Carbon Emission Trading Costs and Allowance Allocations: Evaluating the Options

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The lessons learned from examining three approaches to allocating carbon dioxide (CO_2) allowances in the electricity sector are likely to be highly relevant for an economywide program.

Although the Bush administration declined to participate in the Bonn agreement that addressed international reductions in carbon dioxide (CO_2) emissions, the president has repeatedly acknowledged the severity of the climate change problem. The preponderance of scientific evidence suggests that greenhouse gas emissions are warming the planet's atmosphere. Carbon dioxide emissions are primary contributors to the buildup of greenhouse gases, and the United States accounts for 24% of global carbon dioxide emissions.

President Bush has ordered a cabinet-level review of U.S. climate change policy and spoken about the need for market-based approaches to reducing emissions. It is possible the president's carbon policy will be similar to one of his father's significant environmental initiatives, which included a sulfur dioxide (SO_2) emission trading program as part of the 1990 Clean Air Act Amendments. If Bush proposes a similar trading program for CO_2, one of the biggest issues will be how to initially allocate the emission allowances.

The approach to allocating emission allowances for CO_2, which we measure in equivalent units of carbon, is important for two reasons. The first is that the potential transfer of wealth within the economy under a carbon trading program is tremendous and is likely to far outstrip the magnitude of any previous trading program. The market value of emission allowances that are allocated, bought and sold, and potentially reflected in electricity prices can be as much as 10 times greater than the actual cost of compliance with an emission reduction target. This is because every ton of carbon emission would require an allowance. For example, if the United States were to reduce its emissions by 5%, the marginal cost per ton of those reductions would be expected to determine the price of an emission allowance, and this would be the value per ton for each of the remaining 95% of emissions.

The second reason the allocation of carbon emission allowances is important is its effect on the economic cost of achieving emission reductions. This may come as a big surprise to many advocates of emissions trading. For the most part, the economics literature has either ignored allowance allocation entirely or primarily treated it as a distributional issue. Most courses in economics, public policy, or law teach that emission trading programs can be efficient and do so without considering how emission allowances are allocated in the design of the program. However, this idea is based on an idealized characterization of markets that often is not realized. In practice, how one allocates allowances affects the efficiency of a trading policy.

In new research at RFF, we have investigated the cost-effectiveness and distributional effects of three approaches to distributing carbon emission allowances under an emission-trading program in the electricity sector. The focus on the electricity sector is not meant to detract from the view of most economists that an economywide approach to trading carbon emissions would be preferable, a view we share. Nonetheless, the focus here on the electricity sector is deliberate. Although it is responsible for a little more than one-third of carbon emissions in the United States, the electricity sector would be expected to contribute two-thirds to three-quarters of the emission reductions under a policy that encompasses the entire economy in a cost-effective, or least-cost, way. The lessons we learn by examining the electricity sector in detail are likely to be those most relevant for an economywide program.

One way to allocate the emission allowances is through a revenue-raising "auction." The auction could be coupled with a cap—or safety valve—on the maximum price for allowances. (This approach has become known as the Sky Trust proposal, after a group by that name formed to advance this approach.) A second approach is grandfathering, patterned after the SO_2 trading program, in which allowances would be distributed on the basis of historic generation. A third approach is a generation performance standard (GPS), embodied in current legislative proposals and nitrogen oxide (NO_x) policy in Sweden. Under such a standard, allowances would be allocated based on shares of current electricity generation. We solve a detailed national electricity-market model and measure the economic cost, as well as the distributional effects felt by consumers and producers of each of these three allocation schemes.

Findings

Our main finding, and a surprising one at that, is that an auction is dramatically more cost-effective than the other approaches—roughly 50% cheaper than grandfathering or the GPS. This finding is illustrated in Figure 1 in a snapshot for the year 2012. In the absence of a policy, baseline emissions are estimated to be 626 million metric tons of carbon (mtC) in 2012. The horizontal axis indicates the size of emission reductions from this baseline. The vertical dotted line anchors a point equivalent to 1990 emissions in the electricity sector, which were about 150 million mtC less than in the baseline projected for 2012. The vertical axis reports the average social cost in 1997 dollars per mtC of emission reduction.

Average social cost is calculated as the ratio of the total additional economic cost divided by tons of emission reduction, and economic cost is measured as the sum of the changes in consumer and producer surplus in the electricity sector. Consumer surplus is the difference between consumers' willingness to pay for electricity and the price consumers actually pay. We measure this as the area under the demand curve and above electricity price. Producer surplus is the difference between revenues and costs, or equivalent producer profits. A critical issue, as we discuss below, is how revenues collected under the auction are used. In the results illustrated in Figure 1, we assume revenues are redistributed to households.

For more moderate emission-reduction targets, the ratio of cost under the auction approach is closer to one-third the cost of grandfathering and GPS, and it is somewhat greater than one-half of the cost of grandfathering and GPS for more ambitious reduction targets. However, auctioning looks better and better as the emissions reductions we consider become more ambitious because the overall level of costs incurred and the absolute value of the cost savings under the auction approach grow substantially.

The cost-effectiveness of the auction approach holds—in general terms—under a variety of assumptions about the future state of economic regulation and competition in the electricity sector. Accounting for changes outside the electricity sector that result from changes in relative fuel costs reinforces the differences among the three approaches.

The differences in the societal costs of the three approaches flow from the effect of each approach on electricity price. Allocating permits on the amount of electricity a utility generates (GPS allocation) creates an incentive for each utility to increase electricity generation. In effect, the GPS subsidizes electricity which, in turn, mitigates electricity price increases; however, it also raises social cost of reducing CO_2 emissions. The way electricity prices are determined in practice departs from economic efficiency, and the output subsidy amplifies the distortion away

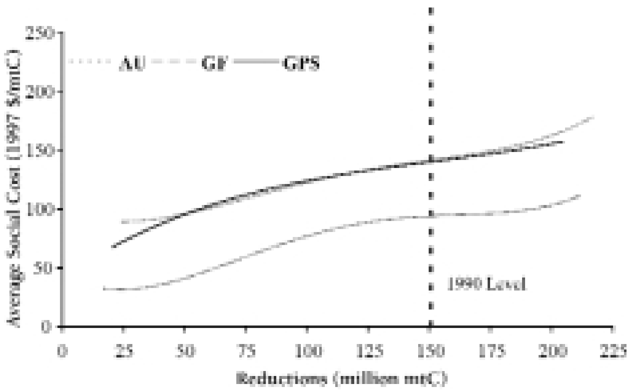

Figure 1. Social cost of allocation approaches over a range of emission targets.

from efficiency in most electricity markets and time blocks. In contrast, the auction approach increases electricity prices the most, but the efficiency costs of the price changes are less than the costs under the other approaches.

Significant distributional differences also exist among the approaches to allocating emission allowances. Electricity consumers face the highest electricity prices but the lowest natural gas prices under the auction approach. Grandfathering falls midway between the other two approaches with respect to both electricity and natural gas price changes. The GPS leads to the lowest electricity prices and consumers are best served by the GPS if we only consider electricity price changes. However, this approach also results in the highest natural gas price.

The auction approach is unique because it raises substantial revenues. In our study, we assume that these revenues are returned to households. Some observers have suggested that electricity companies or state public utility commissions could be responsible for recycling the revenue to households. Several other recent studies find that the method by which revenues are distributed can matter. Many studies argue that an auction or emissions tax can be substantially less costly than other approaches to allocating allowances because auction revenues can be used to reduce the consumer's marginal income tax or other taxes. The approach we model, direct redistribution to households, is the least efficient way that revenues can be recycled if one considers effects in the general economy.[1] If auction revenues are used in a more efficient way, such as to reduce pre-existing taxes, the cost-effectiveness of the auction would further increase.

Just as important to the political dialogue is the effect of allowance allocations on firms. In order to estimate the effect on electric power companies, we calculate changes in the net present value of generation assets over a 20-year horizon, which directly indicates how the value of a firm would be affected under each approach. Figure 2 reports the change in asset value for each major type and vintage of generation capacity on a national aggregate basis. Value is indicated as dollars per megawatt (MW) of capacity. The figure illustrates a specific example of a 35 million mtC (6%) reduction in emissions from baseline levels, phased in and taking full effect in 2008. The designation of existing capacity applies to generation capacity in 1997.

Even though grandfathering appeared to be an intermediate approach when measured by its effect on electricity and natural gas prices, electricity companies have the most to gain from grandfathering (as shown by the middle bar for each type of asset) because it represents a substantial transfer of wealth from consumers to them. In fact, producer profits and asset values increase substantially compared to the baseline (absent a carbon policy)—surprisingly, making electricity generators better off with carbon reduction than without, but leaving consumers substantially worse off. The auction and GPS approaches have much more moderate distributional effects and, therefore, we focus more attention on a comparison of these two alternatives.

The relative performances of the auction and GPS approaches are surprising. Overall, owners of existing and new generation assets in the aggregate enjoy an increase in asset values under both the auction and GPS, and can expect to do at least as well under an auction as they would under a GPS.

Another surprise is that owners of existing assets can expect to do substantially better under an auction than under a GPS.

The value of existing generation assets is indicated by a group of bars in the center of the figure, and it shows that the value of assets falls the most under the GPS. At the regional level, values vary according to the mix of generation assets and by the way prices are set (regulation or competition) in each region. In fact, in several regions we find the values of existing assets actually increase under auction.

The relative performance of the auction approach raises an interesting paradox: producers do better paying for emission allowances (through the auction) than receiving them for free (under GPS). The reason for this is that the GPS yields the lowest electricity price, which erodes the value of existing assets.

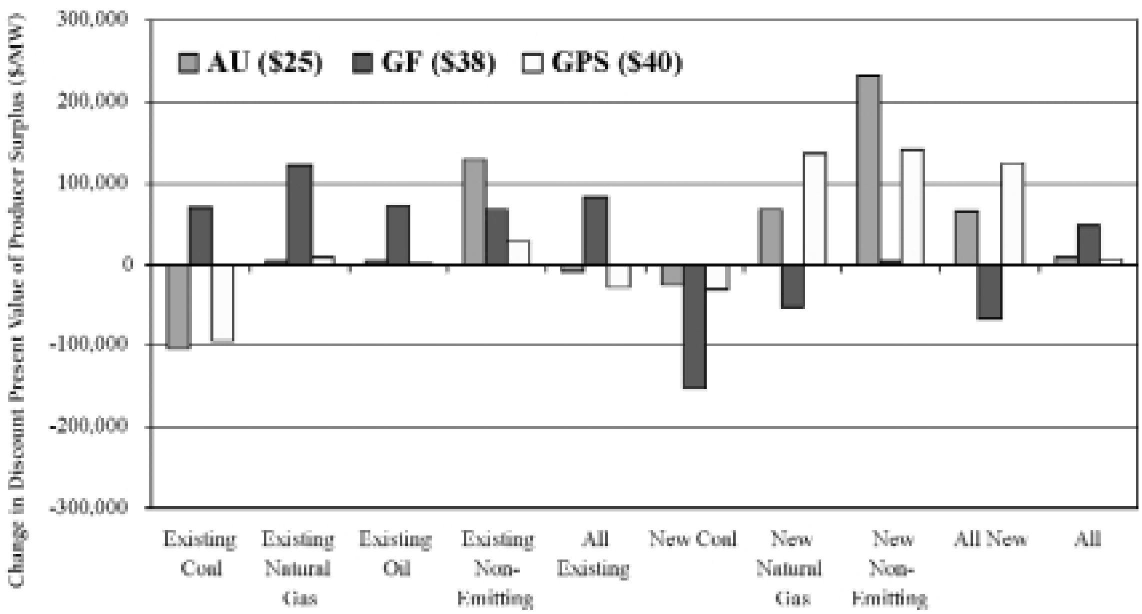

Figure 2. National aggregate changes in asset values by technology and vintage (1997 $/MW in 2001; 35 million mtC reduction).

The auction results in the highest electricity price, which preserves or enhances the value of many generating assets.

Although consumer expenditures increase under the auction approach, substantial revenues also are raised and they serve as compensation to consumers through redistribution to households. In addition, a portion of revenues could be diverted to compensate producers as well, perhaps through a hybrid program that combined an auction with a GPS or grandfathering during a transition period. This hybrid approach could be phased out, ultimately culminating in an auction of all allowances in future years. A portion of revenues under an auction, or allocation of some allowances, could be directed to support energy conservation and other benefit programs.

Admittedly, this is pretty complicated stuff. The bottom line is that the auction approach would result in significantly lower overall costs to society than either of the two gratis approaches to allocating allowances. The auction approach also provides policymakers with flexibility through the collection of revenues that can be used to meet distributional goals or enhance the efficiency of the process even further by reducing pre-existing taxes. Finally, an auction initially targeting only the electricity sector could easily be expanded to an economywide policy, something that would be much more difficult under a grandfathering or GPS approach. Because an auction approach would be cost-effective, reducing CO_2 emissions that way would have less effect on economic growth than under the other two approaches. This attribute provides perhaps the most significant form of distributional benefit.

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1. For a more detailed description, see "The Cost-Effectiveness of Alternative Instruments For Environmental Protection in a Second-Best Setting," 1999, (Lawrence H. Goulder, Ian W. H. Parry, Roberton C. Williams III, and Dallas Burtraw), *Journal of Public Economics*, vol. 72, no. 3 (June), 329–360.)