What are the Costs and Benefits of US Environmental and Energy Regulation?

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UC Berkeley and NBER

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NBER Economic Analysis of Regulation Meeting

Motivation

- **Stakes are high**
  - One pollutant: over a third of monetized benefits of major federal regulations (Dominici et al. 2014)
- **Short history**
  - Regulation: improving environment, slowing productivity? (Gray 1987)
- **Cost-benefit analysis**
  - Executive Orders under Reagan, Bush, Clinton, ...
  - Many academic papers use federal cost-benefit analysis as a foil

Overview

- **Summarize federal cost-benefit analysis**
- **Challenges: benefits**
  - Measuring health damages
  - Defensive investments
  - Stated v. revealed preference
- **Challenges: costs**
  - Compliance costs
  - Market power
  - Tax interactions
  - Uncertainty

Overview: Scope

- **Focus today**
  - Federal policies
  - Market failure: environmental externalities
  - Energy and other industries
- **Less today**
  - State/local policy
  - Taxes/subsidies
  - Economic regulation (e.g., natural monopoly)

Overview: Scope

- **Leading laws**
  - National Environmental Policy Act (1970)
  - Clean Air Act (1970)
  - Clean Water Act (1972)
  - Endangered Species Act (1973)
  - Safe Drinking Water Act (1974)
  - Greenhouse gas emissions (20??)
- **Types of policies**
  - Command-and-control standards
  - Market-based policies (cap-and-trade, pollution taxes, hybrids)
  - Monitoring, permitting, inspections
  - Environmental impact statement
  - Land use restrictions
- **Complexity**
  - Contrast to health

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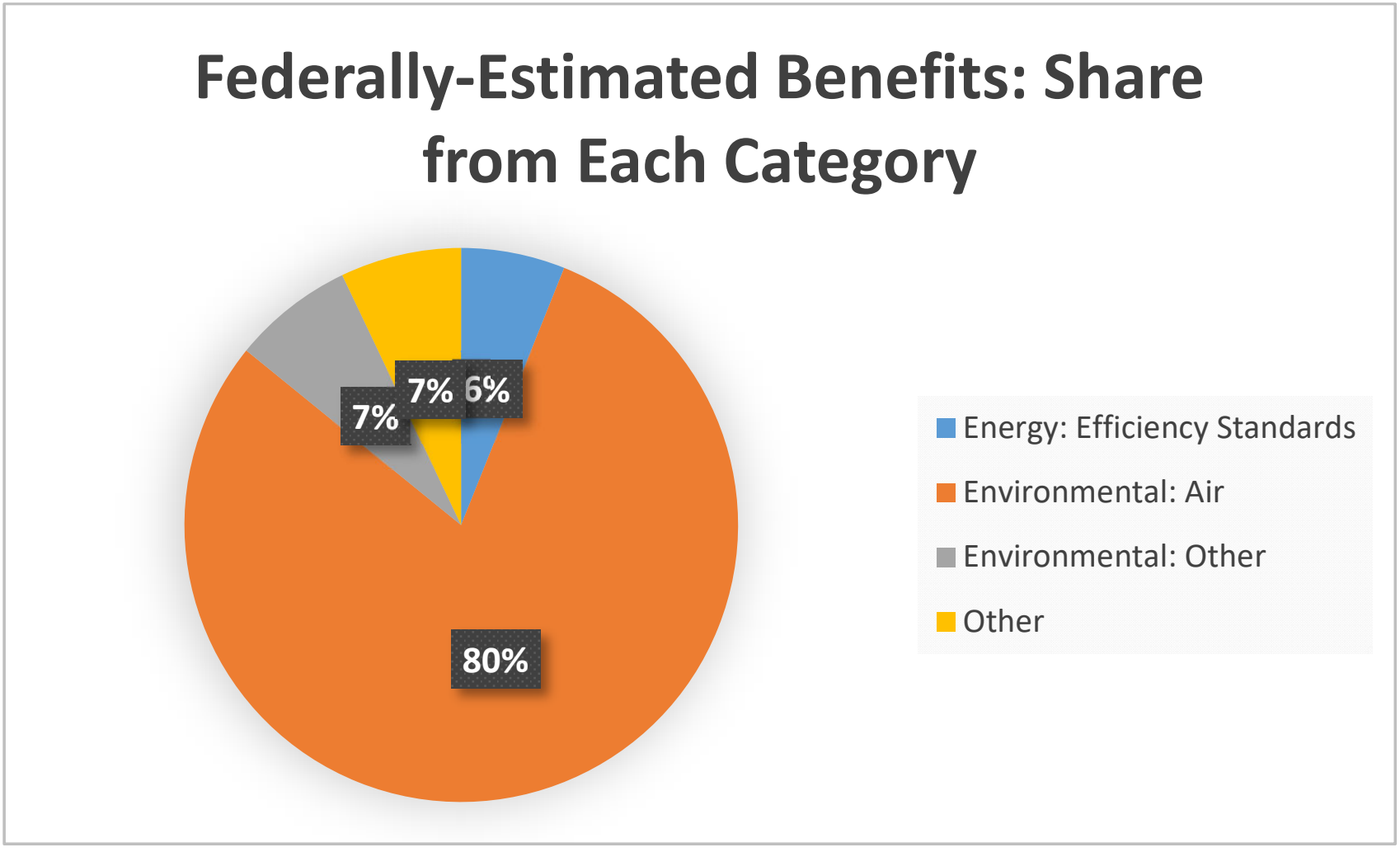
Summarize federal cost-benefit analysis

Table 1--Estimated Monetized Benefits and Costs of New Federal Regulation, 1992-2017, Annual Values from Regulatory Impact Analyses

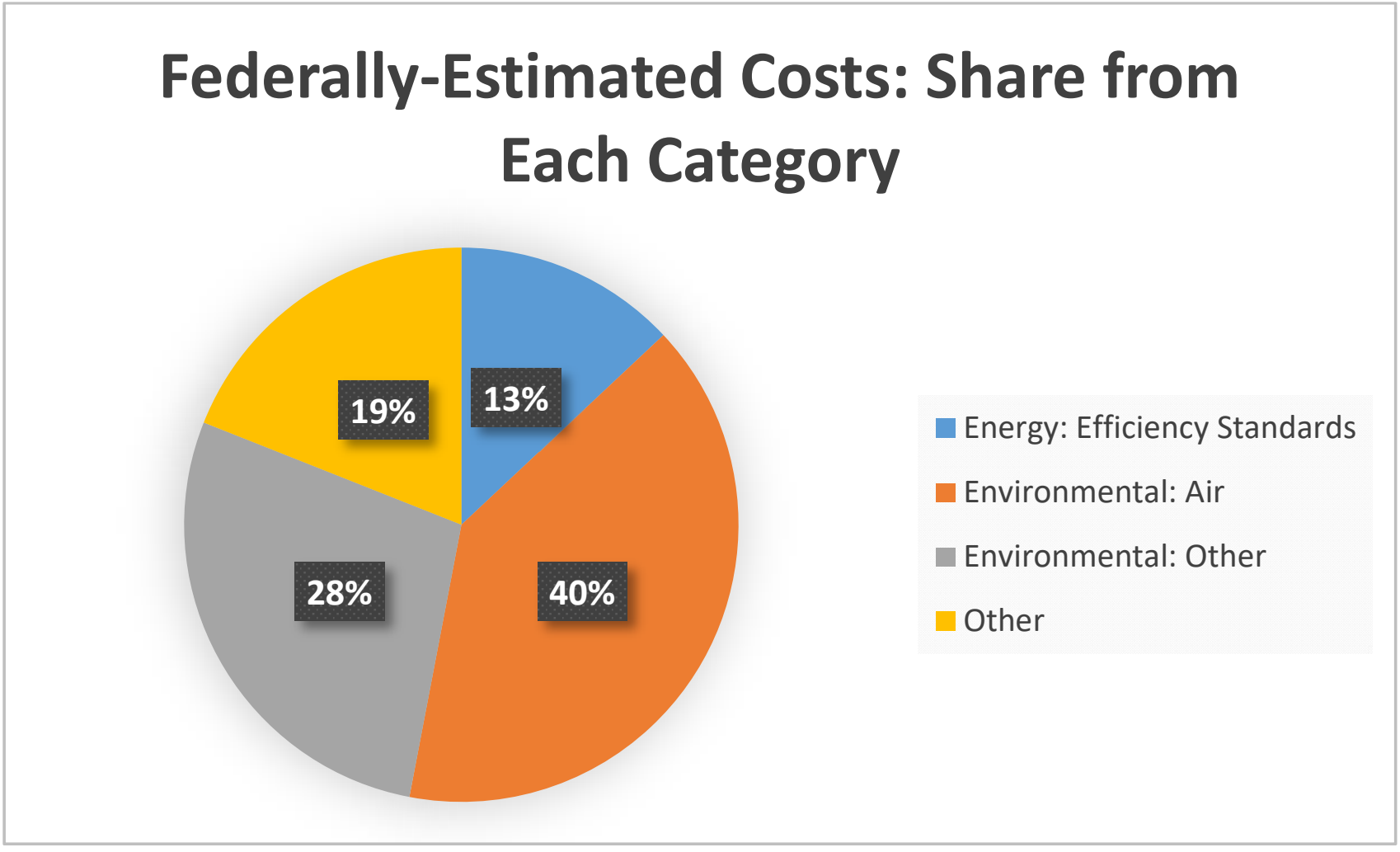
Category	Benefits ($bn)	Benefits (Share of total)	Costs ($bn)	Costs (share of total)
Panel A: Environmental				
Air	$78.1	79.1%	$6.1	39.4%
Drinking water	$0.4	0.4%	$0.1	0.6%
Surface water	$0.1	0.1%	$0.2	1.3%
Other	$7.0	7.1%	$4.4	28.4%
Environmental: total	*$85.6*	*86.7%*	*$10.8*	*69.7%*
Panel B: Energy				
Efficiency standards	$6.1	6.2%	$2.0	12.9%
Other	$0.2	0.2%	$0.3	1.9%
Energy: Total	*$6.3*	*6.4%*	*$2.3*	*14.8%*
Panel C: Other				
Health	$2.8	2.8%	$1.0	6.5%
Labor	$0.6	0.6%	$0.3	1.9%
Transportation	$1.8	1.8%	$0.7	4.5%
Additional	$1.6	1.6%	$0.4	2.6%
Other: total	*$6.8*	*6.9%*	*$2.4*	*15.5%*
Total	$98.7	100.0%	$15.5	100.0%

Summarize federal cost-benefit analysis



Source: Adapted from data underlying Keiser and Shapiro (2019)

Summarize federal cost-benefit analysis



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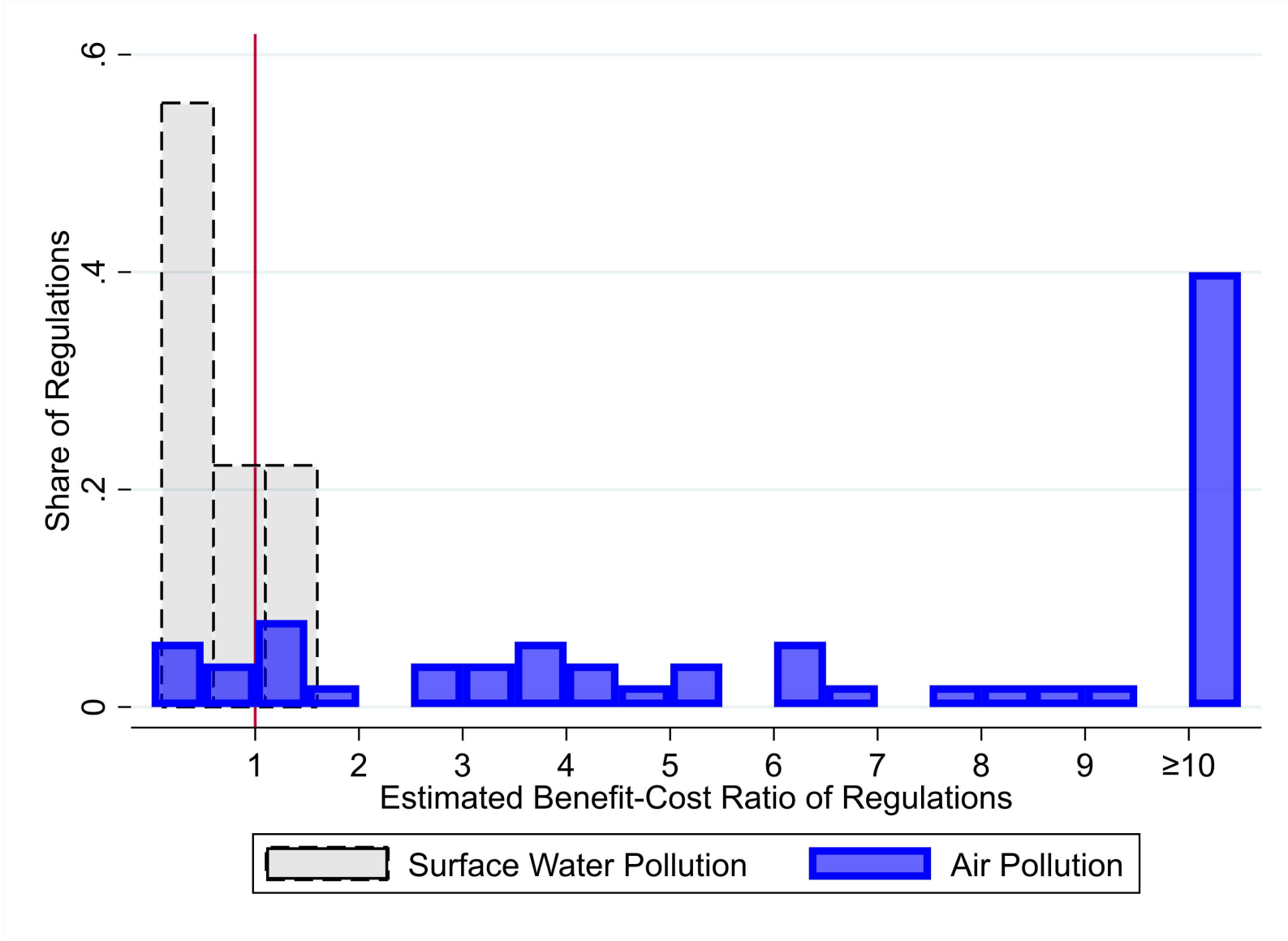
Summarize federal cost-benefit analysis



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Challenges for Benefits (1/3): Measuring health damages

- Avoided premature mortality important benefit
  - For particulate matter air pollution, vast majority of measured benefits
- Life expectancy versus counting deaths
  - Short-term mortality displacement
- Value of a statistical life
  - Level ($1-12 million) and heterogeneity
  - "Senior discount"
  - Under-researched?

Challenges for Benefits (1/3): Measuring health damages

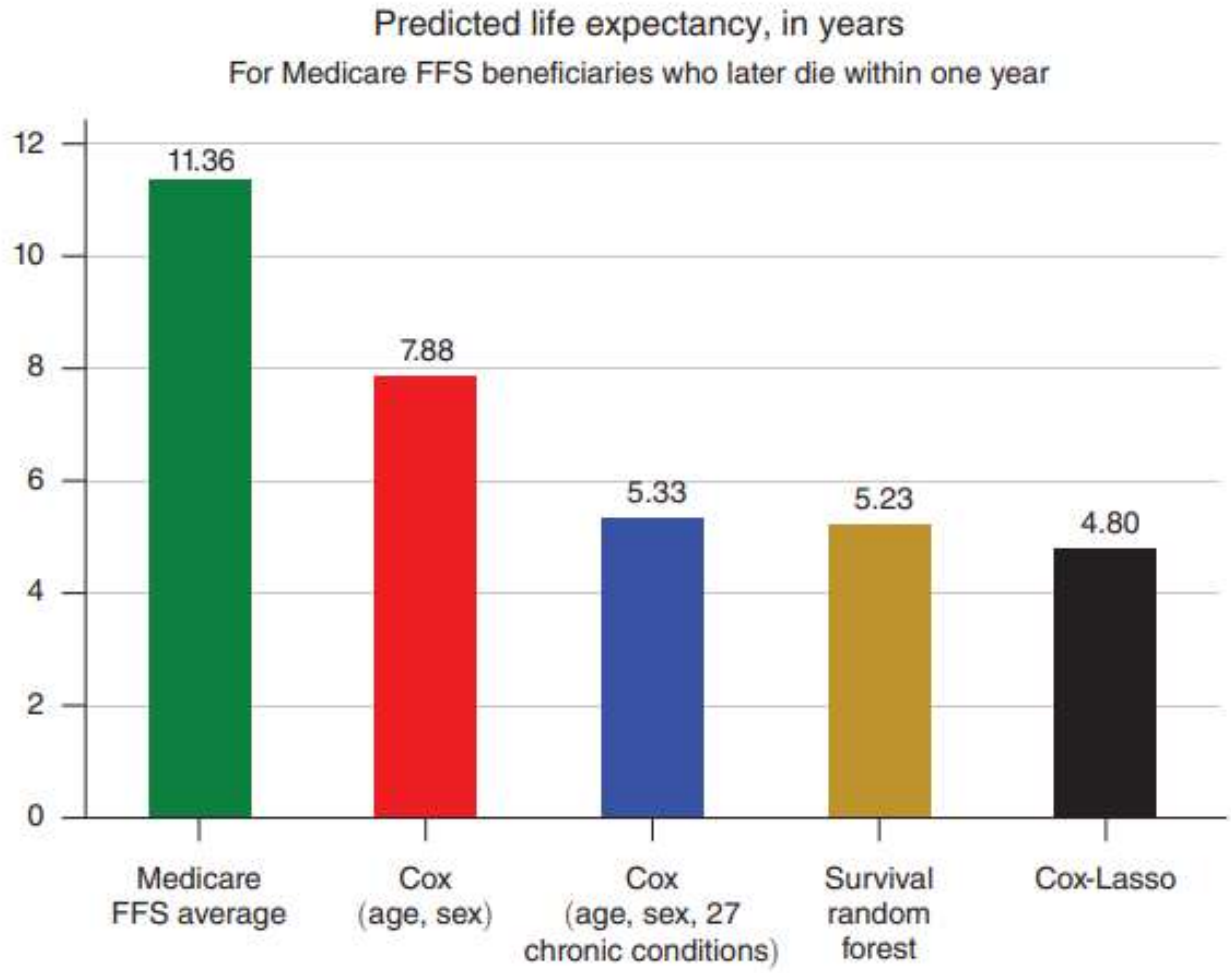


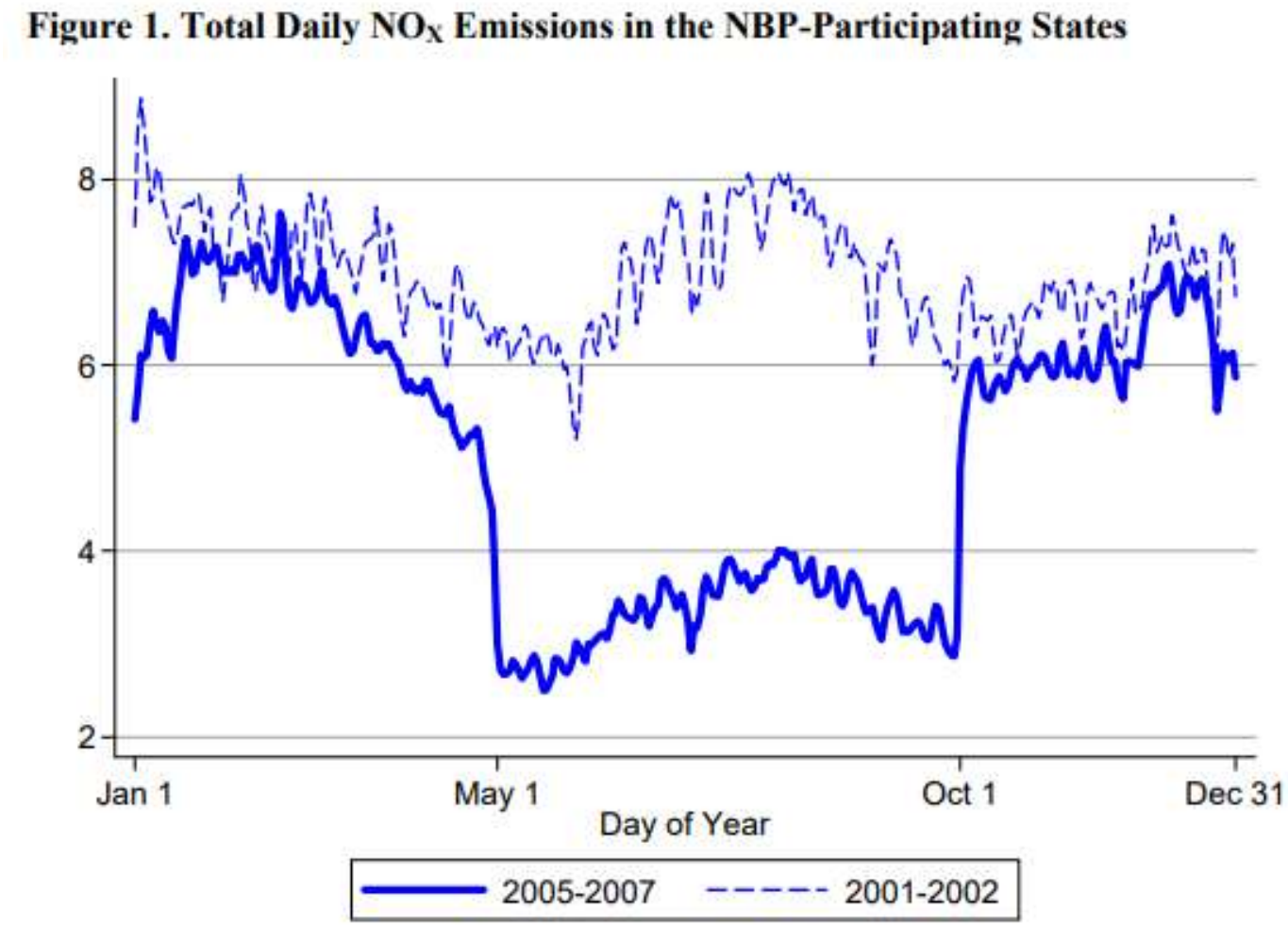
FIGURE 4. AVERAGE LIFE EXPECTANCY FOR CONTINUOUSLY ENROLLED FFS MEDICARE BENEFICIARIES WHO LATER DIE WITHIN ONE YEAR, 2001–2013

Source: Deryugina et al. (2019, p. 4195)

Challenges for Benefits (2/3): Defensive Investments

- Costly investments protect against negative externalities
  - Crime: bars on windows, security systems
  - Climate change: air conditioning
  - Wildfires: air filters
- Challenge for conventional cost-benefit analysis
  - Theory: equate marginal cost of externality to marginal cost of defenses
  - Federal cost-benefit analysis ignores defenses

Challenges for Benefits (2/3): Defensive Investments



Source: Deschenes, Greenstone, & Shapiro (2017, p. 2960)

Challenges for Benefits (2/3): Defensive Investments

TABLE 6—THE WELFARE IMPACTS OF THE NBP AND THE SOCIAL BENEFITS OF NO_x AND OZONE REDUCTIONS

	Medication costs ($ million) (1)	Medication copayments ($ million) (2)	Mortality: Number of deaths (3)	Mortality: Monetized value ($ million) (4)	Total using (1) ($ million) (5)	Total using (2) ($ million) (6)
Panel A. An upper bound estimate of NBP's social costs						
Upper bound per year	–	–	–	–	$1,076	$1,076
Upper bound, 2003–2007 total	–	–	–	–	$4,843	$4,843
Panel B. Estimates of the NBP's benefits						
Total per year	$820	$161	1,975	$1,319	$2,139	$1,480
Total 2003–2007	$3,690	$725	8,887	$5,935	$9,625	$6,660

Source: Deschenes, Greenstone, & Shapiro (2017, p. 2985)

Challenges for Benefits (3/3): Stated v. Revealed Preference

Challenges for Benefits (3/3): Stated v. Revealed Preference

Journal of Economic Perspectives—Volume 26, Number 4—Fall 2012—Pages 3–26

From Exxon to BP: Has Some Number Become Better than No Number?

Catherine L. Kling, Daniel J. Phaneuf, and Jinhua Zhao

Journal of Economic Perspectives—Volume 26, Number 4—Fall 2012—Pages 43–56

Contingent Valuation: From Dubious to Hopeless

Challenges for Benefits (3/3): Stated v. Revealed Preference

- Exxon Valdez oil spill
  - Revealed preference recreational damages: $4 million (Hausman, Leonard, and McFadden JPubE 1995)
  - Contingent valuation non-use value: $5 billion (Carson et al. 2003)
  - Ultimately, Exxon paid: $3 billion
- Non-use / passive values
  - Extremely important in theory
  - Challenging to measure credibly
  - Federal cost-benefit analysis relies on contingent valuation, especially for surface water pollution

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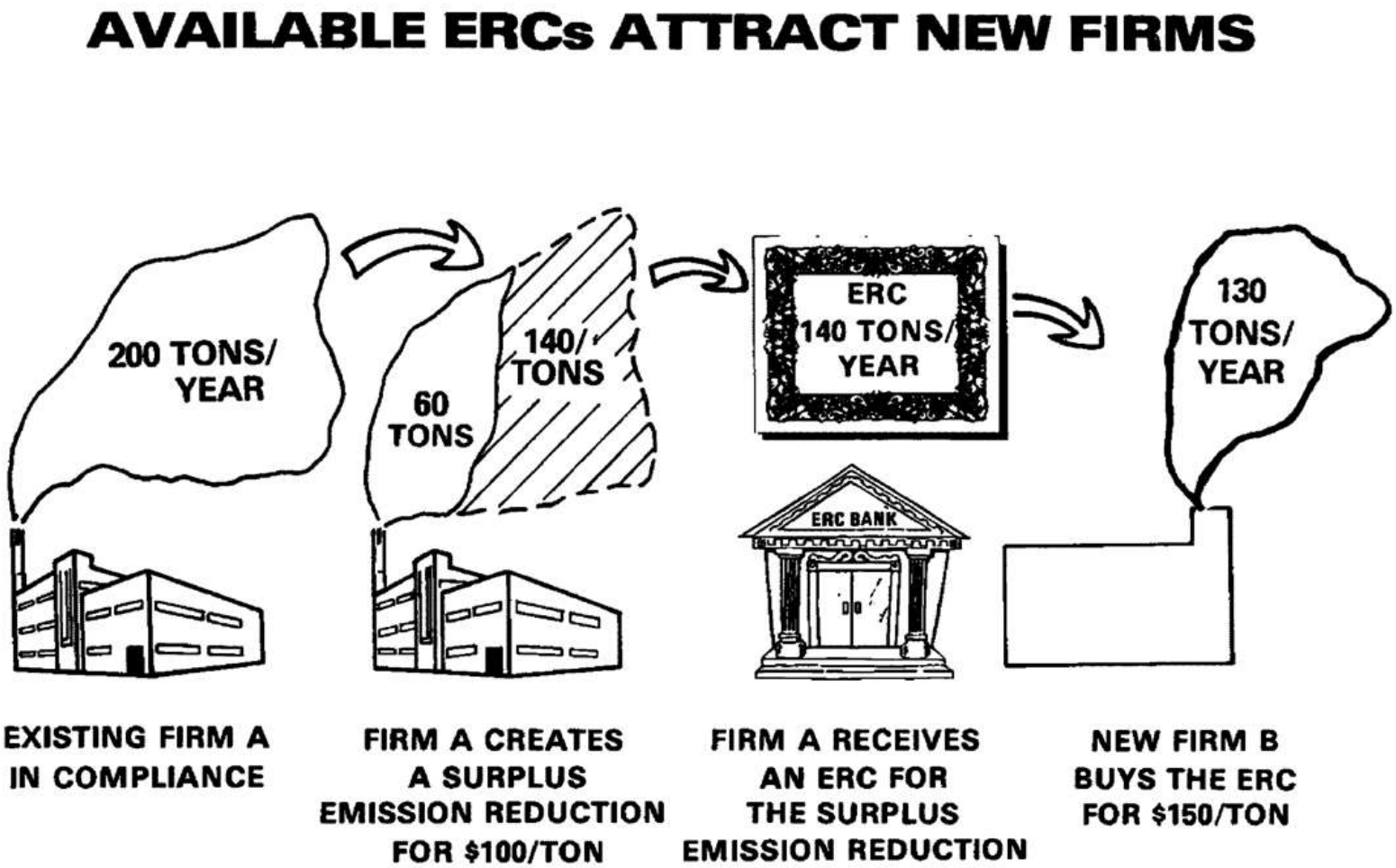
Challenges for Costs (1/4): Compliance Costs

- Standard measure of compliance costs: engineering/accounting methods
  - Hasn't changed much since 1970s
  - Can behave poorly against field/real-world measures

Challenges for Costs (1/4): Compliance Costs



Source: Shapiro & Walker (2020, p. 40)

Challenges for Costs (1/4): Compliance Costs

The State of Texas

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Certificate Number:

2697

Number of Credits:

21.8 tpy VOC

Emission Reduction Credit Certificate

This certifies that

Scan-Pac Mfg., Inc.
31502 Sugar Bend Drive
Magnolia, Texas 77355

is the owner of 21.8 tons per year of volatile organic compound (VOC) emission reduction credits established under the laws of the State of Texas, transferable only on the books of the Texas Commission on Environmental Quality, by the holder hereof in person or by duly authorized Attorney, upon surrender of this certificate.

The owner of this certificate is entitled to utilize the emission credits evidenced herein for all purpose authorized by the laws and regulations of the State of Texas and is subject to all limitations prescribed by the laws and regulations of the State of Texas. This certificate may be used for credit in the following counties:

Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller

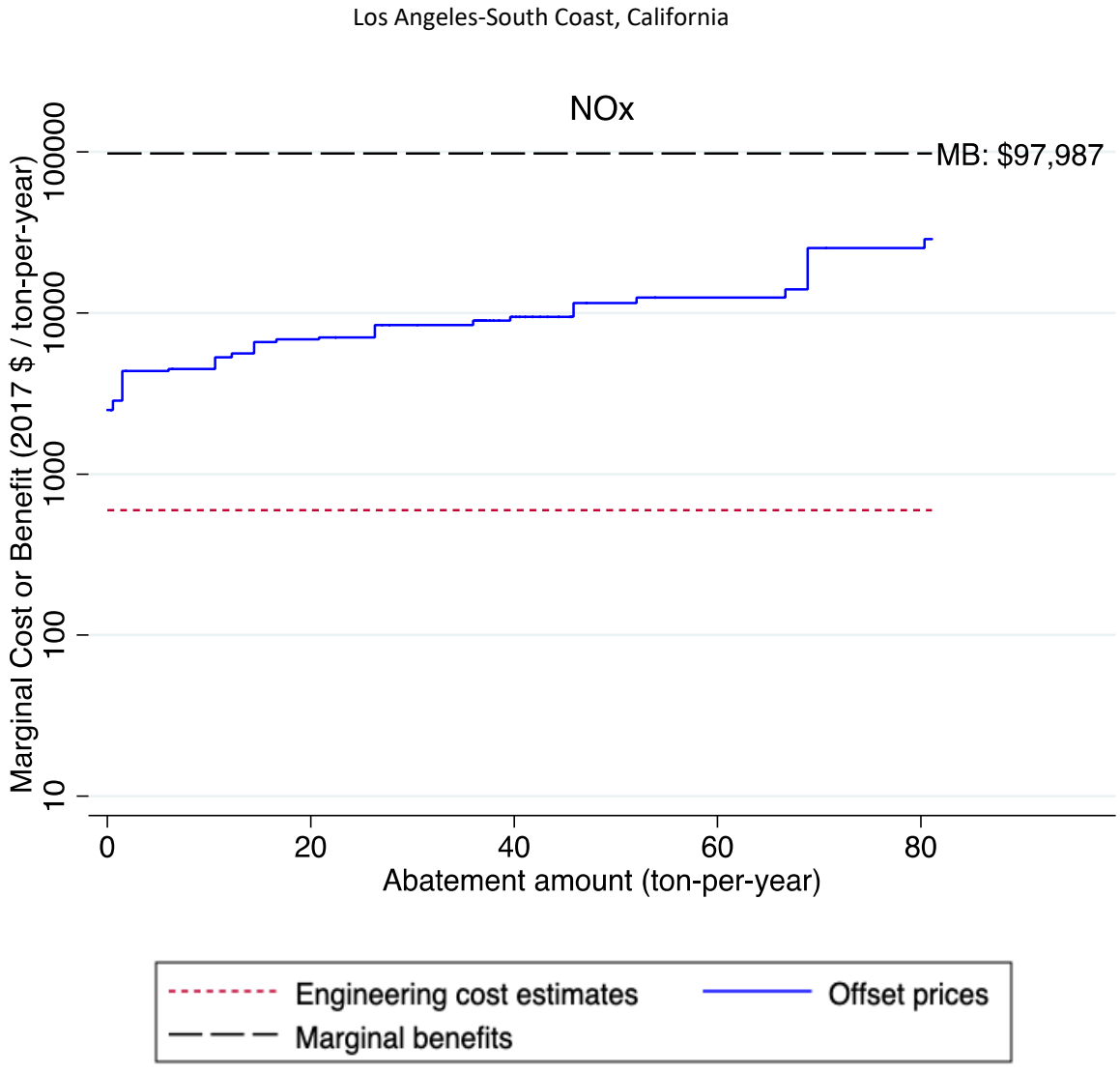
Effective Date of the Emission Reduction: May 15, 2013

Regulated Entity Number: RN100219989

Generator Certificate: Original

County of Generation: Montgomery

Challenges for Costs (1/4): Compliance Costs



Source: Shapiro & Walker (2020)

Challenges for Costs (2/4): Market Power

- Polluting industries are concentrated
  - Often in IO (electricity, oil refining, cement)
  - More due to barriers to entry (fixed costs, regulatory barriers)
  - Less due to differentiated products
- Market power -> even without environmental regulation, production is below welfare-maximizing level
  - Regulation exacerbates penalty to consumers
  - But, federal cost-benefit analyses assume perfect competition

Challenges for Costs (2/4): Market Power

Source: https://en.wikipedia.org/wiki/Cement_kiln, visited 3/11/2022

Challenges for Costs (2/4): Market Power

TABLE X

COUNTERFACTUAL POLICY EXPERIMENTS[a]

	Low Entry Costs (Pre-1990)		High Entry Costs (Post-1990)		Difference	
	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
De Novo Market						
Total producer profit ($ in NPV[b])	43,936.11	(7796.98)	33,356.87	(7767.22)	−11,182.04	(7885.20)
Profit firm 1 ($ in NPV)	45,126.30	(10,304.87)	34,321.61	(9520.93)	−11,965.22	(11,684.96)
Total net consumer surplus ($ in NPV)	1,928,985.09	(62,750.34)	1,848,872.52	(75,729.17)	−66,337.44	(58,404.32)
Total welfare ($ in NPV)	2,116,810.12	(74,265.74)	1,992,937.65	(96,634.83)	−119,771.39	(49,423.06)
Periods with no firms (periods)	1.29	(0.08)	1.32	(0.09)	0.04	(0.08)
Periods with one firm (periods)	1.51	(0.37)	2.60	(0.86)	1.05	(0.78)
Periods with two firms (periods)	8.17	(4.68)	21.43	(9.92)	12.26	(9.99)
Periods with three firms (periods)	54.71	(20.22)	91.35	(21.27)	33.38	(18.85)
Periods with four firms (periods)	135.91	(24.64)	84.03	(32.67)	−46.73	(25.04)
Average size of active firm (tons)	980.71	(76.18)	1054.65	(85.17)	73.42	(74.01)
Average market capacity (tons)	3467.85	(188.21)	3352.23	(208.94)	−112.75	(107.84)
Average market quantity (tons)	3094.23	(161.57)	2987.61	(177.58)	−105.69	(89.41)
Average market price	66.66	(1.90)	68.12	(2.11)	1.47	(1.14)

Source: Ryan (Econometrica 2012, p. 1056)

Challenges for Costs (3/4): Tax Interactions

- Economy has pre-existing distortions
  - Distortionary taxation
  - Information challenges
  - (Market power)
- These change welfare costs of environmental policy
  - Two distinct distortions requires two policies to correct
  - Using only environmental policy requires accounting for other distortions
- Example: carbon taxes and income taxes
  - Countries tax labor, not leisure
  - If carbon and labor are complements or substitutes, income tax affects optimal carbon tax

Challenges for Costs (3/4): Tax Interactions

TABLE 2—DIFFERENCES BETWEEN PIGOVIAN AND SECOND-BEST TAXES

		Realistic Tax System				Optimized Tax System		
Assumed marginal environmental damages (1)	"Optimal" Pigovian tax (2)	Optimal tax, lump-sum replacement (3)	Optimal tax, personal tax replacement (4)	$MCPF_P$ (5)	$MED/MCPF_P$ (6)	Optimal tax (7)	MCPF (8)	MED/MCPF (9)
25	25	−19	8	1.29	19	22	1.16	22
50	50	−10	30	1.28	39	46	1.11	45
75	75	11	52	1.25	60	70	1.10	68
100	100	28	73	1.24	81	93	1.10	91

Notes: All tax rates in 1990 dollars per ton. $MCPF_P$ denotes the marginal cost of public funds obtained through the personal income tax.

Source: Bovenberg & Goulder (1996, p. 992)

Challenges for Costs (4/4): Uncertainty

- Environmental permits
  - How many months/years needed for approval?
  - What technologies / plant design is required?
  - e.g., RACT/BACT/LAER
- Future policy
  - How will environmental policy change during lifetime of an investment?
- Political enforcement
  - How will new governor/president change enforcement of existing environmental policies?
- Business people: uncertainty a large cost of environmental policy

Challenges for Costs (4/4): Uncertainty

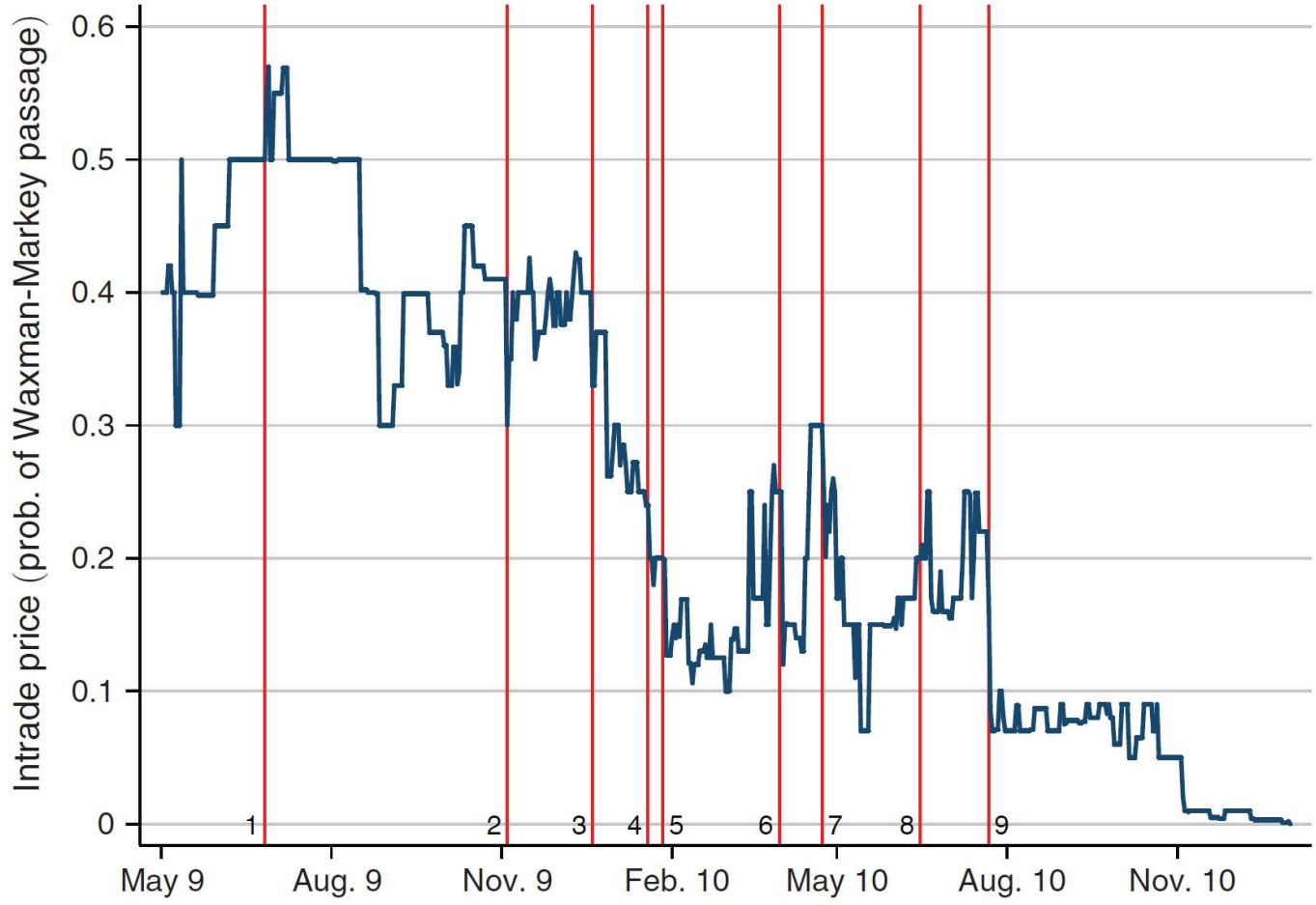


FIGURE 1. CAP-AND-TRADE PREDICTION MARKET PRICES

Source: Meng (2017, p. 756)

Challenges for Costs (4/4): Uncertainty

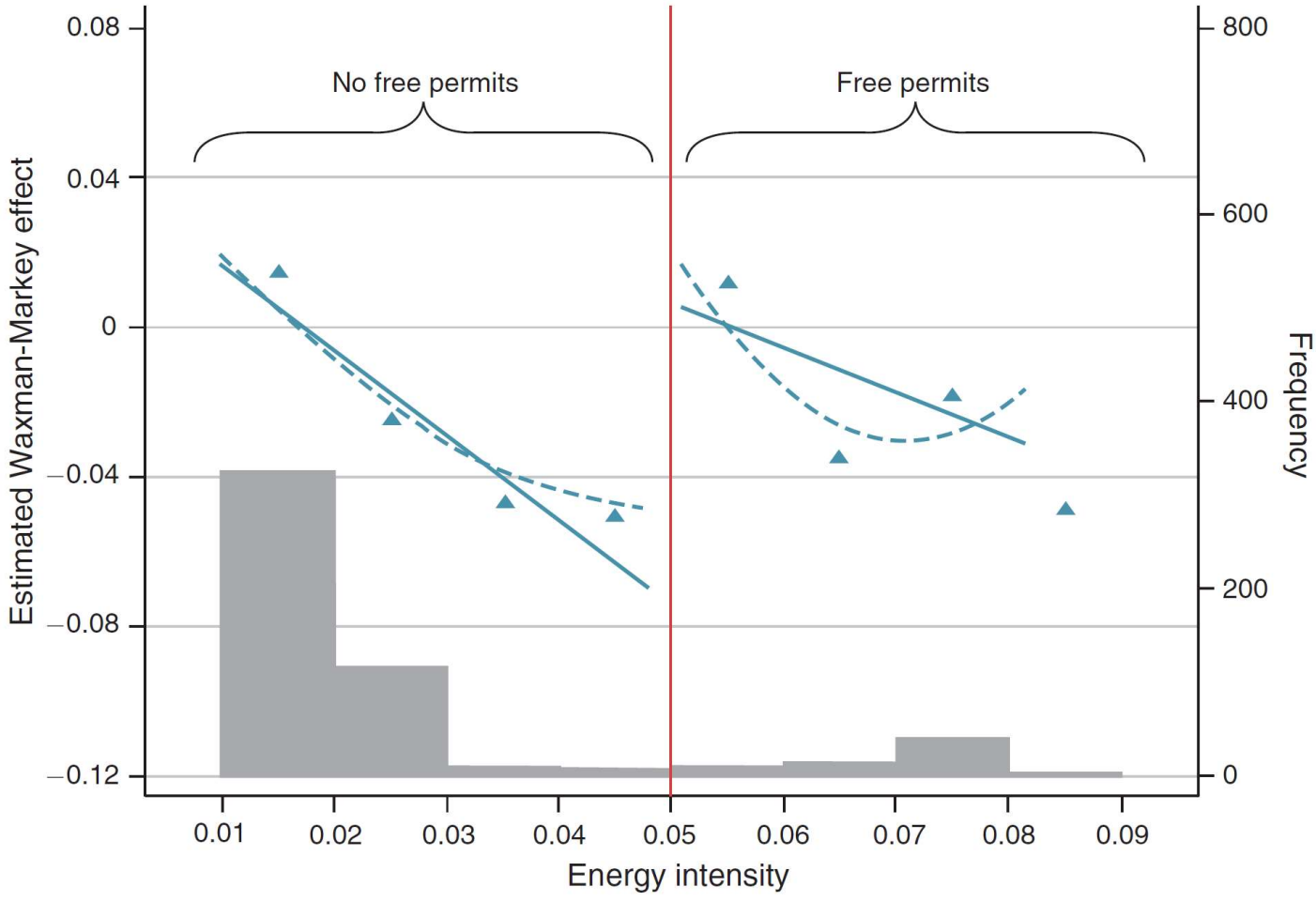


FIGURE 5. DISCONTINUITY IN CAP-AND-TRADE EFFECTS AT 5 PERCENT ENERGY INTENSITY

Source: Meng (2017, p. 765)

Conclusions

- Are federal estimates of regulatory costs and benefits too low or high?
  - Yes
- Open questions
  - Interactions of market failures
  - National security
  - Business cycles and short-run macro interactions