



# RESOURCES

RESOURCES FOR THE FUTURE

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## Theory and Practice

For years, RFF has conducted high-quality research on environmental and natural resource issues and made our results available to decisionmakers across the board—from federal, state, and local policymakers to environmentalists and members of the business and legal communities. We have learned a great deal about turning theoretically attractive concepts into practical tools.

As this *Resources* shows, our scholars continue to extend the frontier of knowledge about economic aspects of environmental issues and to apply this essential know-how to pressing problems in the real world. For example, given that new technologies have often helped us find alternatives for scarce resources, David Austin explains how economists can use patents as indicators of innovation in market economies. He also considers how investment in research, as measured by patents, can be optimized to create value and efficiency in resource use.

Robert Stavins, an RFF university fellow from the John F. Kennedy School of Government at Harvard University, delves into the problem of how transaction costs—the costs of buying and selling—can affect the success of emission-permit trading programs. These programs, which were welcomed as a market-based means of reducing polluting emissions, have not been as successful as economists predicted, and transaction costs may be one reason for this.

Vito Stagliano, an RFF visiting scholar, served in the Department of Energy and helped develop Bush's "National Energy Strategy." He traces the history of national concern about energy security and argues that energy security has been overempha-

sized as a problem. OPEC is far from being a serious threat to U.S. energy security, he says, even though energy policy continues to be haunted by OPEC's ghost.

Walter Spofford's article on RFF's work on environment and development issues in the People's Republic of China is less about pure research than about how RFF's research storehouse is being put to practical use. He reviews RFF's collaboration with Chinese universities and municipalities, beginning with a project to translate fifteen RFF books into Chinese through RFF's efforts to train Chinese economists to carry on this important work.

"Inside RFF" is packed with examples of our research being put into the hands of decisionmakers. For example, Congress invited three of our researchers to testify on issues related to benefit-cost analysis and Superfund. In addition, RFF is publishing two books on Superfund this year, one of which was the subject of a book briefing.

We are especially pleased that Ma Zhong, an eminent Chinese scholar, completed his third working visit to RFF, and that two notable practitioners—Dick Morgenstern, former director of EPA's Office of Policy Analysis, and George Eads, former vice president and chief economist at General Motors—have arrived for long-term residences at RFF.

Such activities are a crucial part of RFF's mission. We are grateful to the generous support of our contributors, who make our research possible both in theory and in practice.

Robert W. Fri, President

## The Power of Patents

David Austin

In a world of finite resources, what would become of humankind if everything were someday depleted? Such a stark scenario is softened by human ingenuity and its resulting technological change, which over the ages have consistently shifted our focus from expensive, limited resources to cheaper, more plentiful ones and, in the process, have transformed seemingly free resources into valuable ones. We have turned sand into silicon chips, harnessed the energy in sunlight, and mined our very bodies for valuable protein-based drugs. Most resources will never actually be depleted: as their supplies dwindle, prices will rise and trigger a search for replacements. This process is as sustainable as our ingenuity.

Our ingenuity also has its downside: clean air and water, for example, are among the once-free resources that we have transformed into valuable ones by making them scarce. Still, by creating value and efficiencies in resource use, technological change is our best engine of growth. Since technological change comes at a cost, there is at all times some optimal level of investment in it. To invest more, or less, than this amount is to use our resources at less than full efficiency. This article is about how we find that optimal level and how, in an economy where investment decisions are decentralized, we attempt to induce that level of investment.

Patents figure heavily in both of these considerations. To firms, patents give monopoly rights to their intellectual property; as a reward for innovating, patents therefore provide incentives to perform research and development (R&D). To economists, patents not only correct imperfections in markets for research, but they are also a rich source of data: there is an abundance of them (more than 5.3 million U.S. patents have

been issued since 1790), the data are easily collected, and they contain technically precise categorical information about each innovation. Patents are perhaps the most widely used indicator of the innovative output of a market economy.

Patents are more than a reward or a source of data, however. They have real effects on firms, their rivals, and consumers. The primary purpose of my research on patents has been to estimate these effects. My work has been motivated by having observed the extremely intense competition for patents in certain fields (with large consequences for the winners and losers). What is a patent worth? How *lasting* are its effects on rival firms? My secondary purpose has been to use these estimates as a way to improve the performance of patents as an indicator of research output. Useful as they are, patents have several shortcomings in that role, which I will discuss below.

### Why patents are valuable

A monopoly is the most profitable of all possible market structures. Since patents create monopoly power for inventors, patents can be a powerful inducement to innovate. (Where an invention is one of several similar products on the market, however, the inventor's monopoly power might be quite limited.) Where a patent would lead to large profits, it can attract entrants to the field, raising the chances of inefficiencies from multiple firms, performing duplicate research. Where patents are weak, firms may rely instead on trade secrecy, and the social benefit of the information disclosed in a patent is lost. Although monopolies themselves come at a social cost—they raise prices and lower output relative to any other market structure—there tend to be positive net

social benefits, in both the short and the long run, from innovation.

Biotechnology research, a high-stakes gamble among hundreds of very young firms, is where these ideas are illustrated most forcefully. Building on the initial discovery of recombinant DNA techniques in the 1970s, firms suddenly could genetically engineer any of dozens of drugs that until then could only be distilled painstakingly and in small quantities from

*Since the 1970s, biotechnology research has become a high-stakes gamble among hundreds of young firms, each racing to discover and patent a protein's genetic sequence or the means of producing it.*

natural sources. At times, eight firms and more have raced to discover and patent a protein's genetic sequence, to perfect a process for synthesizing the protein, or sometimes—with luck—to do both. Often, however, product and process patents have been issued to separate firms, and this has necessitated many expensive, time-consuming lawsuits to sort out who owns the rights to the market.

Perhaps the most revealing example of the stakes involved was the race to develop synthetic erythropoietin (EPO), a kidney hormone, the absence of which causes anemia. EPO-replacement therapy eliminates the need for blood transfusions in dialysis patients, whose failed kidneys no longer manufacture EPO. Since the patients then must dose three times per week while awaiting a kidney transplant, the EPO market was extremely attractive to potential suppliers. In this race, however, there was no immediate lucky winner: in October 1987 a biotechnology firm named Amgen got the patent on the genetic sequence coding for EPO. The trouble was that a rival firm, Genetics

Institute (G.I.), had won a patent on the EPO molecule itself three months earlier—to Amgen's complete shock, because G.I. had filed its application a year after Amgen filed its own.

Because the scope of these two patents seemed to overlap, each firm sued the other for patent infringement. The litigation played out over four years before the case was settled in Amgen's favor: the firm currently has a complete monopoly over synthetic EPO in the United States. Largely as a result of this monopoly, Amgen's corporate worth has increased more than tenfold in recent years, to the point where it is now the world's largest biotechnology company. Meanwhile, G.I. was forced to stop manufacturing EPO and has since had to seek an outside buyer.

Although Amgen's patent ultimately forced G.I. out of the EPO market, without the prospect of one firm's winning an exclusive patent, it is possible that neither firm would have pursued its EPO research at all. Without exclusive rights, not only would the rivals have had to share the market, but by competing they would have undercut the monopoly

profit outcome—leaving each with half of a smaller pie. In a world without patents, the two firms also would have been vulnerable to market entry by any other firm. If the absence of a patent system would have made expected returns from EPO investment appear negative, the two firms might not even have begun the research, and there would be no EPO treatment for dialysis patients.

Thus, in a market economy—where most R&D investment takes place in the private sector—patents are necessary to allow firms to protect their investments in R&D. While firms pursue patents for profit, governments award patents because of the so-called *public goods problem*: once new knowledge such as an invention has been produced, it often can be duplicated at low cost and disseminated without financial benefit to the innovating firm. Without a patent system, firms would have to rely strictly on secrecy. This would slow the pace of technological change, since patents not only encourage R&D, but also codify and disseminate new knowledge in a way meant to help future innovators improve on the inventions. In the extreme, if secrecy were inef-

fective at allowing firms to appropriate at least some of the benefits created by their inventions, firms would have no incentive to innovate, since they would recover none of their investment.

### Using patents to monitor R&D investment output

The importance of technological change to growth is widely acknowledged, but it is a challenge to know *how much* private (and public) R&D investment there should be. Among all possible R&D projects, the law of diminishing returns dictates that beyond a point, each additional dollar of investment in R&D will yield less than a dollar in total benefits. Firms will not choose to invest to this point unless they can appropriate *all* of the benefits from their investments—a practical impossibility, since firms would have to be able to charge individual consumers their maximum willingness to pay for the firms' products. Patents cannot fully overcome the appropriability problem, but they can raise investment levels closer to the optimum than they would otherwise be.

A patent system that is too weak will not stimulate enough research; one that is too powerful could induce too much—by attracting too many firms into research—or too little—by giving an original patentee overly broad rights to control future inventions. In theory, the system could be tailored by varying the value of a patent up or down whenever private R&D investment is too low or too high.

As a means of encouraging optimal levels of R&D, though, the patent system is a very blunt instrument. A patent's value for a given invention is a function of its length (the number of years it is in force), its breadth (the span of its claims allowed by the patent examiner), and a firm's reputation and resources for enforcing the patent. In practice, these adjustments to patent value either are not practical or not yet well-enough understood to use patents to fine-tune R&D investment levels. The statutory length of a U.S. patent—seventeen years—has been

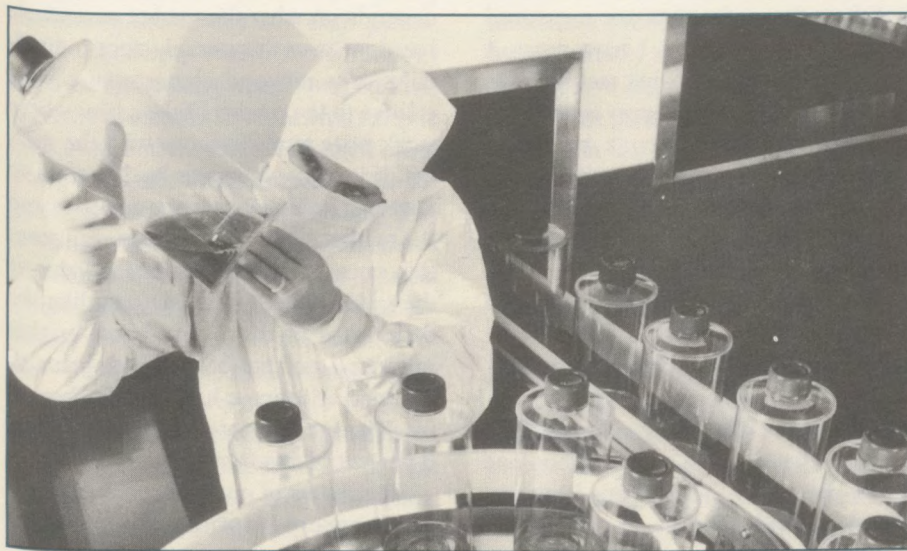


Photo courtesy of Amgen

Building on the discovery of recombinant DNA techniques in the 1970s, biotechnology firms became able to genetically engineer dozens of drugs that until then could only be distilled painstakingly and in small quantities from natural sources. The ability to obtain a patent—exclusive use of certain knowledge—means that companies can make money on the results of their research, thus encouraging them to invest in R&D. The patented results of research then become widely available, providing benefits to society as a whole.

essentially unchanged since 1790. The more useful policy instrument is patent breadth, which affects a firm's ability to control its current inventions and any future ones they inspire. Patent breadth can be varied on an individual basis, and economic research has begun to show how a patent's breadth relates to its value.

For economists to estimate the optimal level of R&D, they would need better measures of R&D productivity than are currently available. Patents are a promising source of data for this exercise, but they have several limitations. One, which I suggested earlier, is that not everybody patents their inventions. Trade secrecy tends to be preferred to patents, especially in fields where inventions become obsolete quickly and do not need the lengthy protection of a patent. My research is aimed at another problem—that not all patents are equally valuable. To calculate productivity, economists need to know the value of *outputs*: a simple count of issued patents would not estimate accurately even the total output of *patented* innovations. A simple count would value minor innovations (a new type of door latch, say) equally with major ones (the DNA sequence for EPO). Economic research has shown that if, instead, patents are weighted by something correlated with their relative values, the resulting weighted sum much better represents the value of patented outputs.

### New patents drive firms' market values

My approach to estimating an individual patent's value is to measure the change in a firm's market value when it receives a patent. This technique, called an *event study*, often has been used to determine the effects of specific, significant events on firms affected by them, such as product recalls, new regulations, or mergers. While other approaches are available, the event study can help estimate the effect of a particular patent on, say, rival firms researching the same drug. In effect, an event study compares changes in

Estimating the value of a patent based on movements in a firm's stock price relative to the market



Note: This chart demonstrates an event study, a technique often used to determine the effects on companies of specific, significant events, such as product recalls, new regulations, or mergers—or the issuance of a new patent. The net change in a firm's stock price before and after an event is adjusted depending on how the market as a whole moved during the same period, since individual stocks move in characteristic ways relative to the general market.

In this example, a firm's value rose 9.5 percent in the first three days after it received a patent. The change in stock price of this particular firm tends to be about twice the corresponding market movement. Since the market rose 2.5 percent over the same three days, the firm's stock price would have been expected to rise 5 percent without the patent grant. Thus, the estimated value of the patent is 4.5 percent of the firm's equity.

firm values with the values that would have been expected had the event not occurred.

Often these changes are measured over just a few days, as I have done. A crucial assumption of this technique is that all relevant information is reflected immediately in the stock prices of affected firms. Assuming no other significant events have occurred around the time a patent is issued, the change in a firm's value from that patent event represents the value *today* of all net income the patent is expected to generate in the future. (Future income is discounted because one dollar "tomorrow" is less valuable than one dollar today.) The market's patent valuation is a forecast, but one that is based on the market's historical experience with patents.

The precise technique by which estimated patent values are teased out of changes in a firm's stock prices is somewhat involved. In essence, the estimate is the difference between the actual change in a firm's value around the time it re-

ceives a patent and the change that would have been expected had there been no patent. This expected change depends on what the market as a whole has done over this period, since individual stocks move in characteristic ways relative to the market. Take a firm whose stock price tends to move with the market. If its value increases by 2 percent in a week in which it receives a patent, and the market average climbs 1 percent over that same period, the estimated value of the patent would be something like the difference of these numbers, in this instance 1 percent of the firm's value. If the market average had instead *dropped* by 1 percent, the patent's value would be 3 percent of this firm's equity.

The results of my study confirm some commonsense notions about patent value, but there have also been some intriguing surprises. With my focus on biotechnology patents, I constructed a sample of more than 550 patents issued to the twenty largest domestic biotechnology firms—and an additional seventy

patents issued to other companies in these firms' research areas. I found that, for a typical patent in this sample, a firm's value increased by 1.2 percent (net of the market change) in the first two days after it received the patent. That is an annual rate of 141 percent; for a firm of median size in this sample, the patent is estimated to be worth \$2.4 million.

I then looked at how a firm's value changed when it received a *key patent*, one that experts have tended to identify as being among the most influential biotechnology patents. Strikingly, for firms holding key patents, the estimated values average an astonishing \$11 million. These high *prospective* valuations appear to have held up nicely into the future, in the sense that patents of above-average estimated value have demonstrated a greater likelihood of being cited by later patents, compared with citation rates for the less valuable patents in my sample. Citations, which are made whenever subsequent patent applications build on what is contained in the cited patent, have been shown elsewhere to correlate with the actual value of an invention.

My research estimated the direct effects that patents have on rival firms as well. By examining the contents of each patent, and by knowing which biotechnology firms are researching which compounds, I was able to identify all of the rival firms in each of seventeen selected research areas. These firms may be in competition for the same patent, but, more importantly, they are after shares of the same market. I found that when a firm received a patent in one of these research areas—this describes about a quarter of the patent sample—the values of its rivals dropped by an average of 0.6 percent (\$1.3 million). Here, too, an influential, key patent has a much larger effect, causing a 2.4 percent (\$5 million) decline for each rival. These numbers represent the direct effect of the patentee's expected market power, although I found, by measuring effects from patent *applications*, that the other firms actually appear to benefit from knowing that the prospective patentee has been successful in its line of research

(which through scientific exchanges is evidently somewhat familiar to all of them).

The remaining question is to what extent biotechnology patents enable firms to control their particular markets. Within the research areas I have studied, I find some limited support for the notion that a key patent depresses the future research output of rival firms. Interestingly, only in

*Only once did a firm's winning of a valuable biotechnology patent appear to force out all rival firms. Usually, rivals carried on their research, but at a less intense level.*

the case of EPO did a patent appear to have forced out *all* rival firms. In most cases, where one firm wins a valuable patent, its rivals have appeared to carry on with their research, but at a less intense level. These firms all have research going on in multiple areas, so they may decide to shift their resources to areas of more immediate promise. On the other hand, by not actually exiting the market where another firm has received a strong patent, these firms perhaps are maintaining their research in that area, in hopes they eventually will be able to develop a patentable, second-generation product.

### Looking ahead

Increasingly, government investments of all kinds are coming under scrutiny by a Congress intent on lowering the federal budget deficit. Among the most prominent of spending programs currently in the sights of Congress are two that involve government coinvestments with private firms performing advanced-technology research. These programs are derided by their critics as subsidies for private industry: the National Institute of Standards and Technology's Advanced Technology

Program (ATP) and the U.S. Department of Defense's Technology Reinvestment Project (TRP). In both programs, funded firms are not required to repay those public investments even should they ultimately bear fruit. The purpose of the programs, however, is to create large public benefits (such as an enhanced standard of living and increased U.S. competitiveness) by funding ventures considered too speculative for private venture capital markets to be willing to bear the risk.

Supporters of federal investments in private R&D, including the Clinton administration, will have to rebut the critics by demonstrating positive net payoffs from federal investments in ATP and TRP. To date, the administration has no hard evidence to support this contention; the patent methodology I have presented here can be used to value some of the benefits from these programs. Valuing the patents that have resulted from public investments in private R&D will count only a fraction of the total benefits that may result from these programs. Still, if the values of the patents alone are greater than the public investments that brought them about, this would provide compelling evidence for continuing such programs. (If the patents appear less valuable, program supporters would need additional evidence.) If repayment is politically necessary, the estimated values of the resulting patents could be used as a basis for determining the appropriate share of any privately realized profits to be returned to the public coffers by program beneficiaries.

A patent system's primary benefits—overcoming the public goods problem and stimulating technological change—clearly are not limited to these virtues. Patents are invaluable as technology indicators, public disseminators of new knowledge, and building blocks for future inventions as well.

*David Austin is a fellow in RFF's Quality of the Environment Division. The research and issues discussed in this article are detailed in RFF discussion paper 94-36, "Estimating Patent Value and Rivalry Effects: An Event Study of Biotechnology Patents."*

## The Ghost of OPEC in Energy Security Policy

Vito A. Stagliano

In a ritual dating from the energy crisis era, the White House will soon transmit to Congress a national energy-policy plan—the seventh since 1977. Previous energy-policy plans have run the gamut from the highly prescriptive “National Energy Plan” drafted by the Carter administration to the laissez-faire “Energy Security Report” issued by President Reagan at the end of his second term in office. The most recent plan, the Bush administration’s “National Energy Strategy,” straddled the energy-policy ground with a professed adherence to both free markets and federal intervention to reduce the country’s perceived overreliance on Middle Eastern oil. While energy-policy plans have varied in the extent to which they called for manipulation of the energy sector by the federal government, they all have reflected a costly preoccupation with energy security or, more precisely, with reducing U.S. oil imports. Will the Clinton administration’s plan break new ground?

In December 1993, Hazel O’Leary, secretary of the U.S. Department of Energy (DOE) provided a clue. In launching what she called the “Domestic Natural Gas and Oil Initiative,” O’Leary declared that the administration’s energy goal was to “develop new and expanded opportunities for jobs in the domestic gas and oil industries, while fostering a climate which will increase production from domestic resource bases and reduce our reliance on foreign oil.” The emphasis given energy security here is clearly a throwback to energy policymaking of the 1970s.

Energy security—or fear of reliance on imported oil—entered the lexicon of American public policy in the wake of the Arab oil embargo of 1973. Rooted in the conflict of the Middle East and linked to

the vast petroleum supplies of the Persian Gulf, security considerations have dominated U.S. energy-policy thinking for two decades. The security dimensions of energy policy have profoundly complicated the otherwise legalistic, technological, and economic debate about the transformation, transportation, trade, and use of energy. In short, security considerations have saddled energy policy with highly unstable political baggage.

In the elusive and costly search for energy security, federal and state governments have for two decades experimented with a wide array of regulations, programs, taxes and subsidies, and research and development initiatives in an attempt to reverse what is essentially a geologic and political reality: the oil wealth and weak governments of the Persian Gulf.

*Considerations about energy security have saddled U.S. energy policy with highly unstable political baggage.*

The failure of these efforts points to two conclusions. First, the United States cannot, now or in the foreseeable future, meet its petroleum requirements without importing oil from the Persian Gulf. Second, energy policy in and of itself is unlikely to alter substantially the nation’s insecurity about this fact of life.

The review of U.S. energy security policy presented here reveals that the evolution of that policy owes much to successive administrations’ rhetoric of wounded national pride in the wake of the 1973 oil embargo by a few Arab members of the

Organization of Petroleum Exporting Countries (OPEC). As the review further shows, the ensuing energy crisis—largely self-inflicted—led to an obsession with U.S. dependence on *all* imported oil, from secure and insecure sources alike. This obsession has resulted in large federal investments that have not measurably enhanced the nation’s energy security. Despite the high cost of these investments, fear of OPEC’s potential power to curb oil supplies and to significantly raise oil prices haunts U.S. energy policy. In short, OPEC’s influence, which is actually minimal in present-day oil markets, continues to distort this policy. For this reason, the Clinton administration should contemplate two proposals that might exorcise the ghost of OPEC from U.S. energy security considerations.

### Energy security in the 1970s

Security concerns about petroleum can be traced to the U.S. Navy’s decision in 1904 to convert its ships from coal power to fuel oil. But these concerns did not rise to national prominence until 1973, when a few Arab members of OPEC embargoed oil exports to the United States. President Nixon responded to the embargo by imposing energy price controls and ordering large federal investments to produce domestic substitutes for imported oil. He even advocated the use of nuclear weapons to stimulate natural gas yields from tight-sands formations. By characterizing the oil embargo as a “blow to American pride and prosperity” and “a turning point in our history,” Nixon made energy policy a pivotal issue in the success or failure of his and future administrations. He presided over the most significant expansion of the federal energy bureaucracy since the New Deal and set the pattern for obsessive energy policymaking.

In 1975, President Ford declared that “Americans are no longer in full control of their own national destiny, when that destiny depends on uncertain foreign fuel at high prices fixed by others.” He

proposed a sweeping federal investment program to produce energy from domestic coal and uranium; to build pipelines, power plants, railroads, and ports; and to suspend environmental regulations that might impinge upon these efforts.

President Carter devoted the better part of his term in office to the energy crisis created by the 1979 revolution in Iran. He alternately cajoled and hectored Americans to enter "the battlefield of energy to win for our Nation a new confidence, and to seize control again of our common destiny." Surprisingly, his battle plan comprised a Republican-spirited energy-price deregulation policy. But it also included extensive government control of energy end-use sectors, prohibitions on the use of natural gas and oil in electricity generation, preprinting of gasoline rationing coupons in expectation of the next oil crisis, and creation of the ill-fated \$75 billion Synthetic Fuels Corporation.

Carter characterized his quest for energy security as the "moral equivalent of war," thereby creating the image of an epochal struggle for national survival. As late as 1982, former Secretary of State Henry Kissinger was moved to write, "Since the first price explosion of 1973, we have learned that the energy crisis is not a mere problem of transitional adjustment; it is a grave challenge to the political and economic structure of the free world."

### The facts behind the energy crises of the 1970s

It seems improbable, in retrospect, that political leaders should link the fate of the nation to hydrocarbons and electrons and that a topic as technical and utilitarian as energy should inflame human passions. Energy is, after all, neither created nor destroyed, but transformed by mechanical processes invented and managed entirely by humans. For most of human history, access to energy supplies has been easy to gain, and any constraints resulting from unexpected growth in

energy demand generally have been overcome with new and better technology.

The "security" of energy has never been a problem, even allowing for the overwrought social environment in which the term "energy security" was first popularized. When Arab OPEC members embargoed oil exports in 1973, the United States had plenty of coal, natural gas, uranium, hydropower, and geothermal resources, as well as oil. In retrospect, the energy crisis was fundamentally a crisis of policy—specifically, federal oil policy—rather than a national, systemic failure. And yet the embargo precipitated a crisis of national confidence on a par with that of the Great Depression.

*By the early 1980s, the energy crisis was perceived to be a socioeconomic conflict involving a global scramble for strategic advantage.*

This reaction seems surprising, given that the embargo was neither a plan to capture the international oil market nor an effort to harm American interests; it was not even a strategy to maximize profits. Arab governments conceived the act almost entirely as a means of influencing U.S. foreign policy in the Middle East. It was their response to U.S. rearmament of Israel during the Yom Kippur war with Egypt. The embargo was, in fact, a diplomatic rather than an economic act. Oil, coincidental to the purpose, was used as an instrument of foreign policy because the Arab governments involved had no other credible means of expressing displeasure at U.S. Middle-Eastern policy.

The U.S. government viewed the embargo as the perhaps inevitable price of ensuring the survival of the state of Israel. What ensued was not, as might reasonably have been expected, a U.S. engagement to address Arab grievances by means of foreign and security policy. Rather, a

diplomatic confrontation was transformed initially into a national obsession with U.S. dependence on *all* imported oil, and subsequently into a tool for social engineering. The temporary oil embargo of 1973 and the more prolonged oil-supply disruption of 1979 inexplicably provoked a moral crisis over the foundation of Americans' use of resources. Energy itself became the enemy, the degree of its use a measure of civic virtue or vice. The oil-supply disruptions also gave credence to the then-popular theory of limits—limits on the sustainability of natural resources, on economic development and growth, on the creation of economic wealth, and, significantly, on human ability to manage human affairs.

### Too high a price

In the name of energy security, the much-abused federal budget was made to absorb subsidies for otherwise uneconomic domestic oil wells, investments in uncompetitive coal liquefaction and gasification, financial support for the shale oil industry, and perennial subsidies for the ethanol industry. In addition, Congress extended tax subsidies to producers of high-cost unconventional gas, even as overproducing conventional gas suppliers were seeking in vain for customers. And it provided financial support to makers of every conceivable renewable energy system.

Energy security considerations also ensured the survival of the civilian nuclear power industry and were instrumental in federalizing research for the development and demonstration of a new generation of coal-burning electric power plants. Notably, neither nuclear power nor coal-fired electricity plants had any practical relevance to energy security, an issue that, despite the broadness of the label, has always centered on U.S. dependence on oil imports from the Persian Gulf. Nuclear and coal research subsidies have remained on the federal budget books (below the line, in the deficit category), even as oil use in the electricity



Photo courtesy of the New York Mercantile Exchange

The U.S. government withdrew from the oil business in 1981, leaving the field to spot and futures markets such as the New York Mercantile Exchange, where energy futures and options are traded. The efficiency of these markets has rendered the acts of governments increasingly irrelevant.

generation sector served by these fuels has declined to an insignificant level—less than 700,000 barrels per day of the seventeen million barrels consumed daily by the entire U.S. economy.

The cost of energy security has been high. In the twenty years spanning the first energy crisis and enactment of the Energy Policy Act of 1992, the federal government spent more than \$100 billion on programs to enhance energy security. It built the Strategic Petroleum Reserve and invested yearly in research and development of nearly every energy supply and demand technology that could possibly contribute—cost competitively or not—to the goal of reducing American reliance on foreign oil. Notwithstanding the broadly competitive structure of the U.S. energy industry, one half of the annual budget for DOE is devoted to research and develop-

ment, demonstration, and commercialization of energy technology. To these explicit budgetary expenditures one can add the cost of less obvious subsidies from the U.S. treasury to the energy sector, which the Energy Information Administration estimates to be \$5–10 billion per year. These investments have not measurably altered the energy security of the nation. Instead they have engendered recurrent costs without dividends.

But dividends *have* flowed from the consequences of a single, cost-free change in U.S. policy: decontrol of the oil industry. The benefits of decontrol were especially evident in 1986, when, unconstrained by government meddling, the market drove the price of oil down to \$9.00 per barrel. The market's performance stood in sharp contrast to the expectations of federal policymakers, who throughout the 1970s had

forecast that oil prices would reach \$60–100 per barrel in the 1980s. Decontrol was a victory of common sense over common fear, of free trade over protectionism, and of private competition over government direction and control. It was also a victory over OPEC.

The policy that defeated OPEC—government's liberation of the oil market—emerged fully only after forty-six years, the period between enactment of the Connally Hot Oil Act of 1935 and issuance of the executive order that accomplished full decontrol of oil prices in the first month of the Reagan administration. The U.S. government's withdrawal from the business of oil in 1981 left the field to spot and futures markets. The efficiency and transparency of these markets has rendered the acts of governments, even of possibly colluding governments, increasingly irrelevant. Ironically, Congress debated oil price controls for six years before finally enacting a phased decontrol policy, but had created the counterproductive Synthetic Fuels Corporation in a single session and in less than six months.

### The ghost of OPEC

Energy security policy continues to be haunted—at least within the halls of government—by fears of OPEC's potential ability to curb oil supplies to the United States or to unexpectedly raise prices to economy-damaging levels. Although ineffective as a cartel operating in a global, generally free, oil-trading system, OPEC continues to exert (mainly psychological) influence in excess of its market role. Industry observers regularly seek OPEC "reactions" to market-price movements, and organizations such as the International Energy Agency report these reactions as meaningful. In addition, OPEC's production quotas, which in a practical sense are unconnected to actual oil production in OPEC member states, are still factored into oil traders' decisions during periods of abnormality, such as labor strife at oil-producing



fields, emergency shutdowns of operating wells, or acts of war or natural disasters that impede deliveries of expected oil supplies.

In spite of OPEC's notorious internal conflicts, its members—which are, after all, *governments* and not private businesses—remain prone to collusion for political purposes. The last such instance occurred at the outset of the Iraqi war, when OPEC's governing board waited twenty-five days before releasing its members from production-quota obligations and “allowing” them to bring excess production capacity on-line. In this case, the OPEC decision might have been merely a political cover for members who were waiting to discover which countries would support or oppose Iraq. But the delay served to postpone the market's price adjustment to the loss of Iraqi and Kuwaiti oil production, and it earned OPEC members income unwarranted by actual market conditions.

Because OPEC's continued existence skews the energy policy debate in the United States and in other oil-consuming countries, and because it complicates otherwise constructive relations between the United States and the Arab world, the Clinton administration should confront OPEC and America's energy security concerns directly. In its forthcoming energy-policy plan, the administration could declare the abolition of OPEC to be a goal of U.S. foreign and trade policy. The dissolution of OPEC is justified on the ground that its existence and purpose are contrary to the objectives established by the international community in the General Agreement on Tariffs and Trade (GATT). Since OPEC members are GATT signatories and benefit from free-trade rules, they should be compelled to reevaluate the role of their cartel—one of the world's remaining few—in an international community made free to trade. The governments of OPEC members might well find the idea of competition liberating. Competition might even be a stimulus to the members' economic renewal, as well as a catalyst for their democratization.

As a countermeasure, U.S. energy policymakers should abandon the inflammatory frame of reference of energy security. No practical purpose has been served domestically or internationally by adherence to a policy that in the end has simply raised the economic cost of a vital commodity. The federal government has more pressing, and more explicit, security concerns than those that have come to be associated with access to oil supplies. Crises may continue to be a part of the world of oil. But they need not, indeed should not, instigate a return to the security obsessions of the past. In any

case, and if history is any guide, future turmoil in the Persian Gulf will probably not be resolved, mitigated, or otherwise affected by U.S. energy policy. The time is ripe to abandon the rhetoric and policies of the long-past era of energy crises and instead commit to mutually beneficial free trade.

*Vito A. Stagliano, a visiting scholar at Resources for the Future, served as deputy assistant secretary of energy for policy planning during the Bush administration. He also directed the development of the Bush administration's “National Energy Strategy.”*

## Transaction Costs and Markets for Pollution Control

Robert N. Stavins

Since the early 1980s, government authorities have been experimenting with emission-permit markets as a way to reduce the costs of achieving a given emission-reduction goal. In such markets, a fixed number of permits to emit a given pollutant is issued to polluting firms, who are then free to reduce emissions and sell their unneeded permits or to buy permits rather than reduce emissions, depending on which is cheaper. Although emission-permit trading will probably be less costly than more conventional pollution-control instruments, transaction costs can make a permit approach less cost-effective than promised. Such costs can significantly affect the quantity and pattern of trading and hence the total cost of pollution control when permits are traded. For this reason, choosing between permits and other approaches must be made on a case-by-case basis. And if permit trading is to achieve its cost-effectiveness potential, permit markets must be designed in ways that minimize transaction costs.

For more than two decades, environmental law and regulation have been dominated by command-and-control approaches—typically either mandated pollution-control technologies or inflexible discharge standards on a smokestack-by-smokestack basis. But in the past five years, policymakers increasingly have explored market-based environmental policy instruments—mechanisms that provide economic incentives for firms and individuals to carry out cost-effective pollution control. Marketable emission permits, which can be traded among potential polluters, have been at the center of these efforts in the United States.

The transition from command-and-control approaches to economic-incentive approaches has not been easy. In some cases, environmental policymaking has outrun our basic understanding of the new pollution-control instruments. Consequently, the claims made for the cost-effectiveness of marketable permit systems often have exceeded what can be reasonably anticipated.

Several factors can adversely affect the performance of marketable permit systems: monopoly power by permit holders; non-profit-maximizing behavior, such as attempts to increase sales and staff; the preexisting regulatory environment; and the difficulty of monitoring and enforcing permit-trading rules. One potential problem has received little attention: the effect of transaction costs on the market for permits. Below I discuss the forms and sources of transaction costs, cite evidence of these costs in permit markets, and examine the effects of the costs on the performance of permit markets. I then suggest some implications that these effects have on decisions to use permits as opposed to other pollution-control approaches and on designs for a system of tradable permits.

### Forms and sources of transaction costs

In general, *transaction costs*—those costs that arise from the exchange, not the production, of goods and services—are ubiquitous in market economies. They can arise from any exchange: after all, parties to transactions must find, as well as communicate with, one another. These parties may need to inspect and sometimes even measure the goods to be sold. They also may need to draw up contracts, consult with lawyers or other experts, and transfer titles.

Transaction costs can take one of two forms. One form consists of services provided by buyers or sellers; the other is the margin (difference) between the buying and selling price of a commodity in a given market. This margin may be due to the direct financial costs of brokerage services.

Three potential sources of transaction costs exist in tradable permit markets. The first source is the search for a trading partner. A potential buyer of a discharge permit expends time and effort in finding a seller, though—for a fee—brokers can facilitate the process. A second, less obvious, source of transaction costs is

bargaining. Once buyers and sellers enter into negotiations, they incur significant resource costs, including fees for brokerage, legal, and insurance services. A third source of transaction costs is monitoring and enforcing permit trades. These costs, which also can be significant, are typically borne by the responsible government authority rather than by trading partners.

### Evidence of transaction costs in permit markets

The cost savings that may be realized through marketable permits depend upon active trading. Impediments to active trading can thus limit savings. Abundant anecdotal evidence illustrates both the prevalence of significant transaction costs in tradable permit markets and the impediments to efficiency that can result from *thin* markets—that is, markets in which few trades occur.

Many studies have found fewer trades—and hence lower cost savings—in real-world permit markets than theoretical models predict. In several cases, transaction costs appear to have played a particularly adverse role. For instance, administrative requirements generated transaction costs that essentially eliminated potential gains from trade in the Fox River (Wisconsin) program for buying and selling water-pollution permits. Likewise, transaction costs in the form of brokerage and consultant fees may be having an adverse effect on the emission-permit trading program that the U.S. Environmental Protection Agency (EPA) created for criteria air pollutants.

On the other hand, high levels of trading—and significant cost savings—may result when transaction costs can be kept to a minimum. Such was the case when, in the 1980s, EPA created a market for the use of lead in gasoline as part of the phaseout of leaded gasoline. The success of this market owed much to minimal administrative requirements, as well as to the fact that potential trading partners (oil refineries) already were

experienced in striking deals with one another. Minimization of transaction costs also may be responsible for the success of a transferable development-rights program in the New Jersey Pinelands. In this case, the government provided free brokerage services.

### The effects of transaction costs on permit-market performance

How much are permit markets affected by transaction costs? To find out, we need to know first how the burden of transaction costs is shared between permit sellers and buyers. Not surprisingly, transaction costs lower the gains from trade for both sellers and buyers. Most of the burden, however, will fall on the trading partner that has less flexibility in controlling its pollution, regardless of who may actually pay brokerage fees or other direct transaction costs.

*Transaction costs reduce the overall economic benefits of permit trading by absorbing resources directly and by suppressing exchanges that otherwise would have been mutually and socially beneficial.*

In the presence of transaction costs, total expenditures on pollution control generally will exceed those that would be incurred in the absence of transaction costs. Moreover, total pollution-control expenditures in the presence of transaction costs usually will exceed those in the absence of transaction costs by an amount greater than the sum of the transaction costs. This suggests that transaction costs reduce the overall economic benefits of permit trading not only by

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# INSIDE RFF NEWS AND PUBLICATIONS

## RFF council discusses changes in the electric utility industry

"The Restructuring of the Electric Utility Industry" was the topic of a meeting of the RFF Council held on April 6 in Carmel, California, as part of the spring 1995 board of directors meeting. Highlights of the council meeting included a talk on regulatory reform by RFF Vice President and Senior Fellow Paul R. Portney and a discussion of RFF research on the economic and environmental effects of restructuring the electric utility industry. Fellow Karen L. Palmer

and Senior Fellow Alan J. Krupnick of the Quality of the Environment Division, along with Gilbert White Fellow Timothy J. Brennan and Visiting Scholar Vito A. Stagliano, presented their views on key issues associated with this restructuring to a group that included participants from federal and state government and the business and environmental communities, as well as members of the RFF council, board of directors, and research staff.



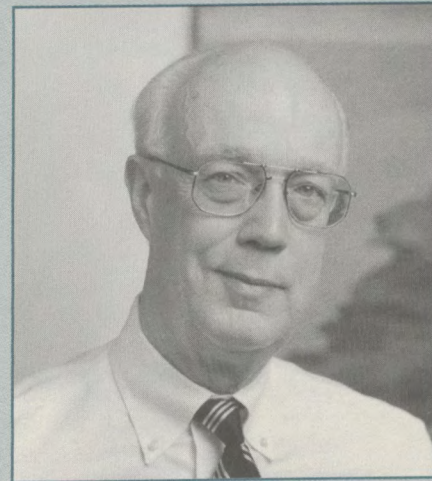
At a recent RFF Council meeting on restructuring the electric utility industry, presenters and respondents included (from left) Vito A. Stagliano; Alan J. Krupnick; Kathy Treleven, senior strategic planner at Pacific Gas & Electric Co.; and Ronald Russell, commissioner of the Michigan Public Service Commission.

## Portney, Probst discuss Superfund book at briefing

*Footing the Bill for Superfund Cleanups: Who Pays and How?*, a new study jointly published by RFF and the Brookings Institution, was the subject of a book briefing held at Brookings in Washington, DC on January 31. Three of the coauthors—RFF Senior Fellow Katherine N. Probst, RFF Vice President Paul R. Portney, and Don Fullerton of the

University of Texas—Austin—presented highlights of their research findings to an audience that included representatives of industry, environmental organizations, environmental lawyers, government agencies, and Congress, as well as the press.

Their study is the first comprehensive analysis of the economic effects of



Robert W. Fri

## RFF president stepping down

Robert W. Fri has announced that he intends to step down as president of Resources for the Future, a position he has held since March 1986. He informed RFF's board of directors of his decision at the April board meeting. "Rather to my surprise, I realized that I have been here for nearly ten years," Fri said. "RFF is in great shape, so it seemed like a good time for me to turn the organization over to a new leader and move on to pursue some of my other interests."

Fri will remain as president until a successor is named. The search for a new president has begun under the direction of RFF Board Chair Darius W. Gaskins Jr. and is expected to take several months.

Photo by Rudy Quiddeleg

Superfund's liability provisions and taxes. According to Probst, Portney, and Fullerton, transaction costs could be reduced if some of these liabilities were relaxed. But they also noted that each proposal to do this carries with it some potential unforeseen consequences that would have to be taken into account for

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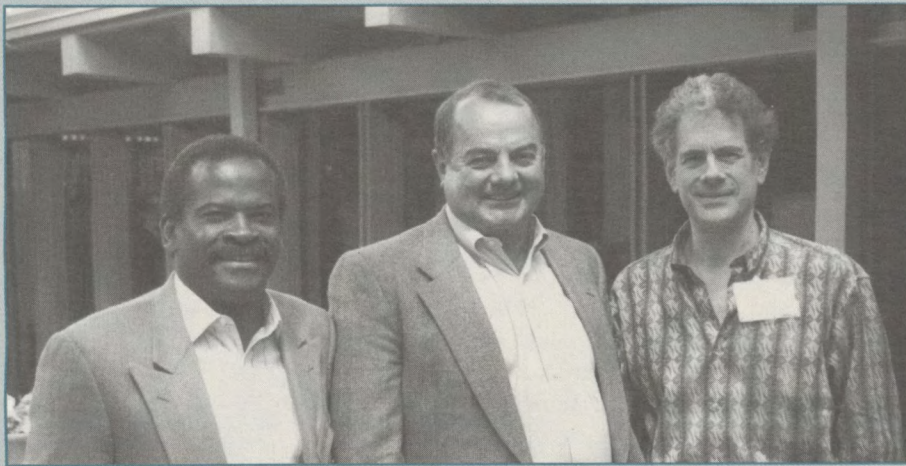


Photo by Rudy Quidlig

Two new members of RFF's board of directors are Frank L. Matthews (left) and Edward L. Strohbehn Jr. (right), shown here with chair Darius W. Gaskins Jr.

## RFF board gets five new members

Resources for the Future recently appointed five new members to its board of directors. They are Jodie T. Allen, John C. Borum, James D. Maddy, Frank L. Matthews, and Edward L. Strohbehn Jr. Together, they represent a wide range of perspectives and experience.

Allen, who is currently editor of the Sunday "Outlook" section in *The Washington Post*, is regularly interviewed on National Public Radio, CNN, and C-SPAN on a variety of economic and social matters. Before joining the *Post*, she worked at the U.S. Department of Labor, as deputy assistant secretary for policy, valuation, and research and as special assistant to the secretary of labor. Before that she served as senior vice president and director of the Washington office of Mathematica Policy Research, Inc. She also has been an executive officer of the Urban Institute.

Borum is responsible for environmental, product, and occupational safety for AT&T, where he serves as environment and safety engineering vice president. He also is chairman of the Environmental Forum of the Annapolis Center for Environmental Quality and serves on the advisory committee of the Environmental Justice Committee of the Conservation Council of the National Wildlife Federation. In addition, Borum is an associate of the Environmental Law Institute.

Maddy is president of the League of Conservation Voters, a bipartisan political arm of the American environmental movement. In recent years he was president of the American Political Network and executive director of the Western Governors' Association.

Matthews, who has devoted his career to black and minority concerns, is founder and publisher of the nationally circulated news journal, *Black Issues in Higher Education*. He also publishes *Community College Week* and is cofounder of Cox, Matthews, and Associates, Inc., a Fairfax, Virginia-based communications company. A member of the faculty of George Mason University for fifteen years, Matthews teaches in the university's law school and school of business administration.

Strohbehn is a partner in and cochair of the Environmental and Natural Resources Group of McCutchen, Doyle, Brown & Enersen, which is located in San Francisco. He specializes in providing advice on business transactions and compliance matters with respect to permitting and enforcement issues in environmental law. He is a former executive director of the Council on Environmental Quality and cofounder of and former senior staff attorney at the Natural Resources Defense Council.

## RFF fellows testify on Capitol Hill

In recent months, RFF fellows were invited to speak before congressional committees on issues related to benefit-cost analysis and Superfund.

On February 3, RFF Vice President Paul R. Portney presented testimony before the Committee on Science, U.S. House of Representatives, regarding Title III and Title VII of proposed legislation H.R. 9, "The Job Creation and Wage Enhancement Act of 1995." These titles deal with the role of benefit-cost analysis in federal regulation. Portney told the committee that such analysis is "a powerful analytical tool that can play a very useful role in public policymaking," and one that, in his view, "has been consistently under- rather than overutilized by federal regulatory agencies...."

On March 8, RFF Senior Fellow Alan J. Krupnick presented testimony before the Committee on Governmental Affairs, U.S. Senate, regarding S. 291, "The Regulatory Reform Act of 1995." Krupnick addressed some of his remarks to provisions relating to benefit-cost analysis. He said that the real issue is not limiting regulations to those where benefits exceed costs, but rather deciding "which benefits and costs have standing." He said that many important effects of health and environmental improvements brought about by regulation cannot be reliably quantified, "let alone expressed in monetary terms." He therefore urged that any regulatory reform bill passed by Congress "grant standing to all potential benefits and costs, whether quantifiable or not and whether they relate to efficiency or equity benefits."

On March 10, RFF Senior Fellow Katherine N. Probst presented testimony before the Subcommittee on Superfund, Waste Control, and Risk Assessment, Committee on Environment and Public Works, U.S. Senate. Her remarks focused on two key areas of the Superfund program: first, the current liability scheme and the implications of eliminating retroactive liability and, second, the

need for clearer cleanup goals in the Superfund law. According to Probst, "We should not kid ourselves that eliminating retroactive liability and shifting responsibility for cleanups to the government is going to lead to cheaper, faster cleanups." Indeed, releasing private companies from Superfund liability "would actually increase the cost of site cleanups, as private sector cleanups are 20 percent less expensive than the gov-

ernment's." Probst also asserted that the most important change that Congress could make to Superfund is "a clear policy regarding the goal of site cleanup." She said lack of agreement about this goal "contributes to a lengthy site study and cleanup process and to distrust and miscommunication among all involved."

The complete text of each testimony is available at RFF's World Wide Web site. The address is: <http://www.rff.org>.

### Visit RFF on the Internet

RFF has set up a World Wide Web site on the Internet and invites *Resources* readers to browse our home page. There, you will find both general information about RFF and specific information about recent and upcoming activities.

For instance, "RFF in Brief" gives a short history of RFF and outlines our goals, activities, and general research areas. "What's New at RFF" includes, among other documents, a list of upcoming Wednesday noon seminars; descriptions of new RFF publications; press releases; announcements of RFF fellow-

ships and internships; and a rundown of special events, including conferences and recent testimony by RFF researchers before Congress. In addition, lists and abstracts of all in-print discussion papers are available, as is a catalog of RFF's books and other publications.

In the future, Internet users will be able to access this information through FTP and Gopher. In the meantime, we are adding regularly to the information at our Web site, so you'll want to visit it often. Point your browser to <http://www.rff.org> to access our home page.

### Chinese scholar returns to RFF to work on environment and development projects

Professor Ma Zhong, the first recipient of an RFF visiting fellowship in environment and development, recently completed his third visit to RFF. In China, Ma serves as the deputy director of the Institute of Environmental Economics (IEE) at Renmin University of China. At RFF for an eight-week stay in February, March, and April, Ma consulted with RFF Senior Fellow Walter O. Spofford Jr. on two projects related to development and the environment in China.

The first RFF project is a study for the World Bank on environmental regulatory reform in Chongqing, a municipality of fifteen million people in southwest China. RFF is working with the newly created Beijing Environment and Development Institute (BEDI), of which

Ma is president. The institute, which Ma helped to establish, is modeled on RFF and is China's first nongovernment, non-profit, public-interest environmental research organization.

The BEDI team has assessed the existing environmental regulations in Chongqing and identified the main obstacles to compliance with them. The purpose of identifying these obstacles is to provide a basis for recommending improvements in the environmental regulatory framework of Chongqing. Moreover, taken together, these obstacles suggest the range of difficulties that many Chinese cities face in trying to make environmental improvements.

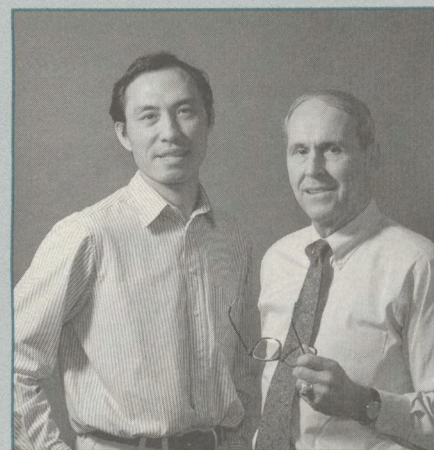
In commenting on the obstacles, Ma identified the impediments as economic,

financial, institutional, administrative, and managerial. He noted that because of the urgent need for infrastructure development, the Chongqing municipality's budget for environmental protection is very tight. Similarly, many polluting firms are not profitable businesses and thus have little money to invest in pollution control. In addition, institutional conflicts among various bureaus in charge of economic development, individual industries, and environmental protection serve to diminish the effectiveness of environmental regulation. And even within local environmental protection bureaus, Ma said, "some of the existing environmental programs lead to conflicts, and these conflicts reduce efficiency."

In a second RFF project, Ma and Spofford are assessing the costs and benefits of continued agricultural development in the Sanjiang Plain in northeastern China, a region that includes most of the country's wetlands. Ma's work on this study, which began in 1992, is being conducted at his home institution in China, as well as at RFF.

The Chinese government began developing the Sanjiang region as an agricultural base in the 1950s by converting the region's wetlands to farm land. The process proceeded slowly until the late 1970s, when the first large-scale, modern farms were established. According to Ma, one 20,000-hectare farm was established by the Japanese in 1981, and three other

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Ma Zhong and Walter O. Spofford Jr.

## Chinese scholar

*continued from page 13*

farms of similar size were backed by financing from the World Bank.

At first, these farms did well; today, however, they are losing money. Ma noted that the climate and soils of the Sanjiang wetlands do not make good land for farming and that farmers are finding that the soil's natural fertility is exhausted a few years after they drain the land. Low harvests, increasing production costs, and debt on imported farm equipment have put Sanjiang farmers heavily in debt.

In addition to economic losses in Sanjiang, Ma has documented evidence of losses to biodiversity. Twenty-six mammal and bird species supposedly protected by national laws have dwindled in number; some are in danger of extinction.

The red-crowned crane has been threatened by drainage of wetlands, and the white-tail eagle and the white stork have been adversely affected by the cutting of trees, which serve as nesting sites.

Sound uses of the natural resources of the region exist, however, according to Ma. Fishing, grazing, edible wild herbs, and Chinese medical herbs in the wetlands hold huge economic potential—they are much more profitable than agriculture and offer additional environmental benefits.

In 1994, Ma reported the results of his RFF research in the Sanjiang region to the National People's Congress. The congress responded by requiring the Ministry of Agriculture, the Ministry of Forestry, the National Environmental Protection Agency (NEPA), and the

provincial government to reassess existing agricultural development projects in the region. NEPA, in turn, required its Conservation Department to take responsibility for wetlands protection. In May, Ma will accompany the deputy administrator of NEPA on a field trip to the Sanjiang region to assess environmental damages firsthand. In addition, at the behest of BEDI, the Chinese government is setting aside for preservation an increased amount of acreage of Sanjiang wetlands that originally had been earmarked for agricultural development.

Support for Ma's visiting fellowship has been provided by a grant to RFF from the Henry M. Jackson Foundation. For a comprehensive description of RFF's environment and development projects in China, see page 20.

## Chief EPA policy analyst begins residence as RFF visiting scholar

Richard D. Morgenstern, until recently the director of the U.S. Environmental Protection Agency's (EPA) Office of Policy Analysis and the highest-ranking economist in EPA's senior executive service, has begun a two-year residence as a visiting scholar at Resources for the Future.

Morgenstern will work with RFF researchers on environmental policy issues. "Dick Morgenstern brings practical experience in and historical knowledge of environmental policy that only someone inside the environmental regulatory system can gain," said RFF Vice President Paul R. Portney. "He has an eye for policy relevance and a long track record of innovative thinking on environmental issues."

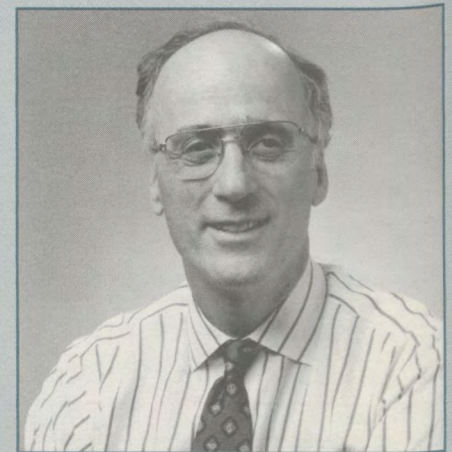
During his stay at RFF, Morgenstern will examine efficiency and distributional aspects of environmental policy, as well as explore opportunities for achieving cost-effective environmental gains. According to Morgenstern, such research is particularly timely given the rising interest in the role of economics in the setting of environmental policy.

"As Congress seems poised to introduce more concretely the concept of eco-

nomics efficiency into environmental considerations," he said, "the issue of how regulatory agencies will respond to this new direction becomes increasingly important. RFF is an ideal place to do research on this issue because of its enormous technical capacity and its clout to convene experts and stakeholders."

One means for achieving greater economic efficiency is comparative risk assessment. Morgenstern noted the increasing use of such assessment as a tool in environmental decisionmaking at state and local levels since 1987, when the EPA's Comparative Risk Task Force—which Morgenstern chaired—presented the landmark report, *Unfinished Business: A Comparative Assessment of Environmental Problems*.

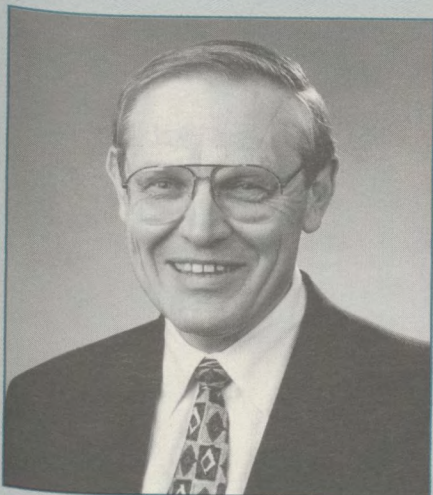
"If Congress requires EPA to use comparative risk-assessment approaches in its priority setting," Morgenstern noted, "a major reordering of regulatory and policy activities would likely result. This will call for the development of consistent and high-quality comparative risk and economic research of the kind RFF is known for."



Richard D. Morgenstern

Morgenstern has directed EPA's policy analysis office since 1982, with time out to serve as acting assistant administrator for policy, planning, and evaluation and, during the latest period of presidential transition, as acting deputy administrator. He graduated with honors from Oberlin College and holds a PhD in economics from the University of Michigan. Morgenstern was a tenured faculty member at Queens College of the City University of New York before joining the Congressional Budget Office in 1976. He subsequently served as director of the energy program at the Urban Institute and as legislative assistant to Senator J. Bennett Johnston.

## Former economic adviser to the White House is new RFF scholar, consultant



George Eads

George Eads, former vice president and chief economist at the General Motors Corporation and before that a member of President Carter's Council of Economic Advisers, has taken residence as a consultant and visiting scholar at Resources for the Future. Eads is also former dean of the School of Public Affairs at the University of Maryland, where he taught for six years.

"Few people have worked in such high-level positions in government, academia, and the corporate world," noted RFF Vice President Paul R. Portney in announcing the appointment. "George's depth and breadth of experience will be useful in helping RFF to further broaden its perspectives concerning economic issues in environmental policymaking."

While at RFF, Eads will explore ways to design an environmental regulatory system that makes extensive use of economic incentives. "For political and other reasons," said Eads, "people have shied away from such a system. Today, economic incentives are being tried, but regulations that incorporate these incentives are still the exception. They must become more the rule."

Economists have been touting market-based environmental regulation for years,

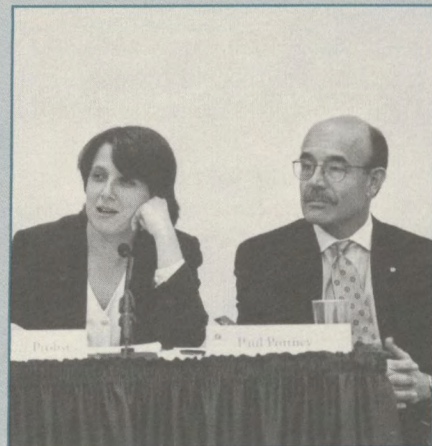
but they have done little, Eads maintains, to guide policymakers in smoothing the transition away from a command-and-control system. Dealing with policymakers is only half the problem. According to Eads, economists must do more to convince firms to abandon the relative comfort of command-and-control regulation and instead take advantage of economic incentives for pollution control. "Right now, firms are suspicious of such incentives," said Eads. "You can't jump from one system to another overnight—that is one lesson we've learned from Eastern Europe in recent years."

Eads foresees RFF's playing a crucial role in creating ways for firms to handle the risks they will face in making the transition to a market-based environmental regulatory system. "RFF researchers were among the first economists to point out the benefits of such a system," said Eads. "By working on the real-world implementation of a true market system, they can help change the mindset that has thus far hindered the adoption of environmental regulation based on economic incentives."

## New books

**Analyzing Superfund: Economics, Science, and Law**  
 Edited by Richard L. Revesz and Richard B. Stewart

*Analyzing Superfund: Economics, Science, and Law* takes a probing look at the key issues involved in the Superfund reauthorization debate and the future of this controversial environmental liability and remediation program. Superfund is roundly criticized as being wasteful and inefficient, excessively stringent and expensive, and plagued by high transaction costs, serious administrative deficiencies, and long delays.



RFF Senior Fellow Katherine Probst and RFF Vice President Paul Portney answer questions about their research regarding the economic effects of Superfund's liability provisions and taxes at a book briefing hosted by the Brookings Institution.

## Superfund book briefing

*continued from page 11*

a reasoned policy judgment. Any new taxes created to finance Superfund cleanups, said the authors, would generate compliance costs of which Congress should be aware.

*Footing the Bill for Superfund Cleanups: Who Pays and How?* was published in January and is available from RFF and Brookings in both cloth and paper editions.

Despite these criticisms, Superfund has been the subject of little dispassionate study. *Analyzing Superfund* brings together some of the most important theoretical and empirical work from the research community on four issues central to the evaluation of Superfund: cleanup standards, the liability regime, transaction costs, and natural resource damages.

Three empirical studies examine the U.S. Environmental Protection Agency's cleanup decisions, paying particular regard to the role of benefit-cost considerations. Liability issues are assessed in two chapters, one a theoretical analysis

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### New books

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of the relative merits of joint-and-several liability as compared with nonjoint liability, the other an examination of the likely financial impact of three alternative liability schemes upon various sectors of the national economy.

Is too much money being spent on litigation rather than cleanups? One chapter summarizes and analyzes empirical research conducted by RAND on Superfund transaction costs; a second chapter explores EPA's use of *de minimis* settlements—a legal arrangement for achieving quick settlement with parties responsible for only a small share of the liability at a given site.

Liability for damage to natural resources is a rapidly expanding and potentially explosive aspect of Superfund. The final chapter of *Analyzing Superfund* presents one view of significant conceptual, legal, and practical difficulties with the natural resource damages regime, which is portrayed as a novel blend of tort liability, public trust, and administrative models. According to this view, problems of high transaction costs, wasteful expenditures of recoveries, and severe difficulties in developing an appropriate measure of damages could well offset legislative progress made at reducing the cost of the Superfund scheme, thereby generating demands for change analogous to those found in the reauthorization debate concerning liability for cleanups.

The basic issues addressed in *Analyzing Superfund*, while central to the debate surrounding reauthorization, will endure long after the legislative action is completed.

Richard L. Revesz is professor of law at the New York University School of Law; Richard B. Stewart, also professor of law at the New York University School of Law, is a former assistant attorney general in the Environment and Natural Resources Division of the U.S. Department of Justice.

May 1995. 260 pages.

\$39.00 cloth. ISBN 0-915707-75-6

### The Handbook of Regulations on Environmental Protection in China

Translated by Lu Ruilan

The handbook presents the environmental laws, regulations, and standards in the People's Republic of China and the implementation regulations in Beijing Municipality. The Chinese original was prepared for use by Beijing Municipality in carrying out the national environmental policy.

Lu Ruilan of the Academia Sinica in Beijing translated the work while in residence at RFF as a visiting scholar. While changes—particularly to regulations and standards—have occurred since the original Chinese text was published in 1988, the handbook accurately reflects the nature of current environmental policy in China.

April 1995. 413 pp.

\$250.00 paper. ISBN 0-915707-77-2

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The following papers have recently been released.

- "Finding the Story Behind the Headlines: A Test of the Contributions Model for Contingent Valuation," by V. Kerry Smith. (95-07)
- "The Potential of High-Yield Plantation Forestry for Meeting Timber Needs: Recent Performance and Future Potentials," by Roger A. Sedjo. (95-08)
- "Environmental Policy in a Transitional Economy: Designing Tradable Permits for Poland," by Robert N. Stavins and Tomasz Zyllicz. (95-09)
- "The Usefulness of Microeconomics Statistics in Explaining International Differences in the Diffusion of Process Innovations: A Note," by Allen Blackman and James Boyd. (95-10)
- "Environmental Policy in a Transitional Economy: Prospects for the Former Soviet Union," by R. David Simpson and Michael A. Toman. (95-11)
- "Environmental Policy, Innovation, and Competitive Advantage," by R. David Simpson. (95-12)
- "Evaluating Environmental Equity: The Impacts of Industrial Hazards on Selected Social Groups in Allegheny County, Pennsylvania," by Theodore S. Glickman and Robert Hersh. (95-13)
- "Social Benefits of Education: Feedback Effects and Environmental Resources," by V. Kerry Smith. (95-14)



## Especially for RFF donors: Supporting charities while increasing lifetime income

In this column, we have described several planned giving options that RFF donors have used in their charitable gift and estate planning. These options include bequests, the RFF Gift Fund, gift annuities, and gifts of appreciated property. Another option is the creation of a charitable remainder trust. This trust pays a specified distribution to the donor or another beneficiary for life or a specified number of years, with one or more charities receiving an irrevocable remainder interest at the end of the time frame of the trust. The charitable remainder trust is an excellent way of retaining or increasing lifetime income, as illustrated in the following example:

Donor owns stock with market value	\$100,000
Pays annual dividend	\$3,000
Donor creates charitable remainder trust with stock	\$100,000
Federal and state income tax savings	\$21,200
Capital gains savings (28%)	<u>\$22,400</u>
"Net cost" of gift	\$56,400
RFF provides 6% of \$100,000 to donor for lifetime	\$6,000

The charitable remainder trust described here can increase annual income by \$3,000 annually over the original dividend. The donor receives a large income tax deduction in the year the trust is established, avoids capital gains tax, and provides resources for RFF's future.

For more information about the RFF Gift Fund, gift annuities, gifts of appreciated securities, bequests, or other types of planned gifts, please contact RFF Vice President-Finance and Administration Ted Hand at 202-328-5029 or check the appropriate box on the enclosed reply envelope for individual contributions.

## Recent contributions from individuals

The following individuals made gifts of \$100 or more between December 2, 1994 and March 10, 1995 in support of research and education programs at Resources for the Future:

Anonymous (1)	Harold M. Hubbard	Michihino Miyagi
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Jong-Tsun Huang	Mary E. McWilliams	Dale Whittington

The following individuals and corporations made gifts between December 2, 1994 and March 10, 1995 in memory of former RFF President Joseph L. Fisher, in whose name RFF has established dissertation awards to support graduate students in the final year of their dissertation research on environmental and natural resource issues:

Pierre R. Crosson	Laurence I. Moss	Todd Sandler
B. Delworth Gardner	Reasoner, Davis & Fox	R.M. Solow
Judd Hammack		Shue Tuck Wong

## Recent contributions from corporations and foundations

RFF received contributions from the following corporations and foundations between December 2, 1994 and March 10, 1995:

American Petroleum Institute	Ford Motor Company	Philip Morris Companies, Inc.
ARCO Foundation	Forest Investment Associates, L.P.	Phillips Petroleum Company
Ashland Oil Foundation, Inc.	GE Fund	Potlatch Foundation II
BP America, Inc.	General Public Utilities Corporation	Potomac Electric Power Company
Bristol-Myers Squibb Company	The William and Flora Hewlett Foundation	Unocal Corporation
Browning-Ferris Industries	Kennecott Corporation	USX Corporation
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Chrysler Corporation Fund	Montgomery Street Foundation	Washington International Energy Group
Cigna Foundation	Northern States Power Company	Westvaco
Consumers Power Company	Pacific Gas and Electric Company	Wisconsin Energy Foundation, Inc.
Dominion Resources, Inc.		
E.I. du Pont de Nemours and Company		

A matching gift was provided by Philip Morris Companies.

*continued from page 10*

absorbing resources directly but also by suppressing exchanges that otherwise would have been mutually (indeed socially) beneficial.

If transaction costs suppress mutually beneficial exchanges, we might ask whether in the presence of these costs the initial (free) allocation of permits affects the posttrading allocation of pollution-control responsibility and pollution-control costs. Economists assert that the posttrading allocation of pollution-control responsibility, and hence the aggregate costs of pollution control, are independent of the initial permit allocation. Does this assertion still hold in the presence of transaction costs? The answer is, "It depends."

When incremental transaction costs are independent of the size of individual transactions, the initial allocation of permits has no effect on the posttrading allocation of pollution-control responsibility and aggregate pollution-control costs. But when incremental transaction costs increase with the size of individual trades, the initial allocation *can* affect the posttrading outcome. As a firm's allocation of emission permits increases (that is, its ini-

tial pollution-control responsibility decreases), the firm's posttrading level of pollution control will decrease. This process drives up aggregate pollution-control costs.

Economists note that incremental transaction costs are unlikely to be increasing with larger trades, since parties can simply split their transactions into smaller trades in order to economize. But incremental transaction costs can be increasing if they are combined with sufficiently high fixed transaction costs.

On the other hand, incremental transaction costs might decrease with the size of transactions when brokers offer quantity discounts on their services. In this case, if we shift the initial permit allocation away from a cost-effective outcome, the posttrading outcome will be *closer* than otherwise to the cost-effective outcome. What explains this apparently counterintuitive result? Decreasing incremental transaction costs mean that there are economies of scale in trading of which firms can take advantage.

In the presence of transaction costs, then, the initial distribution of permits can affect the efficiency of pollution permit markets. For this reason, environmental

agencies and legislatures may have less discretion than they believe to allocate permits as they please—in other words, to allocate them in a way that generates support for a tradable permit system. As a result, the political attractiveness and feasibility of such a system may decrease.

## Implications for policymaking

Choices between conventional command-and-control approaches and market-based instruments for pollution control ought to reflect the imperfect world in which these instruments are applied. But such choices are not simple.

On the one hand, even if transaction costs prevent significant levels of trade from occurring, aggregate costs of pollution control probably will be less than those of a conventional command-and-control approach. A trading system in which no trades occur is still likely to be less costly than a system that imposes a technology standard—that is, requires specific pollution-control technologies to be used. Moreover, a trading system in which no trades occur is no more costly than a system that imposes a uniform performance standard—that is, requires that all polluters reduce emissions by a specified amount. On the other hand, the total compliance costs (including transaction costs) of a trading system could exceed (depending upon the initial allocation of permits) those of a uniform performance standard that imposed small administrative costs. Thus, case-by-case examinations of alternative instruments are required.

Despite the varying consequences of transaction costs in different circumstances, economists can make some general observations about the effects of these costs. First, transaction costs increase the aggregate costs of pollution control not only directly but also indirectly by reducing total trading volume. Second, this effect tends to be ameliorated in markets with relatively large numbers of potential traders. As the pool of potential trading partners increases,



Photo courtesy of the Electric Power Research Institute

The 1990 Clean Air Act Amendments called for sulfur dioxide emission-permit trading among electric utilities, which received initial allocations of permits free of charge. The number of permits that each utility received was based on its historic emission level.

potential buyers are easier to find, and transaction costs are thereby lowered. In addition, a larger number of firms can mean more frequent transactions and, as a result, more and better information about potential buyers and sellers. These observations suggest that, due to possible transaction-cost effects (and due to the likely effects of market concentration and traders' strategic behavior), we ought to be least confident of relying on tradable permit systems when permit markets are likely to be thin.

Like choices between command-and-control approaches and market-based approaches for pollution control, choices among market-based approaches should be made with care. Consider the choice between tradable permit markets and pollution taxes. Economists usually emphasize the symmetry between these two instruments, but they are not symmetrical under conditions of uncertainty, in the presence of transaction costs, or under other special conditions. Studies comparing taxes and permits have assumed that permit markets entail no transaction costs. This assumption is troubling, given evidence that these costs are common in permit markets. Of course, systems of pollution taxes can involve substantial administrative costs, both fixed (per firm) and variable. Hence, these instruments should only be compared on a case-by-case basis.

### Implications for designing policy instruments

Where a system of tradable permits is the instrument of choice for controlling pollution, three sets of design issues stand out.

The first set relates to the point in the product cycle at which pollution ought to be regulated. The simplest pollution-control systems (whether they involve tradable permits or other instruments) focus on inputs to production processes—say, the lead content of gasoline or the carbon content of fossil fuels. When the focus shifts away from inputs, pollution-con-

trol systems may become more sophisticated and, as a result, potentially more costly. For example, trading in permits for emissions (an output) represents substantially greater administrative complexity and transaction costs than trading in inputs. Further along this path of increasing complexity are ambient-pollution permit trading, exposure trading, and finally risk trading. Each system along this path may come closer to a theoretical ideal but also may entail greater public costs because of increased monitoring and enforcement and increased private transaction costs. Indeed, these practical considerations may explain why—contrary to economists' models—public authorities have adopted input and emissions trading but not ambient-pollution, exposure, or risk trading.

A second set of design issues centers on how trading programs can be designed to provide information needed by potential traders. Government authorities can take actions that directly reduce traders' uncertainty about market variables, as well as reduce barriers to private brokerage services and make allowance for the development of futures markets. At a minimum, government authorities can avoid creating regulatory barriers (such as requiring government approval of trades before the trades take place) that drive up transaction costs and discourage trading. More actively, they can try to reduce market uncertainty by taking on a brokerage role. That is, they could help potential traders identify one another by supplying information about potential buyers and sellers.

Private brokerage services can also play an important role in supplying information. In the national sulfur dioxide permit-trading program created under the 1990 amendments to the Clean Air Act, commercial brokers provide forecasting services for electric utilities by using computer models to predict the supply and demand for permits. In local programs, such as EPA's Emissions Trading Program, commercial brokers may conduct the air-quality modeling that is required for some permit trades.

While commercial brokers receive fees and therefore contribute to transaction costs, their basic service—bringing together buyers and sellers by matching buy orders and sell orders—can reduce transaction costs below what they would otherwise be. In general, brokers can contribute to social welfare by helping parties to economize on transaction costs. In addition, brokers can play the role of consultants, adding value to their basic function as intermediaries by understanding the regulatory process and by maintaining information about prospective buyers and sellers. Finally, brokers may assume risk by buying, holding, and selling permits.

*Government authorities can take actions that directly reduce traders' uncertainty about transaction costs. One way to do this would be to take on a brokerage role.*

A third set of design issues concerns the initial allocation of permits, which—as noted above—gains significance in the presence of transaction costs. This single aspect of design can establish or destroy the political feasibility of any tradable-permit system. Because government authorities need to establish a constituency for a proposed permit market, they usually choose to distribute permits free of charge. This politically attractive choice enables them to devise all sorts of initial allocations that will win support for an emission-trading program.

Typically, economists assume that these alternative initial allocations have only distributional implications, since they also assume that initial allocations do not affect aggregate abatement costs. But initial allocations may have more than distributional effects when transaction costs are present. Thus, a successful attempt to establish a politically viable

emission-trading program through specific permit allocations can actually result in a program that will be far more costly than promised.

Such a result may argue for the economist's favorite permit-allocation mechanism: auctions. This approach becomes even more attractive in the presence of transaction costs. But political barriers to permit auctions and political incentives in favor of all sorts of free distributions are likely to remain in place for the foreseeable future.

What, then, is the general message for public policy? With transaction costs present in markets for tradable permits, the

"devil is in the details." And while the existence of transaction costs may make the choice between ambient-pollution permits and emission permits more obvious, it may well make the choice between conventional approaches and permits more difficult because of the ambiguities that transaction costs introduce. Likewise, the supposed symmetry of taxes and permits becomes questionable, and the need to compare these instruments on a case-by-case basis becomes more compelling. Finally, transaction costs require government agencies to pay greater attention to the details of designing specific tradable-permit systems. Doing so will

lessen the risk of overselling these systems and increase the chance that well-designed systems will be implemented successfully.

*Robert N. Stavins is a university fellow at Resources for the Future and an associate professor of public policy at the John F. Kennedy School of Government at Harvard University. A detailed investigation of the topics explored in this article is forthcoming in the Journal of Environmental Economics and Management and in a discussion paper available from the author. A preliminary analysis is found in RFF discussion paper QE93-16.*

## Integrating Environmental Management and Economic Development in China

Walter O. Spofford Jr.

**The People's Republic of China is the world's most populous country—it is also one of the world's most rapidly industrializing nations. Explosive growth there is being accompanied by swiftly escalating pollution. To improve living standards and safeguard the international financial assistance that drives its industrial development, China must curtail the devastating environmental effects of its growth. Through various arrangements with the World Bank and other international organizations, RFF is helping China integrate environmental management with its spectacular economic development.**

In 1988, the State Education Commission of the People's Republic of China directed the People's University of China in Beijing to establish a curriculum in environmental economics. To support this initiative, the university approached Resources for the Future (RFF) for permission to translate into Chinese and publish fifteen RFF books

on environmental economics and management. Through these writings, RFF had, in the words of the Volvo Environment Prize awarded to RFF Senior Fellows Allen V. Kneese and John V. Krutilla, "established resource and environmental economics as a respectable and comprehensible research discipline." In turning to RFF, the People's University anticipated that the books would open the way to similar achievements in China.

The RFF-China Book Series quickly expanded to include a new overview volume written by Kneese, as well as a commitment from RFF to help apply the economic concepts of regional environmental quality management that RFF scholars had developed. Chinese officials, facing environmental challenges of massive proportions and recognizing a unique opportunity to link environmental protection with economic development, were seeking help in identifying appropriate projects that could be implemented over time by local authorities, as well as financial assistance for such projects.

Soon, RFF was engaged in technical assistance projects with the World Bank and the China Council for International Cooperation on Environment and Development, a nongovernmental body comprised of fifteen Chinese ministers and an equal number of international members. Through these activities, RFF began to develop relationships with government agencies and academic institutions throughout the country.

RFF organized its expanding China agenda to become part of its Environment and Development Program. Through the program, RFF provides technical assistance, conducts applied research and policy studies, and helps to build indigenous capacity to analyze, design, and implement environmental strategies and policies. Since the mid-1960s, RFF staff has provided assistance with environmental planning and management to the governments of South Korea, Malaysia, Taiwan, Indonesia, Thailand, Nepal, Pakistan, Egypt, Israel, Brazil, Poland, former Czechoslovakia, Hungary, Yugoslavia, and the People's Republic of China.

RFF's work in east Asia began in 1980 with an environmental sector study of South Korea conducted for the country's principal economic planning agency with support from the Asian Development Bank. RFF subsequently helped prepare an environmental master plan for Korea's Han River Basin, which includes the cities of Seoul and Incheon. The Korean government's decision to implement the plan's recommendations was pivotal to the country's obtaining the 1988 Olympic games.

In 1986-87, RFF assisted in preparing an environmental master plan for the government of Malaysia. The plan assessed the cost-effectiveness of environmental management strategies and the capacity of the regional economy to support investments in pollution control in the river valley that includes Kuala Lumpur, the national capital.

### Early projects in China: technical assistance and capacity building

The thrust of RFF's early work in China has been predominantly analytical, complemented by a sustained commitment to capacity building. Clear parallels exist between how master plan studies designed by RFF worked out in South Korea and Malaysia and how environmental planning and policy studies initiated by RFF are unfolding in China. Under a variety of administrative arrangements with the World Bank, RFF staff has initiated, designed, or conducted economic analyses for four technical assistance projects in China and has provided technical guidance for a fifth.

*Beijing Environmental Master Plan Studies.* By designing a study to evaluate least-cost strategies for managing air and water quality and urban refuse, RFF initiated a project that is expected to provide the foundation for investments in environmental infrastructure in Beijing through the year 2015. Referring to the success of the environmental master plan for the Han River Basin, RFF justified the



Photo by Walter O. Spofford Jr.

RFF pioneered the development of pollution-charge systems in the 1960s; now RFF is helping to make China's current pollution levy system more effective and efficient in controlling pollution such as this wastewater effluent in Sichuan Province.

inclusion of environmental master plan studies as a component of a World Bank environment loan to Beijing Municipality. These studies, are expected to be completed in late 1995.

*RFF is also helping to develop an indigenous Chinese capacity to integrate environmental management and economic development through fellowships, workshops, and on-the-job training.*

*Shanghai Environmental Master Plan Studies.* Based on the study design prepared for the Beijing work, the Shanghai studies are expected to provide the foundation for environmental planning in Shanghai Municipality through the year 2015. These studies are expected to be completed by mid-1995.

*Changzhou Least-Cost Environmental Planning Study.* Through the design of an environmental planning study for Changzhou, a city of some 500,000 people located near Shanghai, this project assisted the Chinese in developing a capacity at the national level to establish long-term strategic plans for managing air and water quality and urban refuse in metropolitan regions. City officials are using the results of this study to guide industrial land use planning and industrial relocation in the city, as well as to design a municipal sewerage system.

*Beijing Central Heating Project.* As part of preparation for the World Bank's Beijing environment project, RFF analyzed a proposal for providing commercial space heat through cogeneration at a suburban electric power plant while also achieving ambient standards for sulfur dioxide and suspended particulates through elimination of building boilers in the urban area. RFF's analysis demonstrated that the project, while not the least-cost strategy for providing space heat, was the least-cost option when improvements in air quality were also

considered. Based on RFF's analysis, the World Bank approved a construction loan for the project; construction was completed in 1994.

*Study of the Chinese Pollution Levy System.* RFF, which under the leadership of Kneese pioneered the development of pollution charges in the 1960s to reduce the costs of pollution control, designed a study to improve fee formulas, rate schedules, and the monitoring, enforcement, and administrative procedures in the existing Chinese levy system. The reformed system aims to promote economic efficiency in pollution control, distribute the costs of pollution control more equitably, raise revenues for environmental management, and raise capital for pollution control.

In parallel with its technical assistance efforts, RFF is developing an indigenous Chinese capacity to integrate environmental management and economic development. Activities addressing this goal have included, in addition to the RFF-China Book Series, an RFF visiting fellowship for Chinese scholars, an RFF summer intern program for Chinese graduate students in the United States, a workshop sponsored by the World Bank

on environmental economics and management, and on-the-job training of Chinese environmental economists working on RFF projects in China. As part of this capacity-building effort, RFF staff members hold academic appointments at both Peking University and Renmin University (formerly the People's University) of China.

### The next phase: regulatory reform

Five years of work by RFF in China paid off in 1994 with the initiation of a study for the World Bank on environmental regulatory reform in Chongqing Municipality, a heavily industrialized and severely polluted region of some fifteen million people in remote southwest China. RFF is leading a team that includes Chinese researchers from the Chongqing Environmental Protection Bureau and RFF-trained economists from Renmin University, Peking University, and Stanford University to assess the adequacy of Chongqing's existing regulatory framework for pollution control. If deficiencies are identified, the team will rec-

ommend adoption of more stringent emission and effluent standards and explore the feasibility of strengthening existing market-based instruments for controlling the region's industrial air and water pollution. The Chongqing project brings together the technical assistance, applied research, and capacity-building themes of RFF's environment and development strategy to address fundamental environmental policy issues.

### Other ongoing projects

RFF's China program gained momentum with the initiation of several new projects during the past year.

Researchers at Renmin University under the direction of RFF visiting scholar Ma Zhong (see "Inside RFF," page 13) are working with RFF researchers to estimate the costs and benefits of continued agricultural development in northeast China, including the costs of damage to the natural environment.

During the past fifteen years, China has instituted a number of policies to address its natural resource and pollution problems. These include emission and effluent standards, the use of emission and effluent fees, discharge permits, forced plant closings, and more recently the freeing of coal prices. In some cities, ambient monitoring data suggest that air quality is no longer deteriorating. RFF Fellow H. Keith Florig is evaluating emissions data from industrial enterprises in eighty-two Chinese cities to determine how patterns of pollution emissions have changed over time and whether apparent improvements in air quality result from environmental and energy policies or are a consequence of industrial restructuring brought on by economic reform.

Outdoor ambient concentrations of suspended particulates and sulfur dioxide exceed national air quality standards in most Chinese urban areas most of the time. The widespread use of biomass and coal for heating and cooking results in high indoor pollutant levels as well. Drawing upon existing epidemiological

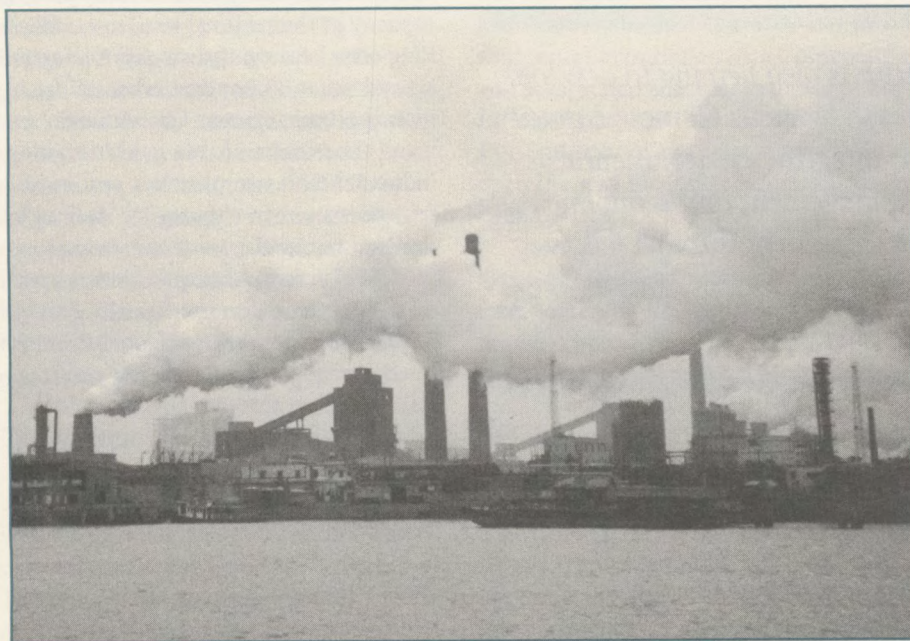


Photo by Walter O. Spofford Jr.

Industrial pollution in Shanghai, such as that shown here, will be brought under control after the environmental master plan prepared by the city has been implemented.

evidence in China and in the West, Florig is assessing the health impacts of air pollution in China. His preliminary findings suggest that air pollution is responsible for roughly a half million premature deaths and a billion lost workdays each year.

China is experimenting with several environmental policies that incorporate economic incentives to reduce emissions and effluents, shift production to cleaner industries, and discourage activities harmful to the environment. Market reforms, such as allowing enterprises to retain a portion of their profits, have resulted in significant improvements in the pollution intensity of industry measured by reductions in the mass generation of pollutants per unit of output. Under the sponsorship

*One RFF researcher is assessing the health impacts of air pollution in China; his preliminary findings suggest that pollution is responsible for roughly a half million premature deaths and a billion lost workdays each year.*

of the United Nations Environment Programme (UNEP), Florig, Ma Zhong, RFF Senior Fellow Walter O. Spofford Jr., and RFF Visiting Scholar Ma Xiaoying have prepared a description of the role of economic incentives in China's environmental policy. This report will be part of a comprehensive assessment by UNEP of the use of economic instruments in pollution control in developing countries.

A review of past and present energy-related air pollution problems in China by Spofford and RFF summer intern Liu Feng assessed prospects for future control of emissions from energy-related activities. Research is addressing issues related to monitoring, the use of economic incentives, and financing for pollution control. The goal of the study is to enhance under-

standing of the physical, economic, and social environments within which air pollution control policies are developed. Understanding of the interrelationships among technical, economic, financial, institutional, and social factors in environment and development will assist China to develop energy and environmental reforms that are consistent with the country's ongoing industrial restructuring and economic reform and with its goals for sustainable development.

### Forward thinking

RFF's program in China has recently taken new form. Through the efforts of Ma Zhong, a research institute modeled after RFF—the Beijing Environment and Development Institute—was established in China in late 1994. At the behest of the new institute, the Chinese government is setting aside increasing acreage of wetlands in northeast China that had originally been earmarked for agricultural development.

After the United Nations Conference on Environment and Development in 1992, most countries now accept that environmental protection and sustainable development are essential. This is especially relevant in east Asia, one of the world's fastest-growing regions, where sustained real annual growth rates are approaching 10 percent. With national wealth accumulating at this rate, unique opportunities exist now to coordinate environmental concerns and development goals in industrial investment decisions, policy design, planning functions, and institutional organization and responsibilities. Unless this coordination is achieved, concern for development goals will likely fail to integrate environment and development issues at local and regional levels where most decisions affecting the environment are made.

RFF has taken a comprehensive, long-range approach to assist China in achieving its twin goals of economic development and environmental protection: comprehensive, because for China to

## China Seminars

In addition to its work in China, RFF addresses issues related to China's environment through a series of seminars held in its Washington, DC offices. Launched in 1993 by RFF Fellow Keith Florig, the series has included presentations by people from universities, government agencies, and research organizations.

Those who wish to add their names to the mailing list for upcoming RFF seminars, including those on environmental issues in China, should contact RFF's Office of External Affairs: by phone, 202-328-5025; by electronic mail, [info@rff.org](mailto:info@rff.org); or in writing, 1616 P Street, NW, Washington, DC 20036-1400.

achieve these goals environment and development must be integrated in policy design and planning functions, and long-range, because it will take twenty or more years for the development process to play out and for urban areas to achieve levels of environmental quality comparable to those found in the most advanced cities of the world. China cannot afford to postpone these goals; the government policies and programs that are put in place today and the investments in fixed assets and decisions on the disposal of industrial wastes that are made today will affect the pathway of development and environmental damage well into the future.

*Walter O. Spofford Jr. is a senior fellow in the Quality of the Environment Division at Resources for the Future and director of RFF's Environment and Development Program. Currently, he directs RFF's half-dozen environment and development projects involving the People's Republic of China. He was assisted in preparing this article by Richard Getrich, RFF's director of publications.*

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1616 P Street, NW  
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