Environmental Economics

1. Intro: Why monetize the environment?
2. How to monetize the environment.
   a. Travel cost models
   b. Averting expenditures
   c. Hedonic property values, wages, and the value of a statistical life
   d. Contingent valuation
3. Policy designs
   a. Market-based policies: taxes and tradable permits
   b. Grandfathering existing sources
   c. Federalism
4. Effects of environmental regulations on

   firm location, wages, trade … and the environment.

The New York Times

Court Blocks E.P.A. Rule on Cross-State Pollution

By MATTHEW L. WALD

Published: August 21, 2012

WASHINGTON — A federal appeals court on Tuesday overturned a federal rule that laid out how much air pollution states would have to clean up to avoid incurring violations in downwind states.

David J. Phillip/Associated Press

The rule was intended to address how to deal with states whose plants pollute air in other states.

The decision sends the Environmental Protection Agency, and perhaps even Congress, back to the drawing board in what has become a long and paralyzing argument over how to mesh a system of state-by-state regulation with the problem of industrial smokestacks pumping pollutants into a single atmosphere.

Why value the environment in $?

1. For damage assessment in legal cases.
2. To choose among policies.
3. To choose the stringency of policy.

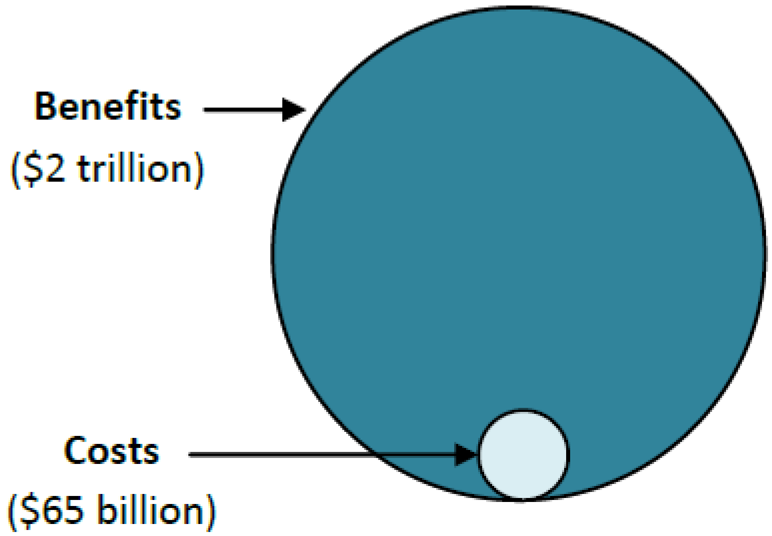
To choose among policies.

Cost of U.S. Environmental Regulations per Life Saved

Regulation	Year Enacted	Cost per life saved (millions of 2012 $)
Trihalomethane in drinking water	1979	$0.4
Radionuclides standards for uranium mines	1984	7.2
Benzene NESHAP (original)	1984	7.2
Ethylene dibromide in drinking water	1991	12.0
Benzene NESHAP (revised)	1988	12.9
Ethylene oxide occupational exposure limit	1984	43.0
Arsenic / copper NESHAP	1986	48.3
Petroleum sludge hazardous waste listing	1990	58.0
Cover / move uranium mill tailings (inactive)	1983	66.5
Benzene NESHAP (revised)	1990	69.1
Cover / move uranium mill tailings (active)	1983	94.5
Asbestos ban	1989	232.3
Benzene NESHAP (revised)	1990	352.9
1,2-Dichloropropane in drinking water	1991	1,370.3
Hazardous waste land disposal ban	1988	8,793.4
Municipal solid waste landfills	1988	40,094.8
Atrazine / alachlor in drinking water	1991	193,202.0
Wood-preservatives hazardous waste listing	1990	11,961,062.6

Source: Viscusi et al., *Journal of Risk and Uncertainty* 1997.

The Benefits and Costs of the Clean Air Act from 1990 to 2020: Summary Report



Benefits
($2 trillion)

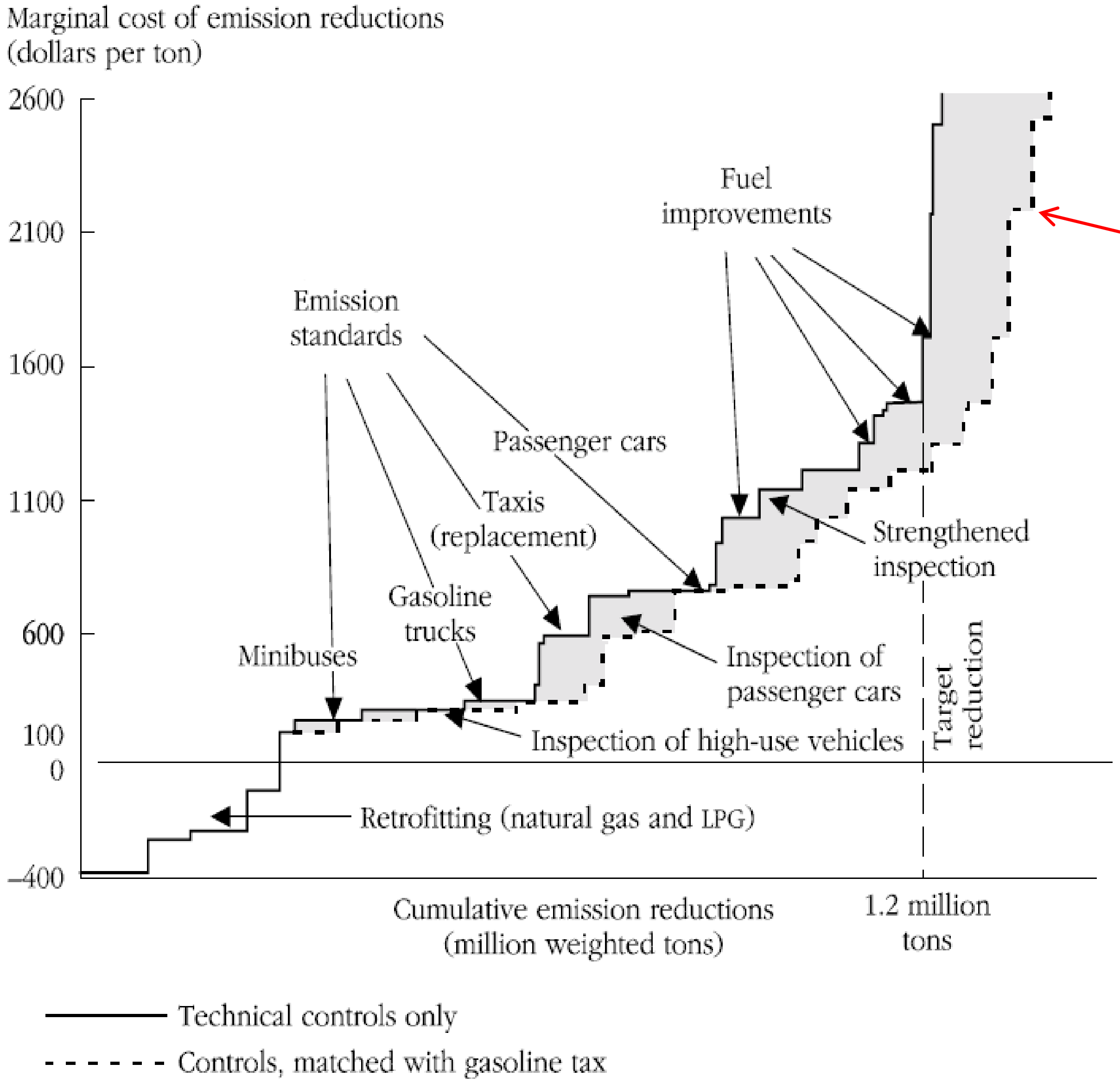
Costs
($65 billion)

The 1990 Clean Air Act Amendments prevent:

	Year 2010 (cases)	Year 2020 (cases)
Adult Mortality - particles	160,000	230,000
Infant Mortality - particles	230	280
Mortality - ozone	4,300	7,100
Chronic Bronchitis	54,000	75,000
Acute Myocardial Infarction	130,000	200,000
Asthma Exacerbation	1,700,000	2,400,000
Emergency Room Visits	86,000	120,000
School Loss Days	3,200,000	5,400,000
Lost Work Days	13,000,000	17,000,000

http://www.epa.gov/oar/sect812/prospective2.html

Program to Reduce Air Pollution Emissions from Transport in Mexico City, with and without a Gasoline Tax

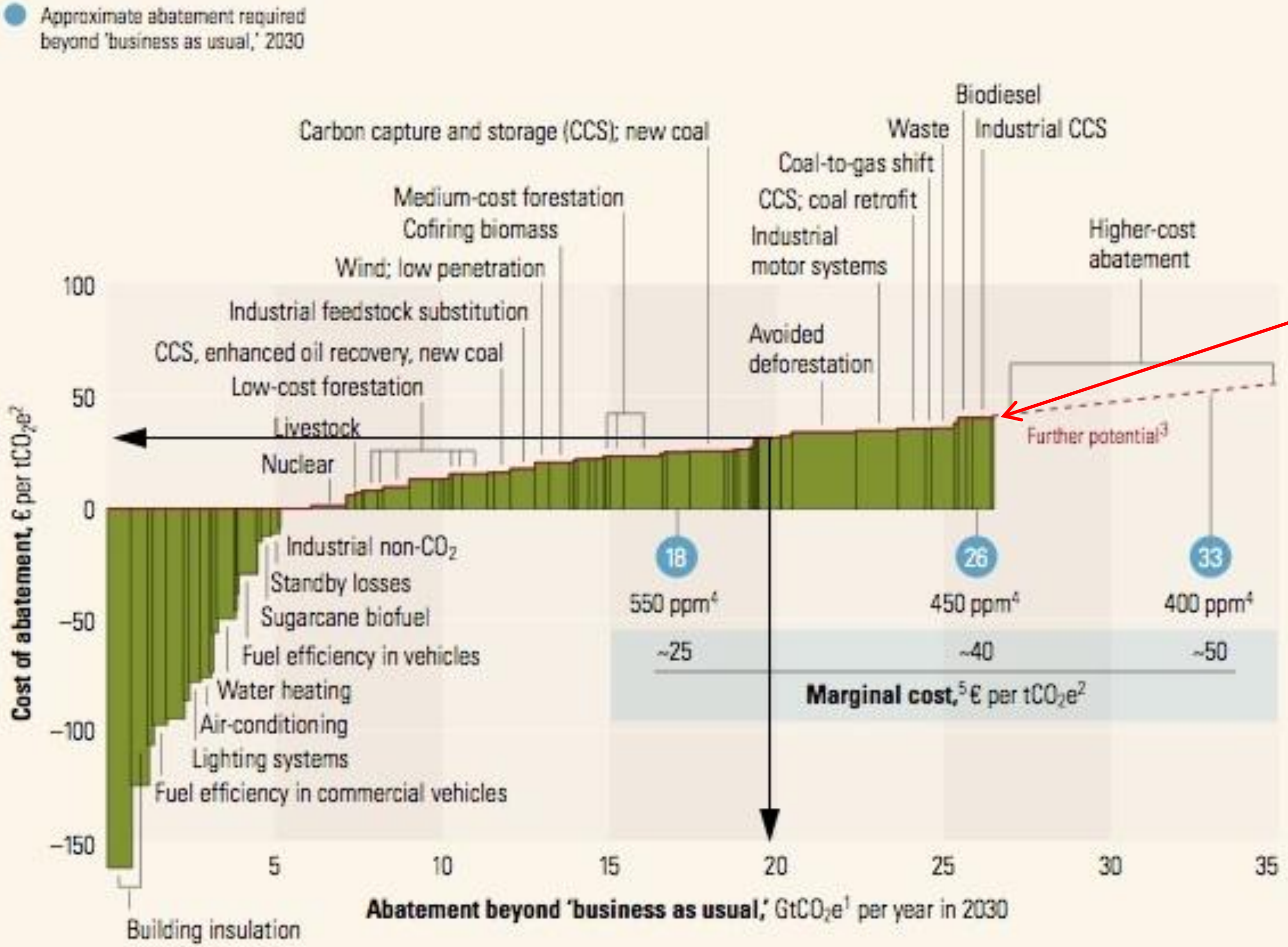


Marginal Abatement Cost (MAC)

Eskeland, 1994

What might it cost?

Global cost curve for greenhouse gas abatement measures beyond 'business as usual'; greenhouse gases measured in $GtCO_2e$[1]



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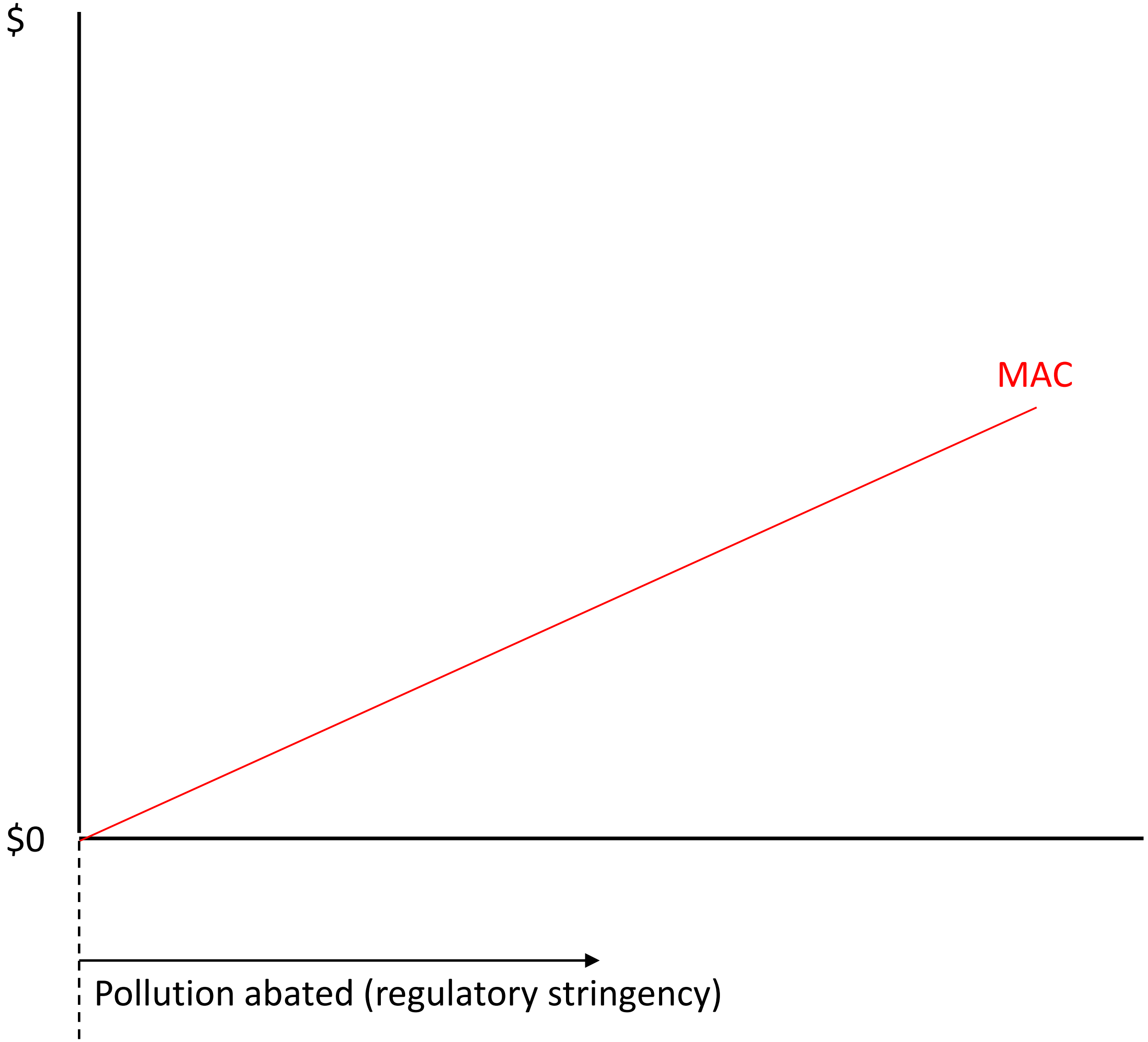
[1] $GtCO_2e$ = gigaton of carbon dioxide equivalent; "business as usual" based on emissions growth driven mainly by increasing demand for energy and transport around the world and by tropical deforestation.
[2] tCO_2e = ton of carbon dioxide equivalent.
[3] Measures costing more than €40 a ton were not the focus of this study.
[4] Atmospheric concentration of all greenhouse gases recalculated into CO_2 equivalents; ppm = parts per million.
[5] Marginal cost of avoiding emissions of 1 ton of CO_2 equivalents in each abatement demand scenario.

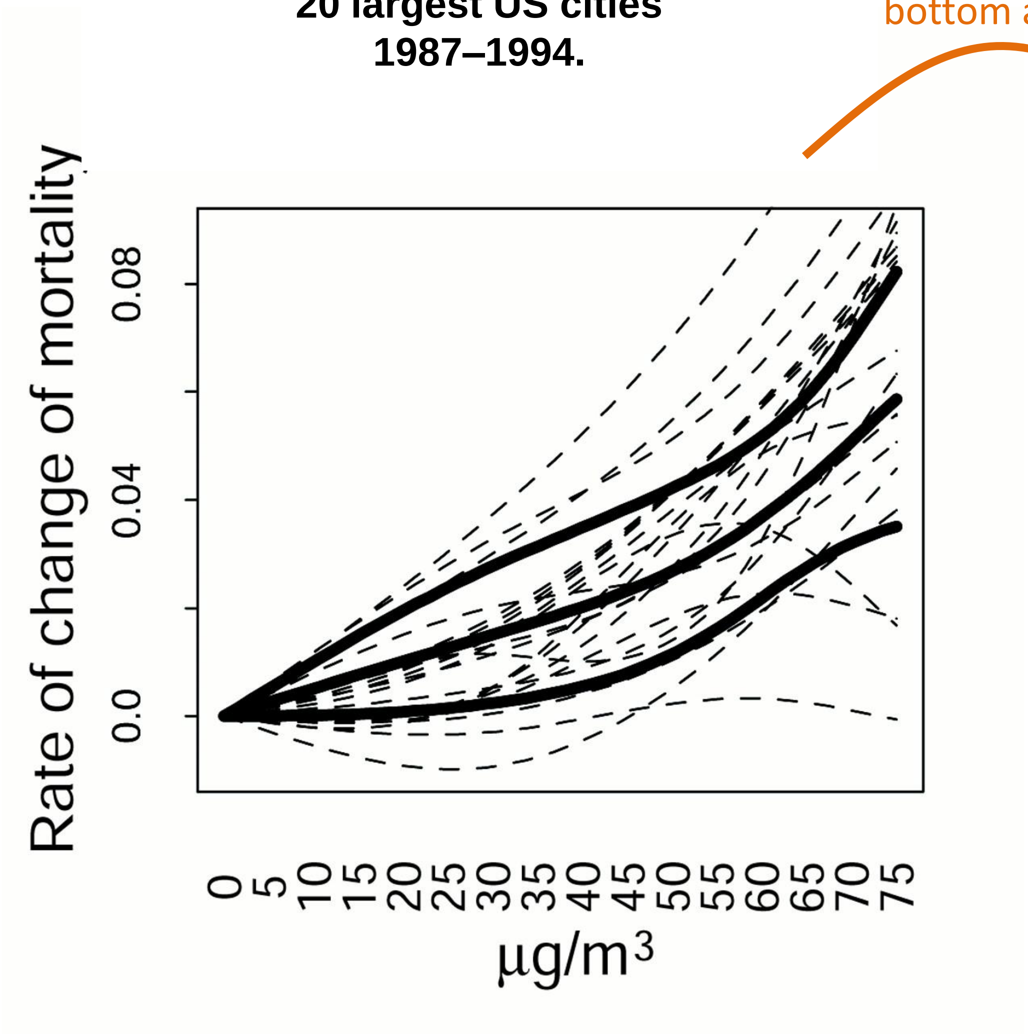
Marginal Abatement Cost (MAC)

Source: http://www.epa.gov/oar/caaac/coaltech/2007_05_mckinsey.pdf

Marginal Abatement **Cost** Curve

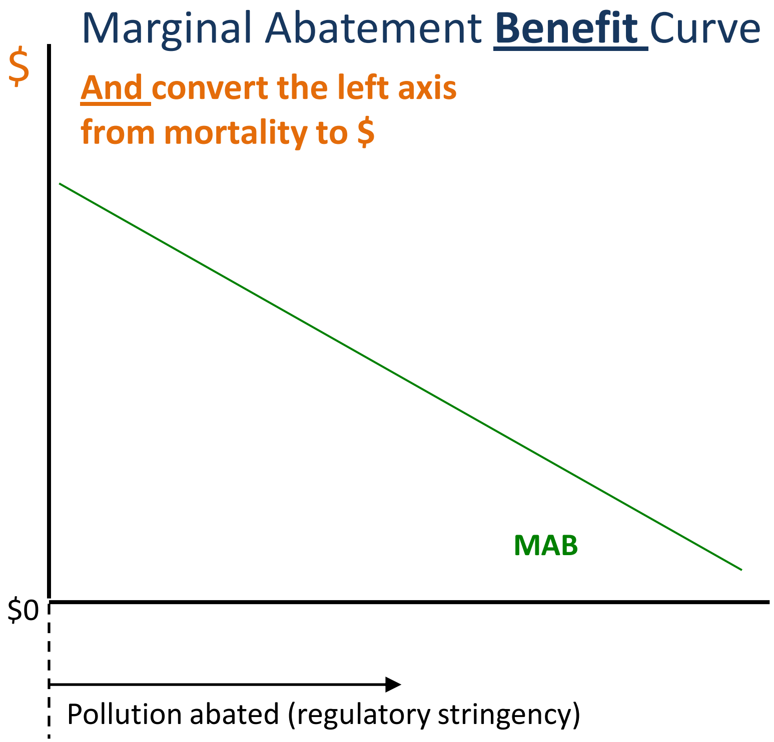


Particulate dose-response
20 largest US cities
1987–1994.



Daniels M J et al. Am. J. Epidemiol. 2000;152:397-406

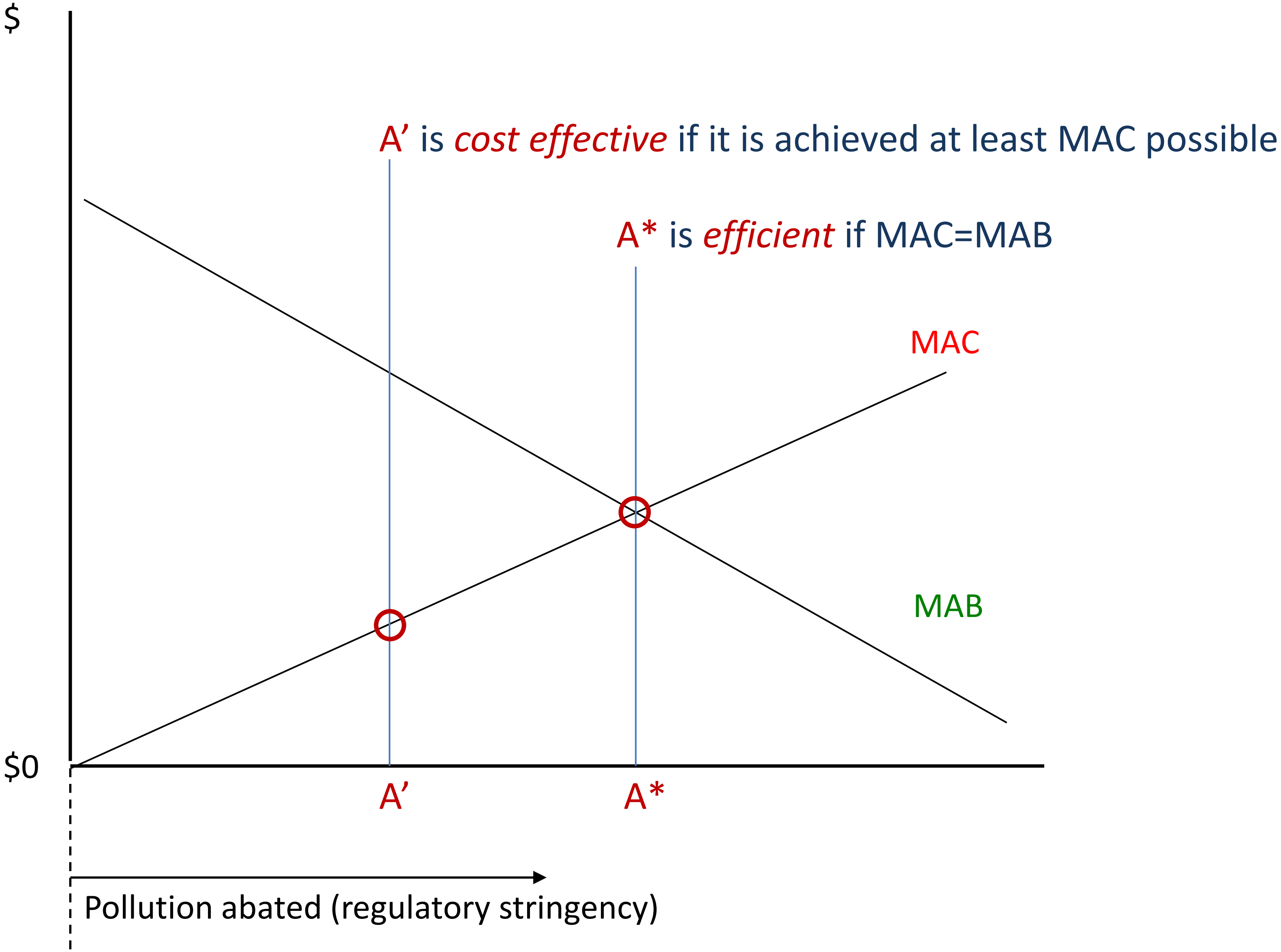
Reverse the bottom axis



Marginal Abatement **Benefit** Curve

And convert the left axis from mortality to $

Two policy goals: cost effectiveness and efficiency



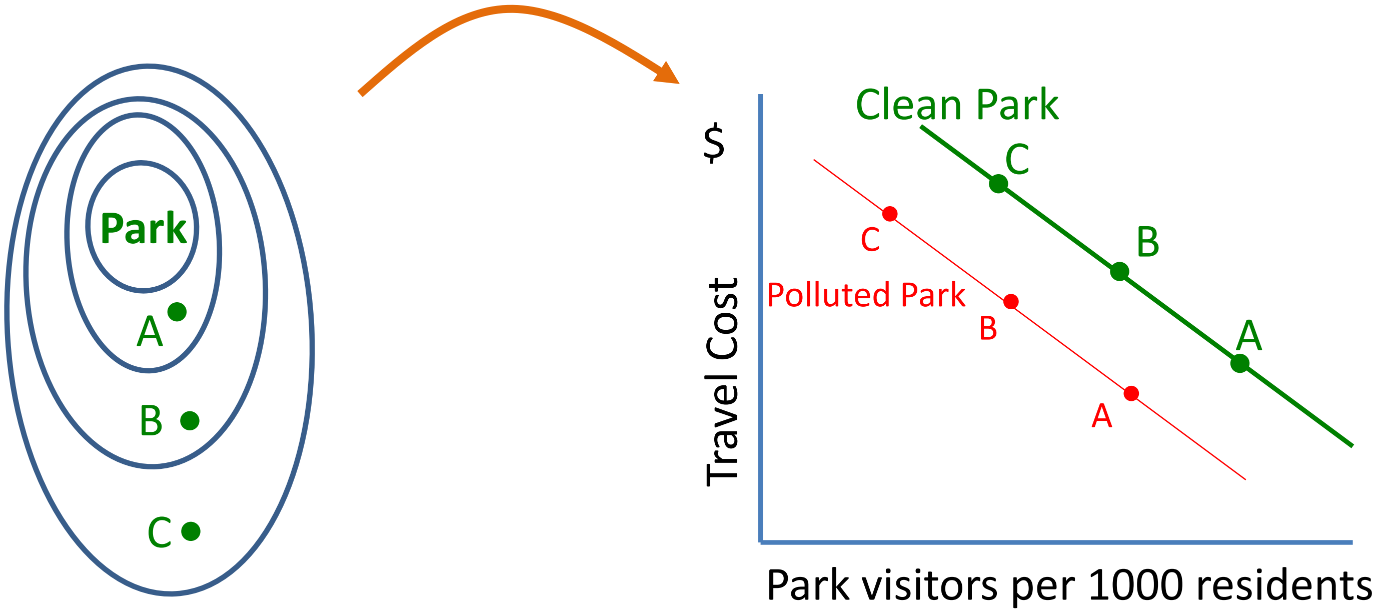
A’ is *cost effective* if it is achieved at least MAC possible

A* is *efficient* if MAC=MAB

2. How to monetize the environment.
    a. **Travel cost models**
    b. Averting expenditures
    c. Hedonic property values, wages, and the value of a statistical life
    d. Contingent valuation

Harold Hotelling, Letter to National Park Service, 1947

Let concentric zones be defined around each park so that the cost of travel to the park from all points in one of these zones is approximately constant. …. The comparison of the cost of coming from a zone with the number of people who do come from it, together with a count of the population of the zone, enables us to plot one point for each zone on a demand curve for the service of the park.



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Amoco Cadiz Oil Spill, 1978

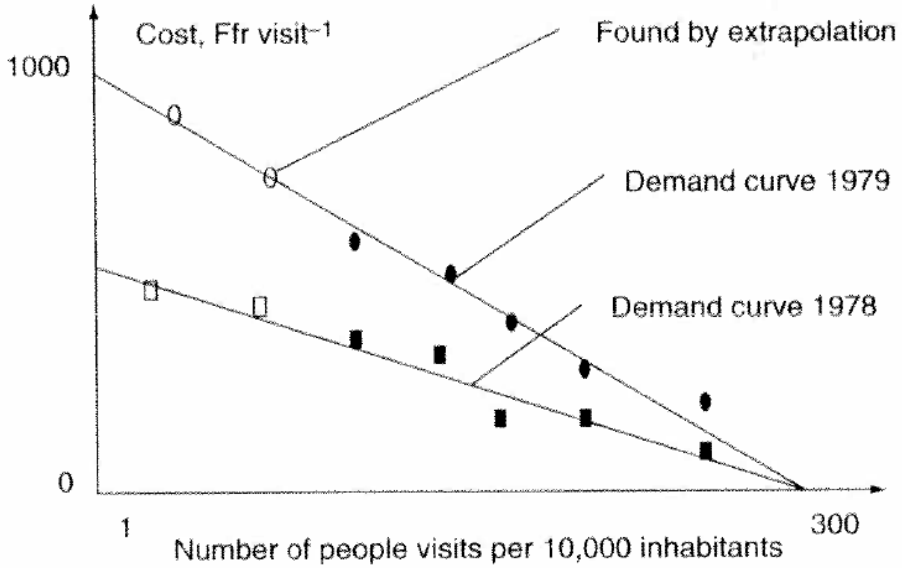

Figure 8-3. Demand curves for beach recreation in Brittany, France just after the Amoco Cadiz oil spill 1978 and one year after.[16]

Lost Consumer Surplus:
≈ $ 4 million ($2012)

Source: Seip, Knut Lehre Dordrecht, 2006.

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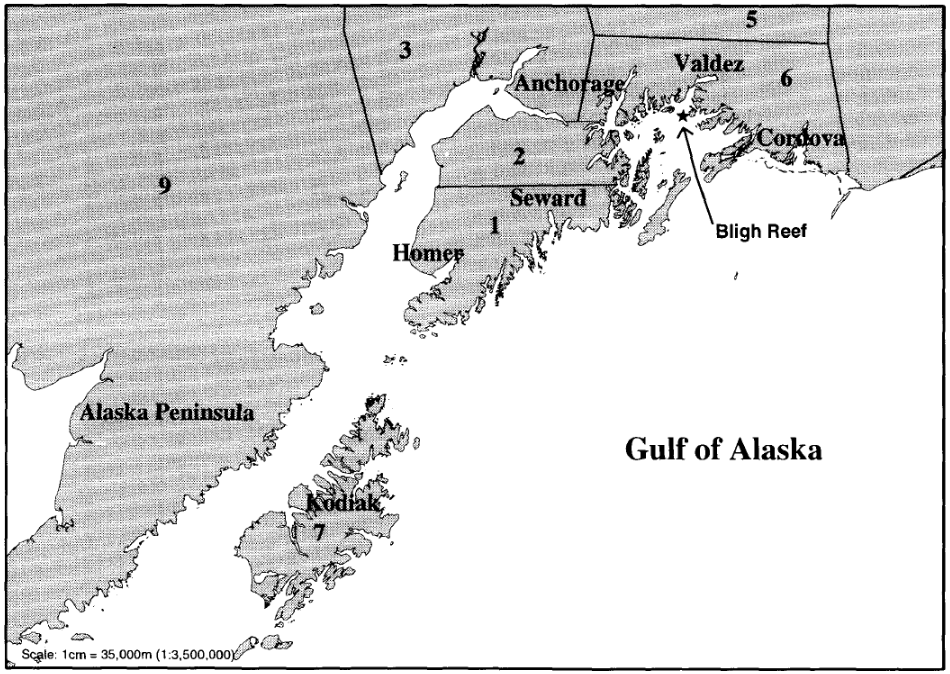
Exxon Valdez Oil Spill, 1989



Source: Hausman, Leonard, McFadden, 1995.

Lost Consumer Surplus:
≈ $ 7 million ($2012)

- 1994 Jury awarded
  - $287 M compensation
  - $5 B punitive damages
- 2001 9th Circuit
  - $2.5 B punitive
- 2008 US Supreme Court
  - $507 M

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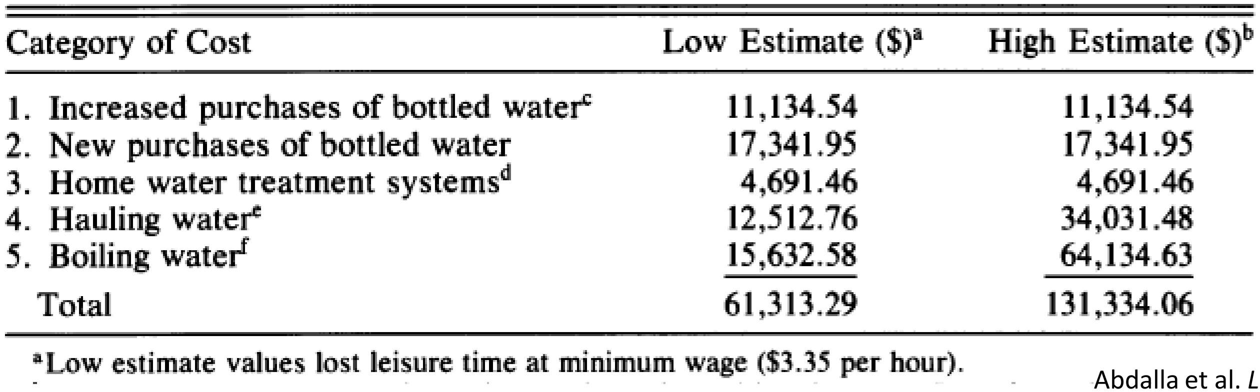
Cost of Groundwater Contamination in Perkasie, Pennsylvania, 1988



Category of Cost	Low Estimate ($)[a]	High Estimate ($)[b]
1. Increased purchases of bottled water[c]	11,134.54	11,134.54
2. New purchases of bottled water	17,341.95	17,341.95
3. Home water treatment systems[d]	4,691.46	4,691.46
4. Hauling water[e]	12,512.76	34,031.48
5. Boiling water[f]	15,632.58	64,134.63
Total	61,313.29	131,334.06

[a] Low estimate values lost leisure time at minimum wage ($3.35 per hour).

Abdalla et al. *Land Economics,* 1992

Other examples

- Air conditioners and filters to avoid air pollution.
- Health expenditures.

Problems

- Overstated costs if expenditures buy complementary goods.
- Understated costs if expenditures incompletely offset pollution.

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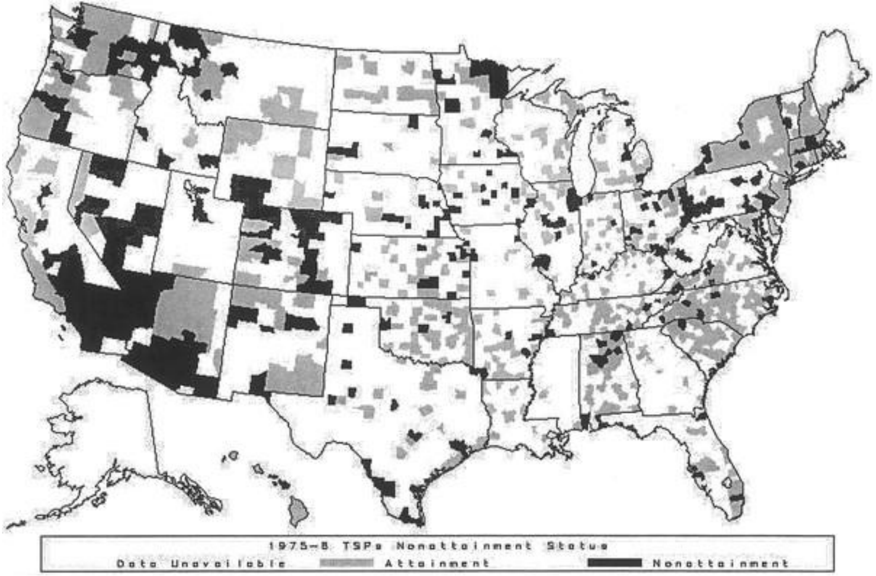
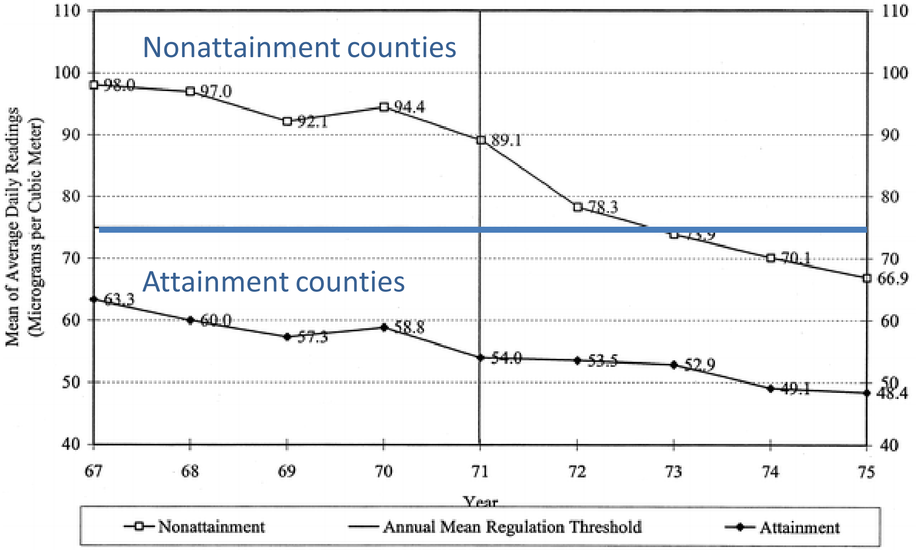
Benefits of the 1970 Clean Air Act

Nonattainment counties, 1972



Annual air pollution levels

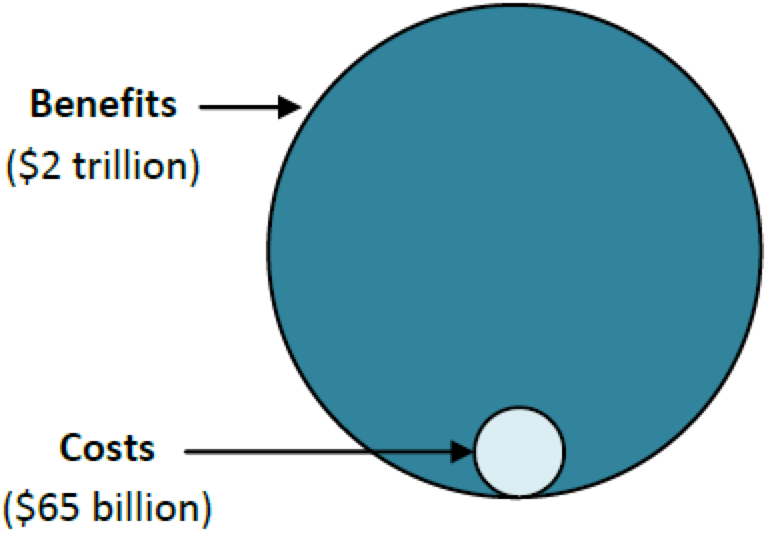


- Property values rose $2609 *more* in “nonattainment” counties.
- × 19 million homes …

$45 Billion

Chay and Greenstone *JPE* (2005).

The Benefits and Costs of the Clean Air Act from 1990 to 2020: Summary Report



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Reduced early deaths account for about 85 percent of estimated benefits.

http://www.epa.gov/oar/sect812/prospective2.html

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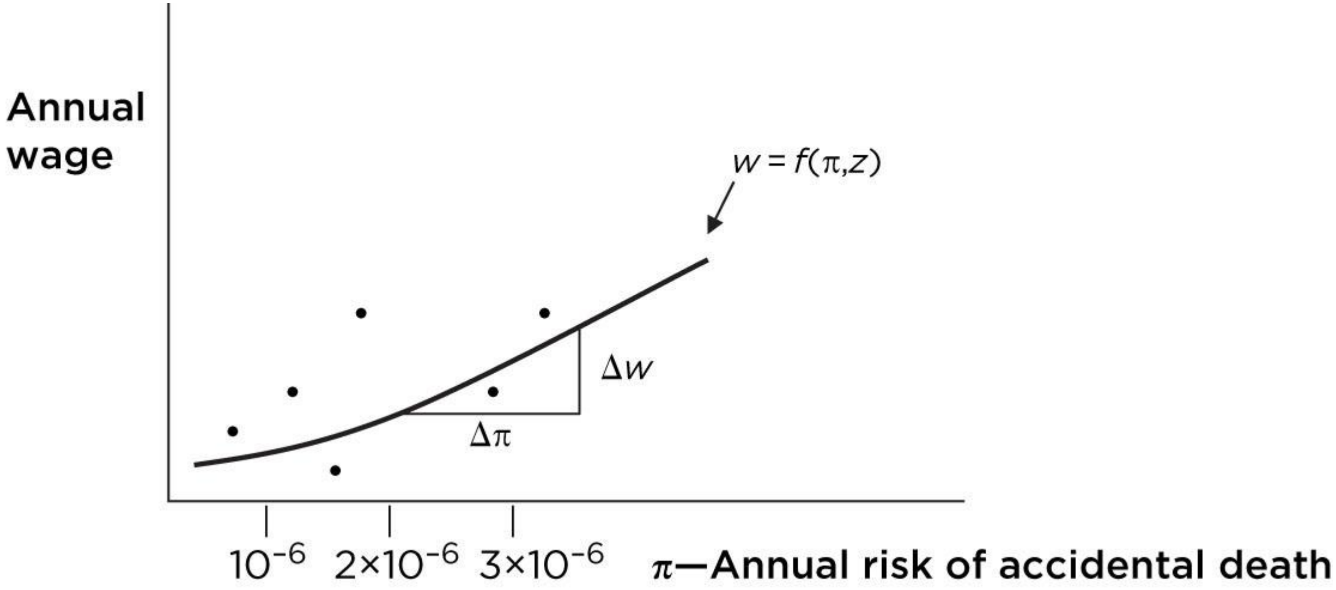
Risky jobs pay more, *all else equal*



Kolstad *Environmental Economics* 2010.

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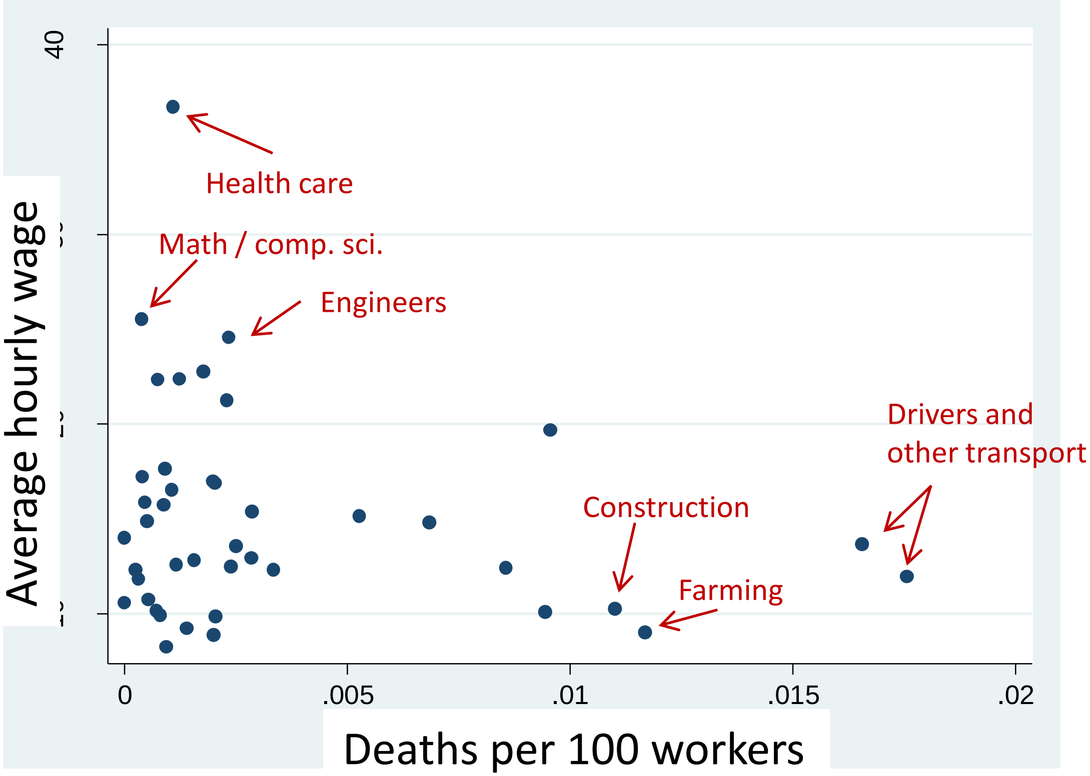
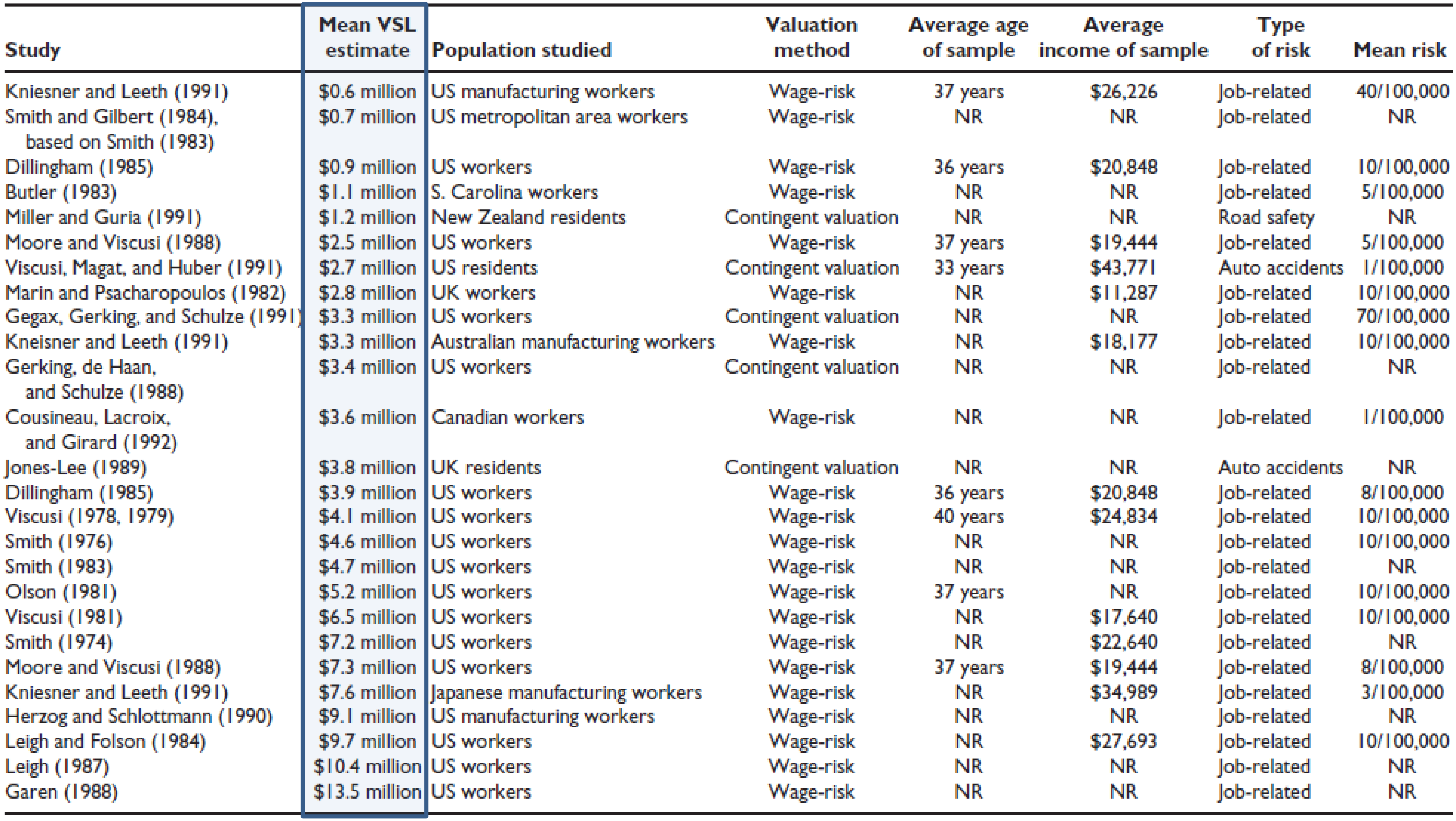
Problem: Risky jobs pay *less*



Value of a Statistical Life Used by the Environmental Protection Agency ($1990)



Study	Mean VSL estimate	Population studied	Valuation method	Average age of sample	Average income of sample	Type of risk	Mean risk
Kniesner and Leeth (1991)	$0.6 million	US manufacturing workers	Wage-risk	37 years	$26,226	Job-related	40/100,000
Smith and Gilbert (1984), based on Smith (1983)	$0.7 million	US metropolitan area workers	Wage-risk	NR	NR	Job-related	NR
Dillingham (1985)	$0.9 million	US workers	Wage-risk	36 years	$20,848	Job-related	10/100,000
Butler (1983)	$1.1 million	S. Carolina workers	Wage-risk	NR	NR	Job-related	5/100,000
Miller and Guria (1991)	$1.2 million	New Zealand residents	Contingent valuation	NR	NR	Road safety	NR
Moore and Viscusi (1988)	$2.5 million	US workers	Wage-risk	37 years	$19,444	Job-related	5/100,000
Viscusi, Magat, and Huber (1991)	$2.7 million	US residents	Contingent valuation	33 years	$43,771	Auto accidents	1/100,000
Marin and Psacharopoulos (1982)	$2.8 million	UK workers	Wage-risk	NR	$11,287	Job-related	10/100,000
Gegax, Gerking, and Schulze (1991)	$3.3 million	US workers	Contingent valuation	NR	NR	Job-related	70/100,000
Kneisner and Leeth (1991)	$3.3 million	Australian manufacturing workers	Wage-risk	NR	$18,177	Job-related	10/100,000
Gerking, de Haan, and Schulze (1988)	$3.4 million	US workers	Contingent valuation	NR	NR	Job-related	NR
Cousineau, Lacroix, and Girard (1992)	$3.6 million	Canadian workers	Wage-risk	NR	NR	Job-related	1/100,000
Jones-Lee (1989)	$3.8 million	UK residents	Contingent valuation	NR	NR	Auto accidents	NR
Dillingham (1985)	$3.9 million	US workers	Wage-risk	36 years	$20,848	Job-related	8/100,000
Viscusi (1978, 1979)	$4.1 million	US workers	Wage-risk	40 years	$24,834	Job-related	10/100,000
Smith (1976)	$4.6 million	US workers	Wage-risk	NR	NR	Job-related	10/100,000
Smith (1983)	$4.7 million	US workers	Wage-risk	NR	NR	Job-related	NR
Olson (1981)	$5.2 million	US workers	Wage-risk	37 years	NR	Job-related	10/100,000
Viscusi (1981)	$6.5 million	US workers	Wage-risk	NR	$17,640	Job-related	10/100,000
Smith (1974)	$7.2 million	US workers	Wage-risk	NR	$22,640	Job-related	NR
Moore and Viscusi (1988)	$7.3 million	US workers	Wage-risk	37 years	$19,444	Job-related	8/100,000
Kniesner and Leeth (1991)	$7.6 million	Japanese manufacturing workers	Wage-risk	NR	$34,989	Job-related	3/100,000
Herzog and Schlottmann (1990)	$9.1 million	US manufacturing workers	Wage-risk	NR	NR	Job-related	NR
Leigh and Folson (1984)	$9.7 million	US workers	Wage-risk	NR	$27,693	Job-related	10/100,000
Leigh (1987)	$10.4 million	US workers	Wage-risk	NR	NR	Job-related	NR
Garen (1988)	$13.5 million	US workers	Wage-risk	NR	NR	Job-related	NR

Current EPA standard = $8 Million

Robinson, *REEP*, 2007.

Cost of U.S. Environmental Regulations per Life Saved

Regulation	**Year Enacted**	**Cost per life saved (millions of 2012 $)**
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Source: Viscusi et al., *Journal of Risk and Uncertainty* 1997.

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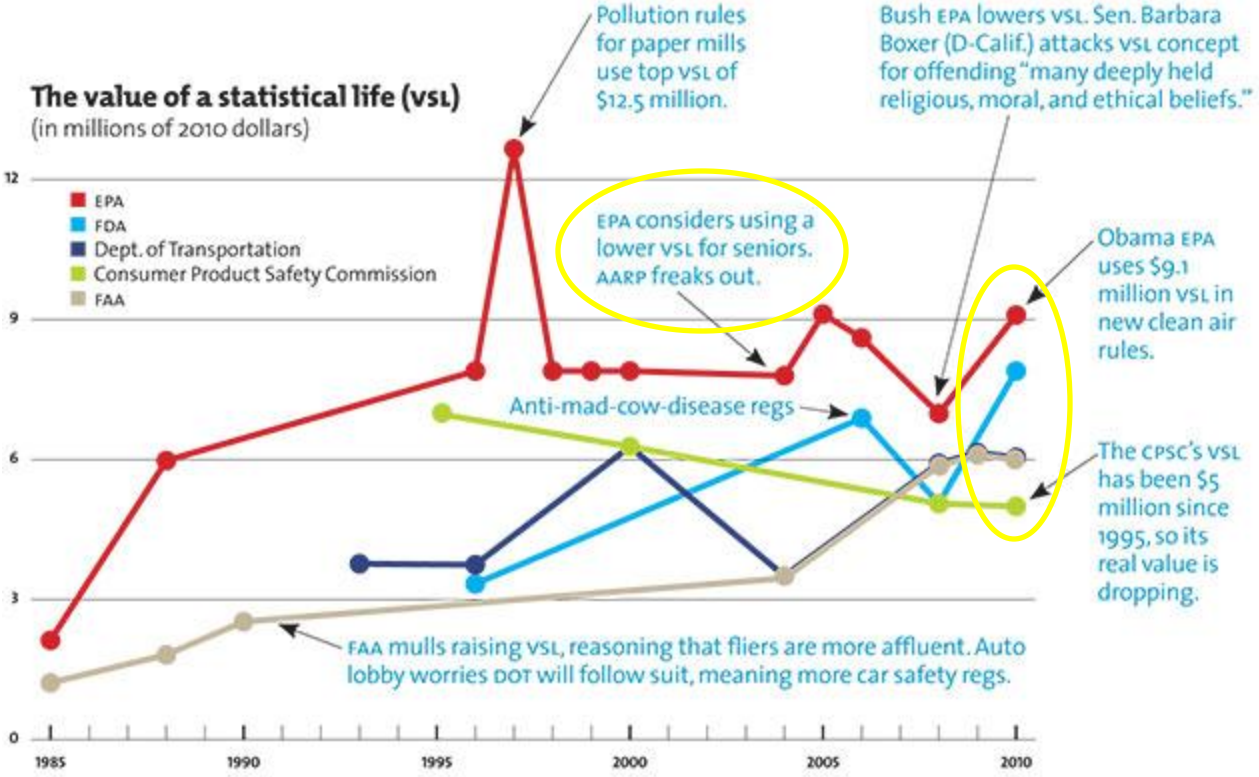

The value of a statistical life (VSL)
(in millions of 2010 dollars)

Pollution rules for paper mills use top VSL of $12.5 million.

Bush EPA lowers VSL. Sen. Barbara Boxer (D-Calif.) attacks VSL concept for offending "many deeply held religious, moral, and ethical beliefs."

EPA considers using a lower VSL for seniors. AARP freaks out.

Obama EPA uses $9.1 million VSL in new clean air rules.

Anti-mad-cow-disease regs

The CPSC's VSL has been $5 million since 1995, so its real value is dropping.

FAA mulls raising VSL, reasoning that fliers are more affluent. Auto lobby worries DOT will follow suit, meaning more car safety regs.

Sources: W. Kip Viscusi, Vanderbilt University; CPSC; DOT; EPA; FAA; FDA

Mother Jones (2011).

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How measure “non-use” value ?

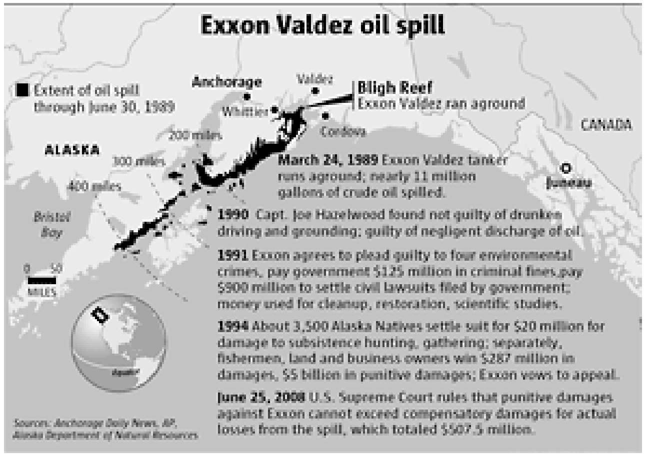
1995 NOAA Panel chaired by Arrow and Solow

1. Personal interviews.
2. Yes or no referendum format.
3. Respondents be given detailed information.
4. Income effects carefully explained.
5. Follow-up questions.

CV Example: Exxon Valdez Oil Spill

Survey of 1600 US residents.

CV Example: Exxon Valdez Oil Spill



March 24, 1989 Exxon Valdez tanker runs aground; nearly 11 million gallons of crude oil spilled.

1990 Capt. Joe Hazelwood found not guilty of drunken driving and grounding; guilty of negligent discharge of oil.

1991 Exxon agrees to plead guilty to four environmental crimes, pay government $125 million in criminal fines,pay $900 million to settle civil lawsuits filed by government; money used for cleanup, restoration, scientific studies.

1994 About 3,500 Alaska Natives settle suit for $20 million for damage to subsistence hunting, gathering; separately, fishermen, land and business owners win $287 million in damages, $5 billion in punitive damages; Exxon vows to appeal.

June 25, 2008 U.S. Supreme Court rules that punitive damages against Exxon cannot exceed compensatory damages for actual losses from the spill, which totaled $507.5 million.

Sources: Anchorage Daily News, AP, Alaska Department of Natural Resources

MCCLATCHY-TRIBUNE

CV Example: Exxon Valdez Oil Spill

<u>Carefully explain:</u>

- The accident.
- Effects on shore and wildlife.
- Birds and mammals are not endangered species.
- Wildlife populations expected to recover in 3-5 years.
- Exxon's efforts to clean up.

- A <u>proposal</u> to prevent future accidents.
- How the program would be financed: a one-time federal tax per household.

- The program is expected to prevent one similar spill during the next 10 years.

CV Example: Exxon Valdez Oil Spill

Question #1

At present, we expected the program to cost your household $60.

Would you vote for the program?

☐ Yes
☐ No

Question #2

- If the answer to question #1 is "yes".

What if the program were to cost your household $120?
Would you vote for the program?

☐ Yes
☐ No

- If the answer to question #1 is "no".

What if the program were to cost your household $30?
Would you vote for the program?

☐ Yes
☐ No

CV Example: Exxon Valdez Oil Spill

Results…..

Answers to first and second questions

Version	**Yes-Yes**	**Yes-No**	**No-Yes**	**No-No**	**Total**
A ($10, $30, $5)	45.1%	22.4%	3.0%	29.6%	100%
B (**$30**,**$60**,$10)	26.0%	**26.0%**	11.3%	36.6%	100%
C (**$60**,$120,**$30**)	21.3%	29.1%	**9.8%**	39.8%	100%
D ($120,$250,$60)	13.6%	20.6%	11.7%	54.1%	100%

Median answer: $30

Problem:

What fraction of the population is willing to pay between $30 and $60?

- People who answered “Yes” to $30, but “No” to $60: **26%.**
- People who answered “No” to $60” but “Yes” to $30: **9.8%**

CV Example: Exxon Valdez Oil Spill

Results…..

	Answers to first and second questions				
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B (**$30**,**$60**,$10)	26.0%	**26.0%**	11.3%	36.6%	100%
C (**$60**,$120,**$30**)	21.3%	29.1%	**9.8%**	39.8%	100%
D ($120,$250,$60)	13.6%	20.6%	11.7%	54.1%	100%

Median answer: $30

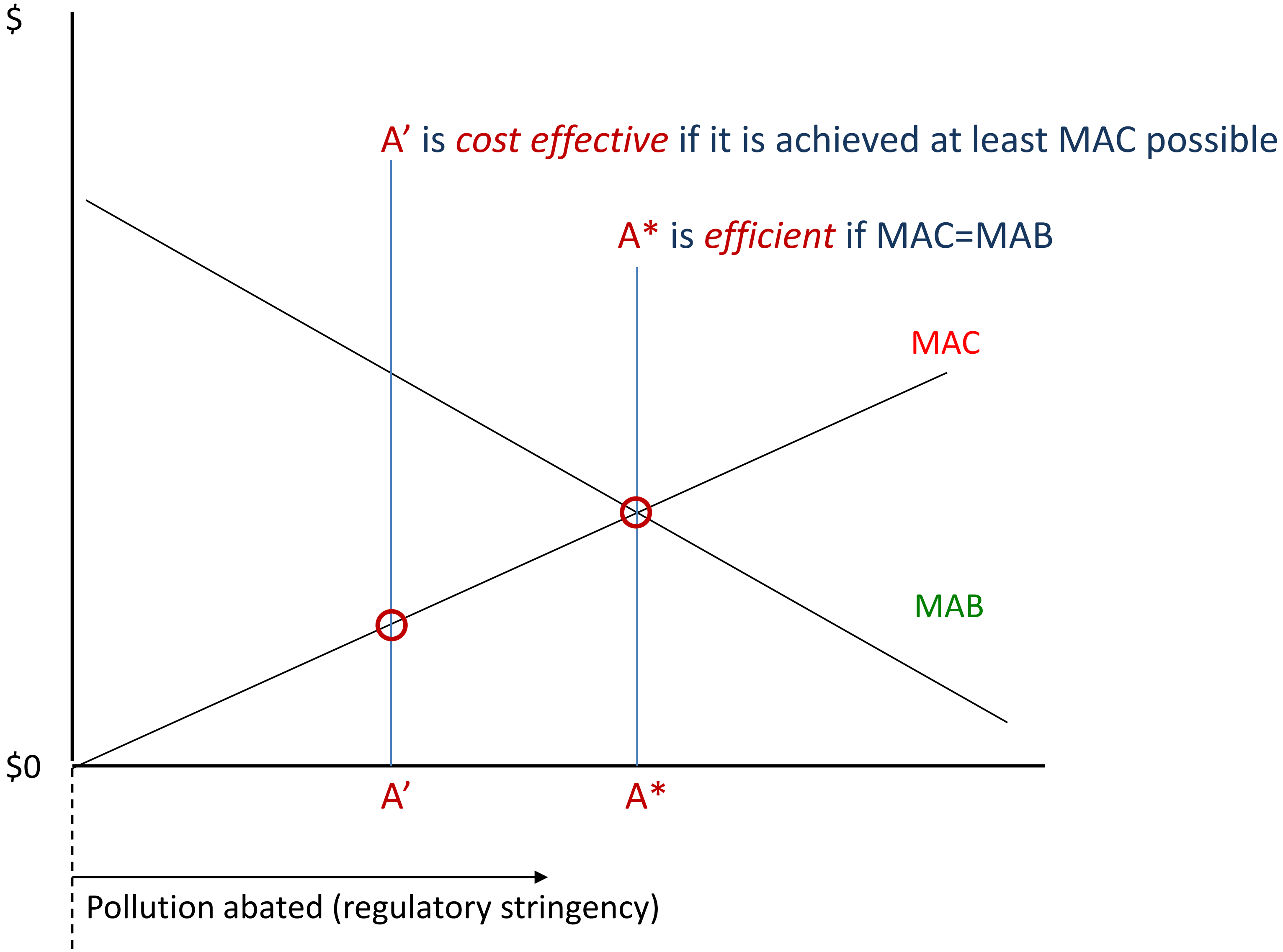
- Multiply by 90 million English-speaking U.S. households …

$2.8 Billion in $1990

($4.9 Billion today)

3. Policy designs

Two policy goals: cost effectiveness and efficiency



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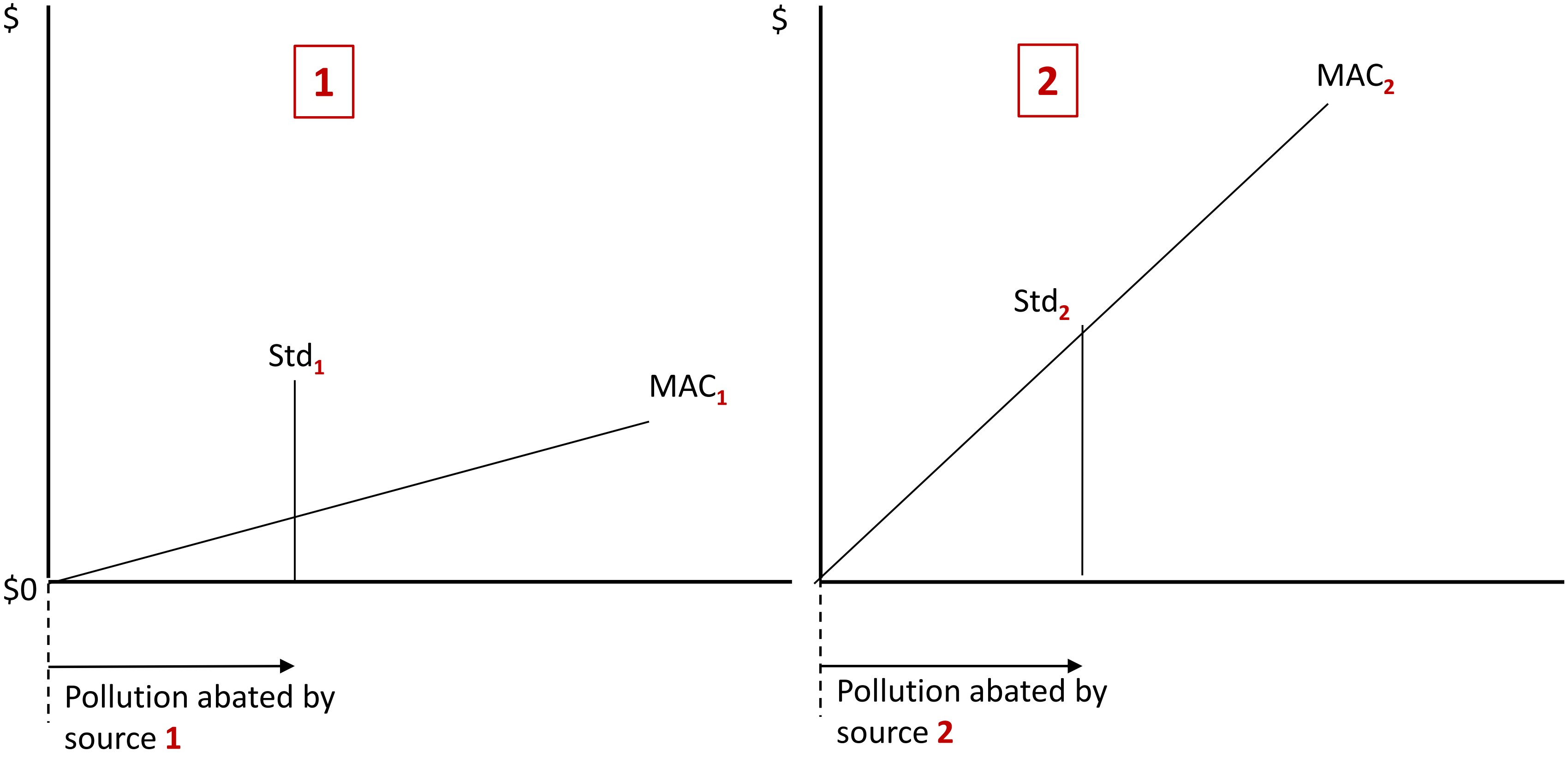
A* is *efficient* if MAC=MAB

THE TEXTBOOK MODEL



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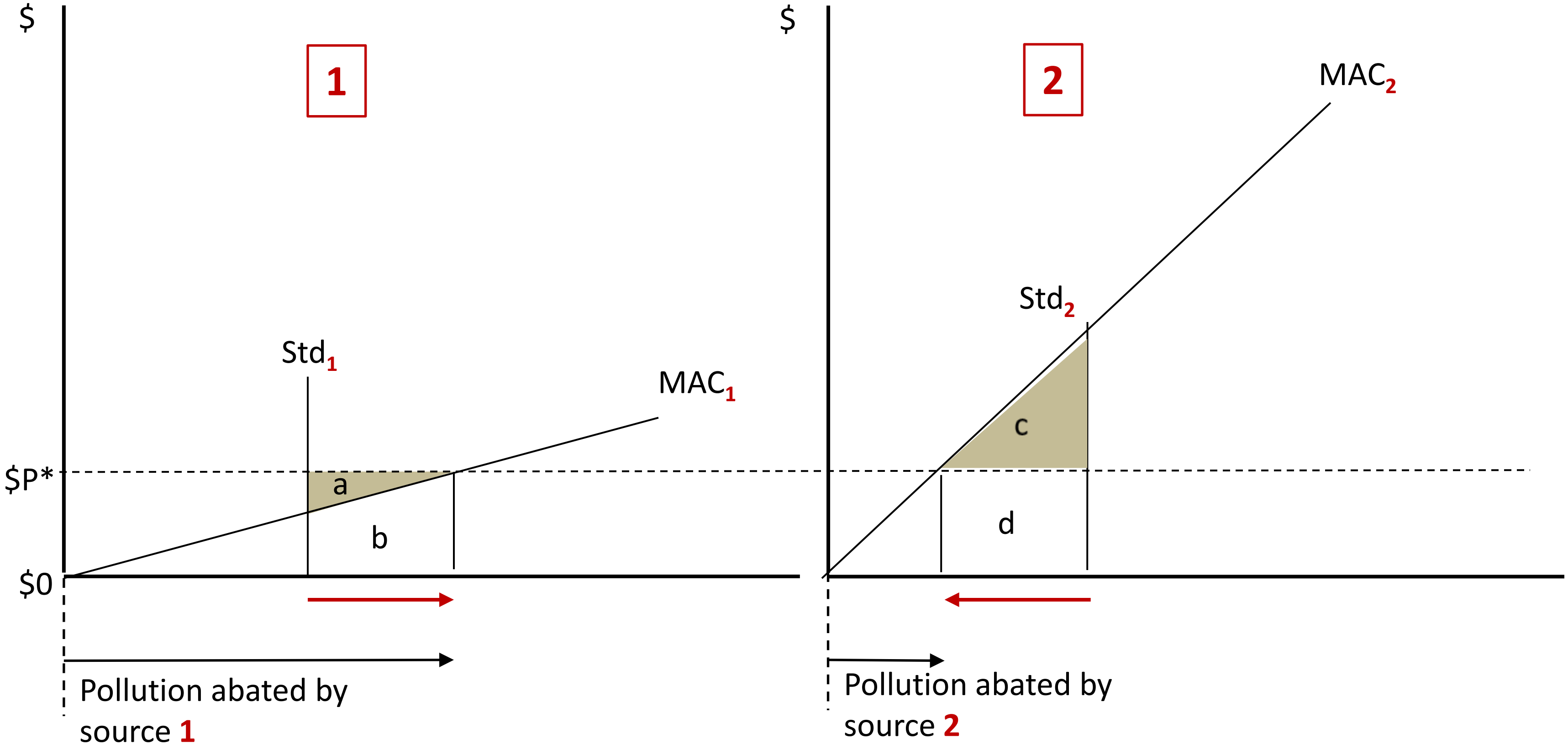
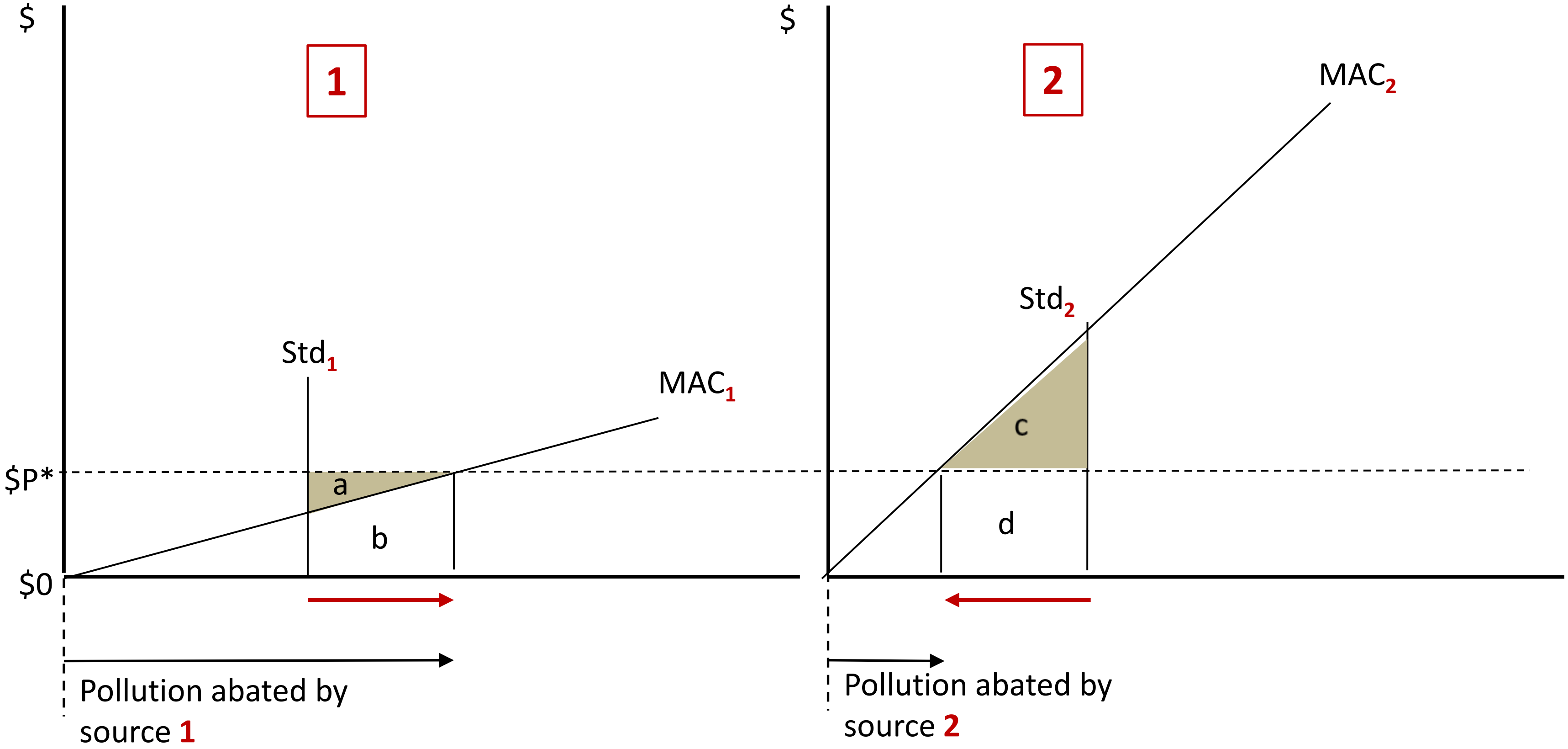


Extra cost = b

Savings = c+d

Net savings = a+c

THE TEXTBOOK MODEL



Sources:	- Power plants
Technologies:	- Clean coal & scrubbers / Fuel efficiency vs car size
States /countries:	- Climate change

US Acid Rain Program

2000 Auction Results

BIDS	BIDDER'S NAME	QUANTITY
$250.00	Midwest Environmental Law Caucus	1
$200.77	Sacramento Municipal Utility District	100
$150.00	Maryland Environmental Law Society	5
$150.00	Acid Rain Retirement Fund	13
$138.50	American Electric Power	10,000
$135.00	ARME 451 / ECON 409 Cornell Univ. 2000	1
$134.11	The Detroit Edison Company	500
$133.01	The Clean Air Conservancy	5
$130.89	Enron North America	9,550
$127.50	The Dayton Power and Light Company	10,000
$126.86	PG&E Energy Trading - Power, L.P.	12,700
$126.00	Baltimore Gas and Electric Company**	2,500
$126.00	Clearing Price	

http://www.epa.gov/airmarkets/trading/2000/00spotbids.html

US Acid Rain Program

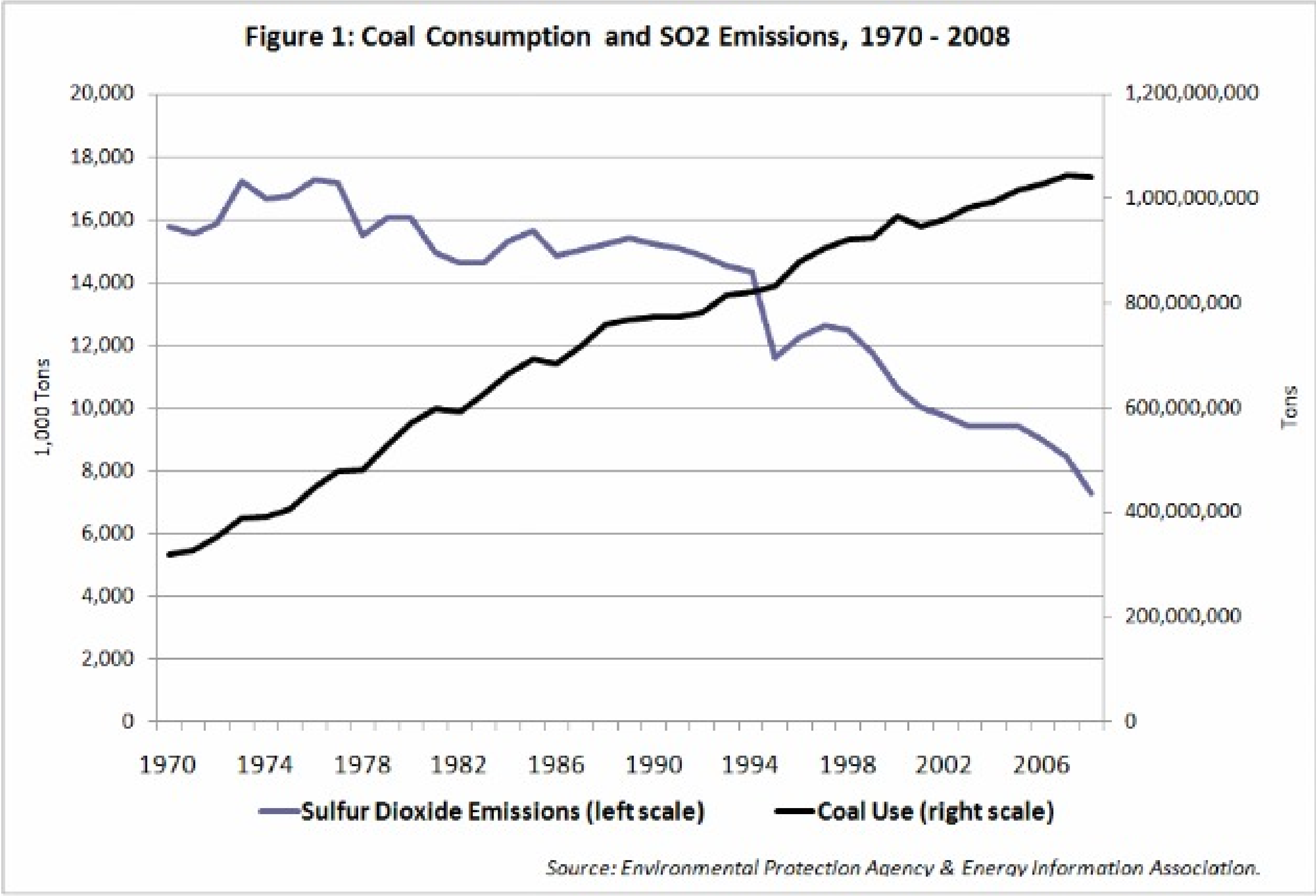
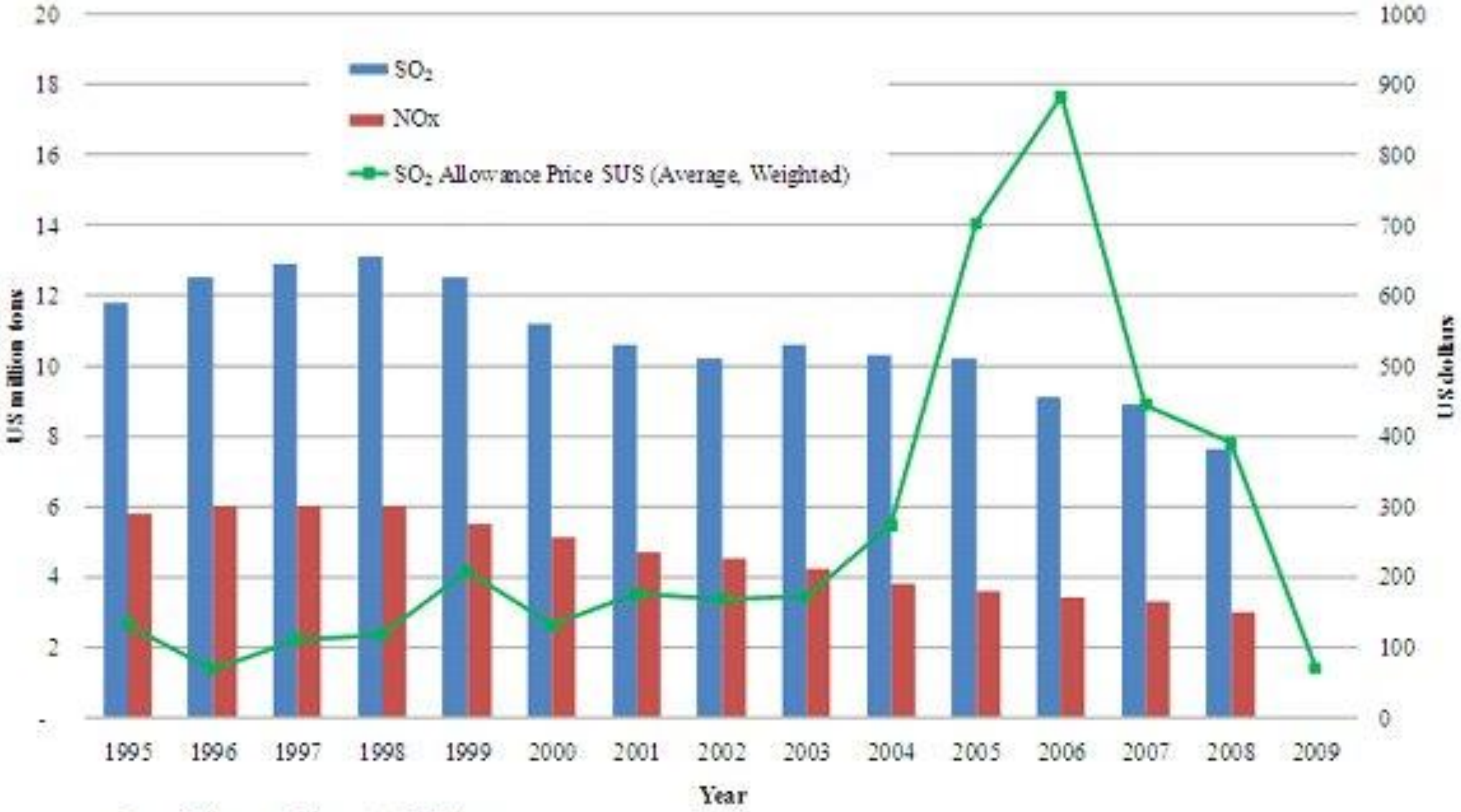


Figure 1: Coal Consumption and SO2 Emissions, 1970 - 2008

Source: Environmental Protection Agency & Energy Information Association.

US Acid Rain Program

Graph 1 - US Acid Rain Program Covered Emissions 1995 to 2008 Million Tons Vs SO_2 Allowance Price $US 1995 to 2009



Source: Parliamentary Library using EPA data.

The New York Times

Court Blocks E.P.A. Rule on Cross-State Pollution

By MATTHEW L. WALD

Published: August 21, 2012

WASHINGTON — A federal appeals court on Tuesday overturned a federal rule that laid out how much air pollution states would have to clean up to avoid incurring violations in downwind states.

David J. Phillip/Associated Press

The rule was intended to address how to deal with states whose plants pollute air in other states.

The decision sends the Environmental Protection Agency, and perhaps even Congress, back to the drawing board in what has become a long and paralyzing argument over how to mesh a system of state-by-state regulation with the problem of industrial smokestacks pumping pollutants into a single atmosphere.