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Cost-Effective Carbon Restrictions—A conference summary

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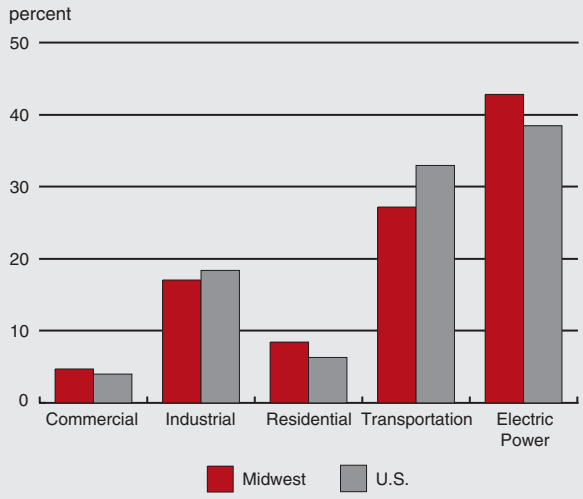
On October 15, 2007, the Federal Reserve Bank of Chicago held a conference at its Detroit Branch to explore alternative ways of reducing carbon emissions. Conference participants analyzed market-based and technology-driven approaches to carbon emission reductions, as well as the costs and impacts of these options.

Last fall's Detroit meeting on reducing carbon emissions was timely as Congress is in the process of shaping carbon emission proposals and the media is highlighting carbon-related issues.[1] After years of inactivity on this issue, the U.S. may finally be poised to regulate so-called greenhouse gases (GHGs). In April 2007, the Supreme Court ruled that the federal government has the authority to regulate GHG emissions, which most scientists believe accelerate the warming of the earth's atmosphere, causing disruptive and costly climate changes. Carbon dioxide (CO_2) is the major source of such GHG emissions, making up 75% to 80% of the total volume. The U.S. leads the world in the emission of carbon followed by China. In the near future, Congress is expected to consider bills to regulate GHGs. Meanwhile, state and local governments, as well as businesses and nonprofit organizations, are already acting to reduce GHGs or curb their growth.

1. Share of carbon dioxide emissions, by sector, 2004



SOURCE: U.S. Environmental Protection Agency.

The Midwest stake

According to William Testa, Federal Reserve Bank of Chicago, the Midwest states of Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin have a keen interest in policies to mitigate carbon emissions. The Midwest produces more carbon per unit of output than the overall U.S. Moreover, the region's relative carbon intensity has been increasing. The Midwest's carbon emissions per unit of output were 17.8% above the nation's in 2001; they were 4.1% higher than the nation's in 1963. For this reason, the region could be affected unduly by costly approaches to carbon reduction.

Interestingly, it is not the Midwest economy's greater concentration in heavy industry that explains its greater carbon intensity—at least not directly. Figure 1 shows that in the Midwest, as in the nation overall, the electric power sector accounts for the largest share of carbon emissions—42.8% in the Midwest versus 38.4% for the nation in 2004.

Our electricity-related carbon emissions are higher than the nation's because midwestern power-producing facilities burn mostly coal, which is the most carbon-intensive among major fossil fuels. Power generation facilities in every Midwest state (save Illinois) burn coal to a greater degree than those of the nation as a whole—a 41% greater share as of May 2007. Illinois's lower carbon

intensity derives from its use of nuclear facilities to generate electric power. Indiana and Ohio are especially dependent on coal to generate power.

The Midwest continues to specialize in motor vehicle production, and this is another sector that could potentially be affected by new carbon reduction policies. Midwest-domiciled automakers, especially the Detroit Three (Chrysler LLC, Ford Motor Co., and General Motors Corp.), have so far found it more difficult than other manufacturers to achieve corporate average fuel economy (CAFE) standards on their fleets of cars and light trucks.[2]

Sugandha Tuladhar, CRA International Inc., discussed how Michigan would be affected by various carbon restriction policies. He examined two potential policies: the Waxman Bill—labeled the stringent cap-and-trade policy—and the Bingaman Bill—labeled the moderate cap-and-trade policy because it includes a safety valve on the price of CO_2. The Waxman Bill sets no price limits on CO_2 and is therefore more stringent. The safety valve in the Bingaman Bill sets an initial ceiling price of CO_2 at $10 per ton of emissions, and allows an increase in prices of 5% per annum in real terms. Both bills assume an initial allocation of allowances, availability of offsets, and use of alternative transportation fuels. The Waxman Bill has an emissions target of 40% below 2006 levels of emissions by 2030, while the Bingaman Bill aims to achieve a 15% reduction by 2030. Tuladhar estimated the price of CO_2 by 2030 would be approximately $114 per ton of emissions for the more stringent policy and $20 for the moderate policy.

According to the analysis, residential prices of electricity, natural gas, and petroleum products would rise by 50% in Michigan by 2030 under the stringent policy and by at least 10% under the moderate policy. The higher costs under both scenarios are predicted to lead to job losses and lower industrial production. By 2035, manufacturing production is projected to drop by 3% in the stringent scenario and by slightly less than 1% in the moderate scenario; for the transportation sector, the estimated declines are 6% and 1%, respectively. Michigan's gross state product is projected to fall by 3% under the stringent policy—a rather adverse effect compared with that for other states—and by 0.8% under the moderate policy.

Materials presented at the conference are available at www.chicagofed.org/news_and_conferences/conferences_and_events/2007_emissions.cfm.

National overview

Howard Gruenspecht, U.S. Department of Energy, Energy Information Administration (EIA), provided a GHG policy perspective and evaluated bills to limit carbon emissions that have been proposed in Congress. According to Gruenspecht, the threat of climate change due to rising atmospheric concentrations of GHGs differs in both scope and nature from energy-related environmental issues that have been previously confronted, such as acid rain, smog, and depletion of stratospheric ozone. One difference is this threat is intergenerational: The benefits of GHG mitigation will accrue in the future, while the costs are exacted both now and in the future. International cooperation on this issue is essential, Gruenspecht said, since reductions by all major emitters will be required to significantly reduce GHG concentrations. Limitation of GHG emissions would require us to constrain the use of fossil fuels, which currently provide 80% of the world's energy and 85% of U.S. energy.

Carbon emissions accounted for about 83% of total U.S. emissions of GHGs in 2005, considerably higher than the global share of 58%. Electricity generation and transportation are the largest producers of carbon emissions, and their contribution is projected to increase relative to that of other sectors. Coal is heavily used in electric power generation, making it likely to be greatly affected by virtually any emission reduction program.

Although coal is a relatively inexpensive fuel, the CO_2 content of coal is about 25% greater than that of oil and nearly 75% greater than that of natural gas. Consequently, policy solutions such as a carbon tax will have a relatively larger impact on coal prices because of its higher CO_2 emissions as well as its relatively lower price. For example, a $10 per ton CO_2 tax would increase coal prices by 60%, compared with a 4% rise in oil prices and a 5.5% increase in natural gas prices. It was estimated that a $25 per ton CO_2 tax would raise gasoline prices by about 23 cents per gallon.

The GHG emissions come from a variety of sources for which a wide variety of behavioral adjustments and technologies may be available in the future to mitigate emissions. Command-and-control or "one-size-fits-all" regulations are not likely to reduce emissions at the lowest cost and with the least disruptions, Gruenspecht argued. So, too, such regulations offer few incentives for technological innovation that would reduce the cost and enhance the effectiveness of carbon mitigation. Further, it is the cumulative stock of GHG emissions rather than year-to-year variations that matter to the environment. Under such circumstances, the advantage lies in the direction of "economic instruments," such as cap-and-trade programs or emission fees and taxes, because they allow consumers and producers the flexibility to adjust their behavior over time as individual conditions warrant and as incentives to move toward major technological innovation emerge.

Owing to the U.S. economy's large size, small percentage cost impacts are sometimes represented as large dollar amounts. One feasible proposal analyzed by the EIA indicates that GHG reductions would result in a real gross domestic product (GDP) that is cumulatively lower by 1 trillion dollars by the year 2025. When converted to percentages, however, this translates into real GDP being just 0.6% smaller than otherwise would be the case.

One specific policy that Gruenspecht examined was S 280, the McCain–Lieberman Bill, which would reduce GHGs by employing a cap-and-trade system while supporting the use of new climate-change-related technologies. Gruenspecht looked at different scenarios involving the adoption of S 280, including the adoption of this policy by other countries. Gruenspecht found that by 2030 even global adoption of S 280-type requirements would reduce emissions by only 7% from current levels, though without such universal adoption, the atmospheric concentration would double over the course of the century. Under S 280, the main sectoral reduction occurs in the electric power sector—that is, a 50% reduction from current CO_2 emission and nearly a two-thirds drop from what emissions would have been in 2030. The increased cost of coal-generated power is estimated to increase electricity prices nationwide by at least 1.5 cents per kilowatt hour, with the greatest regional impact occurring in the Southwest and North Central regions of the U.S.

Policy approaches

In anticipation of GHG mitigation policies, some private sector and voluntary associations have formed to establish market-based approaches. Mike Walsh, Chicago Climate Exchange Inc. (CCX), explained how his exchange aims to reduce emissions.

The CCX is a voluntary association whose members have made legally binding commitments to reduce baseline emissions by 6% by 2010. Launched in 2003, the organization has more than 300 members, representing such diverse sectors as automotive, electric generation, forest products, state and local government, and transportation. The CCX members are awarded an initial baseline cap of GHG emissions or "allowances" per year that are measured, for instance, as tons of CO_2. Though such allowances are ratcheted down each year, members can trade them with each other on the exchange—purchasing extras when needed and selling any excess. To ensure compliance and enhance the credibility of the exchange's contracts, all reports are audited.

Such trading systems allow emission targets to be met at least cost. The least cost result comes about because those traders that can reduce emissions at low cost have strong incentives to do so. By reducing emissions, they generate excess allowances that can be sold on the exchange. Also, the market-based system is flexible enough to accommodate various modifications, such as safety valves, initial allocation of tradable permits, and technological developments.

An alternative approach to a cap-and-trade system, and one that has many similar characteristics, is an emissions tax. Gilbert Metcalf, Tufts University, compared the carbon tax and cap-and-trade options. The advantages of a carbon tax include familiarity with the tax concept; low uncertainty about the costs of mitigation, since the tax rate is known; and low administrative costs, since the Internal Revenue Service can be used to collect (or rebate) taxes. As a result of a price increase in response to the tax, firms and consumers would adjust their spending patterns to reflect estimated damages arising from GHG emissions. With cap-and-trade, there is no precedent for the huge scale of permits to be auctioned (a similar program to address acid rain was much smaller in scope). Also, the number of permits to be issued and whether some emissions would be exempt would need to be determined. Administrative costs are likely to be sizable, since a new administrative body would have to be formed. And under a cap-and-trade system, there would likely be considerable uncertainty and volatility in the price of permits. Such uncertainties could result in unexpected costs to the economy. Also, price uncertainty would tend to make potential innovators reluctant to make long-term investments in new mitigation technologies.

Metcalf examined the impact of a $15 per ton CO_2 tax combined with a refundable tax credit. The two were combined so that the regressivity of the carbon tax could be offset by the tax credit. Metcalf estimated that the combination would not result in gains or losses among income groups except for the lowest 20% of the income scale, which would see an approximately 1% drop in disposable income. Regionally, there was very little distributional impact of this tax. Metcalf estimated that the tax would reduce emissions 8.5% by the year 2015; it would have a greater impact on GHG emissions other than CO_2, at least initially, because it is easier and cheaper to reduce them.

Besides market-based approaches, national and state policymakers have also been considering regulatory steps, such as tightening existing fuel economy standards on light vehicles. Martin Zimmerman, University of Michigan, discussed integrating the transportation industry, specifically its CAFE standards, into a national cap-and-trade system. He pointed out that having a separate cap-and-trade system as well as CAFE standards could lead to inefficiencies. It is estimated that the marginal cost to achieve a ton of CO_2 emission reduction for the automotive manufacturers is, at a minimum, in the $90 to $100 per ton range, while proposed legislation implicitly assumes costs of $30 to $40. Although the unit cost of emission reductions for the auto sector is greater than that of the other sectors, without some price transfer mechanism in place, there is no procedure of equilibrating the two to achieve cost-effectiveness.

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Zimmerman suggested that CAFE standards can exist with a cap-and-trade system as long as a pattern of trading credits across sectors is allowed. Integrating the two would yield one economy-wide price for carbon, thus informing consumers, producers, and governmental entities about the actual cost of policy. It would also equalize the cost of mitigation, leading to a cost-efficient pattern of carbon usage, within and across sectors. At the same time, some of the distributional effects—such as those between domestic auto firms and foreign-domiciled auto firms, as well as among various consumer groups—would be greatly diminished.

Technological fixes

David Schmalzer, Argonne National Laboratory, discussed how to reduce carbon emissions in power generation via technology and process changes. One option is to switch from coal to natural gas. However, because of both limited fuel switching capacity of existing equipment and limited domestic supplies of natural gas, substituting natural gas for coal would not reduce emission levels sufficiently to have an effect on GHG concentrations. Another option would be to capture the carbon emissions post combustion. This approach turns out to be expensive and inefficient, and it has not been used on such a large scale. A third option is to use the integrated gasification combined cycle (IGCC) precombustion capture method. Plant and electricity costs from additional built-in features would not increase as much as they would with post-combustion capture, but they would be higher than current costs. There are currently only two IGCC plants in the U.S., implying that a switch to IGCC would take considerable time.

Don Jones, RCF Economic and Financial Consulting Inc., examined the feasibility of nuclear power generation as an alternative to fossil fuels, since this option produces close to zero GHG emissions. Although nuclear power generation is currently at a cost disadvantage, changes in demand or imposition of carbon restriction policies would make this option more feasible and attractive. Currently, construction of nuclear plants is at a cost disadvantage to coal-fired and gas-fired plants. The range of costs is $47 to $71 per megawatt hour for nuclear, $33 to $41 for coal, and $35 to $45 for gas. The imposition of GHG policies would raise the cost of coal-fired plants to the $83 to $91 range and gas-fired plants to the $58 to $68 range. Further, the considerable design and regulatory approval costs of constructing nuclear plants decline significantly as more are constructed. Reducing the nuclear plant construction time from seven years to five years, gaining learning curve improvements, and increasing the debt-to-equity mix would allow the fourth and fifth plants of the same design to have electricity costs similar to those of coal-fired and gas-fired plants.

Conclusion

The time horizon over which GHG policy actions will take place is just beginning. Because fossil fuel consumption is deeply integrated into the global economy, policy dimensions must be considered from several perspectives—from individuals and households to businesses and organizations to state, federal, and international governments. Furthermore, the fossil fuel dominance of our energy consumption, combined with the absence of ready alternatives, requires that the policy solutions identified and implemented are cost-effective. Market-based mitigation regimes offer cost-effective mitigation along with the most promising avenues for technological improvements over time. As Don Hanson, Argonne National Laboratory, commented, many basic technologies are a public good, so we as a nation need to invest more in climate-friendly, advanced energy technologies. This will give us more options for the future and lower future energy costs.

[1] The authors thank Thomas Klier, Federal Reserve Bank of Chicago, and Don Hanson, Argonne National Laboratory, for helpful comments.

[2] For more details on the CAFE standards, see www.nhtsa.dot.gov/cars/rules/cafe/overview.htm.