are similar to the best-guess case and occur with high probability while extremely unfavorable scenarios occur with low probability.
- Nordhaus finds that only 2% of possible scenarios -- the least favorable -- would call for a carbon tax in 1995 of over $100/ton.

Basis for Results

Nordhaus's results derive from three key assumptions:

- that the *costs* of reducing carbon emissions are relatively high;

- that the *benefits* of carbon control (in the form of averted damages) are relatively low; and

- that the social rate of discount is greater than zero.

Critics have attacked Nordhaus on all three points, and it is worth examining each point in greater detail.

1. Costs

The cost of reducing carbon emissions is determined by the responsiveness of the economy to a given level of carbon-control effort. For example, if a $10 carbon fee elicits a large response in terms of lower carbon emissions, the cost of carbon control will be low. Conversely, if a $10 carbon fee elicits a small response, program cost will be high.

The impact on the economy of a carbon-control program in Nordhaus's model is determined by two key assumptions — one concerning the "static" response, given current technologies and carbon use, the other concerning the "dynamic" response, reflecting induced changes in carbon use and advances in technology.

- Nordhaus bases his assumption about static responses on existing empirical studies. His assumptions here are not particularly contentious.

- Nordhaus attempts to capture dynamic responses by assuming that technology will improve at about the same rate in the future as it has done in the past. Importantly, the trend rate of improvement is not allowed to vary depending on the price of carbon permits or the level of a carbon tax. Critics find fault with this approach, since his model thus assumes that carbon taxes will in no way accelerate the development of non-carbon technologies — in stark contrast to the "technologist" view.

Nordhaus notes that his results are sensitive to assumptions about technology, but he does not document the extent of that sensitivity in isolation from other uncertainties.

2. Benefits

The benefits of carbon control are determined by the magnitude of damages averted -- that is, damages that would have occurred in the absence of a control program. Nordhaus calculates that these damages would be relatively modest. For example, he estimates that a 3°C temperature increase results in only a 1.3 percent loss of output per year.

Some critics feel that damages averted will be greater than Nordhaus assumes. They note that SO2 and particulate emissions will be reduced, biodiversity will be better maintained, and negative health effects will be avoided.

In a survey of experts, Nordhaus finds that the median cost prediction for a 3°C rise in temperature is 1.9 percent of output annually -- 40% higher than his own. The mean prediction is much higher, at 3.6 percent.

3. The social rate of discount

Given that costs are borne up front and benefits accrue mainly in the distant future, assumptions about the social rate of discount are crucial. Nordhaus assumes that the social rate of discount is 3 percent per year; this rate is sufficiently large as to significantly reduce the present value of the distant and already modest benefits.

Many critics (mainly non-economists) feel that a social rate of discount greater than zero is indefensible on ethical grounds. However, mainstream economists strongly endorse the approach to discounting which Nordhaus uses and find it difficult to understand very low rates of time preference in the context of observed behavior.

Nordhaus re-evaluates the optimal policy when the pure rate of time preference is only 1 percent and finds that the optimal carbon tax in this case is considerably greater (see Table 2).

Table 2

	Optimal Carbon Tax ($/ton)		
Rate of Time Preference	1995	2045	2095
3%	5.3	13.7	21.0
1%	23.6	52.6	77.5

Conclusion

Nordhaus's analysis implies that little should be done either in the short term or in the long term. His results hinge on assumptions about technology improvements, appropriate discount rates, and the size of potential damages. Critics feel that Nordhaus may be:

- overestimating mitigation costs because he ignores the possible influence of higher energy prices in spurring the development of new technology; and
- underestimating damages from climate change.

While both would tend to cause Nordhaus to be too lax in his policy recommendations, it is not clear that such criticisms can be sustained far enough to overturn Nordhaus's basic point that strict action is inappropriate in the short term. The discount rate issue, while crucial, is difficult to settle.

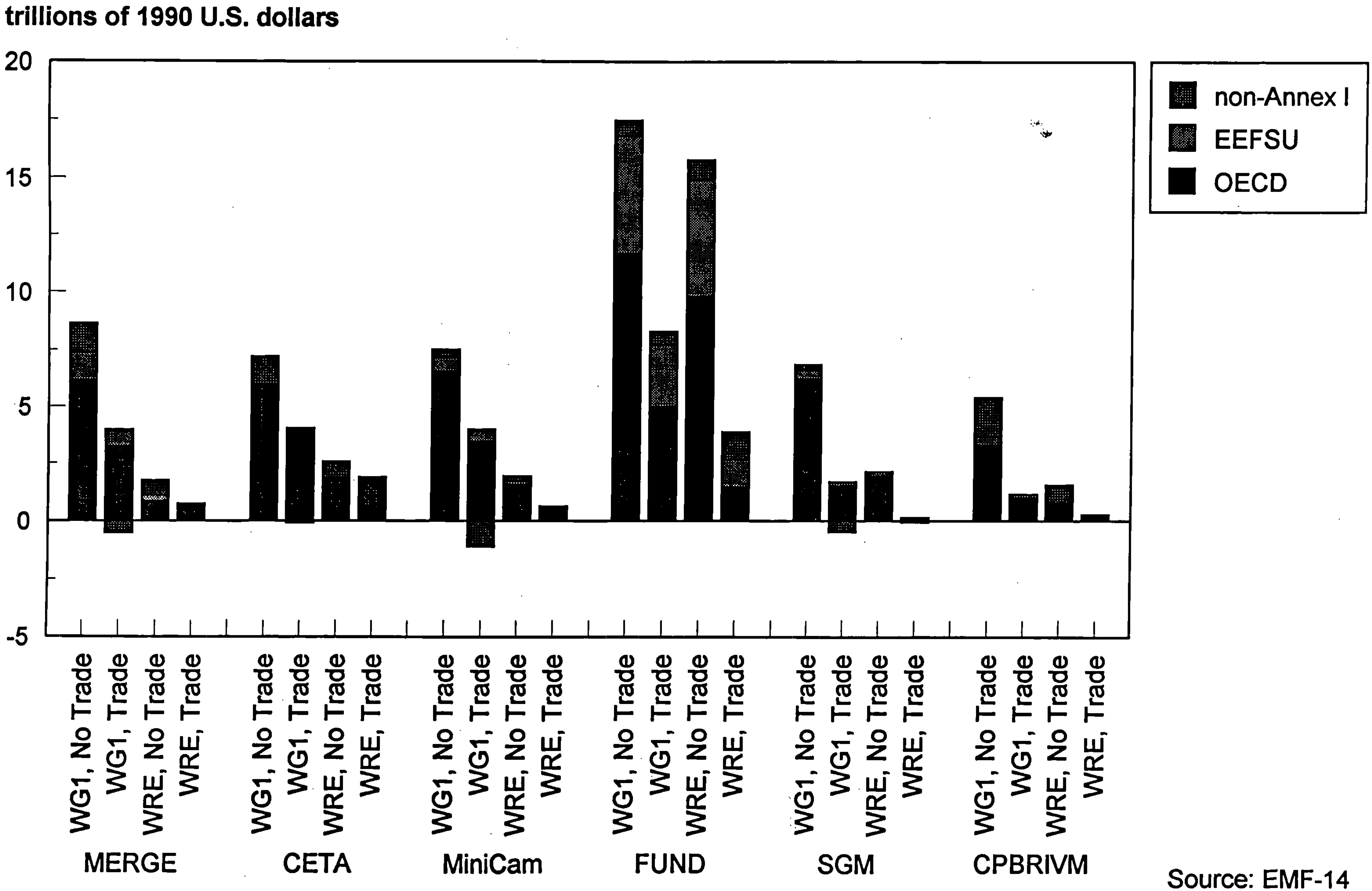
EMF-14

trillions of 1990 dollars (U.S.)

Model	Scenario	OECD	EEFSU	non-Annex I
MERGE	WG1, No Trade	6.121	1.258	1.282
MERGE	WG1, Trade	3.237	0.738	-0.517
MERGE	WRE, No Trade	0.851	0.275	0.631
MERGE	WRE, Trade	0.604	0.028	0.127
CETA	WG1, No Trade	5.94		1.27
CETA	WG1, Trade	4.03		-0.09
CETA	WRE, No Trade	1.83		0.71
CETA	WRE, Trade	1.86		0.03
MiniCam	WG1, No Trade	6.51	0.66	0.34
MiniCam	WG1, Trade	3.44	0.53	-1.12
MiniCam	WRE, No Trade	1.58	0.13	0.21
MiniCam	WRE, Trade	0.54	0.09	-0.01
FUND	WG1, No Trade	11.71	5.09	0.669
FUND	WG1, Trade	4.97	2.7672	0.574
FUND	WRE, No Trade	9.8197	5.071	0.8709
FUND	WRE, Trade	1.4731	1.1907	1.2077
SGM	WG1, No Trade	6.172	0.412	0.25
SGM	WG1, Trade	1.482	0.2	-0.487
SGM	WRE, No Trade	1.844	0.067	0.208
SGM	WRE, Trade	0.127	0.013	-0.059
CPBRIVM	WG1, No Trade	3.25	0.4	1.72
CPBRIVM	WG1, Trade	0.99	0.15	0
CPBRIVM	WRE, No Trade	0.64	0.13	0.77
CPBRIVM	WRE, Trade	0.17	0.02	0.08

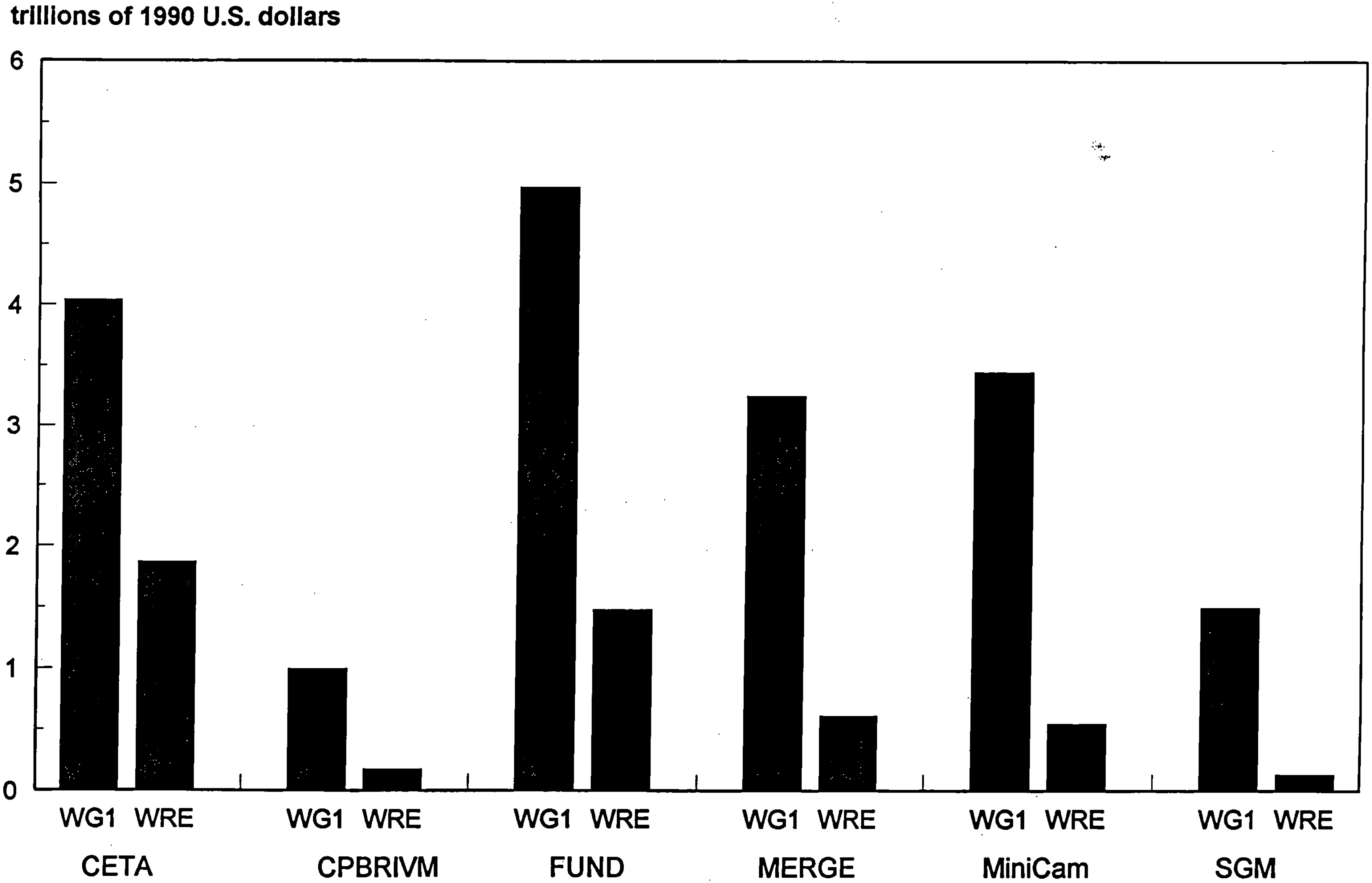
OECD, No Trade			
Model	WRE	WG1	WRE/WG1
MERGE	0.851	6.121	0.139
CPBRIVM	0.64	3.25	0.197
MiniCam	1.58	6.51	0.243
SGM	1.844	6.172	0.299
CETA	1.83	5.94	0.308
FUND	9.8197	11.71	0.839
OECD, Trade			
Model	WRE	WG1	WRE/WG1
SGM	0.127	1.482	0.086
MiniCam	0.54	3.44	0.157
CPBRIVM	0.17	0.99	0.172
MERGE	0.604	3.237	0.187
FUND	1.4731	4.97	0.296
CETA	1.86	4.03	0.462

Cost to World of Stabilizing CO_2 Concentrations at 550ppmv
PDV of Foregone Consumption through 2100



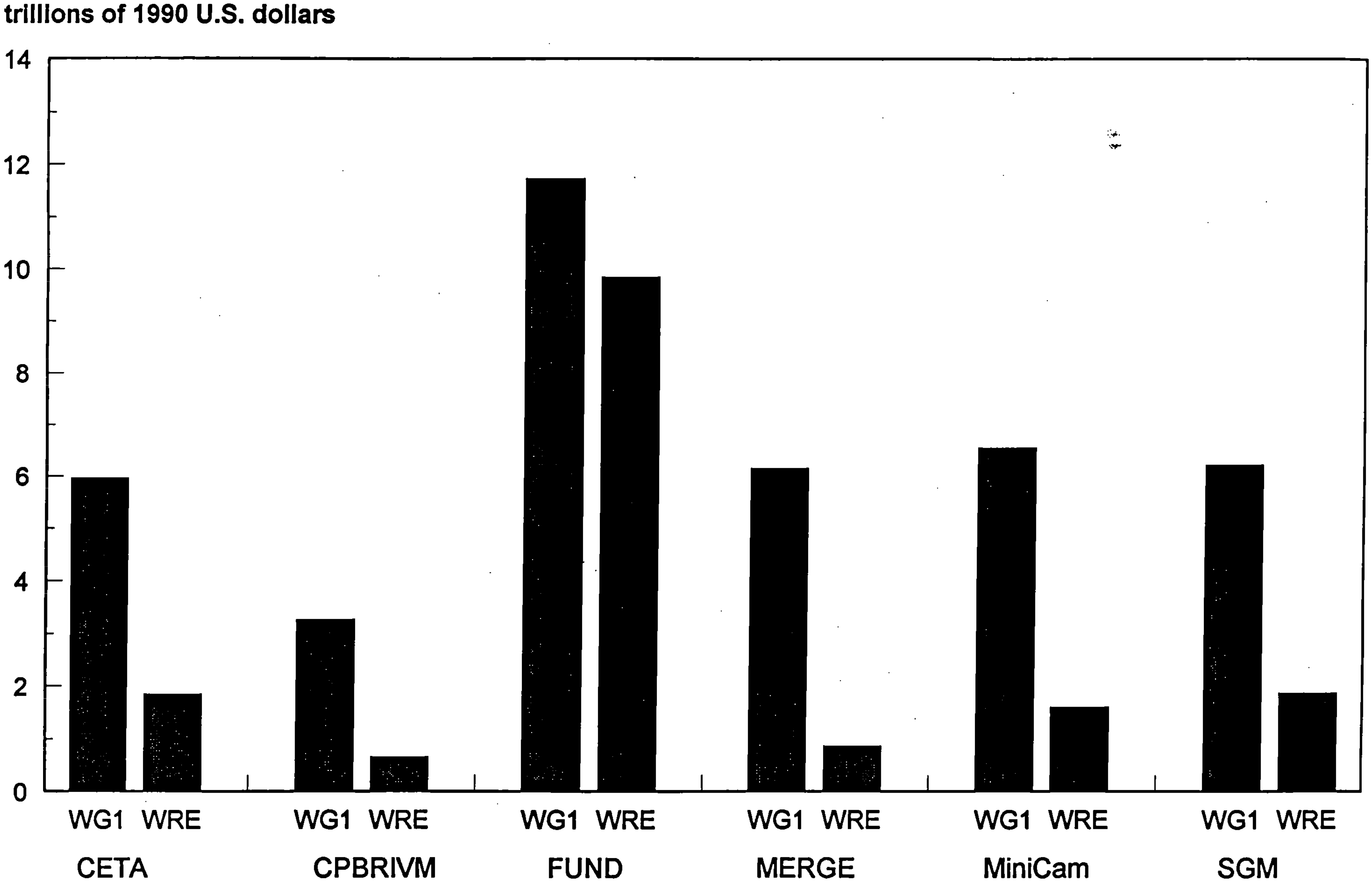
Source: EMF-14

Cost to OECD, with Trading, of Stabilizing CO_2 Concentrations at 550ppmv, PDV of Foregone Consumption through 2100



Source: EMF-14

Cost to OECD, without Trading, of Stabilizing CO_2 Concentrations at 550ppmv, PDV of Foregone Consumption through 2100



Source: EMF-14

11-1

Three kinds of model experiments and results:

1. Full cost-benefit optimization (in Integrated Assessment models [Nordhaus et al])

- General conclusion: optimal path shows emissions continuing to rise (though at a reduced rate) at least until 2080.
- Criticisms:
    - Insufficient weight to the probability of a discontinuously-large catastrophe
    - Insufficient weight to the welfare of future generations that will bear the costs of climate change (the discount rate is too high).
    - Neglects basic uncertainty about all parameters.
    - Omits a basic point about political credibility: an announcement that stringent policy measures will be taken 50 years or more into the future will not be credible.

2. Comparison of costs of alternative paths to reach a given goal for concentrations & climate effects [Energy Modeling Forum, WRE, Manne and Richels]

- Moderate paths have Annex I emissions continuing to rise for several decades, peaking around 2010-2025, returning to 1990 levels around 2040, and falling thereafter, in order to reach terminal concentrations of twice pre-industrial levels.
    - WRE path
    - least-cost path
    - "peak in 2015, 1990 levels by 2040"
- Aggressive paths have emissions turning down almost immediately, returning to 1990 levels or below by 2010, but ultimately producing the same terminal concentrations.

3. Comparison of effects of alternative proposed dates by which to stabilize emissions.

EMF-14

A1

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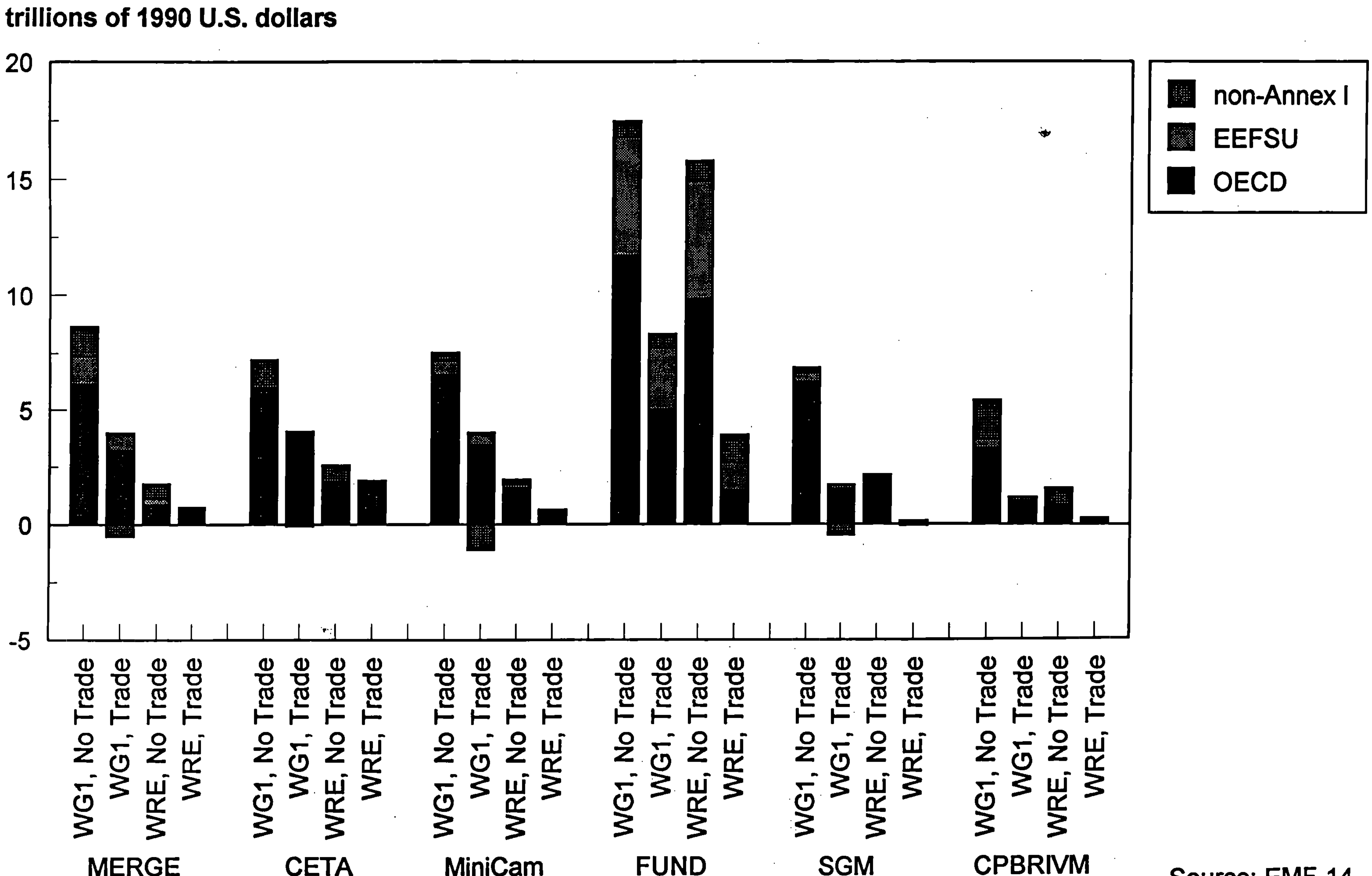
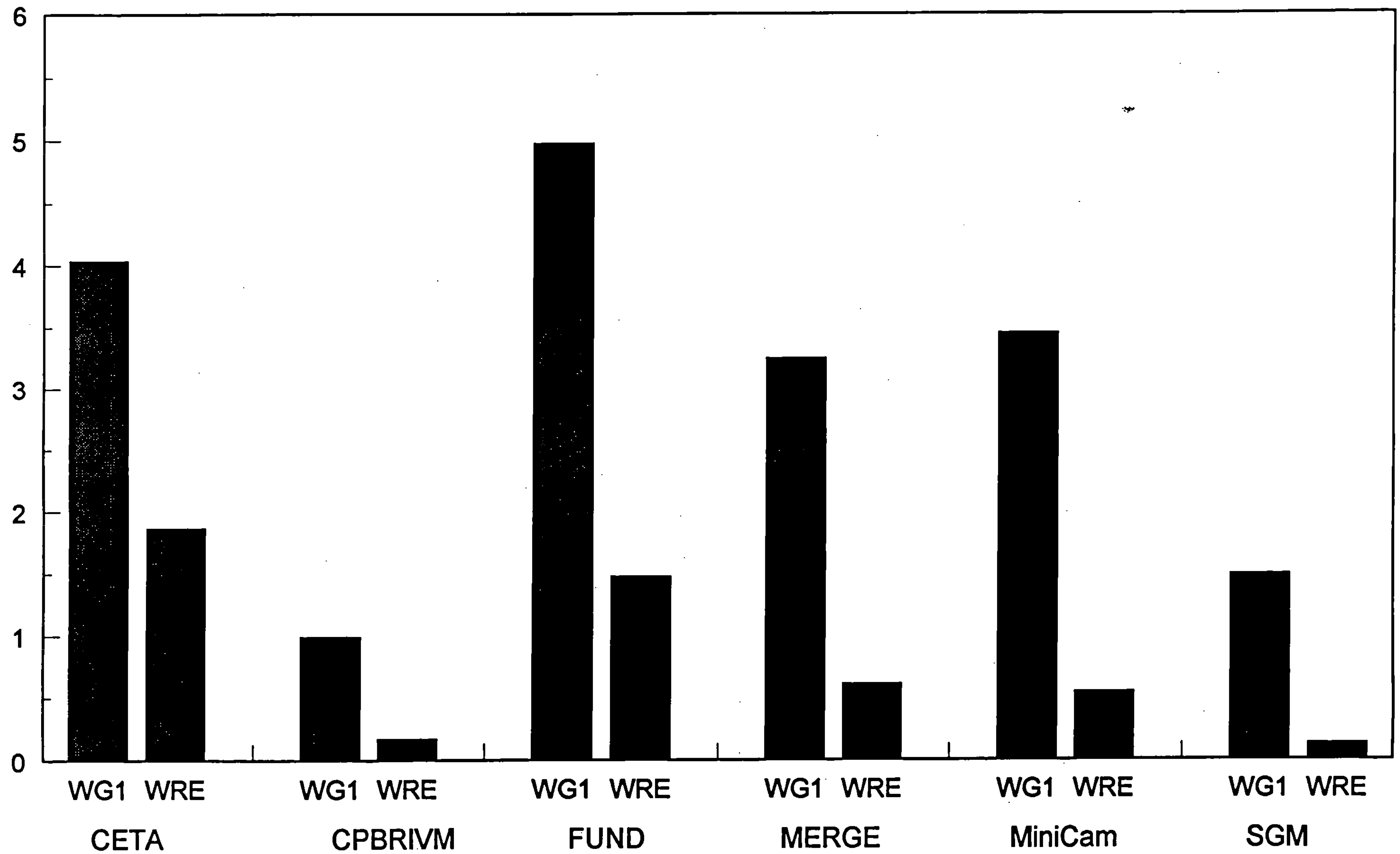


Source: EMF-14

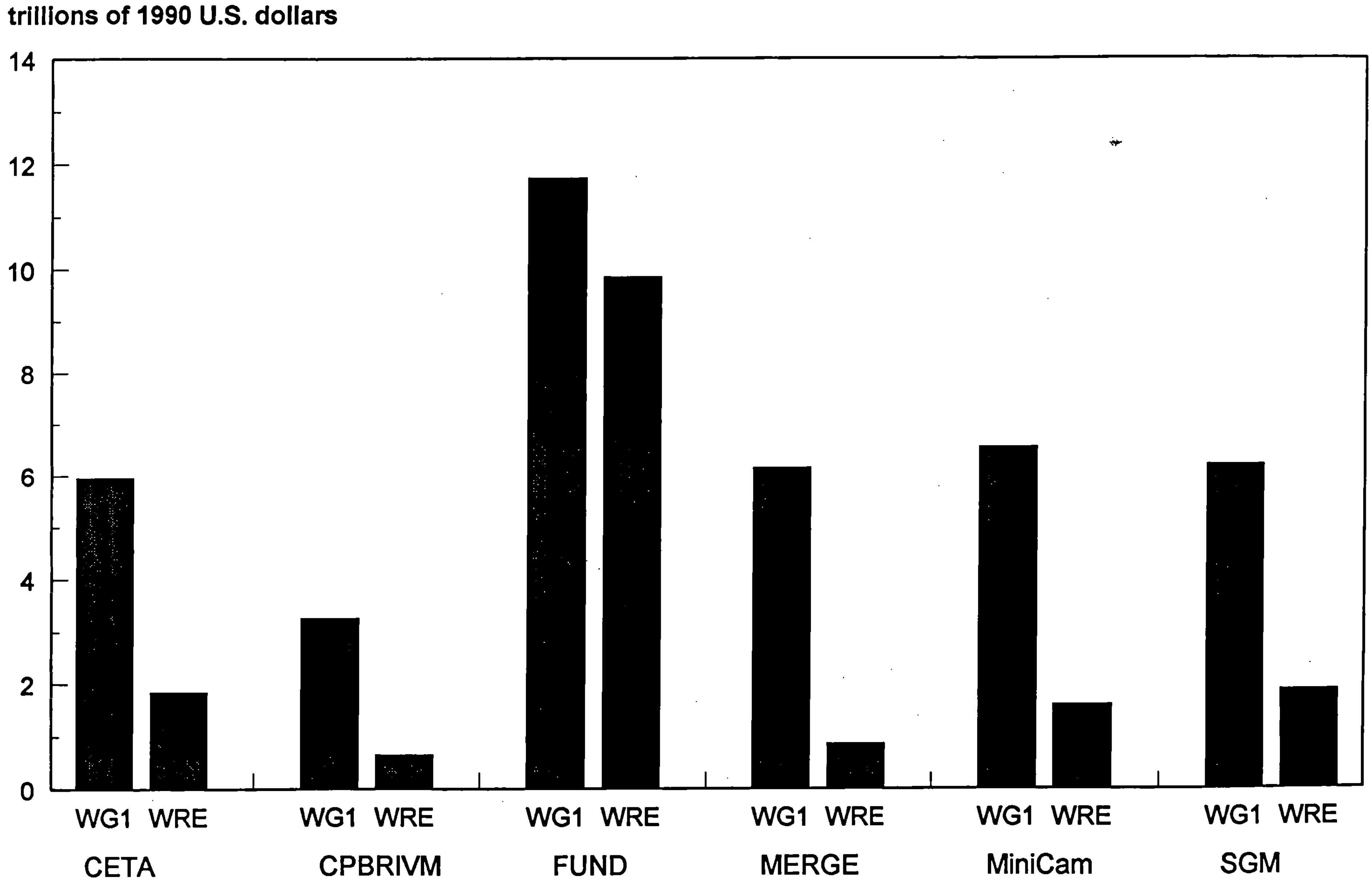
Cost to OECD, with Trading, of Stabilizing CO_2 Concentrations at 550ppmv, PDV of Foregone Consumption through 2100

trillions of 1990 U.S. dollars



Source: EMF-14

Cost to OECD, without Trading, of Stabilizing CO_2 Concentrations at 550ppmv, PDV of Foregone Consumption through 2100



Source: EMF-14

	A	B	C	D
1	Year	CO2 Emissons1000 mtc	10 Year	Total Energy Consump
2	1950	696069	696069	33.08
3	1951	716717		35.47
4	1952	697920		35.3
5	1953	714462		36.27
6	1954	680491		35.27
7	1955	745973		38.82
8	1956	781912		40.38
9	1957	775115		40.48
10	1958	750766		40.35
11	1959	781360		42.14
12	1960	799544	799544	43.8
13	1961	801875		44.46
14	1962	831489		46.53
15	1963	875633		48.32
16	1964	912912		50.5
17	1965	948264		52.68
18	1966	999673		55.66
19	1967	1039174		57.57
20	1968	1080969		61
21	1969	1132028		64.19
22	1970	1155779	1155779	66.43
23	1971	1162650		67.89
24	1972	1215253		71.26
25	1973	1262913		74.28
26	1974	1218402		72.54
27	1975	1167836		70.55
28	1976	1248095		74.36
29	1977	1252334		76.29
30	1978	1274009		78.09
31	1979	1278610		78.9
32	1980	1236297	1236297	75.96
33	1981	1195706		73.99
34	1982	1139230		70.85
35	1983	1143714		70.52
36	1984	1184227		74.14
37	1985	1202453		73.96
38	1986	1224096		74.3
39	1987	1268062		76.89
40	1988	1340168		80.22
41	1989	1360885		81.32

	E
1	10 year
2	33.08
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	43.8
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	66.43
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	75.96
33	
34	
35	
36	
37	
38	
39	
40	
41	

	A	B	C	D
42	1990	1293219	1293219	84.09
43	1991	1310386		83.99
44	1992	1333718		85.52
45	1993	1361342		87.34
46	1994	1387256		89.21

	E
42	84.09
43	
44	
45	
46	

Scenario #	Model ID	Scenario	Model	Modelers	Target	Timetable	Trading	Permit Allocation	Revenue Recycling	Burden Sharing	BAU Emissions Path Assumption	AEEI	Ramp-up	Time Path	Outputs PDV (3%; 2000-2050) Foregone Consumption	Permit Prices: 2010	Permit Prices: 2025	Permit Prices: 2050	Electricity Prices: 2010, 2025, 2050
	SGM1	BAU	SGM	Battelle	n/a	n/a	n/a	n/a	n/a	n/a	IAT	1.0	n/a	-->2050, -->2100 (climate)	$183,155 billion (BAU consumption)	$0	$0	$0	
#1 G	SGM2	1990 in 2010	SGM	Battelle	1990 emissions level	stabilize in 2010	domestic only	auction	lump-sum	no LDC part.	IAT	1.0	no	-->2050, -->2100 (climate)	$1126 billion	$110	$191	$582	
	SGM3	1990 in 2010	SGM	Battelle	1990 emissions level	stabilize in 2010	Annex I	auction	lump-sum	no LDC part.	IAT	1.0	no	-->2050, -->2100 (climate)	384 billion	$42	$84	$149	
	SGM4	1990 in 2010	SGM	Battelle	1990 emissions level	stabilize in 2010	worldwide	auction	lump-sum	no LDC part.	IAT	1.0	no	-->2050, -->2100 (climate)	$5 billion	$16	$23	$32	
#4 M2	SGM5	1995 in 2010	SGM	Battelle	1995 emissions level	stabilize in 2010	domestic only	auction	lump-sum	no LDC part.	IAT	1.0	no	-->2050, -->2100 (climate)	$737 billion	$62	$131	$317	
	SGM6	1995 in 2010	SGM	Battelle	1995 emissions level	stabilize in 2010	Annex I	auction	lump-sum	no LDC part.	IAT	1.0	no	-->2050, -->2100 (climate)	w/o > SGM3 ? $645 billion	$74	$119	$201	
	SGM7	1995 in 2010	SGM	Battelle	1995 emissions level	stabilize in 2010	worldwide	auction	lump-sum	no LDC part.	IAT	1.0	no	-->2050, -->2100 (climate)	$38 billion	$27	$32	$41	
	SGM8	-10% if 1990 in 2010	SGM	Battelle	-10% 1990 emissions level	stabilize in 2010	domestic only	auction	lump-sum	no LDC part.	IAT	1.0	no	-->2050, -->2100 (climate)	$1630 billion	$175	$304	$924	
	SGM9	-10% if 1990 in 2010	SGM	Battelle	-10% 1990 emissions level	stabilize in 2010	Annex I	auction	lump-sum	no LDC part.	IAT	1.0	no	-->2050, -->2100 (climate)	$808billion	$91	$137	$238	
	SGM10	-10% if 1990 in 2010	SGM	Battelle	-10% 1990 emissions level	stabilize in 2010	worldwide	auction	lump-sum	no LDC part.	IAT	1.0	no	-->2050, -->2100 (climate)	$63 billion	$33	$37	$45	
#3 B	SGM11	Peak in 2015	SGM	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	domestic only	auction	lump-sum	no LDC part.	IAT	1.0	no	-->2050, -->2100 (climate)	$498 billion	$0	$84	$559	
	SGM12	Peak in 2015	SGM	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	Annex I	auction	lump-sum	no LDC part.	IAT	1.0	no	-->2050, -->2100 (climate)	$125 billion	$0	$47	$155	
	SGM13	Peak in 2015	SGM	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	worldwide	auction	lump-sum	no LDC part.	IAT	1.0	no	-->2050, -->2100 (climate)	-$16 billion	$0	$14	$33	
	MM1	BAU	Markal	DOE	n/a	n/a	n/a	n/a	n/a	n/a	IAT	~1.0	n/a	-->2025	n/a	$0	$0	n/a	
#16	MM2	1990 in 2010	Markal	DOE	1990 emissions level	stabilize in 2010	domestic only	auction	lump-sum	no LDC part.	IAT	~1.0	n/a	-->2025		$148	$192	n/a	
	MM3	1995 in 2010	Markal	DOE	1995 emissions level	stabilize in 2010	domestic only	auction	lump-sum	no LDC part.	IAT	~1.0	n/a	-->2025		$136	$146	n/a	
#2	MM4	1990 in 2020	Markal	DOE	1990 emissions level	stabilize in 2020	domestic only	auction	lump-sum	no LDC part.	IAT	~1.0	n/a	-->2025		$0	$198	n/a	
#3 B	MM5	Peak in 2015	Markal	DOE	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	domestic only	auction	lump-sum	no LDC part.	IAT	~1.0	n/a	-->2025		$0	$99	n/a	
		550ppm Least-Cost	MERGE	Richels	550ppm concentration														

Values continued on next page

Oil Prices: 2010, 2025, 2050	Conc. (ppmv) in 2050 (Deviation from BAU)	Conc. (ppmv) in 2100 (Deviation from BAU)	Year Conc. (550 ppmv) Reaches 2x Pre-Ind. Level (Deviation from BAU)	Change in Temp. (deg. C) from 1990 in 2050 (Deviation from BAU)	Change in Temp. (deg. C) from 1990 in 2100 (Deviation from BAU)	Emissions Peak, mmtce (year)	Year Returns to 1990	Intl. Trade of Permits, 2010, 2050 (mmtce)	Date Received Run	File	
	502	711	2065	1.06	2.36	no peak: 2245 (2050)	n/a	n/a	08/21/97	aldy/sgmruns/cea90_~1.xls	
	485 (-17)	658 (-53)	2072 (+7)	0.99 (-0.07)	2.16 (-0.20)	1637 (2005)	2010	n/a	08/21/97	aldy/sgmruns/cea90_~2.xls	
	485 (-17)	658 (-53)	2072 (+7)	0.99 (-0.07)	2.16 (-0.20)	no peak: 1714 (2050)	never returns	-202, -364	08/21/97	aldy/sgmruns/cea90_~2.xls	
	485 (-17)	658 (-53)	2072 (+7)	0.99 (-0.07)	2.16 (-0.20)	no peak: 2102 (2050)	never returns	-313, -752	08/21/97	aldy/sgmruns/cea90_~2.xls	
	481 (-21)	648 (-63)	2074 (+9)	0.98 (-0.08)	2.12 (-0.24)	1637 (2005)	never returns	n/a	08/21/97	aldy/sgmruns/cea95_~1.xls	
	481 (-21)	648 (-63)	2074 (+9)	0.98 (-0.08)	2.12 (-0.24)	1637 (200	never returns	36, -122	08/21/97	aldy/sgmruns/cea95_~1.xls	
	481 (-21)	648 (-63)	2074 (+9)	0.98 (-0.08)	2.12 (-0.24)	no peak: 2073 (2050)	never returns	-131, -593	08/21/97	aldy/sgmruns/cea95_~1.xls	
	481 (-21)	653 (-58)	2074 (+9)	0.97 (-0.09)	2.11 (-0.25)	1637 (2005)	2010	n/a	08/21/97	aldy/sgmruns/cea90m_~1.xls	
	481 (-21)	653 (-58)	2074 (+9)	0.97 (-0.09)	2.11 (-0.25)	1637 (2005)	never returns	-180, -332	08/21/97	aldy/sgmruns/cea90m_~1.xls	
	481 (-21)	653 (-58)	2074 (+9)	0.97 (-0.09)	2.11 (-0.25)	no peak: 2060 (2050)	never returns	-332, -845	08/21/97	aldy/sgmruns/cea90m_~1.xls	
	489 (-13)	653 (-58)	2072 (+7)	1.01 (-0.05)	2.15 (-0.21)	1807 (2015)	2040	n/a	08/21/97	aldy/sgmruns/cea90_~1.xls	
	489 (-13)	653 (-58)	2072 (+7)	1.01 (-0.05)	2.15 (-0.21)	1807 (2015)	never returns	0, -367	08/21/97	aldy/sgmruns/cea90_~1.xls	
	489 (-13)	653 (-58)	2072 (+7)	1.01 (-0.05)	2.15 (-0.21)	no peak: 2102 (2050)	never returns	0, -752	08/21/97	aldy/sgmruns/cea90_~1.xls	
	n/a	n/a	n/a	n/a	n/a	no peak: 2066 (2025)	n/a	n/a	08/26/97	aldy/markal~18_26run1.wk4	
	n/a	n/a	n/a	n/a	n/a	1586 (2005)	2010	n/a	08/26/97	aldy/markal~18_26run1.wk4	
	n/a	n/a	n/a	n/a	n/a	1600 (2005)	n/a	n/a	08/26/97	aldy/markal~18_26run1.wk4	
	n/a	n/a	n/a	n/a	n/a	1749 (2010)	2020	n/a	08/26/97	aldy/markal~18_26run1.wk4	
	n/a	n/a	n/a	n/a	n/a	1767 (2015)	2040*			aldy/markal~18_26run1.wk4	

Cost-Benefit optimal path

Peck + Teisberg (92) [uses Global 2100 model of Manne + Richels (92), = one of two used by R + Edmonds (95)]

Alt damage functions (% of GDP as a functn. of warming degrees): one linear, one non-linear

non-linear calls for ~~more~~ lower emissions after 2050, & much lower in 22nd century than BAU or linear d.f., peaking in 2080-90

BAU very close to each other 2000-2050.

Joseph E. Aldy
09/05/97 11:08:53 AM

Record Type: Record

To: Jeffrey A. Frankel/CEA/EOP

cc:
Subject: chart

I made a modification to the description of the temperature and concentration model used in our results. Insert the following file (not the one I sent last night), into the paper.

T&T_CHRT.WPD

9/10
T&T_CHRT2.WPD

Global Climate Research
Facsimile Transmission

Sender: Richard Richels
Phone: (415) 855-2602
Subject: Some Results

Pages (including cover): ~~2~~ ~~8~~ 2
Date: sept 3, ~~August 28,~~ 1997

Destination Information

Name	Jeff Frankel
Company	CEA
Division	
Fax	202 395 6958

Please see attached
~~Some initial results. More to come.~~

Richard

~~A bit rough but sufficient for our next conversation.~~

ELECTRIC POWER RESEARCH INSTITUTE
3412 HILLVIEW AVENUE
P.O. BOX 10412, PALO ALTO, CALIFORNIA 94303

Main Phone: (415) 855-2000
Department Phone: (415) 855-2965
Facsimile: (415) 855-2950

Thurs. a.m.

9/4/97

Joe

Here's another fax from Rich Richels. After sending it, he called to say he wants to drop column (1), & make some other changes. I asked him to call you, and coordinate with you from now on. You can tell him what new tables we need filled in (hopefully using the runs he has already done for us.

JF

cc: Lutter
Morris

To consider the possibility that developing countries might decline to participate, or decide to participate only to a lesser degree than the Manne-Richels burden sharing formula, we ask what would be the effects both economic and climatological, if the Annex 1 countries were constrained to the WRE path and developing countries do not participate, that is that developing countries continue to follow their business as usual path. The welfare losses (in terms of discounted present value) will depend upon whether there is trading in emission rights among Annex 1 countries. If this is the case, Annex 1 losses rise from $.62 trillion to $.91 trillion or 47%. If emission trading among Annex 1 countries is prohibited, then losses rise to $1.00 trillion or 61%. Turning to the US, in the absence of developing country participation, welfare losses rise from $.28 to $.36 trillion or 29%, assuming Annex 1 trading. Losses rise to $.41 trillion or 46% in the absence of Annex 1 trading.[1]

[1] For purposes of this comparison, we assume that if developing countries do participate, there will be full global trading.

OCC
ZXT

Richels

cost to Annex 1 relatively un affected
not right
Returning 1990 by 2010 $40 / ton least cost
only An I Trading → $132 / ton
global

no trading at all cost to us $204 / ton

welfare nos wrong
Ed Rich Ormsby Berlin Manhap OECD & non Trading reduced costs by 70%

lead slopes
p7
p8 bottom filled in

US

It is important to keep in mind that these estimates of the value of carbon emission rights are drawn from least-cost scenarios. That is, they assume that 1) emission reductions will take place where it is cheapest to do so regardless of their geographical location, and 2) there is flexibility in their timing. This is referred to as "where" and "when" flexibility and is necessary if we are to minimize mitigation costs. The following table compares the value of carbon emission rights when Annex 1 emissions are returned to 1990 levels under alternative assumptions about where and when flexibility. In the most constrained case (the right-most column), the tax will be country specific. Here we report values for the US.

Table X. The Value of Carbon Emission Rights ($/ton) in 2010 under Alternative Assumptions about Where and When Flexibility

Where flexibility	~~Global~~	Global	Annex 1 only	None
When flexibility	~~Yes~~	No	No	No
Value of carbon emission rights ($/ton)	~~40~~	67	132	204

Jeff,

Notice additional column. This will be important for exposition. I need latest version to start integrating new material on costs to USA.

Rich

RR

If LDCs don't participate?

Welfare Min costs go up by 45% in developing countr

CSO WRE with full trading very close to least-cost scenario

without LDCs but still Annex I tradg.
Annex on same path of ~~physical~~ e. as ~~billion~~ before.
em permits / targets $635 → $922 b
can no longer buy their way to higher emissions

- will read above (if LDCs out)
- if no int. trdg.

- [U.S. alone

rl cc: JA

Global Climate Research
Facsimile Transmission

Sender: Richard Richels
Phone: (415) 855-2602
Subject: Some Results

Pages (including cover): ~~2~~ ~~8~~ 2

Date: August 28, 1997

Destination Information

Name	Jeff Frankel
Company	CEA
Division	
Fax	202 395 6958

Some initial results. More to come.

Richard

~~A bit rough but sufficient for our next conversation.~~

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Table X. The Value of Carbon Emission Rights ($/ton) under Alternative Assumptions about Where and When Flexibility

Year	Full Interrregional and Intertemporal Trading	Interrregional Trading Within Annex 1 Only	No Intertemporal or Interregional Trading
2010	40	132	204

This should go on page 8
at end of third paragraph

Joseph E. Aldy
09/05/97 11:58:20 AM

Record Type: Record

To: Jeffrey A. Frankel/CEA/EOP

cc:
Subject: EMF-14 and MERGE

Jeff,

I just spoke with Richels. He said that John Weyant, Director of EMF, gave a presentation at the Oslo meeting on EMF-14. In this analysis, they used about 10 models to assess the economic impacts of the WRE and WGI paths. They found that MERGE fell in the middle of the model results. Richels thought it would be good to at least footnote this in the paper, since we might get some heat if we rely on just one model. I have left a message for Weyant indicating that we would like a copy of his presentation.

Joe

Joseph E. Aldy
09/04/97 10:06:03 PM

Record Type: Record

To: Jeffrey A. Frankel/CEA/EOP

cc:
Subject: Richels new data

Jeff,

Attached is a WP file with section 3 of the T&T paper with Richels comments and new data he sent to us today.

Joe

RICHELS1.WPI

3. Estimates of least-cost paths to stabilize concentration levels

An alternative strategy is to reason that the probability of catastrophe may rise to unacceptable levels unless GHG concentrations are capped at some particular level. Such an approach has the disadvantage that the choice of any specific concentration level is arbitrary, and is inconsistent with the spirit of cost-benefit analysis. But it has the advantage of being analytically tractable.

Stabilization of concentrations at 550 ppmv

We will consider the question of the optimal path subject to the constraint that concentrations be stabilized at 550 ppmv (approximately double the pre-industrial level of 275 ppmv[1]). One might ask why we need accept a level of concentrations, and corresponding probability of catastrophe, as high as this. Indeed, why accept any probability of catastrophe? It is important to recognize that it is already too late to keep this probability at zero (even if one were to accept that it would have been worth the cost to do so, had we known at the beginning of the Industrial Revolution what we know now). Concentrations are already at 365 ppmv, and it is impossible to prevent them rising further in the short run; one would have to reduce emissions virtually to zero to do so.

It would be useful to quantify the implicit gap between this strategy and the strategies resulting from the unconstrained optimization by the Integrated Assessment models. The difference represents the role being accorded to the four bullet points above. In addition, some sensitivity analysis with respect to the level of the concentration constraint would be desirable.

Results for a less aggressive path

Wigley, Richels and Edmonds (1996) [WRE] examined alternative paths to reach 550 ppmv and other concentration levels. They considered a path where global emissions peaked in 2030 and did not return to 1990 levels until some date past 2100. Manne-Richels (1997) use the MERGE model to examine the implications of the WRE path in more detail. In their model, emissions from OECD countries as well as from other Annex I countries (most of the former Soviet Union and Eastern Europe) peak in the decade 2010-2020. (Annex I emissions do not return to their 1990 levels until sometime early in the decade 2030-2040. The price of crude oil peaks in 2040.) The reason that the peak in worldwide emissions lags two decades behind the peak in Annex I emissions is that the developing countries do not peak until 2050.

WRE argue that this path has much lower economic costs than proposed paths that are more aggressive in terms of timing, while producing the same terminal effects on concentration. The more aggressive path they examine is the IPCC Working Group path 1 [WGI], which entails Annex I fossil fuel emissions peaking in 1990, and falling 24 percent worldwide below 1990 levels by 2010.[2] (Of course, it is too late for this scenario to be realized. Below, we will also consider

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[1] The concentration figure refers only to CO2. Emission of other greenhouse gases will raise the warming potential, or carbon-equivalent, above this level.

[2] Worldwide emissions are up 8 percent in 2010 [from 5.885 to 6.351]. These numbers come from 8/28 personal communication with Richels. (Earlier communication had worldwide emissions rising 13.64% by 2010 under the IPCC path [to 7.798 PgC]. Evidently the former statistic refers only to fossil fuel

other alternative proposals that, while sufficiently ambitious as to be expensive to achieve, at least have the virtue of not having been ruled out by the passage of seven years during which emissions manifestly have not in fact begun to fall in the overwhelming majority of countries.)

The best single measure of aggregate economic costs is the present discounted value, i.e, the appropriate summation over time, of foregone consumption. The IPCC Working Group path shows a total worldwide consumption loss of $8.6 trillion. (The number would be lower if international trading were allowed -- $3.3 trillion. On the other hand, the cost would be higher if the developing countries do not agree to the targets envisioned. Indeed, if the developing countries do not participate at all, then the goal would be impossible to attain at any cost.) The more moderate WRE path toward the same concentration goal entails far smaller costs: a total worldwide cost of $1.57 trillion. (With global trading, it is $0.77 trillion. The difference illustrates the great benefits of "where flexibility," assuming that international trading can be successfully implemented.) Thus the saving from letting emissions continue to rise as late as 2010 is more than three-quarters of the cost.

WRE did not attempt to compute the least-cost path for reaching the same goal.

The least-cost mitigation path

Manne and Richels (1997) is believed to be virtually the first paper to compute the path that minimizes costs (again, using the MERGE model), subject to the constraint of stabilizing concentrations at a level such as 550 ppmv.[3] They must necessarily make some assumption about international burden-sharing. The particular question is as follows: how much can we insist that developing countries (who are poor, but in many cases rapidly growing) reduce their emissions, relative to their (low, but often rapidly growing) paths? For the case of 550 ppmv concentrations, they assume that non-Annex I countries can plausibly be expected to begin to limit emissions in 2030, and to complete a transition to a regime under which their per-capita emission rights are equal to those of the industrialized countries by 2050. [4]

The global numbers that Manne and Richels reported in their paper need to be broken down by region. In addition, we asked them to constrain the year 2000 emission levels to the BAU level, under the theory that a treaty that reduces emissions beginning in 1990 has already been ruled out by history, and that even a start in 1998 is so unlikely. Their model implies that the least cost mitigation path has emissions from OECD countries, as well as from other Annex I countries, in general, peaking in the decade 2020-2030, a bit behind the WRE path. The peak of Annex I emissions is 29 percent above 1990 levels. [Source: personal communication from

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emissions and the latter to all carbon emissions.)

[3] Also Manne and Richels (1995). Kosobud, et al (1994) examine alternative paths to achieve a given <u>temperature</u> target in 2100. All three papers find that a return to 1990 emission levels early in the 21st century is a needlessly costly way to attain the 2100 goals for concentration and climate.

[4] Based on 1990 populations. We consider alternative scenarios in Appendix _.. One alternative is that the developing countries do not participate at all. It would also be desirable to look at the implications of a plan under which a small number of middle-income countries (particularly Korea and Mexico) begin to limit emissions by 2010. Without China and India, however, the emissions of the middle-income countries are a small fraction of the world total, so that their involvement would be important only in order to point the way for other emerging economies, rather than to reduce emissions perceptibly in their own right.

Richels, 8/21 and 8/28/97.] Emissions do not return to their 1990 levels until after 2050. Emissions from developing countries peak in 2050. As noted, the sum of the two, total worldwide emissions, also peaks in 2050. Worldwide emissions return to their 1990 levels shortly before the end of the 21st century. By mid-century, developing countries are such an important source of emissions that they dominate the global peaking date and the date of return to 1990 levels.

The least cost mitigation path generates quite low values for carbon emissions rights after implementation in 2000. In 2010, the permit price is $2/ton and slowly rises to $3/ton in 2020. Only in the latter part of the century does it rise significantly to $156/ton in 2100. In contrast to the least cost path, the following table demonstrates the effect of constraining Annex I emissions relative to 1990 levels in 2010. The constraint is imposed over the period 2010-2030. After 2030, further reductions in Annex I emissions occur consistent with the burden sharing formula described earlier. The permit price estimates presuppose full global trading (where flexibility) but not intertemporal trading (when flexibility).

Change in emissions relative to 1990	Permit Price in 2010 ($/ton)	Permit Price in 2020 ($/ton)	Consumption Losses (trillions of dollars)[5]		
			U.S.	Annex I	World
+10%	4	65	0.293	0.564	0.782
0%	67	88	0.303	0.619	0.939
-10%	120	112	0.429	1.054	1.276

It is important to keep in mind that the permit price estimates assume perfect global trading. Under this assumption, emission reductions occur where it is cheapest to do so regardless of geographic location. The following table shows permit prices in 2010 when Annex I emissions are constrained to 1990 levels under alternative assumptions about where flexibility.

U.S. Permit Prices in 2010, 1990 Level in 2010 Scenario

Where Flexibility	Global Trading	Annex I Only Trading	Domestic Only Trading
Permit Price in 2010 ($/ton)	67	132	204

According to Manne and Richels, their least cost mitigation path costs the U.S. $0.124 trillion in terms of lost consumption (present discounted value), as compared to $1.28 trillion under the IPCC Working Group path and as compared to $0.303 trillion under the "1990 in

[5] The present discounted value of consumption assumes a 5% discount rate and a time horizon of 1990-2100.

2010" path. Thus the least cost mitigation path generates savings of 90 percent from WGI and 60 percent from the 1990 in 2010 path. (Most of this gain is also reflected in the WRE path, as described above.) It is important to keep in mind that all these cost estimates are "best case" scenarios, in the sense that they assume efficient market implementation, international trading, and full international participation and enforcement. Actual costs could be much higher if less efficient command-and-control mechanisms of implementation are used, if there is not effective international trading, or if some countries do not accede to or abide by a treaty.

What if the developing countries do not agree to go along?

It is difficult to imagine that the industrialized countries will be able to extract commitments from developing countries much more serious than those assumed in the preceding section, the Manne-Richels burden-sharing schedule. What if, as is more likely, the commitments extracted from developing countries are less strong than this, rather than more? On the one hand, as a matter of arithmetic, meeting the 550ppmv concentration constraint would require more aggressive targets and timetables on the part of the Annex I countries, if indeed it would be possible at all. On the other hand, as a matter of politics, the absence of the developing countries would probably lead the peoples of the Annex I countries to choose a less aggressive path, even though it would produce a higher terminal concentration level.[6] (An analytical balancing of costs and benefits would give the same answer -- a less aggressive path -- once the concentration constraint is relaxed.)

To consider the possibility that developing countries might decline to participate, or decide to participate only to a lesser degree than the Manne-Richels burden-sharing formula, we ask what would be the effects, both economic and climatological, if the Annex I countries were constrained to the WRE path and developing countries do not participate (i.e., developing countries remain on their BAU path). The welfare losses (in terms of present discounted value) will depend upon whether there is trading in emission rights among Annex I countries. If Annex I trading occurs, then Annex I countries' losses increase from \$0.62 trillion to \$0.91 trillion, or 47%. If emission trading among Annex I countries does not occur, then losses rise to \$1.00 trillion, or 61%. For the U.S., in the absence of developing country participation, welfare losses rise from \$0.28 to \$0.36 trillion, or 29%, assuming Annex I trading. Without Annex I trading, U.S. losses rise to \$0.41 trillion or 46%.[7]

Even if the Annex I countries choose an aggressive path of reducing emissions 10% below 1990 levels by 2010 (and stay at that level thereafter), the effect is to reduce global concentrations only 7 % below BAU levels in the year 2100. This is less than a third of the reductions achieved when the developing countries participate [22%; conversation 8/28] This result illustrates the problem of free riding. The estimate does not include an allowance for "leakage" of carbon savings from participating to non-participating countries (e.g., reduced oil demand in the former, via a lower world price of oil, raises oil consumption in the latter). Once leakage effects are

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[6] Conversely, the developing countries are less likely to agree to participate if the Annex I countries have not already taken serious action.

[7] For purposes of this comparison, we assume that if developing countries do participate, there will be full global trading.

added to the free-riding problem, the difficulty of accomplishing meaningful reductions without the help of developing countries are even greater. The savings is only 5 percent in this case. In other words, of the 22 percent reductions achieved when the developing countries participate, 15 percentage points are lost to free-riding, and another 2 points to carbon leakage. [conversation 8/29.]

[The difference for concentrations can be crudely translated into an estimate of the effect on temperature in 2050 or 2100 by means of simple interpolation of IPCC estimates...]

Draft.

3. Estimates of least-cost paths to stabilize concentration levels

An alternative strategy is to reason that the probability of catastrophe may rise to unacceptable levels unless GHG concentrations are capped at some particular level. Such an approach has the disadvantage that the choice of any specific concentration level is arbitrary, and is inconsistent with the spirit of cost-benefit analysis. But it has the advantage of being analytically tractable.

Stabilization of concentrations at 550 ppmv

We will consider the question of the optimal path subject to the constraint that concentrations be stabilized at 550 ppmv (approximately double the pre-industrial level of 275 ppmv1). One might ask why we need accept a level of concentrations, and corresponding probability of catastrophe, as high as this. Indeed, why accept <u>any</u> probability of catastrophe? It is important to recognize that it is already too late to keep this probability at zero (even if one were to accept that it would have been worth the cost to do so, had we known at the beginning of the Industrial Revolution what we know now). Concentrations are already at 365 ppmv, and it is impossible to prevent them rising further in the short run; one would have to reduce emissions virtually to zero to do so.

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WRE argue that this path has much lower economic costs than proposed paths that are more aggressive in terms of timing, while producing the same terminal effects on concentration. The more aggressive path they examine is the IPCC Working Group path 1 [WGI], which entails Annex I fossil fuel emissions peaking in 1990 and falling 24 percent worldwide below 1990 levels by 2010.2 (Of course, it is too late for this scenario to be realized. Below, we will also consider other alternative proposals that, while sufficiently ambitious as to be expensive to achieve, at least have the virtue of not having been ruled out by history ~~the passage of~~ seven years during which emissions has passed manifestly have not in fact begun to fall in the overwhelming majority of countries.)

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It is difficult to imagine that the industrialized countries will be able to extract commitments from developing countries much more serious than those assumed in the preceding section, the Manne-Richels burden-sharing schedule. What if, as is more likely, the commitments extracted from developing countries are less strong than this, rather than more? On the one hand, as a matter of arithmetic, meeting the 550ppmv concentration constraint would require more aggressive targets and timetables on the part of the Annex I countries, if indeed it would be possible at all. On the other hand, as a matter of politics, the absence of the developing countries would probably lead the peoples of the Annex I countries to choose a less aggressive path, even though it would produce a higher terminal concentration level.6 (An analytical balancing of costs and benefits would give the same answer -- a less aggressive path -- once the concentration constraint is relaxed.)

To consider the possibility that developing countries might decline to participate, or decide to participate only to a lesser degree than the Manne-Richels burden-sharing formula, we ask what would be the effects, both economic and climatological, if the Annex I countries were constrained to the WRE path and developing countries do not participate (i.e., developing countries remain on their BAU path). The welfare losses (in terms of present discounted value) will depend upon whether there is trading in emission rights among Annex I countries. If Annex I trading occurs, then Annex I countries' losses increase from $0.62 trillion to $0.91 trillion, or 47%. If emission trading among Annex I countries does not occur, then losses rise to $1.00 trillion, or 61%. For the U.S., in the absence of developing country participation, welfare losses rise from $0.28 to $0.36 trillion, or 29%, assuming Annex I trading. Without Annex I trading, U.S. losses rise to $0.41 trillion or 46%.7

Even if the Annex I countries choose an aggressive path of reducing emissions 10% below 1990 levels by 2010 (and stay at that level thereafter), the effect is to reduce global concentrations only 7 % below BAU levels in the year 2100. This is less than a third of the reductions achieved when the developing countries participate [22%; conversation 8/28] This result illustrates the problem of free riding. The estimate does not include an allowance for "leakage" of carbon savings from participating to non-participating countries (e.g., reduced oil demand in the former, via a lower world price of oil, raises oil consumption in the latter). Once leakage effects are added to the free-riding problem, the difficulty of accomplishing meaningful reductions without the help of developing countries are even greater. The savings is only 5 percent in this case. In other words, of the 22 percent reductions achieved when the developing countries participate, 15 percentage points are lost to free-riding, and another 2 points to carbon leakage. [conversation 8/29.]

[The difference for concentrations can be crudely translated into an estimate of the effect on temperature in 2050 or 2100 by means of simple interpolation of IPCC estimates...]

~~revisions~~ of section 2

of 7x7 paper

Joseph E. Aldy
09/04/97 04:00:15 PM

Record Type: Record

To: Jeffrey A. Frankel/CEA/EOP

cc:
Subject: Toman's write-up

Appendix 1

Courtesy of Zach, here is Toman's IA write-up.

TOMAN_IA.WPD

2. Cost-benefit analysis in "Integrated Assessment" models

Integrated Assessment (IA) analyses try to bring together assessments of the physical, ecological, economic, and social impacts of climate change with assessments of policies for responding to climate change and their socioeconomic consequences. Generally speaking, the models can be described schematically as linking economic decisions in the energy (and agriculture) sectors that give rise to GHG emissions (and changes in carbbon sequestration), models of atmospheric composition, climatic change, and changes in oceans, and models that describe the potential impacts of climate change on health, natural resources, coastal areas, and other factors of socioeconomic interest. Different components of various IA frameworks are represented in differing degrees of detail and sophistication. A few models contain the capacity to be used for a benefit-cost analysis, in which it is possible to evaluate changes in the long-term path of GHG emissions that maximizes the net benefits of GHG control (these benefits are the avoided damages of climate change less the costs of control). A larger number of IA models can evaluate the benefits and costs of specified policies but are unable to indicate what emissions reductions maximize net benefits. IA frameworks are inherently more "top-down" in their characterization of economic decisionmaking, though some models contain a fair amount of energy sector detail.

A very striking feature of IA models is that they tend to indicate the desirability – from the perspective of maximizing net benefits over time -- of emissions continuing to rise well into the next century, if not beyond. (For a recent comparison of IA model results, see Manne 1996. [JEFF: Do you want cites of individual models too?]) By 2010, the models indicate only small deviations downward from a business as usual (BAU) path (see also IPCC 1996b, Chapter 10). In some cases the emissions do stabilize toward the middle of the next century, but in other cases they continue rising (though more slowly than with business as usual) even beyond 2100. These emissions paths clearly imply increases in atmospheric concentrations of GHGs well beyond the kinds of targets that have been considered in current policy debates (e.g., 550 ppm). One important consequence is that the models indicate costs of near-term emissions stabilization well in excess of the avoided damage costs.

As noted in text,
A number of criticisms have been levelled at these IA results. These criticisms include:

Failure to consider the possibility of unlikely but catastrophic events that could result from climate change (e.g., catastrophic sea level rise from melting of the Antarctic ice sheet, runaway global warming from frozen methane releases, or relocation of the Gulf Stream – see IPCC 1996a, Chapter __).

Failure to give adequate consideration to the scale of potential damages, even in the absence of catastrophe. Cline (1992), for example, argues that damages are much higher than is incorporated in most IA models (see also IPCC 1996a, Chapter 6 for various estimates). One specific concern that has been raised is that the IA models do not account adequately for the costs of a less stable climatic and ecological systems in the face of GHG accumulations.

Failure to consider the adverse consequences of less aggressive abatement policies for future generations – in the context of IA models themselves, the criticism is that discounting of future generations' well-being is excessive. Cline (1992) also raises this concern, as does Howarth (199_).

Failure to consider how uncertainty about all these effects affects the "optimal" decision (Pizer 1997).

Failure to consider how lack of early action will jeopardize the achievement of any longer-term mitigation by signalling a lack of political will ([NEED CITE]), or how lack of early action will retard induced technical progress that is needed to make mitigation affordable (Grubb 1995).

Sensitivity analyses carried out with IA models suggest that at least some of these criticisms are not major concerns; others may be serious concerns, but empirical judgments are not possible given the current state of knowledge. The Manne (1996) survey referred to above considered scenarios in which the climate's sensitivity to accumulating GHGs was greater than is typically assumed, or the the damages are larger (by a factor of almost 8) for a given change in the atmosphere. In either case emissions should (from the perspective of maximizing net benefits) be lower, but the extra degree of emissions reductions required by 2010 is significant (on the order of 25 percent or more) only if climate damages are much higher than expected (the sensitivity of the atmosphere to GHG emissions seems much less important in these analyses). And even in this case, emissions still will be higher than 1990 levels unless the atmosphere and the ecological-economic systems both are quite sensitive. (Broadly similar conclusions follow if, instead of looking at higher damages, one looked at damages that grew proportionately faster as atmospheric GHG concentrations grew [CETA cite]). Thus, the IA models give little support for a policy of near-term emissions stabilization unless damages turn out to be much higher than at least some experts expect.

(6 th Cir

It is also true that the results of IA models are sensitive to the choice of discount rate used to compare consumption today and in the future. A very low discount rate will imply greater weight on damages accruing over time to future generations, and thus the need for a more aggressive abatement strategy. This tradeoff is influenced by the rate of economic growth, since growth will make future generations better off and thus better able to afford and respond to the damages of climate change (Schelling 1995). However, there are numerous economic and ethical controversies surrounding the appropriate way to discount future damages in IA models, and no clear consensus has emerged. One important point that is often ignored in this debate is how much *today's* generation is willing to sacrifice to provide for the increased protection of future generations through GHG abatement; this is a critical unknown since it is today's generation that must necessarily must decide to pay the bill. All that can be said analytically, therefore, is that intergenerational equity *might* be an argument for more aggressive abatement.

Uncertainty about future damages or other influences on the costs and benefits of abatement can make a difference. However, Pizer's (1997) analysis suggests that the most important source of uncertainty concerns the nature of our preferences for consumption and environmental protection. (Unlike the Manne (1996) analysis, Pizer considers the possibility that damages may be lower as well as larger.) A recent paper by Gjerde et al (1997) considers the risk of a sudden loss of economic output and well-being on the scale of the Great Depression from climate change. While their analysis indicates more aggressive abatement than other IA analyses without this risk, the introduction o the risk has little relative effect on the desirable level of emissions reduction by 2010, and little effect for a number of years thereafter (unless the loss is much larger even than the Depression).

This leaves the issues of political credibility and induced technical change. As for the latter, it is true that sending a less strong signal to energy markets will slow up technical progress. However, there is great uncertainty about how much of a loss this would be in practice, and the loss would have to be greater than most models seem to indicate before the substantial costs of near-term stabilization could be justified. This does *not* mean, however, that *no* actions are justified on cost-benefit grounds to reduce emissions or stimulate technical progress. Aside from initial steps to curb emissions growth, which signal the need for technical change, longer-term measures to promote the development of new technology are warranted. Political credibility is a more complicated issue to which we return below.

3. Estimates of optimal paths to stabilize GHG concentration levels

Much of the debate about GHG stabilization takes as given that simply allowing emissions to continue to grow for a long period, albeit more slowly, puts the biosphere at too much risk and is not credible politically. An alternative strategy....[continue with current text]

Comments on political credibility to be inserted somewhere in the text

Political credibility arises frequently in the discussion of imtertemporally flexible approaches to GHG mitigation. It is argued, that allowing emissions reductions to be deferred to a more distant future invites noncompliance with our domestic obligations, and risks sending a signal to countries not in line for immediate emissions targets that curbing emissions is not a serious matter. Several other points do not seem to surface in this debate and are important to put the issue in context.

(1) A proposed agreement that demonstrably imposes much higher costs than an alternative more measured approach, and thereby invites substantial domestic political opposition, will also suffer from credibility problems both here and abroad.

(2) The concern about emissions reductions agreements being shirked rather than postponed is a legitimate one, but there are a variety of ways it might be addressed. [Add options here – they should include performance bonds that require carbon debts to be paid back, and (less efficient but more straightforward) simply a backloading of emissions reductions goals in the targets/timetables. The latter may not be credible, but there is little that can be done if a country really sees the burden of successively greater emissions reductions as greater than the cost of noncompliance.]

(3) Demonstrating willingness to reduce our emissions may not make much difference to the willingness of other countries to reduce their emissions anyway, particularly in developing countries for whom climate change is a low-priority issue. It might be much more effective to take some of the subtantial cost savings from shifting emissions reductions into the future and use them to help develop and diffuse low-emissions technologies that those countries will want to adopt for their own reasons.

toman @ rff.org
08/25/97 09:43:00 AM

Record Type: Record

To: Jeffrey A. Frankel

cc:
Subject: text on IA models with catastrophe

One of the criticisms of many integrated assessments (IAs) is that they do not incorporate the possibility of catastrophe. Recent extensions of the IA literature include the possibility of a major, discontinuous jump inh the damages caused by climate change. For example, a European paper by Gjerde et al (1997) incorporates the risk that climate change will sudenly cause damages equal to a significantr share of global GDP. The risk is assumed to rise with an increase in temperatre from global warming; following Nordhaus (1994), the benchmark risk scenario assumes a 12% chance of a loss equal to 25% of GDP (the scale of the great depression) in 2090 if climate has warmed by 3 degrees C. Incorporating this risk into the IA framework causes the optimal path for global emissions to be reduced, but not by that much in the early years. By 2060, optimal emissions are only somewhat over half what they would have been without the risk of catastrophe, but the reduction by 2020 is on the order of 15% below the no-catastrophe case and still above emissions in 1990. (The no-catastrophe optimal path is substantially below BAU in this analysis, an artifact of the assumptions of low abatement cost and high damage cost.) fn Even sharper emissions reductions are implied if the catastrophe is truly shattering (on the order of the entire GDP), or if the discount rate is extremely low (high intergenerational egalitarianism.)

Jon Gjerde, Sverre Grepperud, and Snorre Kverndokk, "Optimal Climate Policy Under the Possibility of Catastrophe," presented at the 1997 EAERE meetings, Tilburg. [WARNING: NOT PEER_REVIEWED and may be unreliable as a consequence. The only peer-reviewed analyses I could find had technical drawbacks, mainly oversimplified models of damages.]

William Nordhaus, "Expert Opinion on Climate Change," AMERICAN SCIENTIST vol 82, 1994, 45-51.

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- wishful thinking / tech free lunch

- Magn. of transfer

- p8 Table

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