Purdue Climate Change Research Center

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Policy Brief

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A Primer on Market-Based Approaches to CO_2 Emissions Reductions

By Leigh Raymond and Gerald Shively

Recent political developments have brought to the political fore the issue of controlling emissions of greenhouse gases. In the United States, numerous proposals have surfaced promoting policies to limit domestic emissions of gases like carbon dioxide (CO_2), a primary contributor to climate change. Many of these proposals embrace "market-based" approaches, including the creation of a new tax or a new trading program for carbon emissions. In this flurry of political advocacy and activity, a fair amount of ambiguity and confusion has arisen concerning what these policy options might entail, and how their impacts might differ. The purpose of this policy brief is to describe some of the basic features of carbon taxes and carbon-based emissions trading. Our goal is to aid decision makers to more effectively weigh the advantages and disadvantages of these approaches.

The brief proceeds in five sections. First, we review how *cap and trade* emissions trading systems work. Second, we outline the history of emissions trading as a policy option in the United States and elsewhere. Third, we review the similarities and differences between a cap and trade system and an *emissions tax*. We then discuss some critical issues for policymakers contemplating either approach. After concluding we offer a few suggestions for further reading.

Carbon dioxide emissions in Indiana have increased 13% since 1990.

I. What is cap and trade?

Cap and trade systems draw on the ideas of economic thinkers like Ronald Coase, who argued that a clear specification of property rights can improve environmental conditions in many instances more effectively than a tax on undesired behavior. Cap and trade systems rely on two instruments to create these private property rights: the "cap," a ceiling on total allowable emissions (typically defined within a given industry or geographical region); and "trade," or creation of exchangeable emissions permits (often called "allowances") that grant the right to emit one unit of pollution in a given year. The cap appeals to those seeking environmental protection because it firmly limits total pollution loading regardless of additional economic growth: new facilities seeking to emit the pollutant typically must buy or otherwise obtain sufficient allowances from those in possession of permits to maintain the total cap.

At the same time, the system appeals to those seeking to limit the overall costs of meeting the environmental target for several reasons. The first is that allowances are tradable among emitters, allowing them to equalize their costs of compliance at the margin, and thereby achieve the overall environmental goal at least total cost to society. Meeting strict standards is often more difficult and costly for older facilities, for instance, than for newer ones. With a cap and trade system, emissions trading directly addresses this problem. In other words, firms facing very high pollution control costs can continue to emit high levels of pollution

503 Northwestern Avenue, West Lafayette, IN 47907; Tel: (765) 496-3209; Fax: (765) 496-3210
Email: pccrc@purdue.edu; WWW: http://www.purdue.edu/climate

and buy allowances from other firms that can make emissions reductions more cheaply. The result is a lower overall regulatory impact of the program, as well as additional incentives for low-cost firms to overcomply with pollution regulations in order to sell unused allowances to high-cost firms. Beyond this basic characteristic of equalizing marginal costs of compliance, the cap and trade system is a good example of a performance-based standard that allows firms maximum flexibility to comply with the overall pollution limit as they see fit because the method of emission reduction is typically left to the discretion of the firm. This can unleash the creative thinking of multiple polluters seeking cheaper ways to reduce emissions, in contrast to traditional technology-based regulations that require firms to install a certain type of pollution control equipment. It also limits the hand of government regulators on the operational decisions of private corporations, making the programs more popular in general with the private sector while often reducing enforcement costs substantially.

It is also important to note that emissions trading can result in a higher level of emissions in one area, even as the overall cap is maintained. For some pollutants, this potential *hot spot* problem is a non-issue: emissions of carbon dioxide for instance, have no negative localized impacts (although emissions of other pollutants that often accompany the burning of fossil fuels may pose a distinct, but related, problem). For other pollutants that have been the subject of cap and trade proposals, however, like mercury or even sulfur dioxide, the issue of hot spots is an important potential liability (one raising issues of environmental justice as well, if the hot spots occur primarily in poor or minority communities) unless trading is carefully monitored and potentially even restricted in order to limit negative distributional effects. Fortunately, existing experience with emissions trading shows that with carefully designed trading rules, hot spots can be reduced or eliminated.

II. History of Cap and Trade Policy Efforts

Cap and trade first emerged as a serious policy alternative in the context of fisheries management. In the 1950s, the idea of limited entry emerged as a new way to manage fisheries and prevent their overuse and collapse. Limited entry often was proposed in the form of *individual quotas* or quasi-property rights to a specific percentage of the total allowable catch for each fisherman. Only quota holders could legally harvest fish under such a system. Often, the quotas have been made transferable in practice (then called *Individual Transferable Quotas*, or ITQs) in order to make sure they go to those who value them the most.

In the 1960s and 1970s economists increasingly promoted cap and trade systems in other policy contexts, particularly for air pollution problems. A series of modest early experiments with variations on cap and trade included *netting* and *bubbling* options in nonattainment areas under the Clean Air Act. A lead trading program introduced among gasoline refineries in the 1980s added to interest in the idea. In the late 1980s, New Zealand embarked on a substantial experiment with market-based approaches to environmental policy, including a major new ITQ program for many of their local fisheries.

Finally, in 1990 Congress created the largest U.S. experiment with emissions trading to date. Under Title IV of the Clean Air Act Amendments of 1990, Congress created a new cap and trade program for electricity utilities emitting sulfur dioxide (SO_2), a pollutant known to impair human health and exacerbate the problem of acid rain. The new law took a phased approach, limiting the emissions of the largest and dirtiest facilities in the first period of compliance and then expanding the program to more than 3,000 electricity generating facilities after the year 2000. The cap was set at approximately 8.9 million tons of SO_2 per year, with each emissions allowance equivalent to one ton of SO_2. Utilities were provided free allowances based on a complex series of formulas that struck a rough balance (with a number of important exceptions) between existing levels of energy consumption and a fixed (or "benchmarked") level of pollution per unit of energy consumed. Once initiated, the program allowed utilities flexibility in complying with the law. Firms could buy allowances from other utilities, install scrubbers or other pollution control equipment, burn lower sulfur-content coal in their boilers, or combine these and other strategies.

The success of the 1990 SO_2 program is widely recognized. Even many environmentalists who were opposed to buying and selling the "right to pollute" have become sold on the program's achievement. SO_2 emissions have dropped dramatically, trading has been relatively robust, firms have complied in a variety of creative and cost-effective ways, and administrative and enforcement costs have been far lower than in traditional air pollution programs. Perhaps most surprisingly, the law has achieved virtually 100% compliance from affected units, a record unmatched by other air pollution regulations. The latest analyses of the program indicate that its benefits outweigh its regulatory costs by a factor of ten to one or higher.

Other governments have emulated the success of the acid rain program. Most prominently, the European Union adopted an extensive multi-nation emissions trading program for carbon dioxide (CO_2) in 2005 as part of its efforts to meet its emissions reduction obligations under the Kyoto Protocol. Although this EU emissions trading system (ETS) has had a bumpier road than the U.S. acid rain program, with greater

price volatility for emissions allowances and other problems, the program remains a prominent example of cap and trade in the climate change area. Many observers remain optimistic that the system can reduce the overall costs of regulatory compliance.

III. Cap & Trade vs. Carbon Taxes

The other prominent idea frequently mentioned as a market-based approach to controlling CO_2 emissions is a specific tax on carbon-based energy use. This idea has not gained much support by lawmakers, but remains popular among some advocates, academics, and independent think tanks. It tends to start out at a disadvantage in any political conversation because it invokes the word "tax," but in practice carbon taxes and a cap and trade system share many features, although they differ in important ways. In essence, with cap and trade, one establishes the emissions level, and the market determines the emissions price. With a carbon tax, the tax is the emissions price, and the market determines the emissions level.

Most importantly, both policies are market-based in the sense that they put a price on a commodity that was formerly free. In this instance, both create scarcity and a price for the atmosphere's ability to absorb CO_2. By putting a (higher) price on carbon emissions, both policies seek a similar goal: to encourage companies and individuals to emit less carbon by raising the price of the activity. In both cases, the higher price is an incentive to conservation and innovation: neither policy dictates how individuals and firms should deal with the higher prices of carbon-based fuels, they simply raise the price and then let individuals and firms figure out the best strategies for adapting.

A crucial difference hides within this similarity, however. In a cap and trade program, the price of emissions is directly set by the market. The demand and supply of emissions allowances determines what their price will be, and that price fluctuates over time. In the acid rain program, the price of allowances moved from $80 to $200 per ton, until recently jumping much higher due in part to revisions in the program rules. In the EU ETS, the price of CO_2 allowances for phase I of the program has fluctuated more dramatically, from 20 Euros per ton to the current price (as of this writing) of just over 1 Euro per ton. The bottom line, however, is that policy makers cannot directly control the price of emissions, and therefore cannot directly control the economic impact of the regulations. Instead, the policymaker sets the cap and then lets the market set the price faced by industry.

A carbon tax would reverse this relationship. Here, policymakers set the price of the emission of carbon, rather than the total amount of carbon emitted. Thus, the government might phase in a tax of $20 per ton of emitted CO_2 This will raise the cost of all carbon-based fuels accordingly, in a manner that is fixed and easily calculated by government decision makers. What is unclear is how the market will respond to this new tax in terms of changing behavior. How much less carbon will companies emit in response to this higher price? What will individual consumers do? The simple answer is: we don't know. Although economists can estimate the shape of demand curves and measure price responsiveness in an effort to predict these choices, they can't be sure how firms or consumers will respond, or how much less carbon they will choose to emit at a given price.

Thus, in one important sense a carbon tax offers something a cap and trade system does not: relative cost certainty. If a policy maker is more concerned about ensuring that the economic costs of a new climate change regulation do not get too large, then a fixed carbon tax actually offers a simpler and easier mechanism for ensuring that cost certainty than a cap and trade system. While some recent cap and trade policies have incorporated so-called "safety valve" features that raise the total emissions cap when the price of allowances hits a certain level, in doing so they simply emulate a carbon tax but in a more awkward manner.

Another vital difference between the two approaches relates to revenue. With a carbon tax, obviously, the government obtains a potentially significant new source of revenue. This could be used any number of ways, including funding the general treasury or specifically funding additional environmental programs designed to mitigate the potential impacts of climate change. Under its traditional form, therefore, a carbon tax threatens to be regressive—hurting poor consumers the most by raising the price of energy consumption equally for all income brackets. A recent policy innovation to address this concern is the idea of *tax shifting*. Under this model, higher prices for energy are offset directly by lower taxes on labor, generally via a lower payroll or income tax. Thus, the carbon tax can be framed as revenue neutral, simply shifting government income from beneficial labor to less beneficial fossil fuel consumption. While the details of any such tax shift would be complicated, the general impact would be to make the new carbon tax less regressive and have a smaller relative impact on low income consumers. Indeed, some studies have suggested such a shift would actually offer net benefits to the poorest workers. Such a tax shift would also encourage desirable behavior like creating jobs (by lowering employment taxes), while discouraging undesirable activities like polluting.

Cap and trade, by contrast, has often relied on giving emissions allowances away for free to current users of the resource. The 1990 acid rain program took this approach, as have most countries for most allowances under the more recent EU ETS. Under this allocation method, the government forgoes the potential revenue from these new assets, instead giving that value away to private interests. Recently, however,

there has been greater interest in alternative methods for distributing emissions allowances, including using different allocation rules based on measures of pollution efficiency (or "benchmarks"), economic efficiency, or even per capita distributions based on relative population sizes. In addition, there has also been growing interest in the idea of selling emissions allowances through an auction. This makes cap and trade a bit more like a carbon tax, by creating a new revenue stream for government. As with an auction, the regressive nature of any cap and trade policy can then be substantially or entirely offset by a redistribution of the auction revenue to citizens, either through lower taxes or a direct "dividend" payment to all citizens based on some percentage of the total sale revenue each year. Once considered politically unviable, auctions are gaining support both in the US and in the EU ETS as an important new policy option for any cap and trade system, and are already used extensively in other policy settings including recent government sales of the broadcast spectrum for mobile communications.

IV. Key choices/Issues

Beyond these core qualities discussed above, both cap and trade and carbon taxes create several additional choices and issues for policymakers. The first is who should pay the tax or obtain the permits. Some prefer to implement the market system "upstream" in the economy, forcing a relatively small number of affected businesses to pay the tax or obtain the necessary allowances for new carbon-based fuel sources as they first enter the economy. Under this model, energy importers, extractors, and refiners are the directly affected parties. Alternatively, one can move the permits or taxes "downstream" to end users including, in the extreme case, to individual citizens. In this sense, the current federal gasoline tax is a clear example of a downstream program, affecting each individual consumer directly. While downstream implementation is easier to imagine with a tax, there has been growing interest in a similar program for "personal" emissions allowances as well. The logistics of distributing and regulating the trade of individual allowances to emit CO_2 are admittedly daunting, but the potential gains in changing personal behavior and educating the public directly about their carbon impact are appealing to some.

In addition, there is the question of setting the right "cap" for allowances or "price" for a carbon tax. Both are difficult questions, one in the ecological sense of determining the ideal total loading of carbon in the atmosphere, the other in the economic sense of determining the optimal level of taxation for an efficient policy. Either way, setting the cap or the tax level (or both, in the case of cap and trade programs with "safety valve" features) is a challenge for any new policy in this area. In theory, one can always find a tax level that leads to the same emissions outcome as established by a given level of permits, but in practice one often lacks the information required for doing so. Under either system, the carbon tax or the cap can be changed if it is found that the initial level was inappropriate. However, such changes introduce additional uncertainty into the market.

Critics of policies to put a price on carbon often point to losses in trade competitiveness for the United States that could result. Under this argument, U.S. businesses might move their operations to unregulated countries like China or India in order to avoid the new domestic cost of burning carbon-based fuels. This *pollution haven* hypothesis is a valid concern. At the same time, recent research on the effect of other environmental regulations on global capital flows suggests that environmental regulations are rarely a precipitating factor in a firm's decision to move operations overseas—instead, the strongest influence by far is the lower cost of labor in other nations. Thus, concerns about reduced competitiveness for U.S. firms under a carbon tax or cap and trade system can be exaggerated.

Finally, there are enthusiasts of a market-based approach who sometimes suggest that setting the "right price" on carbon-based fuels will solve all our problems. This is clearly incorrect. Even in a perfectly efficient market, private firms will undersupply certain public goods like research and development, since it is hard for them to fully capture all the financial gains arising from those efforts. Thus, even if the government adopts a strong market-based approach to regulating CO_2 emissions, continued public investment in R&D related to this issue will be important, among other policy efforts.

V. Conclusion

The growing interest in and acceptance of ideas like emissions trading and pollution taxes over the past 20 years is remarkable. Both approaches capture some of the power of markets to achieve public policy goals in ways that offer real advantages in the right settings. That said, discussion sometimes omits important limitations to both strategies, as well as important ways in which they differ or are similar. In order to have the widest set of tools available to deal with emerging policy challenges like climate change, it is important to be clear about the advantages and disadvantages of both cap and trade and carbon taxes, and to consider them as part of a larger portfolio of policy strategies in this area.

For Further Reading

Emissions Trading: Principles and Practice, by Tom Tietenberg (RFF Press, 2006).

The Paparazzi Take a Look at a Living Legend: The SO_2 Cap-and-Trade Program for Power Plants in the United States, by Dallas Burtraw and Karen Palmer, Resources for the Future Discussion Paper 03-15 (2003), available at http://www.rff.org/Documents/RFF-DP-03-15.pdf.

Allocation in the European Emissions Trading Scheme: Rights, Rents and Fairness, edited by A. Denny Ellerman, Barbara K. Buchner, and Carlo Carraro (Cambridge Univ. Press, 2007).

Markets for Clean Air: The U.S. Acid Rain Program, by A. Denny Ellerman, Paul L. Joskow, Richard Schmalensee, and Juan-Pablo Montero (Cambridge Univ. Press, 2005).

Who Owns the Sky? by Peter Barnes (Island Press, 2001).

The EU Emissions Trading Directive: Opportunities and Potential Pitfalls by Joseph Kruger and William Pizer, available at http://www.rff.org/documents/RFF-DP-04-24.pdf.

The Emissions Trading Education Initiative (http://www.etei.org/links.htm).

About the Authors

Leigh Raymond (Ph.D., University of California, Berkeley) is Associate Professor of Political Science and Associate Director of the Purdue Climate Change Research Center. Leigh's research focuses on environmental policy, property rights, and the role of normative ideas in political behavior. Climate change policy has been an area of research interest for him since 1999, primarily in terms of the political process of creating and allocating tradable allowances for greenhouse gas emissions. His ideas about allocation and equity in climate change policy have been published in the journals Energy Policy and Science. Leigh's 2003 book (published by Resources For the Future Press), "Private Rights in Public Resources," deals with the issue in more detail, devoting a chapter to this allocation process as undertaken by the Ad Hoc Committee on the Berlin Mandate from 1995-1997.

Gerald Shively (Ph.D., University of Wisconsin, Madison) is Professor of Agricultural Economics and a member of the Purdue Climate Change Research Center executive committee. Jerry is an applied economist with research interests in tropical forests, agriculture, and land use change. He works with colleagues in Purdue's Center for Global Trade Analysis to develop novel approaches to integrated assessment of climate change research, especially the development of methods to evaluate economic costs and benefits of alternative climate change scenarios. He has conducted studies to assess the carbon storage potential of tropical forest and agroforestry systems. He is the author of more than 50 peer reviewed publications and co-editor of the recent book, "Land Use Change in Tropical Watersheds: Evidence, Causes, and Remedies" (CAB International, 2005).

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