RESOURCES

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America's Oil Addiction: Tensions and Tradeoffs

From the President

Phil Sharp

Oil Déjà Vu?

We devote this issue of *Resources* to oil—the largest source of energy fueling American prosperity and indeed, the global economy. But the concentration of oil reserves in the Middle East has confounded our foreign policy, raising significant security risks, while projected growth in global consumption ensures that oil will continue to be the largest source of carbon dioxide (CO_2) emissions for decades to come.

The price of oil has powerful impacts on a host of investor decisions, consumer choices, and government actions. Recently, as gasoline moved toward $3 per gallon, a new fervor arose for fuel-efficient vehicles and substitutes for gasoline. Those of us who dealt with similar issues in the 1970s understand Yogi Berra's feeling of "déjà vu all over again."

When prices spiked in 1973 and 1979, intense interest was exhibited in the market and in politics for reducing oil use. Most of this interest was dramatically undercut by the nosedive in prices in 1986. With the slide in prices in recent months, it remains to be seen whether the demand for conservation measures will be sustained and actually reduce our dependence on oil.

The conventional wisdom—at the moment—holds that oil prices will remain substantially higher than they were just two years ago. However, 30 years of hindsight suggest that great humility is warranted when predicting oil prices, much like predicting the direction of the stock market or election returns.

Three decades later, however, the challenges are considerably different. Higher oil prices have not had the predicted negative impact on our economy. China, India, and other developing nations are growing oil consumers. The adequacy of oil supply is subject to intense debate. Strong voices argue that current reserves are so overstated that production will soon be outpaced by demand. The more widely held view contends that while we are unlikely to find major new supplies of conventional or easy-to-get oil, reworking old fields, drilling for harder-to-get deepwater oil, and developing unconventional oil sources like tar sands and shale oil will meet world needs for the foreseeable future. But some of these sources require considerable energy to produce, resulting in even greater CO_2 emissions.

The most compelling difference from the 1970s: the intensifying scientific view that emissions of CO_2 and other greenhouse gases must be controlled to slow global warming. Whether motivated by concerns about adequate supply, security, or climate change, the United States and other nations are once again searching for effective policies to reduce oil use over time. If any of these policies are to genuinely work, we will have to avoid the on-again, off-again pattern of the past.

Phil Sharp

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1616 P Street, NW
Washington, DC 20036–1400
202-328-5000
www.rff.org

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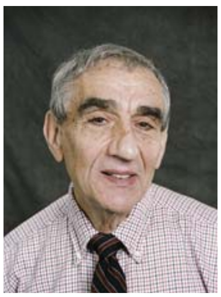
Joseph E. Aldy


Dallas Burtraw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Robert J. Weiner

Contributors

Joseph E. Aldy, a fellow at RFF, conducts research that addresses questions about climate change policy, mortality-risk valuation, energy subsidies to low-income households, and energy policy. From 1997 to 2000, he served on the staff of the Council of Economic Advisers, where he was responsible for an array of environmental and resources issues.

RFF Senior Fellow **Dallas Burtraw** is one of the nation's foremost experts on electricity and the environment. One of his current research areas centers on the design of carbon dioxide emissions trading programs in the Northeast, California, and the European Union. He serves on a U.S. Environmental Protection Agency committee looking at the use of the Second Generation Model, which models issues related to climate change.

In his nearly four decades at RFF, Senior Fellow **Joel Darmstadter** has conducted research centered on energy resources and policy. His recent work addresses issues of energy security, renewable resources, and climate change.

An RFF scholar for almost 30 years, Senior Fellow **Raymond J. Kopp** is an expert on energy issues that go beyond power generation, with a focus on climate change and the important role played by fossil fuels. He studies the environmental aspects of energy policy and technological responses to environmental issues.

Virginia McConnell is an RFF senior fellow and professor of economics at the University of Maryland–Baltimore County. At RFF, she has worked on environmental issues related to urban growth and the environment, air pollution, and transportation. She has served on several National Academy of Sciences panels related to transportation and the environment.

Senior Fellow **Richard G. Newell's** research and outreach efforts focus on the economic analysis of incentive-based policy, technological change, and the operation of markets. He served on the Council of Economic Advisers in 2005–2006 as senior economist for energy, environment, and resources.

Karen Palmer is the Darius Gaskins Senior Fellow at RFF. She is an expert on the environmental and economic consequences of deregulation and restructuring of the electricity industry.

Ian W.H. Parry, a senior fellow at RFF, focuses primarily on environmental, transportation, tax, and public-health policies. He has studied a range of policies—including gasoline taxes, fuel-economy standards, transit subsidies, and congestion tolls—to reduce the social costs of motor vehicles.

RFF Senior Fellow **William A. Pizer** is widely recognized for his research into the design of policies to address climate change risks caused by manmade emissions of greenhouse gases. In addition to his work at RFF, he is a senior economist at the National Commission on Energy Policy and served as senior economist at the Council of Economic Advisers in 2001–2002.

Robert J. Weiner, the 2005–2006 Gilbert White Fellow at RFF, is professor of international business and international affairs at George Washington University. From 2001 to 2005, he was chairman of the university's Department of International Business. He concurrently serves as Membre Associé, GREEN (Groupe de Recherche en Économie de l'Énergie et des Ressources Naturelles), Département d'economique, Université Laval, Québec. ■

In Memoriam

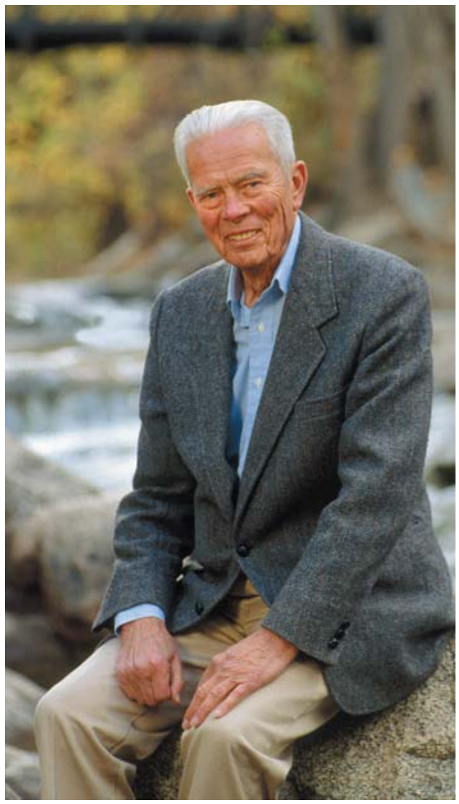
Gilbert F. White, 1911–2006

Gilbert F. White, a pioneer in the field of global resource management and an influential former chair of the RFF Board, died October 5 in Boulder, Colorado, at the age of 94. He was the Gustavson Distinguished Professor Emeritus of Geography at the University of Colorado, where he had been a professor since 1970 and founded the Natural Hazards Research Center.

White's work had profound impact on environmental research, global poverty eradication, and civilization's ability to manage the effects of natural hazards, particularly floods and other weather-related phenomena.

At RFF, White was instrumental in creating a renewed vision for the mission of the institution at a crucial time in its history. "Gilbert White played the key role in ensuring RFF's very existence when it was threatened nearly 30 years ago," said former RFF President Paul R. Portney, who worked closely with White. "In addition, he contributed to RFF generously through the years. Moreover, his research on water resource management and environmental risks and hazards has had a profound influence on the work of RFF scholars through the years." White served on the RFF Board of Directors from 1968 to 1979.

White's legacy to RFF includes the Gilbert F. White Postdoctoral Fellowship Program, established in 1980. This competitive award brings mid-career academicians to RFF for one-year sabbaticals to pursue independent research in resource policy. Arik Levinson of Georgetown University is the current honoree in a program that has brought promising scholars to RFF from around the world.



In 1942, White received his doctorate in geography from the University of Chicago, after he wrote a landmark dissertation entitled "Human Adjustment to Floods." In it, he asserted that devastation from natural disasters such as floods, earthquakes, and hurricanes could be better avoided by changing human behavior. "Floods are 'acts of god,'" he wrote, "but flood losses are largely acts of man."

His work led to the creation of the National Flood Insurance Program in the United States and to better management of flood plains around the world, particularly in developing nations. When he was president of Haverford College, he observed that small-scale, local projects in Asia, Africa, and Latin America could have as great an impact on human welfare as major projects, such as dam building and other large-scale engineering efforts. His suggestion was instrumental in laying the groundwork for the U.S. Peace Corps in the 1970s.

White's world views were deeply rooted in his Quaker faith. As an alternative to military service in World War II, White joined the American Friends Service Committee and aided refugees in France. He was captured in 1943 and was a prisoner of war in Baden-Baden, Germany, until 1944, when he was allowed to return to the United States.

Contributions in honor of White may be made to: The Gilbert F. White Fellowships, Resources for the Future, 1616 P Street NW, Washington, DC 20036. ■

Should States Be Allowed to Set Emissions Standards for Mobile Sources of Pollution?

Virginia McConnell

In response to controversy over a Clean Air Act amendment that bars states other than California from setting their own emissions standards on small-engine vehicles, Congress requested a National Academy of Sciences panel be created to review the standard-setting process. I served on the resulting committee charged with reviewing the state and federal standards for mobile-source emissions.

Beginning with the earliest attempts to reduce emissions from light-duty

vehicles in the 1960s, policymakers realized that multiple-state standards would result in efficiencies in both production and distribution of these vehicles. So in the 1970 Clean Air Act, the federal government preempted state-established emissions standards and required uniform national standards for all mobile sources. There was, however, one exception to that rule: California, because of its special air quality problems and its pioneering efforts to reduce emissions, was given authority to set its own vehicle emissions standards, as long as they were at least as protective as the federal standards. In later Clean Air Act amendments, other states were given the authority to adopt the California standards.

However, in 2003, a provision advanced by Sen. Kit Bond (R-MO) was passed that barred other states from adopting California's first-time standards on small gasoline engines. Although light-duty vehicles have been heavily regulated for years, mobile sources such as generators, leaf blowers, and lawnmowers had been virtually unregulated. The so-called Bond Amendment served to focus attention on the appropriate role for states and the federal government in setting mobile source standards as other engines and engine types are regulated.

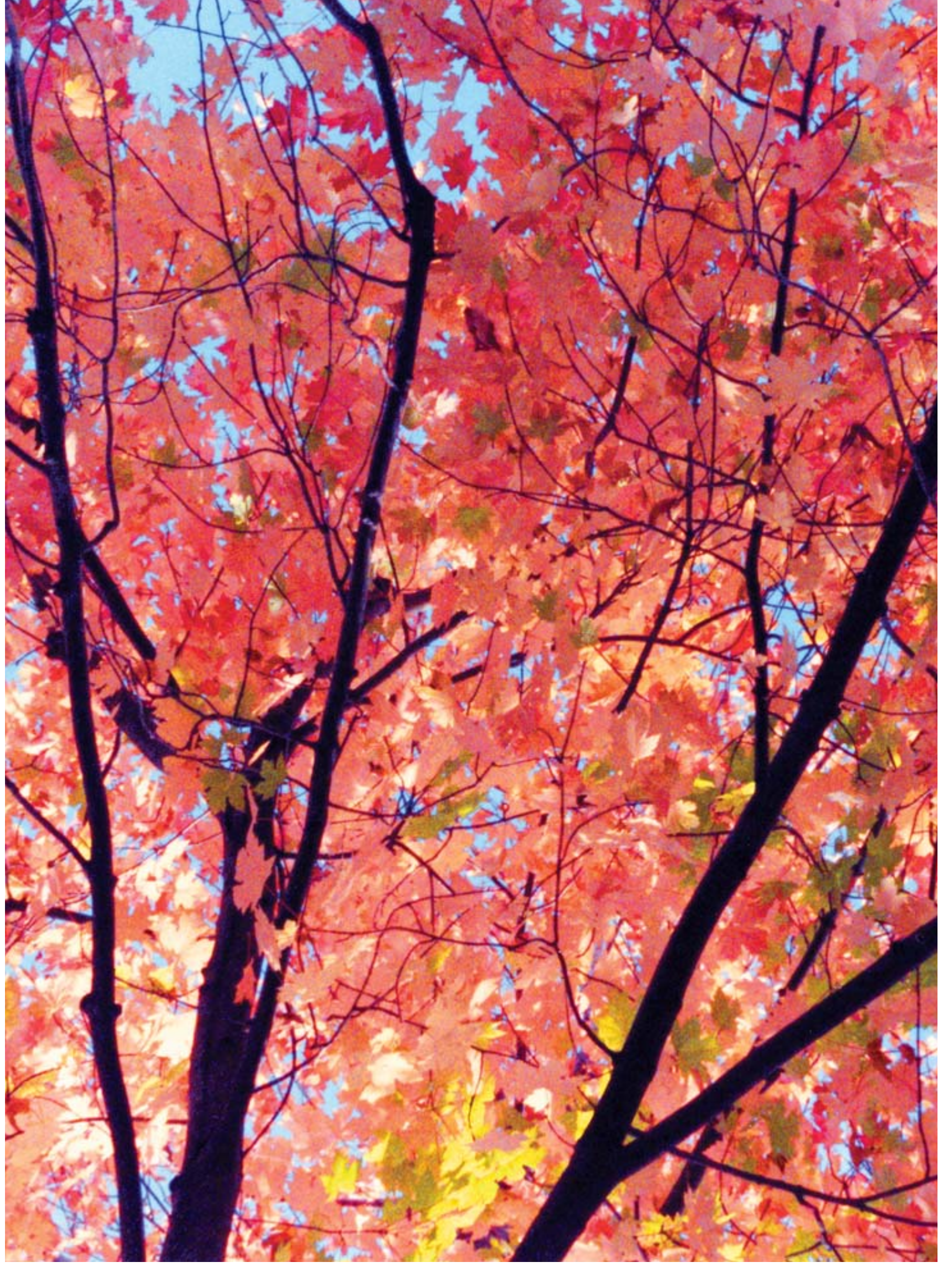
The National Academy of Sciences committee set out to investigate the process for setting standards, including the reasons for setting stricter standards and the practices used. One finding is that California's ability to set tighter standards has played a key role in the development of mobile-source emissions controls. Emissions standards on new vehicles were "technology forcing," requiring the development of new strategies for control that were not currently available. This approach may spur innovation, but it has the potential to come at a high cost. But by setting a stricter standard and serving as a laboratory for development of the technology to achieve it, California lowered the total costs for the nation. Along the way, there were both successes and failures as California pursued stricter standards.

The committee also found that the responsibility for setting standards has often been shared between state and federal governments. For example, California led with the strictest standards on light-duty vehicles and more recently with small non-road engines, while EPA led in establishing standards for on-road heavy-duty diesel vehicles and off-road diesel engines, which have been adopted uniformly across the nation.

While California's ability to set different standards should be protected, the committee was less clear about whether the same should hold for other states. We found no clear evidence on the costs of distributing vehicles to many different states or the costs of enforcing different standards across state borders. Nor were the air quality benefits always made clear by states. Further confounding the issue, EPA's role in evaluating claims about benefits often comes late in the process. In addition, under current practice, the opt-in process often results in lengthy and litigious controversies over whether a state used the same fuel as California or whether temperatures were the same. For these reasons, some on the committee felt that a different approach that included a larger role for EPA in an expanded review process would be beneficial. ■

RFF Convenes Workshop to Support RGGI

Dallas Burtraw and Karen Palmer



This summer, we organized a workshop that provided assistance to states looking to satisfy a key requirement in the Regional Greenhouse Gas Initiative (RGGI), an agreement to lower carbon dioxide (CO_2) emissions generated by the Northeast power sector. The workshop was sponsored by RFF with financial support from the Energy Foundation, Kendall Foundation, and William and Flora Hewlett Foundation.

In December 2005, after two years of planning, the governors of seven Northeast states signed a Memorandum of Understanding outlining an agreement to implement RGGI, with Maryland joining as the eighth participating state this spring. The initiative will stabilize CO_2 emissions from the region's power sector between 2009 and 2014, leading to a 10 percent reduction from current levels by 2019.

A crucial feature in the program design is that at least 25 percent of each state's emissions allowances will be allocated to broadly defined public purposes. Possible ways to satisfy this requirement include direct allocation to consumers, energy-efficient firms, or non-emitting generators. Alternatively, allowances could be converted to cash through an auction and the funds dispensed for various purposes.

Exploring this second option, the workshop brought together nearly 120 stakeholders and state officials engaged in RGGI and experts on various aspects of using auctions. The collective wisdom of the workshop speakers provides some important insights into how best to proceed in designing a CO_2 allowance auction under RGGI, should the states chose to use one. Importantly, as Joe Kruger of the National Commission on Energy Policy pointed out in a wrap-up discussion, the auction design should be aligned with the auction goals, which need to be clearly articulated.

Most speakers recommended conducting laboratory experiments to help understand how the auction works and how changes in various design elements affect its performance. Such experiments pack a "dual punch," said University of Virginia's Charlie Holt: they provide consultants with the confidence to make recommendations that are relatively free of assumptions and policymakers with a clearer view of how the policy might work.

Evan Kwerel of the Federal Communications Commission (FCC) emphasized that collaboration between government, industry, and academics was essential in designing the FCC airwave auctions, one of the best-known examples in the United States. By fostering such collaboration in the case of RGGI, the workshop provided a crucial stepping stone in the planning process. ■

What's the Big Deal about Oil?

HOW WE CAN GET OIL POLICY RIGHT

Richard G. Newell

America's massive transportation network runs almost exclusively on oil—and increasingly the country considers that reality to be a source of vulnerability. Effectively dealing with this problem will require reducing our consumption of oil, especially on the highway. How can we do that without damaging a huge economy that crucially depends on fast, inexpensive movement of people and goods?

We are now being forced to consider this question more seriously than at any time since the age of oil began more than a century ago, for a number of reasons. One is the recent series of disruptive swings, mostly upward, in oil prices. These price swings hurt both household budgets and the larger economy. Another is political instability in oil-exporting regions that, in many cases, involves a U.S. military presence. Importantly, there is also mounting evidence of global climate change caused by burning oil and the other fossil fuels, coal and natural gas.

These concerns were reflected in President Bush's much-quoted line in the 2006 State of the Union Address that "America is addicted to oil." That leads to all the hard questions about how to best address this problem, the role of the market and public policy in efficiently deploying options, and how to balance the search for expanded supplies with policies that can reduce demand. In this special issue of *Resources*, we put the president's comment in perspective and evaluate various policy options.

Where's the Oil?

Existing oil reserves are geographically concentrated in some of the world's most volatile regions, in many cases under the control of governments that are unfriendly to U.S. interests. This raises concerns about the possibility of oil supply disruptions due to war, revolution, terrorist attacks, or trade embargoes, as well as the likelihood of continued or increased U.S. military presence abroad. Although the United States contributes 10 percent of global oil production, it has just 2 percent of proven world reserves. In contrast, about 60 percent of proven oil reserves are located in the Middle East, 10 percent in Africa, 6 percent in Venezuela, and 5 percent in Russia. Canadian tar sands are a relative bright spot in this geopolitical picture, comprising about 14 percent of proven oil reserves.

Some analysts have also drawn recent attention to the view that world oil production has peaked. In the past, however, new discoveries and improved technology have continually led to increases in world oil reserves and production along with consumption growth. A case in point is Chevron's announcement in September that it has tapped petroleum reserves in the Gulf of Mexico that could rival Alaska's Prudhoe Bay in size. In the process, it set several records for ultra-deep drilling. And while conventional oil production will no doubt peak *at some point in time*, unconventional and synthetic sources of oil—such as tar sands and coal-to-liquids (CTL)—are already competitive at or near current price levels and could last for a long time to come.

Putting **Prices** in Perspective

At press time, the average price of gasoline at the pump was about $2.30 per gallon, down from recent highs above $3 per gallon. Since early 2002, gasoline prices have doubled, along with a tripling of crude oil prices from around $20 per barrel to $60 or more per barrel. Crude oil price changes tend to be quickly passed through to consumers at the rate of about 24 cents per gallon of gasoline, for every $10 per barrel change in the price of crude (see the graph on next page).

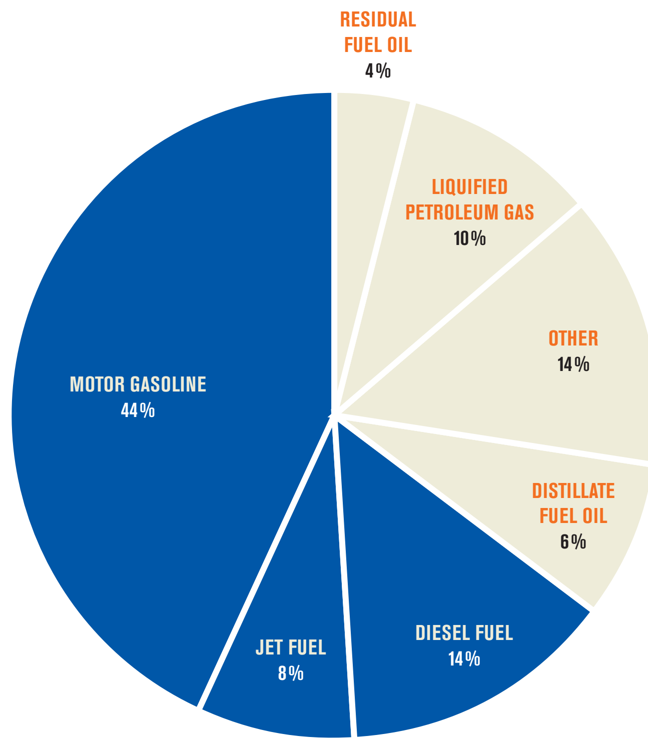
The vast majority of the gasoline price increases over the last several years are therefore attributable to crude oil price increases. Historically tight refining capacity and weather-related disruptions have played secondary roles. Refinery or pipeline shutdowns—such as during Hurricanes Katrina and Rita last year—can impede production and distribution of petroleum products, leading to short-term gasoline price spikes.

Crude oil is freely traded internationally and prices are determined by balancing supply and demand at the global level. Due to vigorous economic growth in the United States, China, and other countries, world petroleum demand has soared over the past several years.

At the same time, world oil production is very close to full capacity, and new production capacity has been slow to emerge. Industrialized countries have exhausted most low-cost domestic production opportunities, and oil companies face considerable risk and restrictions when making investments in less-developed countries. Global oil supply stands at 84 million barrels per day, while spare capacity is only 1 to 1.5 million barrels per day—the lowest level in three decades.

These tight market conditions, coupled with concerns over potential oil supply disruptions in locations such as Iraq, Iran, Nigeria, and Venezuela, are behind a roughly threefold increase in crude oil prices since early 2002. In a global oil marketplace, a disruption anywhere raises prices

Oil Used for Transportation, Heating, Power, and Other Purposes

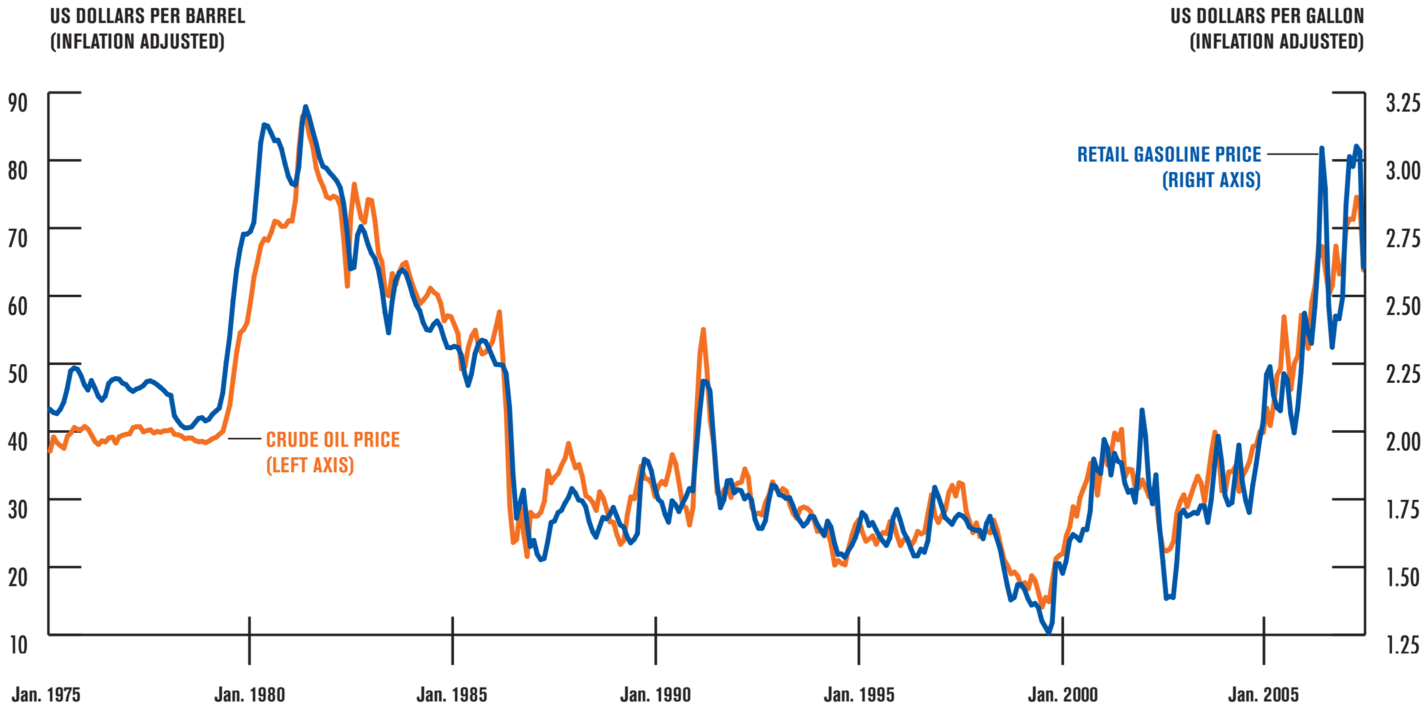


U.S. Energy Information Administration, *Annual Energy Review* (2005)

What's all the oil for?

America runs on oil, by far our biggest single fuel source. About 40 percent of the energy used in the United States comes from consuming 21 million barrels per day of petroleum products, the majority of which is imported. Two-thirds of U.S. oil consumption is for transportation purposes and the majority of that goes into passenger vehicles. The balance of transport fuels, including diesel and jet fuel, go for the planes, trucks, and ships that make it possible for us to have raspberries in January and get packages absolutely overnight. The U.S. industrial sector gets 37 percent of its energy from petroleum, and home-heating oil comprises a significant portion of energy costs for homes in the Northeast. Crude oil is also used for an array of other consumer and industrial products, including lubricants, asphalt, and plastics.

Crude Oil Prices Largely Determine Gasoline Prices



Monthly averages from U.S. Energy Information Administration

everywhere—regardless of how much is imported. The bottom line is that there is little the government can do to control the price of oil.

Implications for the **Economy**

The macroeconomic impact of oil price spikes is a distinct concern. Every major oil price increase since 1970, except the current one, has been associated with a recession. This raises worries about inflationary effects, interest rate hikes, increased production costs, slower GDP growth, and potential recession and job losses.

Then there's the fact that the United States imports 60 percent of the petroleum it consumes, about double the share we imported two decades ago. When oil prices spike, we send large additional amounts of wealth overseas to pay for an increasing oil-import bill—over $240 billion in 2005. This has to be balanced, of course, against the fact that U.S. households and businesses benefit greatly from the same imports, particularly when prices are low.

So far, however, the price increases over the last several years have been only a modest drag on economic growth. In contrast to conditions during price shocks of the 1970s and early 1980s, global economic growth has been robust, inflation and interest rates have been historically low, and the oil intensity of the U.S. economy (the ratio of oil consumption to GDP) has declined.

Pricing the **Alternatives**

Although oil prices have risen to more than $70 per barrel in recent months, they have also averaged as low as $20 per barrel within the last five years. Having lived through the oil price spikes—and then dramatic declines—of the 1980s, oil companies typically use an expected oil price of less than $40 per barrel when making long-term investments. Most current forecasts by government and private analysts project oil prices in the $35–$55 per barrel range over the next two decades, whereas the large capital investments associated with many alternatives would last for several decades.

Only conventional oil, tar sands, and gas-to-liquids (GTL—conversion of natural gas to transport fuel) are clearly profitable at these prices (see the figure on next page). The federal ethanol subsidy of 51 cents per gallon is equal to about $30 per barrel of oil equivalent (that is, energy equal to one barrel of oil), making ethanol competitive at oil prices as low as $20 per barrel of oil. Given these market signals, large-scale commercial production of Canadian tar sands and ethanol has already begun and is expanding rapidly. One million barrels of oil from Canadian tar sands are being produced per day, a rate that is projected to almost triple over the next decade. U.S. ethanol production, virtually all of which comes from corn, has risen from 106,000 to 250,000 barrels per day since 2000. It is expected to roughly double again by the end of the decade at projected oil prices and with current government subsidies.

GTL technology has developed rapidly in recent years, as higher oil prices have made it a more attractive option for "stranded" natural gas reserves that have no local market. Currently, only Malaysia and South Africa have commercial GTL operations, but new projects have been proposed for Algeria, Australia, Egypt, Iran, Nigeria, and Qatar. Commercial-scale CTL plants have operated in South Africa for several decades. Interest in other countries was limited until recently, but China now has plans to open two CTL plants after 2008 and a number of proposals have been floated in the United States.

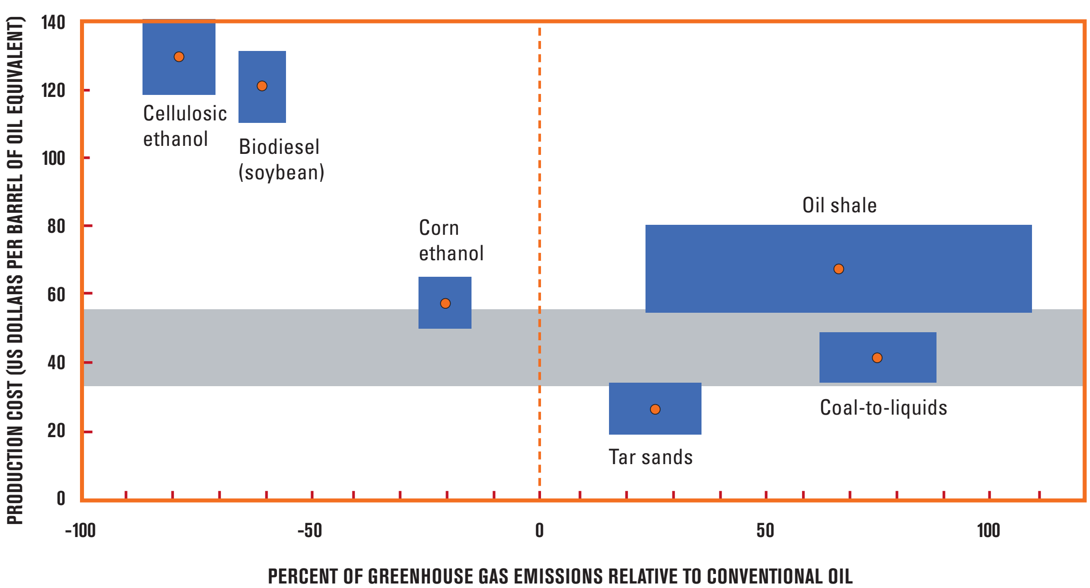
For other alternatives, such as oil shale and cellulosic ethanol, costs are uncompetitive even at the high prices recently experienced. The technologies needed for production require further research, development, and demonstration to bring down costs and establish commercial viability. Cellulosic ethanol is made from grasses, agricultural waste, and other sources of biomass rather than corn, sugar cane, or other higher-value agricultural feedstocks. Interest in cellulosic ethanol has increased considerably, and the federal renewable fuel standard passed in the Energy Policy Act of 2005 ensures that at least some commercial cellulosic ethanol will be produced in the next several years.

Dealing with the **Environmental** Consequences

While recent congressional debates have focused on the potential benefits and environmental risks of expanding access for drilling in the Outer Continental Shelf and Arctic National Wildlife Refuge, the larger environmental issue looming is global climate change. Rising oil prices present both opportunities and risks from the perspective of reducing greenhouse gas (GHG) emissions, particularly carbon dioxide. The incentive that high oil prices bring for increasing fuel economy and encouraging other sources of demand reduction is a clear winner for the climate.

Renewable fuels like ethanol can also lead to moderate or more dramatic reductions in GHG emissions, depending on the feedstock. Although corn-based ethanol offers significant gains in terms of reducing petroleum use, it offers only moderate climate benefits. GHGs from corn-ethanol production and use are only about 20 percent lower than for gasoline because of the need to use fossil fuels like natural gas in the process of growing and processing the corn. More importantly, cellulosic ethanol has the potential to reduce GHG emissions by about 80 percent relative to gasoline.

On the other hand, the most economically competitive, large-scale substitutes for conventional oil are currently not renewable fuels, but tar sands and CTL. Shale oil is currently expensive to produce, but the resource base is large, and costs could come down considerably. Reasonable estimates put GHG emissions associated with the production and use of tar sands at about 25 percent higher, oil shale at about 65 percent higher, and CTL at about 75 percent higher than conventional oil. These higher levels of GHG emissions are due to greater emissions during the production process, whereas GHG emissions from end-use combustion of these fuels are roughly the same.



Oil Alternatives: Costs and Emissions Vary Widely

- High and low range of costs and emissions
- Range of most crude oil price forecasts over next 20 years

Source: Costs. U.S. Energy Information Administration, *Annual Energy Outlook* (2006), other sources. Emissions. A. Brandt and A. Farrell (2006), M. Wang (GREET model 2006).

An **Economic** Perspective on Oil Policy

Economists have identified a number of problems related to oil production and use that may not be adequately incorporated in private market decisions in the absence of government policy. These include the macroeconomic impacts of oil price shocks, local environmental and global climate -related effects, and national security consequences associated with constrained foreign policy and military burdens.

Policy responses tend to fall into two broad classes: supply-side and demand-side approaches. Supply-side policy approaches typically focus on expanding domestic production of crude oil and its alternatives (such as ethanol and CTL). Demand-side approaches focus instead on reducing petroleum consumption through increased fuel economy, reduced driving, alternative modes of transportation, and non-transport conservation. The Strategic Petroleum Reserve serves a unique role, by holding public stocks of oil for potential release to mitigate price shocks due to severe supply disruptions.

Supply-side options

Increased access for domestic oil development is potentially justified based purely on traditional economic grounds—if the value of the oil is greater than the production and environmental costs. However, increased domestic supply does little to decrease our vulnerability to oil price shocks or associated national security threats. Since oil prices are determined in a global market, U.S. prices will rise by the same amount in the event of a disruption regardless of whether they are for domestic or foreign barrels. And money will flow to unfriendly regimes even if it is not U.S. dollars. Iran is a useful reminder: the United States has banned oil imports from Iran since 1979, but that does not reduce Iran's oil wealth or the sway it holds over oil prices.

Policies oriented toward increasing the supply of alternative fuels through subsidies or mandates, such as ethanol and other liquid fuels, do little to reduce our vulnerability to price shocks. They are direct substitutes for oil and have relatively high production costs. In the event of an oil price shock, the price for fuel will therefore be determined largely by the international price of crude oil, not domestic fuel production costs. Only a dramatic shift to an alternative energy source that is not in direct competition with oil (for example, electricity or hydrogen) could remove this strong linkage. One way in which supply-side options can help, however, is by increasing the diversity of fuel supply types and locations.

As described earlier, the environmental impacts of expanding domestic alternatives to conventional oil could be either positive or negative, depending on the fuel type.

Demand-side options

In contrast, policies that encourage demand-side reductions in fuel consumption are better targeted at addressing all the major concerns related to oil production and use. With lower fuel use, households and businesses are affected less by oil price shocks, and other negative macroeconomic consequences are reduced, as are local environmental effects and GHG emissions. Two categories of relatively cost-effective policies are most often discussed: policies that directly or indirectly raise fuel prices, and policies that raise vehicle fuel economy. The first category includes taxes on gasoline or petroleum, as well as policies that put a price on GHG emissions, such as a cap-and-trade system or carbon tax. Each of these provides a direct monetary incentive to reduce petroleum consumption, although the breadth of a petroleum tax or a price on GHG emissions is much greater than a tax solely on gasoline.

Fuel economy policies, the second category, can take the form of either performance standards—as with Corporate Average Fuel Economy (CAFE) standards—or purchasing incentives, such as "feebates" that combine fees on inefficient vehicles with rebates for efficient ones. Each can be designed in a flexible, cost-effective manner or can be riddled with constraints and loopholes that render it ineffective and inefficient. Relative to policies that raise fuel prices, however, fuel economy policies have the disadvantage of not encouraging demand reduction through reduced driving.

Conclusion

The key to more effective policy on oil and its alternatives lies in correctly deciding which part of the oil "problem" to solve. Policymakers often look no further than high gasoline prices and oil imports, an orientation that leads to "solutions," such as repealing the federal gasoline tax and expanding wasteful government subsidies for domestic energy production. These approaches can actually hurt rather than help.

The top priorities for oil policy should instead be reducing both our vulnerability to supply disruptions and GHG emissions. The emphasis would then turn to reducing our exposure to these risks through reduced fuel consumption, diversifying our options through research and development of low-emission alternative fuels and technologies, and insuring against disruptions through wise use of the Strategic Petroleum Reserve.

Proposals have been floated to target virtually all of the options laid out in this special issue of *Resources*, but few have passed Congress or reached the president's desk. When that day comes, decisions should be guided by reason, not rhetoric: our economic and environmental future is at stake. ■

Expanding Oil Supplies

Joel Darmstadter and Robert J. Weiner

Expanding conventional and unconventional oil supplies in the United States and internationally sounds, at first glance, like a very logical thing to do. It potentially would lower world oil prices and increase resilience to disruptions and shocks, with likely environmental consequences the chief concern. Both economic theory and experience suggest caution, however. For expanded oil supplies to improve world output and economic well-being, their market value would have to exceed the total resources consumed in their exploration, development, production, and distribution. Given the size, sophistication, and capital of oil companies around the world, it is reasonable to first ask why oil production has not expanded more already, raising doubts about whether—in the United States, at least—the expectation of increased output, and thereby its economic benefit, may not be misplaced. Higher oil prices encourage such expansion. But the proposition that oil supply expansion can be stimulated through policy intervention deserves careful scrutiny.

What, then, is the economic rationale for intervening in oil markets? Is it because policymakers have better forecasts than oil companies? This is possible during a crisis, when government intelligence may help in deciding whether to use strategic reserves, but is implausible in the long run. Or is there some reason why the market price of oil does not reflect the true value of new supply? There are three potential reasons why the social value of additional oil and its price may differ: increased production may lower the world oil price, increased production may enhance resilience to supply disruptions and price shocks, and increased production risks environmental harm.

Limits of Intervention

Both conventional crude and unconventionally derived supplies (coal-to-liquids, for example) enter the world oil pool and thereby exert price impacts through the global market. A substantial increase in world oil production will lower world oil prices. However, the lower oil prices that would result will aid economic well-being only if the benefits exceed the resources consumed in producing an incremental barrel.

There is a second reason why the oil market might not yield outcomes that maximize economic well-being. Government regulation may prevent exploration and development of oil reserves in areas where oil can be produced economically but are off limits due to environmental concerns.

Many governments do not allow access to foreign reserves that could be produced economically. Were governments in low production-cost regions, like the Middle East, to allow free access to the private sector, world economic well-being would improve through lowering production costs. But then diversity would decline, and the oil industries of high-cost countries—such as the United States, Canada, the United Kingdom, and Norway—might well disappear.

Supply disruptions arising from regional conflicts or problems in oil-producing countries will be smaller relative to the world market if world production is more geographically dispersed.

Some countries that might want to encourage exploration cannot attract foreign capital because of the perceived threat that foreign firms may be expropriated. Many oil-producing countries have unilaterally changed the contract and/or fiscal terms under which foreign firms operate, and such political risk deters oil investment. This problem is potentially present whenever governments play a major role in a market. Addressing this problem through subsidized political-risk insurance, for example, could enhance oil production and welfare.

Indeed, the United States, the United Kingdom, and Japan already provide such insurance to oil projects outside their borders. Moreover, the benefits of correcting market failure are limited to supply that diversifies current sources, as noted above.

Reducing Economic Vulnerability

The idea that expanded oil production would itself reduce the macroeconomic impact of oil shocks should also be treated cautiously. It would be hard to argue that the U.S. economy is more vulnerable to oil shocks than it was in the 1970s, despite the substantial decline in U.S. oil production and the attendant increase in oil imports. Many countries experienced recessions following the oil shocks of the early 1970s, despite the then-prevailing low oil prices. Why should restoring U.S. oil production to 1970s levels—even if it could be done economically—reduce economic vulnerability?

In principle, expanded oil supplies could diminish economic vulnerability by reducing

Characteristics of Oil Supply

To understand the effects of policies aimed at enhancing oil supply, it is important to bear in mind a few characteristics of oil production:

PRODUCTION TECHNOLOGY *has low variable costs and high fixed costs, implying operation close to capacity, so that downward as well as upward price jumps will only slightly affect supply unless capacity itself changes.*

INCREASING PRODUCTION CAPACITY *(and transportation capacity in many areas) requires substantial up-front investment, implying that sharp price increases will elicit little additional supply capacity in the short run.*

RESERVES ARE GEOGRAPHICALLY CONCENTRATED, *so local problems can have global consequences. Local problems may include: natural disasters that damage production or transportation infrastructure (for example, hurricanes); political risk and domestic instability; regional conflict; and accidents or equipment malfunction.*

PRODUCTION AND TRANSPORTATION CAN HAVE ENVIRONMENTAL CONSEQUENCES, *particularly leakage and spills. In the case of unconventional oil supplies that require mining to extract, issues like water use and land and habitat degradation must be considered.*

the size of the shocks themselves. To do so, however, supplies would have to be able to be increased substantially in response to price spikes or would have to be located in areas of the world that are not shock prone. As discussed in the box on the prior page, these conditions are not easily met.

Expanded output could potentially attenuate shocks in two ways. In a famous quote on the occasion of switching energy supply from domestic coal to imported oil, Winston Churchill said, "Safety and certainty in oil lie in variety and variety alone." Supply disruptions arising from regional conflicts or problems in oil-producing countries will be smaller relative to the world market if world production is more geographically dispersed. In this respect, policies such as opening up the eastern Gulf of Mexico to drilling would, at best, lead to increased supply from an area of the United States already highly prone to hurricane disruption. It would also do little for energy security, especially as 25 percent of all U.S. oil production already comes from there. In contrast, expanding supplies from multiple sources should help; oil reserves are widely distributed in Africa, for example.

In theory, the second way for expanded oil supply to attenuate shocks is by reducing their impact on prices. This would require supply to be price elastic—able to be increased quickly and substantially in response to the higher oil prices accompanying shocks. Unfortunately, just the opposite is the case. Maintaining the spare capacity needed for expanding supply quickly would be far too costly.

Increasing oil supply in response to price changes is simply unrealistic in the short run. Any policy-induced increase would need several years to take effect—at best a policy for the long term.

Expanding oil supplies through government subsidies should be regarded with healthy skepticism. Increasing oil supply in response to price changes is simply unrealistic in the short run, and any policy-induced increase would take several years to take effect, at best a policy for the long term. The only supply source that can be increased or decreased quickly and substantially in response to oil-price changes is inventory, whether private or public. The case for government intervention is strongest in the case of mitigating oil shocks, but this is a matter of using strategic reserves, not expanding supply capacity. Several countries maintain oil stockpiles, including the United States, in the form of the Strategic Petroleum Reserve.

Environmental Pros and Cons

Expanding oil production capacity is the subject of considerable environmental controversy, leading to moratoria on oil exploration and development in selected federal offshore waters and—particularly controversial—the prohibition on oil drilling in the Arctic National Wildlife Refuge (ANWR). The environmental impacts of oil production can range from modest to significant, depending on geographic location, the technology used for oil extraction, the means of transport, and—in all cases—availability of labor and technology to mitigate environmental impacts.

The oil-environment tradeoff is especially vexing in the case of ANWR, where the government's best estimate is reserves of around 10 billion barrels. Development of ANWR would likely result in annual production of about a million barrels a day 10 years from now, a level of output representing a 1 percent increase in world supply, with gasoline prices falling by just a few cents per gallon.

Other things being equal, an expanded volume of oil supply inescapably exacerbates the environmental threat, which in recent years has prompted concern over rising carbon dioxide (CO_2) emissions. Of course, other things aren't always equal. So it's important to recognize that, while the public's oil-related attention is normally directed to the negative environmental effects of extraction, transport, refining, and end use, a variety of technological advances have, over the years, enhanced the environmental integrity of oil operations spanning the entire fuel cycle—from wellhead to tailpipe.

Moreover, the petroleum sector offers the potentially beneficial prospect of at least one contribution to managing perhaps the most vexing environmental dilemma of our time—greenhouse gas emissions. That contribution is carbon sequestration—the injection into underground cavities or reservoirs of CO_2 that would otherwise be released into the atmosphere. CO_2 is routinely injected into existing onshore oil wells to increase pressure and oil recovery. More innovatively, a considerable quantity of CO_2 is being sequestered in the seabed in the North Sea Sleipner Field.

As the exploitable resource base shifts to unconventional sources of oil—as is already happening on a significant scale with respect to Alberta's tar sands—the nature of environmental concerns changes. A case in point is water scarcity in an arid region like the U.S. Rockies, where substantial oil-shale reserves are located. There, problems of water scarcity and the challenge of re-vegetating a desert landscape compound the need to deal with the volume of mine wastes that oil-shale extraction poses. Just as worrisome is the relatively high carbon intensity of these synthetic fuels: a gallon of tar-sand-based gasoline has been estimated to produce at least 25 percent more CO_2 than a gallon of fuel derived from conventional crude oil. The prospective conversion of coal to liquids won't make things any easier.

Decisions by oil companies and market arrangements governing trade, investment, and contractual practices will be central to future oil-supply conditions. Though their role is often controversial—witness the unhappy experience of the U.S. Synthetic Fuels Corporation (see the box below)—governments clearly have significant responsibilities in formulating policy initiatives to address the sharp divergence in benefits and costs facing oil companies from the benefits and costs facing society.

In short, eliminating vulnerability to oil shocks through expanded oil supplies is unrealistic. In a world of unpleasant surprises, with major oil resources largely situated in difficult regions of the world, the years ahead are likely to be anything but smooth. ■

The Synthetic Fuels Corporation: A Cautionary Lesson on Picking Winners?

Government has an undeniably important role in supporting the development of alternative fuels and innovative energy systems. At the same time, the inclination—from time to time—to target *specific* resources, technologies, or outcomes can prove risky and ill-advised. A sobering historic example relates to the initiatives of the U.S. Synthetic Fuels Corporation (SFC).

SFC was created as a quasi-independent but public institution under the Energy Security Act of 1980 in response to the energy turmoil of the 1970s. Through a variety of financial incentives, it sought to stimulate production of shale oil and coal-derived fuels.

The bullish atmosphere that accompanied formation of the SFC rested on the prospect of synfuel costs being within a range likely to be approached and perhaps surpassed by world oil prices within a near-term planning horizon. A synfuels capacity for the production of several million barrels per day of crude oil equivalent was seen to have a good chance of materializing in less than a decade, albeit with prospective federal financial support in the billions of dollars.

Alas, it didn't happen. The world oil-price collapse in the mid-1980s and formidable technical hurdles ensured the corporation's demise in 1986.

But it is best not to view all this as a morality tale of the hazards of government taking upon itself an overly entrepreneurial role, best left to the private sector. For the private sector was, in fact, itself a significant actor in the SFC drama. Exxon in 1981 committed nearly $2 billion (in price levels of the period) to its Parachute, Colorado facility. Within a couple of years, the company was estimated to have spent hundreds of millions of (non-federal) dollars in Colorado alone. No shale oil was produced. But hindsight is cheap; even hard-nosed private entrepreneurial strategies can founder when the unpredictability of oil price trends is compounded by untested technological challenges.

REPLACING OIL

ALTERNATIVE FUELS AND TECHNOLOGIES

Raymond J. Kopp

Most experts look to alternative fuels and technologies as promising complements to petroleum in the near term and likely substitutes in the long term. Currently, 98 percent of the U.S. transport sector runs on petroleum. The reasons for this dominance are simple. Transportation fuels derived from petroleum pack a lot of energy in a small volume and weight. The internal combustion engine (ICE) found in practically every vehicle is compact, powerful, and well suited to transportation applications. And until recently, petroleum has been a bargain, at least in the United States. If alternative energy sources are to compete effectively with petroleum, they must be price competitive, perform well with existing ICE technology, or be packaged with a new motor entirely, probably an electric one.

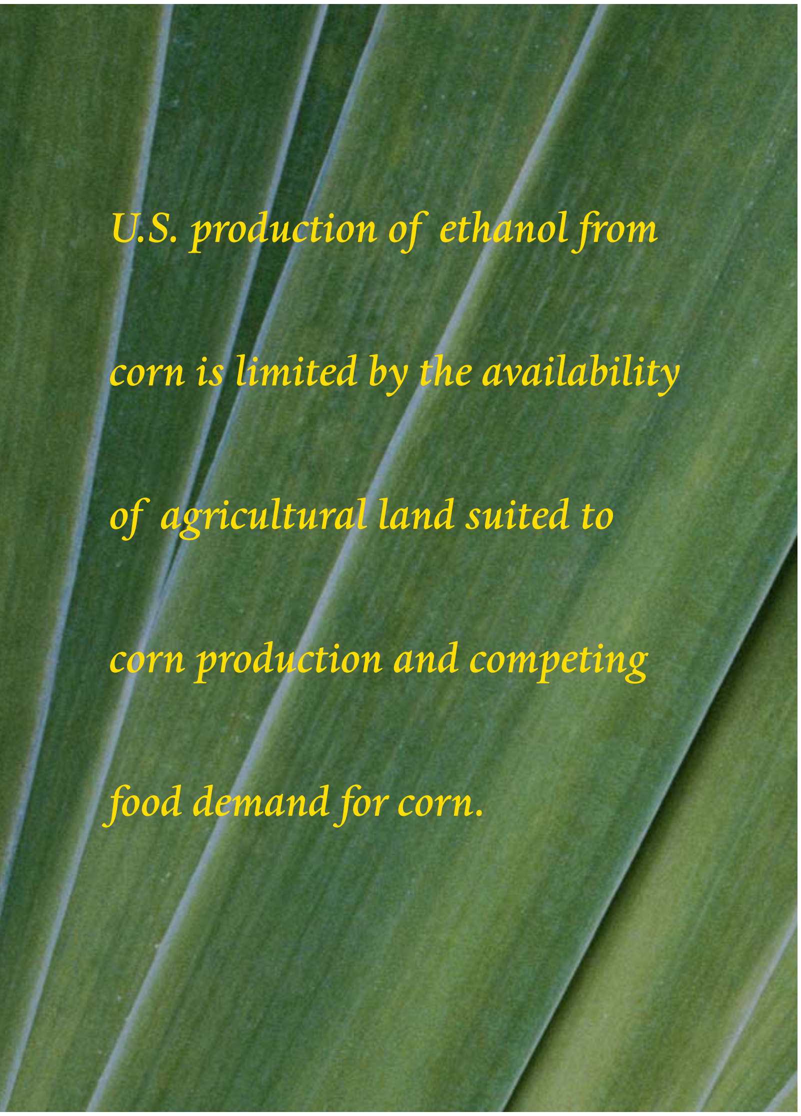
The extent to which alternative fuels can reduce U.S. dependence on petroleum, lessen the impact on U.S. consumers of spikes in the world price of petroleum, and improve U.S. national security through reductions in imported petroleum depends on the scale of their penetration into the transport fuel market. Penetration in turn depends on the cost of delivered alternatives in relation to gasoline and diesel, the degree to which these alternatives are viewed as viable substitutes by consumers, the availability of vehicles designed to utilize the fuels, and the necessary fuel distribution infrastructure.

The advantages enjoyed by petroleum divide the potential competitors into two camps—liquid biofuels (ethanol and biodiesel) that can be used in ICEs and other energy sources, such as hydrogen and electricity, that require new motor technologies. In the case of hydrogen, a radically new delivery infrastructure is also needed. In the near-to-medium term, biofuels are poised to be competitive. In the longer term, hydrogen and electricity offer the technical potential to completely wean the United States from petroleum use.

Biofuels over the Next 5–10 Years

Biofuels seem well positioned to penetrate the transportation market. Ethanol can be produced from corn, sugar, and fibrous plants, such as switchgrass. Currently, 10 percent ethanol is blended with gasoline to make E10, in large part as a substitute for MBTE (once added to gasoline for environmental purposes). However, with limited vehicle modifications costing between $50 and $150 per vehicle, new vehicles can be produced to run on as much as 85 percent ethanol (E85) as well as 100 percent gasoline. These "flex-fuel" vehicles are currently being produced by U.S. automakers; General Motors, for example, estimates that more than two million of its flex-fuel vehicles are on the road in the United States today.

A government subsidy of 51 cents per gallon already makes corn-based ethanol price competitive in the United States with gasoline in the neighborhood of $3.00 per gallon. However, the relatively small quantity of ethanol produced is predominately used in E10 blends. If E85 becomes popular, production must be scaled up, which may raise the cost as demand rises. Further, ethanol has about 70 percent of the energy content of gasoline, which equates to fewer miles per gallon. Therefore, if gasoline sells for $3.00 per gallon, competitive E85 must sell for no more than $2.20 to attract consumers.



The Renewable Fuels Association lists 102 ethanol refineries currently operating in the United States, with an additional 43 refineries and seven expansions under construction. However, U.S. production of ethanol from corn is limited by the availability of agricultural land suited to corn production and competing food demand for corn.

Outside the United States, ethanol has been made for many years from sugar; in Brazil, for example, ethanol from sugar accounts for about 20 percent of the transport fuel market. Indeed, the World Bank believes Brazil can make ethanol from sugar for about $1 per gallon. Unfortunately, imports of ethanol from Brazil face high tariffs, a 2.5 percent tax on the value, and a secondary tariff of 54 cents per gallon, imposed to roughly offset the 51-cents-per-gallon domestic subsidy. Reducing or eliminating these tariffs might expand ethanol supply to the United States, thereby lowering cost and accelerating the penetration of this fuel into the U.S. transportation fuel market

Ethanol can also be produced from woody fibrous plants, such as switchgrass. The use of a low-cost and readily available feedstock has led many to believe that cellulosic ethanol could be very price competitive with gasoline in the future after the production technology has evolved somewhat further. Honda Motor Company recently reported successes using strains of microorganisms developed in Japan to more efficiently convert the sugar in cellulose into alcohol. And unlike corn, biomass for cellulosic conversion need not consume prime agricultural land and, as a result, may be grown in larger quantities.

The Department of Energy forecasts total ethanol production from corn and cellulose to be 10–14 billion gallons annually by 2030. While this would amount to 30 percent of worldwide ethanol production, it is still less than 10 percent of projected U.S. gasoline demand. The president's Advanced Energy Initiative, announced in his 2006 State of the Union speech, will increase research funding for cellulosic ethanol, with the goal of making it cost-competitive with corn-based ethanol by 2012.

Production of biodiesel made from recycled cooking oil (called yellow grease) or raw vegetable oils from crops such as soybeans was developed as early as the invention of the diesel engine in 1878. Like ethanol production, biodiesel enjoys government subsidies that make it price competitive with petroleum. The Energy Information Administration estimated the current cost of a gallon of biodiesel made from vegetable oil to be $2.49 and the cost from yellow grease to be $1.39 in 2002 dollars. In comparison, EIA estimated the cost of diesel from petroleum to be 78 cents a gallon. To compete, biodiesel received a production subsidy from the Commodity Credit Corporation during fiscal years 2004–2006 of $1.45–$1.47 per gallon if made from soybean oil and 89–91 cents per gallon if made from yellow grease.

On top of this production subsidy rests a tax credit for blenders who add biodiesel to petroleum diesel. The blenders receive a credit against the federal excise tax they pay of approximately $1.00 per gallon for vegetable oil-based diesel and 50 cents per gallon for yellow grease. These subsidies and tax credits bring the production cost of biodiesel very close to that of petroleum-based diesel.

Biofuels not only substitute for petroleum but they also can have beneficial impacts on climate change. Ethanol and biodiesel are produced within a relatively closed carbon cycle where carbon dioxide (CO_2) released into the atmosphere during combustion is recaptured by the plant material and used to produce additional fuels. To the extent these biofuels displace petroleum, they reduce CO_2 emissions and therefore are more climate-friendly than petroleum.

However, crops must be cultivated to provide the needed feedstock and then processed to produce the fuels. Cultivation and processing involve the use of energy and other inputs, such as fertilizer, that can have negative effects on greenhouse gas emissions and other environmental impacts, like water pollution.

A full production-cycle analysis is needed to make definitive statements regarding the positive climate impacts of large-scale biofuel production. Careful studies put the "well-to-wheels" greenhouse gas benefits of corn ethanol at about a 20-percent reduction and cellulosic ethanol at about an 80-percent reduction relative to gas derived from conventional oil.

Carbon-Free Cars

To some, transportation nirvana involves not ICEs, but electric cars running on storage batteries or electricity generated from on-board, hydrogen-powered fuel cells. If ICEs have a role in this utopia, it is in the form of plug-in hybrids—electric cars with sizable on-board battery storage and ICEs to either recharge the batteries or, when needed, provide power directly to the wheels. In either case, the extent to which these alternatives affect our reliance on petroleum again depends on their relative cost with respect to petroleum and biofuels and their acceptability in eyes of the consumers.

Battery-powered pure electric (as opposed to plug-in hybrids) and fuel cell–powered electric vehicles cannot, at present, compete on price and attributes with ICE-powered vehicles. Battery-powered vehicles are much closer to commercial production than fuel-cell vehicles, but as yet none of the major manufacturers have committed to large-scale production (although some small-scale production by start-up companies is expected).

If the goal is to reduce U.S. petroleum consumption over the next decade or two, battery-powered electric vehicles may play a role, but the size of that role depends, as it has in the past, on advances in battery technology. Fuel-cell vehicles must overcome larger engineering problems, including hydrogen storage and development of a safe hydrogen-delivery infrastructure, before they are ready for any widespread commercial deployment.

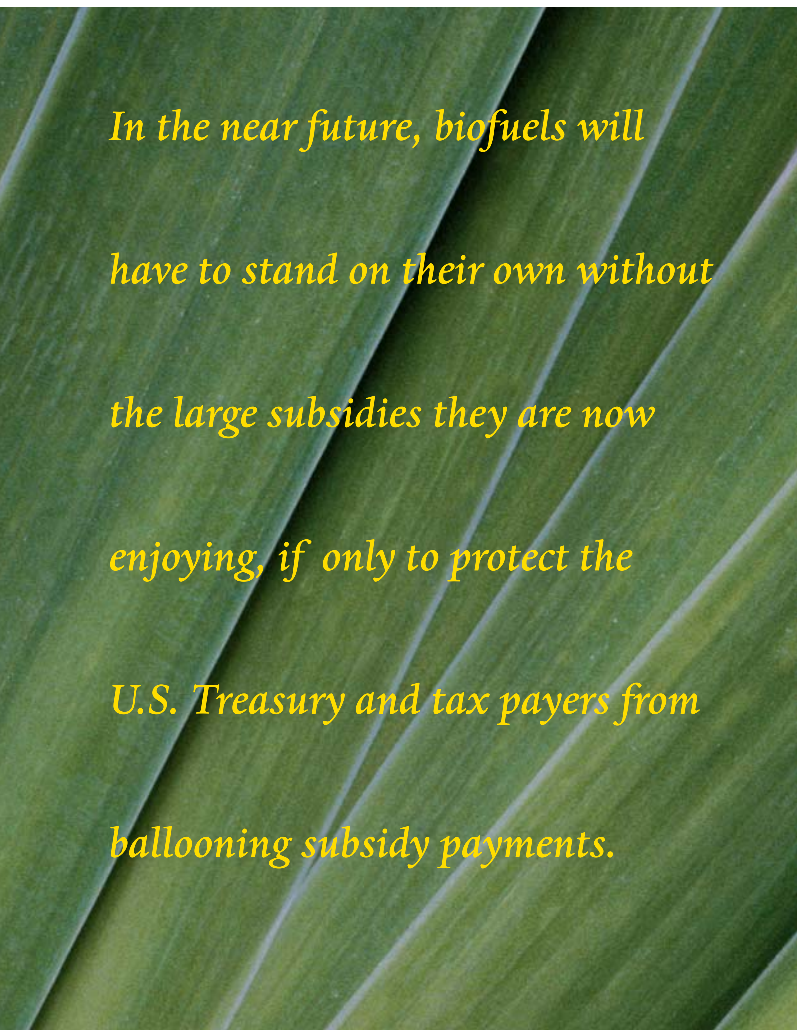
The bridge between internal combustion engines and an automotive future that doesn't rely solely on petroleum might be the plug-in hybrid that uses grid-charged batteries for short trips (of 50 miles or less). However, the plug-in hybrid still faces the same battery issues that have plagued electric-car development, namely weight, range, and cost. *The New York Times* reports that Toyota has a plug-in hybrid ready for the market—only time will tell.

Sticks and Carrots

Government policy is often a combination of sticks and carrots (mandates and incentives), and this is true for biofuels and advanced vehicles. With respect to advanced vehicles, sticks (mandates) applied to vehicle manufacturers come in the form of regulations like the California Zero Emission Vehicle (ZEV) mandate, which directed automakers to produce specific quantities of electric cars starting in 2003 but has been modified over the years due to litigation. Carrots (incentives) come in the form of tax credits to consumers. For example, tax credits ranging from $400 to $3,400 were available for purchasers of all new hybrid vehicles, but upper limits on government funds available for such credits mean that for certain hybrids (notably the Toyota Prius) funds will soon be exhausted. Tax credits up to $4,000 are still available for purchasers of new pure electric cars that run on batteries or electricity from hydrogen fuel cells. The idea behind both sticks and carrots is to develop a market for these vehicles in the hopes that increased production will lead to lower costs, making these vehicles competitive with ICEs.

Government biofuel policy is also composed of incentives and mandates designed to establish markets and increase domestic production. The most important mandate is the recent renewable-fuel standard contained in the 2005 Energy Policy Act requiring that 2.78 percent of the gasoline sold or dispensed in calendar year 2006 be renewable. There is good reason to believe this target will be met if not exceeded. Incentives are provided through provisions of the 2002 Farm Bill encouraging the production of biofuels through small grant programs, the subsidies provided by the Commodity Credit Corporation (discussed previously), and 2005 Energy Policy Act's provision of additional subsidies to domestic ethanol and biodiesel producers

One can't know for certain how effective incentives—in the form of purchase subsidies—have been at spurring hybrid, pure electric, and fuel-cell vehicle sales. However, it seems likely that although hybrid sales have benefited from the credits, consumer satisfaction with the vehicles, combined with fear of ever-higher gasoline prices, has been a substantial motivator. Similarly, it is doubtful that continued credits will do much to build consumer demand for pure electric and fuel-cell vehicles until those vehicles meet customer demands and gasoline prices remain high. What is needed is breakthrough battery technology; any government policy that can accelerate the attainment of this goal will have a significant effect on the commercialization and penetration of these vehicles.



Subsidies have no doubt been instrumental in the growth of biofuel production. The issue facing policymakers now is whether these subsidies will be necessary in the future, how they can be set in some optimal sense (that is, as low as possible to achieve the desired result), and how can they be removed or reduced given the political constituency they have developed.

Second-Best Alternatives

The key rationale for reducing petroleum consumption lies in the fact that the market price does not account for its full social cost: the negative externalities or consequences associated with petroleum use—such as greenhouse gas emissions and national security issues—are not incorporated in the market prices.

For economists, the standard policy response to these externalities is the imposition of a tax equal to the marginal value of the externality so that the market price would represent the full social cost of petroleum consumption. The policies discussed above are second-best alternatives to a tax policy and therefore will be less efficient than a tax (perhaps by a wide margin). Given the lack of political will to impose taxes on petroleum, second best may be all we have at the moment, but that is no reason to cease striving.

Even in a second-best world, some policies are better than others. In the case of biofuels, we are concerned with their continued commercialization, the establishment of a robust market for them, and the growth of delivery infrastructure. In the case of new motor technologies (all electric or fuel-cell cars), we are concerned with continued technology development in this pre-commercial phase. Subsidies and mandates are better suited to commercialization, while policies focusing on R&D are better suited pre-commercialization.

In the near future, biofuels will have to stand on their own without the large subsidies they are now enjoying, if only to protect the U.S. Treasury and taxpayers from ballooning subsidy payments. At the very least, the corn-ethanol subsidy should be phased out, as well as the import restrictions. ■

The Strategic Petroleum Reserve

A Short-Term Response

PHOTO PROVIDED BY U.S. DEPARTMENT OF ENERGY

Joseph E. Aldy

In contrast to other policies that focus on long-term solutions to the problem of oil dependence, the Strategic Petroleum Reserve (SPR) offers policymakers a short-term response to disruptions in oil markets. And, not surprisingly, they hold a variety of views on the role and purpose of the SPR: to offset an oil supply shock; to deter future oil supply shocks, such as an oil embargo; to aid diplomatic efforts to encourage additional production from major oil exporters when oil prices are high; to manage oil prices; and, in recent years, to offset supply shocks in the Northeast heating oil market.

The SPR, which was established following the 1973 oil crisis, is comprised of four sites on the Gulf of Mexico located near major petrochemical refining and processing facilities. The petroleum, all in the form of crude oil, is stored in artificial caverns created in salt domes below the surface. SPR oil has been sold on the open market under emergency conditions only twice in the reserve's history. More often, it has been "loaned" to oil companies facing major pipeline and refinery disruptions and later returned.

The primary purpose of the SPR is as a political tool; distribution of the actual oil is quite limited. Its effectiveness depends on both the magnitude of the total holdings as well as the maximum rate of drawdown (how much oil can be pumped out in one day). The Department of Energy estimates that the SPR currently holds 688 million barrels and can deliver 4.4 million barrels per day, which is less than one-third of U.S. daily imports of crude oil and petroleum products.

In an integrated world oil market, however, the economic benefits of the SPR are not defined by the ratio of the SPR stock to the flow of daily imports. Rather, the benefits reflect the ability to lessen the magnitude and duration of a shock as well as the scope for coordination with other countries. For example, the decision to increase the oil holdings at the existing SPR in October 2001, from 570 to 700 million barrels, makes sense if one is concerned about an oil supply disruption that requires the maximum daily SPR drawdown rate for more than four months (or a series of supply shocks with comparable magnitude and duration). This increase in SPR size had no impact on the drawdown rate or, therefore, the magnitude (versus duration) of shock the SPR can accommodate. To put this in context, the 1991 Desert Storm emergency drawdown was the largest in the history of the SPR at 17 million barrels over 2 months. This all suggests that the SPR could help mitigate the costs of a range of disruptions for many months.

The global oil market has become far more integrated. In most circumstances, an oil embargo targeted at the United States would not adversely affect the country. We would buy oil elsewhere at essentially the same price.

If It Ain't Broke…

Because of its large size (both in terms of barrels and economic value) and limited historical use, some have advocated reforms for the SPR that would focus on a more active management of its crude oil stocks. Some have called for privatizing the SPR and requiring the private SPR operator to post prices at which it would buy (at low prices) and sell (at high prices) oil. An alternative SPR reform would result in government officials buying and selling SPR oil in an attempt to stabilize oil prices—an oil equivalent of the Federal Reserve. Such active stock management policies raise serious questions about the responses of private inventory holders and major oil exporters, which often are the first to increase supply to the market when prices are high and pull product off of the market (or produce less) when prices are low. These approaches also raise questions about whether they are consistent with the economic and national security objectives of the SPR and whether they would be effective in a market where OPEC members or other producers could modify their behavior to maintain influence over prices.

In response to the spike in heating-oil prices in winter 2000, the federal government developed a two-million barrel heating-oil reserve in the Northeast. The rules for use of the heating-oil reserve stipulate that a drawdown should be authorized only as a result of a shock in heating-oil prices above and beyond spikes in crude oil markets. In recent years, some have also advocated for regional gasoline reserves. Such product reserves could help address local and regional shocks—such as ice-locked harbors in the Northeast, pipeline disruptions, or multiple refinery outages—that could cause a short-term increase in prices. However, they may also reduce the incentive for private firms to hold product inventory and, in the case of a crude-oil shock, would have little to no impact on product prices, relative to a drawdown of crude oil from the SPR.

The Strategic Petroleum Reserve was created some three decades ago to address a physical supply shortage, such as from another oil embargo. In the years since then, the global oil market has become far more integrated, and, in most circumstances, an oil embargo targeted at the United States would not adversely affect the country—we would buy oil elsewhere at essentially the same price. The SPR, in coordination with other developed countries' petroleum reserves, can address more generally the price spikes that arise from supply shocks, whether from labor strikes, hurricanes, wars, or explicit political decisions. The threat of a drawdown can complement diplomacy to encourage production from energy exporters, but an active SPR price-management policy would likely undermine such diplomatic efforts. ■

The Economics of Improving Fuel Economy

William A. Pizer

Improving fuel economy offers us the promise of reducing our oil use without requiring us to sacrifice driving our vehicles. Reduced oil use, in turn, means both fewer carbon dioxide (CO_2) emissions and a smaller economic impact when oil prices rise, thereby improving both the environment and our economic security. Despite this promise, however, the average fuel economy of new light-duty vehicles (cars and light trucks) in the United States has worsened over the past 20 years as sales of larger and more powerful vehicles have risen. Why has this happened, and how should we think about policies to improve fuel economy?

Numerous studies suggest that improvements in fuel economy can be cost-effective; that is, the gasoline savings can pay for the cost of fuel-saving technologies. A 2004 summary by the bipartisan National Commission on Energy Policy (NCEP) estimated that fuel economy could be improved by 20 to 50 percent with a net savings (fuel savings minus vehicle cost) to car buyers (see figure 1 on page 22). Significant gasoline price increases since 2004 would only increase the level of cost-effectiveness, as would further penetration of gas-electric hybrid technology.

Why have market forces not driven consumers to demand—and manufacturers to produce—more fuel-efficient cars? Part of the answer is that most technologies that can be used to increase fuel economy can also be used to increase horsepower (see figure 2 on page 25). And, arguably, consumers have found greater value in vehicle power and size than in fuel economy. Imagine a $10 technology that can save $15 in fuel. If that same technology can be used to provide an increase in power or size that is worth $20 to consumers, the market will push technologies toward power and size over fuel economy.

If consumer choices about size and power versus fuel economy are carefully informed, the only rationale for government intervention is if the market price of oil does not reflect its true social costs, such as the environmental or security issues associated with oil use that affect society but are not reflected in market prices. Economists would say the best response is an oil tax based on these additional social costs. Oil taxes have the advantage of not only encouraging more fuel-efficient vehicles, but also encouraging less driving for a given vehicle (in contrast, fuel-economy improvements actually tend to spur more driving).

Several arguments, however, suggest that consumers and manufacturers are *not* making good decisions about fuel economy. The first is that consumers may not know, understand, or believe there really are differences in fuel economy among vehicles—a view possibly supported by EPA's recent rulemaking to significantly adjust fuel-economy labeling. Second, if consumers understand that those differences exist and are real, they may not rank fuel economy high enough to worry about when shopping for a car; cargo capacity, power, and styling may be more important. Finally, even if consumers do consider fuel economy, they may not find that the corresponding net gain of about $50–$500 (depending on the payback period) associated with fuel-economy decisions makes a big enough difference to sway their choice of vehicle. Finally, consumers may not properly account for the full value of future fuel savings from a more fuel-efficient car, considering, for example, only the first few years of savings rather than the entire vehicle lifetime.

If some of these consumer undervaluation arguments are true, it might make sense to regulate fuel economy, regardless of the significant social costs regarding security and environment. But even if they are not, we might still pursue fuel economy if fuel taxes are politically unfeasible and the social costs are significant. Regardless of why we pursue fuel-economy standards, it will be important to consider not just the dollar cost of a technology to improve fuel economy (and its benefit in terms of reduced fuel use), but the value of that technology applied to its next-best alternative use—say, increasing power—in estimating a cost-effective standard.

Current and Past Policy

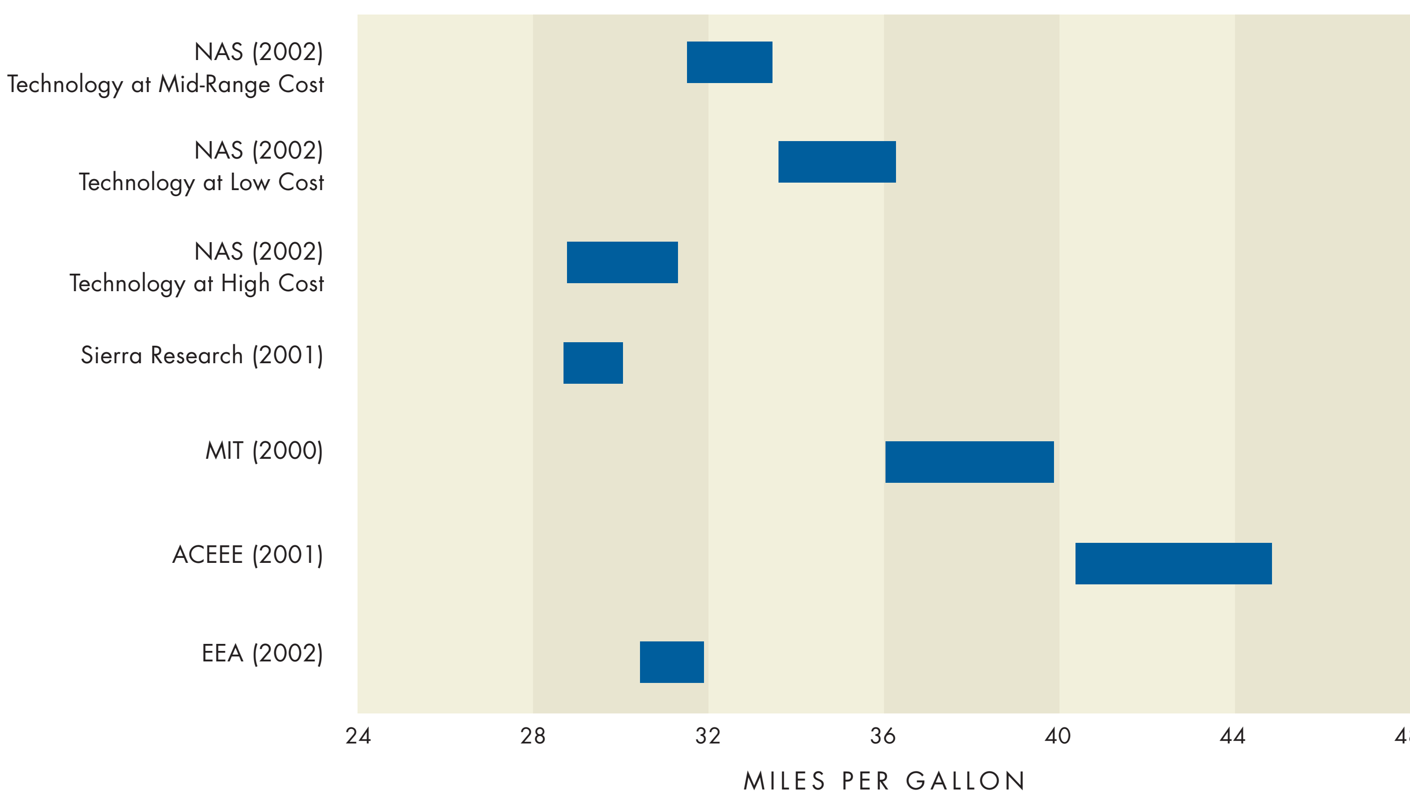
Under the Corporate Average Fuel Economy (CAFE) rules, vehicle manufacturers are required to meet a specific miles-per-gallon (mpg) standard, on average, for all the different classes of vehicles they produce. There are different standards for cars versus sport-utility vehicles (SUVs) and light trucks, and the standard for cars must be met separately for domestically manufactured vehicles and imports (that is, cars manufactured overseas cannot be averaged with cars manufactured within the United States).

Manufacturers that improve average fuel economy beyond the standard earn credits that can be saved or "banked" for use in that same fleet within the next three years. On the other hand, manufacturers that fail to meet the standard must pay a per-vehicle penalty based on how badly they miss it. The standard for cars has been 27.5 mpg since 1985; the standard for

FIGURE 1

Various analyses suggest a range (20–50 percent) of possible fuel economy improvements, versus the current, roughly 24-mpg average rating for new light-duty vehicles.

Source: National Commission on Energy Policy. *Ending the Energy Stalemate: A Bipartisan Straegy to Meet America's Energy Challenges* (2004).

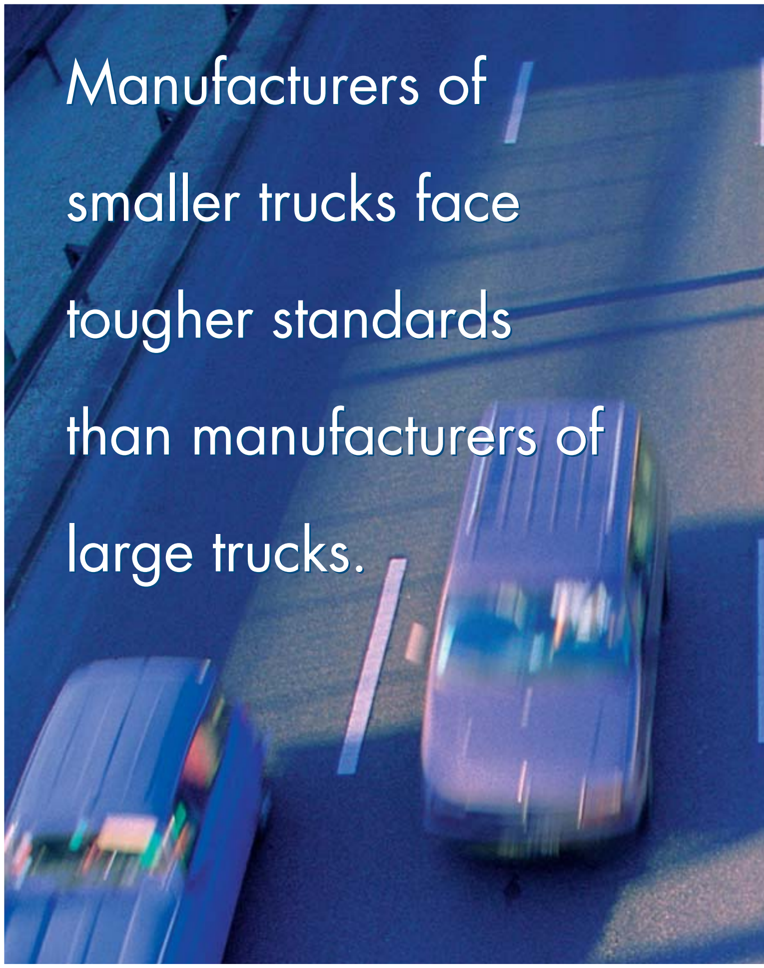


light trucks was unchanged at 20.7 mpg from 1996 until 2005. Since then, it has gradually increased about 0.5 mpg per year.

Most Asian manufacturers routinely beat the standard, while many European manufacturers routinely miss the standard and pay the penalty. U.S. manufacturers typically struggle to just meet the standard. These facts alone suggest that the current program is inefficient and inequitable across manufacturers, with clear differences in impacts and costs among manufacturers in different regions of the world.

Rather than installing new technologies to meet a fuel-economy standard, manufacturers can choose to make smaller cars that are naturally more fuel efficient—a phenomenon referred to as downsizing. While some might applaud a shift to smaller vehicles, this frequently raises concerns about safety as smaller cars tend to provide less protection in accidents.

Concerns about safety, inefficiency, and inequity among manufacturers recently led to significant changes in the CAFE standards for SUVs and light trucks. Because light trucks were a small part of the light-duty vehicle fleet (and primarily used in agriculture) in 1975 when the law was written, Congress gave the regulating agency (the National Highway Traffic and Safety Administration, or NHTSA) greater discretion to change the design of the light-truck regulations while the law is much more precise about the regulation of cars. This past year, NHTSA changed the regulation in a way that differentiated the standard by size: manufacturers of smaller trucks face tougher standards than manufacturers of large trucks. This new regulation reduces the aforementioned incentive to downsize and shifts the burden from high cost, (mostly U.S.) large-SUV and truck manufacturers toward lower cost, (mostly Asian) small-SUV and truck manufacturers that previously faced no real burden under CAFE.



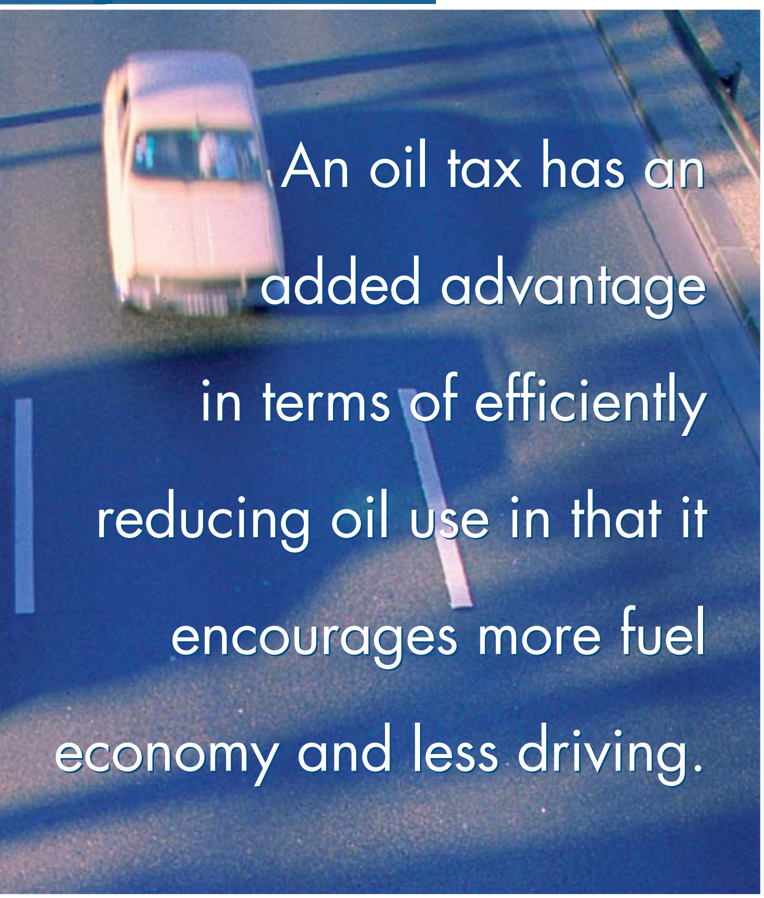
Potential Reforms to CAFE

Even with the noted changes to the light-truck CAFE regulations, the program remains largely inefficient. Suppose, for example, that improvements are particularly inexpensive for Honda to make in its imported fleet of cars but very expensive for General Motors to make in its domestic fleet of light trucks. As it stands, there is no way to trade off those obligations, forgoing potential savings to both GM and Honda. For this reason, economists would advocate making the program fully tradable—that is, credits earned in any fleet by any manufacturer when they beat the standard can be used to offset obligations in any other fleet of any other manufacturer. Economists would similarly advocate removing the three-year limit on banking credits. Finally, given the uncertainty surrounding the cost of various technologies, it would be sensible to turn the penalty provision into a "safety valve," whereby manufacturers could pay a fee (with no negative connotations) if it turns out to be too expensive to meet the standard.

Another, more subtle improvement could be made by considering longer time horizons in setting the standard. In the most recent light-truck rule, an important consideration that limited the achievement of tighter standards was lead time to phase in the use of new technologies. Partly as a consequence, the March 2006 final rule for model years 2008–2011 provides a roughly 8 percent improvement while many of the studies reviewed by the NCEP sug-

gested a larger improvement was cost-effective over a sufficiently long horizon. Setting standards further in advance would reduce this problem.

One way to solve the lead-time problem altogether is to shift to a "feebate" policy whereby each year vehicles above a set level, or "pivot point," of fuel economy would pay a graduated fee depending on how much they exceed the set level. These fees would then be rebated on a graduated basis to vehicles that beat the set level. The pivot point would be regularly adjusted in such a way that the revenue from the fees exactly equals the cost of the rebates. Aside from avoiding the question of lead time, another advantage of this system is that it provides manufacturers the flexibility to make, and consumers to buy, whatever vehicles they want subject to the applicable fees and rebates.



Given that further CAFE reforms will require new legislation (something sought by the administration this past spring), it is useful to think about whether the entire system ought to be replaced by either feebates or an oil tax. A fully tradable CAFE credit system would fix the overall mpg level, while leaving the cost somewhat uncertain (though perhaps capped if a safety valve is included in the reforms). Traditionally, that mpg level is fixed until new regulations are promulgated, although a recent bipartisan proposal by Senators Barack Obama (D-IL), Richard Lugar (R-IN), and others included a presumptive 4 percent annual improvement. Meanwhile, a feebate would provide a continual incentive for improving fuel economy, but would leave the actual level and trend in fuel economy uncertain. Both fully tradable CAFE credits and feebates put some of the consequences of fuel economy up front in the purchase price, effectively lowering the cost of more fuel-efficient cars and raising the price of less fuel-efficient cars. In this way, these policies might be viewed as more comprehensive versions of a gas-guzzler tax or the current gas-electric hybrid subsidy. Both tradable CAFE and feebates can be designed to be least-cost policies to improve fuel economy.

Under an oil tax, in contrast, the cost of fuel economy remains disbursed over future purchases; the tax also redistributes wealth from consumers to government as they pay the tax and, in turn, to whatever use (tax cuts or spending) the government finds for the revenue. Importantly, an oil tax has an added advantage in terms of efficiently reducing oil use in that it encourages more fuel economy *and* less driving, whereas CAFE and feebates, if anything, stimulate more driving as the cost per mile to consumers will fall.

What Lies Ahead

While fuel-economy standards do not reflect economists' preferred solution—namely, an oil tax—to various environmental and security concerns surrounding oil use, a tax does not address a possible failure in the way manufacturers and consumers make decisions about fuel economy and other vehicle attributes. However, the existing approach to regulating fuel economy could be significantly improved by increasing flexibility, in part by extending recent changes in light-truck regulations to include passenger cars. Such changes may require a political compromise that has not yet been struck in order to satisfy a range of stakeholder interests.

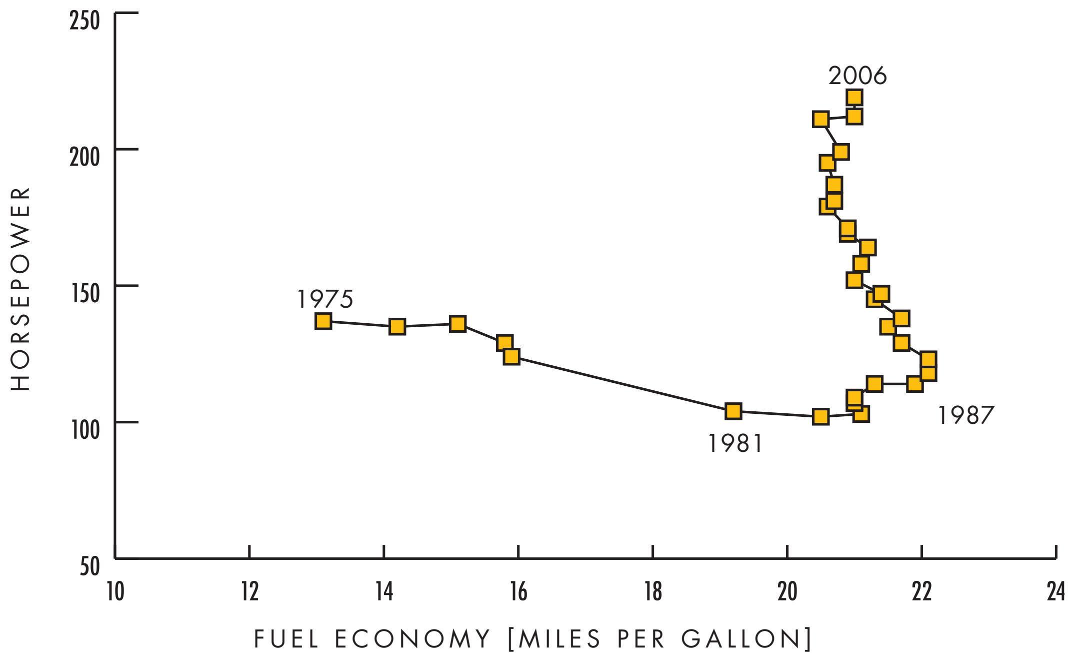


FIGURE 2

Average on-road fuel economy of new light-duty vehicles has declined since 1987 as average power has increased dramatically.

Source: EPA, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 through 2006* (2006).

Specifically, consumers, manufacturers, labor unions, environmentalists, and security hawks all have an interest in fuel-economy regulation, and their often-opposing positions have been responsible for a nearly 20-year stalemate. Why has the debate been so heated?

A key reason is that traditional, undifferentiated fuel-economy regulations have been more burdensome for domestic than foreign manufacturers because domestic manufacturers produce, on average, larger and less fuel-efficient cars and trucks. Given the naturally lower fuel economy of larger vehicles, a single standard applied to all manufacturers will hit U.S. manufacturers harder than others. Domestic manufacturers are therefore opposed to significant increases in an undifferentiated standard. However, differentiating standards by size may make it easier for domestic manufacturers to move production of smaller vehicles overseas, production that is currently required domestically to balance domestic production of larger vehicles. Such a move could take away the domestic jobs that go with domestic production of small cars—a point made by the United Autoworkers Union at a recent hearing, leading them to oppose differentiated standards without an undifferentiated "backstop."

Against this backdrop, California recently enacted legislation to reduce carbon dioxide emissions from vehicles—implying a boost in fuel economy—by 30 percent over the next 10 years for cars and light trucks. This has prompted lawsuits over whether California has the legal authority to create such standards. Under federal law, states are preempted from setting vehicle-emissions standards above national standards, but California has a unique option to apply for an exemption because of its particularly difficult pollution problems (which, if approved, leaves other states free to adopt the tougher, California standard). If California wins the lawsuit, other states have already lined up to adopt the tougher standards. Meanwhile, the recent, aforementioned proposal to tighten fuel-economy standards at the federal level garnered bipartisan sponsorship from Senators Lugar, Gordon Smith (R-OR), and Joseph Biden (D-DE)—all defense hawks concerned about energy security.

All of this suggests that the debate over fuel-economy standards is far from over. While the obstacles that have hampered strengthening and reform over the past two decades remain, there is increasing pressure from the left and right to surmount those obstacles. The question is not only whether the pressure to strengthen and reform succeeds, but whether it does so in an economically sensible manner, sensitive to costs, benefits, and efficiency. ■

The Case for a Pay-by-the-Barrel Oil Tax

Ian W.H. Parry

Economists frequently recommend using taxes to address "market failures" arising when the actions of individuals impose broader costs on society; for example, taxes could be designed to make motorists pay for their contribution to highway congestion. Are there also market failures associated with our addiction to oil? If so, how high should the tax be, and should it be levied on all oil uses? Is a tax a more cost-effective approach than other policy instruments and how effective might it be in reducing oil use?

Oil dependence is potentially harmful to the stability of the economy as a whole, the environment, and national security, although to what extent the market fails in these regards is often murky. Oil price shocks can disrupt the economy by temporarily idling labor and capital as industries contract in response to higher energy costs, and by transferring purchasing power from oil importers to foreign suppliers. However, the macroeconomic impacts of oil price volatility are difficult to gauge because they depend on many factors, including the oil intensity of the economy (the ratio of oil use to gross domestic product), the oil import share, whether the economy is booming or slumping, and how jittery financial markets might already be about trade and fiscal imbalances.

Market Failures

The extent to which macroeconomic disruption costs constitute a market failure is also contentious; some analysts argue that firms and households adequately account for oil price volatility in their decisions, while others argue that disruption costs partly reflect market imperfections (for example, frictions preventing the smooth reallocation of resources across industries, or underinvestment in fuel-efficient technologies). In short, the case for taxing oil based on macroeconomic concerns is not clear cut; available estimates of the appropriate tax vary from near zero up to about $10 per barrel (25 cents per gallon of gasoline).

Taxing oil might yield another economic benefit to the nation by lowering the world demand for oil and thereby the long-term world price. Put another way, the oil tax burden would not be fully passed on to U.S. consumers in higher domestic prices but would be borne, in part, by foreign oil suppliers in the form of lower world prices. The price impact is difficult to judge—it would depend on how oil producers and consumers throughout the world respond to a slackening of global demand—but is likely modest. Studies suggest that U.S. market power might warrant a further oil tax of anything up to $5 per barrel.

Local environmental effects of oil use are less of a concern today for many regions than in the past; for example, regulations have helped to dramatically reduce passenger-vehicle tailpipe emissions. The biggest problem is the contribution of carbon dioxide emissions from oil combustion to future global climate change, which will impact agriculture, coastal activities, human health, ecosystems, and so on. In this regard a global cost of oil consumption is not reflected in the market price. Although the measurement problems are daunting, climate economists have put this cost at about $5–$50 per ton of carbon, even making some crude allowance for the risk of extreme climate scenarios; in principle, this justifies an additional oil tax of anywhere from 50 cents to $6 per barrel.

Dependence on oil also constrains U.S. foreign policy to the extent that oil-producing nations with governments hostile to the West may retaliate to U.S. pressure by disrupting the oil market. But the overriding fear now is that oil revenues are funding governments, like Iran, or other groups, such as terrorists or insurgents in Iraq, that threaten regional or U.S. security. Unfortunately, however, unilaterally taxing oil would do little to reduce these revenue flows to foreign oil producers; for example, a tax of $20 per barrel would likely lower the long-term world oil price by only 1–5 percent, which is small when set against the recent doubling of world oil prices. Other factors, such as the effect of U.S. foreign policy on the degree of anti-Western sentiment, proliferation of weapons of mass destruction, and political developments in the Middle East, are far more important in the near term for determining terrorist threats than unilateral U.S. conservation policies designed to lower world oil prices.

The United States also maintains a military presence in the Middle East to protect oil supplies, although this serves other objectives, such as attempts to promote regional security. Studies that apportion part of this military burden to oil suggest that these costs amount to around $3–$6 per barrel of oil consumption, although valuing the annualized cost of U.S.-involved conflicts is extremely controversial. Nonetheless, taxing oil only yields an additional dividend if military resources are scaled back in proportion as oil imports fall. This may not be realistic, at least for modest import reductions, given that the United States would still be vulnerable to oil price shocks from supply and other market disruptions.

Summing up, I might, albeit tentatively, put the appropriate tax to correct for market failures at somewhere in the region of $5–$25 per barrel, or 12–60 cents per gallon of gasoline. While gasoline is already taxed at the federal and state levels at about 40 cents per gallon, oil refined into gasoline should not be exempt from a new oil tax, as this existing tax

Using Oil Taxes to Promote New Technologies

Most likely, the private sector lacks adequate incentives to develop commercially viable alternatives to current oil technologies, such as plug-in electric hybrid vehicles. For one thing, other firms can adopt new technologies; an individual firm may have little incentive to take these "spillover" benefits to other firms into account when deciding on its own R&D budget, especially if firms are located in rapidly industrializing countries, such as China and India. Firms may also be reluctant to undertake major R&D projects when the ultimate payoffs are highly uncertain, due to oil price volatility.

The spillover problem provides the *raison d'etre* for the patent system, and various tax credits and other government subsidies for private sector research. However, these inducements can be problematic: for example, public funding for research involves the government attempting to pick winners among alternative investment projects. In this regard, complementing existing technology policies with a tax-induced increase in the oil price is attractive, as it leaves applied R&D decisions in the hands of private firms.

may be warranted to reduce traffic congestion and highway accidents. (However, taxing vehicle mileage, for example at peak period in urban areas, would be far better than gasoline taxes to address these concerns).

Taxing Oil versus Alternative Approaches

Reducing oil use through a broad oil tax imposed on crude oil inputs to refineries (and imported refined petroleum products) involves lower economic costs than taxing gasoline use alone, as it exploits conservation opportunities across all oil uses (including aviation, trucking, manufacturing, and home heating) rather than placing the entire burden on passenger vehicles, which account for just under half of total oil consumption.

In addressing larger issues like climate change and energy security, policymakers often turn quickly to options like fuel-economy standards (the CAFE rules). But they are even less cost-effective than a gasoline tax because they do not raise fuel prices and therefore do not directly encourage people to economize on vehicle use. Many analysts argue that higher fuel-economy standards are needed (in conjunction with higher energy taxes) because new car buyers undervalue fuel economy, although there is little solid evidence on this issue either way.

An oil tax would impose some burden on households; for example, a $10 tax per barrel would increase annual fuel costs for the average motorist by around $150. On the other hand, this oil tax would also raise an extra $70 billion in tax revenues for the government each year, which might be used productively. For example, the revenue could be used to lower the federal budget deficit by around 25 percent, thereby reducing the burden of debt payment on future generations. Alternatively, the revenue could be used to lower the average individual's federal income tax bill by around 7 percent, roughly compensating households for higher oil prices. Using revenues to cut other taxes that distort incentives for work, savings, and educational investment would help to keep the overall economic costs of the oil tax low.

Nonetheless, an oil tax by itself is not going to solve our oil dependency overnight; for example, a $10-per-barrel oil tax imposed at current prices would, at best, reduce near-term oil consumption by 10 percent below market-determined levels. However, the tax may have more dramatic impact over the longer term by encouraging firms to develop oil-conserving technologies, especially if it were designed to impose a floor price for oil, thereby removing some of the downside risk for large-scale investments. In fact, an oil tax may be a better way to promote such critical R&D efforts than more traditional policies (see the box on page 27).

A Ray of Hope

Skeptics of a broad oil tax have raised two important practical objections: the revenue advantage of taxes may be squandered on pork-barrel spending, and lobbying groups representing motorists and energy-intensive industries would likely stave off any attempt to introduce a new oil tax. While I am no political scientist, I am slightly more optimistic about the prospects for a tax shift onto oil over the longer term.

The problem of oil dependence is going to be with us for some time to come, and policies that may appear infeasible today may not be a decade or more down the road. Environmental tax shifts have recently been implemented in many European countries, and the same may happen in the context of traffic management; for example, the U.K. government has proposed replacing its gasoline tax with a nationwide congestion tax. It is conceivable that this trend toward innovative taxes may spread to the United States as their merits become more transparent and they become more acceptable to the general public. In fact there is already much debate at the local level about the use of pricing instruments to improve traffic flow and safety.

Moreover, pressures to find new sources of revenue will likely increase in the United States in upcoming years as the Baby Boomer generation begins to retire, imposing a growing burden on the Social Security and Medicare systems. And policymakers might turn oil volatility to their advantage to alleviate the burden of a new oil tax on politically influential groups. The tax might be set very modestly at first, and then ratcheted up during periods of depressed oil prices, leaving motorists and other groups no worse off than under recently experienced price levels. ■

Oil Policy Strategies: Assessing the Tradeoffs

Impacts/ Strategies	Increase oil and gasoline taxes	Increase fuel efficiency (CAFE)	Expand alternative fuels and transport technologies	Expand domestic oil production
Energy Security Effects	This option strengthens security by reducing oil consumption and exposure to disruptions and price shocks.	This option strengthens security by reducing oil consumption and exposure to disruptions and price shocks. The potential in the medium term (10–15 years) is considerable.	This option may strengthen security somewhat by increasing supply diversity and fuel flexibility. In the long run, it provides more significant opportunities to decrease oil use.	This option is unlikely to strengthen security, unless it lessens the geographic concentration of supply subject to disruption.
Environmental Consequences	This option reduces both conventional pollution and greenhouse gas emissions.	This option reduces greenhouse gas emissions.	The consequences depend on which fuels are chosen. Ethanol can cut both conventional pollution and greenhouse gas emissions. For electric-powered vehicles, benefits depend on electricity emissions.	This option increases both conventional pollution and greenhouse gas emissions.
Economic Effects (distinct from environmental and security consequences)	This option expands economic well-being as long as the revenues are used productively.	Economic effects depend on the relative degree of consumer myopia, environment, and other market imperfections versus the technology costs.	Smart R&D can improve economic efficiency. Subsidies typically cannot.	Increased access is a positive if environmental damages are lower than the expected profits from increased production. Subsidies to increase production are unlikely to benefit the economy.
Budget Effects	A $10-per-barrel oil tax would bring in around $70 billion a year to the federal treasury.	The effect on the budget is negligible, unless fuel economy is increased through heavy subsidies.	It depends on whether, and how, alternative fuels are subsidized or otherwise supported by government policy. Subsidies drain the budget.	Expanded production through increased access can raise royalty revenues. Subsidies to increase production drain the budget.
Political Prospects	Environmental and other tax shifts remain politically unpopular in the United States. Using revenues to reduce income taxes would help to compensate households for higher energy prices.	This option is popular with the public. Legislative mandates are unpopular with domestic automakers and unions.	This option is popular with the public, agricultural interests, and domestic automakers.	This option is popular with firms and resource-rich areas but unpopular with environmentalists.
Limitations	Potential for reducing oil consumption is limited in the very near term, although it encourages efficiency, conservation, and innovation in oil-saving technologies over the long term.	This option does not reduce vehicle miles traveled, an important avenue for reducing transport fuel use.	Producing ethanol from corn is limited. Cellulosic ethanol is not ready for the market but could expand the potential. Hydrogen will be decades in the future.	Past price increases and subsidies have, at best, cushioned the decline in conventional U.S. oil production.

Papers Commissioned for Landmark Frontiers of Environmental Economics Conference

Extending its longstanding role as a proponent of leading-edge thinking on environmental policy, RFF will host a historic Frontiers of Environmental Economics conference February 26–27, 2007.

Supported by the U.S. Environmental Protection Agency's National Center for Environmental Economics, the meeting will continue RFF's mission to introduce and advance pathbreaking research. A panel of distinguished environmental economists has selected eight papers for the landmark conference, which will be held in Washington, DC.

Alan Krupnick, an RFF senior fellow, notes that these papers present innovative ideas that have the potential to change the orientation of environmental economics—moving this subdiscipline into new frontiers—and ultimately contribute to improving public policy.

"The papers chosen for this conference survived an intense international competition," Krupnick said. "We believe they represent some of the most seminal thinking in our field, and we are particularly pleased that several are cross-disciplinary in nature."

Panel members are Krupnick; Joseph E. Aldy, RFF; F. Catherine Kling, Iowa State University; John List, University of Chicago; former RFF President Paul Portney, dean, University of Arizona Eller College of Management; and V. Kerry Smith, Arizona State University.

The eight papers were chosen from more than 175 submissions from economists as well as researchers in other social, health, and natural sciences. The selected papers are:

- "What Drives Long-Term Biodiversity Change? New Insights from Combining Economics, Paleo-Ecology and Environmental History," by Nicholas Hanley, Dugald Tinch, and Althea Davies, University of Stirling; Fiona Watson, Past Experience; and Edward Barbier, University of Wyoming.
- "Using Biomedical Technologies to Inform Economic Modeling and Environmental Policy: Challenges and Opportunities for Improving Descriptive and Positive Policy Analysis," by Brian Roe and Timothy Haab, Ohio State University.
- "Cost-Benefit Analysis as Market Simulation: A New Approach to the Problem of Anomalies in Environmental Evaluation," by Robert Sugden, University of East Anglia.
- "Virtual Experiments and Environmental Policy," by Stephen Fiore, Glenn Harrison, Charles Hughes, and E. Elisabet Rutström, University of Central Florida.
- "A Dynamic Model of Household Location, Regional Growth, and Endogenous Natural Amenities with Cross-Scale Interactions," by Elena Irwin, Ciriyam Jayaprakash, and Yong Chen, Ohio State University.
- "Quasi-Experimental and Experimental Approaches to Environmental Economics" by Ted Gayer, Georgetown University; and Michael Greenstone, MIT.
- "Non-Price Equilibria for Non-Marketed Goods," by Daniel Phaneuf, North Carolina State University; Joseph Herriges, Iowa State University; and Jared Carbone, Williams College.
- "The Importance of Spatial-Dynamic Processes in Renewable Resource Economics," by James Sanchirico, RFF; Martin Smith, Duke University; and James Wilen, University of California-Davis.

The conference will also feature discussants of each paper and will close with a panel of world-renowned thinkers who will offer their views on where the frontiers of environmental economics are. These panelists include Nobel Laureate Thomas Schelling, University of Maryland; Dennis Epple, Thomas Lord Professor, Carnegie Mellon University; and Simon Levin, Moffett Professor of Biology and director, Center for BioComplexity, Princeton University.

Since the mid-1970s, RFF has convened key conferences highlighting the role of economics in environmental policymaking. Research has focused on valuing environmental amenities, accounting for impacts of environmental regulation, creating market-oriented solutions, and assessing the performance of environmental institutions.

RFF's prominence in environmental economics dates from before the topic was recognized as a distinct academic discipline. Research results have been recognized as signal pronouncements in valuation of environmental and health benefits, discounting and intergenerational equity, and design of market-based incentives to environmental problems. ■

RFF Awarded More Than $1.5 Million in Grants for Climate, Energy Efficiency, and Trade Policy Research

Grants totaling more than $1.5 million have been awarded to RFF to support new research on climate policy, energy efficiency, and the impact of international trade regimes on the global environment. The grants include $250,000 from the William and Flora Hewlett Foundation, $704,000 from the Goldman Sachs Center for Environmental Markets, $250,000 from the Exelon Corporation, and $370,000 from the Swedish foundation Mistra.

"These grants represent continuing confidence in the value of our independent research toward resolving some of the most critical issues of our time," said RFF President Phil Sharp. "They will allow us to build on an already substantial reservoir of impressive work."

U.S. Climate Policy Forum Launched

The Hewlett Foundation and Goldman Sachs gifts are in support of RFF's Climate and Technology Policy Program, which seeks to advance intellectually credible and politically sensible approaches to dealing with climate change. In response to a growing need for understanding the potential impact of mandatory federal controls on greenhouse gas emissions, this grant will support a new venture—the U.S. Climate Policy Forum—that will bring together companies from across the spectrum of the U.S. economy with the intent to provide legislators with well-vetted, detailed policy options; important criteria for policy assessment; and well-articulated concerns (specifying strengths and weaknesses) from which effective federal policy might be crafted.

The forum will have representation from auto manufacturers, electric utilities, oil and gas producers, and transportation and chemical industries, as well as large energy consumers and insurance, technology, and financial services firms.

"Federal policymakers need information on the implementation details of particular policy options and approaches, as well as the implications for international competitiveness and deployment of technology through investment and technology transfer," noted Mark Tercek, director of the Center for Environmental Markets at Goldman Sachs. "The U.S. Climate Policy Forum will provide a unique environment for informed dialogue on policy options to foster a common understanding of these implications."

"Our hope is that the Climate Forum can help corporations and RFF researchers find options that are fair, have low total costs, and produce meaningful reductions in CO_2 emissions," said Hal Harvey, environment program director at the Hewlett Foundation.

The forum will not seek to reach consensus on a specific set of recommendations or courses of action, according to RFF Senior Fellow Ray Kopp, who will lead the initiative. "While consensus efforts are valuable contributions to the national debate, they can limit the range of economic and environmental interests, views, and concerns that can be brought to the table." Kopp said the process will combine research with dialogue and will unfold in two phases over the coming year.

Advancing public discourse on climate policy is a major goal of the Climate and Technology Policy Program. Scholars participate in international climate meetings, such as the annual Conference of the Parties to the United Nations Framework Convention on Climate Change; conferences and workshops are held for stakeholders and policymakers on timely policy issues; scholars testify before Congress; and www.weathervane.rff.org, a website dedicated solely to climate change policy and economics, is maintained.

Focus on Energy Efficiency and Conservation

The grant given by Exelon will support research on energy efficiency and conservation by the RFF Electricity and Environment Program. The work seeks to formulate policies to promote energy conservation in a cost-effective manner.

"Our contribution to RFF is money well spent," said John Rowe, chairman and CEO of Exelon Corporation. "While there is little doubt that improved efficiency and conservation are critical to a sustainable energy future, there is much doubt about how best to promote them. RFF is uniquely qualified to conduct the required analysis and give both policymakers and the industry real metrics on the effectiveness of utility-sponsored efficiency and conservation programs."

Interest in such policy options has grown in light of higher energy prices, concerns about global warming, and the desire to promote energy security, noted Karen Palmer, the Darius Gaskins Senior Fellow at RFF, who will lead the research effort.

"A key element of the research will be to identify cost-effective approaches to demand-side management programs that encourage energy conservation through a variety of means, ranging from improving the energy efficiency of buildings and household appliances (everything from light bulbs to hot water heaters) to providing information on changes in behavior that can reduce consumption," said Palmer.

Examining Impact of Trade on Environment

RFF Senior Fellow Carolyn Fischer is the recipient of a three-year $370,000 grant from the Swedish foundation Mistra, which supports strategic environmental research, for a program titled "Environment and Trade in a World of Interdependence." The program involves a consortium of researchers from RFF, the University of Gothenburg, the Institute for International Economic Studies, the International Institute for Sustainable Development, and IVL (Swedish Environmental Research Institute).

According to Fischer, the goal of the project is to conduct research and establish a policy dialogue on the interface between international trade, World Trade Organization rules, and environmental policies. Among the policy options to be studied are ecolabeling schemes as a way to encourage more environmentally friendly trade mechanisms. ■

Columbia Business School Dean Joins RFF Board

Elected to the RFF Board of Directors in October, R. Glenn Hubbard brings intellectual depth and wide-ranging policy experience from a career that has spanned both academic and governmental positions.

R. Glenn Hubbard

Hubbard, dean of the Columbia Business School and Russell L. Carson Professor of Finance and Economics, served as chair of the Council of Economic Advisers (CEA) during George W. Bush's first term. His portfolio included environmental policy as well as tax and budget policy, financial markets, international finance, and health care.

RFF Senior Fellow William A. Pizer worked under Hubbard when he served as a senior economist at CEA in 2001–2002 and helped to recruit Hubbard to serve on the RFF Board.

"Glenn's a conservative economist who favors lower taxes and smaller government, and values public policy that is based on economically and scientifically sound analysis. Environmental protection is one area where he sees government having an obvious and important responsibility. He has a real appreciation for the role that RFF plays in informing the design of economically sensible environmental regulation. His interest and commitment to these issues was visible though his active role in the administration's deliberations on energy and climate change policy, as well as his decision to chair the Organisation for Economic Co-operation and Development's ad hoc committee on sustainable development."

After earning his Ph.D. in economics from Harvard in 1983, Hubbard taught at Northwestern, then moved to Columbia in 1988 and was named senior vice dean of the business school in 1994. Since 1999, he has been co-director of its Entrepreneurship Program, which emphasizes finding opportunity and employing individual initiative in the context of uncertainty and tight resources.

Among his other affiliations—as adviser, fellow, visiting professor, trustee, and board member—are the American Enterprise Institute, Harvard's Kennedy School of Government, the Council on Competitiveness, the American Council on Capital Formation, the Tax Foundation, the Center for Addiction and Substance Abuse, R.H. Donnelley Inc., and the Economic Club of New York.

Hubbard's 100-plus peer-reviewed research articles on tax policy, corporate and international finance, and monetary economics have been published in *American Economic Review, Journal of Political Economy, RAND Journal of Economics,* and other academic journals, but he has also reached a wide lay audience through his columns and commentaries in the *Wall Street Journal, New York Times, Washington Post,* and *Business Week,* and his appearances on the PBS financial show *Nightly Business Report* and NPR's *Marketplace.* ■

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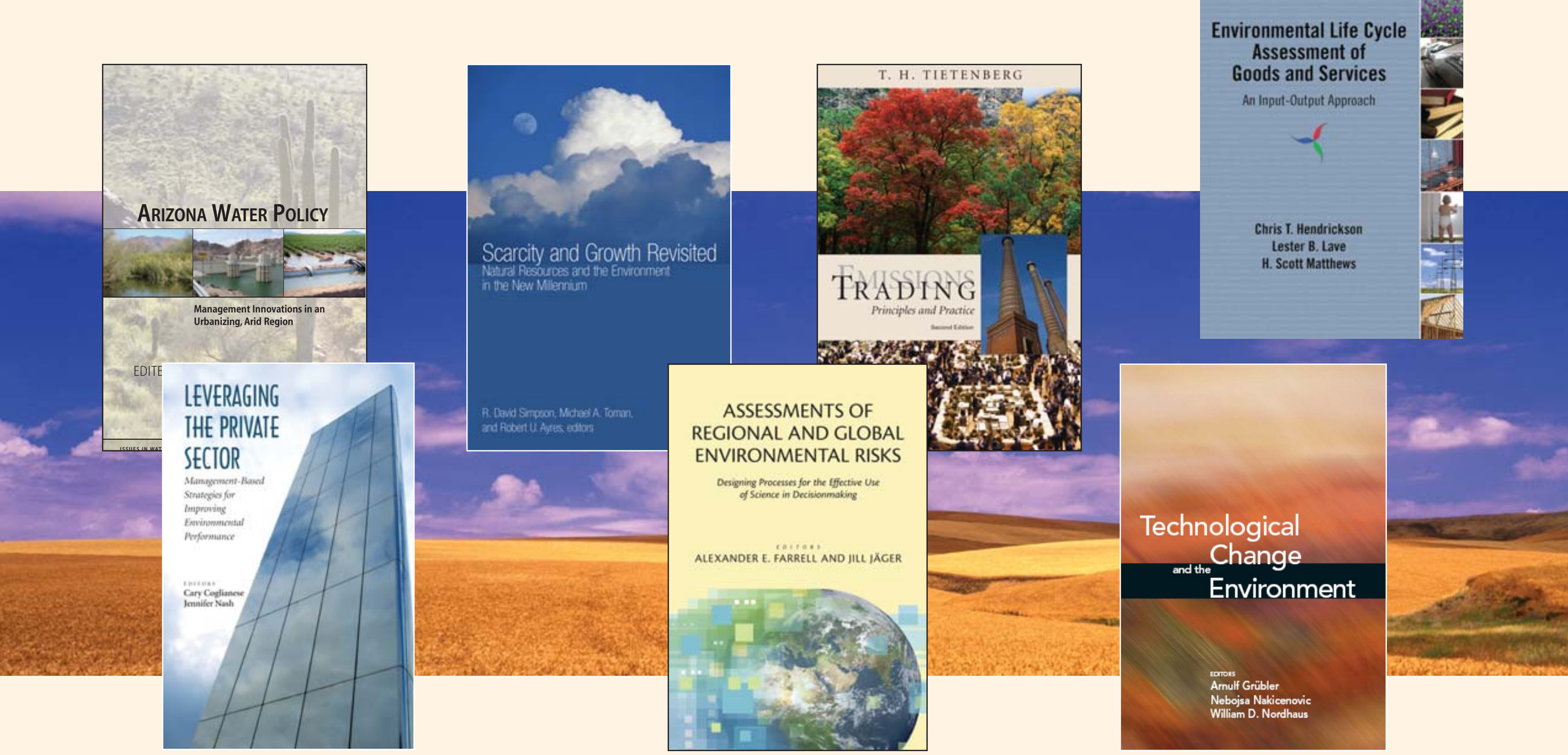

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