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Benefit-Cost Analysis of the RECLAIM Program

Nancy Pfeffer

The most common approaches to the control of environmental pollution are emission standards and emission fees. Standards strictly limit the amount of pollution, but provide no incentive to reduce emissions below the standard. Fees, in theory, provide an economic incentive for firms to reduce pollution, but do not in themselves limit emissions.

An alternative policy is the trading of pollution permits, which in theory should control pollution more cost-effectively than prescriptive requirements such as standards. As early as the 1920's, economists pointed out the potential for market forces to serve as an incentive to reduce pollution. The Economic Incentive Programs described in the Clean Air Act Amendments of 1990 provide a statutory basis for emissions trading programs at the federal, state, and local levels.

In a research project for a graduate course, another student (Ariel Ramirez, PhD candidate at the University of Southern California) and I evaluated the costs and benefits of an emissions permit trading program in the Los Angeles metropolitan area. The program, known as RECLAIM (Regional Clean Air Incentives Market), allows industrial facilities to reduce emissions of nitrogen oxides (NOx) and sulfur oxides (SOx) either directly or by purchasing reductions from other facilities.

RECLAIM was adopted by the South Coast Air Quality Management District (the Dis-

trict) in October 1993, and it took effect in January 1994. The District, originally established in 1947 as the Los Angeles Air Pollution Control District, is among the oldest local air-quality regulatory bodies in the United States. It also has one of the toughest jobs: meeting stringent ambient air quality standards in the most heavily polluted air basin in the country.

Facilities entering the RECLAIM program are assigned a "starting allocation"—a permitted quantity of emissions—for each pollutant. Over the 10-year life of the program, each facility's allocations decrease annually. Facilities can meet these declining emissions caps by installing pollution control equipment, by modifying facility processes, or by purchasing credits (emission reductions) from other facilities in the program. The facilities' operating permits have been consolidated and reformatted to reflect the allocations.

Compliance with the allocations is determined partly through typical enforcement methods (site inspections, for example), but the RECLAIM program also requires participants to install continuous emission monitoring systems (commonly known as CEMS) that report emissions data electronically to the District every day.

For simplicity, we focused the analysis by:

- Calculating benefits and costs related only to the petroleum industry. In many respects, this industry accounts for a large portion of benefits and costs observed in the program generally.
- Calculating benefits and costs only for SOx.

The implications of these choices are discussed under Sensitivities and Uncertainties, below.

Methodology

Benefits and costs of the RECLAIM program were evaluated in comparison to traditional regulations known as "command-and-control." In other words, we calculated benefits and costs as the difference between what happened under RECLAIM and what would have happened under command-and-control regulations resulting in equivalent emissions reductions. Typical command-and-control requirements for

the petroleum industry displaced by RECLAIM include the treatment of fuel gas to remove sulfur (thereby reducing SOx emissions) and the modification of refinery heaters to reduce NOx formation.

Since California must meet federal ambient air quality standards in all regions, RECLAIM should result in emission levels at least equivalent to those under command-and-control. In theory, then, the RECLAIM program must achieve at least the same quantity of reductions as the command-and-control scheme.

Benefits and costs were quantified by interviewing District and industry personnel and reviewing industry cost records. To estimate costs and benefits for the Southern California petroleum industry, we determined costs and benefits for one company (ARCO) and extrapolated those costs to the industry as a whole.

Benefits of RECLAIM

The largest benefit of the RECLAIM program is the cost savings to businesses that can now choose less expensive control methods than under command-and-control. The program benefits are, in effect, avoided costs in the private sector; no benefits were assumed to accrue in the public sector.

Two other potential types of benefits from the RECLAIM program were considered, but not quantified. The first was environmental and health benefits resulting from reduced emissions of SOx. Current and former District personnel confirmed that it was probably reasonable to assume that RECLAIM was an "air-quality neutral" program: in other words, enactment of RECLAIM in place of command-and-control regulations could be expected, over the life of the program, to achieve the same level of air quality improvement.¹ It is, of course, possible that RECLAIM will result in more air quality improvement than the command-and-control approach would have, particularly if emission reductions prove substantially less expensive or even profitable under the emissions trading

¹ Communications with M. Buckantz, Justice & Associates, and J. Broadbent, South Coast Air Quality Management District, March 1998.

scheme.² However, such benefits would be difficult to quantify and were not included in this analysis. In fact, even though the District monitors ambient air quality continuously in the Los Angeles area, the data reflect the effect of all pollution control measures taken together. From these measurements, the effects of emissions trading on air quality cannot be distinguished from the effects of other pollution control programs.

The other potential benefit considered was job creation due to the creation of a market for permits. This benefit was not quantified for two main reasons. First, it would be difficult to prove that new jobs resulted from RECLAIM and not from general regional economic growth or other factors. Second, the number of new jobs would probably be quite small, thus having little effect on the analysis.

Costs of RECLAIM

Two main categories of program costs were estimated—formulation costs and implementation costs—including both public-sector and private-sector expenditures. Formulation costs were included because the move to an emissions trading system represented a departure from traditional methods of pollution control. Both the District and the affected industries were intensely concerned that the program be well designed and workable, and both devoted a considerable amount of time and effort to this end. Starting allocations of emission allowances, known as RECLAIM Trading Credits (Credits), were especially contentious, as were the format and design of the consolidated permits and the details of electronic reporting of emissions data. To adjust the formulation costs for the fact that the analysis looked only at SO_x, all estimates were multiplied by 40/330, or the approximate number of SO_x facilities out of the universe of all RECLAIM facilities, SO_x and NO_x.

Implementation costs were included in the analysis to the extent that they exceeded the

² For example, anticipating a rise in the price of emission permits in later years, a company could buy permits or reduce emissions early for later sale at a higher price per ton.

costs of equivalent command-and-control rules. For the regulatory agency, these costs included RECLAIM program startup and additional enforcement, as well as the cost of computer upgrades necessary to handle the influx of compliance data. For example, permit consolidation alone was an effort involving 30 to 40 full-time equivalent personnel for half a year. However, the District estimated that, aside from startup costs, their implementation costs were not substantially higher than the costs of administering equivalent command-and-control regulations; in fact, the only difference was a slight increase in the level of enforcement resources. For industry, implementation costs included installation and certification of continuous emission monitoring systems, the ongoing maintenance of these systems, and the costs of emission controls (or Credit purchases) needed to comply with the declining emissions caps.

As with benefits, some costs were not quantified. For example, transaction costs (private firms' costs in locating, purchasing, and documenting Credits) might have been substantial, but no data were available on these costs. Costs related to loss of jobs attributable to RECLAIM also were not quantified, for the same reasons mentioned in the section on benefits.

Some environmental groups and scholars have expressed concern that trading programs such as RECLAIM could lead to inequities in the distribution of emissions. While emissions under RECLAIM cannot increase above a facility's cap, neighbors of facilities that buy credits might have to wait for actual improvements in localized air quality. However, the District's first three-year audit of RECLAIM found no distinct evidence of a shift in the geographic distribution of emissions. We did not attempt in this study to quantify or include costs, if any, related to environmental justice concerns.

Time Horizon and Discount Rate

Since RECLAIM program formulation began in October 1990, and the program is scheduled to last until 2003, the analysis covered this 14-year time frame. A real discount rate of 4% was used, and cost and

benefit estimates were not adjusted for inflation.

Results and Discussion

In the base case, the RECLAIM program for SO_x had a positive net present value of \$134.9 million for the petroleum industry. Total discounted program costs were estimated to be \$51.3 million and total discounted program benefits \$186.2 million. The corresponding discounted benefit-cost ratio was 3.63. This result was obtained even though formulation costs were counted.

These results indicate that the SO_x portion of the program has left petroleum industry participants better off than if it had not been implemented. During the formulation stage (1990–1993), agency cost estimates generally exceeded industry cost estimates by roughly a factor of two, but during implementation (1994–2003), industry costs were estimated to exceed agency costs substantially. Overall program costs for the agency were only 1.5%–2% of industry costs. For further details on project results, please request a full copy of the report from the author.

Sensitivities and Uncertainties

The sources of uncertainty in this analysis are described in turn below, along with the results and implications of sensitivity analyses that were performed. None of the sensitivity analyses changed the conclusions of the study, even when all the sensitivities were taken together—that is, the net present value remained positive in every case. Table 1 summarizes the base case and the results of all sensitivity analyses.

- *Restricting the analysis to the petroleum industry.* The agency's costs were for the whole program, not just one industry. However, including all these costs (as was done) would have the effect of overstating the costs, a conservative assumption.
- *Restricting the analysis to SO_x only.* Industry costs and savings for SO_x alone were quantified with fairly good accuracy. For the agency, total costs were estimated, then scaled as if they had applied to SO_x alone. This approach could tend to underestimate the costs of the pro-

Table 1. Summary of base case analysis and sensitivity analysis results (all dollars in millions)

	Base Case	Higher Public Sector Labor Rate	Counting All Implementation Costs for SOx	Including 20% Transaction Costs	Private Sector Discount Rate	All Sensitivities (4% Rate)	All Sensitivities (12% Rate)
Interest Rate	4%	4%	4%	4%	12%	4%	12%
Discounted Costs	\$51.3	\$52.2	\$59.9	\$51.2	\$33.2	\$67.2	\$46.3
Discounted Benefits	\$186.2	\$186.2	\$186.2	\$186.2	\$99.2	\$186.2	\$99.2
Net Present Value	\$134.9	\$134.0	\$126.3	\$134.5	\$66.0	\$118.6	\$52.8
Discounted Benefit-Cost Ratio	3.63	3.57	3.11	3.60	2.99	2.75	2.14

gram in relation to its benefits. A sensitivity analysis was performed on this factor by changing the scaling ratio to 1, so that all program costs were balanced against just the SOx benefits. The net present value in this case was still \$126.3 million.

- *Uncertainty in benefit estimates.* One company's estimated benefits were assumed to be representative of the entire local industry's experience. If this assumption is incorrect, the estimate of industry savings (benefits) could be overstated (or understated).
- *Omission of environmental benefits.* The benefits actually quantified already exceed the program costs; addition of environmental benefits, if any, would only reinforce the result.
- *Omission of environmental justice costs.* These costs, if they occur, would be difficult to quantify. We cannot say how they would affect our analysis and, within the scope of our work, could not estimate their magnitude.
- *Uncertainty in agency cost estimates.* An hourly labor rate of \$50/hr was assumed for public agency employees. In a sensitivity analysis, this rate was varied to \$100/hr (the same rate used for private-sector labor), but the net present value was still \$134.0 million.
- *Uncertainty in industry cost estimates.* The District forecasts that future SOx control costs may rise sharply, but the analysis was based on industry control costs that are quite close to the future forecast number (\$2000–2400 per ton). However, it is impossible to verify the accuracy of even the District's forecast, and actual future control costs may be quite different from those estimated.

- *Omission of transaction costs.* No data were available on transaction costs in the RECLAIM market. However, a sensitivity analysis was done assuming a rule-of-thumb 20% transaction cost for Credits that were purchased by industry to meet emission caps. The net present value in this case was still \$134.5 million.
- *Sensitivity to discount rate.* In one case run using a 12% discount rate (a private-sector rate), the net present value dropped to \$66.0 million. Even this result indicates that the RECLAIM project was a good idea.

In a final test, all the sensitivity factors—higher public sector labor rate, omission of the cost ratio for SOx, and inclusion of transaction costs—were applied at once to the benefit-cost calculation. At a 4% discount rate, the net present value was still \$118.5 million; even at a 12% rate, the net present value was still \$52.8 million.

Conclusions

These results indicate that the RECLAIM program is a more cost-effective way to reduce SOx emissions from the Southern California petroleum industry than command-and-control regulations leading to equivalent emission reductions. Using conservative benefit and cost estimates, a positive net present value was obtained for all the scenarios examined—meaning that the industry (and the region) is better off under this portion of RECLAIM than under command-and-control. The two alternatives were assumed to result in the same level of regional air quality, which is achieved at lower cost under RECLAIM.

The uncertainties in the analysis suggest areas for further investigation. For ex-

ample, the positive results recommend expanding this analysis to include more industry sectors and the NOx portion of the program. Since the benefit and cost estimates were extrapolated from a single company's experience, further research might involve industry surveys to assess these values more accurately.

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Interactive Ethics

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Editors' Note: This column is a continuation of one that ran in the NAEP News prior to publication of Environmental Practice. In each issue, an ethical dilemma presented in a previous issue is addressed, and a new situation is introduced. The dilemmas presented in the final two issues of NAEP News will be reprinted as appropriate to provide continuity.

The Situation: What Did You Do In Seattle?

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Two employers have sent people to a professional conference. They paid registration, hotels, travel, and meal expenses of almost a thousand dollars so that the two could go to Seattle for a week of whatever it is you do at a conference.

One person went out every night partying with other night owls. He (or she) never got