Market-based Approaches to Environmental Regulation

Market-based Approaches to Environmental Regulation

Ted Gayer

Georgetown University
3520 Prospect Street, NW, 4th Floor
Washington, DC 20007, USA

gayert@georgetown.edu

John K. Horowitz

Department of Agricultural and Resource Economics
2104 Symons Hall, University of Maryland
College Park, MD 20742, USA

jhorowitz@arec.umd.edu

the essence of knowledge

Boston – Delft

Foundations and Trends® in Microeconomics

Published, sold and distributed by:
now Publishers Inc.
PO Box 1024
Hanover, MA 02339
USA
Tel. +1-781-985-4510
www.nowpublishers.com
sales@nowpublishers.com

Outside North America:
now Publishers Inc.
PO Box 179
2600 AD Delft
The Netherlands
Tel. +31-6-51115274

A Cataloging-in-Publication record is available from the Library of Congress

The preferred citation for this publication is T. Gayer and J.K. Horowitz, Market-based Approaches to Environmental Regulation, Foundation and Trends® in Microeconomics, vol 1, no 4, pp 201–326, 2005

Printed on acid-free paper

ISBN: 1-933019-37-9

Foundations and Trends® in Microeconomics

Volume 1 Issue 4, 2005

Editorial Board

Editorial Scope

Foundations and Trends® in Microeconomics will publish survey and tutorial articles in the following topics:

- Environmental Economics
- Contingent Valuation
- Environmental Health Risks
- Climate Change
- Endangered Species
- Market-based Policy Instruments
- Health Economics
- Moral Hazard
- Medical Care Markets
- Medical Malpractice
- Insurance economics
- Industrial Organization
- Theory of the Firm
- Regulatory Economics
- Market Structure
- Auctions
- Monopolies and Antitrust
- Transaction Cost Economics
- Labor Economics
- Labor Supply
- Labor Demand
- Labor Market Institutions
- Search Theory
- Wage Structure
- Income Distribution
- Race and Gender
- Law and Economics
- Models of Litigation
- Crime
- Torts, Contracts and Property
- Constitutional Law
- Public Economics
- Public Goods
- Environmental Taxation
- Social Insurance
- Public Finance
- International Taxation

Information for Librarians
Foundations and Trends® in Microeconomics, 2005, Volume 1, 4 issues. ISSN paper version 1547-9846. ISSN online version 1547-9854. Also available as a combined paper and online subscription.

Foundations and Trends® in
Microeconomics
Vol. 1, No 4 (2005) 201–326

DOI: 10.1561/0700000013

now
the essence of knowledge

Market-based Approaches to Environmental Regulation

Ted Gayer[1] and John K. Horowitz[2]

[1] *Georgetown University, 3520 Prospect Street, NW, 4th Floor, Washington, DC 20007, USA, gayert@georgetown.edu*
[2] *Department of Agricultural and Resource Economics, 2104 Symons Hall, University of Maryland, College Park, MD 20742, USA, jhorowitz@arec.umd.edu*

Abstract

Economists argue that policymakers should take advantage of market principles in designing environmental regulations. Such market-based approaches – environmental taxes and cap-and-trade – use economic incentives to achieve environmental goals at lower costs. Market-based approaches have now become common due to near-unanimous advocacy by economists and early positive policy experiences. Despite this acceptance, policymakers have often merged market-based incentives onto existing non-market approaches resulting in a set of mixed policies whose economic properties are often difficult to unravel. Thus, even the most prominent market-based regulations contain many non-market elements. The authors review the economics literature on the rationale for and optimal design of environmental taxes and cap-and-trade systems. They then discuss the structure and economics of the major U.S. market-based policies.

Contents

1

Introduction

For nearly a century, economists have argued that policymakers should take advantage of market principles in designing environmental regulations. Such market-based approaches would use economic incentives to achieve environmental goals at lower costs. Pigou (1920) suggested levying a tax on production activities that generate environmental externalities and showed that this would achieve the same desirable effects as the free market does for ordinary goods. Much later, Dales (1968) suggested that the same advantages could be gained if polluters were assigned transferable rights to their pollution, with the total number of such rights set equal to the overall emissions goal. This approach to environmental regulation was originally known as tradable permits and is now known simply as cap-and-trade. These two mechanisms – taxes and cap-and-trade – together constitute the set of market mechanisms.

While these economic approaches to environmental problems have existed for many years in the minds of economists, they have been slow to be adopted as actual regulations. The Clean Air Act Amendments of 1970 and the Clean Water Act of 1972 – the cornerstones of U.S. pollution policy – contain no economic incentives as recommended by the economics literature. Shortly after their passage, however, policymakers began to experiment with market-oriented solutions.

Market-based approaches have now become more common, due in large part to the long-standing and unanimous advocacy of such approaches by economists and some early positive policy experiences. Market-based approaches have become more widely accepted among policymakers as reasonable ways to tackle U.S. environmental concerns. Even among environmentalists, support for market-based approaches has increased, although many critics still exist in this community.

Despite this apparent acceptance, a gap remains between the real-world market-based policies that have made it into law and the ideas that have been propounded by academic economists over the course of eighty-plus years. In short, policymakers have often grafted or merged market-based incentives onto existing non-market approaches. The result is a set of mixed policies whose economic properties are often difficult to unravel. Economists have almost uniformly conceived of market approaches as the sole regulatory instruments to be used for a given problem, but this has rarely been the case in practice. Careful examination of any environmental regulation, even ones considered by most people as market-based, will reveal that they in fact consist of a complicated mix of market and non-market mechanisms. The economics of such mixed approaches remains under-explored.

A similar sort of gap exists between the problems that market-based regulations should tackle and the problems that they actually tackle. Since the most common market instrument is cap-and-trade, we call this the "misplaced cap" problem. Fuel standards are a perfect example; they cap miles per gallon of new cars, not gallons of gasoline or miles driven, which are closer to true externality causes. As with the mixed approach, the economics of this misplaced cap problem have received rather little attention.

In Section 2, we review the economics literature on the theory of market-based environmental regulations. Section 3 covers design issues for environmental taxes and cap-and-trade systems. In Section 4, we discuss the U.S. experience with a number of regulatory approaches that are commonly characterized as market-based. We describe the mix of market and non-market instruments that characterize these policies. Section 5 draws our main conclusions.

References

Adar, Z. and J. M. Griffin (1976), 'Uncertainty and the choice of pollution control instruments'. *Journal of Environmental Economics and Management* **3**, 178–88.

American Farmland Trust (2001), *Fact sheet: Transfer of development rights*. retrieved Feb. 21, 2006, from www.farmlandinfo.org/documents/27746/FS_TDR_1-01.pdf.

Anderson, T. L. and P. J. Hill (1975), 'The evolution of property rights: A study of the American west'. *Journal of Law and Economics* **18**(1), 163–79.

Atkinson, S. E. and D. H. Lewis (1974), 'A cost-effectiveness analysis of alternative air quality control strategies'. *Journal of Environmental Economics and Management* **1**(3), 237–50.

Atkinson, S. E. and T. H. Tietenberg (1982), 'The empirical properties of two classes of designs for transferable discharge permit markets'. *Journal of Environmental Economics and Management* **9**(2), 101–21.

Bailey, E. M. (1998), *Allowance trading activity and state regulatory rulings: Evidence from the U.S. acid rain program*. Working paper #98-005, MIT Center for Energy and Environmental Policy Research.

Bandyopadhyay, S. and J. Horowitz (2006), 'Do plants overcomply with water pollution regulations?'. *Topics in Economic Analysis and Policy* **6**(1). Article 4.

Barnett, A. H. (1980), 'The pigouvian tax rule under monopoly'. *American Economic Review* **70**(5), 1037–41.

Barrett, S. (1991), 'Global warming: Economics of a carbon tax'. In: D. Pearce (ed.): *Blueprint 2: Greening the World Economy*, London: Earthscan.

Baumol, W. J. (1972), 'On taxation and the control of externalities'. *American Economic Review* **62**(3), 307–22.

Baumol, W. J. and W. E. Oates (1975), *The Theory of Environmental Policy*. Prentice-Hall Inc., 1st edition.

Baumol, W. J. and W. E. Oates (1988), *The Theory of Environmental Policy*. Cambridge University Press, 2nd edition.

Berthold, W. (1994), 'Issues in the design of environmental excise taxes'. *Journal of Economic Perspectives* **8**(1), 133–51.

Biglaiser, G., J. Horowitz, and J. Quiggin (1995), 'Dynamic pollution regulation'. *Journal of Regulatory Economics* **8**(1), 33–44.

Boland, J. (1986), *Economic Instruments for Environmental Protection in the United States*. ENV/ ECO/86.14. Organization for Economic Cooperation and Development.

Bovenberg, A. L. and L. H. Goulder (1996), 'Optimal environmental taxation in the presence of other taxes: general equilibrium analyses'. *American Economic Review* **86**(4), 985–1000.

Bramhall, D. F. and E. S. Mills (1966), 'A note on the asymmetry between fees and payments'. *Water Resources Research* **2**(3), 615–16.

Breetz, H. L., K. Fisher-Vanden, L. Garzon, H. Jacobs, K. Kroetz, and R. Terry (2004), 'Water quality trading and offset initiatives in the U.S.: a comprehensive survey'. Unpublished manuscript, Dartmouth College.

Buchanan, J. M. (1967), 'Cooperation and conflict in public-goods interaction'. *Western Economic Journal* **V**, 109–21.

Buck, E. (1995), *Individual Transferable Quotas in Fishery Management*. Report 95–849 ENR, Congressional Research Service.

Buechner, W. (Undated). 'History of the gasoline tax,' retrieved March 1, 2006, from <www.artba.org/economics_research/reports/gas_tax_history.htm>.

Burtraw, D. (1996), 'The SO_2 emissions trading program: Cost savings without allowance trades'. *Contemporary Economic Policy* **14**(2), 79–94.

Burtraw, D., A. Krupnick, E. Mansur, D. Austin, and D. Farrell (1997), *The costs and benefits of reducing acid rain*. Discussion Paper 97-31-REV, Resources for the Future.

Carlson, C., D. Burtraw, M. Cropper, and K. Palmer (2000), 'Sulfur dioxide control by electric utilities: What are the gains from trade?'. *Journal of Political Economy* **108**(6), 1292–326.

Carraro, C. and D. Siniscalco (1994), 'Environmental policy reconsidered: The role of technological innovation'. *European Economic Review* **38**(3–4), 545–54.

Center for American Progress (2003), 'Mercury follies: The administration's plant puts our children at risk'. An interview with Carol Browner.

Chupka, M. W. (2003), 'Designing effective renewable markets'. *The Electricity Journal* **16**(4), 46–57.

Coase, R. (1960), 'The problem of social cost'. *Journal of Law and Economics* **3**, 1–44.

Collinge, R. A. and W. E. Oates (1982), 'Efficiency in pollution control in the short and long runs: A system of rental emission permits'. *Canadian Journal of Economics* **15**(2), 347–54.

Congressional Budget Office (CBO) (2001), 'An evaluation of cap-and-trade programs for reducing U.S. carbon emissions'.

Congressional Research Service (CRS) (2000), 'RL30304: The federal excise tax on gasoline and the highway trust fund: a short history'.

Connecticut Department of Environmental Protection (2003, 2004, 2005), 'Report of the nitrogen credit advisory board'.

Cornes, R. and T. Sandler (1986), *The Theory of Externalities, Public Goods, and Club Goods*. Cambridge University Press.

Costonis, J. J. (1973), 'Development rights transfer: An exploratory essay'. *The Yale Law Journal* **83**(1), 75–128.

Cramton, P. and S. Kerr (1997), 'A tax-cut auction for the environment'. Unpublished manuscript.

Crandall, R. W. and J. D. Graham (1989), 'The effect of fuel economy standards on automobile safety'. *Journal of Law and Economics* **32**(1), 97–118.

Cronshaw, M. B. and J. B. Kruse (1996), 'Regulated firms in pollution permit markets with banking'. *Journal of Regulatory Economics* **9**, 179–89.

Cropper, M. L. and W. E. Oates (1992), 'Environmental economics: A survey'. *Journal of Economic Literature* **30**(2), 675–740.

Dales, J. (1968), *Pollution, property, and prices*. (University Press: Toronto, Ontario).

Dasgupta, Partha, P. Hammond, and E. Maskin (1979), 'The implementation of social choice rules'. *Review of Economic Studies* **46**, 185–216.

Downing, P. and L. White (1986), 'Innovation in pollution control'. *Journal of Environmental Economics and Management* **13**(1), 18–29.

Earnhart, D. (2004), 'Regulatory factors shaping environmental performance at publicly-owned treatment plants'. *Journal of Environmental Economics and Management* **48**(1), 655–81.

Electric Power Research Institute (2004), 'EPRI comments on EPA proposed emission standards/proposed standards of performance, electric utility steam generating units: Mercury emissions'. EPA Docket ID No. OAR-2002-0056-2578.

Electric Power Research Institute (2005), 'EPRI comments on EPA notice of data availability regarding a proposed clean air mercury rule'.

Ellerman, A. D. (2003a), *Lessons from phase 2 compliance with the U.S. acid raid program*. MIT-CEEPR Working Paper.

Ellerman, A. D. (2003b), 'Ex post evaluation of tradable permits: The U.S. SO_2 cap-and-trade program'. MIT-CEEPR Working Paper.

Ellerman, A. D., P. Joskow, R. Schmalensee, J.-P. Montero, and E. M. Bailey (2000), *Markets for Clean Air: The U.S. Acid Rain Program*. Cambridge UK: Cambridge University Press.

Ellerman, A. D. and J.-P. Montero (2002), 'The temporal efficiency of SO_2 emissions trading'. MIT-CEEPR Working Paper.

Environment Reporter (2003), *Oregon Wastewater Utility Likely to Receive Innovative Watershed-Based Discharge Report*, Vol. 34 of *49*, p. 2728.

Environmental Protection Agency (EPA) (1997), *Mercury Study Report to Congress*. Washington, DC.

Environmental Protection Agency (EPA) (2001), 'The United States experience with economic incentives for protecting the environment'. National Center for Environmental Economics.

Environmental Protection Agency (EPA) (2004), 'Water quality trading assessment handbook: Can water quality trading advance your watershed's goals?'. (Office of Water).

Environomics (1999), 'A summary of U.S. effluent trading and offset projects'. (Prepared for Dr. M. Podar, U.S. Environmental Protection Agency, Office of Water). Retrieved Feb. 21, 2006, from http://www.epa.gov/owow/watershed/trading/traenvrn.pdf.

Evans, L. (1984), 'Driver fatalities versus car mass using a new exposure approach'. *Accident Analysis and Prevention* **16**, 19–36.

Federal Highway Administration (2006), 'When did the federal government begin collecting the gas tax?'. http://www.fhwa.dot.gov/infrastructure/gastax.cfm(accessed May 31, 2006).

Field, C. B. (1997), *Environmental economics*. New York: McGraw-Hill, 2nd edition.

Field, C. B. and J. M. Conrad (1975), 'Economic issues in programs of transferable development rights'. *Land Economics* **51**(4), 331–40.

Gayer, T. (2004), 'The fatality risks of sport-utility vehicles, vans, and pickups relative to cars'. *Journal of Risk and Uncertainty* **28**(2), 103–33.

Gayer, T. and R. W. Hahn, 'Designing environmental policy: Lessons from the regulation of mercury emissions'. *Journal of Regulatory Economics*. Forthcoming.

Goodin, R. E. (1994), 'Selling environmental indulgences'. *Kyklos* **47**(4), 573–96.

Goulder, L. H. (1998), 'Environmental policy making in a second-best setting'. *Journal of Applied Economics* **1**(2), 279–328.

Goulder, L. H., I. W. Parry, and D. Burtraw (1997), 'Revenue-raising versus other approaches to environmental protection: The critical

significance of preexisting tax distortions'. *Rand Journal of Economics* **28**, 708–31.

Greene, D., J. Kahn, R. Gibson, and C. Robert (1999), 'Fuel economy rebound effect for U.S. household vehicles'. *Energy Journal* **20**(3), 1–31.

Greene, D., P. Patterson, M. Singh, and J. Li (2005), 'Feebates, rebates, and gas-guzzler taxes: A study of incentives for increased fuel economy'. *Energy Policy* **33**(6), 757–75.

Griffin, R. C. and D. W. Bromley (1982), 'Agricultural runoff as a nonpoint externality: A theoretical development'. *American Journal of Agricultural Economics* **64**, 547–52.

Hahn, R. W. (1984), 'Market power and transferable property rights'. *Quarterly Journal of Economics* **99**(4), 753–65.

Hahn, R. W. (1989), 'Economic prescriptions for environmental problems: How the patient followed the doctor's orders'. *Journal of Economic Perspectives* **3**(2), 95–114.

Hahn, R. W. and G. L. Hester (1989), 'Where did all the markets go? An analysis of EPA's emissions trading program'. *Yale Journal on Regulation* **6**, 109–53.

Hall, J. and C. Howett (1994), 'Albemarle-pamlico: Case study in pollutant trading: most of the nutrients came from nonpoint sources'. *EPA Journal* **20**, 27–29.

Hanson, J. E. and K. E. McConnell (2005), 'Nutrient trading for controlling Abatement Costs in the Chesapeake Bay'. Unpublished working paper, Department of Agricultural and Resource Economics, University of Maryland.

Helfand, G. E. and B. W. House (1995), 'Regulating nonpoint source pollution under heterogeneous conditions'. *American Journal of Agricultural Economics* **77**, 1024–1032.

Hoag, D. L. and J. S. Hughes-Popp (1997), 'Theory and practice of pollution credit trading in water quality management'. *Review of Agricultural Economics* **19**(2), 252–62.

Hoerner, J. A. (1997), 'Taxing pollution'. In: E. Cook (ed.): *Ozone Protection in the U.S.: Elements of Success*. World Resources Institute.

Horowitz, J. and L. Lynch (1998), 'Comparison of farmland programs in Maryland'. In: *The Performance of State Programs for Farmland*

Preservation. Proceedings of a Conference in Columbus, Ohio, Ohio State University.

Jones, C. T. (1993), 'Another look at U.S. Passenger vehicle use and the 'rebound effect' from improved fuel efficiency'. *Energy Journal* **14**, 99–110.

Joskow, P. L., R. Schmalensee, and E. M. Bailey (1998), 'The market for sulfur dioxide emissions'. *American Economic Review* **88**(4), 669–85.

Jung, C., K. Krutilla, and R. Boyd (1996), 'Incentives for advanced pollution abatement technology at the industry level: An evaluation of policy alternatives'. *Journal of Environmental Economics and Management* **30**(1), 95–111.

Kamien, M. I., N. L. Schwartz, and F. T. Dolbear (1996), 'Asymmetry between bribes and charges'. *Water Resources Research* **2**(1), 147–57.

Karp, L. and M. Hoel (2002), 'Taxes versus Quotas for a Stock Pollutant'. *Resource and Energy Economics* **24**(4), 367–84.

Kashmanian, R. M., M. K. Podar, M. A. Luttner, and R. G. Graff (1995), 'The use and impact of intraplant trading in the iron and steel industry to reduce water pollution'. *Environmental Professional* **17**(4), 309–15.

Keohane, N. O. (2003), 'Prices, quantities, and two-part tariffs: Optimal environmental policy with endogenous technical change'. Unpublished manuscript, Yale School of Management.

Keohane, N. O., R. N. Stavins, and R. Revesz (1998), 'The choice of regulatory instruments in environmental policy'. *Harvard Environmental Law Review* **22**(2), 313.

Kerr, S. (1993), 'The operation of tradable rights markets: Empirical evidence from the United States lead phase-down'. In: Anderson and Marshall (eds.): *New Partnerships: Economic Incentives for Environmental Management*, Pittsburgh PA: Air and Waste Management Association.

Kerr, S. and R. Newell (2003), 'Policy-induced technology adoption: Evidence from the U.S. lead phasedown'. *Journal of Industrial Economics* **51**(3), 317–343.

Kieser, M. and F. Fang (2005), *Water quality trading in the United States*. retrieved February 20, 2006 from http://

ecosystemmarketplace.com/pages/article.news.php?component_id=3954&component_version_id=5593&language_id=12.

King, D. M. and P. J. Kuch (2003), 'Will nutrient credit trading ever work? An assessment of supply and demand problems and institutional obstacles'. *Environmental Law Reporter* **33**, 10352–68.

Kling, C. and J. D. Rubin (1997), 'Bankable permits for the control of environmental pollution'. *Journal of Public Economics* **64**(1), 101–15.

Kneese, A. V. (1964), *Economics of Regional Water Quality Management*. Baltimore: Johns Hopkins Press.

Kneese, A. V. and B. T. Bower (1968), *Managing water quality: Economics, technology, institutions*. Baltimore: Johns Hopkins Press.

Laffont, J.-J. and J. Tirole (1996), 'Pollution permits and environmental innovation'. *Journal of Public Economics* **62**(1–2), 127–40.

Lee, D. R. (1975), 'Efficiency of pollution taxation and market structure'. *Journal of Environmental Economics and Management* **2**, 301–12.

Lee, D. R. and W. S. Misiolek (1986), 'Substituting pollution taxation for general taxation: Some implications for efficiency in pollution taxation'. *Journal of Environmental Economics and Management* **13**, 338–47.

Levinson, A. (1997), 'Why oppose TDRs? Transferable development rights can increase overall development'. *Regional Science and Urban Economics* **27**(3), 283–96.

Levinson, A. (1999), 'NIMBY taxes matter: The case of state hazardous waste disposal taxes'. *Journal of Public Economics* **74**(1), 31–51.

Liski, M. and J.-P. Montero (2005a), 'A note on market power in an emission permit market with banking'. *Environmental and Resource Economics* **31**(2), 159–73.

Liski, M. and J.-P. Montero (2005b), 'On pollution permit banking and market power'. *Journal of Regulatory Economics*. Forthcoming.

Maleug, D. (1989), 'Emission credit trading and the incentive to adopt new pollution abatement technology'. *Journal of Environmental Economics and Management* **16**(1), 52–57.

Malik, A. (1990), 'Market for pollution control when firms are noncompliant'. *Journal of Environmental Economics and Management* **18**(2), 97–106.

Malik, A., D. Letson, and S. Crutchfield (1993), 'Point/nonpoint source trading of pollution abatement: Choosing the right trading ratio'. *American Journal of Agricultural Economics* **75**(4), 959–67.

McCay, B. J. (2001), 'Community-based and cooperative fisheries: Solutions to fishermen's problems'. In: J. Burger, E. Ostrom, R. B. Norgaard, D. Policansky, and B. D. Goldstein (eds.): *Protecting the Commons: A Framework for Resource Management in the Americas*, pp. 175–94, Washington, DC: Island Press.

McClelland, J. D. and J. K. Horowitz (1999), 'The cost of water pollution regulation in the pulp and paper industry'. *Land Economics* **75**(2), 220–32.

McConnell, V., M. Walls, and E. Kopits (2005), *Zoning, TDRs, and the density of development*. Discussion Paper 05–32, Resources for the Future.

Meade, J. E. (1952), 'External economies and diseconomies in a competitive situation'. *Economic Journal* **62**, 54–67.

Milliman, S. R. and R. Prince (1989), 'Firm incentives to promote technological change in pollution control'. *Journal of Environmental Economics and Management* **17**, 247–65.

Mirrlees, J. A. (1971), 'An exploration in the theory of optimum income taxation'. *Review of Economic Studies* **38**, 175–208.

Montero, J.-P. (2002), 'Prices versus quantities with incomplete enforcement'. *Journal of Public Economics* **85**, 435–54.

Montgomery, D. (1972), 'Markets in licenses and efficient pollution control programs'. *Journal of Economic Theory* **5**, 395–418.

National Highway Traffic Safety Administration (NHTSA) (1997), 'Relationship of vehicle weight to fatality and injury risk in model year 1985–1993 passenger cars and light trucks'. NHTSA Summary Report DOT HS 808 569. Springfield, VA: National Technical Information Service.

National Research Council (NRC) (1999), *Sharing the fish: Toward a national policy on individual fishing, quotas*. Washington, DC: National Academy Press.

National Research Council (NRC) (2000), *Toxicological effects of methylmercury*. Washington, DC: National Academy Press.

Oates, W. E. and D. Strassmann (1984), 'Effluent fees and market structure'. *Journal of Public Economics* **24**, 29–46.

OECD (1998), *Lessons from existing trading systems for international greenhouse gas emission trading*. Report ENV/EPOC 98.13/REV1.

O'Ryan, R. E. (1996), 'Cost-effective policies to improve urban air quality in santiago, chile'. *Journal of Environmental Economics and Management* **31**, 302–13.

Parry, I. (1995), 'Pollution taxes and revenue recycling'. *Journal of Environmental Economics and Management* **29**, S64–S77.

Parry, I. (1997), 'Environmental taxes and quotas in the presence of distorting taxes in factor markets'. *Resource and Energy Economics* **19**, 203–20.

Parry, I., C. Fischer, and W. Harrington (2004), *Should corporate average fuel economy standards be tightened?* Discussion Paper 04–53, Resources for the Future.

Pautzke, C. G. and C. W. Oliver (1997), *Development of the Individual Fishing Quota Program for Sablefish and Halibut Longline Fisheries off Alaska*. North Pacific Fisheries Management Council, Anchorage, AK.

Pigou, A. C. (1920), *The Economics of Welfare*. MacMillan & Co.: London.

Pizer, W. A. (1998), *Prices vs. Quantities Revisited: The Case of Climate Change*. Discussion Paper 98–02, Resources for the Future.

Portney, P. (2000), 'Air pollution policy'. In: P. Portney and R. Stavins (eds.): *Public Policies for Environmental Protection*. Washington, DC: Resources for the Future, 2nd edition.

Poterba, J. (1993), 'Tax policy to combat global warming: On designing a carbon tax'. In: R. Dornbusch and J. Poterba (eds.): *Global Warming: Economic Policy Responses*, Cambridge: MIT Press.

Requate, T. and W. Unold (2003), 'Environmental policy incentives to adopt advanced abatement technology: Will the true ranking please stand up?'. *European Economic Review* **47**(1), 125–46.

Roberts, M. J. and M. Spence (1976), 'Effluent charges and licenses under uncertainty'. *Journal of Public Economics* **5**, 193–208.

Rose, K. J. (2000), 'Electricity industry restructuring and the SO_2 emissions trading program: A look ahead by looking back'. In: R. F. Kosobud (ed.): *Emissions Trading: Environmental Policy's New Approach*, New York: John Wiley & Sons, Inc.

Rubin, J. D. (1996), 'A model of intertemporal emission trading, banking, and borrowing'. *Journal of Environmental Economics and Management* **31**(3), 269–86.

Sagoff, M. (1997), *Controlling Global Climate: The Debate Over Pollution Trading*. retrieved Feb. 20, 2006 from http://www.puaf.umd.edu/IPPP/winter99/controlling_global_climate.htm.

Sandel, M. (1997), 'It's immoral to buy the right to pollute'. *New York Times*.

Sandmo, A. (1975), 'Optimal taxation in the presence of externalities'. *Swedish Journal of Economics* **77**.

Schennach, S. M. (2000), 'The economics of pollution permit banking in the context of Title IV of the 1990 Clean Air Act Amendments'. *Journal of Environmental Economics and Management* **40**(3), 189–210.

Schmalensee, R., P. Joskow, A. D. Ellerman, J.-P. Montero, and E. M. Bailey (1998), 'An interim evaluation of sulfur dioxide emissions trading'. *Journal of Economic Perspectives* **12**, 53–68.

Schulze, W. D. and R. C. d'Arge (1974), 'The coase proposition, information constraints, and long-run equilibrium'. *American Economic Review* **64**(4), 763–72.

Segerson, K. (1988), 'Uncertainty and incentives for nonpoint pollution control'. *Journal of Environmental Economics and Management* **15**, 87–98.

Seskin, E. P., R. J. Anderson, and R. O. Reid (1983), 'An empirical analysis of economic strategies for controlling air pollution'. *Journal of Environmental Economics and Management* **10**(2), 112–24.

Shabman, L. A. and P. Scodari (2004), *Past, Present, and Future of Wetlands Credit Sales*. Discussion Paper 04–48, Resources for the Future.

Shelby, M., R. Shackleton, M. Shealy, and A. Cristofaro (1997), 'The climate change implications of eliminating U.S. energy (and related)

subsidies'. In: *Reforming Energy and Transport Subsidies*, Paris: OECD.

Shortle, J. S. and J. W. Dunn (1986), 'The relative efficiency of agricultural source water pollution control policies'. *American Journal of Agricultural Economics* **68**, 668–77.

Sigman, H. (1996), 'The effects of hazardous waste taxes on waste generation and disposal'. *Journal of Environmental Economics and Management* **30**(2), 199–217.

Spulber, D. F. (1985), 'Effluent regulation and long-run optimality'. *Journal of Environmental Economics and Management* **12**(2), 103–16.

Stavins, R. N. (1996), 'Correlated uncertainty and policy instrument choice'. *Journal of Environmental Economics and Management* **30**(2), 218–32.

Stavins, R. N. (2000), 'Market-based environmental policies'. In: P. R. Portney and R. N. Stavins (eds.): *Public Policies for Environmental Protection*. Washington, DC: Resource for the Future, 2nd edition.

Stavins, R. N. (2003), 'Experience with market-based environmental policy instruments'. In: K.-G. Maler and J. R. Vincent (eds.): *The Handbook of Environmental Economics, Vol. 1*, Amsterdam: North Holland.

Terkla, D. (1984), 'The efficiency value of effluent tax revenues'. *Journal of Environmental Economics and Management* **11**, 107–23.

Tietenberg, T. (1985), *Emissions Trading: An Exercise in Reforming Pollution Policy*. Washington, DC: Resources for the Future.

Turner, M. and Q. Weninger (2005), 'Meetings with costly participation: An empirical analysis'. *Review of Economic Studies* **72**(1), 247–68.

Viscusi, W. K. and R. J. Zeckhauser (1979), 'Optimal standards with incomplete enforcement'. *Public Policy* **27**, 437–56.

Weisman, D. (1997), 'An economic analysis of the mid-atlantic surf claim and ocean quahog fishery using logit, hazard, and survival rate functions'. Department of Agricultural Economics and Marketing, Rutgers University. Unpublished M.S. thesis.

Weitzman, M. L. (1974), 'Prices vs. quantities'. *Review of Econ. Studies* **41**(4), 477–91.

Weitzman, M. L. (2002), 'Landing fees vs. harvest quotas with uncertain fish stocks'. *Journal of Environmental Economics and Management* **43**(2), 325–38.

Wiser, R., K. Porter, M. Bolinger, and H. Raitt (2005), 'Does it have to be this hard? Implementing the nation's most complex renewables portfolio standard'. *The Electricity Journal* **18**(8), 55–67.

Woodward, R. and R. Kaiser (2002), 'Market structures for U.S. water quality trading'. *Review of Agricultural Economics* **24**(2), 366–83.

Woodward, R. T. (2001), *The Environmentally Optimal Trading Ratio*. Paper presented at the Annual Meeting of the American Agricultural Economics Association, August 5–8, 2001, Chicago.