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RESOURCES FOR THE FUTURE

RESEARCH THAT MAKES A DIFFERENCE

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Our Global Perspective

"From coast to coast and around the world ..." If memory serves me, that's how a popular news program began many years ago. But it's also a very accurate description of the geographic reach of RFF's research and outreach efforts, something this issue illustrates quite well indeed.

Starting close to home, Ian Parry writes about the traffic congestion that plagues Washington, DC—and most large cities everywhere—and what might be done about it. Heading westward, Jim Boyd talks about the environmental damage that sometimes accompanies mining and endorses the use of performance bonds to ensure that bankruptcy does not become an attractive way to evade liability. Touching down briefly in California, Tim Brennan writes illuminatingly about that state's troubled efforts to deregulate its electricity regulation business.

Quickly now to China, where an RFF research team led by Dick Morgenstern and Alan Krupnick is assisting the industrial province of Taiyuan in the design and implementation of a program to control, through a cap-and-trade program, sulfur dioxide emissions from the coal-fired power plants there. This is RFF at its best, I believe—combining careful research with hands-on policy design, and in a country that needs to balance most carefully economic growth and environmental quality.

Dipping into the southern hemisphere, you can read about RFF projects dealing with fisheries management in New Zealand and water policy in Chile and Argentina—two projects with truly global significance. You will read within about RFF's incipient work on the problems associated with the growing resistance in both human and animal populations to antibiotics. You will be reading much more in future issues on the work of Ramanan Laxminarayan and his colleagues on this subject. Similarly, Mike Taylor and Sandy Hoffman report here on their work on food safety. While it has a U.S. flavor, so to speak, the issues are quite clearly global—witness the furor in Europe over mad cow disease and genetically modified organisms in food. This is the first appearance in *Resources* of work related to a rapidly growing program on the global food system.

Happy reading!

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
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Halting the Worldwide 'Race to Fish'—RFF Researchers Evaluating New Zealand's Tradable Quota System for Fisheries as a Model Approach

Today, commercial fishing operations around the world are utilizing ever-larger ships with increasingly sophisticated technology to capture a dwindling resource that cannot be easily regulated. Up until the early 1970s, most fisheries were either completely unmanaged or regulated under command-and-control regulations that failed to check the number of vessels working a given area and encouraged fishermen to work around equipment constraints, such as the size of vessels or type of nets. Since that time, several countries have experimented with approaches based on creating property rights, which limit fishing operations in a given area typically by setting a cap on the total allowable catch (TAC) and allocating the TAC to existing participants based on historical catch.

In the early 1980s New Zealand established one of the first individual transferable quota (ITQ) programs, giving fishermen rights to shares in the total allowable catch in a given fishery. Two RFF researchers, James Sanchirico and Richard Newell, are working with a New Zealand colleague, Suzi Kerr of the Motu Economic and Public Policy Research Trust, to analyze that country's program—considered to be the most comprehensive ITQ system in the world—to see what lessons can be learned.

More than 15 other countries have followed New Zealand's lead and established similar programs covering some 60 fisheries, including 4 in the United States. Even though the current set of programs are getting positive reviews, their political future is unclear. In 1996, Congress established a moratorium against fishing quotas to allow time for the establishment of national standards for determining fishing quotas. That

moratorium expired October 1, 2000, and several congresspeople are holding hearings about how to move forward. Sen. Olympia Snowe, R-Maine, has introduced S. 637, the Individual Fishing Quota Act of 2001, which would amend the Magnuson-Stevens Fishery Conservation and Management Act to authorize the establishment of, and conditions for, individual fishery quota systems.

The 'Race to Fish'

The dual problems of overfishing and overcapacity (in terms of number of fishing vessels and equipment capacity) have been studied for decades. Without any sense of ownership over fish until they are caught, fishermen engage in a "race to fish." And the historical record shows that the race will continue until fish stocks are depleted and the number and types of vessels in a fishery

New Zealand Fisheries Geographic Zones

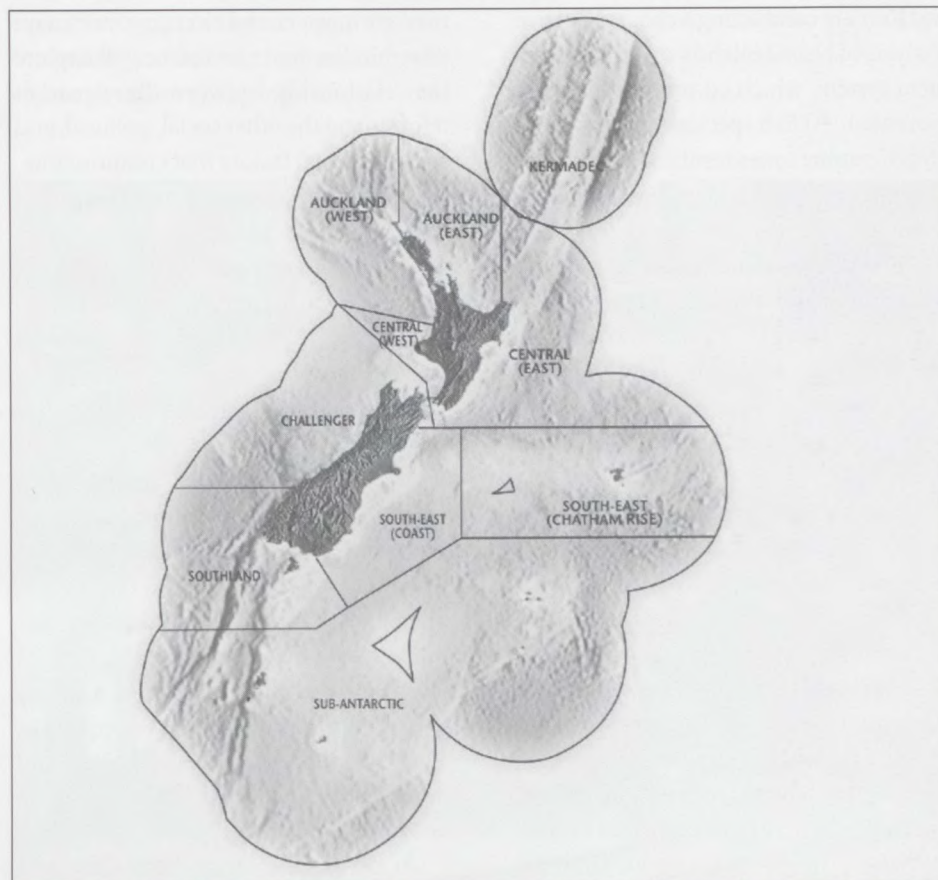


Figure 1: New Zealand's quota management system covers more than 40 fish species distributed across 10 geographic zones. Many individual fish stocks cross over several zones. (©1998 Clement & Associates Ltd.)



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exceed its viable capacity. Because fishermen have a guaranteed share of the TAC under the ITQ model, ITQs eliminate the race to fish. Another benefit is that fishermen have a financial stake in the resource—the quota share is an asset whose value is directly related to the health of the fish stock—and thereby should take into account how fishing today will affect future catch levels.

ITQs essentially give fishermen the right to fish or to transfer, sell, or lease that right. In New Zealand, markets for these rights have been established that closely resemble the successful market in this country for trading sulfur dioxide emissions permits. Sanchirico, Newell, and Kerr are conducting a comprehensive analysis of New Zealand's quota management system, which currently consists of more than 40 fish species ranging across 10 geographic zones resulting in well over 100 quota/lease markets (figure 1 illustrates the 10 geographic zones).

"The idea of a quota system is simple and appealing, but the design and implementation process is mired in politics, which complicates things considerably," Sanchirico said. "We want to develop a rigorous empirical record of how ITQ markets function. Do the big guys force out the little guys? Are there barriers to entering and exiting the market? How well do quota and lease prices correlate to total catch limits, fish prices, and other important variables?"

The researchers believe that their findings will address some key concerns surrounding ITQs. In Congress, legislators will be looking at whether property right regimes should take a more central role in U.S. fishery policy, whether to control the number of shares that an individual can hold, and whether the shares can be traded or leased. ■

RFF Researcher Exploring How Chile and Argentina, with Free-Market Economies, Protect Their Water Resources

By the end of September, RFF researcher Carl Bauer will be settled in Chile, where he will log a year of fieldwork as part of a comparative study of water law and policy in Latin America and the western portion of the United States. This trip, some of which will be spent in Argentina, is an outgrowth of the 10 years of research Bauer has already conducted on Chile.

The idea is to compare Chile and Argentina. Both have carried out, to different degrees, economic and political reforms favoring privatization and free markets in water and electric sectors, says Bauer. In the water sector, he will explore the relationship between these market reforms and the other social, political, and environmental factors that comprise integrated water resource management. Because Chile and Argentina are frequently held up as examples of free-market approaches on the international stage, particularly by the World Bank, Bauer believes that trends in those countries will speak to the development of similar policies elsewhere.

"A lot of the pending water problems in Chile, which is the world's leading example of free-market water policies, have to do with those kinds of issues that are not well handled by markets, such as ecological preservation and coordination of different kinds of water users in a shared river basin," Bauer says. Consequently, there is a need for research on the legal and institutional frameworks that should be associated with markets.

In the electric sector, both Chile and Argentina are notable for their market-oriented policies and deregulation and, like

the rest of South America, they depend heavily on hydroelectric power. "The question in both Chile and Argentina, as well as in the western United States," Bauer says, "is what is the impact on water and dam management of electricity deregulation?" Argentina's electric system is closely linked to the systems of neighboring countries, much like the relationship between California and its neighbors. Bauer hopes his findings in Argentina will shed light on the complex links between water and energy problems in California and other western states.

Bauer also is interested in the changing role of the South American courts. As markets are strengthened, government regulation has been weakened and reduced, which means courts in Chile and Argentina must take on a larger and more difficult role in resolving policy conflicts and regulatory issues. The challenges facing the courts dovetail with another ongoing interest of Bauer's: the relationship between law and economics in professional and academic circles.

"I try to bring law and economics down to earth in the area of property rights because, in my view, that is where law and environment and economy come together," explains Bauer. "I hope to come out of all this with a better understanding of the interdisciplinary nature of property rights and institutions, and the relative contributions of legal and economic perspectives to understanding these issues."

Funding for this project is provided by the Hewlett Foundation's U.S.–Latin America Program and RFF general support. ■



Working with Local Officials, RFF Researchers Designing System to Control Air Pollution in the 'Pittsburgh' of China

Following a visit earlier this spring to Shanxi Province, in north-central China, to confer with government officials, a team of RFF researchers has started designing a system for controlling air pollution in Taiyuan, the provincial capital. This area is the industrial heartland of China and has been likened to the Pittsburgh of 75 years ago, with virulent air pollution and public health concerns to match, including high pulmonary and respiratory disease rates and decreased life expectancy.

RFF received a technical assistance contract from the Asia Development Bank to enhance the use of market-based instruments to improve air-quality management in the province and to strengthen the institutional capabilities of the provincial agencies involved in environmental matters.

The RFF team is composed of senior fellows Richard Morgenstern and Alan Krupnick, visiting scholar Ruth Greenspan Bell, and research assistant Xuehua Zhang. They recently met with representatives from the provincial and city planning commissions and environmental protection bureaus and toured local factories to gain a thorough perspective on current practices and to better understand the scope of the environmental and public health problems at hand. They are now working on a plan of action for a demonstration project in Taiyuan that would establish a sulfur dioxide (SO₂) emissions trading program modeled in part after the successful SO₂ trading program in the United States.

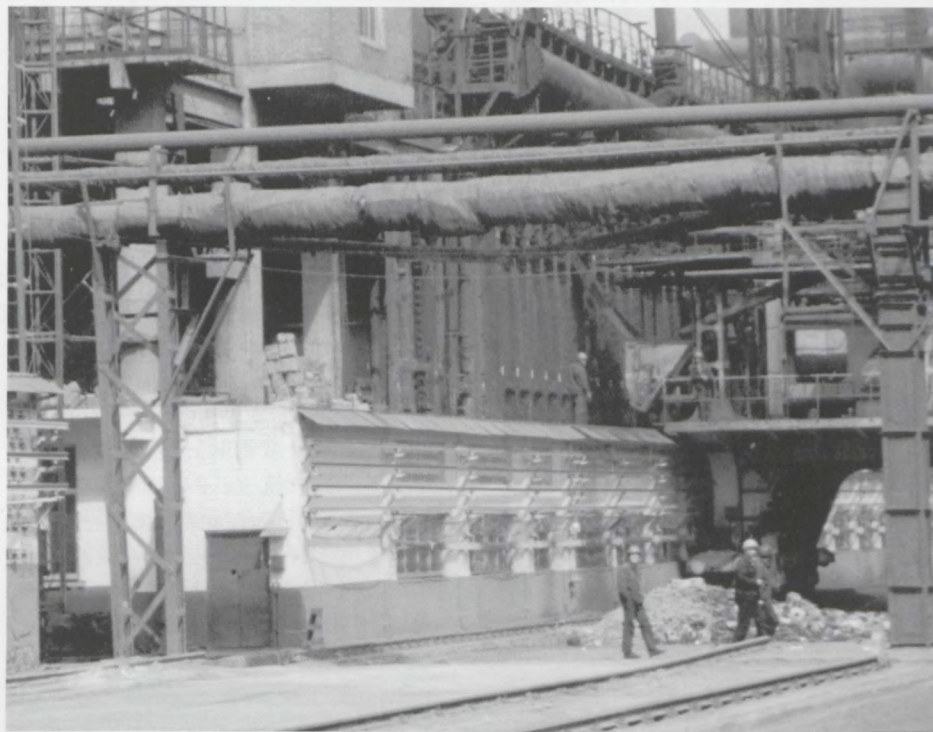
To carry out the demonstration proj-

ect, the RFF team will work closely with local officials to define precise environmental goals, establish the administrative framework of the program, analyze potential cost savings from trading and the likely allowance prices, develop implementation guidance, assess monitoring needs, and work on training and capacity building. The project is expected to take approximately 15 months.

According to Morgenstern, there is broad political support at high levels of the People's Republic of China government for improving air quality and integrating market mechanisms into the country's still-evolving legal and enforce-

ment framework. "It's the most exciting project I've ever been involved with," he said. "We have an opportunity here to use innovative methods to reduce emissions in the world's most populous country."

The potential for achieving dramatic health benefits is enormous, Morgenstern said, including a significant reduction in premature mortality. However, achieving those health benefits poses daunting challenges, he said. Taiyuan is considered by the World Bank to be the dirtiest city in the world in terms of air pollution. ■



Steelworkers at a coking facility in Taiyuan



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At Recent RFF Conference, Scientists from Array of Disciplines Debated the Economics of Resistance to Antibiotics

Resistance by pests and bacteria to all efforts to control them is a common problem. Pest resistance to transgenic or genetically modified crops and viral resistance to HIV medication, for example, threaten to undo some of the most remarkable scientific achievements of the past century. RFF recently held a conference to explore issues relating to the evolution of resistance and how it is affected by the economic behavior of individuals and institutions.

According to RFF Fellow Ramanan Laxminarayan, who organized the conference, the understanding gained through environmental and natural resource economic models can be applied to the problems of treating infectious diseases in general and antibiotic resistance in particular. Both of these problems are characterized by externalities. On the one hand, individuals fail to take into consideration the impact of receiving successful antibiotic treatment on lowering their likelihood of passing on the infection to other individuals. On the other, individuals ignore the cost of increased resistance—and therefore depleted usefulness—to the rest of society when they choose to use antibiotics.

The conference specifically focused on the economics of drug resistance and the economics of pest resistance in agriculture, in separate workshops. The audience of nearly 70 participants included economists, medical and plant epidemiologists, ecologists, agronomists, physicians, and policymakers from academia, industry, and government, in both the United States and Europe.

The Economics of Drug Resistance

In the first session, Jim Wilen, University

of California at Davis, and Gardner Brown, University of Washington, Seattle, gave presentations on the optimal use of antibiotics in a hospital setting. Both researchers used epidemiological models of the evolution of infection and resistance to characterize the order and manner in which antibiotics should be used to maximize their benefit to society while minimizing the individual and social costs of bacterial infection. In their models, resistant bacteria were assumed to bear an evolutionary disadvantage compared to susceptible bacteria when no antibiotics were being used. This disadvantage, also called the fitness cost of resistance, could potentially enable antibiotics to be used as renewable resources since antibiotics can be periodically be removed from active use and allowed to recover their effectiveness.

The second session dealt with the contradictions between the current system for prescription treatment guidelines for patients and the need to address the problem of rising drug resistance. Martin Weitzman, Harvard University, showed that uniform treatment guidelines are inherently problematic in the case of treating infectious diseases, because they place excessive selection pressure on resistant bacteria to evolve. He further demonstrated that standard cost-effectiveness analyses that failed to take into account the social cost of resistance could be fundamentally flawed and concluded that treatment heterogeneity using a variety of drugs could constitute a more prudent strategy to follow, even if some of the drugs were not cost-effective from the individual patient's perspective.

Marc Lipsitch, Harvard University, opened the third session with a presentation of his work on epidemiological models

and issues pertaining to measuring and interpreting associations between antibiotic use and penicillin resistance in *Streptococcus pneumoniae*. David Howard, Emory University, presented a framework for assessing the social costs of resistance, specifically a model in which physicians selected antibiotics both on the basis of their attributes as well as their effectiveness against infections that are resistant to older drugs. Based on this model and a large individual-level dataset on the treatment of ear infections in the United States, he estimated that resistance increases antibiotic spending on ear infections by \$82 million annually.

The final session of the workshop featured an open discussion of the key elements of epidemiological models that are critical to any economic analysis of the resistance problem. Thus far, economists have focused on the role played by natural selection in the evolution of resistance. However, in the case of resistance to antibiotics, natural selection is not the only mechanism by which resistance evolves. Bacteria possess the ability to directly transfer genetic material between each other using a mechanism known as plasmid transfer. Plasmids are packets of genetic material that serve as a vehicle for the transfer of resistance between different bacterial species and are believed to be responsible for the geographical spread of resistance among regions of the world.

The natural scientists spoke of the importance of incorporating dynamics of plasmid transfer of resistance and fitness cost of resistance into future economic models of resistance. Further, they underscored the importance of linking specific model assumptions with the observed realities of a particular disease, such as tuberculosis or gonorrhea, so that the policy implications of such economic models



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for the treatment of a particular disease could be understood better.

The Economics of Pest Resistance in Agriculture

The second workshop was devoted to the economic consequences of pest resistance to pesticides and genetically modified crops that have been engineered to be pest resistant. In separate presentations, Felicia Wu, Carnegie Mellon University, and Justus Wessler, Wageningen University, discussed their research on the use of the real option value approach—measuring the value of taking a course of action immediately versus at a later date, when more information will be available—to estimate the costs and benefits of irreversible changes in pest resistance that would be brought about by the introduction of genetically modified crops.

Timo Goeschl, University of Cambridge, outlined a fundamental incompatibility between the dynamics of the patent system and the resistance problem as it applies to pesticide effectiveness.

He showed that the patent system—which encourages manufacturers to come up with new products—is incapable of sustaining society against a background of increasing resistance problems. In addition, he said, the externalities within a patent-based system indicated that decentralized mechanisms could result in systematic underinvestment in new pesticides. Hermann Waibel, Hannover University, provided an overview of the economics of pesticides and how the insights gained from the relatively long history of pesticides could be used to assess the impact of pest-resistant transgenic crops.

There were common and contrasting themes between the two days of the conference. For example, the fitness cost of resistance—which allows both antibiotic effectiveness and pesticide effectiveness to be treated as renewable resources—was a common element in many discussions. Further, empirical analyses were presented on both days that attempted to quantify the cost imposed on society of evolving resist-

ance to antibiotics in medicine and pesticides in agriculture.

The contrasting incentives for pesticide manufacturers and drug firms to take into consideration the societal cost of resistance to their products was also discussed in detail. The consensus view among the participants was that the incentives for developing new antibiotics encourage the development of broad-spectrum drugs that are active in promoting bacterial resistance since they impose broad selection pressure on all bacteria in a patient's body, including ones that are not causing the infection. However, in the case of pesticides, regulations written with the environmental side effects of pesticides in mind have resulted in the development of relatively narrow spectrum pesticides that do not place broad selection pressure on all pests.

The papers presented at the conference will appear in *Economics of Resistance*, to be published by the RFF Press early next year. Audio transcripts of the conference proceedings can be found on the conference webpage at www.rff.org/resistance. ■

RFF Receives Major Grant to Support New Fellowships to Study Implementation of Environmental Regulations

RFF has received a \$1.2 million grant from the **Andrew W. Mellon Foundation** to support fellowships for scholarly research that documents how environmental regulations have been implemented and their actual outcomes. The objective of the fellowships is to develop a base of scholarship that systematically examines environmental regulations in practice, and that subsequently will be used to inform regulators, industry, and others on assumptions of environmental laws and

policies. Beginning in 2002, RFF will award two-year fellowships to academicians and scholars from the country's leading universities and research organizations. Information on how to apply for the fellowships will be published in the fall issue of *Resources*.

In addition, the **Smith Richardson Foundation** awarded RFF a \$200,000 grant to conduct a performance-based analysis of the effectiveness and efficiency of environmental regulations. The

research will draw on a dozen in-depth case studies of major environmental programs in the United States and Europe to illuminate the actual performance of different policy instruments addressing similar environmental problems. Senior Fellows **Winston Harrington** and **Richard Morgenstern** will lead an international team of researchers who will use retrospective analyses to compare the performance of two different types of environmental regulations—command-and-control versus economic incentives.



Drawing Lessons from the California Power Crisis

Timothy Brennan

Opening statewide electricity markets, a topic usually interesting to only a few policy aficionados, has become a major story because of the California power crisis. High prices, rolling blackouts, bankrupt utilities, bailouts, and allegations of anticompetitive conduct should provide lessons that other states can use. The danger in focusing on California's mistakes, however, would be to overlook the inherent difficulties of even a well-implemented open competition plan.

In the last 25 years, the economy has reaped great benefit from weaning industries from having the government determine who gets to sell what for how much. Not only has this led to lower prices in the short run, but also to innovations in technology and marketing plans with more substantial benefits.

In theory, opening electricity markets could also generate these benefits to that industry. As new entrants with the latest technology challenge incumbent utilities, competitive pressure among power suppliers should lead to lower prices overall for electricity. Opening markets may allow power retailers to obtain for ordinary consumers the low prices that politically powerful industrial purchasers have typically received under regulation. It should also allow innovative options in providing energy services, so customers can better reap the rewards from using more energy-efficient equipment. Additional benefits can come from product differentiation. For example, some environmentalists backed deregulation because it would allow consumers to purchase electricity from suppliers

using "green" technologies, such as wind or solar power.

Making electricity markets more competitive, however, is complicated by an inability to deregulate "all the way." Local distribution of electricity is a monopoly because it would be wasteful for a second provider to install its own lines, poles, and conduits over the existing grid. The long-distance transmission grid also is, functionally, a single interconnected economic unit. Because electricity flowing between any two points takes all available paths, maintenance of and congestion along some lines significantly affects the operating characteristics of other lines. Until customers can economically produce electricity on their own premises using "distributed-generation" technologies, local distribution and long-distance transmission will remain regulated monopolies. Policymakers continue to contemplate how much corporate separation between the regulated "wires" and the generation and marketing sectors in the industry is necessary to preserve competition while maintaining system reliability—a topic that will be addressed in further detail.

California Electricity Prices

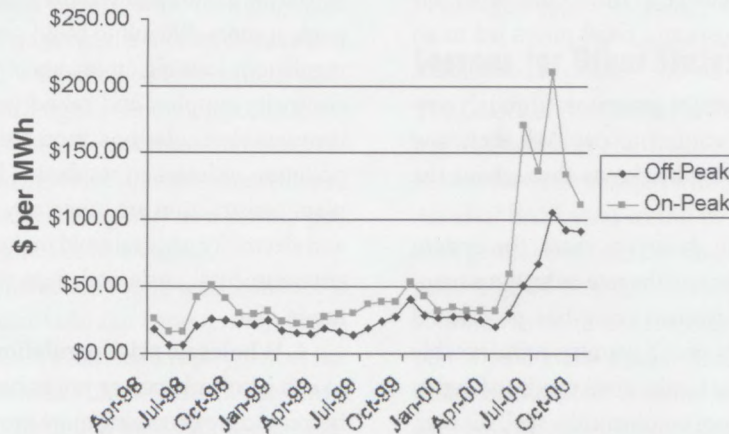


Figure 1: California wholesale electricity prices, 4/98–10/00 (California ISO)

The California Experience

Following a series of feasibility studies, the California legislature unanimously passed Assembly Bill (AB) 1890 in 1996, which began the process of opening the state's electricity markets to competition. The bill set up an independent system operator (ISO) to manage the California transmission system and procure power to keep loads balanced—that is, to keep power supplies equal to demand. The legislation also mandated a power exchange in which most power would be traded. To ensure that utilities would recover potentially “stranded” costs of older investments in power plants and long-term contracts, AB 1890 included a “competitive transition charge” to be paid by all consumers, whether or not they continued to buy power from the state's original regulated utilities.

AB 1890 specified that retail markets would be fully open by January 1, 1998. For the first four years, the state's three investor-owned utilities (IOUs) were required to buy power from the independent power exchange, rather than through independently negotiated contracts. Each IOU's retail rates were reduced by 10% until it recovered its stranded costs. The only IOU to qualify was that serving San Diego, where retail rates were deregulated in June 2000. To improve prospects for competition, the IOUs were required to divest their oil- and natural-gas-fired power plants. By 1999, they had reduced their share of California's generation capacity from 81% to 46%.

Restructuring the California energy industry seemed to work well for more than two years. The system was generally reliable and, as Figure 1 indicates, until June 2000, electricity in California remained inexpensive.

The turn for the worse began around that time. Wholesale prices started to skyrocket, and reserves hit precariously low levels with greater frequency. The retail price ceilings prevented the IOUs from covering their expenses. As they teetered at the edge of bankruptcy, generators became less willing to sell them electricity, fearing they would not be paid. Prices in the winter of 2001 jumped to levels exceeding those of the previous summer and fall. Trying to ward off the impending financial disaster, California regulators raised retail power prices by 40%, and a reluctant legislature approved other steps, including authorizing the state to purchase power. The state also began negotiating deals to purchase the utilities' transmission systems at prices greater than book value. Nevertheless, the investor-owned Pacific Gas & Electric filed for Chapter 11 bankruptcy protection on April 6.

In assessing the California experience, three insufficiently recognized facts should be remembered:

- California's restructuring plan was designed to satisfy virtually every interested stakeholder, as reflected in the unanimous vote for AB 1890 following extensive public debate and political negotiation.
- The character of the “crisis” has changed over time. It began with higher consumer prices in San Diego in the summer of

2000, following the rise in wholesale rates. Then came a threat of blackouts throughout the state. As summer passed into fall, the crisis became financial as the accumulated difference between wholesale costs and retail prices led to an over \$14 billion deficit that no one—utility stockholders, electricity consumers, taxpayers, or generators (through government-ordered rebates—wanted to pay. We then saw regular emergencies and rolling blackouts throughout the winter of 2000–2001.

- As Figure 1 shows, for more than two years, the system worked, holding prices at or below the rate reductions mandated by AB 1890. So far, restructuring has performed reasonably well in other parts of the country, most notably Pennsylvania. Any explanation for the crisis needs to keep in mind that restructuring does not automatically spell disaster.

Reasons for the Crisis

The severity of the power crisis has inspired an ample supply of potential explanations. Were it possible to convert explanations into electricity, California's dilemma would disappear. Here is a "top 10" list of potential culprits, with comments on their likely significance:

1. Supply and demand. At the head of the list is the fact that California hit a very hard wall when steadily growing demand, fueled by increased population and a strong economy, strained production capacity to the limit. During the 1990s, demand for electricity in California grew by over 11% while capacity fell slightly. Population and economic growth in other western states reduced electricity supplies that California might otherwise have imported. Exhausting the capacity to produce electricity would have led to higher prices, rolling blackouts, or perhaps both, even if California had not adopted restructuring. Other factors described below may have made a bad situation worse, but had capacity remained plentiful relative to demand, electricity policy would have remained an obscure pursuit.

2. Higher fuel costs. The price for power rose in part because the fuels used to produce it, particularly natural gas, became far more expensive. Among the portfolio of generation technologies used to supply electricity in California, natural gas-fired generators are the ones called upon to meet peak demands. As supplies get tight relative to demand, the generators called upon to meet power needs are increasingly less efficient. Consequently, when the price of natural gas rose, the cost of meeting peak demand increased, raising the price required to attract enough

electricity to meet demand.

3. Environmental regulations. Somewhat more controversial are claims that NIMBY ("not in my back yard") attitudes made it more difficult to build generators in the state, and that regulations limiting emissions of particular pollutants reduced electricity supplies and raised generation costs. Even if environmental regulations increase such costs, damages from pollution or losses in residential land values caused by nearby plant construction are inherently no different than other costs, and electricity prices should include them. If not, we will ignore environmental costs and treat power too cheaply, using too much of it.

4. Wholesale price regulation, actual or threatened. Calls to cap wholesale power prices have been made since the crisis began and are becoming more prominent in academic and political arenas. They may alleviate a politically undesirable redistribution of wealth from consumers to generators. They may also discourage suppliers from withholding supplies to drive up prices. However, threatening to cap prices could have discouraged supply.

5. Retail price controls. If hitting the capacity wall was the primary cause of the crisis, holding down retail prices made matters worse. Low retail rates would keep demand high and discourage conservation that might have eased the stress on the power system. Utilities lost billions of dollars when they had to purchase wholesale power at prices up to five times the retail level to meet their legal obligations to serve the public. The potential for bankruptcy called into question their ability to pay, leading to a vicious circle in which wholesalers would raise prices to cover the risk of nonpayment.

6. Wealth redistribution in markets. One important difference between competition and regulation is that under the former, as prices rose to cover the cost of marginal generators, all suppliers got to charge the higher prices. In San Diego, where retail rates had been deregulated, this led to a reported doubling or tripling of electricity bills and reregulation of rates by September 2000. Higher prices are efficient, in that they send the right message about the value of conservation, but they also lead to a politically undesirable transfer of money from consumers to producers. Retail rates in San Diego were, in fact, quickly reregulated. The long-term solution is for more generators to come on-line, but that may be a politically difficult wait.

7. No real-time metering. Because electricity cannot be stored, the cost of producing it and the value of conserving it

are highly sensitive to when it is used. Electricity may cost 10 times as much to produce on a hot summer afternoon than later that same evening. But standard meters, which tell only how much electricity one uses during a particular month, do not allow prices to be charged based on when the power was used. Real-time meters would allow such charges, encouraging consumers to conserve and reschedule use for off-peak times. While a generator and its customers have an incentive to enable more efficient power billing, greater real-time metering may be a worthy policy goal if the alternative is a series of blackouts.

8. Lack of long-term contracts. A long-term contract is essentially insurance against price volatility. Long-term contracts here would have helped the IOUs avoid bankruptcy, just as fire insurance protects against financial ruin when a house burns down. But the benefits of contracting in hindsight could exaggerate its benefits going forward. Contracts alone do not reduce the expected price of electricity. If higher prices are likely, a long-term contract will reflect them. In addition, like other forms of insurance, long-term contracts can lead to "moral hazard," namely, being less careful after reducing exposure to risk. In electricity, long-term contracting could encourage greater consumption at a lower contract price and discourage conservation.

9. Auction design. The California power exchange ran an auction in which each generator could specify up to 16 prices and amounts of electricity it would sell at those prices. Generators might have been able to "game the system" by offering only a small amount of power at a very high price. If that small amount of power went unsold, little would be lost, but if the power were purchased, the generator would get that high price on all of its sales.

10. Market power. The most hotly debated allegation in the California crisis is whether generators exercised market power, that is, intentionally withheld electricity to drive up its price. The number of competitors in the California wholesale market would seem to make illegal collusion unlikely. But each seller may have found it unilaterally worthwhile to reduce output, especially when retail regulation and the absence of real-time metering would have made demand largely insensitive to price. Whether outages were designed to raise prices remains under regulatory scrutiny. Some studies find that electricity prices were above the average variable cost of generating power, but these need to be interpreted with care. Peak-period prices would normally cover not only variable costs but capital costs as well.

Moreover, the prices charged may have been inflated to compensate for the possibility that bankrupt utilities might not have been able to pay their bills.

Lessons for Other States

The causes of the California disaster are so varied that forecasting its likelihood elsewhere is risky. But the experience offers lessons for those charged with implementing retail competition. An ideal first lesson would be to lift retail price controls along with getting the local distribution monopolies out of the competitive retail business. If this is impractical and utilities will continue to dominate the market, any continued retail regulation should allow a pass-through of wholesale prices to deter utility bankruptcy. Whether or not retail regulation is continued, policymakers should consider ways to encourage real-time pricing if the prospect of blackouts is significant.

Market mechanics may be improved by eliminating impediments to long-term contracting between generators and customers or electricity retailers. One might rethink having publicly maintained or chartered central auctions to buy and sell power beyond purchases needed to maintain the technical integrity of the power grid and to alleviate emergencies. If central auctions are to be maintained, their rules should be modified to reduce the incentive for gaming by offering small amounts of power at very high prices.

As noted above, the flow of wealth from California electricity customers and, increasingly, taxpayers to generators charging very high prices makes wholesale price controls tempting. But price caps are unlikely to produce more power unless suppliers are acting strategically. To the extent that wholesale price caps translate to lower retail prices, they will discourage production and encourage consumption, putting the system at greater risk.

Would These Fixes Suffice?

Paradoxically, the severity of the California crisis may give a false sense of security about opening retail markets in other states to competition. That is, focusing on California-specific issues could lead us to think that electricity markets can work just fine, if only obvious mistakes were avoided.

One potentially generic problem California has brought to light is the potential incentive for generators to exercise market power by withholding electricity when supplies are tight. Theoretical models suggest that usual indicators of competitiveness may not apply in electricity, with firms having as little as 10%

of a market finding it profitable to raise prices substantially above cost. Absent a very clear indication of why California is unique, imposition of "temporary" wholesale price caps—as FERC has recently done in this instance—when capacity is taxed near its limits would be repeated when the next demand crunch hits. If prices are capped when supplies are scarce, are we really deregulating?

An even more fundamental quandary, however, springs from a combination of factors that make electricity challenging to deregulate. Plainly, it is crucial to the economy. In addition, electricity is highly vulnerable to even momentary load imbalances. If electricity supply exceeds demand, the system can break down; if demand exceeds supply, blackouts can occur. Finally, the electricity system is interrelated. Load imbalances affect the entire grid, not just specific buyers and sellers.

These three factors imply that some cooperation or centralized management is necessary to ensure reliability. Such cooperation was not inherently problematic when the industry was largely divided among regulated monopoly utilities. Can we achieve such cooperation when the suppliers are competing with one another? Prior to California, the most likely deregulation cri-

sis would have been a major unexpected blackout followed by finger-pointing, revealing that cooperation had failed.

The second question is how much central control is necessary to maintain reliability. The optimistic view is that a relatively passive ISO can oversee transmission and distribution operations, with only minimal intervention in the market necessary to keep loads balanced and procure power to deal with infrequent outages. The pessimistic view is that the level of control to maintain reliability extends so far into organizing markets, setting prices, regulating contracts, and dispatching generators that little scope is left to achieve the benefits that competition, new entry, innovative marketing, and product differentiation can bring.

Perhaps electricity will join the list of other industries in which the benefits of deregulation have proven positive. But it may turn out to be the sector in which markets meet their match.

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Redesigning Food Safety

Using Risk Analysis to Build a Better Food Safety System

Michael R. Taylor and Sandra A. Hoffmann

Our current food safety system is hampered by an outdated and fragmented patchwork of food safety laws and agencies. At the same time, it is challenged by an unacceptably high incidence of preventable foodborne illness, new technologies, an increasingly globalized food supply, and intense public and media scrutiny on issues like mad cow disease and biotech foods. Risk analysis should be carefully harnessed in the design and management of a food safety system that will be better able to meet these challenges.

The overarching purpose of food safety regulation and other government food safety interventions is to minimize the risk of food-borne illness. With this objective in mind, in 1998, a National Academy of Sciences (NAS) committee called for a complete redesign of the federal food safety system. The committee documented how an outdated and fragmented patchwork of food safety laws and agencies impeded the efforts of regulators who sought to reduce the risk of foodborne illness. It recommended a science-based, integrated food safety regulatory system under unified and accountable leadership—a system that would be better able to deploy resources in the manner most likely to reduce risk.

The need for improvement in the food safety system was subsequently underscored by new estimates from the Centers for Disease Control and Prevention (CDC) of the persistently high incidence of foodborne illness in the United States: approximately 5,000 deaths, 325,000 hospitalizations, and 76 million illnesses annually. Many of these are linked to new and emerging microbial

pathogens, changing American eating habits, and an aging population—factors not considered in the legislation enacted over the course of the past century, through which the current system evolved.

Our food safety system also is challenged by new agricultural and food technologies, such as genetically engineered food crops; an increasingly globalized food supply, which makes European and Latin American food safety problems potential problems for the United States; and intense public and media scrutiny on issues like mad cow disease and biotech foods. Even as the food safety job has become more difficult, chronically strained food safety budgets have seriously eroded the government's scientific staffing and inspection resources.

In response to these stresses, there is growing interest within congress, consumer groups, and the food industry, in modernizing our food safety laws and structures along the lines contemplated by the NAS committee. While the vagaries of the political process make any time line for implementing such reform uncertain at best, it

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is not too soon for the scientific and research community to consider what knowledge and methodologies will be needed to design and implement a science-based, integrated system—one capable of prioritizing risk reduction opportunities and deploying resources efficiently. Indeed, better priority setting and more efficient use of available resources are goals that should be pursued regardless of whether Congress modernizes the existing regulatory infrastructure for food safety.

Risk analysis will have to play a central role in designing and managing a more science-based, integrated food safety system. Such a system would rely more heavily on biological risk assessments to set food safety standards—with greater emphasis on risks posed by microbial pathogens. Even more important, risk analysis must be harnessed to rank risks and prioritize opportunities for risk reduction so that the government can make the best use of its resources to reduce the risk of foodborne illness.

Government's Role in Food Safety

Food safety is, first and foremost, the responsibility of food producers, processors, and others throughout the food chain, including consumers. The government does not produce food and cannot, by itself, make food safe or unsafe. It does, however, play two important roles in the effort to minimize food safety risk.

The first and broadest role is to set and enforce food safety standards through laws, regulations, inspections, and compliance actions. This role fulfills the uniquely governmental function of ensuring that those commercially involved in the food system have some accountability to the public for meeting basic food safety standards.

The government's second role is to tackle food safety problems that are beyond the control of any individual participant in the food chain and that require more than a regulatory solution. The dangerous pathogen *E. coli* O157:H7, for example, originates in the gut of cattle, is spread through the environment to contaminate water and fresh produce, and contaminates beef during the slaughter process, posing a significant hazard when present in any raw or undercooked food. Tackling this and many other food safety problems requires a strong research base; development of effective control measures; and collaboration among growers, animal producers, food processors, retailers, and consumers.

Ideally, the government would deploy its resources and focus its efforts across this range of activities in the manner best suited

to achieve the primary goal of reducing risk, but the food safety laws do not permit this. Under current law, the Food and Drug Administration (FDA) is authorized to inspect food establishments but is not required to do so. With approximately 50,000 processing and storage facilities under FDA's jurisdiction and with resources to conduct about 15,000 inspections per year, many plants under FDA's watch go years without inspection. Even plants FDA rates as "high risk" may be inspected only once a year or less frequently. In contrast, the U.S. Department of Agriculture (USDA) has a statutory mandate to inspect every carcass passing through slaughter establishments and to inspect every meat and poultry processing plant every day, without regard to the relative risks the operations in these plants pose.

This bifurcated approach to inspection, which reflects fundamental differences in statutory mandates and modes of regulation between FDA and USDA, skews the allocation of resources in ways that are not optimal for public health and do not maximize the government's ability to contribute to risk reduction. For example, USDA's budget for regulating meat and poultry is about \$800 million. FDA's budget for all the rest of the food supply is less than \$300 million. USDA employs about 7,600 meat and poultry inspectors, while FDA has a total field staff (inspectors, laboratory technicians, and administrative staff) for all of its food programs of about 1,700. Approximately 3,000 USDA inspectors are committed to the statutorily mandated, carcass-by-carcass inspection program in poultry plants, which NAS evaluated nearly 20 years ago and concluded was unable to address microbial pathogens, the most significant food safety issue affecting poultry. Yet, this inspection program costs \$200 million, more than FDA has to inspect the entire food supply beyond meat and poultry.

The potential role of risk analysis in improving this situation is apparent. According to the 1998 NAS report, the agencies should be free to allocate their inspection and other resources across the entire food supply to "maximize effectiveness," which requires "identification of the greatest public health needs through surveillance and risk analysis." Such an improvement would not only make the core inspection and regulation programs more effective, but it could also improve the government's efforts to tackle food safety problems through research, collaborative efforts with the food industry, targeted regulatory interventions, and consumer education programs. These efforts are resource intensive, but they can bring about the change in practices and behavior that are often necessary to reduce the

risk of food-borne illness. In recent years, for example, FDA and USDA have carried out initiatives to reduce the risk of illness posed by *Salmonella enteritidis* in eggs. The result has been a decline in *Salmonella enteritidis* outbreaks and cases, but only after a significant investment of time and energy.

Risk analysis has a critical role to play in deciding which initiatives to pursue and in managing the initiatives. For example, the CDC reports through its FoodNet active surveillance program on cases of illness associated with nine specific bacterial and parasitic pathogens that are significant sources of food-borne illnesses. These pathogens enter the food supply through a range of foods and at different stages of the food production process. If the government is to make the best use of its food safety resources, it should assess and compare the risks posed by various pathogen/food combinations and prioritize opportunities for reducing these risks through targeted research, regulatory, and education initiatives.

Likewise, the presence in food of environmental contaminants, such as mercury, lead, and dioxin, remains a matter of public health concern. The government has had success in the past with initiatives to reduce the levels of such contaminants, lead being a notable example. Through risk analysis, the government can identify opportunities for further risk reduction and mount initiatives accordingly.

Unfortunately, there are numerous statutory, organizational, and resource constraints on the use of risk analysis in food safety decisionmaking, priority setting, and program design. Central among these are the statutory compartmentalization of the food supply, the antiquated USDA inspection mandate, and the severe underfunding of FDA food safety programs. Together, these features allocate much of the federal food safety resources on the basis of factors other than risk, and impede risk-driven food safety initiatives that consider the food supply as a whole and address risk problems that cut across agency jurisdictional lines. These problems in the food safety system would have to be addressed through legislative action.

Improving Risk Analysis to Set Priorities

In addition to the need for legislative reform, there is much room for improvement in the data collection and methodologies required to carry out risk analysis of the kind contemplated here. The analyses include risk assessment, risk comparison and ranking (in terms of public health significance), and prioritization of

risk reduction opportunities (taking into account feasibility, cost, and social considerations).

With regard to risk assessment, CDC reports foodborne illness cases and outbreaks by pathogen, but it does not have complete information about the specific food/pathogen combinations that account for the illness. Because regulatory initiatives and other efforts to reduce risk are necessarily oriented toward specific foods, such information is necessary for risk assessments intended to support regulatory priority setting and resource allocation.

Chemical risk assessment also needs attention if it is to contribute as a priority-setting tool. For chronic effects such as carcinogenicity, risk assessment yields quantitative expressions of the estimated upper bound on the risk an individual might be exposed to, based primarily on animal toxicity data. For most other effects, the results of risk assessment for food substances are expressed as an "acceptable daily intake." In neither case are the results readily comparable to the results of epidemiologically derived estimates of risk associated with microbial pathogens that, typically are expressed in terms of the number of cases of illness associated with a specific pathogen. How can chemical risk assessment and the manner of expressing its results be adapted to foster risk comparison and ranking in relation to microbial hazards?

There also is much work to do in the social sciences to meaningfully compare and rank food safety risks for the purpose of better allocating food safety resources. Such comparisons and rankings are inherently complicated due to the diversity of risks and health outcomes of concern and the diversity of values and practical considerations that are relevant to priority setting. Chemical risks range from the acute to the chronic, vary significantly with exposure, sometimes affect age groups differently, and often are predictable only with great uncertainty. Microbiological risks also are diverse—ranging from minor intestinal infections to permanently disabling disease and death—and vary among age groups, while microbial risk assessments are typically grounded in epidemiological data on actual illnesses. How can these factors be taken into account when comparing and ranking the public-health significance of food safety risks?

Once risks are ranked for public health significance, further analysis is required to prioritize opportunities for risk reduction. Optimal use of finite government resources should take account of where in the food system opportunities lie to minimize the risk, what are the cost and feasibility of reducing the

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risk through government intervention, and how the public perceives and values various risks. To successfully prioritize opportunities for risk reduction, public health experts and social scientists need to collaborate on developing risk analysis methods and prioritization models that consider these and other relevant factors.

Conclusion

The ultimate objective of risk analysis is not risk comparison and ranking for its own sake or to provide the basis for concluding that some food safety risks are unimportant. In the daily activities of people who produce, market, and consume food, any significant risk of harm is important and should be prevented to the extent reasonably possible. For the government, however, the question is how best to allocate finite resources to reduce the risk of foodborne illness. This requires building on risk comparison and ranking to prioritize opportunities for risk reduction. It means not stopping with an understanding of the relative mag-

nitude of food safety risks but examining how the government can make the best use of its resources to reduce risk.

The 1998 NAS committee report said, "[T]he cornerstone of a science-based system of food safety is the incorporation of the results of risk analysis into all decisions regarding resource allocation, programmatic priorities, and public education activities." Achieving this goal will require statutory and organizational reform so that the results of risk analysis can be fully implemented in program design and management. It also will require significantly greater investment to improve the data and methods available for risk analysis. With these changes, the regulatory system can effectively reduce the risk of foodborne illness and, in turn, maintain public confidence in the food supply and preserve America's international leadership role on food safety.

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Finding the Funds to Pay for Our Transportation Crisis

A Look at Options for Solving Washington, DC's Traffic Woes

Ian W.H. Parry

Like other big cities across the country, Washington, DC, has horrific traffic problems. Traditional solutions to relieving crowded highways and gridlocked streets are hard to implement—the cost of building new roads has skyrocketed, federal funding has fallen, and political battles have become increasingly heated.

Traffic congestion is a major problem in the metropolitan Washington, DC, area. According to some measures, the Washington area is the second most congested in the nation, behind only Los Angeles. Severe congestion at peak periods has now spread to vast stretches of the Washington-area highway system where, 10 years ago, traffic moved relatively freely.

The main cause of increasing congestion is that road building has not kept pace with the growth in traffic. Between 1982 and 1997, vehicle miles traveled on Washington, DC, freeways almost doubled, while freeway mile capacity increased by only 40%. These trends are set to continue. Expanding the road network is difficult because of opposition from environmental and community groups. But there also are financial constraints: road construction is expensive in densely populated urban areas where property values are high. Moreover, effective funds for highway spending have shrunk—the real gasoline tax per mile driven in the United States has fallen by approximately 50% since 1960, due to improved vehicle fuel efficiency and the failure of nominal tax rates to keep pace with inflation.

Recently, there has been much debate about expanded funding for transportation programs. For example, a

Maryland state commission says the state will need to spend \$27 billion more than planned during the next 20 years to keep pace with likely traffic growth. Several factors are relevant when evaluating transportation expansion projects. Political feasibility is important: public opposition to adding a lane to an existing road might be less than to constructing a brand-new road through neighborhoods. Distributional issues might be a concern: for example, does a new subway station primarily help poorer or wealthier neighborhoods? The benefits of the project are obviously important, such as improved accessibility and the alleviation of traffic congestion; they should be weighed against the costs of financing the project, which will depend on how the revenues are raised.

Several local policy options for generating additional transportation revenues exist. One possibility is to increase transportation charges, such as the gasoline tax or mass transit fares; another is to implement charges for driving on busy roads during peak periods (sometimes called a congestion tax). Other revenue options include increasing local income taxes, sales taxes, or property taxes. Some of these are more politically feasible than others; for example, it seems to be particularly difficult to start charging

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people to drive on roads they previously used for free. But the cost of different policies is an important consideration.

Revenue Source Costs

For households and businesses, the cost of transportation spending is the money they end up paying in higher taxes to the government or road contractor (before the money is recycled to produce transportation benefits). But for society as a whole, the cost also includes the effect the policy has on the efficiency of resource use. For example, social costs will be higher to the extent that the policy reduces employment and investment and lower to the extent that the policy reduces pollution and traffic congestion (independent of the improved transportation infrastructure). For a given amount of additional spending, the money cost of different financing options would be the same, so the discussion here focuses only on the implications of revenue-raising policies for the efficiency of resource use.

Gasoline Taxes

Higher gasoline taxes raise the costs to motorists of driving, and therefore they indirectly discourage traffic congestion and perhaps also the risk of injuries and fatalities from traffic accidents. They also would reduce the use of fuel, thereby reducing pollutants caused by gasoline combustion. Economists such as Alan Krupnick (Resources for the Future) and Kenneth Small (University of California, Irvine) have estimated that people would be willing to pay no more than 60 cents per gallon to avoid the damages to human health and visibility caused by motor vehicle pollution. Gasoline combustion also produces greenhouse gas emissions, and studies have suggested that the damages from future global climate change might amount to anything between 0 and 30 cents per gallon.

But the congestion and pollution benefits should not be overstated because the amount people drive is not especially sensitive to higher gasoline taxes. London is still gridlocked even though gasoline taxes in Britain are seven times as high as in the United States. Moreover, even though reducing gasoline consumption and driving has benefits, it also has economic costs because people are induced to purchase more expensive, fuel-efficient vehicles or make fewer trips. Indeed, a significant portion of the pollution damage is already reflected in the price of gasoline due to federal and state gasoline taxes, which amount to about 40 cents per gallon in the Washington, DC, area. Higher transportation taxes also raise the cost of commuting to work and the cost to firms of doing business, both of which can indi-

rectly reduce employment levels. Reducing employment involves economic costs because it compounds distortions created by taxes on labor earnings. In short, it is not clear that the pollution and congestion benefits of higher gasoline taxes would greatly exceed the costs.

Transit Fares

In principle, transit fares should be set to cover the marginal cost of operating trains or buses more frequently in order to carry additional passengers. A modest fare subsidy might be justified because pricing at marginal cost might not yield enough revenues to cover total operating costs. However, the existing fare subsidy in the Washington area is substantial and probably cannot be justified purely on these grounds. Fare revenues cover only about 50% of the operating costs (and this figure does not include subsidies for infrastructure expansion). If the subsidy is excessive, there might be sizable economic benefits from raising fares for public transportation. But on the other hand, higher transit fares would, indirectly, cause more pollution and traffic congestion because they would induce some people to drive rather than use mass transit. Overall, I estimate that higher transit fares would, most likely, produce a net economic cost for the Washington, DC, region.

Congestion Taxes

On first inspection, congestion taxes might appear to be a very attractive means of raising additional revenues because they discourage traffic congestion. Implementation of this policy could involve charging people to use the major highways into downtown Washington on weekdays during the morning and afternoon peaks. There have been some limited experiments with congestion pricing in California and Texas; such charges can be deducted electronically from a "smart card" installed on a vehicle's windshield.

Congestion pricing is a more effective way to reduce congestion than raising gasoline taxes or subsidizing transit fares, as it encourages people to exploit all possible alternatives to using congested roads, including rescheduling trips to drive at off-peak periods or driving on less congested, minor routes into town. But again, there are some subtle points to bear in mind. The demand for peak-period driving is not greatly sensitive to price; most people will still continue to drive at peak period even if they have to pay. Moreover, even if congestion pricing were implemented, it might not be very comprehensive; for example, it might be restricted to a limited number of highways and be applied to

Table 1. Summary of the Economic Effects of Taxes

	Policy				
	Gasoline tax	Transit fare	Congestion tax	Income tax or Sales tax	Property tax
Benefits	Reduces pollution; Modest effect on congestion	Reduces excessive fare subsidy	Reduces congestion		Reduces real estate subsidy
Costs	Higher driving costs	Higher transit costs; More pollution and congestion	Higher driving costs	Reduces employment	Reduces employment and investment
Revenue potential	Limited	Limited	Limited	Large potential	Large potential
Net economic benefit or cost*	Modest net benefits to modest net costs	Net costs, but probably smaller than income/sales taxes	Modest net benefits	Significant economic costs	Modest net benefits to modest net costs

* Excludes the cost of the money transfer from the private sector to the government.

only one lane on a highway rather than all lanes. Limited forms of congestion pricing are obviously less effective for tackling congestion in the Washington, DC, region; congestion on unpriced roads could worsen because people choose to drive on them rather than on priced (but less congested) roads.

Sales and Income Taxes

New transportation projects could be paid for by regional sales taxes, or by an increase in local income taxes. A proposal to allow jurisdictions in Northern Virginia to have a referendum on a 1% increase in the sales tax with half the revenues earmarked for transportation narrowly failed to pass the state's general assembly in 2001. The main economic effect of increased income and sales taxes is to reduce employment, which can lead to significant economic costs.

Property Taxes

Property taxes provide another source of general revenues for local governments. The effect of the tax system on the real-estate sector is a complicated matter, but we can draw out two important opposing factors. On the one hand, local property taxes may be viewed as a tax on real estate (although firms and households may be compensated in part by better local services). On the other, the owner-occupied housing component of the real-estate sector is heavily subsidized through various tax provisions, including the income tax deduction for mortgage interest. Overall, there is probably a modest net subsidy for real estate, implying an excessive amount of spending on real estate relative to other goods. Raising property taxes can improve economic efficiency by counteracting this subsidy; however, by raising costs to businesses, it may adversely affect investment and employment.

Conclusion

Table 1 summarizes the economic effects of the various taxes. The revenue potential of the three transportation taxes (gasoline taxes, transit fares, and congestion taxes) is limited. For example, to increase transportation spending by 20% would require an increase in regional gasoline taxes of around 40 cents, or an increase in transit fares from approximately 50% of operating costs to well over 100% of operating costs. Neither of these tax increases would be politically viable. Taken individually, transportation taxes could only be part of a package of measures to raise a substantial amount of extra funding. However, because the general taxes (property, income, and sales) have a much broader base, only small changes in the rates of these taxes would be required to generate significant revenues.

An economic case can be made for relying on congestion taxes, gasoline taxes, and possibly property taxes to raise additional revenues. All three produce a direct benefit by reducing congestion, pollution, or a subsidy from the tax system. However, support for using congestion and gasoline taxes needs to be qualified for several reasons. Demand for both peak-period driving and gasoline is not greatly price sensitive, which limits the congestion and pollution benefits per dollar of revenue raised from these policies. Because they raise transportation costs, these policies can have adverse effects on employment and this narrows the difference between their costs and those of direct taxes on labor earnings or sales taxes. And some of the costs of pollution are already reflected in the price of gasoline through taxes.

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Show Me the Money:

Environmental Regulation Demands More, Not Less, Financial Assurance

James Boyd

Financial assurance rules require potential polluters to demonstrate they have the resources to correct any environmental damage that may be caused by their operations. A new set of such rules, finalized by the Clinton administration and soon to be implemented by the Bush administration, will toughen the bonding requirements for hardrock mines. The environmental record of firms operating without such requirements underscores the need for this highly valuable environmental compliance tool.

The Bush administration is moving forward with new rules that will strengthen financial assurance requirements for hardrock mines on U.S. lands. The rules—which were championed by and finalized under the Clinton administration—are a long-overdue response to environmental compliance problems in the mining industry. The recent announcement by the Bureau of Land Management (BLM) that it will institute the strengthened bonding rules presents an opportunity to reflect on the substantial benefits of financial assurance, the problems created when assurance is not provided by polluters, and the political forces that can act as a barrier to this form of environmental regulation.

Financial assurance rules, also known as financial responsibility or bonding requirements, require potential polluters to demonstrate they have the financial resources to correct environmental damage caused by their operations. Financial assurance is demanded of a wide variety of commercial operations, including municipal landfills, ships carrying oil or hazardous cargo,

hazardous waste treatment facilities, offshore oil and gas installations, underground gasoline tanks, nuclear disposal and nuclear power facilities, and mines. Firms needing assurance can purchase it in the form of insurance, surety obligations, or letters of credit from a bank, or they can set up trust funds or escrow accounts. Some regulatory programs allow compliance via demonstration of an adequate asset base and high-quality bond rating, or a financial guarantee from a wealthy corporate parent.

A bedrock principle of environmental law and regulation is that pollution costs should be borne by their creators. While often at odds over the details of environmental policy, most economists, environmentalists, and legal experts agree that polluters should pay to correct the environmental damage they cause. Cost internalization—the full payment of compensation for damages and environmental repair by polluters—yields the most equitable means of victim compensation, the alternatives being no compensation or compensation provided by public funds. It also leads to prices that fully

reflect a product's social costs. Most important of all, cost internalization promotes deterrence by creating incentives to reduce environmental risks before they materialize.

Unfortunately, cost internalization's intended impact is not always achieved in practice. Bankruptcy and corporate dissolution defeat the law's ability to force polluter cost internalization by allowing many firms to abandon environmental responsibilities after reaping short-term financial gains. Nonrecoverable environmental obligations are more than a theoretical possibility. The U.S. landscape is littered with environmentally damaging operations that were either abandoned entirely or left unreclaimed due to bankruptcy.

Consider some illustrative figures: the U.S. Environmental Protection Agency (EPA) estimates there are nearly 190,000 abandoned underground petroleum storage tanks in the United States, each capable of soil and water contamination. A Society of Petroleum Engineers study calculates there are 57,000 abandoned oil and gas wells nationwide, themselves capable of serious ground and surface water contamination. Or consider landfills. A recent inventory by Texas regulators located 4,200 abandoned landfills in that state alone. An EPA Superfund study estimates that the cost of so-called orphan shares—liability costs for site cleanup that cannot be recouped due to a polluter's bankruptcy or absence—will range from \$150 million to \$420 million every year at federal Superfund sites alone. These numbers are just the tip of the iceberg, since they relate only to abandoned obligations. Huge costs also are associated with polluters that do not abandon sites, but rather avoid cost internalization via the bankruptcy process.

Assurance rules address the cost-internalization problem by requiring an up-front guarantee of potential polluters' ability to pay off liabilities or meet future ecological restoration obligations. For that same reason, the financial penalties associated with assurance rules promote compliance with immediate regulatory requirements such as monitoring, control, and reporting standards. Assurance rules also promote environmental monitoring. The insurers, sureties, and banks that provide the financial products used to demonstrate compliance have an incentive to train an extra set of eyes on the financial and environmental risks posed by potential polluters. When compliance and unfulfilled obligations are an issue, stronger assurances could be the answer.

The Mining Industry's Record

Historically, the mining industry has had particular difficulty with

unperformed environmental obligations. The Surface Coal Mining and Reclamation Act (SMCRA) of 1977 was a partial response, though it applies only to coal-mining operations, not to hardrock mining. The act has had a beneficial impact on the reclamation of both previous and current coal-mining operations. This should be viewed in its proper context, however: namely, decades of site abandonment and failed reclamation. In large part, the improvements brought about by SMCRA are due to stronger reclamation bond requirements, which guarantee that a site will be returned to its natural condition upon completion of a mining operation.

During the last two decades, SMCRA's bonding requirements have improved, though not completely solved, the problem of unreclaimed coal-mining sites and their associated environmental problems. A looming issue is the treatment of acid mine drainage (AMD), which contributes to water-quality problems in many states. A recent study placed a minimum estimate of \$1 billion on long-term mine drainage costs, associated primarily with abandoned mines, in the state of Pennsylvania alone. Due to the passage of time and the lack of bonds for this kind of damage, a large percentage of AMD liability will not be recoverable from responsible mine owners and operators.

Perhaps more problematic are unfunded costs created by the hardrock mining industry. EPA estimates that it will cost approximately \$20 billion to clean up mine sites currently on the Superfund National Priorities List. Recent studies identified dozens of large-scale, but bankrupt, western hardrock mines that pose ongoing environmental and financial problems. The poster child is Colorado's Summitville mine, abandoned in 1993, which by itself has an estimated cleanup cost of \$150–180 million. Another candidate for infamy is Montana's Zortman-Landusky mine. One of the first mines to use cyanide for gold extraction, the mine's owners declared bankruptcy in 1998, leaving behind as much as \$100 million in unrecovered environmental costs.

Against this backdrop, former Interior Secretary Bruce Babbitt championed a set of new rules to minimize hardrock mining damage on lands administered by the BLM. The rules have had a tortured history. A set of updated hardrock mining requirements was originally proposed by BLM in 1991. A full six years later, BLM issued the "first" final rules. The rules expanded the universe of operators required to post bonds, raised overall bond levels, required operations to pass a water-quality compliance test, and mandated third-party reclamation cost audits. Based on a challenge from the mining industry, these rules were over-

turned in U.S. district court in 1998 for failure to comply with the Regulatory Flexibility Act (RFA). Under the RFA, agencies must consider the effect of new rules on small businesses. BLM was found to have conducted an inadequate analysis of small-firm effects and to have understated the rules' likely impact on such firms.

In response, another set of rules was proposed in 1999. These rules were finalized, but not implemented, at the end of Clinton's term. They featured higher bonding requirements and stronger performance standards for mine activities, reclamation, and treatment. The mining industry again challenged the rules on procedural grounds, claiming violations of the RFA, Administrative Procedures Act, and the National Environmental Policy Act because BLM did not appropriately consider the impact on small business. The mining industry sought an injunction to block the rules, which failed, and the rules were finalized in January this year. With the change in administration, and after some delay, BLM has announced its intention to retain the financial responsibility provisions of the Clinton rule. Other parts of the rule remain open for comment at this time.

The new financial responsibility rules will raise bond levels; apply bonds to previously exempted, small operations; and promote the use of more financially sound assurance mechanisms. Large, existing mines will feel much of the rules' impact due to increased mine reclamation and assurance costs. But opposition from small mining firms has been the loudest.

Holding 'Small' Business Responsible

The most common tactic on the part of financial responsibility's opponents is to claim that the rules will significantly harm small business. It may seem churlish to admonish opponents of stronger bonding rules, given that stronger rules are about to be implemented. But opposition to financial responsibility is common whenever financial assurance rules are proposed, implemented, or strengthened. It is also misplaced. Will the new mining regulations affect small business? Yes. Should they? Absolutely. The government can and should reduce the barriers to family-owned enterprises and other small businesses, as long as those businesses do not pose the threat of generating multimillion-dollar damages to the environment. While it sounds almost un-American to proclaim the need for stronger small-business regulation, our environmental history speaks for itself: many small firms create environmental risks out of proportion to their size and leave the public holding the messy bag.

Protection of small-scale enterprises is one thing. Letting small business externalize pollution costs is another.

The history of financial assurance regulation also speaks for itself: assurance does not bankrupt whole industries and it does not mean the end of small business. Opponents of stronger bonding rules claim the rules "threaten a crippling blow" to the mining industry and the communities dependent on it. This mantra has been heard many times before, whenever assurance rules are proposed and implemented. But in all of the industries so far subject to financial assurance regulations, the crippling blow has never materialized.

Private financial markets develop to provide the insurance, bonds, and other financial instruments necessary to demonstrate assurance, and they provide them at reasonable cost. Ten years ago, underground storage tank assurance rules were supposedly going to bankrupt the retail gas industry. Today, you can insure such a tank for \$400 a year—less than it costs to insure a car. Assurance for oil tankers and vessels carrying hazardous substances was supposedly going to result in mass bankruptcy and the withdrawal of maritime insurance coverage for vessels in U.S. waters. Today, dozens of firms compete to provide tanker financial assurance at rates that continue to fall.

Assurance Rules as a Compliance Tool

RFF researchers are exploring the ways in which assurance rules fulfill, or fail to fulfill, their promise. Assurance programs raise a set of design issues, including the level of assurance to be required, the financial mechanisms to be allowed, the conditions under which bonds are released, and the interaction of assurance rules with other areas of law—most importantly, bankruptcy law. As currently implemented under a variety of programs, assurance rules are not perfect. The typical problem with assurance is not that it goes too far, but rather, that it doesn't go far enough. For example, most programs allow wealthy firms to "self-demonstrate" assurance via a variety of book-keeping measures, such as asset demonstrations and good bond ratings. These measures make some sense, but in practice often undermine the goals of assurance. The problem is that accounting measures are difficult for regulators to verify and monitor closely over time. Also, good-looking accounting numbers can deteriorate quickly, leaving a once-healthy firm insolvent and unable to come up with other forms of assurance. There is an almost constant pressure on regulators to relax the criteria by which firms can pass these financial tests. After all, if they pass

the test, assurance is free. That pressure should be resisted.

Perhaps the strongest motivation for assurance requirements arises from contemplation of the alternatives. Since environmental costs never simply vanish on their own, someone must pay. The question is, who? Having the public pay is highly undesirable since it implies that the polluter has escaped its own costs. Another alternative, one that should strike fear in the hearts of the business community, is that obligations not internalized by polluters can be imposed on their business partners. In some contexts, the law currently extends liability to the business partners of insolvent or absent defendants. This relieves the public burden and promotes compensation, but is inefficient and highly disruptive. First, the extension of liability does not guarantee cost internalization, since there may be no applicable business partners from whom to seek compensation, or if there are, they may themselves be insolvent. Second, extended liability implies significant transaction costs associated with the division of responsibility among jointly liable defendants. Third, the threat

of extended liability can distort business relationships by raising the fear of unwittingly catching an insolvent business partner's liability. Viewed against this alternative, assurance is by far the most transparent, low-cost way to guarantee cost internalization.

In concrete terms, financial responsibility ensures that the expected costs of environmental risks appear on a firm's balance sheets and in its business calculations. Third-party assurance providers are obviously concerned that their capital will be consumed by clients' future liabilities. As a result, firms and their underwriters have a strong incentive to monitor environmental safety and fulfill their restoration obligations. In practice, assurance rules improve cost recovery and are a relatively low-cost means to improve regulatory compliance. History shows that they are both needed and, when applied, not commercially disruptive. The new, improved federal hardrock mining requirements should be welcomed with open arms.

James Boyd is a senior fellow in RFF's Energy and Natural Resources Division.



INTERVIEW

The Value of Patience and Pragmatism

Victoria J. Tschinkel is senior consultant at Landers and Parsons, P.A., in Tallahassee, FL. She has worked on environmental and resource management issues for several decades in both the public sector and private industry. Elected to the RFF Board in 1993, she recently spoke with Jonathan J. Halperin, RFF's director of communications planning and strategy.

RFF: Tell me what about the RFF research process makes it a model, from your perspective.

Tschinkel: RFF researchers do not try to second-guess a lot of scientific and biological and physical issues. They find and understand the range of opinions on an issue. Then, given that information, they ask what is the best way to go about solving this problem? They don't take one-sided positions, castigating all industry as bad or all environmentalists as misguided. The RFF approach is to say okay, we have a real problem. What's a sensible way that's going to produce the best results?

RFF: Let me ask you to look into your crystal ball regarding the kinds of environmental problems where that model would be well applied. Let's look out 20 years. What do you think the environmental and natural resource problems will be? How should we begin to think about them now?

Tschinkel: In the old days, we talked about water pollution and air pollution as distinct problems that represented trade-offs to some degree. Looking ahead, the interdependence of economics, energy, and environment—the truly complex multiple-equation issues—are going to be the principal characteristics of the problems that we share. Therefore, the research and modeling efforts that need to be done

should focus on how we maximize the beneficial aspects of energy, the environment, economic development, and land use.

RFF: Our perspective on the relationship between regulated industry, government agencies, and public stakeholders has evolved a great deal in recent years. So have



our policy tools. How do you think these shifts will influence how we solve environmental problems 20 years from now?

Tschinkel: The solutions will have to be even more complicated than the science, by definition. Two issues particularly stand out in my opinion. The first one is land use and

our view as Americans of having infinite land resources. From a sociological standpoint, that's already been challenged and it's beginning to be challenged in the resource area. More and more people see biodiversity as a global issue. Land use and the understanding of how we reinvent respect for land and see it as a limited resource shared by all of us will be the next big breakthrough.

The second big challenge will be in the area of energy. Clearly, understanding the balance between extraction, conservation, and next-generation technologies is something that every American is going to need to grasp. We all like turning on one switch and getting everything right away, but from here on out, we're going to have to make much more complex choices. The difficulties in California offer a window of opportunity for the entire country to look around and see how we're headed, which is very single-mindedly, in my view.

RFF: As the former secretary of the Florida Department of Environmental Regulation, you were actively involved in policy issues surrounding the Everglades. Can you talk about the lessons to be learned from the decades-long process of protecting this important natural resource?

Tschinkel: The first lesson we learned is to try not to make irreversible decisions about natural resources. Wherever possible, it is important to try to understand all the dif-



ferent features of a given natural resource as well as all the different groups seeking to gain what they perceive as ownership over the natural resource. Maintaining a balance so that the ecological integrity of the resource is sustained, the public has access, and agriculture can continue can be an enormous challenge. Unfortunately, we're facing many circumstances where we don't know what impacts those decisions are going to have—this is why I feel very strongly that the less we do to natural systems the better off we are.

The second lesson is to try to learn to live with nature rather than pretending that we can alter it to our benefit. That doesn't mean that we can't continually harvest certain resources where appropriate. The third lesson I've learned is that without proper science as a backbone, the decisionmaking process will be in chaos. We had virtually no hard science on the damage to the Everglades that we could rely on for the restoration project when we first started out, which made it extremely difficult to get started. In Florida, which has always been a wet/dry cycle state, having one year's worth of data or even 10 years' worth of data is completely meaningless.

RFF: Look back at the multitude of projects that you've been involved with and reflect on the permitting process. In general, are there ways to improve the permitting process so that it advances the public agenda and enables businesses to effectively compete?

Tschinkel: It would be desirable for agencies to set limits and goals, but keep an open mind on technology and the means of accomplishing those goals. The degree to which we can allow industry to reach for new technologies and quickly implement

them is going to allow better things to be done faster. I think a lot of agencies pay lip service to that, but they get uncomfortable sticking their necks out for anything new. Another way to expedite the permitting process is for regulated industry to reach out to its neighbors early in the project planning process. People need to meet and start talking about large projects before plans are finalized and the neighborhood has decided that it hates the idea. Most companies that I consult with try to do this. It's hard for some companies to understand that even if they do reach out, there are always going to be outliers in the neighborhood who are not happy with them. But that's to be expected. I think that many friends can be gained and many good ideas can be incorporated if a company is open to establishing a dialogue.

RFF: You've seen the first few months of the new Bush administration. If you were asked for advice, would you offer any and what would you say?

Tschinkel: The first thing I would say is that it is important to listen to people. Because people have not been supporters of yours or perhaps don't share your political views doesn't mean that they don't have good ideas. In fact, I think most Americans share a fairly fervent and practical approach toward environmental issues.

Early decisions almost always turn out to be a mistake, in my opinion. Decisions should be made carefully and slowly and new people should always feel their way. I think whether ideas come from industry or the environmental groups, they should always be taken from the highest common denominator.

To some degree, the new administration has decided what it thinks the energy industry wants or needs and it has put those

positions in play without consulting with industry leaders about what they think would make the system work better.

RFF: With this being half prediction and half advice, what would you like to see RFF, which is now approaching its 50th anniversary, doing in the next 50 years?

Tschinkel: RFF should continue to be the source for unbiased new ideas on looking at the economic ramifications of environmental issues. However, I think RFF needs to play a much stronger role in helping the public to understand the issues and the choices. The organization also needs to play a more important role helping the states, where a lot of these decisions are now being made, to develop exciting new programs for managing their land and other natural resources. In addition, as I said before, we're going to need some new and rather complicated analytic tools for these multivariate problems. There are some great opportunities for young researchers to get involved with making better decisions in such a complex technical environment.

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INSIDE RFF

2001 Award Winners

Gilbert F. White Fellowships

Vic Adamowicz and **Jean-Thomas Bernard** are the winners of RFF's 2001 Gilbert White Postdoctoral Fellowships. Awarded annually since 1980 in honor of the retired chairman of the RFF Board, the fellowships support postdoctoral research in the social or policy sciences in areas related to natural resources, energy, or the environment. Adamowicz, an economics professor in the Department of Rural Economy and the Sustainable Forest Management Network at the University of Alberta, will work on valuing human health in the aftermath of forest fires, and on methodological approaches to valuing children's health. Bernard, a professor in the

economics department at the University of Laval will study electric power exchanges between regional transmission organizations, including those between Canada and the United States.

Walter O. Spofford Jr. Memorial Internship

Shawei Chen, a first-year graduate student in public policy and administration at the University of Massachusetts, Amherst, will focus on climate change issues, ozone depletion, and fisheries/ocean management. This award is given in honor of the late RFF researcher who helped launch RFF's China Program and to continue the work he started.

Joseph L. Fisher Dissertation Awards

In honor of the late president of RFF, the

following students will receive support during their final year of study: **Douglas Noonan**, the Harris School of Public Policy Studies at the University of Chicago, for a dissertation based on three essays of applications of public finance to the environment and natural resources; **Sumeet Gulati**, the Agricultural and Resource Economics program at the University of Maryland, for work on a model of trade and the environment; **Dennis Becker**, College of Natural Resources at the University of Idaho, for work on community involvement in environmental policymaking; **Halla Qaddumi**, School of Forestry and Environmental Studies, Yale, for work on water management in India; and **Matt Neidell**, Department of Economics, UCLA, for a dissertation on air pollution and children's health.



Each year, RFF invites a number of students to spend the summer as research assistants. Interns can work with RFF researchers on a variety of ongoing projects or assist in the development of entirely new areas of research and policy analysis. Pictured here are this year's interns posing with Vice President for Programs Ray Kopp and Division Director Alan Krupnick. Front row (l-r): Derek Gurney, Yutaka Yoshino, Chris Farley, and Justin Mosley. Second row: Shawei Chen, Marta Montoro, Amy Marino, Eszter Tompos, and Alejandra Palma.



DEVELOPMENT

NAFTA's Influence on Environmental Quality at the U.S.-Mexico Border Evaluated at RFF Council Meeting

As the demonstrations in Seattle, Washington, DC, and, most recently, Quebec have shown, multilateral trade agreements have become a political flashpoint in the 21st century. Public opinion is strong on all sides of the debate over the effect of international trade on the environment, and the economies of developing countries. Given the importance of these issues in the policy arena and the complexity of such agreements, social scientists have a key role to play in shaping strategies to guide future trade policies, according to members of the RFF Council at the group's spring meeting April 19–20 in San Antonio, Texas.

Members of the Council met with researchers, government officials, environmental advocates, and business leaders to discuss the relationship between environmental quality and the creation of multilateral agreements. RFF put together several panels to address these issues, including the impact of the North American Free Trade Agreement (NAFTA) on environmental quality and economic development as well as the interdependence of environmental, political, and business concerns in the forging of multilateral agreements.

RFF Fellows Allen Blackman and Carl Bauer set the stage for the first session by outlining their research on air quality and water management in the U.S.-Mexican border region. Discussions centered on the magnitude of the impact that informal Mexican firms have on the environment, and how trading partners could promote investment in clean technologies as one step toward promoting sustainable growth. Bauer discussed the last decade of water law and policy reforms in Mexico in the context of wider international debates about

integrated water resource management.

The twinned issues of environmental quality and economic development along the U.S.-Mexican border served as a starting point to take a closer look at NAFTA in the second session. Gary Hufbauer from the Institute of International Economics framed the discussion by providing a historical perspective on NAFTA, emphasizing that the environmental problems of the border region were not the result of the treaty. In his view, the treaty's environmental dimension could be enhanced to improve living conditions at the U.S.-Mexican border, where economic growth has been greatest.

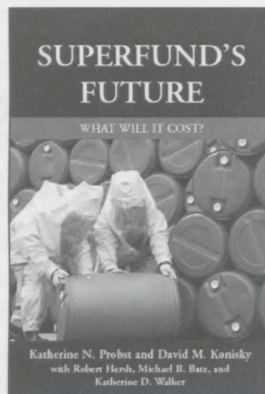
Peter Emerson, senior economist at Environmental Defense, argued that, to achieve the goal of improved living conditions in the border region, public participation would be essential. He called formation of community-level environmental management districts an important step so that local businesses, citizens, government, and advocates could work together to push for cleaner technologies and stricter environmental compliance. Javier Mancera, director of trade and NAFTA in the Embassy of Mexico, acknowledged Emerson's point on community involvement, but said that it was equally important for the United States to make direct investments in small business within Mexico to help formalize many of its industry sectors and in education to further improve living conditions.

The final session of the meeting had a broader focus on cross-border and multilateral agreements. David Victor of the Council on Foreign Relations and David Van Hoogstraten, from the U.S. Department of State, outlined issues related to

trade liberalization and environmental protection. Victor was quick to point out that future trade pacts do not subvert domestic environmental regulation, and highlighted the dangerous precedent that may be set if the United States is successful in defeating the European Union's current ban on genetically modified organisms. Jake Caldwell from the National Wildlife Federation outlined several ways to achieve improved environmental quality through trade, including one of the most basic—ensuring transparency and accountability within agreements.

John Manzoni, BP Amoco's new regional president, provided council members with one major company's perspective on international differences in environmental and energy regulation and their impacts on trade and diplomacy. BP Amoco's new corporate environmental policy is to ensure that environmental performance worldwide meets U.S. standards, even at facilities in developing countries. When asked by Council members what prompted the policy change, he replied, "shareholder value." Manzoni explained that, as shareholders become increasingly concerned with the environment, BP Amoco must take steps to reduce its environmental impact. Manzoni elaborated by describing BP Amoco's innovative approach to voluntarily reducing its global carbon emissions through trading between business units. He said the price per ton of carbon within the trading program has stabilized and the program has been successful in pushing business units to develop cleaner technologies. The goal is to secure the company's place in the future through a sustainable approach that meets the needs of customers and the environment, Manzoni said.

The RFF Council will gather again on October 10 for its next meeting. ■



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