No. 190 • 2015

RESOURCES

RESOURCES FOR THE FUTURE

SPECIAL ISSUE:
Creating Equity in Environmental Policy

Resources

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Published since 1959, *Resources* (ISSN 0048-7376) contains news of research and policy analysis regarding environmental, energy, and natural resource issues. The views offered are those of the contributors and should not be attributed to Resources for the Future, its directors, or its officers.

Printed with soy-based inks on 50% recycled (and recyclable) paper containing 25% postconsumer fiber, processed chlorine free, in an FSC-certified plant.

MIX Paper from responsible sources FSC® C006849

PRINTED WITH SOY INK

Cover photo © Ron Haviv/VII/Corbis

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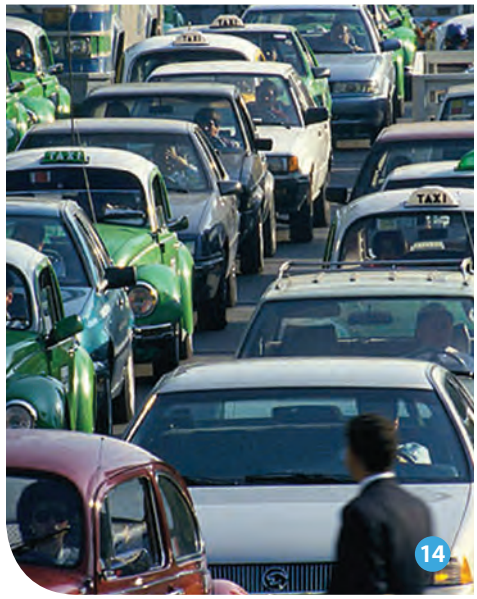

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In This Issue

Alpízar

Francisco Alpízar is the director and a senior research fellow at the Environment for Development Initiative Center for Central America. His fields of specialization include environmental policymaking and economic valuation of the environment.

Blackman

Allen Blackman is the Thomas Klutznick Senior Fellow at RFF. An expert on environmental and natural resource policy in developing countries, he focuses principally on industrial pollution control and tropical deforestation in Latin America and Asia.

Burtraw

RFF Darius Gaskins Senior Fellow **Dallas Burtraw** is one of the nation's foremost experts on environmental regulation in the electricity sector. For two decades, he has worked on creating a more efficient and politically rational method for controlling air pollution.

Darmstadter

Fredrik Carlsson is a professor of environmental and behavioral economics at the University of Gothenburg's School of Business, Economics, and Law. His research interests include behavioral economics and environmental economics, particularly stated preference methods.

Davies

Joel Darmstadter is a senior fellow at RFF, which he joined in 1966 following earlier stints in the corporate sector and at several research organizations. He specializes in the economic and policy aspects of energy and the environment and has written, coauthored, and contributed chapters to numerous books and journal articles.

Epanchin-Niell

J. Clarence Davies is a political scientist and senior fellow at RFF who, during the last 30 years, has written several books and numerous articles about environmental policy. While serving as a consultant to the President's Advisory Council on Executive Organization, he coauthored the reorganization plan that created the US Environmental Protection Agency.

Hafstead

Rebecca Epanchin-Niell is a fellow at RFF. Her research focuses on ecosystem management, particularly understanding how human behavior affects ecological resources and identifying strategies to improve management.

Marc Hafstead is a fellow at RFF. His research spans environmental and macroeconomics, with an emphasis on developing detailed dynamic general equilibrium models.

Kroetz

Kailin Kroetz is a fellow at RFF. Her research focuses on policy questions related to coupled natural–human systems in marine and terrestrial ecosystems.

Leard

RFF Fellow **Benjamin Leard**'s research covers several areas of environmental and energy economics, with a particular focus on distributional issues in climate change policy and regulation in the transportation sector.

Andrew Liebhold is a research entomologist at the US Forest Service's Northern Research Station. Much of his research focuses on understanding ecological processes operating during the arrival, establishment, and spread of biological invasions.

McConnell

Virginia D. McConnell is a senior fellow at RFF and a professor of economics at the University of Maryland, Baltimore County. She works on environmental issues related to air pollution and urban transportation.

Morgenstern

RFF Senior Fellow **Richard D. Morgenstern**'s research focuses on the economic analysis of environmental issues with an emphasis on the costs, benefits, evaluation, and design of environmental policies, especially economic incentive measures.

Marisol Rivera Planter is the deputy director of sectoral and regional models at Instituto Nacional de Ecologia y Cambio Climatico in Mexico.

Sanchirico

James N. Sanchirico is a professor of environmental science and policy at the University of California, Davis, and an RFF university fellow. His work primarily focuses on the economic analysis of marine policies, especially the effects of individual transferable quotas and marine protected areas.

Stone

Chad Stone is the chief economist at the Center on Budget and Policy Priorities. He has been part of the center's efforts, begun in 2007, to ensure that climate legislation includes measures to protect low-income households.

Williams

Roberton C. Williams III is a senior fellow and the director of academic programs at RFF. He studies both environmental policy and tax policy, with a particular focus on interactions between the two. In addition to his roles at RFF, he is a professor at the University of Maryland, College Park, and a research associate of the National Bureau of Economic Research.

Creating Equity in Environmental Policy

At RFF, we often talk about the importance of economic analysis in developing cost-effective policy solutions to environmental and natural resource challenges. For economists, this means identifying how to get the most "bang for the buck," reducing—or even eliminating—the tension between protecting the environment and growing the economy.

This approach focuses on the costs and benefits to the overall economy, but it provides only one important litmus test for good public policy. Other factors inevitably go into the calculus. The costs and benefits of any policy have disparate impacts on sections of the population or regions of the country. Wise policymakers often will want to know who wins and who loses, motivated by fairness, political necessity, or the avoidance of damage to an important economic sector when the overall benefits are not critical for society.

This issue of *Resources* looks at several policy approaches through this prism.

Roberton Williams, Dallas Burtraw, and Richard Morgenstern examine the impacts of a carbon tax across states and income groups, showing how different uses of the resulting revenue might ameliorate distributional concerns. Lump-sum rebates are the most progressive of these uses, and in a companion piece, Chad Stone proposes how to design and implement such rebates using existing tax and benefit systems.

Marc Hafstead and Roberton Williams analyze how environmental policies might impact jobs. Although the overall effect is relatively small, there are important transitional issues: jobs are lost in dirtier industries in favor of new ones in cleaner sectors.

Allen Blackman's work with international colleagues shows that Mexico City's program to reduce traffic congestion and air pollution requires the poor to bear a disproportionate cost.

Kailin Kroetz and James Sanchirico focus on Alaskan fisheries to show how attempting to resolve fairness questions within a permit trading program can diminish its economic returns, a cost that must be balanced against the program's social goals.

Joel Darmstadter explores what may be the distributional issue of the next century: the likelihood that the most devastating impacts of climate change will be felt by the poorest nations, which don't have the economic and institutional capacities to adapt.

By identifying who stands to benefit from policy proposals and who stands to lose (and by how much), economic analysis can help resolve legitimate political concerns about fairness, increasing the chances that sound policies are ultimately implemented. That remains the goal at RFF.

Phil Sharp, President
sharp@rff.org

The Benefits of Preventing Invasive Species: Timing Matters

Rebecca Epanchin-Niell and Andrew Liebhold

Experts estimate that invasive plants and animals in the United States cost the nation billions of dollars in damages each year. However, empirical studies of invasion costs and impacts primarily focus on short-term damages rather than long-term total costs, which are important for quantifying the benefits of preventing invasions.

In our new research published in *Ecological Economics*, we find that temporal factors are critical to determining the long-term invasion costs and evaluating the benefits of quarantine and prevention policies. We focused in particular on the lag time between an invader's arrival and the initiation of damages, as well as the persistence of damages.

Several characteristics of invading species cause damages to accrue quickly, or over a larger area, increasing the benefits of prevention:

- short lag times between their introduction and spread;
- short lags between their arrival and the initiation of damages;
- larger, short-lived damages as opposed to smaller, persistent damages;
- faster or earlier spread; and
- larger potential range sizes.

To illustrate, we predicted the long-term impacts for two forest insects currently spreading through North America—the aphid-like hemlock woolly adelgid and the gypsy moth—from the time of their introduction to their potential future saturation of the eastern United States. We focused on residential property value loss,

Table 1. Long-Term Impacts of Two Invasive Species, from Introduction through Saturation

Species	Lag time	Saturation	Estimated long-term damages
Hemlock woolly adelgid	60 years	100 years	Less than $4 million
Gypsy moth	11 years	Multiple centuries	$250 million

the largest single type of damage caused by each species. The disparity across our "back-of-the-envelope" damage estimates for the two species (Table 1) arises from differences in the local damage potential of each species as well as their temporal characteristics.

The timing and pattern of spread vary greatly for each insect. The hemlock woolly adelgid experiences a long lag time (Table 1) but then saturates climatically suitable portions of the eastern United States in only 100 years (Figure 1). In contrast, the gypsy moth invasion unfolds over multiple centuries (Figure 2) after a relatively short lag time (Table 1), saturating a much larger swath of the United States. These temporal characteristics should be considered in species risk analyses and economic evaluations of quarantine and eradication programs. ●

Figure 1. Past and Predicted Future Spread of the Hemlock Woolly Adelgid (following 60-year lag time)

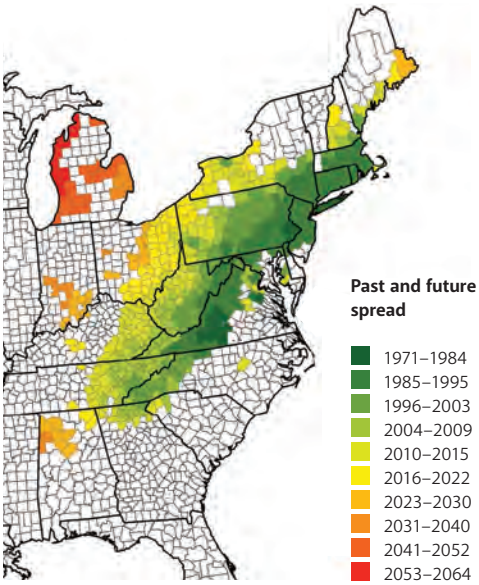
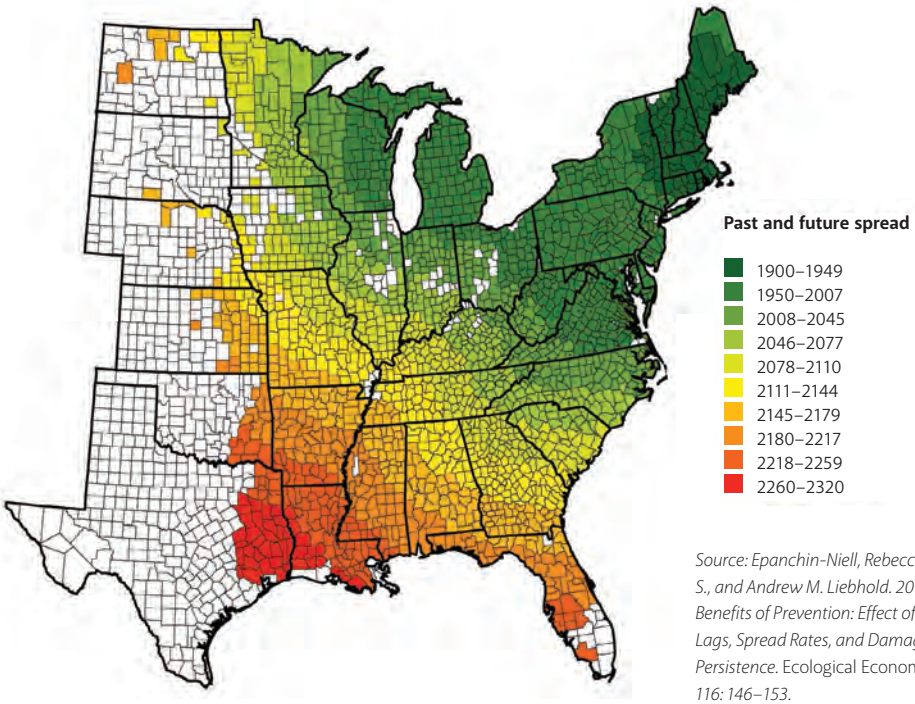


Figure 2. Past and Predicted Future Spread of the Gypsy Moth (following 11-year lag time)



Source: Epanchin-Niell, Rebecca S., and Andrew M. Liebhold. 2015. Benefits of Prevention: Effect of Time Lags, Spread Rates, and Damage Persistence. Ecological Economics *116: 146–153.*

Highlights from Recent Events at RFF

Food and Human Innovation

"Food is the real way that we need to use our ingenuity, and what our species has done for so long over millennia is to figure out how to manipulate the enormous bounties of our planet—the biodiversity, genetic resources, water, and recycling apparatus of our planet—combined with our incredible ability to accumulate and share knowledge."

Ruth DeFries, Denning Family Chair in Sustainable Development, Columbia University; May 27, 2015

The Employment Impacts of Environmental Policies

"It's important to understand where job losses are because they are always going to be an important part of the debate. [This is] in part because of the very high emotional and financial costs that unemployment can impose on dislocated workers and their families—and, in some cases, on the whole community."

Terry Dinan, Senior Advisor, Congressional Budget Office; May 6, 2015

Energy Leasing Decisions in the US Arctic

"We have a duty to consider the interests of subsistence users, and we take that very seriously. Alaska Natives vary in terms of whether they're against or for development, but I would say they're unified in their shared interest to protect [these] resources so they're around for use."

William Brown, Chief Environmental Officer, Bureau of Ocean Energy Management; April 1, 2015

The Upcoming UN Climate Negotiations in Paris

"I don't think we can leave Paris without an agreement . . . and I think the political situation is different [than in previous years]. The US–China joint declaration [gave] the signal that the world is ready. We see everyone moving, and we see that even those who couldn't think of making contributions—the poorest countries—are in the process of preparing their Intended Nationally Determined Contributions."

Anna Lindstedt, Ambassador for Climate Change, Government of Sweden; April 21, 2015

Encouraging Renewable Energy in China

"The big challenge is [China's] electricity institution. In China, from my own view, we have no electricity market. In our study, we [assume] that by 2025, China must establish a completely [competitive] market. If by 2025 we cannot establish this electricity market, [there will be] no hope for [high penetration of renewable sources]. So the next 10 years will be very important for China."

Wang Zhongying, Director, China National Renewable Energy Center, and Deputy Director General, Energy Research Institute, National Development and Reform Commission (China); April 20, 2015

To view videos and presentations from these events, visit www.rff.org/events.

Above: Ruth DeFries at “Creative Conservation: How Humanity Innovates to Protect Nature.”
Below (clockwise from middle): Terry Dinan at “How Do Environmental Policies Affect Jobs?”; Wang Zhongying at “Report Release of China 2050 High Renewable Energy Penetration Scenario and Roadmap Study;” William Brown at “Reforming Offshore Leasing in the US Arctic;” and Anna Lindstedt at “Looking Ahead toward Paris: International Perspectives on National Commitments.”

Adaptation: An Essential, but Lagging, Part of Global Warming Policy

Joel Darmstadter

What does the Republic of Vanuatu, an island nation in the South Pacific, have in common with the state of California? Whether the former's inundation, brought on by Cyclone Pam in March of this year, was exacerbated by sea-level rise or whether the latter's prolonged drought similarly might be an early harbinger of global warming—each case dashes the illusion that there is time to spare. Even if there were, the long-term benefits of a global greenhouse gas mitigation regime remain an uncertain prospect. In short, a delay in adaptation to unavoidable climatic threats is an unaffordable luxury. Action can no longer be averted on account of eventual mitigation measures.

At the same time, adaptation presents unique challenges, unlike those associated with mitigation. Although Vanuatu and California may share vulnerability to the same underlying climatic phenomenon, the comparison exposes a striking asymmetry. The United Nations Population Fund classifies Vanuatu as "one of the most vulnerable nations to natural hazards," emphasizing that it "faces the challenge of eradicating widespread poverty in the face of climate change." As in California, the nation's leaders have developed a detailed climate adaptation strategy that identifies not only the risks but also options, policies, and plans for action. But in contrast to Vanuatu's clear lack of the economic resources needed to put such plans in place, California's financial ability to confront climatic stress and threats will not hamper its ability to act, as evidenced by the aggressive launch of Governor Brown's water-management reforms.

The dual challenges of mitigation and adaptation were firmly established more than a quarter century ago. In a 1989 essay, Roger Revelle, an eminent oceanography and climate science scholar, underscored in particular the vulnerability of poor agricultural economies to climatic stress (in the RFF Press book *Greenhouse Warming: Abatement and Adaptation*). More recently, at RFF's Fourth Hans Landsberg Memorial Lecture in December 2006, Nobel Laureate Thomas Schelling focused still more pointedly on the economic disparity that deprives many developing countries of the resilience and means to address the same climatic threats that face advanced countries. The core challenge, in Schelling's

A delay in adaptation to unavoidable climatic threats is an unaffordable luxury.

Ngalueng K. Iatakee, Mayor of Abaiang Island Council, shows the changing landscape of Abaiang, a Kiribati island where severe coastal erosion and saltwater intrusion caused the village of Tebunginako to relocate more than 15 years ago.

2006 reflections, is one of providing financial support to climatically vulnerable poor countries, even recognizing that international aid programs rarely work out as smoothly as hoped: "[W]hat we have to worry about is the developing countries, where a third of the [GDP] may be agricultural. And maybe for half the population, they live on agriculture—many of them subsistence agriculture. . . . And there, I think, is where we look for the most severe impacts of climate change."

Indeed, there are bound to be circumstances where even the prospect of financial support offers necessary, but far from sufficient, relief from the threat of climate change. Take the case of another Pacific island nation—that of Kiribati, where the highest point (a mere three meters) is already threatened and is below sea-level peaks likely to materialize long before a global climate protocol may offer the distant prospect of stabilized shoreline conditions. Out-migration of Kiribati's population could be an obvious, if virtually unprecedented, defensive strategy. But neither have the nation's 100,000 citizens yet acceded to such a solution, nor have countries with the territorial capacity to absorb such a relatively modest population size shown any willingness to consider accepting them—perhaps because of the tactical temptation to conflate an environmental plight with the unwelcome specter of refugees fleeing political, military, or economic turmoil. Whatever the impediments, they have not stopped Kiribati's President Tong from actively pursuing the possibility of land purchases on Fiji to resettle his nation's population.

But it would be unfair to associate the prospects of climate-induced demographic upheavals with just the unique circumstances of small Pacific island states. Therefore, picture the contrasting case of, say, Bangladesh—a poor and still relatively low-emitting developing country of more than 160 million people, often cited for its particular susceptibility to major coastal flooding and attendant loss of life among its sizable coastal population. With Bangladesh having an overall population density three times higher than India's, relief through inland migration to higher ground is an unrealistic safety valve. Under a global carbon tax regime, the country could see some relief from increasing coastal inundation that a stabilizing climate would confer—but only in a matter of decades. Only at that point might the country benefit disproportionately from greenhouse gas emissions abatement to which the world's leading emitters would be committed. Until then, however, along with whatever foreign assistance it may receive, Bangladesh would almost certainly have to rely predominantly on its own adaptive capacity and financial resources for coastal protection.

Advocates for climate change action are pressing vocally and understandably for the earliest possible enactment of mitigation policies (such as a carbon tax or its effective equivalent). The evident urgency of adaptation measures notwithstanding, it's hard to dispel the thought that such groups—both private and public—may be hesitant to blur policy discourse by injecting adaptation as a vital complementary initiative to address global warming. Perhaps there is apprehension that doing so would dilute the preventive and priority goal of mitigation. Time, unfortunately, does not offer the luxury of a prolonged failure to recognize the respective demands of both mitigation and adaptation.

Almost surely, the benefits of a successful adaptation strategy will have to materialize well before the efficacy of a mitigation policy takes hold. A carbon tax that comes into force, say, by 2020 might trigger some anticipatory behavioral fuel shifts and other changes, but its estimated full effects would lag for many years to come. And even considering the long-term benefits of a mitigation policy, there will inescapably be unanticipated circumstances requiring alternative action; in other words, strategies to build and ensure adaptive capacity will endure as a needed tool of global warming policy. Perhaps even more evident now than in Schelling's perspective of a decade ago will be the continuing financial and equity challenges posed by climate change.

The benefits of a successful adaptation strategy will have to materialize well before the efficacy of a mitigation policy takes hold.

In the context of global warming issues, it might be misplaced to underscore the argument for adaptation almost as emphatically as the imperative to abate emissions. That said, I believe it's fair to characterize adaptation as a seriously lagging and neglected matter of concern—one that, moreover, may continue to pose burdens that even an elusive carbon tax era may not altogether put to rest. ●

This article originally appeared on RFF's blog, *Common-Resources*, www.rff.org/blog.

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How COSTLY Are DRIVING RESTRICTIONS PROGRAMS?

EVIDENCE FROM MEXICO CITY

Allen Blackman, Francisco Alpízar,
Fredrik Carlsson, and Marisol Rivera Planter

If you think traffic congestion and air pollution are bad where you live, a visit to Mexico City may provide some perspective. The average commuter there spends the equivalent of three 40-hour work weeks stuck in traffic each year. And some sections of the city have unhealthy concentrations of every major pollutant.

Perhaps not surprisingly, government officials in Mexico City have resorted to heavy-handed tactics to deal with these problems. Among them is the "Day Without Driving" (*Hoy No Circula*) program, which since 1989 has banned some vehicles from driving one workday each week (and since 2008 one Saturday each month), depending on the last digit of the license plate.

At first blush, this policy had some attractive features. It seemingly removes a significant fraction of vehicles from the city's roads six days a week. There appears to be an element of fairness because license plate numbers determine which vehicles are banned each day. And implementation seems relatively straightforward.

But on reflection, there is plenty of room for doubt. Used vehicles, particularly old and highly polluting ones, are relatively inexpensive in Mexico City. What if drivers purchase clunkers to commute on days that their primary cars are banned, increasing the number of vehicles in the city and maybe even overall driving? And what if drivers simply shift driving to unrestricted days, so that net driving does not drop? In fact, several rigorous evaluations of the Day Without Driving program have concluded that it has not cut congestion or pollution over the long run for exactly these reasons.

Why then has the program been kept in place for a quarter century? One reason is that we know virtually nothing about the costs it imposes on households or the distribution of these costs across socioeconomic strata. On the face of it, these costs could be substantial. Depending on where in Mexico City households are located, public transportation can be inaccessible or otherwise unattractive. So the costs of not being able to drive one or two days per week could be quite large. Moreover, one would expect these costs to be highest for poorer households that can least afford second cars, taxis, and delivery services. We conjectured that a rigorous analysis of the costs to drivers of the Day Without Driving program could help generate political will for reforming it.

But how can the costs of driving restrictions programs be measured? Simply adding up costs for representative drivers is likely

to be impractical because of the challenges of counting nonmonetary costs (such as lost time), estimating the costs of complex adaptation strategies, and controlling for ancillary benefits of adaptation measures.

For these reasons, we used a novel survey-based approach: the contingent valuation (CV) method, which is primarily used to value environmental and health-related nonmarket goods, such as clean air and water. A CV survey typically describes a program or project that would generate a change in the nonmarket good—for example, a municipal sewage project that would improve water quality—and then asks respondents questions about their willingness to pay for it. Given a representative sample, the CV survey data can be used to calculate total willingness to pay for the program or project, which is a measure of its total value.

We adapted this method to measuring the costs of Mexico City's Day Without Driving program. To our knowledge, ours is the first application of the CV method to estimate the costs of a real regulatory program. Our survey describes a program that exempts drivers from weekly driving bans. We administered it door-to-door to a random sample of 2,500 drivers in the greater Mexico City metropolitan area, and we used the responses to calculate the total willingness to pay for rescinding the regulation, which is a measure of the total cost the regulation imposes.

Based on responses to our CV survey, we estimated the costs of the Day Without Driving program to be US$77 to $103 per vehicle per year—about 1 percent of the annual median income in our sample. Given that there were 4.7 million vehicles in the Mexico City metropolitan area the year our survey was administered, these estimates imply that the total cost of the program is US$367 million to $490 million per year—roughly 3 percent of the 2013 gross domestic product of Mexico City.

Our analysis indicates that the Day Without Driving program is regressive: we find that the cost of the program is not significantly different for rich and poor drivers and therefore represents a larger fraction of income for poorer drivers.

Although Mexico City probably has the world's most famous driving restrictions program, several other megacities, including Beijing and São Paulo, have similar initiatives. Altogether, more than 50 million people are now subject to intermittent driving bans. Recent studies of the benefits of these programs have been decidedly mixed. Our results suggest that whatever benefits these programs may or may not have, they can be quite costly and may disproportionately hurt drivers from poorer households. Although additional evidence from other programs is needed to determine whether and how our results generalize, the findings should give pause to policymakers currently using or considering driving restrictions to address vehicular pollution and congestion. ●

FURTHER READING

Blackman, Allen, Francisco Alpízar, Frederick Carlsson, and Marisol Rivera Planter. 2015. A Contingent Valuation Approach to Estimating Regulatory Costs: Mexico's Day Without Driving Program. Discussion paper 15-21. Washington, DC: RFF.

How Do ENVIRONMENTAL POLICIES Affect Employment?

MARC HAFSTEAD AND ROBERTON C. WILLIAMS III

When the US Environmental Protection Agency (EPA) announced its landmark Clean Power Plan in June 2014, it immediately sparked political debate over the proposed regulation's effects on employment. While EPA Administrator Gina McCarthy touted its potential to "encourage investment that expands domestic industries and secures good paying jobs here at home," Senator Mike Enzi (R-WY) represented the opposite stance: "The administration has set out to kill coal and its 800,000 jobs."

This focus on jobs is understandable, given the large potential welfare effects of involuntary unemployment. However, economic studies of the effects of environmental regulation don't yet adequately answer the question of how regulation will affect unemployment. Economists have taken different approaches to analyzing this issue—including empirical evaluation and modeling efforts—but all have shortcomings. Empirical studies, for example, fail to measure the effects on unregulated industries. An even more serious problem is that some of these studies use firms in unregulated industries as controls. To the extent that regulation affects employment at those firms, such studies not only will miss the effects on unregulated firms but also will yield biased estimates of the effects on regulated firms. They also ignore important job creation and destruction dynamics—for instance, are regulations causing layoffs or just reduced hiring?

More comprehensive economy-wide models generally find that environmental regulation causes small decreases in overall employment. But this approach has problems, too. Most notably, it assumes that the economy is at full employment—that everyone who wants a job finds one. In this case, unemployment is always a voluntary choice.

To better understand how environmental regulation affects employment, we developed a new model that takes into account the whole economy, recognizes that people don't find jobs immediately (and that unemployment is never zero), and permits a rigorous cost–benefit analysis that includes effects on jobs. It also takes into account a host of important labor dynamics, such as the costs to employers of finding and hiring workers, employee turnover, and incentives created by unemployment compensation.

In our model, unemployed workers search for jobs and are matched with recruiters from one of two sectors: a polluting regulated sector and a nonpolluting unregulated sector. Because the probability of finding a job is less than one each period, some unemployed workers will remain unemployed for a number of periods until they are matched into a job. Also, in each period, workers may lose their jobs. We use data from the Bureau of Labor Statistics to determine these job finding and job loss probabilities. We then apply the model to analyze three policy scenarios: a $20 per ton carbon tax with revenue returned as a lump-sum rebate to households, the same carbon tax with revenues used to reduce payroll taxes, and a performance standard that achieves the same emissions targets as the carbon tax.

We find that imposing a carbon tax leads to 2.5 to 3 percent fewer jobs in the polluting sector of the economy. Performance standards have a much smaller effect on those industries, with a drop of about 0.25 percent.

In all three policies, however, the job losses in the "dirty" sector are nearly offset by an increase in employment in the nonpolluting sector. Because the carbon tax boosts the price of the carbon-intensive goods, demand shifts from those goods to cleaner substitutes, thereby increasing employment. Consider, for example, a shift away from coal-fired electricity to electricity generated from renewable sources. The shifts are smallest under the performance standard and largest when the carbon tax revenues are used to reduce payroll taxes.

Consequently, the net effect on the unemployment rate in all three policies is relatively small. Instead, the policies mainly cause a shift in labor from the polluting to the nonpolluting sector. The largest unemployment effect is seen with the carbon tax with lump-sum rebates; in that policy, the unemployment rate rises by 0.26 percent. The carbon tax with revenues used to finance payroll tax cuts and the performance standard produce almost no net effect, with unemployment rates rising by 0.02 and 0.04 percent, respectively.

In addition to modeling employment impacts of environmental policies, our model also can consider other labor market outcomes, such as the average length of an unemployment spell and average after-tax earnings. As with net unemployment, we find almost no effect of any of the three policies on the average length of an unemployment spell. At most, the length would increase by only two days. For average earnings, a carbon tax with lump-sum rebates reduces long-run average earnings by almost 1 percent, but the change in long-run average earnings under a carbon tax with payroll tax cuts or a performance standard is near zero.

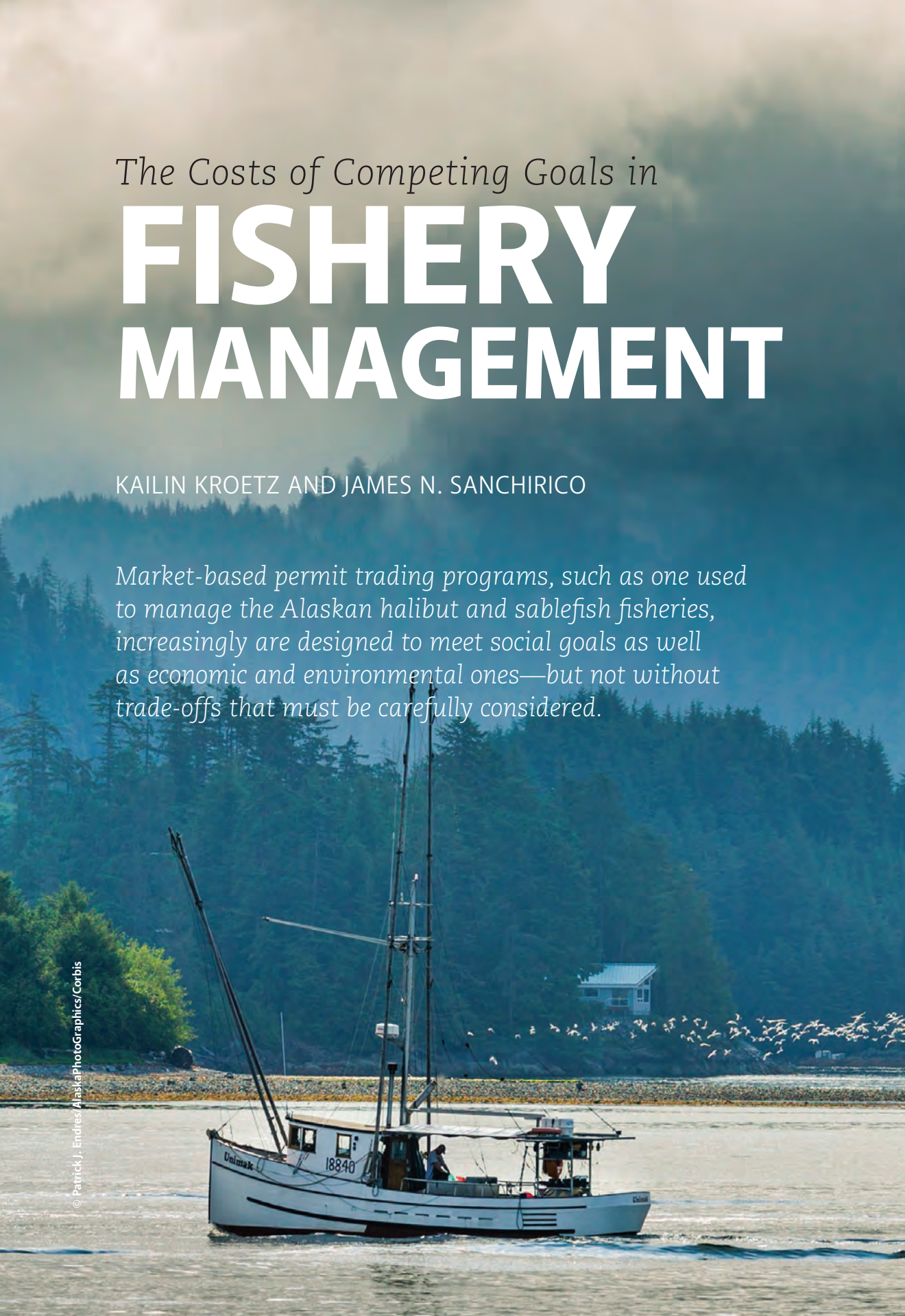
Our results suggest that the overall effects of major environmental policies on unemployment aren't likely to be a substantial factor in the evaluation of those policies. The effects on the labor market are much more of a job shift than net job loss. Phasing in the policy over time, providing money for buyouts, and retraining workers can all limit the costs of reallocation caused by the implementation of a major environmental policy. ●

The Costs of Competing Goals in

FISHERY MANAGEMENT

KAILIN KROETZ AND JAMES N. SANCHIRICO

Market-based permit trading programs, such as one used to manage the Alaskan halibut and sablefish fisheries, increasingly are designed to meet social goals as well as economic and environmental ones—but not without trade-offs that must be carefully considered.



In 2015, the National Oceanographic and Atmospheric Administration's (NOAA's) annual census of US commercial fisheries reported that the number of fisheries classified as overfished had dropped to its lowest number since the census started in 1997. Many lauded the success of approaches in the United States to sustainably managing the nation's fisheries—and they specifically credited the Magnuson-Stevens Fishery Conservation and Management Act with this progress.

Passed in 1976, the Magnuson-Stevens Act is the primary law in the United States that governs marine fishery management in US federal waters. According to NOAA, it "fosters long-term biological and economic sustainability of our nation's marine fisheries out to 200 nautical miles from shore," using scientific analyses to evaluate fish stocks and provide economic benefits.

One policy tool for managing federal fisheries in the United States is market-based permit trading, or quota, programs. These programs function by setting a cap on total fish harvested and allocating permits (called quotas) to fishers, authorizing the holder to fish a portion of the total harvest and also allowing fishers to trade quotas. Historically, a primary motivation for implementing permit trading programs has been to increase economic efficiency. Under the assumption of well-functioning markets, quotas are expected to be traded to the most profitable fishers and thereby maximize the profitability of fishing the available catch.

Increasingly, fishery managers aim to design these trading programs to also meet socioeconomic objectives, such as job retention in remote fishing communities. In fact, National Standard 8 of the Magnuson-Stevens Act requires that the design and evaluation of management policies take into account the impacts on fishing jobs and communities in order to sustain participation and minimize adverse economic impacts. Objectives related to the welfare of coastal fishing communities arise due to the dependence of local economies (for example, school attendance and grocery store revenues) on the presence of fishers and their families. However, addressing these socioeconomic concerns is not without cost, and there is no consensus on how best to address these objectives in the design of management policies.

Increasingly, fishery managers aim to design trading programs to meet socioeconomic objectives, such as job retention in remote fishing communities.

To better understand the trade-offs inherent in designing programs to meet competing goals, we recently collaborated with Daniel K. Lew of NOAA to study a tradable permit program used to manage the Alaskan halibut and sablefish fisheries. The program is well suited to studying multiple objectives. Restrictions on quota trading were imposed to address concerns about the potential impacts of the program on the social and cultural characteristics of fishing communities in Alaska—for example, the concern that larger operators would buy out smaller operators. Not only is the program designed to meet social and community goals, it also is one of the longest-running tradable permit programs for fisheries in the United States, and NOAA has collected detailed data throughout the course of the program related to its functioning. This allows us to develop one of the few empiri-

Small-scale commercial fishers catch halibut by hand using longline gear in Southwest Alaska.

cal measurements of the costs of meeting these non-efficiency goals. Our results suggest that trading restrictions come at a significant cost, reducing permit value by as much as 25 percent.

The Alaskan Halibut and Sablefish Program

The Alaskan halibut and sablefish program was implemented in 1995 by the North Pacific Fishery Management Council, the regulatory body overseeing the management of the fishery. Prior to the implementation of individual transferable quotas (ITQs), both fisheries were managed using restrictions on season length as a means of restricting catch. However, both fisheries went through periods where significant numbers of boats entered the fishery, causing the season lengths to be progressively shortened in an effort to avoid exceeding the annual catch limits.

This changed with the introduction of the ITQ program. At the inception of the program, the North Pacific Fishery Management Council granted revocable permits, called quota shares, to past participants in the fisheries. The quota shares were allocated based on the fishing history of each participant. Ownership of quota shares for a species grants the owner the privilege to fish a percentage of the species' total allowable catch—which is set to sustain healthy fish populations—in an area each year and in perpetuity. Yearly allowances in pounds of fish, called individual fishing quota (IFQ) pounds, are determined by multiplying the percentage of the total allowable catch to which an individual is entitled by the total allowable catch.

By setting a cap on total catch and allocating the catch to fishers via yearly quotas, the yearly total allowable catch could be met while allowing fishers to fish for the entire year.

To keep smaller-scale fishers and those from more remote communities in business, quotas were set aside for relatively small operators and those with small vessels. This has the effect of restricting trade between large vessel owners and relatively small vessel owners and between larger and smaller fishing operations. Two restrictions are of particular importance: the vessel class

Halibut is brought aboard a commercial fishing vessel in Ikatan Bay, Alaska.

restrictions, which limit the use of specific quotas to boats based on their length, type, and ownership; and a practice called "blocking," which makes some quota shares tradable only as an indivisible block that can be owned only by relatively small-scale operators.

Vessel Class

The vessel class restriction dictates the ownership, type, and length of vessels permitted to fish IFQ pounds, based on four categories. With regard to ownership, Class A quota shares and IFQ pounds are the least restrictive: they can be owned by a corporation or an individual, and can be fished by a vessel with or without the owner on board. All other classes of quota shares may be fished only when the owner of the IFQ pounds, who must be an individual, is on board. The class also dictates the type and length of the vessel on which the IFQ pounds can be fished.

In both fisheries, Class A is the only one that can be fished on "catcher-processor" vessels—of any length—that both catch fish and process it at sea. All others must be fished on catcher vessels, which deliver their catch to shore-side processors. Classes B and C in the sablefish fishery and Classes

B, C, and D in the halibut fishery designate a variety of sizes of catcher vessels on which the IFQ pounds can be fished, from largest (B) to smallest (D).

Blocking

The blocking restriction makes some quotas transferable only as an indivisible block. At the beginning of the program, participants who had relatively little fishing history received their quota allocations as a block. Holding more than one block of quota shares disqualifies a participant from holding unblocked quota shares. Furthermore, there is a limit on the number of these small blocks that a participant fishing blocked quotas can hold, which effectively limits the total amount of quotas such a participant can own.

Estimating the Costs of Restrictions Using Quota Prices

In our analysis, we examined one of the best empirical measurements of the economic value that results from ITQ program implementation: data on the prices participants received when selling their restricted and unrestricted quotas to other participants over the years 2000 to 2011. Quota prices reveal the economic return to the fishery resource. We focused on how the vessel class and blocking restrictions affected the value of quotas.

In total, we estimate a $73 million reduction in the value of the quotas due to the vessel class restriction and a $28 million reduction due to the blocking restriction in the halibut fishery. In the sablefish fishery, the impact also is dominated by the vessel class restriction: the associated reduction in value totals $36 million, relative to an $8 million reduction attributable to the blocking restriction.

Comparing the aggregate cost of both restrictions to the total value of the quotas in each fishery gives us estimates of the percentage efficiency loss due to the set of restrictions. Across all our models and the time period 2000 to 2011, we find that the vessel class and blocking restrictions in the Alaskan ITQ program reduce the total value of quotas in the halibut and sablefish fisheries by 25 percent and 9 percent, respectively.

The vessel class and blocking restrictions in the Alaskan ITQ program reduce the total value of quotas in the halibut and sablefish fisheries by 25 percent and 9 percent, respectively.

Conclusion

When multiple management goals exist, using a single policy instrument to accomplish all the goals simultaneously poses challenges for policy design and can reduce a policy's economic efficiency. A tradable permit program can create additional economic value, but as we have shown, altering program design to address other objectives entails trade-offs. But introducing restrictions on a program's design also can have positive impacts, including furthering social and community goals, and can lead to buy-in from stakeholders and earlier program implementation. Policymakers must weigh the expected costs against potential benefits.

Designing tradable permit programs to address multiple objectives occurs in settings outside of fisheries, such as for regulation of air, water, and other sources

In Homer, Alaska, workers prepare to ice and box halibut dumped from a commercial fishing boat.

of pollution. Our current results are relevant for the design and assessment of programs attempting to achieve multiple objectives through the imposition of trading restrictions. For example, programs often include only a subset of user groups, limiting the efficiency gains from potential trades among sectors. In some of the recently implemented pilot programs for carbon cap and trade in China, sectors including transportation, water, hotels, restaurants, and public institutions are excluded from the programs.

We also can look to distributional concerns over who will bear the burden of a policy change, which are commonly considered during policy design. For example, there is concern about the impact of market-based climate and air quality regulations on less well-off citizens and countries, and questions about how trading of pollution allowances may impact citizens in areas where permits are bought and sold.

Learning from past experiences by quantifying the costs and benefits of current program designs can lead to a better understanding of the impact on outcomes—and ultimately to the development of better methods to assess proposed program designs in the future. Building on this research, we are working with NOAA researchers Daniel K. Lew and Steven Kasperski to retrospectively evaluate the impact of the vessel class and blocking restrictions on community-level outcomes under the Alaskan halibut and sablefish ITQ program—particularly the effect on vulnerable communities and community participation in the fisheries. This work will help determine whether the quota trading restrictions have contributed to or detracted from meeting National Standard 8, as well as give a more complete picture of the costs and benefits of including social objectives in the design of Alaska's ITQ program. ●

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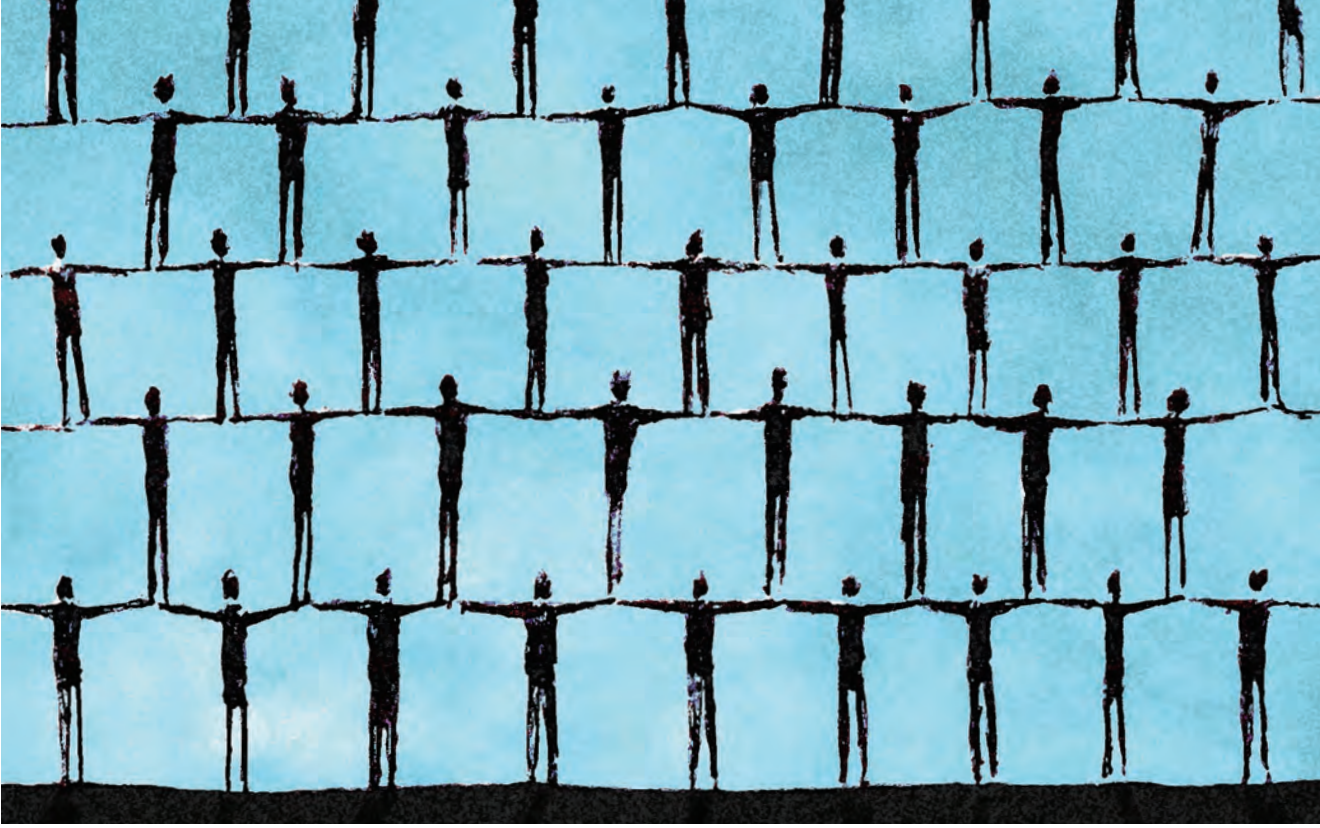


The Impacts of a US

CARBON TAX

across Income Groups and States

A tax on carbon dioxide emissions will create huge revenues, and how they are distributed will determine whether the policy leaves households worse or better off.

ROBERTON C. WILLIAMS III, DALLAS BURTRAW,
AND RICHARD D. MORGENSTERN

This May, six of Europe's largest oil and gas companies penned an open letter to the United Nations affirming their support for a carbon price. BG Group, BP, Eni, Shell, Statoil, and Total wrote that although they have already begun participating in carbon markets and applying "shadow" carbon prices to their investments, national governments ultimately will need to take charge of implementing carbon prices "even-handedly" to reduce "uncertainty about investment and disparities in the impact of policy on businesses."

These potential disparities—not just among businesses, but also among households—have become a subject of increasing interest to economists, many of whom agree that pricing carbon emissions is the most efficient way to reduce greenhouse gas pollutants. Both a carbon tax and a cap-and-trade program introduce a price on carbon and, in so doing, affect different regions, businesses, and households in different ways. Both also create an asset of significant value—the tax revenues or allowances—and the distribution of that asset greatly affects who gains and who loses from carbon pricing.

In our new research, we modeled the impacts of a carbon tax with three different ways to distribute the revenue and looked at the initial effects on US households. Each of these could alternatively be interpreted as cap-and-trade policies with a marginal allowance price equal to the tax level, and with the allowance value used in different ways. Each scenario uses a $30 tax per ton of carbon dioxide (CO_2). The policies recycle the revenue according to the following alternatives:

» Scenario 1: Revenue is returned to households via lump-sum rebates.

» Scenario 2: Revenue is used to cut taxes on capital income.

» Scenario 3: Revenue is used to cut taxes on labor income.

We then went a step further by determining the effects of these policies across US income groups as well as US states. Our results confirm that the effects of a carbon tax on energy prices are somewhat regressive, but that recycled revenue can be used to outweigh this effect.

Modeling a Carbon Tax

To best illustrate the near-term effects of a carbon tax, we linked together two new models of the US economy, providing a more holistic representation than in previous literature. The first model gives an estimate of how consumer prices, wages, returns to capital, and government transfers change upon the implementation of a carbon tax. The second shows how those changes affect households across states and income groups based on changes in individual spending patterns.

We modeled a $30 tax (measured in 2012$) per ton of emissions on all fossil fuel–related CO_2 emissions, under each of the three revenue-recycling scenarios. Cuts to capital and labor taxes are assumed to be onetime, permanent actions that occur at the same time as the carbon tax. Lump-sum rebates would be annual tax-free payments to each household member (regardless of age) that begin when the tax is implemented. Most policy proposals for a carbon tax have a rate that rises faster than inflation, but

We modeled the impacts of a carbon tax with three different ways to distribute the revenue and looked at the initial effects on US households.

for simplicity, we assume that the tax rate rises at the inflation rate.

Impacts across Income Groups

We first examined changes in welfare—measured as a percentage of annual income—across US income groups under the three revenue-recycling scenarios to understand how households experience the immediate, short-term effects of each policy (Figure 1). It's important to note that the results omit the environmental benefits of a carbon tax resulting from reduced greenhouse gas emissions and changes in conventional air pollutants. Because the emissions reductions that do occur are very similar—though not identical—across all three policy cases, not accounting for these benefits doesn't significantly affect the relative attractiveness of any one policy option.

Also, the national averages in Figure 1 are not equal to the averages of the effects across income groups. A 1 percent change for a wealthier group represents a larger dollar change than for a less wealthy group, and thus it has a larger effect on the national average.

We find that lump-sum rebates are the most progressive—but also the most expensive by far. Under this scenario, the three lowest-income groups actually see an increase in income (Figure 1A). For policymakers interested in internalizing the price of carbon while reducing inequality, a lump-sum program could prove popular (see Chad Stone's article on pages 30–35 of this issue for more on the design and implementation of such a program).

Recycling the revenue to cut capital taxes is the most efficient of the three scenarios (that is, the best for the economy as a whole), but it further exacerbates the regressivity of a carbon tax by yielding a wide distribution of outcomes across income groups (Figure 1B). Under this scenario, only the wealthiest group benefits, while the poorest two groups experience the worst outcomes of the three scenarios.

Using carbon tax revenue to reduce taxes on labor can be seen as a middle-of-the-road option that is more progressive (but less efficient) than cutting capital taxes, and more efficient (but less progressive) than a lump-sum rebate (Figure 1C). The distributional effects of a labor tax cut policy are also nearly even across the income distribution as a percentage of income, which could offer a political advantage to policymakers seeking a compromise between efficiency and fairness.

Figure 1. Welfare Impacts of Three Revenue-Recycling Policies by Income Group (Percentage of Income)

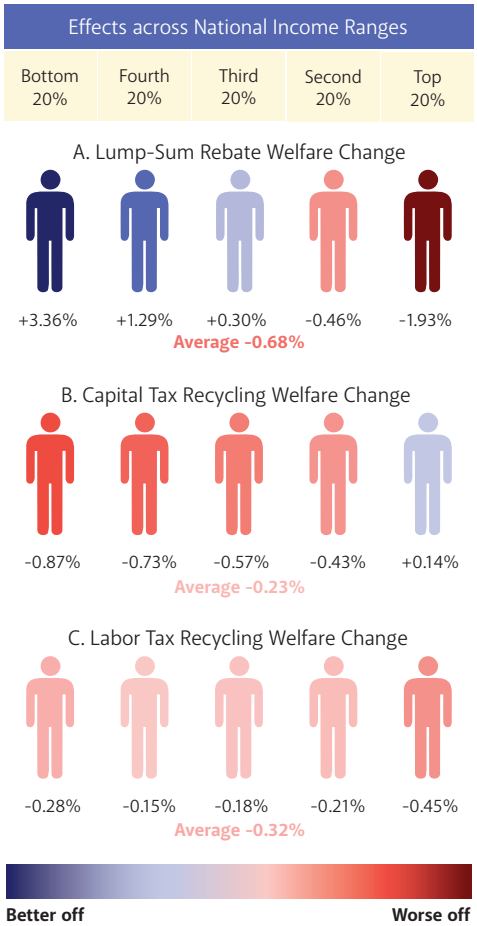
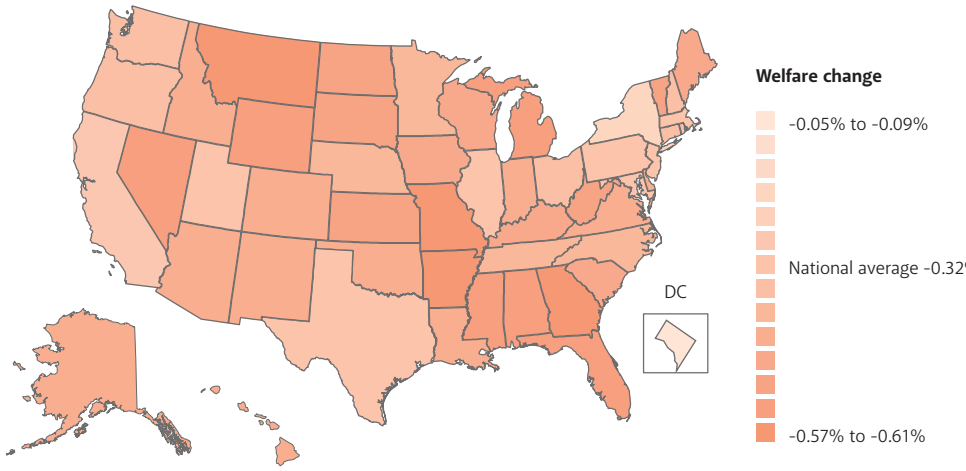


Figure 2. Welfare Change (Percentage of Income) by State for Labor Tax Recycling



Impacts across US States

We also examined differences that emerge on a state-by-state basis, finding that geographic differences are substantially smaller than the differences observed across income groups. In addition, the way carbon tax revenues are used plays a more important role in determining the geographic distribution of welfare changes than the magnitude of energy price changes.

Distributional results were demonstrated as aggregate changes in welfare for each state or region as a percentage of annual income. Thus, these represent the average effect on households in each state but don't say anything about the distribution of gains or losses among income groups within each state. The relative regressivity and efficiency rankings for each revenue recycling policy mirrored our results across income groups, with the labor tax cut scenario offering a middle-of-the-road option by narrowing geographic differences and producing a fairly even distribution of outcomes across US states (Figure 2). For politicians interested in a carbon tax, this approach could be appealing if their goal is to implement a program with welfare effects that are relatively similar, regardless of what region they represent.

Once again, recycling revenue to reduce capital taxes proves to be the most efficient and most regressive of the three policies (Figure 3). Geographically, this method would cause the poorest states in the South and Midwest to bear a disproportionate share of the cost.

A lump-sum rebate offers the least efficient policy strategy, lowering aggregate welfare further than either labor or capital tax recycling while creating the widest gap in welfare losses across states. However, the distributional effects of lump-sum recycling are again sufficient to reverse the pattern of relative welfare drops across states (see Figure 4). This effect translates to smaller losses in southern and midwestern states than in more affluent states along the East Coast.

Choosing a Path

If policymakers could only choose one of these three options, they would pick the capital income tax swap if they cared most about total welfare, the lump-sum rebate if they cared most about what the majority would vote for or if they wanted to reduce inequality, or the labor tax swap if they wanted to have the most even effect on all

Figure 3. Welfare Change (Percentage of Income) by State for Capital Tax Recycling

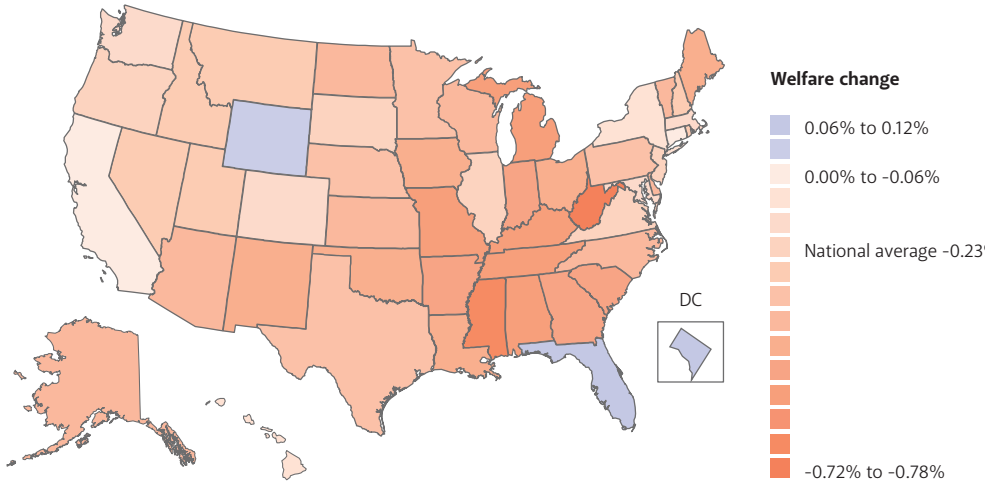
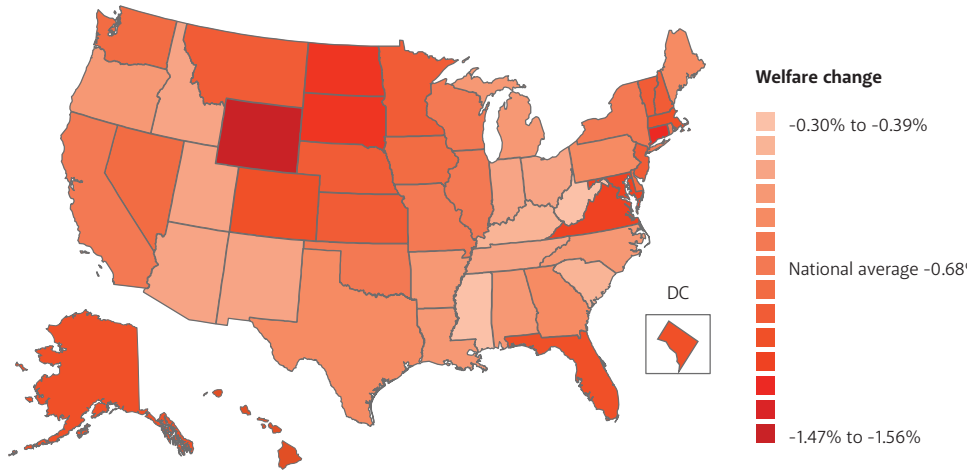


Figure 4. Welfare Change (Percentage of Income) by State for Lump-Sum Rebate



income groups (or to avoid the worst-case scenario for each income group).

In reality, almost every proposal for carbon pricing divides the revenues among multiple uses. Because the lump-sum rebate produces the best comparative results for the lowest-income groups and states—those who seem to be hit hardest by changes in the price of direct energy goods—devoting part of the revenue to a lump-sum rebate would undo some of the inequality resulting from changes in the price of energy. ●

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DESIGNING REBATES TO PROTECT LOW-INCOME HOUSEHOLDS UNDER A CARBON TAX

A climate rebate delivered through the existing tax and benefit systems can shield low- and moderate-income households from the impact of higher energy prices under a carbon tax.

CHAD STONE

A carbon tax is a cost-effective way to reduce greenhouse gas emissions, but the resulting higher prices for home energy and gasoline as well as for food and other energy-intensive goods and services can reduce households' purchasing power. Low- and moderate-income households feel the budget squeeze most acutely; they spend a larger share of their budgets on these items than do higher-income households and are least able to afford new fuel-efficient vehicles, better home weatherization, and energy-saving appliances.

Fortunately, well-designed carbon tax legislation can generate enough revenue to fully offset the impact on the most vulnerable households, cushion the impact for many other households, and leave plenty to spare for other uses—without blunting the price signal that is essential for achieving cost-effective emissions reductions. Providing lump-sum rebates to households is the best way to protect low-income groups. Only a relatively small portion of carbon tax revenues is needed to fund such a rebate program, leaving most of the revenue available for other purposes.

An efficient and effective rebate design can build on existing tax- and benefit-delivery mechanisms to reach as many households as possible, especially those with the lowest incomes. Under the approach proposed by my organization, the Center on Budget and Policy Priorities, all households of a given family size would receive the same lump-sum amount but through different means:

» Lower-income working households would receive it through a refundable tax credit.

» Beneficiaries of Social Security and certain other federally administered benefit programs would receive it as a supplement to their regular payments.

» Very low-income families would receive it through state human services agencies using the electronic benefit transfer (EBT) system already used to deliver food stamp benefits under the Supplemental Nutrition Assistance Program (SNAP).

Principles

This approach is designed to achieve robust low- and moderate-income relief in light of six principles.

Do No Harm

A carbon tax should not make poor families poorer or push more people into poverty. Climate rebates should be designed to fully offset the impact of a carbon tax on the purchasing power of low- and moderate-income households.

Achieve the Broadest Possible Coverage

Climate rebates should reach all or nearly all eligible households. Eligible working households could receive a climate rebate through the tax code, via a refundable tax credit. But many other households are elderly, unemployed, or have serious disabilities and are not in the tax system. Households with incomes below the threshold that would require them to file a federal income tax return could miss out on a climate rebate for which they would be eligible. Climate rebates should reach these households as well.

Minimize Red Tape

Funds set aside for consumer relief should go to intended beneficiaries, not administrative costs or profits. Accordingly, policymakers should provide assistance to the greatest degree possible through existing, proven delivery mechanisms rather than new bureaucracies.

Climate rebates should be designed to fully offset the impact of a carbon tax on the purchasing power of low- and moderate-income households.

Adjust for Family Size

Larger households should receive more help than smaller households because they have higher expenses—although economies of scale mean that costs do not increase in the same proportion as family size.

Do Not Focus Solely on Utility Bills

Higher home energy prices are only one way a carbon tax affects household budgets. Goods and services across the economy use energy as an input or for transportation to market. On top of that, the utility costs of many low- and moderate-income households are reflected in their rent. Rebates should reflect all the direct and indirect channels through which a carbon tax affects household budgets.

Preserve Economic Incentives to Efficiently Reduce Energy Use

Rebates provide benefits to consumers to offset higher costs while still ensuring that consumers face the right price incentives in the marketplace and reduce energy

consumption accordingly. A consumer relief policy that suppresses price increases in one sector, such as electricity, would be inefficient, because it would blunt incentives to reduce fossil fuel use (and resulting emissions) in that sector. Consumers might pay less for electricity, but prices would rise still higher for other items.

Policy Design Considerations

Policymakers face two broad sets of decisions when designing a robust low- and moderate-income climate rebate program to mitigate the effects of a carbon tax:

1. What should the size and scope of the rebate be, and how should eligibility be set?
2. How should the rebate be delivered to eligible households?

If policymakers wish to use a larger share of the carbon tax revenue for consumer rebates, they could raise the income level at which households would be eligible for a rebate, and perhaps set the rebate amounts at somewhat higher levels, such as the average loss to consumers in the next-lowest 20 percent of the income distribution. The total cost of providing rebates would depend on both the average size of a rebate and how far up the income scale rebates would be provided.

The Energy Information Administration, or a similar such agency, could be tasked with determining the annual rebate amounts at the target level of full compensation, setting a reference level of income for determining eligibility for a rebate. But the income level would be adjusted for family size in accordance with current best practices for income distribution analysis. As a result, the size of the rebate would be higher for larger families—but would not be a per capita rebate.

Three different existing mechanisms would be required to achieve the broadest possible coverage: a tax credit, direct payments through Social Security and certain other federal benefit programs, and rebates through state human services.

Size and Scope of Rebates

In accordance with the "do no harm" principle, the rebate should be at least large enough to fully offset the average purchasing power loss of households in the bottom 20 percent of the income distribution (varied by household size). Previous policy proposals, such as the Waxman–Markey and Kerry–Lieberman cap-and-trade bills, set their low-income "energy refund" somewhat higher—at the average purchasing power loss of households with incomes equal to 150 percent of the federal poverty line. Eligibility for a full rebate also was limited to households at or below this threshold, which is roughly the dividing line between the poorest 20 percent and the rest of the population.

Rebate Delivery Mechanisms

Once the size and scope of a rebate program are determined, policymakers would face the challenge of ensuring a practical way to deliver the rebate to eligible households. Three different existing mechanisms would be required to achieve the broadest possible coverage: a tax credit for lower-income working households, direct rebate payments for beneficiaries of Social Security and certain other federally

administered benefit programs, and rebates through state human services for very low-income families.

For households required to file a tax return, a refundable income tax credit is the most effective way to deliver a climate rebate. If it were designed like the Earned Income Tax Credit and the Additional Child Tax Credit, the climate tax rebate would phase in to its full amount over an initial income range and phase out over a range of income above the maximum level at which a household would be eligible for a full rebate.

The tax credit would be provided annually when households file their tax returns. Alternatively (and preferably), the tax credit could be provided throughout the year as an adjustment to employer tax withholding, if possible.

Many low-income households, however, would receive only a partial rebate or be missed entirely under the tax-credit delivery mechanism. Among them are lower-income seniors and people with disabilities who rely primarily on Social Security or other benefits and are not required to file income tax returns. To reach this group, the most effective policy would be for the Social Security Administration, the Department of Veterans Affairs, and the administrator of the Railroad Retirement program to provide climate rebates—preferably quarterly—directly to people receiving those benefits whose incomes fall within the limits established for the climate rebate.

The group that would not be reached through either of these means would be very low-income households (primarily families with children) that have little to no earnings over the year and do not receive Social Security or other similar federal benefits. Arguably this group is the most important to reach with a climate rebate because the loss of purchasing power due to a carbon tax could create serious hardship and push these individuals and their children deeper into poverty.

About one-third of all low-income households with children would receive no rebate or only a partial rebate if the EBT mechanism were not employed.

The best mechanism to reach this group is to provide climate rebates through state human services agencies that already provide SNAP, Medicaid, and other benefits to a broad array of low-income households. States could readily program the climate rebate onto the existing EBT systems that all states use to deliver SNAP and, in most states, other forms of assistance, including cash aid, on a monthly basis.

All three delivery mechanisms would play a critical role in providing rebates to low-income families. Calculations by the Center on Budget and Policy Priorities, using 2012 data, show the following for households in the lowest income group:

» About 47 percent received benefits from Social Security and other agencies and could have qualified for an energy refund for all or part of the year through the federal benefits delivery mechanism.

» About 57 percent received benefits through SNAP and could have qualified for an energy refund for all or part of the year through the state human services delivery mechanism.

» About 21 percent had earnings that would have qualified them for a full or partial tax credit.

Trade-offs between Efficiency and Fairness

All things equal, refunds delivered in a way that encourages individuals and businesses to work and invest more efficiently and expand aggregate economic welfare are preferable to ones that do not. Other things are seldom equal, however.

While carbon tax revenues can be returned to households in a variety of ways that still maintain incentives to reduce emissions, no single approach simultaneously provides economic incentives and robust low-income protection. RFF researchers—including Roberton Williams, Dallas Burtraw, and Richard Morgenstern, who address this topic on pages 25–29 of this issue—generally find that, among the range of policies available for recycling revenues directly to households, cuts to corporate or individual income tax rates provide the largest expected aggregate economic gains but are also the most regressive. Lump-sum rebates to low- and moderate-income households do not provide the same economy-wide efficiency advantages, but they are the best way to provide the most robust low-income protection while preserving the price signal that encourages cost-effective emissions reductions.

But policymakers do not have to pick one or the other. They can use a portion of the revenues generated by a carbon tax to provide robust but targeted low-income protection, which would leave most of the revenue available to pursue other goals.

The EBT mechanism is particularly important for low-income families with children. About one-third of all low-income households with children would receive no rebate or only a partial rebate if this mechanism were not employed.

The percentages above sum to more than 100 percent coverage, indicating that under this delivery approach, some people could qualify for more than one rebate because they participate in one or more of the relevant programs and/or also file an income tax return. Coordination mechanisms would be needed to ensure that people are not overcompensated. For example, state human services agencies would not provide climate rebates to individuals who are receiving Social Security, Supplemental Security Income, veterans' benefits, or Railroad Retirement benefits.

Delivering a climate rebate through existing state eligibility systems and delivery mechanisms would be far less costly to set up and administer than virtually any alternative, while ensuring that the lowest-income families would not be left out and would receive rebates on a monthly basis throughout the year. ●

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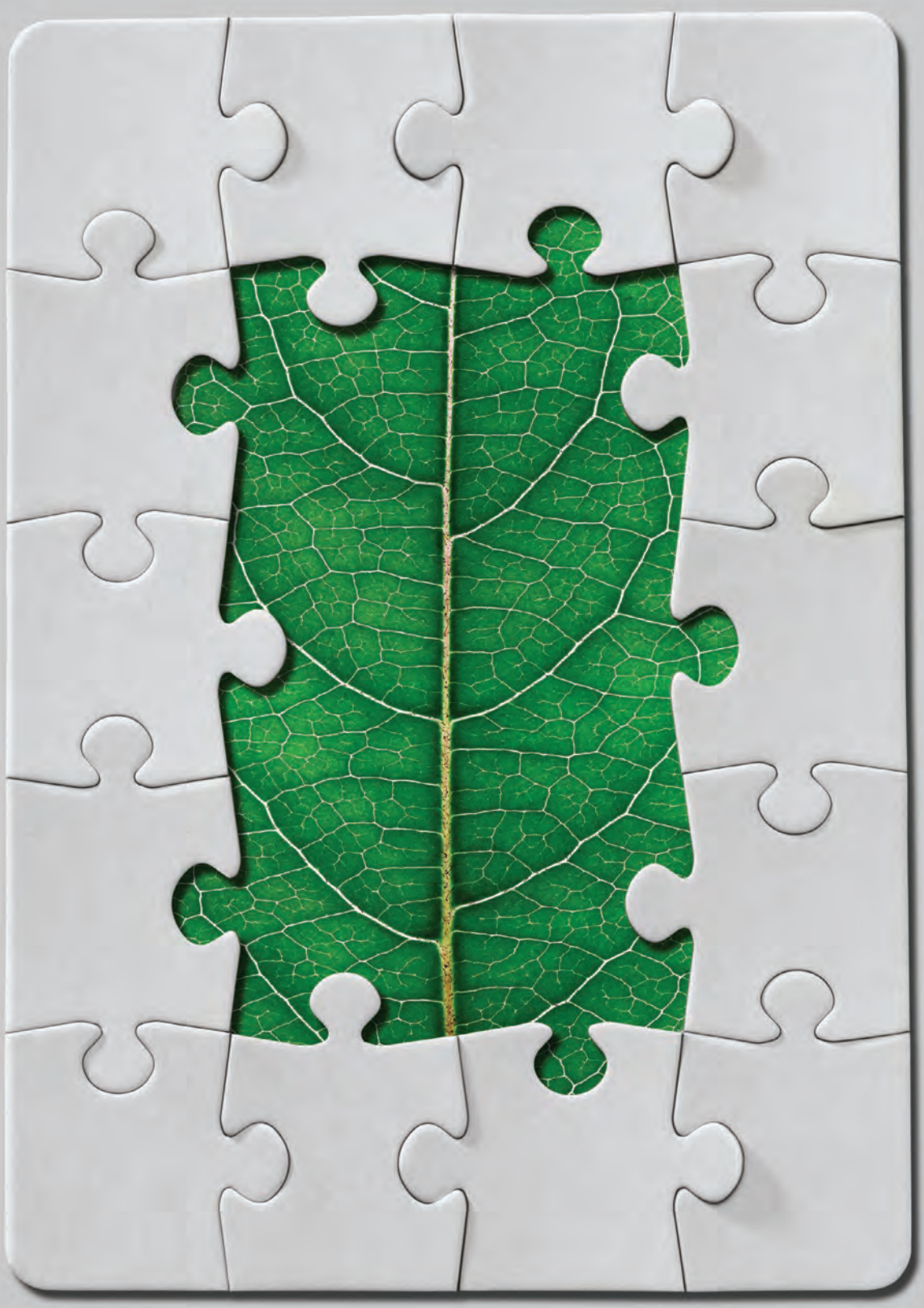

THOUGHTS ON THE FUTURE OF

ENVIRONMENTAL REGULATION

The US federal agencies responsible for enforcing environmental regulations are fragmented and weakening. What would a more integrated approach look like?

J. CLARENCE DAVIES

In the current US political climate, environmental policy, once an area of bipartisan cooperation, has become a partisan battleground. In recent years, despite some progress in a few policy areas, the regulatory agencies have been steadily weakened.

Four federal agencies are primarily responsible for protecting the public from chemical and environmental threats: the Environmental Protection Agency (EPA), the Food and Drug Administration (FDA), the Consumer Product Safety Commission (CPSC), and the Occupational Safety and Health Administration (OSHA). CPSC and OSHA are so lacking in resources and legal authority that they have trouble carrying out their missions. FDA's resources also are inadequate, and its legal authority in some broad areas, such as cosmetics and nutritional supplements, provides little protection to the American consumer.

EPA is under attack from congressional critics and has already suffered a significant reduction in manpower even though its resources have always been insufficient to implement its legal authorities. EPA's workforce is the smallest it has been since 1989. The agency's budget for fiscal year 2015, adjusted for inflation, is only slightly larger than it was in 1971, the first full year of agency operation—and about 60 percent of the 1972 budget.

The most likely future scenario is continuation of the current trends and further erosion of the capabilities of the federal regulatory agencies. The states may take up some of the slack, but many are becoming more wary of regulation. The private sector may be less opposed to regulation than politicians (because regulation tends to help larger firms); however, its focus is on short-term profits rather than long-term public interest.

But the world is becoming more interconnected, and this internationalization may be

a counter trend. Other nations, especially in Europe, are putting more effort into regulation than they have in the past. This effort may put pressure on the United States to enact more stringent regulations.

Overall, the outlook from a traditional environmentalist position is dismal. Environmental regulation is in decline, and regulatory agencies are being weakened. What would a better approach look like? What have we learned from the experience of the past 50 years?

Using Incentives

The two basic types of incentives for environmental compliance are regulatory and economic. As the regulatory incentives have weakened, more emphasis has been placed on economic incentives. Approaches using cap and trade (such as to control sulfur dioxide emissions from US power plants), emissions fees, and taxation have been increasingly employed in the United States and Europe.

Because economic incentives tend to be more efficient and effective, future compliance increasingly will be based on economic mechanisms. However, economic approaches are not feasible in every situation—for example, controlling highly toxic materials—and most economic incentives require elements of the regulatory approach, such as standard-setting. Under cap-and-trade programs, for example, the government must take the critical step of allocating the initial permits, and it can manipulate permit prices by controlling the number issued.

Approaching Integration

The US approach to environmental regulation has evolved in piecemeal fashion. It is fragmented, duplicative, and lacking any coherent rationale. The medium-oriented agencies (focused on air and water) are dominant, but place-based agencies, such as OSHA and the Mine Safety and Health Administration, are important as well. So are agencies, such as FDA and CPSC, that are focused on various types of products. The laws that dictate the actions of these institutions are, if anything, more fragmented. Each of the agencies focuses on its governing legislation and proceeds largely as if the other institutions do not exist.

The US approach to environmental regulation has evolved in piecemeal fashion. It is fragmented, duplicative, and lacking any coherent rationale.

An antidote to this situation is an integrated approach that considers the physical environment as a whole. There are two types of integration—internal and external. Internal integration applies to the relationship among the environmental agencies. External integration applies to the relationship between the environmental agencies and the non-environmental agencies—for example, the relationship between EPA and the Department of Agriculture.

The creation of EPA was itself a major step toward internal integration. However, the government continues to have separate laws devoted to air, land, and water, each implemented by a separate bureaucracy. This organizational and regulatory fracture is inconsistent with what is, in fact, a unified and interconnected physical environment. Most pollutants are naturally transported from one environmental medium to another, almost all pollutants can be disposed

of in any of several different media, and human and environmental exposure to any given pollutant is usually from multiple environmental routes and from more than one medium. The existing regulatory structure mostly ignores these interconnections. The price is paid in dollars, unnecessary environmental damage, and human injury and death.

The cost of failing to consider the environment as a single physical whole is magnified by the helter-skelter organization of regulatory functions. The same pollutant is examined, evaluated, and regulated by multiple organizations. What is an occupational hazard for OSHA is a consumer hazard for CPSC, a food hazard for FDA, and an environmental hazard for EPA. It is not unusual for the same pollutant to be regulated under half a dozen different laws.

A far more efficient and effective organizational structure would be to combine the environmental agencies into a larger, more vigorous Department of Consumer and Environmental Protection. This new agency could be built around three functions—monitoring, oversight, and research and assessment—with perhaps a crosscutting focus on substances and places. England and other European countries have already changed to an integrated approach with a single permit for each facility, which regulates all emissions, and a single office to enforce the permit requirements. The European Union has mandated that, over time, all EU nations should change to this type of approach.

If the push for integration in the United States were motivated only by an urge for neatness, order, and logic, it would be easier to dismiss. Bureaucratic structures are almost never neat. But in the current climate, the choice between internal fragmentation and integration is not between neatness and disorder. It is a choice between a viable structure of environmental regulation and no regulation at all.

The opponents of environmental regulation have discovered from experience that the most effective way to undermine regulation is not to mount a head-on attack against the regulatory laws. Rather, it is to deprive the regulatory agencies of the people and money necessary to do their jobs. The fragmentation of environmental functions allows this to be done surreptitiously and away from the glare of cameras and the attention of even the most diligent reporters. The budgets of CPSC and the Mine Safety and Health Administration are now so small that they no longer appear in the published budget of the US government. If current trends continue, EPA and FDA also may disappear. Survival mandates a consolidated Department of Consumer and Environmental Protection.

External integration is also important but even more problematic. The federal government has developed mechanisms allowing each agency some leverage over its sister agencies. For example, each agency is given a chance to review testimony or legislation proposed by another agency. However, these are cumbersome mechanisms. One

A far more efficient and effective organizational structure would be to combine the environmental agencies into a larger, more vigorous Department of Consumer and Environmental Protection.

possible solution would be for major agencies to create an office of external integration. The mission of the office would be similar to the mission of a diplomatic embassy. It would be responsible for reporting to its own agency the actions and positions of other agencies, and it would try to influence the actions of other agencies to conform to the views of its agency.

The long-term solutions to these problems are in the realm of culture and training as well as legislation. However, short-term structural steps can help. The scientists who collect and analyze the information should be accessible to the regulators. Those who collect information should be able to interact easily and regularly with those who use the information. The danger of having scientific information contaminated by political considerations is real, and there should be safeguards to prevent it. But the danger of having the regulatory decisions made without the benefit of good science is at least as real.

Some of the future challenges will result from solutions of the past being overwhelmed by economic expansion.

Supplying Information

Any environmental regulatory system depends heavily on information supplied by the regulated entity. But within the government, the biggest information problem is incorporating such data into the regulatory process. First, the data must be available and readily accessible to decisionmakers. Second, the decisionmakers must understand the data. Third, the data must be relevant to the decision and framed in a way that allows them to be incorporated in the decisionmaking process. None of these steps is easy.

The current regulatory systems are inadequate in that they do not require regulated entities to provide more information. The private sector has a wealth of relevant information—especially about new materials and products—that could be useful to the regulatory agencies. If the government is to protect the public, it should have the authority to get this information. It must also prove its ability to use and protect the information as well as to police the reliability of the information.

For example, cosmetic manufacturers are not—but should be—required to provide FDA with the results of toxicity testing of their products and FDA should be authorized to respond appropriately to the test results.

Adjusting to Internationalization

The world has become increasingly interconnected both politically and economically. Although it has always been interconnected environmentally, now global environmental problems are being recognized. Regulation in many other countries—especially in the European Union—is now more rigorous than in the United States. This will have a significant impact on internationally traded products but will not much affect US facility-related problems, such as emissions and waste disposal.

What may be the biggest problem in this context—imports of products and materials—is like external integration: not fully recognized as a problem and without adequate mechanisms to address it. A large and growing percentage of the goods Americans consume comes from other countries. The old method of inspectors on the docks

opening random crates is no longer able to determine the safety of imported products. New mechanisms are needed, perhaps based on inspections in the country of origin by certified international organizations.

Facing New Challenges

New entries on the environmental agenda are arising from three sources: the growth of existing pressures on an ecosystem, new scientific knowledge about the environment, and new technologies.

These new challenges will have some of the same characteristics as current problems. They will likely be global in scope, they will not fall neatly into any single medium category, and they will cut across the jurisdictions of multiple agencies, both environmental and non-environmental.

The extraordinary growth in the economies of most nations has brought many benefits, but a higher standard of living also may bring more pollution, a greater use of resources, and more congestion. Some of the future challenges will result from solutions of the past being overwhelmed by economic expansion. The effects of exhaust controls on automobiles, for example, may be outweighed by the many more automobiles on the road. Many crosscurrents are at work, however. Economic expansion will also likely lower the birth rate and facilitate application of environmentally beneficial technologies, for example.

The pace of economic growth has been matched by the geometric increase in scientific knowledge. The better we understand the environment, the better we are able to reduce the damage we do to it. However, with understanding come worry and an obligation to prevent further damage. Science does not cause the problem but identifies it, defines it, and makes it eligible for the policy agenda. Environmental problems—from climate change to stratospheric ozone to endocrine disruptors—do not become policy issues until science can adequately define them.

The technologies of the future will have a staggering impact on the environment and on our lives. Nanotechnology will enable us to make almost any kind of material to our specifications and will change the way we manufacture and use materials. It will change not only how we impact the environment but also how we think about it. Synthetic biology will do the same for living organisms. Each of these technologies poses major challenges for environmental regulation, but regulators have hardly begun to think about them.

The world of the next decades will be very different from the present one. There will be many ups and downs on the journey ahead. All we know for certain is that the scenery will be constantly changing. ●

Environmental problems—from climate change to stratospheric ozone to endocrine disruptors—do not become policy issues until science can adequately define them.

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NEW MARKETS UNDER US Vehicle Fuel Efficiency AND Greenhouse Gas Standards: CREDIT TRADING

Recent changes to the Corporate Average Fuel Economy Standards for automobiles allow manufacturers to buy and sell emissions and fuel consumption credits for the first time. How will this flexibility affect the cost of compliance?

BENJAMIN LEARD AND VIRGINIA D. McCONNELL

Recent changes to the US Corporate Average Fuel Economy (CAFE) Standards are a dramatic departure from previous policy. The changes, established in 2011 jointly by the National Highway Traffic Safety Administration (NHTSA) and the Environmental Protection Agency (EPA), require automakers to reduce not only fuel consumption but also greenhouse gas (GHG) emissions from their vehicles—slashing them roughly in half by model year 2025.

Several provisions have been added to give automobile companies more flexibility to meet the standards, which become progressively more stringent over time. New opportunities for trading emissions and fuel consumption credits offer the promise of achieving compliance at lower costs.

Under the new standards, auto manufacturers can trade such credits between cars and trucks in their own fleets. They can overcomply with their car fleet requirements, for example, and undercomply with those for the truck fleet. Overall emissions or fuel use would be the same. They also have the ability to trade credits with other manufacturers for the first time, allowing for the creation of a market for buying and selling emissions and fuel consumption credits. Additionally, EPA's new rules allowed manufacturers to overcomply with target levels of emissions before the rules were implemented and bank those credits for use when the new rules went in to effect in 2012. NHTSA has always allowed some banking of credits to meet the fuel economy standards.

The potential for savings could be significant because the regulations present uncertain and different costs to the various manufacturers and potentially large penalties for those that do not comply with EPA's rules. But certain features of the rules pose a challenge to the development of a well-functioning market.

Defining Credits

Both NHTSA and EPA allow manufacturers to earn credits, but they are defined differently by the two agencies. EPA's GHG standards are in terms of average grams of carbon dioxide (CO_2) emissions per mile. Under the current footprint standard, each vehicle sold has a different target and each manufacturer will have a standard for its fleet, depending on its mix of vehicle sizes. A manufacturer earns credits when it produces a sales-weighted average fleet with fewer grams of CO_2 emissions per mile than its standard. Deficits occur when the manufacturer's fleet emissions exceed its standard.

NHTSA's rules are framed in terms of fuel economy or miles per gallon (mpg), which is inversely related to a vehicle's fuel consumption. A manufacturer earns credits in the same way as described for CO_2 emissions above. And CO_2 emissions and gasoline fuel consumption are directly related: 1 gallon of gasoline is equal to 8,887 grams of CO_2. The rules are supposed to be harmonized so that manufacturers will not have to meet two separate standards.

Understanding the Differences between NHTSA and EPA Credit Programs

Despite the intention to harmonize the rules, differences exist in how credits can be earned and used for compliance. Yet manufacturers must satisfy both rules. Table 1 outlines some of the differences.

Although the rules have many similar provisions, there are some important distinctions in stringency. EPA's rules are less stringent in that they allow for a longer banking period, and NHTSA restricts a manufacturer's ability to trade between cars and trucks. EPA's rules are stricter, however, in that they impose a Clean Air Act violation rather than a fine for non-compliance. Because the two rules effectively regulate the same thing—

Table 1. Differences between NHTSA and EPA Credit Programs

Regulation	NHTSA CAFE Program	EPA GHG Emissions Program
Definition of a credit	Each $^{1}/_{10}$ mpg below manufacturer's required sales-weighted average mpg	Each 1 gram per mile CO_2 equivalent below manufacturer's required sales-weighted average grams per mile
Credits for alternative fuel vehicles	No credits allowed	Allows manufacturers to count each alternative fuel vehicle as more than a single vehicle; multipliers change over time: 2.0 to 2018, 1.6 to 2022, and 1.2 to 2025; emissions from battery electric vehicles assumed to be zero
Credits for non-tailpipe reductions	Granted for A/C system efficiency improvements that reduce fuel use	Granted for GHG emissions reductions due to improved A/C efficiency, reduced A/C leakage, and other emissions reductions that are not counted in the tailpipe test
Flex fuel vehicles	Accounted for as specified under Energy Independence and Security Act (EISA); assumed to have low gasoline consumption relative to gasoline engine; no expiration date	Earn credits according to EISA provisions only through model year (MY) 2015
Credit banking	5-year banking period	5-year banking period, with the exception that credits earned between MYs 2010 and 2016 can be carried forward through MY 2021
Credit borrowing	3-year carry back period	3-year carry back period
Limits on credit transfers between car and truck fleets for a manufacturer	MY 2011–2013: 1 mpg MY 2014–2017: 1.5 mpg MY 2018–2025: 2 mpg	No limits on transfers between cars and trucks in each manufacturer's fleet
Other credit usage limits	Credits cannot be used to meet the domestic minimum fuel economy standard	No other limits
Exemptions	None	Temporary Lead-time Allowance Alternative Standards for manufacturers with limited product lines through 2015; exemptions for operationally independent manufacturers
Non-compliance penalties	\$5.50 per $^{1}/_{10}$ mpg over standard, per vehicle	Clean Air Act violation; penalty unknown but could be as high as \$37,500 per car

gasoline consumption and the associated GHG emissions—the stricter regulations will tend to dominate in the credit markets. Differences between the two rules also may tend to drive up the credit price—and therefore the cost of compliance.

Establishing a Well-Functioning Market

A well-functioning market for trading credits among companies requires an established way for potential traders to find each other and transparency about the prices of trades

that have occurred. The history of existing credit trading regimes, such as those established by the California Low Emission Vehicle and Zero Emission Vehicle programs, has been that buyers and sellers of credits find each other on an as-needed basis, and the agencies often report information on quantities traded but not on prices. The CAFE credit trading program is getting started in a similar way.

A well-functioning market requires the opposite—information about the prices of trades but not on how many credits other participants traded. Currently, there is virtually no information for participants about prices and a low probability of a single trading price across trades. Finding trading partners also presents high transaction costs. These characteristics tend to make markets thin and inefficient. Private brokers may have a potential role to play in helping interested buyers and sellers find each other and establishing a more formal auction setting.

In future years, the market is likely to become more active as the standards become stricter and the automakers gain more information and experience in buying and selling credits. The agencies also will need to continue to try to make the rules more harmonized and flexible and to facilitate a robust trading market.

Looking Ahead

The market for credit trading among automakers is in its early stages, and whether an efficient market will develop is still not clear. Most automakers have been able to overcomply with the standards and accumulate credits, both before the new rules were implemented and since 2012, when they kicked in. The size of this credit pool is large, as companies have used the banking provisions of both regulations. This behavior is to be expected, however, because the standards are becoming much stricter in coming years.

The agencies may want to establish pricing bounds for this market. In particular, there is concern about the costs of meeting the standards for all companies, especially from 2021 to 2025 and beyond if the standards are extended. Currently, the NHTSA fee of $5.50 per one-tenth of a mile per gallon over a manufacturer's standard represents a price ceiling for NHTSA credits. EPA also might consider establishing a price ceiling. Under the Clean Air Act, EPA cannot require firms to pay a fine in lieu of compliance, but they may be able to sell credits at a specified price that, in effect, represents a maximum cost. Both the agencies also could consider buying permits at some predetermined price floor if the marginal cost of compliance is low. Such interventions would provide information about the range of possible prices to the market participants.

Perhaps the greatest issue with the two credit programs—NHTSA's for fuel economy and EPA's for GHG emissions—is that they are regulating virtually the same thing: fuel use and the associated emissions. Under these conditions, two separate markets for credit trading are unlikely to work well. And having to comply with two different rules will make investment decisions for companies more difficult, which is likely to drive up costs. A single market—and a single credit price—would be simpler and more cost-effective at reducing carbon-based fuel use and the related CO_2 emissions. ●

FURTHER READING

Leard, Benjamin, and Virginia D. McConnell. 2015. New Markets for Pollution and Energy Efficiency: Credit Trading under Automobile Greenhouse Gas and Fuel Economy Standards. Discussion paper 15-16. Washington, DC: RFF.

A Look at What's Happening
Inside RFF

RFF Senior Fellow **Roger Sedjo** has been appointed to the US Environmental Protection Agency's (EPA's) Science Advisory Board on Biogenic Energy and Emissions, whose members provide scientific advice to the administrator and review information for proposed agency regulations.

Leonard Shabman, RFF resident scholar, chaired the National Research Council (NRC) Committee on Affordability of National Flood Insurance Premiums and gave presentations on the committee's report to the Federal Emergency Management Agency. RFF Fellow **Carolyn Kousky** is also a member of the NRC committee.

Molly Macauley, RFF vice president for research and senior fellow, served on the Presidential External Visiting Committee for the Division of Economics and Business within the College of Earth Resource Sciences and Engineering at the Colorado School of Mines.

RFF Senior Fellow **Carolyn Fischer** has joined the editorial board of the journal *Review of Environmental Economics and Policy*. Fischer has also joined the scientific board of Economics for Energy, a private research center.

James Boyd, RFF senior fellow and director of RFF's Center for the Management of Ecological Wealth, has agreed to serve as a member of the EPA Clean Air Scientific Advisory Committee's Secondary National Ambient Air Quality Standards Review Panel for Oxides of Nitrogen and Sulfur. In this new role, Boyd will advise EPA on the agency's technical and policy assessments that support decisions on possible revisions to the standards.

RFF Senior Fellow **Roberton Williams III** has agreed to serve as a member of the Economy-wide Modeling of the Benefits and Costs of Environmental Regulation Panel under EPA's Science Advisory Board.

RFF Announces 2015–2016 Fellowship Awardees

RFF named the following academic fellowship recipients to conduct environmental and energy research during the 2015–2016 academic year.

Joseph L. Fisher Doctoral Dissertation Fellowships

» **Michelle Marcus**, a PhD candidate in economics at Brown University, is studying the childhood health effects of local pollution. Her work investigates the effects of gasoline reformulation on childhood asthma and of leaking underground gasoline storage tanks on infant health.

» **Davide Cerruti**, a PhD candidate in agricultural and resource economics at the University of Maryland, College Park, is conducting research on air pollution and transportation.

» **Ashley Vissing**, a PhD candidate in economics at Duke University, is focusing on competition, matching, and lease terms for shale gas leases.

Gilbert F. White Postdoctoral Fellowships

» **Ujjayant Chakravorty**, a professor in the Department of Economics at Tufts University, will conduct work at RFF on a variety of energy topics, including modeling of world gas and coal markets to estimate how US policy affects Chinese

emissions, comparisons of quantity versus proportional mandates for renewable energy, and the effects of electrification in the Philippines.

» **E. Somanathan**, a professor at the Indian Statistical Institute, will conduct work at RFF on estimating and predicting damages from climate change in the Indian agricultural and manufacturing sectors.

John V. Krutilla Research Stipend

» Postdoctoral researchers and lecturers **Patrick Bayer** and **Alexander Ovodenko** of the Department of Political Science at Washington University in St. Louis will use their stipend for work on the local politics and economics of shale gas development and regulation in the United States.

Walter O. Spofford, Jr., Memorial Internship Program

» **Cheng Xu**, a PhD student in economics at George Washington University, will spend the summer of 2016 at RFF working with Fellow Zhongmin Wang on Chinese shale gas development and Fellow Jhih-Shyang Shih on collecting energy data in China.

RFF Names New University Fellows

RFF has announced the appointment of three new university fellows: **Amy W. Ando** from the University of Illinois, Urbana-Champaign; **Catherine L. Kling** from Iowa State University; and **Catherine Wolfram** from the University of California, Berkeley.

Amy W. Ando is a professor, the associate head of academic programs, and the director of graduate studies for the Department of Agriculture and Consumer Economics at the University of Illinois, Urbana. She is on the editorial boards of *Land Economics* and *Conservation Letters*, among other academic journals, and has served on the board of the Association of Environmental and Resource Economists. She has provided expertise to the US Environmental Protection Agency, the US Department of Agriculture, the City of Chicago Doris Duke Charitable Foundation, and other institutions. Her research focuses on species and habitat conservation, both improving conservation practice and understanding conservation behavior and effects.

Catherine L. Kling is the Charles F. Curtiss Distinguished Professor of Agriculture and Life Sciences and a professor of economics at Iowa State University. She was recently elected to the National Academy of Sciences and is a former president of the Association of Environmental and Resource Economists. Since July 2013, she has served as the director of the Center for Agricultural and Rural Development (CARD) at Iowa State, after having served many years as the division head of its Resource and Environmental Policy Division. In her work at CARD, Kling is undertaking research to examine how agricultural practices affect water quality, wildlife, soil carbon content, and greenhouse gases.

Catherine Wolfram is the Cora Jane Flood Professor of Business Administration at the Haas School of Business at the University of California, Berkeley. She also is a faculty director of the Energy Institute at Haas as well as at the E2e Project. The Energy Institute at Haas brings together research and curricular programs on energy business, policy, and technology commercialization with the goal of bridging gaps between economic and scientific energy research and the marketplace. The E2e Project is a joint initiative of Berkeley, the Massachusetts Institute of Technology, and the University of Chicago, made up of economists, engineers, and behavioral scientists focused on understanding the energy efficiency gap. She has served on the board of the Association of Environmental and Resource Economists.

RFF Remembers Sterling Brubaker and Joy Dunkerley

The RFF family was saddened to learn of the death of two of its former researchers, **Sterling L. Brubaker**, 91, and **Joy Dunkerley**, 82. Brubaker spent most of his career at RFF, where he made impressive contributions on broad-ranging resource and environmental subjects, as well as more narrowly focused technical topics. His prophetic books about the use and protection of Earth's resources include *In Command of Tomorrow: Resource and Environmental Strategies for Americans* and *To Live on Earth: Man and His Environment in Perspective*, both published by RFF Press.

Dunkerley joined RFF in 1974, after working at the *Economist* and the Organisation for Economic Co-operation and Development in Paris. During her time at RFF, she developed an economics-based policy research program on energy in developing countries and coauthored the RFF volume *Energy Strategies for Developing Nations*. She left RFF in 1986 to serve as a senior analyst at the former Congressional Office of Technology Assessment. From 1994 until the late 2000s, she was a consulting economist, working on projects ranging from rural energy supplies in India and Tunisia for the World Bank to global prospects for civilian nuclear power for the Atlantic Council. She received the 2000 US Association for Energy Economics Adelman-Frankel Award for her innovative contributions to the field of energy economics.

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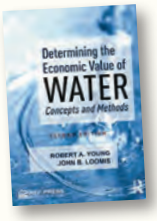

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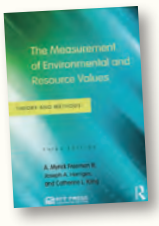

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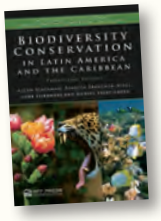

Biodiversity Conservation in Latin America and the Caribbean

Prioritizing Policies

By Allen Blackman, Rebecca Epanchin-Niell, Juha Siikamäki, and Daniel Velez-Lopez

May 2014
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