Thirty Years of Economics at the Environmental Protection Agency

Al McGartland

When the modern era of environmental policy began with creation of the Environmental Protection Agency and passage of the Clean Air and Clean Water Acts, economists and economics were little used. Over time, economics became a major contributor to formation of environmental policy. Executive Order 12291 pushed economics into the policy process but also rendered benefit-cost analysis controversial. I report on economics' role in the policy process over time and examine contributions by economists to environmental policymaking. Advancing benefit-cost analysis is an obvious contribution. I describe other areas in which economists have contributed and highlight milestones for economics at EPA.

Key Words: benefit-cost analysis, EPA, economics at EPA, Executive Order 12291, history of environmental economics

In 1984, I joined a small group of economists working at the U.S. Environmental Protection Agency (EPA). I arrived at EPA eager to apply economic tools and models to environmental problems. After a few months, I wondered if I had made a big mistake. To my dismay, many did not share my conviction that economics had much to offer to policymaking. The notion that economists, with significant input from other scientific disciplines, could or should conduct benefit-cost analysis and help inform regulatory decision-making was either completely foreign or opposed by nearly all. Even offering a conceptual analysis of the form of a potential regulation—market incentives versus command-and-control regulation—proved difficult.

Fast forward almost 30 years. Today, environmental economics is often (but not always) an essential part of the policymaking process. While not all EPA policymakers fully understand benefit-cost analysis and its underpinnings, there is widespread acceptance that economists contribute to our understanding of the consequences of environmental policy options and should be heard. Further, all of the various stakeholders in regulatory and policy development processes—decision-makers, industries, environmental groups, consumer groups, the U.S. Congress, and the White House—frequently draw on benefit-cost analysis in the course of policymaking. Economists at EPA offer suggestions on how to make regulations better by harnessing market incentives and cost-minimization incentives for polluters. Finally, economics is now considered a mainstream science, and economists, with knowledge of

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empirical methods, analysis at the margin, risk and uncertainty, and behavioral responses, are playing influential roles in risk assessment, research design, priority setting, and policy design.

I review the history of economics and its role in policymaking at EPA and provide insight into how economics has changed national environmental policy in the United States. EPA economists and economics make significant contributions to the agency that extend beyond the very important one of providing decision-makers with a sense of the benefits and costs of relevant policy options. An obvious triumph of economics is widespread adoption of market incentive-based policy instruments. Other noteworthy contributions by economists exist but may be less obvious. Taken together, these success stories—or failures, for those who think economics should have made even bigger contributions—provide lessons on how economics can play its role in the policy process. Have economics and economists made a difference to environmental policy? The answer, from my experience, is an emphatic yes. And some of our most profound influences have probably been outside the scope of a benefit-cost analysis.

Both in policy circles and in the policy literature, critics of benefit-cost analysis have argued that it is flawed and plays far too significant a role (Heinzerling and Ackerman 2005). That issue is beyond the scope of this discussion, although I do not want to leave the impression that economics dominates the policy process or is wholly embraced by every facet of EPA. At best, the "economist perspective" is presented alongside public health, legal, environmental, engineering, and political perspectives when briefing decision-makers. In some cases, the economic perspective is missing. Further, for rules that are not economically significant, full and complete economic analyses typically are not conducted. Nonetheless, economics is accepted as a "science" at EPA and is woven into the fabric of the EPA decision-making process.

Assessments of Economics at EPA Have Been Too Narrow

Few studies of the role of economics in environmental policymaking exist. Fraas (1991) looked at the role of economic analysis in the 1980s and concluded that economics sometimes improved regulation but more often was relegated to a very minor role of influence. Pildes and Sunstein (1995) examined the significance of Executive Order (EO) 12866 and its precursor, EO 12291, which required regulatory agencies to conduct benefit-cost analysis for all economically significant regulations. However, they failed to directly assess how economics affected environmental policy. Morgenstern (1997) examined the contribution of economics to environmental policy by presenting a series of regulatory case studies, each written by the EPA economist or consultant responsible for that analysis. The case studies and Morgenstern's overall assessment focused on the benefit-cost analysis done for specific regulations; they did not assess how economics and economists influenced policy in other ways. Morgenstern found overall that "the group of economic analyses studied here made significant contributions to the improvement of the agency's regulations" but "in many instances the economic analyses played only a minor role in actual decision making" (Morgenstern 1997, p. 2–3). Hahn and Dudley (2007) and Hahn et al. (2000) examined the quality of economic analyses at EPA and compliance with EO 12866. These studies found a great deal of variability in quality among regulatory analyses within and across EPA agencies.

These assessments examined the role of economic analysis in the policy process. However, the role of economics in EPA's evolution extends beyond economic analysis. The agency's analyses, paradigms, policy approaches, and mind-set would be different without economics and economists, leading directly to a very different set of policies.

EPA's economic history is presented in three distinct periods: (i) the early years when economics had an insignificant presence at EPA, (ii) the years following EO 12291 (followed by EO 12866) when economics assumed a more prominent role in the regulatory process, and (iii) the current period, which I characterize as a plateau and in which economics faces new challenges. An examination of this history underscores important lessons for improving the capability of economics to contribute to environmental policymaking. For example, it shows that the advancement of economics within EPA would not have been possible without partnership between academic researchers and economists inside EPA. Finally, I summarize economics' main contributions to environmental policy over the last quarter of a century.

Economics at EPA: The Early Years

> *Policy judgments are easier to come by the farther we are from our goals. If there are only two directions and we know which is forward and there are limits to how fast we can go, no fine discrimination is needed. If aid to the poor is far too little, highway traffic far too fast, building codes far too lax, teachers' salaries far too low, or the rights of defendants far too little observed, we know what we need to know to get moving. We can worry about how much is enough when we get close, if we ever do. Meanwhile, we can push on*. (1984, p. 1)
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> —Thomas Schelling

Environmental protection became a national priority in the early 1960s, most notably after publication of Rachel Carson's *Silent Spring* in 1962. *Silent Spring* was Carson's scathing attack on the effects of unregulated pesticide use. Throughout the 1960s, several environmental disasters coupled with Carson's book attracted public attention and led to increased demand for environmental protection, spurring the growing environmental movement. Use of Agent Orange in the already unpopular Vietnam War gave rise to serious questions about the ecological and human health effects of Agent Orange (TCCD) and of DDT (dichloro-diphenyl-trichloroethane), PCBs (polychlorinated biphenyls), and a number of other commonly used chemicals. A series of ten fires from oil and other ignitable pollutants on the surface of the Cuyahoga River in Cleveland, Ohio, not only generated cynical remarks but caused significant economic damage to railway bridges and surrounding properties. By 1970, the environmental movement had gone mainstream, fueled by broad concerns about the environment and specific threats to human health and safety.

In July 1970, Congress passed and President Nixon signed the law that established the EPA. President Nixon combined environmentally related programs from other parts of the government, including U.S. Departments of Agriculture (USDA), the Interior, and Health, Education, and Welfare, into a new agency. Armed with an ambitious new administrator, former Assistant Attorney General William Ruckelshaus, and a host of daunting responsibilities, EPA opened its doors on December 22, 1970.

To staff the new agency, lawyers, toxicologists, biologists, engineers, chemists, and other professionals were transferred from other agencies and merged with program specialists. Very few economists came with them. The only economists brought into the agency in the beginning were agricultural economists from USDA who would form part of EPA's new Office of Pesticide Programs.

The same year EPA began operations, Congress passed the Clean Air Act. Then, in 1972, Congress passed the Clean Water Act. Both of these statutes embodied the notion that we can have safe, even pristine, levels of environmental quality at a reasonable cost. For example, the Clean Air Act instructed EPA to establish air quality standards that, "allowing an adequate margin of safety, are requisite to protect the public health."[1] The law forbade EPA from considering costs when setting those standards, suggesting that Congress believed that pristine or at least "safe" levels of environmental quality were attainable at an acceptable cost. The major provisions of the act left little room for economic considerations.[2]

Hence, in the early days of EPA, there was little need, or at least little or no demand, to include economics in regulatory analyses. A strong mission, new statutes that provided little leeway for economic considerations, and public urgency in demanding action worked against investing in economists and other regulatory policy analysts. EPA hired plenty of MBAs (masters of business administration) to manage agency operations but economists were not included in the hiring plan.

Using well-developed theories, economists could have made big contributions in those early years. Because EPA lacked such guidance from economic professionals, its progress on market incentives was slow at best. The "command and control" strategies that were used at the time offered little incentive for technological change, and in many cases, de facto technology standards discouraged innovation. The states, which inherited most of the responsibility for designing and implementing plans to attain EPA's national environmental quality standards, would have benefited from guidance from economists on how to incorporate cost-effectiveness considerations.

Applied work by economists would have been more of a challenge. If EPA had added economists in the early 1970s, they might not have had the impact that economists in other agencies have had. Consider the development of environmental economics compared to agricultural economics. Economists at USDA have been influential in setting agricultural policy, particularly in the 1970s. One can easily imagine political leaders clamoring for economic analysis of the implications of agricultural subsidy levels, conservation reserve levels, and market conditions for a wide variety of agricultural commodities, and agricultural economists had a relatively well-developed tool chest for determining this information.[3] Agricultural commodities were well-defined. Research that had involved detailed agricultural surveys had characterized the cost of production with enough precision to build accurate economic models of

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[1] Section 109 (a)(1), Public Law 91-604 (Clean Air Act of 1970), 1970.

[2] Since the early 1970s, provisions of some environmental statutes have opened a door for economic considerations in regulatory decision-making, though not with setting national ambient air quality standards (NAAQS). At that point in time, EPA leaders believed that their statutory mandate was to set environmental quality standards that posed no appreciable risk and, at least for the NAAQS, costs were legally excluded from consideration.

[3] Kerry Smith first raised this comparison of agricultural and environmental economics at a seminar at EPA in the late 1980s.

the agricultural sector. Even reasonable ranges of price and income elasticities existed for each commodity. In short, agricultural economists delivered important information that led to informed policies.[4] Given this important contribution, USDA's relatively substantial investment in economics even in its early history is not surprising.

In contrast, most environmental "commodities" are public goods—they are not bought and sold in the marketplace. In 1970, we had far to go to establish standardized definitions of environmental commodities and no generally agreed upon way to measure the quantity or quality of each commodity. We had only vague notions of costs and an even vaguer sense of social value and income and price elasticities of demand. When research did provide estimates of benefits and costs, changes in technology, incomes, and tastes very quickly rendered those studies obsolete. Even cost-effectiveness analysis would have been a challenge.

With these observations in mind, it is not surprising that the formative years of national environmental policy at EPA largely took place without a major role for economics. Indeed, there were savvy "policy wonks" who understood some of our most crucial findings; by and large, however, economists were not represented, economic analyses were not undertaken, and policy was guided almost entirely by a strong public mandate to clean up the environment.

Laying the Foundation for Future Success: Resources for the Future and Academics

While EPA did not embrace economics, environmental economists outside of EPA made huge advances and laid a foundation for future success. Resources for the Future (RFF), founded in 1952, played a pioneering and influential role during the early days of EPA and became much more visible to economists and policymakers during the 1970s. The organization's books, workshops, and policy-oriented research were topics of hallway conversations at EPA in the early years. Inside EPA, converts to incentives and other economic-based regulatory tools were being won as a result of RFF's ability to communicate environmental economics research to the policymaking community. I suspect that much of RFF's early research was inspired by an intimate understanding of policy challenges (Portney 1978). RFF offered sound economic thinking to EPA as well as galvanized environmental economics research among leading research institutions. When I arrived at EPA in 1984, RFF was already a well-known brand and its public forums and written words became grist for the policy-formulation mill.

Based on work done at RFF, Ayres and Kneese (1969) integrated a material and energy balance paradigm into a general equilibrium framework. They showed that pollution was an inescapable part of the production process and that marginal costs would rise as abatement activity increased. Meeting our environmental goals was not a simple matter of requiring polluters to adopt basic control technologies.

It would be some time before EPA and Congress realized the lessons of Ayres and Kneese. While I cannot pinpoint an exact date, I do recall William Ruckelshaus, during his second stint as EPA administrator (1983–1985), saying

[4] Informed policy does not necessarily lead to welfare-maximizing policies. Agricultural subsidies can cause significant inefficiencies in the economy.

that when he first arrived at EPA in 1970 everyone thought we would attain clean air and water by promulgating a round of regulations and we would claim victory. Upon his return to EPA, it was clear that was not the case and that it was going to be much more difficult, that more resources, harder choices, and greater innovation would be required to attain a clean environment.

Beyond RFF, the discipline of environmental economics was attracting excellent economists and making real progress in developing theories and methods for economic analysis of the environment. Members of EPA's Office of Research and Development recognized the need for environmental economics research. In 1971, they started a small environmental economics research program. Over the next decade, the program evolved to include a small staff and funded extramural research grants. The early budget was about $3 million per year in the early 1970s.[5]

These early investments in research paid huge dividends. Seminal works on stated-preference methods for quantifying environmental benefits were funded by the program. Some of the more influential research from this program includes Brookshire et al. (1979), Crocker et al. (1979), Cropper et al. (1979), Mitchel and Carson (1981), Sharefkin (1983), Schelling (1983), and Vaughan and Russell (1982).[6]

The research sponsored by EPA between 1971 and 1983 funded seminal works on the stated-preference methodology for determining benefits, led to development of credible estimates of air and water pollution control benefits, and highlighted the possibilities for using economic incentives to control environmental pollution, which subsequently led to development of cap-and-trade and other incentive approaches.

Necessity Is the Mother of Invention: Emission Bubbles and Offsets

In addition to growing research efforts by environmental economists outside of EPA, market incentives got a big boost from EPA toward the end of this early period. The states were learning that attaining air quality standards would not be easy. Areas that had not met the air quality standards needed policies that would accommodate reasonable economic growth while making continued progress toward cleaner air. A small group of individuals at EPA who had legal, public policy, and economic expertise developed policies that allowed sources of air pollution to undertake limited trading. Some states adopted policies promoted by EPA to allow for the pursuit of such policies and formally institutionalized emission trading. Under this "bubble" policy, facilities that generated multiple sources of the same pollutant were permitted to overcontrol some sources in exchange for permission to undercontrol others so long as the net release was less than the aggregated permitted level. Once the offset policy was formalized, new facilities that emitted pollution could pay other such facilities to offset their emissions, thereby making room for new economic growth in nonattainment areas.

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[5] Even before correcting for inflation, this figure is several times more than the economic research budget today. In 1983, the research grant program was moved to the Office of Policy, Planning, and Economics and the base budget grew to more than $4 million per year. For an overview of this economic research by period, see *http://yosemite.epa.gov/EE/Epalib/ord1.nsf/8e2804a29538bbbf852565a500502e9e/e12e0572cca9eb05852566a40071bc23!OpenDocument*.

[6] I am grateful to Alan Carlin for providing this list of publications.

Outside economists and the mounting literature they created on the design and promise of market incentives converted a growing number of EPA policy analysts and lawyers into supporters of these new policy tools. In the 1970s, EPA lacked a sufficient inside presence of environmental economists to carry that message.

The use of market-incentive systems, broadly defined, was only the beginning for market incentives. Figure 1 depicts the growing adoption of incentive schemes at EPA over time.[7]

Figure 1 goes well beyond the early years to show that, by the 1990s, EPA was creating market-incentive programs with increasing regularity. Now, market incentives are in the mainstream. Instead of advocating for them to noneconomists, I often have to point out obstacles to effective incentives and show that sometimes other policy designs are superior.

Despite some successes, economists were not significant players in the EPA policy process in the 1970s. Soon, however, a major shift in the policy and political landscape would open the door for environmental economics. Thanks to work by environmental economists outside of EPA, we were ready to walk through.

Economics' Ascendancy in the 1980s and 1990s

> *There is rarely a problem that doesn't appear to demand—in addition to lawyers and anthropologists and biologists—an economist. The economist is usually invited because of a perception that, whatever else may be important, there are some important economic implications. The economist who joins up usually finds the "whatever else" more engaging than economics; though he pays his entrance fee in economics, he gets his satisfaction from the whole problem.* (1984, p. vii)
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> —Thomas Schelling

A decade of promulgating rules generated a more vocal industry prepared to question the need for more regulation. And while the environment did improve, the experience fueled only a slow cognitive progression in understanding the environmental quality control problem. Ayres and Kneese's (1969) characterization of the pollution problem was proven with experience as well as science, and EPA realized that attaining risk-free environmental quality levels could not be done quickly, if at all. Achieving safe levels of air and water quality, let alone pristine levels, was not as easy as first thought. Emissions and residuals were a necessary byproduct of the production process, and abatement costs rose as control efficiencies were increased. In addition, pollution sources were more diffuse and technologies were not as readily available as once thought. The more we researched the health and welfare effects of pollution, the more we realized that the notion of a threshold below which there would be no health effects was more wishful thinking than reality.

Economics Comes to the Fore (and Attracts Controversy)

In the 1980s, Ronald Reagan was elected to the presidency on a promise to limit, if not shrink, the role of government. One of his first executive orders,

[7] Thanks to Barry Elman for the data in the figure.

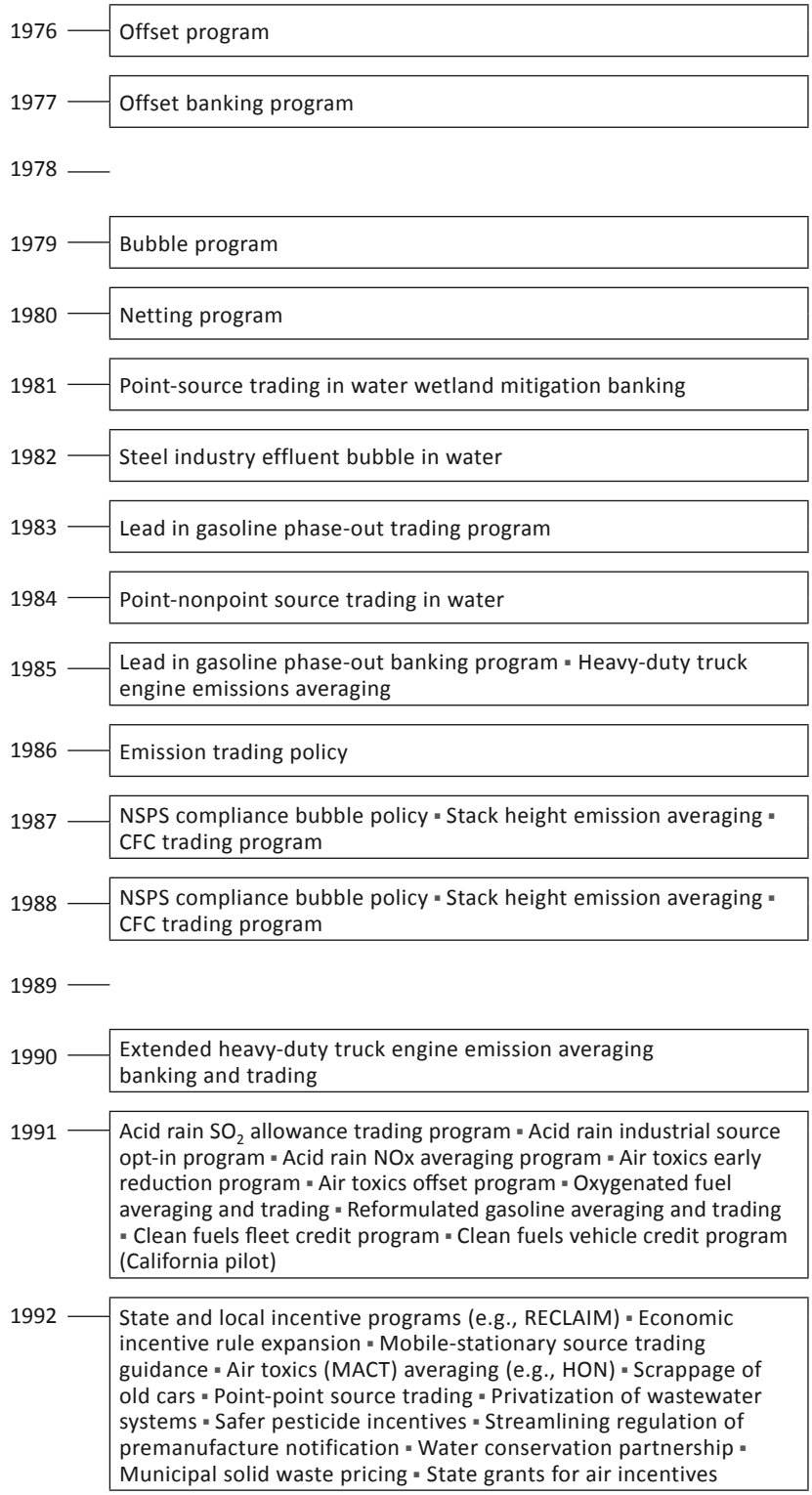

Figure 1. EPA Has Made Greater Use of Market Incentives over Time

EO 12291, had a profound impact on the use of economics at EPA. Specifically, EO 12291 required that a "regulatory impact analysis" (including an assessment of benefits and costs) be conducted for all economically significant EPA rules. Had the order stopped there, who knows what would have happened. But EO 12291 went much further. It specified that, to the extent permitted by law, the policy option that maximized net benefit should be selected. It also gave the Office of Management and Budget (OMB) responsibility for reviewing all regulations for compliance with the order.

In short order, EPA needed to conduct numerous benefit-cost analyses. EO 12291 is the single biggest reason that economics became an important part of the agency's policymaking process in the 1980s. It is also the principal reason why economics in general and benefit-cost analysis in particular are so controversial and misunderstood by many stakeholders and special interests. Because EO 12291 simultaneously called for benefit-cost analysis and a regulatory policy review by OMB, the two became linked. Through that connection, many came to perceive the OMB regulatory review as the process and benefit-cost analysis as the tool by which environmental protection would be rolled back. In hindsight, separating the OMB policy-review requirement from the mandate to conduct scientifically sound benefit-cost analysis might have been better. Such a separation would have allowed the analyses to go forward as largely scientific (positive) endeavors, perhaps including an independent peer review. OMB then could have engaged in the policy discussion through a separate, normative policy review process.

Linking OMB review and benefit-cost analysis fed a widely held suspicion that benefit-cost analysis was a tool for deregulators, a means by which the Reagan administration could fulfill its agenda of deregulation and less government.[8] At the time, few within EPA believed economic analysis could be used to justify additional regulation, and few were truly interested in an unbiased look at what the analysis could say about efficient policy design. Most did not understand what benefit-cost analysis was. Hence, it was viewed by many as a political tool, not a science. Economics became a necessary evil within EPA. Benefit-cost analysis was tolerated but seen more as a procedural box to be checked than as a source of insight and information. Many at EPA and in other stakeholder groups would argue against and even actively resist letting economics into the regulatory process.

EPA could not ignore EO 12291. Realizing that reality, EPA began hiring economists. The major program offices (Air, Water, Waste, Toxic Substances, and Drinking Water) started building economic staffs that would be responsible for producing the analyses. EPA's policy office, which was dominated by MBAs, also created an economics branch that housed a small group of Ph.D. economists (myself included). Bill Ruckelshaus rejoined EPA, accepting a second stint as administrator in 1983. He and his deputy administrator, Al Alm, entertained economics-based policy arguments along with public health, legal, and engineering perspectives when formulating policy. Dick Morgenstern and Milt Russell, both experienced Ph.D. economists, joined EPA in key senior leadership positions in the policy office.

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[8] Since then, separating technical reviews from policy reviews by OMB has been proposed. The proposals have typically suggested that Congress should institute a separate, independent agency to provide technical review of EPA's (and other agencies') regulatory analyses and allow OMB to engage on policy issues informed by the analyses.

Still, the vast majority of EPA staff members did not understand or want economics. They feared that benefit-cost analysis would serve only to second-guess their recommendations. As OMB's reviews became more prominent, program officers decided that they needed to invest in economics and began conducting studies of their own. Some were done jointly with EPA's central policy office (precursor to the National Center for Environmental Economics). Many of these program leaders advocated an investment in economics, mainly benefit analysis, to insure that the benefits of a regulation would be adequately captured in the policy analysis.

In addition to EO 12291, other developments served to make economics more relevant.

1. *Environmental economics was still young but became a mainstream field of economics.* Inside EPA, economics was becoming a science. The Science Advisory Board created a permanent subcommittee for economics, and senior scientists and the advisory board pushed for more economics, not less. Allen Kneese and Kerry Smith were the first co-chairs of this committee.
2. *Environmental problems were becoming more complicated.* The path forward was not always clear. Banning one pesticide because it posed unreasonable dietary risks might lead to farmers using another pesticide that could cause significant bird kills. Cars and light duty trucks were responsible for a growing share of air pollution.
3. *Pollution (residuals) had to go somewhere.* The low-hanging fruit had largely been picked and polluters were moving up the curve on marginal control costs.
4. *Regulatory information packages were not standardized and were incomplete.* Some analyses emphasized risk to the "maximum exposed individual" and ignored the population risk altogether. Some programs filtered the science by requiring higher-quality studies for inclusion in policy analyses. Uncertainty was often ignored, and the degree of "precaution" embedded in the risk analysis varied dramatically. Often, the risk analysis was based on a 0–1 framework—either there were health effects at a certain level of exposure or there were not—that ignored variability across populations. The variance in information and inconsistent assumptions were areas where risk assessors and economists could work together. Benefit-cost analysis would become the basic framework by which presentation of risks, costs, and other information would be standardized across EPA programs.
5. *Some EPA programs used decision criteria that did a poor job of reflecting social preferences.* This gave rise to public concern about both over-regulation and under-regulation.

OMB officials were citing a lack of benefits demonstrated for proposed rules and suggested that EPA should rethink its proposals.[9] Striving to capture benefits, EPA economists learned how to integrate risk assessment and

[9] Perhaps the most famous example is David Stockman, then director of OMB, who pointed out that EPA's acid-rain-reduction proposal would cost $10,000 per fish saved. Prior to making the proposal, EPA economists had proposed undertaking a benefit-cost analysis, but the agency's senior leadership did not think it was necessary. In addition to reducing acidic deposition, co-benefits associated with improved visibility, material damage, and public health could have been quantified (based on the author's recollection).

exposure modeling into their benefit-cost framework, and entrepreneurial economists began the search for economic efficiency. Sometimes those analyses raised concern that the cost of a regulatory option was a bad social investment. For example, the required controls might have an extremely high cost per life saved. To be sure, these early analyses had many shortcomings, but the dearth of analyses made even sketchy information potentially powerful.

In the search for economic efficiency, many compelling cases for additional regulation were uncovered. When EPA's operating paradigm for decision-making differed from the public's concerns, a benefit-cost analysis sometimes revealed that further regulation was warranted. EPA could be "out of touch" with the public's willingness to pay for environmental actions. In fact, there were several analyses that changed at least some people's minds about economics being a tool of deregulators. Analyses of benefits of controlling stratospheric ozone depletion provided strong momentum for implementing the Montreal Protocol, an international agreement to limit production and use of ozone-depleting substances. Two big contributions in the domestic arena that changed the way many people at EPA felt about benefit-cost analysis dealt with Alar (a plant growth regulator) and lead in gasoline.

Regulating Pesticides prior to 1985. In the early 1980s, most economists would have had plenty of criticism for EPA's regulatory approach to pesticides. Many of the pesticides then in use had been registered prior to development of methods by which to assess the long-term chronic risks associated with them. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) charged EPA with reviewing all of those pesticides, which required an evaluation of chronic risks. If the benefit of using the pesticide did not exceed the risk, EPA was to ban or restrict further use. If the benefit of use was greater than the risk, the pesticide was to be reregistered. Prior to the advent of benefit-cost analysis, the pesticide office compared the absolute risk of using the pesticide to changes in farm income, which was defined as the benefit of using the pesticide.

There were two major problems with this approach. First, the regulator should be focused on incremental reductions in risk. If EPA canceled the registration of a particular pesticide, farmers would turn to substitute pesticides so the risk associated with substitution needed to be incorporated as well. Second, changes in farmers' incomes were not a proper measure of the benefit of using—or cost of canceling—the pesticide.

In the mid-1980s, economists in the policy office worked with the pesticide office to do a proper benefit-cost analysis of Alar, the growth regulator used on apples and other fruit. The resulting analysis made a compelling case for removing Alar from the market—the cost per cancer avoided was extremely low even at the margin when considering a total ban of the chemical as opposed to reduced applications. Some within the pesticide office objected; the biologists argued that apple growers very much relied on the chemical and that farm income losses would be unacceptable. The policy office argued for cancellation of Alar. The pesticide office argued against that option based on there being insufficient information about the risk.[10] Thus, Alar was permitted to remain on the market pending further review and data development. CBS's *60 Minutes* followed with a story about how Alar and its metabolite, UDMH (unsymmetrical dimethyl hydrazine), were making their way into apple juice

[10] Interestingly, not regulating because of incomplete data provides chemical manufacturers with a powerful incentive to withhold toxicity and other data.

and other fruit products. Meryl Streep testified before Congress about Alar's dangers. The public reacted strongly—daycare centers and school systems removed apples and apple products from school meals and apple sales plummeted. Alar's producer, Uniroyal Chemical, ultimately removed Alar from the market voluntarily after all of the negative publicity.

While the reaction to the risk posed by Alar was excessive, economists were in a position to say that the panic could have been avoided if EPA had regulated Alar even with the limited data available. With this case, it became clearer to EPA managers that economics did not always conclude that regulation should be weakened.[11] Farm income ceased to be an appropriate measure of the benefit, and the risk associated with substitutes began to be included in agency analyses.

Banning (rapid phase-out) of Lead in Gasoline. The early motivation for removing lead from gasoline was lead's harmful effects on catalytic converters, not humans. Lead in the gas would harm the catalyst and render it much less effective at reducing criteria air emissions. Lead remains a cheap way to increase the octane rating of gasoline. Older cars without catalytic converters were originally permitted to continue to use leaded gasoline but newer cars with catalysts were not. Survey data revealed that a large percentage of motorists were "cheating" and using cheaper, higher octane leaded gasoline. Senior EPA officials wondered if it made sense to ban leaded gasoline altogether and force all motorists to use unleaded gasoline.

A team of economists and risk assessors was assembled to conduct a benefit-cost analysis. Original research by Joel Schwartz suggested that exposure to lead not only caused neurological effects in children but also raised blood pressure in adults. Therefore, reducing the amount of lead in gasoline promised to directly improve health. That benefit combined with improved air quality from better functioning catalytic converters swamped the cost of removing lead from gasoline.[12]

As with Alar, EPA's analysis of lead in gasoline was widely criticized by scientists inside the agency. They pointed out the significant degree of uncertainty in the analysis, though uncertainty had been addressed. Nonetheless, the links between use of leaded gasoline and levels of lead found in blood samples, a biomarker for lead exposure, were very compelling. The health effects of elevated levels of lead buttressed the case that society would be better off without leaded gasoline. Bill Ruckelshaus decided to phase out the use of lead in gasoline, and EPA promulgated the regulation.

Retrospectively, the decision seems like a "no brainer." At the time, it was a big deal, and the large expense associated with it naturally brought out opponents. To bring down the cost, EPA proposed a lead banking and trading program that allowed refiners that reduced lead faster than required to bank credits for sale or use in the future. But, more importantly, the benefit analysis was compelling. OMB accepted its conclusions and the regulation went forward. Without the benefit-cost analysis, the regulation likely would not have been approved.

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[11] Incidentally, the apple industry rebounded quickly. In November 1990, *The New York Times* reported that the industry overall had suffered little fallout. See Shabecoff (1990).

[12] Lead remains a very cheap way to raise the octane of gasoline. Octane ratings reflect the ability of gasoline to resist premature ignition.

Market Incentives

Benefit-cost analysis was not the only "economics" to influence policy. Largely because of important research done by economists outside of the agency, EPA was ready to consider economic incentives in new environmental initiatives. I already mentioned that EPA was quick to adopt a banking and trading scheme for the lead phase-out program. Eileen Claussen, then director of the EPA office responsible for implementing the stratospheric ozone program, was committed to finding a marketable permit scheme to phase out the use and production of chloroflourocarbons (CFCs) and other chemicals that deplete the ozone layer. She became a forceful and articulate advocate of marketable permits. Her staff also understood the political economy of a permit scheme, that grandfathering CFC permits to producers could win their support for regulation. Amendments to the Clean Air Act in 1990 also contained a new Title IV that called for establishing an acid rain trading program. Arguably, the program would, in a short amount of time, be the most successful pollution-control scheme in history, though impetus for the scheme came from political appointees outside of EPA as well. High-level officials in the Bush administration, with the support of Robert Hahn, formerly at the Council of Economic Advisors, and policy leaders at the Environmental Defense Fund, put together the landmark proposal for a cap-and-trade system for sulfur dioxide emissions from coal-fired electric power plants.

Other Contributions by Economists

As time passed, economists were being invited to policy briefings and option-selection meetings. Benefit-cost analysis got us in the door, but once there, we proved our worth in many other ways. As the quote from Tom Schelling at the beginning of this section suggests, economists will naturally find other areas to contribute beyond economics. Following are some examples.

Differentiated Regulation (new source bias). Policies typically impose more stringent requirements for new sources of risk. Economists pointed out the consequences of this practice. New, potentially safer pesticides could not be registered and allowed to compete with existing pesticides. Tighter standards for new emitters of pollution extended the economic lives of dirtier existing emitters. There is no question that differentiated regulation still exists at EPA. My contention is that it would be worse were it not for economists arguing these points.

Ordinal Measures to Indicate Risks (or other attributes) of Pollution Problems. Risk assessment tools, particularly ones that depend on animal toxicity data, are often noisy and rarely comprehensive. Some early approaches assigned cardinal scores to ordinal rankings and aggregated across attributes. It was straightforward to show how such approaches easily could lead to increased risk.

Comparative Risk Studies. When Dick Morgenstern, then head of the central economic/policy office at EPA (now at Resources for the Future), proposed a major study to assess relative risk for all of the environmental problems in the United States, many in the EPA were skeptical. Yet, with the administrator's support, EPA produced the first comparative risk assessment, which subsequently became a major tool for budget and priority setting.

Technology Standards. In the early days of EPA, technology standards were appealing because they offered the potential for certainty and enforceability.

Even performance standards at the time were anchored by a technology. Economists took every opportunity to highlight the problems associated with the standards, and over time, EPA began to emphasize performance standards and emission trading over strict technology standards.

Other Risk-Risk Tradeoffs. Economists infused the EPA with a new appreciation of the law of unintended consequences. Many consequences could not be predicted ahead of time even with careful analysis. For example, agricultural subsidies increased not only the production of food but also intensive fertilizer and chemical use and more nonpoint-source pollution.

The Clean Air Act Retrospective Study. The Clean Air Act Amendments of 1990 called for EPA to assess the benefit and cost of all clean air regulations. EPA first undertook a retrospective study assessing the benefits and costs achieved by clean air efforts between 1970 and 1990. In addition to improved methods for benefit estimation, the retrospective study's empirical findings determined that the net benefit of controlling particulate emissions had been impressively large. Those findings and the results of subsequent studies were later used by both the Clinton and G.W. Bush administrations to aggressively regulate particulate emissions.

Risk Assessment Improvements. There are two areas of risk assessment to which economists made important contributions. First, economists were some of the first scientists to estimate pollution-dose response curves from broad, cross-sectional data sets. Their studies were seminal works that inspired a new subfield of epidemiology that merged environmental data with national or regional health-outcome databases. Prior to that time, risk assessors had relied mainly on data on animals or from test chambers. Economists studied the relationship between particulate matter and measures of morbidity and mortality risks. Shortly thereafter, these studies were incorporated into EPA's benefit-cost analysis and were the basis for most of the agency's major regulatory efforts, which generated extremely large net benefits over the next 20 years. Second, economists reexamined the toxicity models that supported EPA's risk assessments. Much of the toxicology for noncancer health endpoints had estimated a reference level of exposure—an amount "that is likely to be without an appreciable risk of deleterious effects during a lifetime." Economists realized that this type of hazard assessment could not support estimating benefits from changes in pollution. We needed continuous dose-response functions that could provide the probability of an effect from any level of pollution exposure. Hence, EPA economists began working with risk assessors to build new models that allowed for estimation of marginal benefit (risk reduction). That work continues today.

Thinking on the Margin. While economists approached every policy problem with an appreciation of marginal analysis, professionals trained in law, ecology, and health sciences did not. During policy briefings, economists often found themselves pointing out that the marginal net benefit is different than the total net benefit. Since costs and benefits typically are not linear, this distinction becomes very important. Economists' perspective about thinking on the margin extends well beyond policy briefing packages. Ecologists and other scientists often seek to understand how an ecosystem functions. By collaborating with economists, the scientists were able to design studies that could realistically estimate how ecosystem services would change as a result of a change in pollution.

Economics at EPA Today

Today, economics enjoys the status of a science and plays a meaningful role in the regulatory process. As director of the National Center for Environmental Economics, I sit on EPA's Science Policy Council, a cross-agency group designed to resolve science and science policy issues. Our Science Advisory Board has a very active Environmental Economics Advisory Committee comprised of leading environmental economists, and that committee reviews development of EPA's guidelines for preparing economic analysis and offers advice. The guidelines govern the proper conduct of economics, another sign that economics is considered a science at EPA. Most important, when environmental issues are identified, economists are routinely included in task forces, work groups, and initiatives aimed at tackling those issues.

Recent EPA rulemaking on ethanol illustrates how economics is now a major consideration for the agency. The Energy Independence and Security Act of 2007 required EPA to set mandatory minimum quotas for use of renewable fuels by mobile sources (use was to grow from 9 billion gallons in 2008 to 36 billion gallons by 2022). The legislation requires EPA to mandate use of large amounts of corn ethanol unless EPA finds that ethanol would not reduce emission of greenhouse gases. In the 1970s, EPA probably would have had engineers look at a "model plant," examine the net emission from manufacture of ethanol from corn, and compare that to greenhouse gas emission from burning an equivalent amount of gasoline. EPA's recent analysis was designed and conducted by economists with input from engineers and explored many ramifications of an ethanol policy, including "indirect" impacts from increases in agricultural production abroad as the price of ethanol feedstocks (i.e., corn) increases. Several agricultural economic models were included, along with consideration of consumer responses (e.g., rebound effects).

Economics acquiring the status of a science is important. With this stature comes the responsibility to adhere to peer review and other scientific standards. When analyses are completed, decision-makers can seek to understand the methods and results of those studies but cannot order changes to them (at least not without considerable risk of being charged with a lack of scientific integrity). Decision-makers can ask for additional analyses, sensitivity analyses, and peer review by authoritative bodies and can question the reasonableness of some analytic approaches. But if scientific standards are maintained, the analyses are, for the most part, upheld. The economists have a corresponding responsibility to conduct analyses that are consistent with mainstream sciences and to provide transparent, unbiased results. This is a challenge for all regulatory analysts. Subtle biases introduced by poor benefit-transfer applications, optimistic assumptions, and improper baseline characterizations can make a big difference in the results.

Every transition to a new administration presents a new challenge for EPA economists. Some stakeholders believe that benefit-cost analysis dictates what to do. Not so. Rather, benefit-cost analysis is a tool for decision-makers. We look forward to opportunities to explain how we conduct those analyses and how they can assist in decision-making. We are eager to explain that economists do not place a value on human life; rather, we measure what people are willing to pay to experience a very small reduction in the risk of mortality in their own lives. We struggle with reconciling how job changes induced by a regulation should be accounted for in the analysis, and we recognize that an analysis of

benefits and costs speaks to efficiency but not to equity or other concerns. We expect that economics will be ever more relevant for future administrations, not less. In crafting climate change policies, economics will likely be a dominant science, though it is not clear how benefit-cost analysis will be received for such a difficult problem.

Finally, the analyses that have accompanied each economically significant regulation have bestowed a major "co-benefit." Each analysis is placed in the public docket and EPA asks for public comment on every regulatory proposal, including the analysis. Benefit-cost analysis provides for a more transparent process. Stakeholders, the regulated community, the public, and Congress can see how EPA quantifies social benefits and costs and can challenge EPA. Did we ignore important science? Did we underestimate the costs? Did we use "junk" science? Did we comply with standard peer review requirements? Advances in computing, networking, and web technologies increasingly allow the public to simulate our policies using our models and data.

Groups and individuals opposed to environmental regulation typically hold that the cost of regulation greatly exceeds the benefit. Those who broadly want more regulation hold the opposite view. While there are many potential criteria for making decisions, unbiased, honest scientific assessments of benefits and costs (including behavioral responses), coupled with economists' advice on policy formulation, will only grow in importance in the future. I want to thank the research community for providing EPA with the economic tools, theories, and insights needed to bring economics to the policy table.

I began my career at EPA thinking I had made a big mistake. And while there are many challenges and frustrations associated with serving as an economist at EPA, it is the best professional decision I have made.

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