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# Market-Based Environmental-Policy Instruments

Gilbert E. Metcalf\*

The Clean Air Act Amendments of 1990 ushered in a new era in environmental policy, constructing a market in tradable permits for sulfur dioxide emissions at electric utilities in the United States. This law was a watershed in many ways because it was the first large-scale initiative in the United States to use a market-based instrument to manage pollution. Prior to 1990, discussion and analysis of market-based instruments (for example, cap-and-trade systems, environmental taxes, and subsidies to clean production) had been theoretical for the most part because the United States, and most other developed countries, relied primarily on command-and-control regulation to reduce pollution. Interest in market-based instruments has been heightened by concerns about global warming and the role of carbon emissions. The Kyoto Protocol calls for substantial reductions in carbon emissions, and carbon taxes have been seen as a possible instrument for achieving those targets.

My work over the past five years or so has been concerned with two aspects of market-based environmental instruments: design considerations for market-based instruments in the presence of pre-existing tax distortions and distributional implications of environmental-tax reforms.

## Instrument Design in a Second-Best World


The increasing focus in the 1990s on the possibility of market-based instruments along with ongoing con-

cerns about the magnitude of distortionary taxation both in the United States and in Europe, suggested the possibility of using environmental taxes to replace existing factor and commodity taxes. A conjecture dubbed the "Double-Dividend Hypothesis" made the valid point that environmental taxes have two benefits: they discourage environmental degradation and they raise revenue that could offset other distortionary taxes. While the conjecture as stated is certainly correct, its policy implications are not so clear-cut.<sup>1</sup> For example, what are its implications for optimal environmental-tax rates? In a world with no pre-existing taxes, the optimal tax rate on pollution is equal to marginal environmental damages. Because Pigou is credited with this result, the term Pigouvian tax rate is often used to characterize environmental taxes set equal to marginal environmental damages. According to one view, the double-dividend hypothesis implies that the optimal tax rate on pollution should exceed the Pigouvian tax rate. This was "proved" in partial-equilibrium models, so long as the environmental-tax revenue elasticity at the optimal rate was positive. In other words, these models suggested that a pollution tax should be higher than marginal environmental damages if that higher tax rate would raise revenue so that other distorting taxes could be lowered. Lans Bovenberg and Ruud de Mooij constructed a simple general-equilibrium model to show that this result was incorrect.<sup>2</sup> They note that an environmental tax, although beneficial from an environmental point of view, is still distortionary and could exacerbate pre-existing tax distortions. Imagine, for example, that the only other tax


in effect is on wage income, thus causing the supply of labor to fall short of the efficient level. An environmental tax will raise product prices (or reduce factor incomes) so that the real wage falls, thus causing labor supply to fall further. More simply put, an increase in an environmental tax is analogous to an increase in the tax rate on wage income. Since there is already a deadweight loss in the labor market, any increase in taxes has a first-order effect on welfare. Lawrence H. Goulder, who quantifies this in a number of papers using a computable general equilibrium (CGE) model of the U.S. economy, finds, for example, that the optimal carbon tax, the proceeds of which are used to reduce personal income taxes, falls short of marginal environmental damages by 27 to 65 percent, depending on the magnitude of those damages.<sup>3</sup>

This focus on second-best tax rates is important for policy setting, but for purposes of considering the impact of pre-existing tax distortions on environmental quality, it can be misleading. The fact that the optimal pollution tax falls short of environmental quality in the presence of pre-existing taxes suggests that environmental quality also falls. In a recent paper, I show that this is not necessarily true.<sup>4</sup> I argue that in second-best analysis, one must distinguish between issues of "price" — the optimal tax rate — and "quantity" — the optimal level of environmental quality. Using a simple analytical general-equilibrium model, I show that an increase in required government revenue, financed through distortionary taxation, can lead to both a reduction in the optimal tax on pollution and an increase in environmental quality. Although the particu-


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lar finding is specific to the model in that paper, the more general finding is that one cannot infer the impact of increased revenue requirements on optimal environmental quality simply by looking at changes in optimal tax rates.



Revenue is central to the double-dividend hypothesis, and the role of environmental revenue-raising in a second-best world has been an important area of research. Two papers suggest the complexity of that relationship. Goulder and his co-authors make the important point that revenue raising per se is not sufficient to ensure an efficiency improvement in a world with pre-existing taxes.<sup>5</sup> If the environmental-tax revenues are returned to consumers in a lump sum, then there is no scope for reduction of other pre-existing distortionary taxes. An environmental tax on pollution with a lump sum rebate of proceeds has the same economic impact as a cap-and-trade system under which the tradable permits are given to economic agents at no cost. That policy was adopted as part of the sulfur dioxide trading system under the Clean Air Act Amendments of 1990. When environmental-tax proceeds are returned in a lump sum, there is no guarantee that the adoption of an environmental tax will enhance welfare.<sup>6</sup> Don Fullerton and I have shown that raising revenues in order to lower other distorting taxes is not necessary to achieve a welfare gain.<sup>7</sup> For example, imposing a small tax on a polluting input used in production and using the revenue to lower a pre-existing labor tax is equivalent to subsidizing clean inputs used in production through an increase in a pre-existing labor tax. In fact, for small taxes, there is a continuum of policies that might raise revenue, lose revenue, or involve no revenue at all, with identical impact on welfare. Because the focus on revenue can be misleading, we propose an



alternative interpretation that associates the exacerbation of pre-existing tax distortions with policies that generate privately retained scarcity rents. The rents interpretation can be seen most easily in a cap-and-trade program such as the sulfur dioxide trading program just described. Caps on sulfur dioxide emissions serve as an entry barrier for electricity producers. The rents accruing from barriers to entry into this industry are capitalized into the price of tradable permits. If the permits go to the electric utility industry, then the scarcity rents remain in private hands. If, on the other hand, the government were to sell the permits to electric utilities (or to anyone else for that matter), the rents would accrue to government, and there would be no distortionary impact of a new, small environmental tax.<sup>8</sup> While the disposition of economic rents typically is viewed simply as a distributional matter, in a second-best world the disposition of economic rents has an impact on efficiency as well as on distribution. If the rents are left in private hands, the efficiency consequences can be large enough to cause a particular environmental policy to be welfare reducing; if the rents were appropriated by government, that same environmental policy would be welfare enhancing.

This research assumes that environmental policy instruments can be targeted precisely. In the real world, however, most environmental taxes are taxes on proxies for pollution.<sup>9</sup> Goulder examines the institutional barriers to precise environmental taxation and analyzes them using a partial-equilibrium model.<sup>10</sup> Fullerton, Inkee Hong, and I also use a general-equilibrium model with other pre-existing tax distortions to analyze the welfare losses from mistargeted instruments.<sup>11</sup> Within plausible parameters, we find that the welfare gain from an output tax designed to discourage pollution is less than half the

gain from an emissions tax. Although our model is highly stylized, the welfare losses from mistargeting suggest that the ability to measure and tax emissions directly produces efficiency gains and thus improvements.

## Distribution

Environmental and energy taxes typically are viewed as highly regressive. This perception has served as an important impediment to the use of market-based instruments in lieu of command-and-control regulation. But relatively recent work has questioned the regressive nature of those taxes. In a number of papers, James M. Poterba argues that consumption taxes are less regressive when measured over the lifetime rather than in terms of annual income. His point is certainly germane to gasoline taxes, which are passed forward to consumers in the form of higher gasoline prices.<sup>12</sup> In more recent work, I emphasize that although an environmental tax might be regressive (even on a lifetime basis), environmental-tax reform easily could be progressive.<sup>13</sup> What matters for distributional considerations is what tax the environmental tax replaces. So long as the original tax is more regressive than the environmental tax, the reform will be progressive. Finally, it is noteworthy that distributional considerations may arise in other contexts as well. For example, Europeans have long been concerned with unemployment, and recent research on environmental-tax policy focuses on the impact of environmental taxes on unemployment.<sup>14</sup> Bovenberg and Goulder analyze the impact of various carbon dioxide abatement policies on industry equity values.<sup>15</sup> They note that if a cap-and-trade system with tradable permits in carbon emissions were adopted, the cost of permits would be borne primarily by consumers, who would pay higher product prices. Thus, if government wished

to hold corporate shareholders harmless should a cap-and-trade system be introduced, it would need only grandfather a small fraction of the permits. Stated differently, the grandfathering of sulfur dioxide emissions under the Clean Air Act Amendments of 1990 probably over-compensated electric utilities. However, measuring the degree of over-compensation is complicated by the fact that electric utilities had been subject to state regulation up until enactment of the law.

## Other Environmental Issues

This report focuses primarily on market-based environmental instruments, but I'll briefly mention a number of other areas of active environmental research. Many of the papers I describe here were outgrowths of a joint NBER-Fondazione Eni Enrico Mattei (FEEM) conference on environmental policy. Carlo Carraro from FEEM and I organized that conference.<sup>16</sup> One area of NBER research focuses on the costs of complying with environmental regulations. To understand how changes in regulations affect firm behavior and costs, we consider variations in state pollution regulations, as well as the applicability of federal regulations (which depends on the overall quality of the environment in the area).<sup>17</sup> A number of NBER researchers have investigated the links between economic growth and pollution.<sup>18</sup> A more recent literature has begun to investigate how pollution problems (and their solutions) differ between developing versus developed countries. Policymakers must be very careful about exporting policy prescriptions designed for developed countries to developing countries.<sup>19</sup> Finally, there is an emerging literature on the role of information, both in voluntary environmental initiatives and in the design of research and

development programs for pollution abatement.<sup>20</sup>

## Conclusion

General-equilibrium modeling has provided a number of important insights about the interplay between environmental-tax policy and the pre-existing tax system. However, much remains to be done to improve our understanding of market-based environmental policies.

The following is an incomplete research agenda:

- The use of analytical and computable general-equilibrium models has been beneficial and has served to focus attention on key parameters. We need more empirical work with microdata to estimate those parameters. For example, one key parameter for measuring the welfare gains from better targeting of environmental instruments is the elasticity of substitution between pollution and other inputs in production. This elasticity potentially can be estimated from pollution abatement curves if there are sufficient microdata.
- Environmental policy aimed at combating global warming must take into account both international factor flows and the possibility of carbon leakage if international agreements do not include all major greenhouse-gas emitters. International trade models have considered many important trade-related issues that arise from such international agreements as the Kyoto Protocol. But more work at integrating tax and trade models would yield a large payoff.
- Carbon (and other greenhouse gas) emissions can persist in the atmosphere for many generations. Given that pollutants may be highly persistent over time, intergenerational considerations

in climate policy also merit our attention.

- Optimal policy design cannot ignore political-economy considerations. We have only begun to study how to design environmental policies that take political constraints into consideration. The complexity of international climate negotiations, for example, implies the critical importance of this task.

<sup>1</sup> D. Fullerton and G. E. Metcalf, "Environmental Taxes and the Double-Dividend Hypothesis: Did You Really Expect Something for Nothing?" NBER Working Paper No. 6199, September 1997, and Chicago-Kent Law Review, 73 (1998), pp. 221-56.

<sup>2</sup> A. L. Bovenberg and R. de Mooij, "Environmental Levies and Distortionary Taxation," American Economic Review, 94 (1994), pp. 1085-9; and I. W. H. Parry, "Pollution Taxes and Revenue Recycling," Journal of Environmental Economics and Management, 29 (1995), pp. S64-S77.

<sup>3</sup> A. L. Bovenberg and L. H. Goulder, "Optimal Environmental Taxation in the Presence of Other Taxes: General Equilibrium Analyses," NBER Working Paper No. 4897, October 1994, and American Economic Review, 86 (1996), pp. 985-1000.

<sup>4</sup> G. E. Metcalf, "Environmental Levies and Distortionary Taxation: Pigou, Taxation, and Pollution," NBER Working Paper No. 7917, September 2000, forthcoming in the Journal of Public Economics.

<sup>5</sup> L. H. Goulder, I. W. H. Parry, and D. Burtraw, "Revenue-Raising vs. Other Approaches to Environmental Protection: The Critical Significance of Pre-Existing Tax Distortions," NBER Working Paper No. 5641, June 1996, and RAND Journal of Economics, 28 (1997), pp. 708-31.

<sup>6</sup> D. Fullerton and G. E. Metcalf, "Environmental Controls, Scarcity Rents, and Pre-Existing Distortions," NBER Working Paper No. 6091, July 1997, and Journal of Public Economics, 80 (2001), pp. 249-67; and A. L. Bovenberg and L. H. Goulder, "Optimal Environmental Taxation in the Presence of Other Taxes: General Equilibrium Analyses."

<sup>7</sup> D. Fullerton and G. E. Metcalf, "Environmental Controls, Scarcity Rents, and Pre-Existing Distortions."

<sup>8</sup> This result holds under perfect competition. If the producer is a monopolist, the

distortion persists with complete government appropriation of the scarcity rents from the environmental policy. See D. Fullerton and G. E. Metcalf, "Environmental Controls, Scarcity Rents, and Pre-Existing Distortions," and D. Fullerton and G. E. Metcalf, "Cap and Trade Policies in the Presence of Monopoly and Distortionary Taxation," forthcoming as an NBER Working Paper.

<sup>9</sup> For a description of the major environmental taxes in effect in the United States, see D. Fullerton, "Why Have Separate Environmental Taxes?" in *Tax Policy and the Economy*, vol. 10, J. M. Poterba, ed. Cambridge: MIT Press, 1996.

<sup>10</sup> A. Schmutzler and L. H. Goulder, "The Choice between Emission Taxes and Output Taxes under Imperfect Monitoring," *Journal of Environmental Economics and Management*, 32 (1997), pp. 51-64.

<sup>11</sup> D. Fullerton, I. Hong, and G. E. Metcalf, "A Tax on Output of the Polluting Industry Is Not a Tax on Pollution: The Importance of Hitting the Target," NBER Working Paper No. 7259, July 1999, and in *Behavioral and Distributional Effects of Environmental Policy*, C. Carraro and G. E. Metcalf, eds. Chicago: University of Chicago Press, 2001.

<sup>12</sup> J. M. Poterba, "Lifetime Incidence and the Distributional Burden of Excise Taxes," NBER Working Paper No. 2833, July 1989, and *American Economic Review*, 79 (1989), pp. 325-30; J. M.

Poterba, "Is the Gasoline Tax Regressive?" NBER Working Paper No. 3578, January 1991, and in *Tax Policy and the Economy*, vol. 5, J. M. Poterba, ed. Cambridge: MIT Press, 1991; and N. Bull, K. A. Hassett, and G. E. Metcalf, "Who Pays Broad-Based Energy Taxes? Computing Lifetime and Regional Incidence," *Energy Journal*, 15 (1994), pp. 145-64.

<sup>13</sup> G. E. Metcalf, "A Distributional Analysis of Green Tax Reforms," NBER Working Paper No. 6546, May 1998, and *National Tax Journal*, 52 (1999), pp. 655-81.

<sup>14</sup> M. Rauscher, "Factor Movements, Environmental Policy, and Double Dividends," in *Behavioral and Distributional Effects of Environmental Policy*, C. Carraro and G. E. Metcalf, eds. Chicago: University of Chicago Press, 2001.

<sup>15</sup> A. L. Bovenberg and L. Goulder, "Neutralizing the Adverse Industry Impacts of CO<sub>2</sub> Abatement Policies: What Does It Cost?" NBER Working Paper No. 7654, April 2000, and in *Distributional and Behavioral Effects of Environmental Policy*, C. Carraro and G. E. Metcalf, eds. Chicago: University of Chicago Press, 2001.

<sup>16</sup> C. Carraro and G. E. Metcalf, eds., *Distributional and Behavioral Effects of Environmental Policy*. Chicago: University of Chicago Press, 2001.

<sup>17</sup> R. A. Becker and J. V. Henderson, "Costs of Air Quality Regulation," NBER Working Paper No. 7308, August 1999, and in *Behavioral and Distributional Effects of*

*Environmental Policy*; and A. Levinson, "An Industry-Adjusted Index of State Environmental Compliance Costs," NBER Working Paper No. 7297, August 1999, and in *Behavioral and Distributional Effects of Environmental Policy*.

<sup>18</sup> G. Grossman and A. Krueger, "Economic Growth and the Environment," NBER Working Paper No. 4634, February 1994, and in *Quarterly Journal of Economics*, 110 (1995), pp. 353-77; and J. Andreoni and A. Levinson, "The Simple Analytics of the Environmental Kuznets Curve," NBER Working Paper No. 6739, September 1998, and in *Journal of Public Economics*, 80 (2001), pp. 269-86; and D. F. Bradford, R. Schlieckert, and S. H. Shore, "The Environment Kuznets Curve: Exploring a Fresh Specification," NBER Working Paper No. 8001, November 2000.

<sup>19</sup> R. Jha and J. Whalley, "The Environmental Regime in Developing Countries," NBER Working Paper No. 7305, August 1999, and in *Behavioral and Distributional Effects of Environmental Policy*.

<sup>20</sup> Y. Katsoulacos, A. Ulph, and D. Ulph, "The Effects of Environmental Policy on the Performance of Environmental Research Joint Ventures," in *Behavioral and Distributional Effects of Environmental Policy*; and D. Siniscalco, S. Borghini, M. Fantini, and F. Ranghieri, "Environmental Information and Company Behavior," in *Behavioral and Distributional Effects of Environmental Policy*.

