Congressional Budget Office

Testimony

Statement of
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Issues in Designing a Cap-and-Trade Program for Carbon Dioxide Emissions

before the
Committee on Ways and Means
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Chairman Rangel, Congressman McCrery, and Members of the Committee, thank you for the invitation to testify this morning on reducing the economic costs involved in addressing climate change. If policymakers adopt a cap-and-trade program to reduce carbon dioxide (CO_2) and other greenhouse gases, the economic costs will depend on several specific design features of the program.

Global climate change is one of the nation's most significant long-term policy challenges. Human activities are producing increasingly large quantities of greenhouse gases, particularly CO_2. The accumulation of those gases in the atmosphere is expected to have potentially serious and costly effects on regional climates throughout the world. Although the magnitude of such damage remains highly uncertain, there is growing recognition that some degree of risk exists for the damage to be large and perhaps even catastrophic.

The risk of potentially catastrophic damage from climate change can justify taking action to reduce that risk in much the same way that the hazards we all face as individuals motivate us to buy insurance. Some of society's resources may best be devoted to addressing climate change even if the most severe damage ultimately does not materialize.

Reducing greenhouse-gas emissions would be beneficial in limiting the degree of risk associated with climate change, especially the risk of significant damage. However, decreasing those emissions would also impose costs on the economy—in the case of CO_2, because much economic activity is based on fossil fuels, which release carbon in the form of that gas when they are burned. Much of those costs will be passed along to consumers in the form of higher prices for energy and energy-intensive goods.

Designing a cap-and-trade program to achieve such reductions would include important decisions about whether to sell or give away allowances. Those rights to emit greenhouse gases would have substantial value, and policymakers' choices about how to allocate them could have significant effects on the federal budget and on how the gains and losses brought about by the program were distributed among U.S. households. If policymakers chose to sell the allowances, they could use the revenue that would arise in many different ways, including to offset other taxes, to assist workers or low-income households that might be adversely affected by the cap, to support other legislative priorities, or to reduce the budget deficit. Policymakers would also need to decide whether to include provisions to help contain the cost of the policy by allowing firms flexibility as to when they reduced their emissions and whether to include provisions to address effects on international trade, particularly for energy-intensive goods. My testimony makes the following key points about those issues:

- A cap-and-trade program could raise significant revenue because the value of the allowances created under the program would probably be substantial. For example, the Congressional Budget Office (CBO) estimated that the value of the allowances under the cap-and-trade proposal that went to the Senate floor in June would be roughly $112 billion once the cap took effect in 2012 and would increase as the cap became more stringent.

- Issuing allowances to entities at no charge, provided that the recipients can readily convert the allowances into cash, is economically equivalent to selling the allowances and dedicating the revenue to those same entities. That equivalency is likely to hold when the allowances can be sold in a large and liquid secondary market, as would be the case under most cap-and-trade programs for greenhouse gases. CBO's estimate of the federal cost of two recent bills considered by the Senate, S. 2191 and S. 3036, reflected that equivalency by recording the value of most of the freely allocated allowances as both revenues and outlays.

- Policymakers' decisions about how to allocate the allowances could have significant effects on the overall economic cost of capping CO_2 emissions and on the distribution of gains and losses among U.S. households. Giving away a large share of the allowances to companies that produce fossil fuels or energy-intensive goods could be more costly to the economy and more regressive than selling them. That approach would preclude using the value of the allowances to create additional incentives for economic activity. It could also create "windfall profits" for shareholders, while not preventing the cap from causing price increases that would disproportionately affect low-income people.

- If the government chose to sell emission allowances, it could use some of the revenue to offset the disproportionate economic burden that higher prices would impose on low-income households. Selling allowances could also significantly lessen the overall economic impact of a CO_2 cap. Evidence suggests that the economic cost of a 15 percent cut in U.S. emissions (not counting any benefits from mitigating climate change) might be more than twice as large if policymakers gave the allowances away than if they sold the allowances and used the revenue to lower current taxes on labor or capital that discourage economic activity, such as income or payroll taxes. Likewise, dedicating the allowance revenue to reduce the federal deficit could lower the overall economic cost.

- Policymakers could help reduce the cost of achieving any given long-term target for reducing emissions if they included provisions in a cap-and-trade program that allowed firms some degree of flexibility about when emission reductions take place. Such provisions would augment the flexibility about where and how emission cuts are made that is intrinsic to a cap-and-trade program. Timing flexibility would allow firms to reduce emissions more when the cost of doing so was low and would provide firms leeway to reduce their efforts when costs were high. One method of providing timing flexibility would be to set a ceiling and a floor for allowance prices. The ceiling would limit firms' expenses when the cost of cutting emissions was high, and the floor would automatically tighten the cap (and thereby increase emission reductions) when the cost of cutting emissions was low. Policymakers could periodically adjust the speed at which the price ceiling and floor increased to ensure that emission reductions were on track for achieving a long-term target.

- Energy-intensive U.S. industries that face foreign competition (for example, the steel and aluminum industries) could lose sales to imports from countries that did not have similarly stringent policies to reduce greenhouse gases. That substitution of imports for U.S. production could reduce the environmental benefits of the policy, because it would result in emission increases from countries with less stringent policies. Some proposals would address those concerns by providing transitional assistance to manufacturers of energy-intensive products in the United States or requiring importers of those products to purchase allowances. Those proposals could, in the short run, protect domestic manufacturers from being disproportionately harmed and limit the loss of intended environmental benefits. Even so, questions remain about whether the proposals could be effectively implemented in a way that would be consistent with U.S. obligations under its agreements with the World Trade Organization.

How a Cap-and-Trade Program Would Work

Under a cap-and-trade program, policymakers would set a limit on total emissions during some period and would require regulated firms to hold rights, or allowances, to the emissions permitted under that cap. (Each allowance would entitle companies to emit one ton of CO_2 or to have one ton of carbon in the fuel that they sold.) After the allowances for a given period were distributed, firms would be free to buy and sell the allowances among themselves. Firms that were able to reduce emissions most cheaply would profit from selling allowances to firms that had relatively high abatement costs. The trading aspect of the program would lead to substantial cost savings relative to command-and-control approaches—which would mandate how much entities could emit or what technologies they should use—because it would provide more flexibility about where and how emission reductions were achieved.

A cap-and-trade program has been implemented at the federal level in the United States to limit emissions of sulfur dioxide (which contribute to acid rain). That program has been in effect since 1995 and is widely perceived to have reduced emissions at a significantly lower cost than would have been the case if lawmakers had chosen to rely on a command-and-control approach. Several states have considered, or adopted, plans for a cap-and-trade program for CO_2 emissions, but none is yet operational. A cap-and-trade program for CO_2 emissions is currently in operation in the European Union as part of its effort to comply with emission limits under the initial phase of the Kyoto Protocol, which spans 2008 to 2012.

The Potential Value and Budgetary Treatment of Allowances

In establishing a cap-and-trade program, policymakers would create a new commodity: the right to emit CO_2. The emission allowances would have substantial value. On the basis of a review of the existing literature and the range of CO_2 policies now being debated, CBO estimated that by 2020, the value of those allowances could total between $50 billion and $300 billion annually (in 2006 dollars). The actual value would depend on various factors, including the stringency of the cap, the possibility of offsetting CO_2 emissions through carbon sequestration or international trading of allowances, and other features of the specific policy that was selected.[1] On June 2, 2008, CBO estimated that the value of the allowances created under S. 3036 would be roughly $112 billion once the proposed program took effect in 2012; in subsequent years, the aggregate value of the allowances would be even greater.

Policymakers would need to decide how to allocate the allowances that corresponded to each year's CO_2 cap. One option would be to have the government capture their value by selling the allowances, as it does with licenses to use the electromagnetic spectrum. Another possibility would be to give the allowances to energy producers or some energy users at no charge. The European Union has used that second approach in its 2-year-old cap-and-trade program for CO_2 emissions, and nearly all of the allowances issued under the 13-year-old U.S. cap-and-trade program for sulfur dioxide emissions are distributed in that way.

The budgetary treatment of allowances that are auctioned is straightforward: The auctions generate receipts for the federal government, and those amounts are recorded as revenues. In some cases, allowances that are given away by the government should, in CBO's view, also be reflected in the federal budget (recorded both as revenues and outlays). That treatment is appropriate when the allowance recipients would be able to immediately and easily convert the allowances into cash by selling them in a large and liquid secondary market. In such cases, distributing allowances at no charge to specific firms or individuals is, in effect, equivalent to auctioning the allowances and then distributing the auction proceeds to those firms or individuals. Treating allowances issued at no charge as both revenues and outlays reflects the equivalency of those two scenarios. CBO applied that budgetary treatment to most of the allowances freely allocated under S. 2191 and S. 3036. (In contrast, the proceeds associated with the allowances allocated free of charge to producers and importers under smaller, more constrained cap-and-trade programs—such as the cap-and-trade program for hydrofluorocarbons proposed under S. 2191 and S. 3036—should not be recorded in the budget, CBO believes, primarily because the market created for such allowances would be relatively illiquid and, therefore, the allowances would be less like cash.)

The Distributional Consequences of a Cap-and-Trade Program

Whether policymakers decided to sell the allowances or give them away would have significant implications for the distribution of gains and losses among U.S. households. The ultimate distributional impact of a cap-and-trade program would be the

1. Carbon sequestration is the capture and long-term storage of CO_2 emissions underground (geological sequestration) or in vegetation or soil (biological sequestration). For more information, see Congressional Budget Office, *The Potential for Carbon Sequestration in the United States* (September 2007).

net effect of two distinct components: the distribution of the costs of the program (including the cost of paying for the allowances) and the distribution of the allowances' value. Market forces would determine who bore the costs of a cap-and-trade program, but policymakers would determine who received the value of the allowances. The ultimate effect could be either progressive or regressive, imposing disproportionately large burdens on high-income or low-income households, respectively.

Market Forces Would Determine Who Bore the Costs of a Cap

Obtaining allowances—or taking steps to cut emissions to avoid the need for such allowances—would become a cost of doing business for firms that were subject to the CO_2 cap. However, those firms would not ultimately bear most of the costs of the allowances. Instead, they would pass them along to their customers (and their customers' customers) in the form of higher prices. By attaching a cost to CO_2 emissions, a cap-and-trade program would thus lead to price increases for energy and energy-intensive goods and services, the production of which contributes the most to those emissions. Such price increases would stem from the restriction on emissions and would occur regardless of whether the government sold emission allowances or gave them away. Indeed, the price increases would be essential to the success of a cap-and-trade program because they would be the most important mechanism through which businesses and households would be encouraged to make investments and behavioral changes that reduced CO_2 emissions.

The rise in prices for energy and energy-intensive goods and services would impose a larger burden, relative to income, on low-income households than on high-income households. For example, without incorporating any benefits to households from lessening climate change, CBO estimated that the price increases resulting from a 15 percent cut in CO_2 emissions would cost the average household in the lowest one-fifth (quintile) of all households arrayed by income slightly more than 3 percent of its income; such increases would cost the average household in the top quintile just under 2 percent of its income (see Table 1).[2]

The higher prices that would result from a cap on CO_2 emissions would reduce demand for energy and energy-intensive goods and services and thus create losses for some current investors and workers in the sectors of the economy that supply such products. Investors might see the value of their stock decline, and workers could face the risk of unemployment as jobs in those sectors were cut. Stock losses would tend to be widely dispersed among investors, because shareholders typically diversify their portfolios. In contrast, the costs borne by workers would probably be concentrated among relatively few households and, by extension, their communities.

2. Those numbers are based on an analysis that CBO conducted using 1998 data; see Congressional Budget Office, *Who Gains and Who Pays Under Carbon-Allowance Trading? The Distributional Effects of Alternative Policy Designs* (June 2000). CBO is in the process of updating those figures, using recent data on households' expenditures and income.

Table 1.

Effects on U.S. Households of the Higher Prices Resulting from a 15 Percent Cut in CO_2 Emissions

	Average for Income Quintile				
	Lowest	Second	Middle	Fourth	Highest
Annual Cost Increase in 2006 Dollars	680	880	1,160	1,500	2,180
Annual Cost Increase as a Percentage of Income[a]	3.3	2.9	2.8	2.7	1.7

Source: Congressional Budget Office, *Who Gains and Who Pays Under Carbon-Allowance Trading? The Distributional Effects of Alternative Policy Designs* (June 2000).

Notes: These numbers do not reflect any of the benefits from reducing climate change.

The policy examined here is a cap-and-trade program designed to lower U.S. carbon dioxide (CO_2) emissions by 15 percent from 1998 levels. (CBO performed the analysis in 2000 and used 1998 emission levels so that the distributional effects could be based on actual, rather than projected, data on consumer spending and taxes.) CBO assumed that the full cost of cutting emissions would be passed along to consumers in the form of higher prices and that the price increase for a given product would be proportional to the amount of CO_2 emitted from the fossil fuels used in its production.

These numbers reflect data on each quintile's cash consumption and estimates of cash income. (A quintile contains one-fifth of U.S. households arrayed by income.) Because of data limitations, the numbers should be viewed as illustrative and broadly supportive of the conclusions in this analysis rather than as precise estimates.

a. The cost increases are equivalent to percentage declines in households' after-tax income.

Policymakers Would Determine Who Received the Value of the Allowances

Although the price increases triggered by a cap-and-trade program for CO_2 emissions would be regressive, the program's ultimate distributional effect would depend on policymakers' decisions about how to allocate the allowances. As noted above, those allowances would be worth tens or hundreds of billions of dollars per year. Who received that value would depend on how the allowances were distributed.

Lawmakers could more than offset the price increases experienced by low-income households or the costs imposed on workers in particular industrial sectors by providing for the sale of some or all of the allowances and using the revenue to pay compensation. From analyzing the ultimate distributional effects of a cap-and-trade program that would reduce CO_2 emissions in the United States by 15 percent, CBO concluded that lower-income households could be better off (even without counting any benefits from reducing climate change) as a result of the policy if the government chose to sell the allowances and use the revenue to pay an equal lump-sum rebate to every household in the United States. In that case, the size of the rebate would be larger than the average increase in low-income households' spending on energy and energy-intensive goods.[3] Such a strategy would increase average income for households in the lowest income quintile by about 2 percent (see the top panel of Figure 1). At the same time, average income for households in the top quintile would fall by less than 1 percent, CBO estimates.

In contrast, if lawmakers chose to use the allowances to decrease corporate income taxes, the effect would be significantly more regressive than the initial price increases. Because low-income households pay relatively little in corporate taxes, the reduction in corporate tax rates would not offset their increased spending on energy and energy-intensive goods. Households in the top income quintile, however, would experience an increase in after-tax income as a result of the policy. Should policymakers decide to use the revenue from selling allowances to decrease payroll taxes, the effect (not shown in the figure) would be regressive as well, although less so than for a cut in corporate taxes.[4]

Giving all or most of the allowances to energy producers to offset the potential losses of investors in those industries—as was done in the cap-and-trade program for sulfur dioxide emissions—would also exacerbate the regressivity of the price increases. On average, the value of the CO_2 allowances that producers would receive would more than compensate them for any decline in profits caused by a drop in demand for energy and energy-intensive goods and services whose production causes emissions. As a result, the companies that received allowances could experience windfall profits.

For example, in 2000, CBO estimated that if emissions were reduced by 15 percent, as in the scenario discussed above, and all of the allowances were distributed free of charge to producers in the oil, natural gas, and coal sectors, the value of the allowances would be 10 times as large as coal, oil, and natural gas producers' combined profits in 1998. Profits for those industries have climbed substantially since then, yet the value of the allowances associated with the policy that CBO analyzed would still be large relative to those producers' profits.[5] Because the additional profits from the allowances' value would not depend on how much a company produced, such profits would be unlikely to prevent the declines in production and resulting job losses that the price increases (and resulting drop in demand) would engender.

3. One researcher has suggested that an environmental tax credit based on earnings could offer another means of reducing the regressive effects of the price increases that would result from a tax or cap on CO_2 emissions. See Gilbert E. Metcalf, *A Proposal for a U.S. Carbon Tax Swap* (Washington, D.C.: Brookings Institution, October 2007).

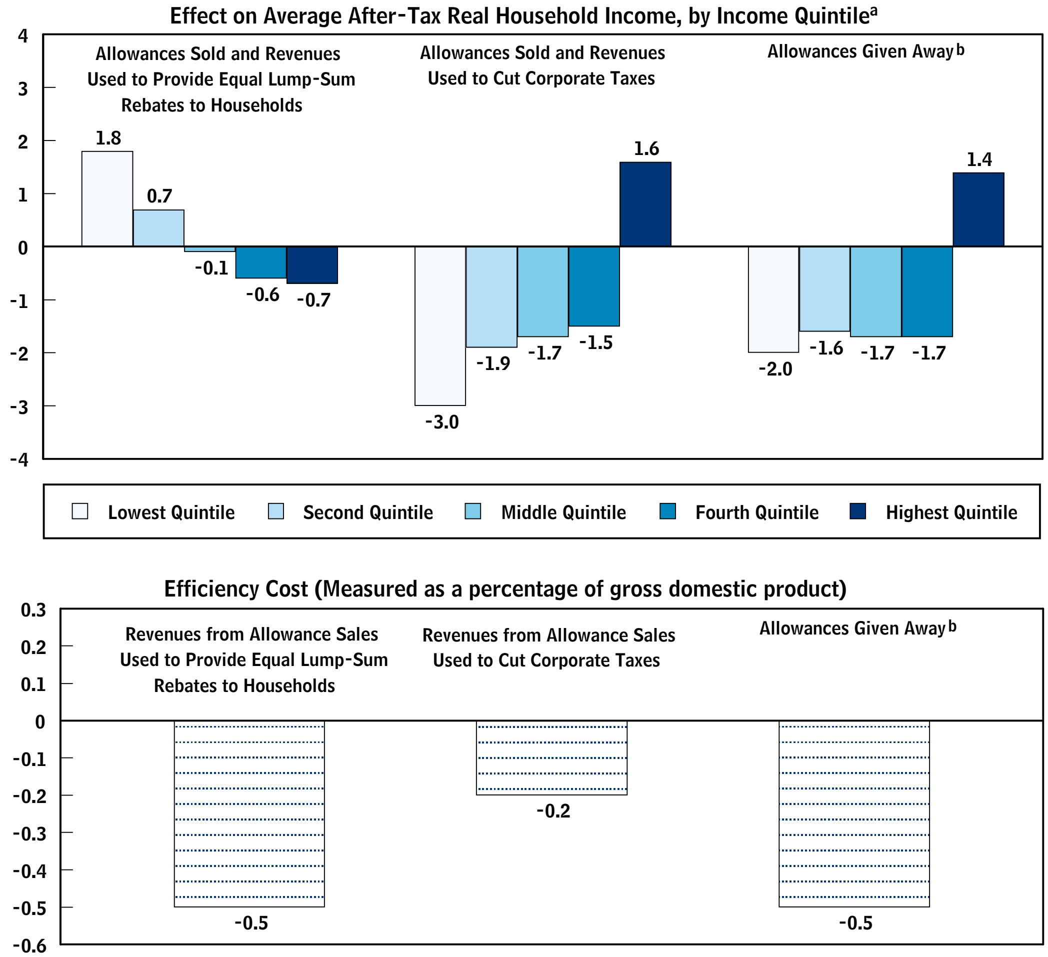
4. For those results, see Congressional Budget Office, *Trade-Offs in Allocating Allowances for CO_2 Emissions* (April 25, 2007).

5. Specifically, CBO estimated that the value in 1998 of the allowances stemming from the 15 percent reduction in U.S. emissions would total $155 billion (in 2006 dollars). By comparison, profits for U.S. producers of oil, natural gas, and coal totaled $13.5 billion in 1998 (in 2006 dollars). Those companies' total profits have grown substantially—for example, in 2006, they totaled $174 billion.

Figure 1.

Effects of a 15 Percent Cut in CO_2 Emissions, with the Allowances' Value Used in Various Ways

(Percentage change)



Sources: Congressional Budget Office (top panel); Terry M. Dinan and Diane Lim Rogers (bottom panel), "Distributional Effects of Carbon Allowance Trading: How Government Decisions Determine Winners and Losers," *National Tax Journal*, vol. 55, no. 2 (June 2002).

Notes: These figures do not reflect any of the benefits from reducing climate change.

The policy examined here is a cap-and-trade program designed to reduce carbon dioxide (CO_2) emissions by 15 percent from 1998 levels. (CBO performed the analysis in 2000 and used 1998 emission levels so the distributional effects could be based on actual, rather than projected, data on consumer spending and taxes.) In the top panel, the costs of the cap-and-trade policy are shown as decreases in real household income, measured as a percentage of after-tax income before the policy change. Those numbers reflect data on each quintile's cash consumption and estimates of cash income. (A quintile contains one-fifth of U.S. households arrayed by income.) Because of data limitations, those numbers should be viewed as illustrative and broadly supportive of the conclusions in this analysis rather than as precise estimates.

a. Indicates the net effect of households' increased expenditures because of cap-induced price increases and the income that households would receive as a result of the allowance-allocation strategy.

b. These estimates assume that the government would use any positive net revenue remaining after accounting for ways in which the policy affected the federal budget to provide equal lump-sum rebates to households. The results would be more regressive if the government used any positive net revenue to decrease corporate taxes or payroll taxes.

In addition, those profits would accrue to shareholders, who are primarily from higher-income households, and would more than offset those households' increased spending on energy and energy-intensive goods and services. Low-income households, by contrast, would benefit little if allowances were given to energy producers for free, and they would still bear a disproportionate burden from the price increases that would nonetheless occur. Thus, giving away allowances would be significantly regressive, making higher-income households better off as a result of the cap-and-trade policy while making lower-income households worse off.

Reducing the Overall Economic Impact of a CO_2 Cap

Restricting CO_2 emissions would impose costs on the economy. Lawmakers could help minimize those costs by using the allowances' value in ways that would benefit the economy and by allowing firms some degree of flexibility about when emission reductions must be made.

Using the Allowance Value to Reduce the Total Economic Cost

The ways in which lawmakers allocate the revenue from selling emission allowances would affect not only the distributional consequences of a cap-and-trade policy but also its total economic cost. For instance, the government could use the revenue from auctioning allowances to reduce existing taxes that tend to dampen economic activity—primarily, taxes on labor, capital, or personal income. As research indicates, a CO_2 cap would exacerbate the economic effects of such taxes: The higher prices caused by the cap would lower real (inflation-adjusted) wages and real returns on capital, which would be equivalent to raising marginal tax rates on those sources of income. Using the value of the allowances to reduce such taxes could help mitigate that adverse effect of the cap. Alternatively, policymakers could choose to use the revenue from auctioning allowances to reduce the federal deficit. If that reduction lessened the need for future tax increases, the end result could be similar to dedicating the revenue to cuts in existing taxes.

The decision about whether or not to sell the allowances and use the proceeds in ways that would benefit the economy could have a significant impact. For example, researchers have estimated that the efficiency cost (discussed below) of a 15 percent cut in emissions could be reduced by more than half if the government sold the allowances and used the revenue to lower corporate income taxes, rather than devoting the revenue to providing lump-sum rebates to households or giving the allowances away (see the bottom panel of Figure 1). The efficiency cost of a policy reflects the economic losses that occur because prices in the economy are distorted in that they do not reflect the (nonenvironmental) resources used in their production. That cost includes decreases in the productive use of labor and capital as well as costs (both monetary and nonmonetary) associated with reducing emissions. To provide perspective on the magnitude of such efficiency costs, they are depicted as a share of gross domestic product.

Allowing Flexibility in the Timing of Emission Reductions to Lower Costs

In its most inflexible form, a cap-and-trade program would require that a specified cap on emissions was met each year. That lack of flexibility would increase the cost of achieving any long-term goal because it would prevent firms from responding to year-to-year differences in conditions that affected costs for reducing emissions, such as fluctuations in economic activity, energy markets, the weather (for example, an exceptionally cold winter would increase the demand for energy and make meeting a cap more expensive), and the technologies available for reducing emissions.

In contrast, the key issue from an environmental perspective involves the emissions and concentrations of greenhouse gases over the long term, not the year-to-year fluctuations in emissions. In other words, limiting global climate change will entail substantially reducing the amount of greenhouse gases that accumulate in the atmosphere over the next several decades, but the benefits of doing so are largely independent of the annual pattern of those reductions.[6] Consequently, a cap-and-trade program could achieve roughly the same level of benefits at a significantly lower cost if it provided firms with an incentive to make greater reductions in emissions at times when the cost of doing so was low and allow them leeway to lessen their efforts when the cost was high.

Including features in a cap-and-trade program that enabled firms to reduce emissions less when the cost was high and more when the cost was low could also reduce the volatility of allowance prices. Experience with cap-and-trade programs has shown that price volatility can be significant. For example, one researcher found that the price of sulfur dioxide allowances under the U.S. Acid Rain Program was significantly more volatile than stock prices between 1995 and 2006 (see Figure 2).[7]

Price volatility could be particularly problematic with CO_2 allowances because fossil fuels play such an important role in the U.S. economy. In 2006, fossil fuels accounted for 85 percent of the energy consumed in the United States. CO_2 allowance prices could affect energy prices, inflation rates, and the value of imports and exports. If those prices were volatile, they could have disruptive effects on markets for energy and energy-intensive goods and services and could make investment planning difficult.

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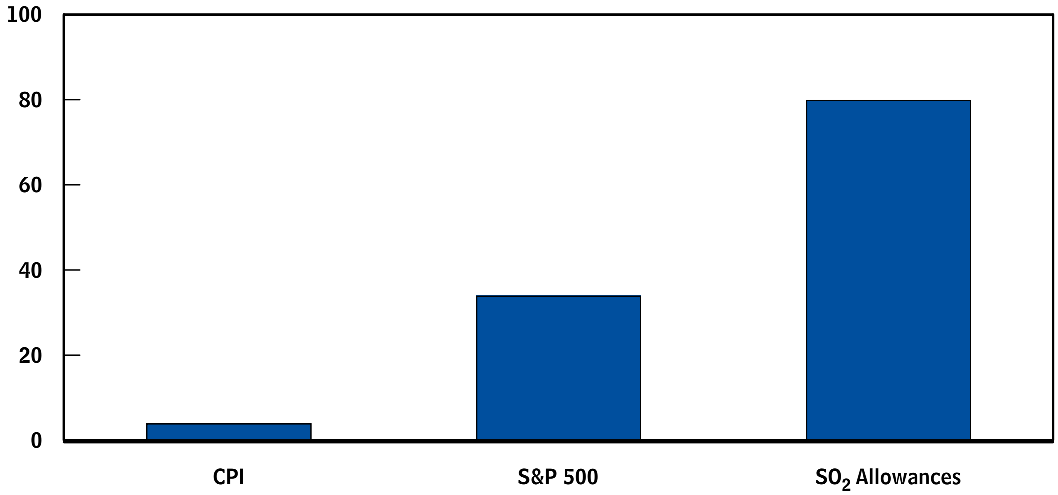
6. Although costs and benefits are difficult to measure, the long-term cumulative nature of climate change implies that the *benefit* of emitting one less ton of CO_2 in a given year—referred to as the marginal benefit—is roughly constant. In other words, the benefit in terms of averted climate damage from each additional ton of emissions reduced is roughly the same as the benefit from the previous ton of emissions reduced, and shifting the reductions from one year to another does not materially affect the ultimate impact on the climate. In contrast, the *cost* of emitting one less ton of CO_2 in a given year—the marginal cost—tends to increase with successive emission reductions. The reason is that the least expensive reductions are made first and progressively more-expensive cuts would then have to be made to meet increasingly ambitious targets for emission reductions.

7. See William D. Nordhaus, "To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming," *Review of Environmental Economics and Policy,* vol. 1, no. 1 (Winter 2007), pp. 37–39.

Figure 2.

Volatility of SO_2 Allowance Prices and Selected Other Prices, 1995 to 2006

(Average annual percentage rate of volatility)



Source: Congressional Budget Office based on William D. Nordhaus, "To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming," *Review of Environmental Economics and Policy,* vol. 1, no. 1 (Winter 2007), pp. 26–44.

Note: Volatility is calculated as the annualized absolute logarithmic month-to-month change in the consumer price index (CPI), the stock price index for the Standard & Poor's 500 (S&P 500), and the price of sulfur dioxide (SO_2) allowances under the U.S. Acid Rain Program.

Design Features Providing Flexibility in the Timing of Emission Reductions

Recent proposals for cap-and-trade proposals include a variety of design features that would provide firms or regulators with flexibility in the timing of emission reductions, thereby reducing the economic costs of limiting greenhouse-gas emissions.

A Price Ceiling and a Price Floor. A combined price ceiling and price floor offers one method of allowing timing flexibility and thereby reducing the economic burden of achieving any desired target for cumulative emissions:

- Setting a ceiling, or safety valve, for the price of allowances could prevent the cost of reducing emissions from exceeding either the best available estimate of the environmental benefits or the cost that policymakers considered acceptable. The government could maintain a price ceiling by selling companies as many allowances as they would like to buy at the safety-valve price.

- Similarly, policymakers could prevent the price of allowances from falling too low by setting a price floor. If the government chose to auction a significant share of the allowances, it could specify a so-called reserve price and withhold allowances from the auction as needed to maintain that price. The efficiency advantage of a price floor would stem from the fact that it could prevent the cost of emission reductions from falling below the expected benefits or below the level of effort that policymakers intended.

A cap-and-trade program that included both a ceiling and a floor for allowance prices could achieve a long-term target for emissions while minimizing both the overall cost of achieving the target and price volatility. Under such a program, policymakers would specify annual emission targets as well as a ceiling and a floor for the price of allowances for each year. Regulators could adjust the levels of the price ceiling and floor periodically (for example, every five years) to ensure that emission reductions were on track for achieving the long-run target. For example, the rate at which the price floor or ceiling rose over time could be increased if regulators determined that the reductions in the previous five-year period were significantly lower than the amount needed to achieve the long-term target. Alternatively, policymakers could include provisions in a cap-and-trade program that would automatically trigger adjustments in the price ceiling and floor. For example, the rate at which the price ceiling and floor rose could be based on the percentage gap between anticipated and actual emissions in the previous five-year period.

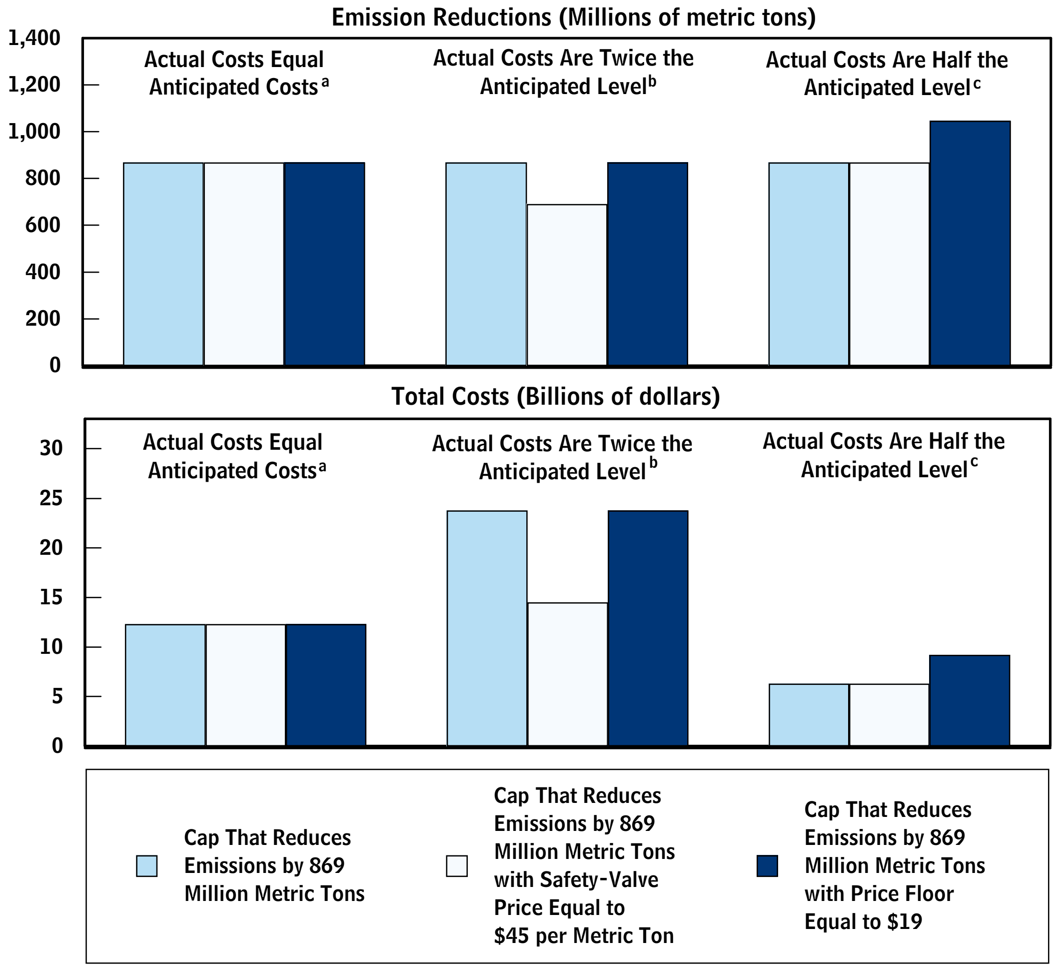
Figures 3 and 4 illustrate the effects of price ceilings and floors. The figures present a simple example of an inflexible cap each year relative to a system involving price ceilings and floors. In Figure 3, the results illustrate what happens if the cost of reducing emissions by 15 percent is twice as high or 50 percent lower than expected in any given year. Under an inflexible cap, the emission reductions are unaffected. Under a price ceiling, fewer emission reductions are undertaken when the cost is high; the result is lower economic costs that year but also less of a reduction in emissions. Under a price floor, more emission reductions are undertaken when the cost is low.

Figure 4 shows the results after one high-cost year and one low-cost year. Cumulative emission reductions are the same under the inflexible cap and the combined price ceiling and floor, but costs are substantially lower under the latter approach. The reason, again, is that more of the emission reductions are undertaken in the low-cost year under that approach.

Borrowing and Banking Allowances. An alternative but generally somewhat less effective approach to reducing economic costs involves allowing companies to borrow future allowances in high-cost years, thereby deferring emission reductions to later years. Borrowing allowances from future years would tend to reduce allowance prices in the current year but then raise prices in the future (because borrowing would allow smaller reductions now but require greater reductions later). Firms would want to borrow allowances only if they expected the price of allowances in the future to be sufficiently below the current price as to make deferring reductions profitable. Most proposals would impose limits on borrowing, furthermore, in part because of concerns about enforcement and questions about who would be liable if the firm that

Figure 3.

Illustrative Comparison of Various Cap-and-Trade Policies to Reduce CO_2 Emissions by Roughly 15 Percent Under Different Cost Conditions in 2018



Source: Congressional Budget Office.

Notes: This example examines the emission reductions and total costs that would result in 2018, assuming that the policy covered only the United States. The cost of firms' emission reductions is derived from Mark Lasky, *The Economic Costs of Reducing Emissions of Greenhouse Gases: A Survey of Economic Models,* Congressional Budget Office Technical Paper No. 2003-03 (May 2003).

A safety valve is a ceiling on the price of emission allowances.

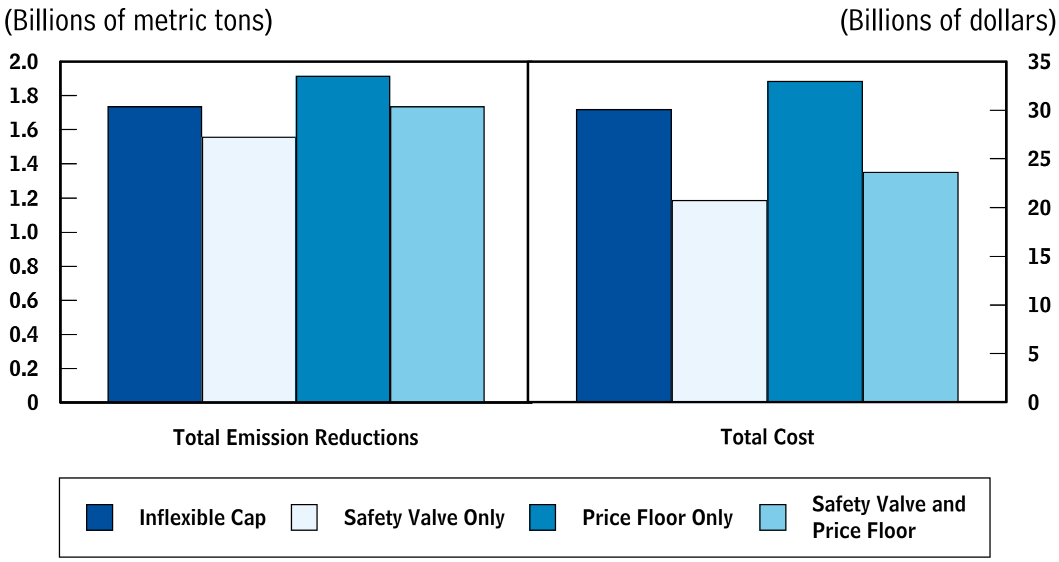
a. Assumes that the actual marginal cost of reducing emissions by 869 million metric tons is $30 per metric ton, the cost that policymakers anticipated when they set the cap.

b. Assumes that the actual marginal cost of reducing emissions by 869 million tons is $60 per metric ton but that the safety valve induces less reductions (691 million tons instead of 869 million), up to a marginal cost of $45 per metric ton.

c. Assumes that the actual marginal cost of reducing emissions by 869 million tons is $15 per metric ton but that the price floor induces more reductions (1,047 million tons instead of 869 million) at a marginal cost of $19 per metric ton.

Figure 4.

Illustrative Comparison of Total Emission Reductions and Total Costs After One High-Cost and One Low-Cost Year



Source: Congressional Budget Office.

Notes: This example represents the cumulative emission reductions and costs over two years of a cap-and-trade policy that would reduce emissions of carbon dioxide by 869 million tons in each year (roughly a 15 percent reduction in 2018). The cost of firms' emission reductions is derived from Mark Lasky, *The Economic Costs of Reducing Emissions of Greenhouse Gases: A Survey of Economic Models,* Congressional Budget Office Technical Paper No. 2003-03 (May 2003).

A safety valve is a ceiling on the price of emission allowances.

For the high-cost year, CBO assumes that the marginal cost of reducing emissions by 869 million tons is $60 per metric ton but that the safety valve induces less reductions (691 million tons instead of 869 million), up to a marginal cost of $45 per metric ton.

For the low-cost year, CBO assumes that the marginal cost of reducing emissions by 869 million tons is $15 per metric ton but that the price floor induces more reductions (1,047 million tons instead of 869 million) at a marginal cost of $19 per metric ton.

borrowed future allowances was unable to pay them back (if it declared bankruptcy, for example).

Similarly, policymakers could help keep the price of allowances from falling too low by allowing companies to exceed their required emission reductions in low-cost years in order to bank allowances for use in future high-cost years. The additional emission reductions motivated by banking in low-cost years would put upward pressure on the price of allowances in those years.

Aggregate Borrowing by Regulators. S. 2191 and S. 3036 would have addressed sustained high prices for allowances by allowing an administrative board, the Carbon Market Efficiency Board, to transfer future allowances to the current year. That approach could be viewed as a form of forced borrowing—that is, it would require firms to trade higher reductions in the future and, hence, higher prices for future allowances for lower reductions and lower prices today, even if they would not have voluntarily made this trade across time. Such transfers could ultimately raise or lower the overall cost of meeting a long-run target depending on how the price of allowances changed over time. For example, if an inexpensive low-carbon energy technology became available in the future, transferring future allowances to the current period would have successfully shifted emission reductions to a time when the cost of achieving them was lower. Alternatively, if policymakers borrowed future allowances with the expectation that such a technology would become available, but it did not, then the transfer could cause even more reductions to be made at a relatively high-cost time.

An alternative approach to the one embodied in those bills, which may be easier for regulators to implement efficiently, would be to adopt a system providing a combined price ceiling and price floor and to have the board be responsible for setting the ceiling and floor prices and for adjusting those price limits periodically as needed to achieve a long-term target.

Design Features Addressing Energy-Intensive Manufacturing Industries

Several bills introduced during the 110th Congress contain provisions that pertain to certain energy-intensive manufacturing industries that are subject to foreign competition. The proposals potentially address the concern that if a cap-and-trade system was adopted in the United States, manufacturing in certain industries could shift to countries with less stringent climate policies, which would undermine the environmental goals that the domestic policy was intended to achieve and harm U.S. manufacturers.

During 2006, about 30 percent of total U.S. greenhouse-gas emissions came from domestic manufacturing industries, either directly through the manufacturing process or indirectly through the use of electricity in manufacturing.[8] Some of those industries—such as those producing chemicals, glass, cement, iron and steel, aluminum, food, and paper and pulp, which accounted for about 15 percent of U.S. energy consumption—face significant foreign competition.

Reducing greenhouse-gas emissions would raise production costs for energy-intensive manufacturers by increasing the prices of the energy that they purchase or by causing them to invest in equipment to reduce their emissions. As a result, their sales, employment, and profits would probably decline, at least in the short run. Over the longer

8. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sink: 1990–2006* (2008).

term, changes in investment and in the mix of output produced in the United States would mitigate those effects.

Unlike companies that face only limited foreign competition, such as electric utilities, manufacturers might have difficulty passing increased costs on to consumers because they face competitors in both the U.S. and international markets. If foreign competitors (either foreign-owned or subsidiaries of U.S. firms) did not experience similar increases in production costs because of less stringent emission standards abroad, U.S. output and employment in those industries would probably decline. Moreover, the environmental benefits of reducing U.S. emissions might be partially offset by increased emissions elsewhere, an effect known as "carbon leakage."

Several recent bills—including S. 1766, S. 3036, H.R. 6186, and H.R. 6316 (see Table 2)—have included two design features that are intended to cushion the economic impacts on energy-intensive manufacturing industries and to protect against carbon leakage: border adjustments and transitional assistance.

Border Adjustments. Recent bills have included provisions that, in effect, would require importers of certain goods from countries without climate policies to obtain allowances from an international reserve on the basis of the carbon emissions embodied in those goods. Such border adjustments would increase the cost of imports, raise their price in the U.S. market, and thus level the playing field for affected U.S. producers. In S. 1766 and S. 3036, the basis for calculating the number of reserve allowances required for imports was the extent to which carbon emissions in a given sector for a given country increased following the introduction of a climate policy in the United States. In more recent proposals, such as H.R. 6186 and H.R. 6316, the allowance requirement is based on the total emissions from a given sector in a given country. Some of the bills also would take into account the economic development status of the exporting country and the extent to which it had undertaken efforts to reduce greenhouse-gas emissions. In addition, many of the bills recently proposed would reduce the allowance requirement by the degree to which transitional assistance was given to domestic manufacturing.

By increasing the price of imports, border adjustments would limit any increase in CO_2 emissions from having unregulated imports displace goods produced in the United States. The requirements would give exporting countries the same incentive to reduce emissions in the production of their exports to the United States that the cap-and-trade program would give to U.S. producers.

Adjustments to exports are also possible but have not been included in recent proposals. Policymakers could provide allowances for free to U.S manufacturers to cover the emissions associated with the goods that they export. Such adjustments would lower compliance costs for U.S. exporters and could help mitigate any losses in U.S. exports that might otherwise occur as a result of a climate policy. When U.S. exports are already less carbon-intensive than foreign competitors' goods, export adjustments would serve to guard against carbon leakage in international markets.

Table 2.

Comparison of Border Adjustments and Transitional Assistance in Recent Bills

Bill Number	Applicability[a]	Effective Dates	Basis for Import Allowance Requirement	Adjustments to Import Allowances	Allowance Allocation for Transitional Assistance[b]
S. 1766	Primary Products	2020–2050	Increase over Baseline in a Covered Good's Embodied Carbon Emissions	Based on Transitional Assistance and Economic Development of Exporting Country	10% of Allowances Allocated to Energy-Intensive Manufacturing in 2012 and Phased out by 2043
S. 3036	Primary Products	2020–2050	Increase over Baseline in a Covered Good's Embodied Carbon Emissions	Based on Transitional Assistance and Economic Development of Exporting Country	10% of Allowances Allocated to Energy-Intensive Manufacturing in 2012 and Phased out by 2030
H.R. 6186	"Trade-Exposed" Primary Goods (Other than fuel)	2020–2050	A Covered Good's Embodied Carbon Emissions	Based on Economic Development of Exporting Country	6% of Allowances Allocated to Energy-Intensive Manufacturing from 2012 to 2019
H.R. 6316	Primary Products and Manufactured Items for Consumption	2015–2050	A Covered Good's Embodied Carbon Emissions	Based on Transitional Assistance, Degree of Comparable Effort, and Economic Development of Exporting Country	10% of Allowances Allocated to Energy-Intensive Manufacturing in 2012 and Phased out by 2019

Source: Legislative Information System (LIS), available at www.congress.gov/index.php (last accessed September 4, 2008).

a. A "covered good" is a primary product (or a manufactured item for consumption in the case of H.R. 6316) that generates, in the course of its manufacture, a substantial quantity of direct or indirect greenhouse-gas emissions and whose cost of production in the United States would be affected by the nation's climate policy; a "primary product" is defined as iron, steel, aluminum, or other manufactured product that is sold in bulk for the purpose of further manufacture (see H.R. 6316, sec. 101); a "manufactured item for consumption" is defined as a good that is not a primary product but that generates a substantial amount of direct or indirect emissions attributable to the primary product(s) in the manufactured item.

b. "Transitional assistance" refers to allocations of domestic allowances free of charge (it can be linked to production decisions about such items as output or labor).

When U.S. exports are more carbon-intensive than foreign competitors' goods, export adjustments could undermine the benefits from meeting a domestic cap on greenhouse gases. Export adjustments would also eliminate the incentive to reduce greenhouse-gas emissions from the manufacture of goods for export, making it more expensive to achieve a domestic cap.

The scope of coverage differs among the bills. They all cover energy-intensive primary goods (for example chemicals, glass products, cement products, iron and steel products, aluminum products, food products, and paper and pulp products), and some include various energy-intensive finished goods, such as vehicles. The wider the scope, the more difficult it becomes to calculate the number of reserve allowances required. Regulators would find it particularly challenging to estimate the carbon emissions embodied in finished goods, especially when inputs might come from different countries using different technologies.

Another challenge is that the national origin of goods exported to the United States could be difficult to determine, particularly if willful schemes using importing and reexporting were used to obscure the origin of components produced in nations without a sanctioned climate policy. The larger the scope of covered goods (and the greater the difference in border adjustments by countries with comparable climate policies), the greater the likelihood of such schemes.

Transitional Assistance. Recent proposals would provide transitional assistance to energy-intensive manufacturers by giving allowances to firms in certain industries: 10 percent of the allowances beginning in 2012 under S. 1766, S. 3036, and H.R. 6316, and 6 percent of the allowances beginning in 2012 under H.R. 6186. Recent proposals would phase out transitional assistance more quickly than earlier proposals—H.R. 6186 and H.R. 6316 would cease allocations to energy-intensive manufacturing in 2019.

Giving allowances to energy-intensive manufacturers for free would not, in general, change their responses to a climate policy unless the grants were explicitly tied to specific production decisions. S. 1766, S. 3036, and H.R. 6316 would tie the amount of allowances allocated to an individual firm to the number of employees in that company relative to the sector average—providing an incentive to increase production or to substitute labor for capital or energy. H.R. 6186 would tie the allocation of transitional assistance to the output of an individual firm relative to the average output in the sector, thus providing an incentive for increased production. In those cases, transitional assistance in the short run could help energy-intensive manufacturers maintain their output and thereby limit the loss of U.S. jobs. Over the longer term, regardless of how the allowances were allocated, many of the affected sectors would probably be able to offset higher energy costs by substituting fuels containing less carbon and adopting technological advances.[9]

9. See Morgenstern and others, *Competitiveness Impacts of Carbon Dioxide Pricing Policies on Manufacturing*, Resources for the Future, Climate Policy Forum, Issue Brief 7 (November 2007).

Compatibility with WTO Agreements. Adopting border adjustments would raise questions about whether using them to reduce carbon leakage would be compatible with U.S. obligations under the various World Trade Organization (WTO) agreements. Border adjustments might be challenged by other member countries of WTO. Even if such border adjustments were eventually found to be legal, many years could pass before rulings by WTO dispute settlement panels and the WTO Appellate Body (in cases challenging not only the U.S. program but other countries' programs as well) made clear precisely what was and what was not allowed. Only a cursory survey of the issues is possible here.

Each member country has agreed to upper limits, known as tariff bindings, beyond which it is not allowed to raise its tariffs. Almost all U.S. tariffs are at or near their limits, so border adjustments or other charges on imports under a cap-and-trade policy would be illegal under the WTO agreements unless covered by one of the exceptions contained in the agreements. Recent analyses point to two exceptions that the United States might use as defenses in any challenge to a border adjustment system.[10]

First, Articles II and III from the General Agreement on Tariffs and Trade (GATT—one of the WTO agreements) allow the imposition of taxes on imports that are equivalent to internal taxes imposed on like domestic goods. Several issues would arise in such a defense, not the least of which is whether two otherwise identical goods were "like" within the meaning of the WTO agreement and jurisprudence if the amount of CO_2 emitted in their production was different. In the past, determinations of "like" goods have generally not considered the processes used to produce them. Moreover, the border adjustments on imports would have to adhere to the most-favored-nation requirements of the agreement, which require that imports from all countries be treated the same. That requirement might mean that the border adjustments could not be reduced for imports from countries taking measures to reduce CO_2 emissions.

The second exception that the United States might use as a defense in a challenge is described in GATT Article XX. Paragraph (g) of that article allows for border measures "relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consump-

10. Joost Pauwelyn, *U.S. Federal Climate Policy and Competitiveness Concerns: The Limits and Options of International Trade Law*, Working Paper NI WP 07-02 (Duke University, Nicholas Institute for Environmental Policy Solutions, April 2007); Jason E. Bordoff, "International Trade Law and the Economics of Climate Policy: Evaluating the Legality and Effectiveness of Proposals to Address Competitiveness and Leakage Concerns" (paper presented at the Brookings Institution's conference on Climate Change, Trade, and Competitiveness, Washington, D.C., June 9, 2008); Gary Clyde Hufbauer, Jisun Kim, and Steve Charnovitz, *Reconciling GHG Limits with the Global Trading System* (draft, Peterson Institute for International Economics, Washington, D.C., August 2008); Robert Howse and Antonia Eliason, "Domestic and International Strategies to Address Climate Change: An Overview of the WTO Legal Issues," in Bigdeli, Cottier, and Nartova, eds., *International Trade Regulation and the Mitigation of Climate Change* (Cambridge University Press, forthcoming); and Andrew Green, "Climate Change, Regulatory Policy and the WTO: How Constraining Are Trade Rules?" *Journal of International Economic Law,* vol. 8, no. 1 (2005).

tion." A number of issues would arise in a defense based on that article as well. For example, past cases suggest that a dispute settlement panel would insist that there be a "sufficient nexus" between CO_2 emissions in the country challenging the tax and the consequences for the climate in the United States. If carbon leakage would be relatively small without a border adjustment (as some studies indicate would be the case), a dispute panel might conclude that the real reason for the border adjustment was not the prevention of carbon leakage but the protection of U.S. industry, which is not a valid justification under Article XX. The introduction to the article also requires that the "measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade." That phrase might be interpreted to require that border adjustments be reduced for imports from countries making efforts of their own to reduce emissions or for some developing countries.

Last, detailed sector or firm-level data on embodied carbon emissions could be needed to develop border adjustments because the WTO requires that producers from different countries be treated the same. Border adjustments based on sector averages have been found to be noncompliant in earlier WTO disputes.[11] If some or all of the allowances in the domestic cap-and-trade program were given away rather than sold, still other issues could arise. For example, they might be considered an actionable subsidy under the Subsidies and Countervailing Measures Agreement if a similar proportion of the permits required for imports were not given away.

11. See, for example, Appellate Body, United States—Standards for Reformulated and Conventional Gasoline, WT/DS2/AB/R (April 29, 1996).