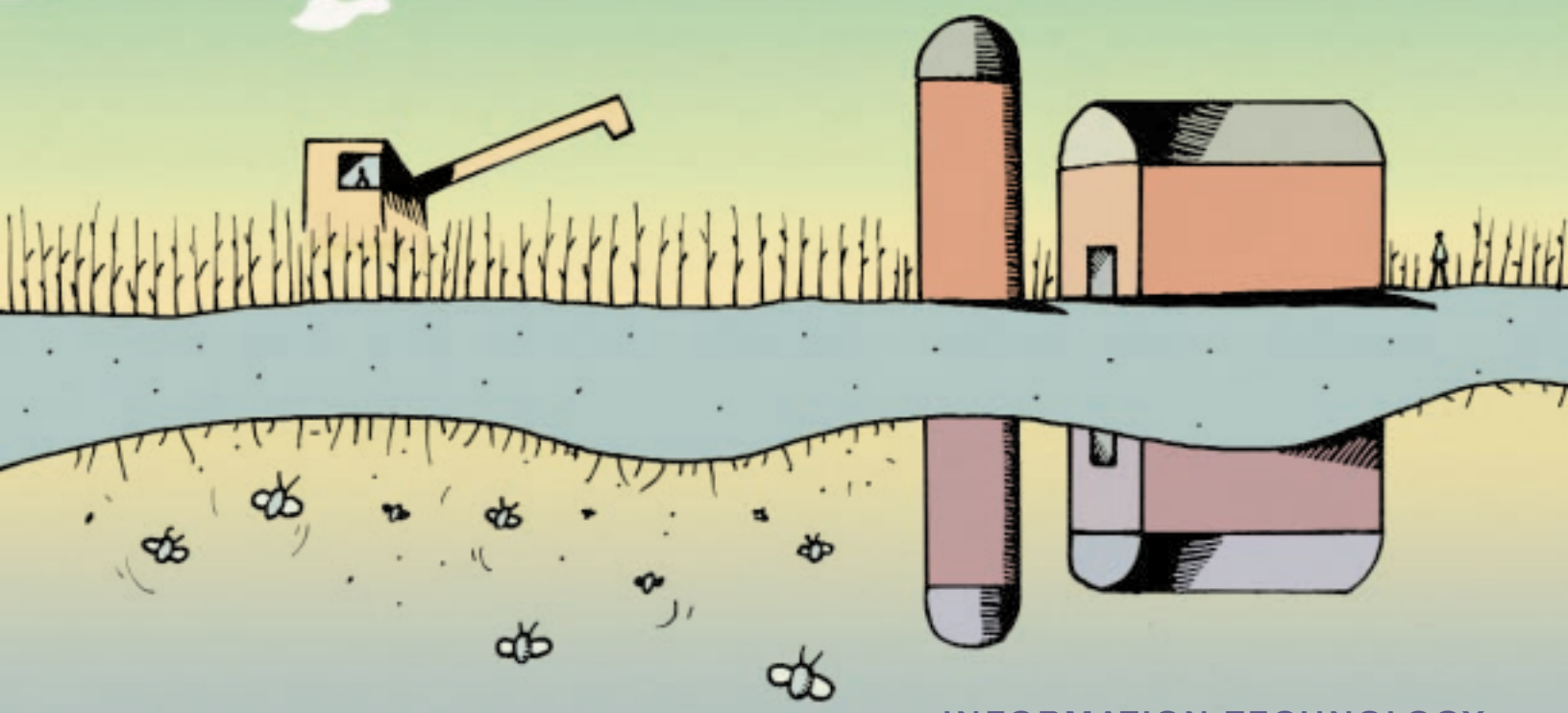
RESOURCES

RESOURCES FOR THE FUTURE FALL/WINTER 2004 · ISSUE NUMBER 152

PEST RESISTANCE



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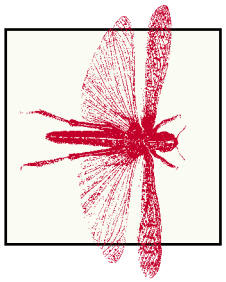

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From the President

PAUL R. PORTNEY

Making Our Ideas Known to the Broader Community

As you read this, the country is preparing for the quadrennial observance of a critical component of our democracy—the presidential election. By spring, we should have a clear idea of whom the Democrats will nominate to run against President Bush. And, as the months pass, both candidates will begin casting about for initiatives for the next four years.

In that spirit, researchers at Resources for the Future are preparing for the election in their own way, compiling a set of policy proposals and recommendations to be ready for the president shortly after the election. These presentations, which will be brief, three to five-page submissions, will be collected into a book that RFF will publish and release at that time.

By the very nature of what we do at RFF and the methods we use to study the problems and issues we examine, our work is often technical, requiring a specialized vocabulary that is sometimes difficult for even a highly educated audience of non-specialists to understand.

Since I became president of RFF more than eight years ago, one of my principal emphases has been to broaden the impact of our work. RFF researchers have always done world-class academic research that has appeared in renowned economic and academic journals. But we haven't always been successful in making our work known to a general public.

We are getting better at what I call the "translation process." We have built a communications department that has been active in reaching out to the policy community in Washington, across the country, and even abroad. Indeed, the publication you are reading now is part of our attempt to make the relevance of RFF's prodigious output more accessible to policymakers and others interested in public policy—not only legislators and government administrators in Washington, DC, but also public officials at the state and local levels. Beyond that, we want to make our ideas known to the broader community of environmental advocates, to the media, and to businessmen and women who can make better informed decisions as a result of our research here at RFF.

This book will be something of a departure for us, but also a continuation of our contribution over the past 50 years to the public dialogue. We pride ourselves on being a detached and objective institution that observes and makes calls without regard to who is playing. This effort will not change that posture. RFF is not becoming an advocate; neither the institution nor the researchers will be lobbying on behalf of their proposals. What is different is that we are asking individual researchers to put their policy recommendations on the table and to draw inferences based on their research and accumulated expertise, to reach what they see as the logical conclusions of their work. We hope that others will discuss these ideas and give them serious consideration.

We don't expect that our publication will hit the best-seller lists—especially since we will be giving it away to the next administration and to other elected offcials—but we do hope to inform and educate a broader community and in that way help improve not only the quality of the public debate but the decisions that emerge from it. ■

Paul R. Portney

Goings On

RFF Scholars Evaluating Delhi's Switch to CNG Auto Fuel as Model for Change

Ruth Bell, Urvashi Narain, and David Simpson

In 1998, after 13 years of legal back-and-forth, the Supreme Court of India ordered that all public passenger vehicles in Delhi run on compressed natural gas (CNG). Five years later, the court's order has had an apparent significantly positive impact on pollution levels in Delhi.

The court's order has not been without its critics. However, its decision has sparked interest among environmental advocacy groups in countries throughout Asia that are frustrated with halting implementation of environmental laws and policies in their countries, many of which are beset by crippling levels of air pollution. They want to understand how Delhi improved its air quality and whether they can replicate that experience at home.

The broader question we would like to consider is, what is a reasonable way to jump-start environmental protection where it has been paralyzed or stalled? We suggest that greater progress might be achieved by taking a closer look at what is really going on in the developing world, to find examples of programs that are fighting the trend and achieving their goals. Along with researchers at Jawaharlal Nehru University, we are studying the developments in Delhi to determine whether their experience is a unique solution for a particular city and country or whether it can be replicated elsewhere.

In order to do that, we first have to reconstruct what happened: retrace the steps that led up to the court's order, understand how the court arrived at its decision, identify the institutions that supported the court, analyze the role played by the executive and legislature in this affiair, define the role of the court in Indian society, and determine the basis of its authority. In short, we have to understand and describe the context in which the decision was made and implemented.

We think this project has important lessons both for other countries and for the international donor and development institutions that offer advice, counsel, and imperatives to developing countries to "clean up their act."

Although theoretically "better" solutions than the CNG mandate were proposed, we are examining whether the solution the court chose was the best possible, given the constellation of circumstances that constitute reality on the ground. The Indian Supreme Court's decision reflected the court's awareness that if it chose increasingly cleaner diesel as the fuel of choice—a fuel that was attractive for a variety of reasons—drivers could easily have sabotaged the decision by adulterating the fuel with cheaper kerosene after filling their tanks at sanctioned filling stations. CNG allows for no such evasion.

In addition to examining the decision, we also are studying the implications for Indian democracy. The Indian Supreme Court enjoys widespread respect in India and that partly explains its authority. We will be exploring questions such as: What is the impact on a court's authority when it intervenes as it did in Delhi? Was the court acting in accordance with democratic principles or as a kind of superlegislature and executive? And, what are the long-term implications of the court's action for the power and authority of the other branches of government?

Visit www.rff.org/clearingtheair to learn more about this project. ■

Changing U.S. Patent Policy Could Bring Food Security to Africa

Michael R. Taylor and Jerry Cayford

Substantial improvement in agricultural productivity is essential for achieving food security and reducing chronic rural poverty in many developing countries, especially in sub-Saharan Africa, according to a new RFF Report by Senior Fellow Michael R. Taylor and Research Associate Jerry Cayford. Modern agricultural biotechnology has the potential to solve some of the basic productivity problems (such as insect control and drought) that plague the millions of small-scale farmers the backbone of African agriculture.

However, the U.S. and European countries that have developed these tools closely guard them behind a thicket of overlapping patents that hinder access by developing countries. For example, there are 70 different patents and licenses that guard vitamin A-enriched "golden rice," which could prevent childhood blindness caused by the lack of that nutrient.

In *American Patent Policy, Biotechnology, and African Agriculture: The Case for Policy Change,* the authors analyze both the formal U.S. patent system and U.S. patent policy in the international arena to look at how current policies could be adapted to improve access without undercutting the innovation incentives patents now provide.

American patent policy needs greater flexibility to give African farmers access to modern biotechnology, Taylor said, speaking at an RFF seminar in December. Obviously, patent policy is neither the direct cause nor the sole solution to hunger in Africa, he said. The achievement of food security is a complex social, economic, and political problem that is affected by a host of U.S. policies and programs, including food aid, agricultural subsidies, and trade barriers that create an unlevel playing field.

Agricultural biotechnology as a tool for providing food security in sub-Saharan Africa carries particular weight, however, because the region was largely bypassed during the "Green Revolution" of 40 years ago that brought genetically improved seed stock, fertilizer, and irrigation methods to developing countries throughout southeast Asia.

Public knowledge about critical concepts, such as germplasm, is becoming increasingly privatized, said Donald Kennedy, editor of the journal *Science* and president emeritus of Stanford University, who also spoke at the seminar. The knowledge "commons" has become more of an anticommons, he said.

The report finds that the holders of biotech patents rarely have economic incentive to use these processes and gene traits for the benefit of farmers in developing countries. To reach them, the authors said, technology will usually have to move through public or public-private agencies, a necessity for which current American policy makes little provision.

The United States and other industrialized nations are leading a campaign to establish uniform patenting standards and practices worldwide, despite widely differing conditions affecting technology development and transfer, especially in developing countries. The authors argue that the United States should support developing countries in exercising the flexibility they already have under the World Trade Organization's Agreement on Trade-Related Aspects of Intellectual Property to devise patent systems that meet local needs. American patent law and policy can be changed, they say, to provide poor countries better access to patented know-how without diminishing incentives for invention or creating direct competition with American patent holders. ■

American Patent Policy, Biotechnology, and African Agriculture is available on the RFF website at www.rff.org/PatentPolicy.cfm.

Creedon Named RFF Vice President for External Affairs

Lesli A. Creedon has been appointed vice president for external affairs. She has served as RFF's director of development since 1999 and corporate secretary since 2001. During that period, she led RFF's 50th anniversary campaign, which raised over $24 million, including the establishment of four endowed chairs. In addition to her fundraising and board responsibilities, she now will also manage RFF's communications strategy and outreach efforts.

"Lesli Creedon has improved everything in which she's been involved at RFF. Working with Jonathan Halperin and the other members of RFF's excellent communications team, they will build on the progress we've made and make RFF's research even more accessible and valuable to those in the policy process," RFF President Paul Portney said.

Prior to joining RFF in 1999, Creedon worked at the Brookings Institution for several years, most recently as director of the Brookings Council. She has also held strategic development positions at the Aspen Institute and the Economic Policy Institute in Washington. She is a graduate of Miami University with a degree in economics, political science, diplomacy, and foreign affairs. ■

The Food Safety Research Consortium Rolls Out New Risk-Ranking Model

Jody Tick

Since its launch at RFF in February 2003, the Food Safety Research Consortium (FSRC) has been developing a model to rank the public health impact of specific foodborne hazards. The model serves as a tool for analysts to better understand which food/pathogen combinations have the largest impact on public health. For example, should we be more concerned about Salmonella in chicken or E. coli in beef?

The project team, comprised of RFF, the University of Maryland, and Iowa State University, rolled out the model to the stakeholder community at a conference hosted by RFF in September. The project has been supported by a grant from The Robert Wood Johnson Foundation and conference presentations can be viewed on the FSRC website at www.rff.org/FSRC.

Foodborne hazards are a much larger, more insidious threat than most of us realize: the Centers for Disease Control and Prevention (CDC) estimates that there are 76 million foodborne illnesses each year, with an associated 325,000 hospitalizations and 5,000 deaths. In addition to the sheer numbers of those affected, the challenge of food safety is that it is a dynamic and evolving problem. The old-fashioned paradigm in which the majority of meals

were prepared at home from a relatively limited list of foodstuffs has become a thing of the past. Today, many more meals are eaten away from home in restaurants or fast food establishments, and the globalization of the food supply has afforded us a variety and availability of food that is historically unprecendented. With these emerging food trends come new issues in food safety.

But what would a more science- and risk-based food safety system look like? The FSRC is working to create a picture of such a system through the formulation of tools that will help policymakers design and manage a more efficient food safety system. The risk-ranking model represents the first phase of research to develop such decision tools, and future plans of work include the development and integration of models to prioritize opportunities to reduce risk and allocate resources accordingly. The FSRC's comprehensive program of work requires a new approach to understanding the food system as a whole and the interaction of factors all across the system that can contribute to the causation and prevention of foodborne illness.

Addressing this need for a new approach, the FSRC's founding members are an interdisciplinary group of institutions and researchers that include the following: the Center for Food Safety at the University of Georgia; the Department of Epidemiology and Preventive Medicine at the University of Maryland School of Medicine; the Food Marketing Policy Center at the University of Massachusetts, Amherst; the Institute for Food Safety and Security at Iowa State University; the Western Institute for Food Safety and Security at University of California, Davis; and RFF. Recently, the consortium welcomed a new member to the group, The National Food Safety and Toxicology Center at Michigan State University, which complements the other member organizations and the work of the FSRC.

Through this collaboration, the FSRC has already started its next phase of work supported by a grant from the U.S. Department of Agriculture's National Integrated Food Safety Initiative. The new project aims to develop a conceptual framework for identifying and evaluating opportunities in the food system (farm to table) for interventions that will reduce the burden of foodborne illness. ■

Jody Tick is an RFF research assistant.

Keeping One Row Ahead of the Bugs

THE ECONOMICS OF PEST RESISTANCE TO TRANSGENIC CROPS

Ramanan Laxminarayan and Carolyn Fischer

The fight against agricultural pests that destroy crops and reduce yields is as old as agriculture itself. In the 21st-century variant of this fight, humans have called in biotechnology. Some commercial varieties of corn, soybean, and cotton, among other crops, have now been engineered to express a protein of Bacillus thuringiensis (or Bt), a soil microbe that can kill caterpillars and other agricultural pests while being apparently harmless to humans and other nontarget species. Bt has been used in foliar sprays for more than four decades, mostly in organic farming. Now, with rapidly expanding acreage of Bt crops and widespread exposure of pests to the Bt toxin from commercial agriculture, resistant strains of pests may develop.

Resistance evolves in the following way. Initially, resistance genes occur at extremely low frequencies in the pest population because they are not essential to the species' survival. Once exposed to a pesticide, however, individual pests that do not possess the resistance gene are killed while the few with the gene survive. Over time and with repeated exposure to the toxin, the proportion of resistant pests becomes significant, reducing the effectiveness of the pesticide. This problem of resistance complicates any effort to control a biological organism through chemical or biochemical methods. This is particularly important in the case of pest-resistant transgenic crops: the rapidly expanding share of genetically modified (GM) crops in agriculture worldwide creates greater potential for systemwide damage if these crops fail against pests.

Economic Costs of Resistance

Since pest resistance to Bt has yet to be detected, the economic impact of resistance to Bt is not measurable. However, estimates for other pesticides may offer some indication of what could lie ahead. According to a recent article in *Science*, each year in the United States the cost of new pesticides to combat resistant pests runs about $1.2 billion, and the cost of pest damage to the food industry ranges between $2 billion and $7 billion. These cost estimates do not include environmental damages associated with increased pesticide use.

From a societal perspective, estimating the costs of pest control measures is further confounded by two additional factors that are external to the individual grower: increased use of Bt crops by any single grower engenders pest resistance, harming all growers, and use of these measures also reduces the pest population, which benefits all growers. Consequently, it is difficult to conclude simply from current levels of pest resistance whether past pesticide use has been optimal.

An important cost of resistance may come in the form of having to invent new technologies to replace those that are no longer effective. It is reported that developing a genetically modified Bt plant variety can take 6 to 12 years and cost $50–$300 million. However, without a proper assessment of the costs of resistance and the benefits of using Bt crops, it is difficult to assess whether the current rate at which technologies are being "depleted" is, from a societal perspective, efficient.

Refuge Strategies

In anticipation of the potential pest resistance to Bt technology, the U.S. Environmental Protection Agency (EPA) has required seed companies to ensure that farmers plant a certain proportion of their fields with a non-Bt variety (to provide a "refuge" where Bt-susceptible pests can survive). Refuges allow for interbreeding between pests that may have developed resistance to Bt and pests that remain susceptible to Bt but feed on the non-Bt crop (to dilute the resistance gene in the total population). Additionally, the strategy calls for a level of Bt toxin in the crop that is more than 25 times the concentration required to kill susceptible larvae (to make it difficult for the resistance gene to overcome the effect). Similar regulations have been imposed in Canada, which require that non-Bt corn be planted within a quarter-mile of the farthest Bt corn in a field.

In the past five years, the socially optimal refuge size and the current refuge requirements have been widely debated. While industry and farmer groups have argued for smaller non-Bt refuges than the currently mandated 20%, environmental groups are fighting for refuge requirements as large as 50% of cultivated acreage.

Current refuge requirements are based on fairly rigid assumptions: Bt crops dominate the marketplace and pests stay fixed in one locale. But when market penetration is assumed to be less than complete and pests are considered to be mobile, then non-Bt fields can operate as natural refuges for Bt-susceptible pests. In fact, high pest mobility and low market penetration can be substitutes in managing pest resistance, and when the rigid assumptions are relaxed, the optimal refuge level for Bt fields is considerably smaller than 20%.

The possibility that stringent refuge requirements could result in lower compliance also must be considered. Farmer

cooperation depends on the costs of growing an appropriately designed and sized refuge crop. One study from Kansas showed that the marginal cost of a 20% refuge requirement was fairly small. As one might expect, the cost to the farmer was greater for a 20% non-Bt (but sprayed) refuge, when compared with an unsprayed refuge of the same size.

Nevertheless, according to a survey by the National Corn Growers' Association, although 90% of farmers said they followed the rules in 2000, only 71% could accurately state the required sizes and locations of the refuges, suggesting that 29% may not have been in compliance. And with increased plantings of Bt corn, few natural non-Bt refuges may remain.

Although 90% of farmers said they followed the refuge rules in 2000, only 71% could accurately state the required sizes and locations of their refuges, suggesting that 29% may not have been in compliance.

Incentives for Compliance

The challenge, then, is to design incentives that encourage farmers to invest in socially desirable refuge strategies. Several mechanisms may offer alternatives to mandatory refuges. For instance, a "resistance user fee" levied on GM seeds would make growers bear the social cost associated with pest resistance. This user fee could be calibrated to the density of Bt crops in the area and could be used to set up common refuge areas or be used to pay some farmers to grow only non-Bt crops. A similar option would allow growers to pool their non-Bt refuge areas or jointly pay a single farmer to grow only non-Bt crops as long as these refuges satisfy biological requirements for spatial proximity to the Bt crops. An alternative strategy may be to subsidize seed mixtures that contain both GM and non-GM varieties and may be suited to pests which tend not to move very much.

Yet another mechanism is one that uses tradable refuge "permits." The concept recalls tradable performance standards under the Clean Air Act and could be applied in areas of monoculture by fixing the maximum share of acreage that could be committed to Bt crops. Growers that focus on non-Bt crops would receive refuge permits that could then be bought by growers of Bt crops who don't plant their own refuges.

Ideally, refuge policies would encourage farmers to optimally manage for resistance on their farms. Large farmers, which suffer more of the resistance problems directly, may have a greater incentive to manage for resistance without external motivating factors than smaller farmers, since they may bear a relatively larger proportion of the burden of resistance that their farming practices may create. A survey of Bt corn growers in Ontario found that farmers living in areas of higher pest infestation were more likely to use Bt corn. Such areas are more likely to see resistance developing and consequently require greater adherence to resistance management strategies.

Regulating a Monopoly?

Some economists, however, have questioned whether refuge regulations are required at all. Since Monsanto is a monopolistic owner of the Bt technology, it may have more incentive for ensuring that growers are scrupulous in planting refuges—thereby ensuring that their seed value is maintained—than if there were a competitive supply of GM seeds. Under certain conditions, this incentive may actually encourage an even greater level of effort on refuges than is socially optimal. That is, one would expect to see refuges being grown even if EPA did not mandate them because the seed company can ignore the cost of growing refuges as long as its customers can grow a profitable crop.

Recent theoretical research suggests that the level of care that Monsanto would exercise in the use of its Bt technology, relative to the socially optimal level of care, depends on the availability of future, alternative Bt technologies. If it had no backup technology available to replace the current one when it was exhausted, Monsanto would behave more conservatively than would government policymakers in ensuring that resistance management plans were implemented carefully. One could then argue for less regulatory stringency. However, if alternatives are being readied, Monsanto should be more likely to care less about resistance than policymakers and even be eager to move on to future revenue sources.

Innovation as a Response

The economic value of refuge strategies to society is largely determined by the availability of substitute technologies. The current pest control technology based on the Bt toxin, is it-

The rapidly expanding share of genetically modified crops in agriculture worldwide creates greater potential for systemwide damage if these crops fail against pests.

self a replacement for older methods based on pyrethroids, which were becoming obsolete because of growing pest resistance. Firms that sell pest control compensate for this obsolescence by investing in research. In anticipation of resistance to today's Bt cotton, Monsanto has developed Bollgard II, which codes for two Bt proteins with different modes of action. The advantage of a "stacked" gene technology is that pests would have to develop resistance to two proteins, the probability of which is far lower than that of developing resistance to a single protein.

But can we count on the private sector to provide an adequate technological response to the resistance problem? Consider the case of resistance to antibiotics. For many years, physicians freely used the available antibiotics in the belief that pharmaceutical companies would continue to develop new ones. However, the widespread resistance to existing antibiotics increases the probability that any new drug will be ineffective shortly after its introduction, and this cross-resistance makes the return on investment risky. Although this does not yet appear to be the case for Bt crops, it may not be an unlikely scenario in the future.

Similarly, estimates of the resistance-related costs of withdrawing organophosphates from apple farming might be too low if there is significant cross-resistance between old and new pesticides. Moreover, the costs of introducing new pesticides have increased dramatically with each generation of pesticide.

The patent system, of course, is intended to encourage new technologies. When pesticide resistance is a recurring problem, however, a seed company faces two considerations that work in opposite directions. On the one hand, a product could be made obsolete by resistance if a firm sells too much, and on the other hand, it could be made obsolete by a competitor's new product before the firm has recovered the research costs. Under such circumstances, the standard patent duration of 17 years may be too short to give the firm suffcient incentive to care about resistance: its product will become obsolete regardless.

A final consideration is whether a firm that holds a monopoly would introduce sufficient variety in technologies to ensure that the selection pressure on any single technology does not result in rapid evolution of resistance. The monopolist must choose between introducing all GM crops up front, which would be socially beneficial, or staggering them, which has two advantages to the firm: it can engage in price discrimination through intentional obsolescence of the older technology, and it enjoys no reward for introducing variety—failure is actually the desired outcome because it forces customers to buy the next generation of seed. The way to get around this is to encourage innovation in new methods of pest control.

The value of new GM crops is lowered to the extent that resistance to current varieties implies more rapid evolution of resistance to new varieties. As with antibiotics and human health, a balanced approach between management of existing Bt technologies while searching for substitute technologies may be desirable. ■

Ramanan Laxminarayan and Carolyn Fischer are RFF fellows. Laxminarayan's research centers on the emerging field of "resistance economics," which involves using economic analysis to develop policy responses to biological resistance in the context of antibiotics and antimalarials in public health and pesticides and transgenic crops in agriculture. Fischer's work deals with policy choices for addressing long-term environmental and resource problems, such as reducing emissions of greenhouse gases, depleting resources like fossil fuels, and antibiotic effectiveness.

For More Information

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Information Technology

THE UNSUNG HERO OF MARKET-BASED ENVIRONMENTAL POLICIES

Blas Pérez Henríquez

Policymakers around the world are planning international environmental commodities markets intended to forestall climate change, slow biodiversity decline, and tackle other global environmental problems. The European Union, for example, is developing a regional market for carbon dioxide emissions to meet targets set under the Kyoto Protocol. Some U.S. state governments, ignoring the Bush administration's position on climate change agreements, want to integrate their emissions trading systems into a global market for greenhouse gases.

The proposed market strategies would create incentives for producers and consumers to make better use of natural resources. The approach gives producers flexibility to meet regulatory standards that protect human health and ecological systems. But since the road from policy prescription to actual market solution is full of pitfalls, it is useful to analyze the implementation of existing market-based programs and extract lessons for the future.

Although it receives relatively little attention, a crucial factor in the success of the U.S. sulfur dioxide trading program—the mother of all market-based environmental policies—turns out to be information and communication technologies and electronic monitoring systems. Information technology can reduce the operational transaction costs of an emissions trading system. By handling vast amounts of information efficiently, information systems permit accurate tracking of emissions and allowance accounting to ensure compliance. Furthermore, Internet access to regulatory information increases the transparency and accountability of market-based environmental management.

Policy on Paper

Title IV of the 1990 U.S. Clean Air Act Amendments, designed to address the acid rain problem by controlling sulfur dioxide (SO_2) emissions, presented an implementation challenge. The mandate to the U.S. Environmental Protection Agency (EPA) was to create a market-based approach to air quality management, now known as the cap-and-trade system.

The resulting Acid Rain Program set a predetermined cap on overall SO_2 emissions while allowing trading of entitlements among pollution sources and other interested parties to meet this standard in a cost-effective manner. The creation of allowances—quasi-property rights for emissions—promised gains by allowing the free trade of these permits, thus in-

troducing flexibility for electric utilities burning fossil fuels in complying with regulations.

By 1994, a fairly robust environmental commodities market in SO_2 allowances had taken shape. The Chicago Board of Trade runs EPA's annual auction of a small percentage of allowances, which generates valuable price information. However, the vast majority of allowances are traded in an over-the-counter secondary air pollution allowance market. The SO_2 emissions market is regarded as efficient and has been characterized by reasonably good liquidity.

In short, the Acid Rain Program led to the development of a functioning market with low transaction costs, price transparency, and extensive trading activity. When in 1999, EPA Acid Rain Division became the Clean Air Markets Division (CAMD), the new name reflected the extent to which air quality management in the United States was now supported by emissions trading.

Implementation Challenges

Markets depend on information. While designing the Acid Rain Program in 1990, EPA administrators decided to reduce regulatory uncertainty by abandoning such past practices as certification of electric utility compliance plans and requiring detailed facility-specific permits—processes that increased transaction costs and discouraged trading. However, those mechanisms had been used to ensure compliance with environmental standards and new mechanisms would have to be found. The challenge was to maintain the environmental credibility of the emissions trading program while program participants expanded in number and increased demand for market exchanges. The Acid Rain Program forgoes the need to obtain government approval of compliance technologies and strategies and focuses on environmental results through stringent measurement of emissions at each source. It is therefore simpler than its predecessor, reducing transaction costs and encouraging market development.

To function, the Acid Rain Program needed information management systems to track allowance transactions and monitor actual emissions. Fortunately, technological advances in information technology allowed EPA to design a system that would reduce costs both for government regulators and for traders by limiting intervention once Congress had set the environmental goal.

Now, after more than a decade of implementing the Acid Rain Program, EPA administrators say that their main task consists of two activities: processing huge amounts of information and disseminating huge amounts of information. EPA's CAMD has become an emissions and allowance "accountant," in charge of managing information and processing it for compliance purposes. Emissions and allowance information also needs to flow back to producers, to make the allowance market efficient and build credibility in the emissions trading approach. According to Joe Kruger, EPA's chief of the Market Policy Branch, "Without recent advances in information technologies, these activities would be considerably more diffcult, if not impossible."

The Essential Digital Infrastructure

Information technology is what has made the SO_2 emissions trading program work. It reduces paperwork and filing costs, and provides public information online through its database registries, making the system transparent and credible as well as permitting electronic reporting, verification, and processing of emissions data. Furthermore, it stretches administrative resources so that the program can cost-effectively cover a larger universe of sources.

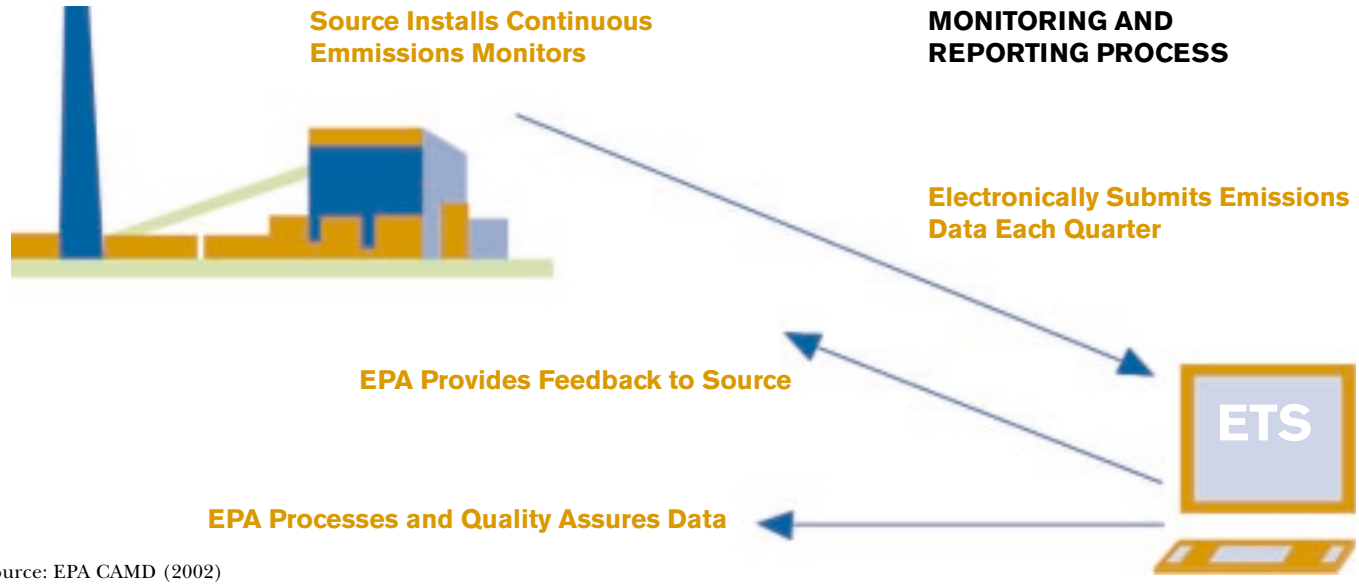
The key elements based on information technology that have been particularly crucial are the allowance tracking system (ATS), the emissions tracking system (ETS), and the continuous emissions monitoring systems (CEMS). These components facilitate regulatory compliance, assist in allowance market development, and allow public access to emissions data.

Allowance Tracking System. ATS was developed as the central registry of allowances used for compliance with the Acid Rain Program.

There are various companies in the private sector that track and disseminate allowance price information for emissions trading markets. In contrast, EPA's ATS tracks transfers of allowances between accounts held by sources and others. Sources that wish to use allowances for compliance must hold them in these accounts.

In addition to its role in compliance, ATS provides a framework for categorizing transactions of SO_2 within the program that is useful in understanding the allowance market. It provides details of all private allowance transfers reported, en-

The concept of a market in emissions allowances was attractive in theory, but information technology made it happen.



Source: EPA CAMD (2002)

abling researchers, market participants, and others to distinguish between "real trades" and those that are only internal administrative transactions between a firm's different emissions sources. There is no regulatory component in this process of categorization; it is conducted to learn more about environmental markets development. Companies are not required to report allowance transfers unless they will use them for compliance.

ATS makes possible more efficient transaction recording processes during the annual reconciliation period in which sources must hold a quantity of allowances equal to or greater than the amount of SO_2 emitted during that year. When the program began in 1995, the rules allowed up to five days to process records because all communications were sent by mail. By 1997, EPA was processing 89% of the transactions in just 24 hours. Today, about 80% of transfers are entered online via the Web by the sources themselves.

Emissions Tracking System (ETS). Although timely allowance transfers are one piece of compliance, the emissions tracking component is probably more important. EPA's Janice Wagner, chief of the Market Operations Branch, which runs the allowance trading mechanism's data systems, calls ETS "the backbone of the program." All quarterly reports are now submitted electronically to ETS, allowing the agency to perform automated data processing to ensure compliance while making the results available to the public. Using the ETS mainframe software, EPA checks utilities' quarterly reports of emissions and automatically sends a score in an "instant feedback" report. If necessary, EPA contacts the utilities to resolve data problems.

Continuous Emissions Monitoring Systems. CEMS are mechanical devices that sample, analyze, measure, and record emissions on a continuous basis. Each emissions unit must install continuous monitoring equipment and report its emissions regularly.

This technology has provided credibility and facilitated the emergence of a relatively effcient market for SO_2 allowances, despite the expense of deploying the monitoring system—an average annual cost of about $124,000 per unit (including operating and capital costs). Capital and operating costs of CEMS amounted to 7% of total observed compliance costs in 1995. The estimated total additional cost is not insignificant—$48 million to $54 million—but the payoff is high-quality data and documentation of early environmental benefits from emissions reductions. According to the EPA, these data are the "gold standard" that backs up the currency of emissions allowances.

Measurement tools are essential for accurately quantifying the pollution commodity being traded and that accuracy in turn promotes smoothly operating markets and environmental integrity. The CEMS requirement thus instills confidence in the market-based approach by verifying the existence and value of the traded allowance.

In 1995, American Electric Power Company submitted its emissions data to EPA via modem. Soon other utilities—Georgia Power, Allegheny Power, and Grain Island Power—followed. CEMS sent emissions data to a utility's computer system, which then compiled it for submission to EPA on a quarterly basis. An EPA software program was developed to assist utilities in preparing, reviewing, and submitting their quarterly reports. This software allows users to check the format and completeness of quarterly reports before submission, and utilities then submit the reports electronically to EPA's computer center. Since virtually all companies in-

cluded in the SO_2 allowance-trading program submit emissions data electronically over the Internet, these processes have been considerably streamlined in contrast to the older dial-up modem data transmission system.

Annual Reconciliation. At the end of each calendar year, EPA compares the number of tons emitted with the allowance holdings of the utility unit to ensure that it is in compliance. Units not in compliance pay a stiff penalty for every ton they emit for which they don't hold an allowance. They are also required to relinquish allowances in the amount of the excess.

Public Access to Data. EPA's data system now serves as an emissions data repository for SO_2, nitrogen oxides (NO_x), and carbon dioxide (CO_2), by source, from the utility industry. The SO_2 and NO_x emissions data may also help states design programs to comply with the National Ambient Air Quality Standards provisions of the Clean Air Act for SO_2, ozone, and particulate matter. While the CO_2 data being collected by ETS only cover the electric power sector, these data will help in the creation of a valuable emissions inventory database for assessing the nation's progress in stabilizing greenhouse gases. Finally, although the ETS and ATS have historically been different systems, they will increasingly be integrated as EPA reengineers its data management systems.

International Implications

The U.S. SO_2 allowance trading program demonstrates that when emissions are capped and accurately measured, an efficient market can develop and the costs of meeting environmental goals can be reduced. Underlying the entire process are electronic monitoring devices, information systems, and Internet communications.

Information technology has become an important tool helping regulators overcome the asymmetry of incentives between themselves and industry: firms have no incentive to provide information to the regulator about the industrial processes being regulated. EPA administrators believe that digital processing changed regulators' role from inspecting compliance choices to measuring results and tracking emissions and allowances—a less costly duty that depends on credible and precise information flows on both pollution emissions and allowance transfers.

Although the extent of the gains from trade derived from the program and its efficiency effects are still debated, to EPA administrators the steady decline in the cost of reducing a ton of SO_2 is proof of the cost savings attributable to the system. From their perspective, the Acid Rain Program is a success: emissions are down by millions of tons, utilities are fully compliant, and trading activity follows an upward trend.

Lessons from implementation of cap-and-trade programs in the United States as well as continued technological progress, such as the possibility of combining remote-sensing technologies in monitoring systems with nanotechnology and global positioning systems, can support the development of more ambitious market-based environmental policy applications.

In the case of developing an international emissions trading mechanism, however, such an arrangement would have to undergo its own process of institutional evolution to become a credible and cost-effective solution to greenhouse gas emissions. In particular, an international greenhouse gas market must provide certainty and transparency in its exchange mechanisms and also address the more challenging economic, technical, social, and political dimensions of the international environmental policymaking context. Information communication technologies and modern monitoring systems will certainly be a critical part of this effort. ■

EPA administrators say that their main task consists of two activities: processing huge amounts of information and disseminating huge amounts of information.

Blas Pérez Henríquez is executive director of the Center for Environmental Policy in the Goldman School of Public Policy and assistant dean, Executive and International Programs, at the University of California, Berkeley. His research focuses on the intersection of policy, markets, and the use of information technologies to improve policymaking.

Further Readings

www.epa.gov/airmarkets

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Economic Incentives versus Command and Control

WHAT'S THE BEST APPROACH FOR SOLVING ENVIRONMENTAL PROBLEMS?

Winston Harrington and Richard D. Morgenstern

Now, decades after the first environmental laws were passed in this country, policymakers face many choices when seeking to solve environmental problems. Will taxing polluters for their discharges be more effective than fining them for not meeting certain emissions standards? Will a regulatory agency find it less costly to enforce a ban or oversee a system of tradable permits? Which strategy will reduce a pollutant the quickest?

Clearly, there are no "one-size-fits-all" answers. Many factors enter into the decision to favor either policies that lean more toward economic incentives (EI) and toward direct regulation, commonly referred to as command-and-control (CAC) policy. Underlying determinants include a country's governmental and regulatory infrastructure, along with the nature of the environmental problem itself.

Even with these contextual factors to consider, we thought it would be useful to compare EI and CAC policies and their outcomes in a real-world setting. To do this, we looked at six environmental problems that the United States and at least one European country dealt with differently (see box on page 14.) For each problem, one approach was more of an EI measure, while the other relied more on CAC. For example, to reduce point-source industrial water pollution, the Netherlands implemented a system of fees for organic pollutants (EI), while the United States established a system of guidelines and permits (CAC). It turned out, in fact, that most policies had at least some elements of both approaches, but we categorized them as EI or CAC based on their dominant features.

We then asked researchers who had previously studied these policies on either side of the Atlantic to update or prepare new case studies. We analyzed the 12 case studies (two for each of the six environmental problems) against a list of hypotheses frequently made for or against EI and CAC, such as which instrument is more effective or imposes less administrative burden.

The Evolution of CAC and EI

Only recently has it been possible to find enough EI policies to carry out a project such as this. Until about 15 years ago the environmental policies actually chosen were heavily dominated by CAC approaches. In the United States, the 1970s saw a great volume of new federal regulation to promote environmental quality, none of which could be characterized as relying heavily upon economic incentives. Since then, however, there has been a remarkable surge of interest in EI approaches in environmental policy. Since the late 1980s, whenever new environmental policies are proposed, it

THE SIX ENVIRONMENTAL PROBLEMS WE STUDIED

In our analysis, we selected six environmental problems in order to compare EI and CAC approaches, which are summarized below. We paired a policy from the United States with one implemented in one or more European countries.

For clarity's sake, although almost all contain some blend of EI and CAC elements, those that are more closely associated with EI instruments are listed first:

1. SO_2 emissions from utility boilers: Permit market (United States) vs. sulfur emissions standards (Germany)

2. NO_x emissions from utility boilers: Emission taxes (Sweden and France) vs. NO_x New Source Performance Standards (United States)

3. Industrial water pollution: Effluent fees (Netherlands) vs. Effluent Guidelines and National Pollutant Discharge Elimination System permits (United States)

4. Leaded gasoline: Marketable permits for leaded fuel production (United States) vs. mandatory lead phase-outs plus differential taxes to prevent misfueling (most European countries)

5. Chlorofluorocarbons (CFC): Permit market (United States) vs. mandatory phase-outs (other industrial countries)

6. Chlorinated solvents: Source regulation (United States) vs. three distinct policy approaches (Germany, Sweden, Norway)

is almost inevitable that economic incentive instruments will be considered and will receive a respectful hearing.

The reasons for the newfound popularity of EI policies are unclear. Perhaps it is due to the growth in awareness of economic incentive approaches among policymakers and policy analysts over the 20 years between 1970 and 1990. In the 1970s these approaches were generally unfamiliar to those outside the economics profession.

Another possibility is the emergence of tradable emissions permits in the late 1970s. Before then, the main EI alternative to the regulatory policies being implemented was a per-unit tax on pollution (sometimes referred to as an effluent fee). By the 1980s the policy community was generally aware of a "quantity-based" EI alternative—tradable emission permits—that seemed to provide the same assurances of the achievement of environmental goals that were offered by CAC approaches.

A third possible cause is the widespread disappointment with outcomes of the CAC regulations adopted in the 1970s. The nearly limitless variety of American industries and industrial processes required the EPA to write very detailed and complex regulations, but despite these efforts, the Agency faced a raft of legal challenges. Regulatory complexity combined with litigiousness delayed the implementation of most regulations far beyond the schedules envisioned by Congress. In other words, much of the enthusiasm for EI could be attributed to disenchantment with CAC.

The Two Sides of the Pond

It is worth underscoring some differences between the United States and Europe that serve as a backdrop to policy decisions and implementation.

First, of course, we are comparing a single federal system in the United States with the many countries of the European Union (EU). Beginning in the late 1960s, environmental policymaking became centralized in the United States. In Europe, each country has adopted policies according to its own timetable, generally beginning in the late 1960s in the wealthiest nations and sweeping south and east to the former Soviet empire by the 1990s. Environmental policy in Europe is now a mix of country-specific and EU-wide measures, which these cases reflect.

Second, there are major differences between the United States and Europe in the extent of pre-regulatory studies undertaken. Because of the U.S. requirement on agencies like the U.S. Environmental Protection Agency to conduct a Regulatory Impact Analysis before taking action, substantially more information was available about the hoped-for benefits of U.S. policies. A further issue concerns the greater reliance on taxes for regulatory purposes in Europe compared to the United States. A number of European nations use such taxes—sometimes combined with incentive-compatible rebate schemes—to achieve environmental objectives.

In the United States, environmental taxes are virtually nonexistent. Overall, despite these various differences in approaches, we were not able to discern clear differences in regulatory outcomes across the Atlantic: in some cases one or more European nations acted sooner or more aggressively to address environmental problems while in other cases the United States acted sooner or more aggressively.

Testing the Hypotheses

Since the 1970s, when western countries began forming comprehensive environmental policies, there has been a good deal of speculation and disagreement over the differ-

ences between EI and CAC instruments in practice. These discussions boil down to assertions or hypotheses about comparative advantages of each instrument. We compiled a list of the 12 most commonly stated hypotheses, recognizing that different observers might develop very different lists.

Below we discuss the five hypotheses that we consider most important in evaluating a policy instrument. For each, we state the hypothesis, review the original rationale in making it, and then test whether the hypothesis holds up in light of one or more of our case studies.

EI instruments are more efficient than CAC instruments: that is, they result in a lower unit cost of abatement.

Rationale: It is commonly believed that EI instruments have an efficiency advantage over CAC instruments, although the case is not airtight. EI instruments are more cost effective at achieving a given emissions reduction. But to get from cost-effectiveness to efficiency requires additional assumptions, including that the system is one of perfect competition and that the emissions are not location-specific. A theoretical counter to this hypothesis is that a CAC instrument can be as efficient if the emissions standard for each plant is chosen so that the marginal costs of abatement equal the marginal social costs of pollutant damage.

Performance: The cases we analyzed show that EI is generally more efficient. For example, in looking at the U.S. program of marketable permits to lower SO_2 emissions, realized costs are only about one-half what was expected back in 1990 and about one-quarter of the estimated cost of various CAC standards. EI also achieved substantial cost savings in the elimination of CFCs and lead in gasoline, in part because of cost heterogeneities that could be exploited during the phase-down period. However, in instances where the regulations are so stringent that practically all available abatement measures must be taken, there is little scope for choosing the most cost-effective ones, and EI instruments do not achieve significant cost savings over CAC. EI also enjoys little advantage if all plants face similar abatement costs. Both these conditions limited, for example, the efficiency losses of using CAC for the German SO_2 emissions.

The real advantages of EI instruments are only realized over time, because they provide a continual incentive to reduce emissions, thus promoting new technology, and permit maximum flexibility in achieving emissions reductions.

Rationale: The effects of CAC on technology are potentially complex. On the one hand, costly regulations provide a spur to find less costly ways of compliance. On the other, the requirement to install a specific technology conceivably discourages research, since discovering new ways to reduce

Regulatory complexity combined with litigiousness delayed the implementation of most regulations far beyond the schedules envisioned by Congress. In other words, much of the enthusiasm for EI could be attributed to disenchantment with CAC.

In the United States, examination of patents, in the context of SO_2 policy, suggests that in a CAC regime only cost-reducing innovations are encouraged, while under EI both cost-reducing and emissions-reducing innovations are encouraged.

emissions can lead to more stringent regulations. More stringent performance standards for new plants have the stated objective of promoting technology, but they can also have the pernicious effect of postponing retirements of older, dirtier plants and discouraging entry by outside firms.

Performance: EI provides greater incentives than CAC for continuing innovation over time in many, but not all, cases studied. For example, the Swedish NO_x tax induced experimentation in boiler operations that led to substantial reductions in NO_x emissions. Because NO_x emissions from boilers are idiosyncratic, it was unknown beforehand what would work in each boiler. Achieving these reductions from CAC would therefore have been impossible. Similarly, the U.S. SO_2 trading policy induced many nonpatentable boiler-specific innovations on utility boilers. Elsewhere, the Netherlands became a world leader in water purification technologies and its industries adopted more advanced, process-integrated measures to reduce pollutants.

Innovation also occurs under CAC, but the results are often different. For example, the lead phase-down induced emissions reductions in all plants during the period when a CAC policy was employed, but when the policy allowed permit trading and banking, the reductions were concentrated in newer plants with longer expected lifetimes, where the improvements were most cost-effective. In the United States,examination of patents, in the context of SO2 policy, suggests that in a CAC regime only cost-reducing innovations are encouraged, while under EI both cost-reducing and emissions-reducing innovations are encouraged.

CAC policies achieve their objectives quicker and with greater certainty than EI policies.

Rationale: In the early 1970s, CAC was seen as the way to expedite compliance, even if the approach was not the least costly. It appeared then that EI instruments, particularly emissions fees, would not achieve the same objectives.

Performance : The evidence from the cases is mixed. Supporting the relative effectiveness of CAC is the U.S. effort to phase out the solvent trichloroethylene (TCE), in which EPA ultimately mandated limits. The EI aspects of the rule did not attract significant industry participation. In phasing out leaded gasoline in Europe, progress would have significantly slowed without mandating catalytic converters and maximum lead content in addition to tax differentials.

On the other hand, several cases argue that EI policies are more effective. In the Dutch water case, for example, the influence of effluent fees on organic waste-load reductions was prompt and large. Similarly, by eliciting industry cooperation, the trading and banking program probably achieved a much more rapid phase-down of lead in gasoline than

would have been possible with a CAC program that industry would have opposed.

A final point on effectiveness is that two cases show that both approaches can result in significant environmental gains, but with undesirable longer-term side effects. In the United States, NO_x emissions from coal-fired power plants were reduced, but the standards, which only affected new plants, caused firms to extend the life of older, more-polluting plants to avoid the costs associated with newer ones. In Sweden, TCE users persuaded the public and authorities that complete implementation of a ban would cause them undue harm. They received numerous waivers and exceptions, thus undermining the authority of the environmental agency and perhaps emboldening other firms to oppose other regulations.

Regulated firms are more likely to oppose EI regulations than CAC because they fear they will face higher costs, despite the greater efficiency of EI instruments.

Rationale: Although EI instruments may have lower social costs overall, firms pay higher costs under EI than CAC. Under CAC, the argument goes, the polluting firm pays to abate pollution; under many EI instruments, the firm pays the cost of abatement plus a fee for the remaining pollution it discharges. The firm is better off only if the abatement cost is lower by an amount at least as great as the fee payments.

Performance: Experience on both sides of the Atlantic suggests that no government has put this hypothesis to the test, which, in a way, is strong support for it. In nearly all cases, governments eliminate the burden of EI instruments by returning fees to the firms. For example, in France, revenues collected through NO_x discharge fees subsidized the firms' abatement investments, while in Sweden the fees were returned to the firms on the basis of the energy they produced. In the United States, where the EI instrument of choice is a tradable permit, the permits have always been given away rather than auctioned off.

CAC policies have higher administrative costs.

Rationale: Administrative costs are determined by the amount of interaction between the regulator and regulated source. Supporters of this hypothesis note that the complexity of setting and enforcing specific requirements is higher than implementing fee-based EI policies. In addition, fees for increased emissions tend to rise gradually, whereas with CAC, a line separates compliance from violation. The potentially high incremental cost at the point of violation gives regulated sources an incentive to defend themselves legally rather than accept sanctions, thus adding to the regulators' burden.

Performance: The cases show no clear pattern. While the CAC-oriented Effluent Guidelines program in the United States imposed high administrative costs on EPA, so did the EI instruments of the lead phase-down program. Looking at SO_2 reduction, the EI oriented U.S. trading program gained a reputation for low administrative costs, but the SO_2 reduction program in Germany does not show evidence of higher administrative costs than a comparable EI program. Overall, because the evidence on this hypothesis is mixed, we could not form a firm conclusion about whether policy outcomes supported or refuted it.

Apples and Oranges?

Questions of effectiveness and efficiency were at the core of the initial selection of policy instruments in the 1970s and 1980s. As these cases show, EI instruments appear to produce cost savings in pollution abatement, as well as innovations that reduce the overall cost. The concern that EI instruments are not as effective is not borne out in our analysis. However, the finding about EI's economic effciency is tempered by evidence that polluting firms prefer a CAC instrument because of its perceived lower costs to them. In all but one of the case studies, the actual or potential revenue raised by EI instruments had to be reimbursed in some way to the firms. This, of course, means the revenues cannot be used for other purposes.

In the 1970s, almost all environmental policies relied on direct regulation, with very rare instances of EI instruments. Since the late 1980s, on the other hand, whenever a new policy is proposed, policymakers at least consider, and often select, an EI instrument. That said, almost all the policies that we studied are a blend of both, beginning as a CAC policy and then having EI elements added or substituted. In the 12 cases we studied, in fact, only a few (reduction of SO_2 emissions in Germany, TCE in Germany and Sweden) had no EI elements in their design. Moreover, we can report significant environmental results from the cases we studied. Averaged across all 12, emissions fell by about two-thirds when compared to baseline estimates. Most outcomes either met or exceeded policymakers' original expectations. This is encouraging news for those seeking environmental improvements in the future. ■

Winston Harrington and Richard D. Morgenstern are both RFF senior fellows. Harrington's research interests include urban transportation, motor vehicles and air quality, and problems of estimating the costs of environmental policy. Morgenstern's research focuses on the economic analysis of environmental issues with an emphasis on the costs, benefits, evaluation, and design of environmental policies, especially economic incentive measures.

Development

RFF Concludes 50th Anniversary Campaign and Looks to the Future

On September 30, 2003, the Board of Directors and staff of Resources for the Future celebrated the successful conclusion of RFF's 50th anniversary campaign, which added $24.1 million to the institution's coffers. RFF's Board Chair Robert Grady said: "This is a terrific vote of confidence by all its supporters in RFF's mission, past accomplishments, and promise for the future.

By recognizing and funding outstanding scholars whose work is influential in policy debates, we will continue to highlight the important role that independent, nonpartisan research can play in policymaking.

These funds form a secure foundation for another 50 years of groundbreaking research and positive impact on environmental policymaking in the United States and throughout the world."

In addition to boosting RFF's annual revenues by $8 million over the last four years, $16 million in cash and pledges was earmarked for the endowment, including four gifts of $2 million each to endow senior fellow positions. A fifth endowed chair in honor of the late RFF economist Allen Kneese is close to being funded, as well. "By establishing endowed chairs at RFF, we will be able to recruit top scholars and policy analysts to the staff as well as reward and support the work of high caliber researchers currently at RFF," according to Paul Portney, RFF President. "We look forward to the day—in the not too distant future—that we announce the first appointments to these chairs. By recognizing and funding outstanding scholars whose work is influential in policy debates, we will continue to highlight the important role that independent, nonpartisan research can play in policymaking."

RFF was also the recipient of a generous gift from W. Mitchell LaMotte of Winnetka, Illinois, to establish a President's Discretionary Fund to help seed new research and communications activities—a fund that we hope will grow with the addition of new gifts in the future.

Lesli Creedon, RFF's vice president for external affairs, added her appreciation: "The campaign could not have been the success that it was without the very generous contributions of more than 800 individuals, corporations, and foundations who value RFF's unique contribution to policymaking. We are thrilled by the outpouring of support and affirmation of our mission that is represented by the gifts we received. We're especially grateful for the efforts of Dod Fraser, our development committee chair; our Board members; and other volunteers who helped make the campaign possible." The campaign was launched in 1999 under the leadership of Darius Gaskins, then-Board chair, and Edward Strohbehn Jr., development committee chair.

While the campaign is officially over, the RFF Board and staff will continue their efforts to strengthen RFF's financial position for the near and long term. Specific institutional goals include augmenting the President's Discretionary Fund, establishing additional endowed chairs and fellowship programs, and increasing annual operating revenues.

At its October meeting, the RFF Board voted to change the institution's policy regarding corporate gifts. Previously, RFF accepted only completely unrestricted gifts from corporations. Now, companies will be allowed to restrict their contributions somewhat—to broad programs of research that are currently being developed by RFF researchers. RFF's ban on the acceptance of corporate contributions earmarked for specific projects remains in effect.

For more information on RFF's 50th anniversary campaign or plans for the future, please contact Lesli Creedon at creedon@rff.org or 202–328–5016. ■

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The RFF Council was created in 1991 to recognize organizations that contribute at least $25,000 and individuals who provide at least $5,000 annually to RFF and who share our deep interest in improving energy, environmental, and natural resource policy worldwide. Each year, we depend on the Council to provide much of the general support required to run the daily business of RFF. In 2003, we received over $1.1 million in annual gifts and nearly $3 million in planned and endowment gifts. We are grateful for all of these contributions and give our thanks to these individuals and corporations:

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RFF would like to extend its thanks to the many corporations and associations that supported our efforts in 2003. While they do not always agree with RFF's recommendations, this community values RFF's unbiased voice in the environmental policy arena. The unrestricted support that RFF receives from these organizations enables us to continue to provide our unique brand of social science research and helps to ensure that we continue to achieve our goals well into the future.

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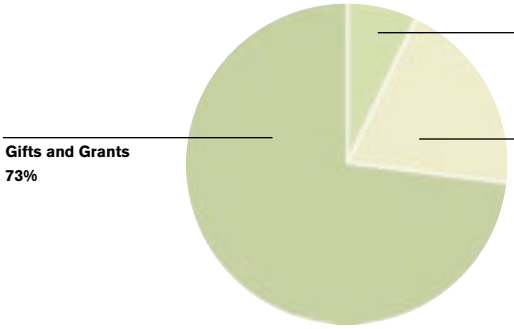
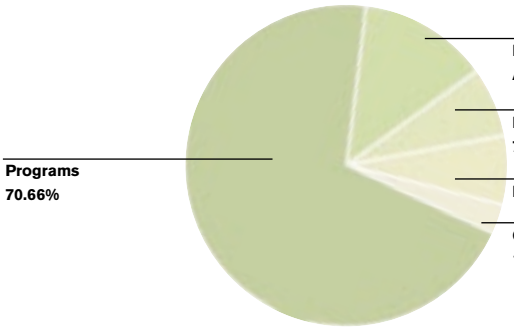
Revenue Percentages

In fiscal year 2003, RFF's operating revenue was $6.2 million, more than 70% of which came from individual contributions, foundation grants, unrestricted corporate contributions, and government grants. RFF augments its income by an annual withdrawal from its reserve fund to support operations. At the end of fiscal year 2003, the reserve fund was valued at $19.1 million.



Expense Percentages

RFF research and educational programs continued to grow in 2003, representing almost three-quarters of total expenses. Management and administration, and development expenses combined were only 21% of the total. The balance is made up of goods sold and building operations related to facilities rented to other nonprofit organizations.



Council Panel Considers Corporate Social Responsibility

Increasingly, when environmental and/or social activists sit down to talk with business leaders, the discussion centers on corporate social responsibility (or CSR), an ill-defined but important subject. Think of it as having to do with the responsibilities of corporations to go above and beyond what the law requires them to do in such areas as environmental protection, worker safety, and social investments in the communities in which they are located. CSR was the topic at RFF's fall Council meeting, held in October, in conjunction with New York University's Leonard N. Stern School of Business.

Speakers included Mindy Lubber, executive director of the Coalition of Environmentally Responsible Economies, an organization that works with corporations to be more transparent in their operations and adopt stricter codes of conduct; Paul Tebo, vice president for environmental health and safety at DuPont and one of those within the corporate world who believes that companies can improve their bottom-line performance by going beyond what the law requires them to do; Bruce Buchanan, director of the Stern School's Markets, Ethics, and Law Program; and Paul Portney, RFF president. Vijay Vaitheeswaran, global environment and energy correspondent for *The Economist*, moderated the debate.

Buchanan posed the fundamental questions. The modern corporation has a duty to maximize the interests of its shareholders. What duties does it have to the stakeholders—the communities, employees, customers, and others affected by its decisions? In the United States, he continued, citizens' right to a clean environment is enforced. What responsibilities not to pollute does a company have in a country without antipollution laws?

RFF Director Dod Fraser and Susan Fraser.

Lubber saw this as a false dichotomy. Responsible corporate behavior will build shareholder value. She rejected the notion that corporate social responsibility is, in effect, philanthropy, arguing that business leaders are in breach of their fiduciary duty if they ignore the repercussions of their actions, such as possible contribution to climate change. She called on CEOs to set goals for sustainability, energy, water, biodiversity, and equality and to seek third-party verification of measurable outcomes.

Portney in turn offered what he called "constructive skepticism" about the very concept of corporate social responsibility. Companies already engage in social responsibility, he observed, because they employ people, issue debt and encourage savings, and provide goods and services. But a company that spends shareholders' money in ways that don't enhance their rate of return becomes less competitive and less viable.

We hear so much about corporate responsibility, Portney speculated, because we are reluctant to tax ourselves to support activities that are the

Top: RFF Director Maureen Cropper, Global Environment and Energy Correspondent for The Economist, Vijay Vaitheeswaran, and StEPP Foundation Board Chairman Frank Stewart
Above: Former Treasury Secretary and Alcoa CEO Paul O'Neill addresses the RFF Board of Directors and Council as well as guests from New York University's Leonard N. Stern School of Business.

legitimate domain of a public sector. And thus Americans turn to corporations, thinking that if a company builds a school or a water treatment plant, it's free. But that, he said, just shifts the cost to customers, employees, and shareholders—and puts an "incredible burden" on corporate executives to decide what public goods ought to be provided, and how.

One corporate manager who bears that burden is DuPont's Tebo. "We don't use the words social responsibility," he said. "Our mission is sustainable growth," which he defined as creating shareholder and society value while decreasing the company's environmental footprint.

Pricing Energy

The cost of energy externalities was a focus of the discussion that followed. Energy should be priced, Portney said, to reflect the full cost of its production and its environmental and social costs. "Then if our oil comes from Saudi Arabia or Venezuela, or if we produce more in the United States, or if we use more in the future," he stated, "it won't matter—so long as the people who use it are confronting the full social cost associated with it."

Lubber, a former regulator, was surprised to find herself on the pro-market side of this issue. Incorporating full life-cycle costs into pricing, she said, will promote energy efficiency.

Tebo found American consumers' interest in the environment ironic because for one thing, "they drive huge cars with 'save the polar bear' bumper stickers." Corporations thus have responsibility to market and, through technology, create environmentally responsible products.

Portney would involve consumers in the transformation by requiring more information to be disseminated. Once consumers understand the environmental consequences of the products they use, the market will drive environmental improvement.

These controversial subjects were the impetus for a lively discussion that ensued among members of the RFF Board, the RFF Council (major individual and corporate donors to RFF) and members of the audience. Then at the dinner that followed, participants were entertained by a fascinating talk given by former Secretary of the Treasury and former Chairman and Alcoa CEO Paul O'Neill about his efforts at both Alcoa and the Treasury to improve accounting practices. ■

Electricity Company Executive Draper Joins RFF Board

E. Linn Draper, Jr.

The RFF Board of Directors recently welcomed E. Linn Draper, Jr., a prominent energy sector executive and nuclear engineer, to a three-year term. Draper is chairman, president, and chief executive officer of American Electric Power Company, headquartered in Columbus, Ohio, and holds the same titles for the AEP Service Corporation, the management and technology arm of the AEP system.

Draper's background includes a degree in chemical engineering from Rice University and a doctorate in nuclear science and engineering from Cornell. At the University of Texas in Austin, he was an associate professor and director of the nuclear engineering program. He is a registered professional engineer in Texas and in 1992 was elected to the National Academy of Engineering, one of the highest distinctions for that profession. Draper has written numerous technical papers and edited books on nuclear power and the engineering aspects of fusion reactors and has been a frequent speaker on behalf of the industry.

In the 1990s, as a member of the President's Council on Sustainable Development, he helped recommend a national economic strategy to protect the environment. The council comprised 15 government, business, labor, and environmental leaders who advised President Clinton on a new environmental management system for the 21st century, focusing on adaptations in the U.S. economy and society that would maximize environmental and social benefits and minimize economic impacts.

Draper joined American Electric Power in 1992, following 13 years with Gulf States Utilities Company in Beaumont, Texas, where he served as chairman, president, and chief executive offcer. He became chairman, president, and chief executive offcer of AEP in 1993. The largest electricity generator in the United States, AEP owns and operates more than 42,000 megawatts of generating capacity in the United States and select international markets. AEP counts almost 5 million customers linked to AEP's 11-state electricity transmission and distribution grid.

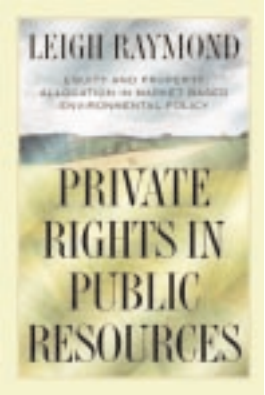
Draper is also president of Ohio Valley Electric Corporation (OVEC) and its subsidiary, Indiana-Kentucky Electric Corporation. OVEC provides electric energy for the U.S. Department of Energy's uranium-enrichment facility at Piketon, Ohio.

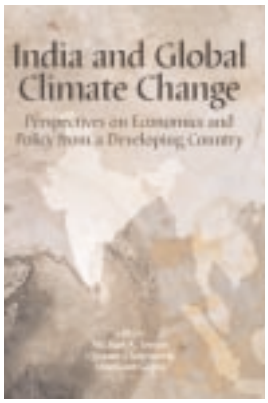
He was appointed to the Board of Governors for the Nature Conservancy in 1999 and serves on the board of the organization's Ohio chapter. Draper is also a member of the Cornell University Council Board, the University of Chicago Board of Governors for Argonne National Laboratory, the University of Texas Engineering Foundation Council, the Nuclear Energy Institute, the National Coal Council, the National Petroleum Council, and the Edison Electric Institute (the trade association of investor-owned electric utilities), plus the U.S. Chamber of Commerce and the National Association of Manufacturers. He is chairman of an environment, technology, and economy task force of the Business Roundtable and chairman of the Ohio Business Roundtable. Draper brings international experience to RFF as well: he is the current chairman of the E7, an alliance of nine energy companies from the G7 nations; the group promotes sustainable energy development.

Draper's many national- and international-level commitments have not precluded his involvement in his local community. He is the current chairman of the Columbus Downtown Development Council and in 1998 was awarded the Distinguished Eagle Scout Award, presented to Eagle Scouts, who after 25 years, have distinguished themselves in their life work and have shared their talents with their communities on a voluntary basis. ■

A Report from RFF Press

RFF Press supports the mission of RFF by publishing books that make a distinct, original contribution to scholarship, teaching, debate, and decision-making about important issues in environmental and natural resource policy.





New Publications

Private Rights in Public Resources: Equity and Property Allocation in Market-Based Environmental Policy, Leigh Raymond. Raymond investigates the role of equity and property norms in shaping environmental policy outcomes. Using three highly original studies—the Taylor Grazing Act, the Acid Rain program, and the debate about allocations of greenhouse gas emissions—he argues that ideas about equity and fairness have long had a significant influence on the political process and ought to be considered more explicitly in both crafting and analyzing public policy.

China's Forests: Global Lessons from Market Reforms, William F. Hyde, Brian Belcher, and Jintao Xu, editors. This is the first book to comprehensively evaluate the effects of forest policy as it has followed or extended from agricultural, trade, and other policy reforms that began in 1978. Among the issues it addresses are the pressures exerted by the growing economy on the forest environment, the environmental effects of extractive activities, the property rights arrangements that have fostered the most sustainable management practices, and the contribution that forestry can make as an agent of development.

India and Global Climate Change: Perspectives on Economics and Policy from a Developing Country, Michael A. Toman, Ujjayant Chakravorty, and Shreekant Gupta, editors. Although the impact of climate change will most likely be greatest on the already poor and vulnerable populations in the developing world, much of the writing about the costs and benefits of different policies to reduce greenhouse gas emissions is by Western scholars. Drawing the majority of its contributions from authors based at Indian universities and other research centers, *India and Global Climate Change* provides a developing world perspective on the debate.

Reviews

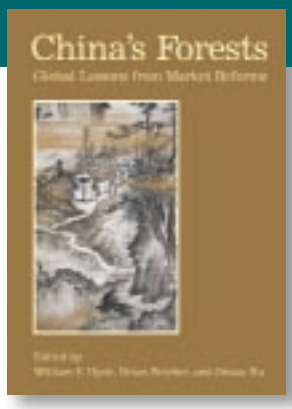
The policy relevance of books by RFF Press has been highlighted in the increasing number of reviews that are appearing in scholarly journals and specialized magazines intended for experts in the policy community. Mentions of RFF books in other venues show a broader or more immediate influence that RFF Press books are having—by serving as source for newspaper articles, providing ideas for legislation, and serving as a guide for employees of a government agency as they evaluate efforts at sustainable resource management.

On Borrowed Time? Assessing the Threat of Mineral Depletion, John E. Tilton.
"In a few short pages this book not only explains in simple terms the major conceptual touchstones of resource economics . . . it also turns on its head that branch of theory rooted in the assumption that minerals can . . . be appropriately viewed as endowments."
—*Journal of Economic Literature*

"A logical exposition that blends historical, theoretical, and empirical elements of the ongoing debate in an appealing way . . . balanced and objective . . . interesting case studies and boxes facilitate the appeal to a wider audience . . . suitable for a variety of audiences [including] mining professionals, students, conservationists, and even politicians."
—*Journal of Energy and Development*

Policy Instruments for Environmental and Natural Resource Management, Thomas Sterner.
"This book not only details the economic principles . . . but also presents a wide range of examples of practical policy design. . . . For at least one of the intended audiences, analysts who advise policymakers, this book is simply indispensable . . . Put simply, a good source of inspiration."
—*Journal of Forest Economics*

From RFF Press



China's Forests

Global Lessons from Market Reforms

William F. Hyde, Brian Belcher, and Jintao Xu, editors

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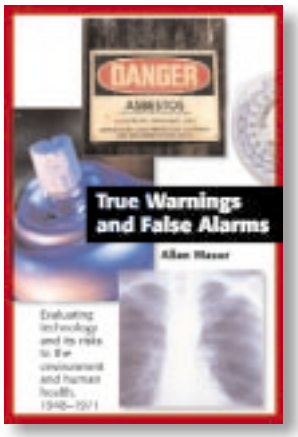
"The strong reliance on empirical analysis and the use of recent data on forest output in China make the book extremely timely and of substantial interest."
—David H. Newman, *University of Georgia*



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Allan Mazur

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—Albert H. Teich, *Director of Science Policy, American Association for the Advancement of Science*

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