Energy Security Initiative
at BROOKINGS





EQUITY AND EFFICIENCY IN CAP-AND-TRADE: EFFECTIVELY MANAGING THE EMISSIONS ALLOWANCE SUPPLY

Adele C. Morris

OCTOBER 2009
Policy Brief 09-05

Printed on 100% recycled paper and with environmentally safe inks

About The Brookings Energy Security Initiative

The Energy Security Initiative (ESI) is a cross-program effort by the Brookings Institution designed to foster multidisciplinary research and dialogue on all aspects of energy security today. ESI recognizes that public and private choices related to energy production and use will shape the global economic, environmental and strategic landscape in profound ways and that achieving a more secure future will therefore require a determined effort to understand the likely consequences of these choices and their implications for sound policymaking. The ESI Policy Brief Series is intended to showcase serious and focused scholarship on topical issues in one or more of these broad research areas, with an emphasis on targeted policy recommendations.

Contact for the Energy Security Initiative:

Lea Rosenbohm
Project Manager
(202) 797-6248
lrosenbohm@brookings.edu

EQUITY AND EFFICIENCY IN CAP-AND-TRADE:
EFFECTIVELY MANAGING THE EMISSIONS ALLOWANCE SUPPLY

This paper is the fouth in a five paper series on US cap-and-trade design

Adele C. Morris

Adele C. Morris is a fellow and Policy Director of the Climate and Energy Economics Project at the Brookings Institution. Her research analyzes the economic consequences of alternative policy options to address climate change.

The author gratefully acknowledges financial support from the Energy Foundation.

Introduction

A cap-and-trade system to control US greenhouse gas (GHG) emissions as proposed in recent draft legislation, for example in H.R. 2454, the American Clean Energy and Security Act (ACESA), creates a limited and declining number of emissions allowances each year (the "cap"). Each allowance is worth one ton of carbon dioxide (CO_2) or its equivalent in other greenhouse gases. The program requires firms with emissions that fall under the cap (the "covered entities") to surrender to the government enough allowances to cover their emissions. The cap declines each year in order to satisfy long-run emissions targets. For example, ACESA sets US emissions goals for 2020 and 2050 that are 17 percent and 83 percent, respectively, below 2005 levels.[1] To achieve the capped levels at least cost, the program allows firms to buy and sell allowances (the "trade" part of cap-and-trade), creating a market that induces the least-cost emissions abatement. The allowance market thus creates a transparent price for the right to emit greenhouse gases.

Policymakers are keenly interested in the likely effect of the cap-and-trade system on their constituents. This paper summarizes the economic literature on the "incidence" (a.k.a. the "distributional effects") of cap-and-trade climate policy, meaning all the ways people may be made better or worse off as a result of the policy.[2]

One often hears about how a particular climate policy approach might benefit corporations as opposed to individuals or vice versa. This paper takes the perspective of the economic literature, which examines the effects of climate policy on individuals and different categories thereof, not the effects on individuals vis-à-vis corporations. Only people can bear the costs and benefits of the program. Although the legal system treats firms as if they were people, the ultimate economic burdens and benefits of climate policy fall not on legal entities but on the owners of firms (shareholders), workers, consumers, and other individuals.

This paper considers the distributional effects of cap-and-trade across different sets of people, including consumers, shareholders, household income groups, and geographic regions, and it explores the role of policy design in determining those effects. The paper describes how the incidence of the program depends on how market forces transmit the costs of emissions abatement through the economy and how the program can

[1] For more discussion of the emissions targets themselves, see Mignone (2009).

[2] This paper focuses on the incidence of abatement policy within the US; the complex distribution of the global environmental benefits is important, but outside the scope of this paper.

create large transfers from one group to another, especially through the way the government doles out allowances. Finally, it explains how the allocation of allowances can lower or raise the overall costs to the economy by reducing other economic distortions or by inducing higher-cost abatement.

Section 2 of this paper reviews existing studies of the incidence of a cap-and-trade system and explains how and when market forces transmit the price on carbon from covered entities to consumers. Section 3 explains how the ultimate economic incidence of the program depends critically on how the government distributes the value of the allowances, either in the form of the allowances themselves or via the proceeds of allowance sales. Section 4 explores how the way in which the government devolves allowances can affect not only the distribution of costs but also the overall level of the costs to the US economy. It also examines other potential uses of the value of allowances, such as enhanced energy research and development funding. Section 5 concludes.

The Price on Carbon and the Economic Incidence of Cap-and-Trade

An allowance is the right to emit one ton of greenhouse gases. Because the government limits how many allowances it issues and every covered emitter needs them, the allowances are valuable. How valuable they are (their price) depends on how tight the limit is (the supply) and how costly it is to reduce emissions to avoid having to buy allowances (the demand). The allowance market will balance supply and demand at a clearing price known as the "price on GHGs," or more commonly the "price on carbon," since CO_2 comprises the lion's share of overall greenhouse gas emissions.

Like ACESA, most proposed cap-and-trade systems set emissions targets as a percentage reduction from a historical level of emissions. However, the actual reductions necessary to hit the cap depend on what emissions would have been without the cap. Economists use computerized economic models to estimate the likely emissions trajectory without the program, called the business-as-usual (BAU) or reference scenario, and the resulting abatement and costs necessary to achieve the target.

The overall distributional effect of the cap-and-trade program is the net result of two factors: the incidence of the price increases that result (i.e. who bears those prices and by how much) and the final disposition of the value of the allowances. This section examines the price effects, and the next section explores allowance allocation.

The Price on Carbon and the Cost of the Program

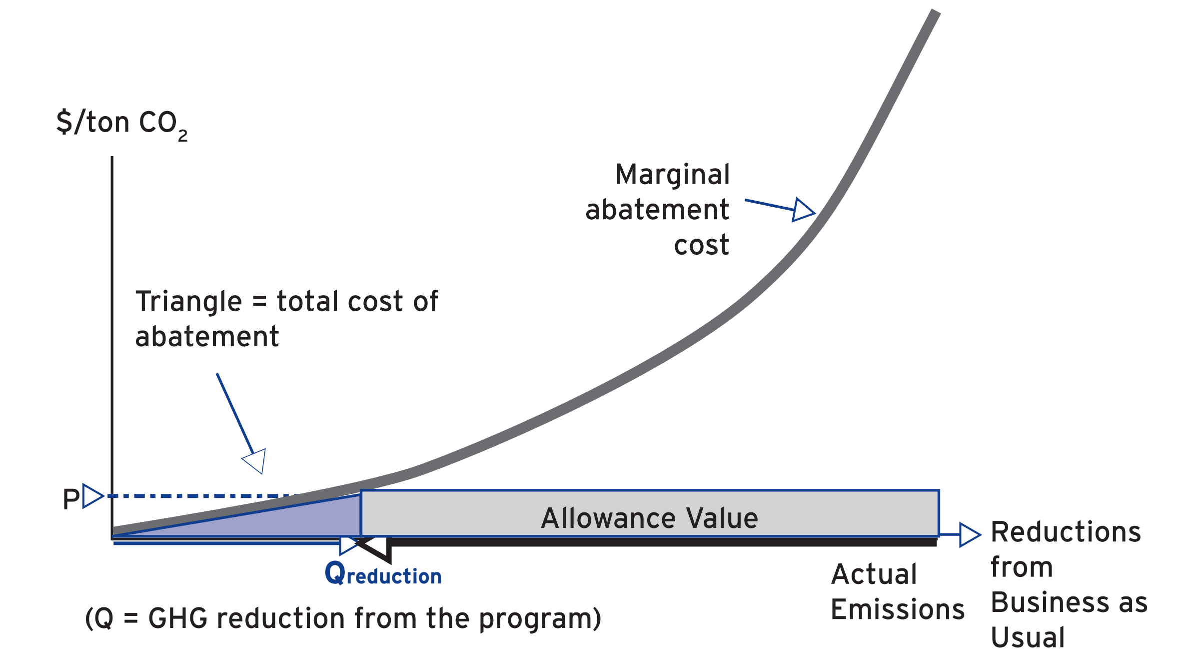
Figure 1 below illustrates how the cap-and-trade system results in an allowance price that achieves the abatement necessary to achieve the cap. The curve sloping up illustrates the marginal abatement cost curve in a given year for the emissions covered by the cap-and-trade system. The incremental costs of abatement start low for the first tons of abatement and gradually rise as emissions reductions relative to BAU increase, moving from left to right on the graph.[3] "Q" (shown by the arrow below the horizontal axis pointing to the right) represents the emissions abatement relative to BAU needed to hit the cap in a given year. The arrow pointing in the opposite direction indicates the emissions that are allowed under the cap in that year.

The market sets the allowance price at the marginal cost of abatement at the level of reductions

[3] Abatement supplied at a cost below zero implicitly appears in the reference scenario.

Figure 1

Abatement Cost and Allowance Value are Different



necessary to hit the cap, labeled "P" in **Figure 1**. The shaded triangle from the origin to Q shows the total abatement cost to hit the cap; it is the sum of the cost of abatement for all the tons leading up to the last one at Q. The rectangle labeled "allowance value" is the aggregate value of allowances: the price of allowances times their quantity.

Figure 1 shows that, depending on the level of abatement, the aggregate value of allowances (the rectangle) can be a lot larger than the overall costs of abatement (the triangle). The cost is a measure of what it takes to reduce emissions below BAU to hit the target, not the value of the remaining emissions that are allowed. We define "cost" as the overall cost to the US economy of abating emissions under the cap-and-trade program, not accounting for the environmental and economic benefits of protecting the climate.[4] Of course, the cost of not taking action could be enormous. Normally economists treat the avoidance of those costs as the benefits from mitigation. Thus one should not infer anything about the net benefits of the program from the focus here on its *gross* costs.

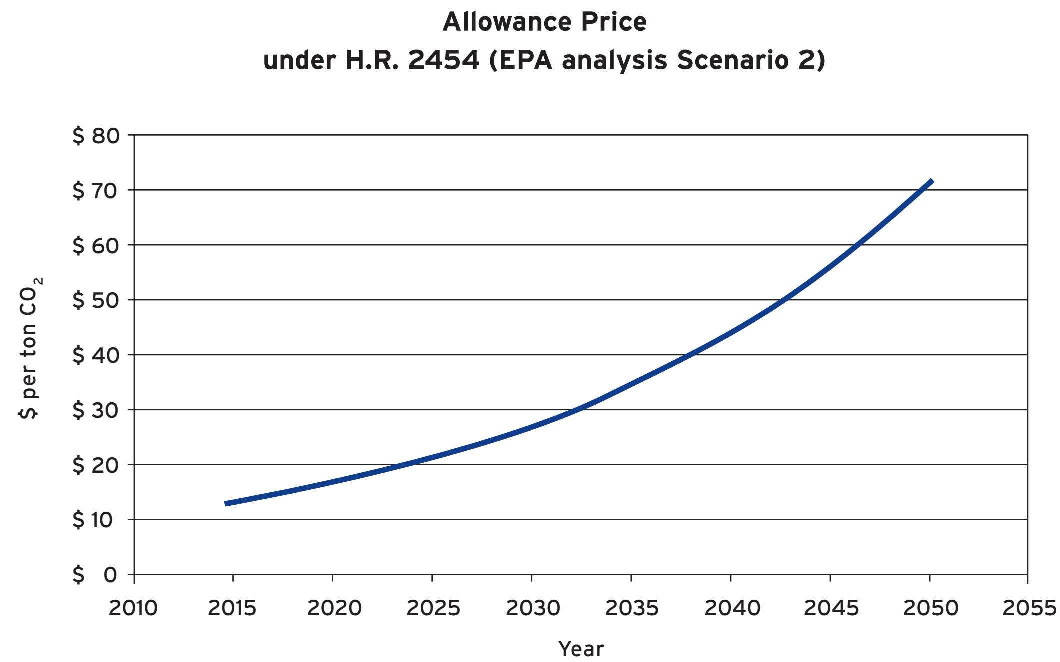
Over the life of the program, the carbon price will increase as the annual cap ratchets down.[5] **Figure 2** below illustrates the potential allowance price trajectory under ACESA as estimated by the EPA (EPA, 2009). It follows a smooth rate of increase because under ACESA firms can bank allowances in the early years to use in later years when the cap becomes tighter. The incentive to bank allowances depends on the alternative returns to capital locked up in allowances, and that governs the estimated growth path of the allowance price.

[4] The overall cost includes both the direct abatement costs as well as broader macroeconomic burdens that flow from the price on greenhouse gases. More discussion on that appears in Section 4.

[5] If carbon-free technologies emerge at a fixed marginal cost, price increases would eventually taper off.

Figure 2

Allowance Prices Rise over Time (source: EPA, 2009)



So who ultimately bears the price on carbon illustrated in the figures above? Listening to their Congressional testimony, you might think that the covered firms bear the full cost of buying the allowances they need.[6] However, economic analyses estimate that in the long-run they and other firms further down their supply chain will pass nearly all their costs to consumers through higher prices. Harberger (1962) pioneered the general equilibrium study of tax incidence, which considered not only what happens in the taxed sector but in all the ancillary sectors (that's what "general equilibrium" means). This shifting of tax burdens across sectors and economic actors is what economists mean when they talk about the transmission of "price signals" that result from the GHG constraint. Put another way, the *statutory* incidence of the cap-and-trade program is not equal to the *economic* incidence. Although entities facing regulation often conflate statutory and economic incidence when arguing for free allowances, the distinction is central to understanding the effects of the program on households and other stakeholders.

When the program goes into effect and gradually the annual caps fall, prices go up to reflect the increasing scarcity of the right to emit greenhouse gases. The overall increase in prices induces a burden equal to the shaded areas of **Figure 1**, which includes the total abatement costs and the value of allowances. Thus whoever gets the allowances or the revenue from a government auction receives a transfer from all the people paying the price on carbon.

Whether firms can pass through the entire cost of GHG regulation to their customers depends on how prices are determined in their market (e.g.,

[6] Here "firm" is shorthand for the owners of the firm, i.e. stockholders. Again, we focus on the distributional effects on *people*, not corporations – legal entities for which the concept of welfare makes no sense.

how responsive demand and supply are to prices) and the time frame under consideration. In the long-run, capital and labor are malleable and mobile. That means that factor markets will reallocate those resources in light of the new relative prices on fuels, energy, and everything else affected by the GHG constraint. Through this reallocation, competitive markets will pass the whole price signal along to consumers in higher retail prices for energy and other goods and services. Those higher energy prices are integral to the economic efficiency of the cap-and-trade program. They lower the cost of the program by inducing more efficient energy use and greater investment in developing energy-efficient technologies.[7] Some of these investments in energy efficiency could offer some of the lowest-cost abatement opportunities.

Under certain market conditions, such as monopoly power or exposure to unregulated foreign competition, output prices may go up by less than the full price on carbon even in the long-run. Fisher and Morgenstern (2009) explore the case of exposure to foreign competitors whose emissions are not constrained. Here we focus on domestic drivers of the incidence of climate policy.

Even if covered entities and other energy-intensive firms can eventually pass along all their climate policy costs in output prices, climate policy can affect shareholders and workers in the short to medium-run. Consider, say, coal or chemical producers, with highly specialized facilities and equipment. Even if they pass the price on carbon to their customers, they can be worse off because at higher prices they will sell less than they did before, meaning less revenue to cover their fixed capital costs. The owners of the firms can reallocate their capital over the long-run, but in the short to medium-run this is costly and time-consuming.[8] Likewise, workers with skills specific to coal mining or chemical manufacturing may be let go as output falls. They may have to retrain or move in order to find work, and their new jobs may pay less than their old ones. Even more likely, some occupations will simply not be growth fields, and new workers will move in other directions.

As global efforts to protect the climate ramp up, we expect emissions-intensive production to shrink substantially. But falling output in those markets doesn't necessarily mean those shareholders are hurt *over the long-run*. As output falls and capital is redeployed, the costs of production fall along with output. Unless stockholders were receiving above-normal profits, the capital deployed to the sector will fall without long-run damage to the returns to the last dollar still invested. The primary burden on owners of capital and workers in fossil industries will be from the adjustment costs they incur in moving to other sectors. Owners of capital that is completely immobile, such as coal deposits, will likely experience more than a transitional hit.[9]

The government can minimize adjustment costs by introducing the carbon constraint gradually and predictably, allowing time for efficient turnover of physical capital such as industrial plants and equipment. Key to reducing these adjustment costs is the formulation of credible long-run expectations around the price of carbon. A predictable phase-in also allows fossil energy workers and the labor market more generally to adjust through attrition and retraining, without the need for layoffs and displacement. Finally, the gradual ramp-up allows consumers to shift their consumption patterns, for example by purchasing

7 A more detailed discussion of the relationship between energy efficiency and energy prices is beyond the scope of this paper, but an extensive literature explores the "energy efficiency gap," the apparent underinvestment in energy-conserving technologies and practices.
8 Ho et al (2008) examine the dynamics of the incidence of climate policy on firms, from the very short-run to the long-run.
9 If carbon capture and storage technology pans out, coal production might not shrink.

more energy-efficient appliances as their old ones die a natural death. Thus the incidence of the program can depend on the timing of emissions reductions as well as their level. Lasky (2003) surveyed economic models and suggested that with 10 years notice before instituting a cap, consumers would initially bear between 94 and 96 percent of the allowance costs.

Despite the clear advantage to predictable policy, research indicates that even if the carbon constraint is unanticipated and firms incur capital adjustment costs, the share of the overall burden of the carbon constraint that falls to energy firm shareholders (relative to consumers) is likely to be small. Bovenberg et al. (2001) explain that a price on carbon can lower stock values by lowering profits and the stream of dividends as firms incur capital adjustment costs. The authors used a general equilibrium model of the US economy to estimate the share of cap-and-trade allowances that the government would have to give to firms in order for stock prices not to fall. They find that to keep oil and gas shareholders whole, the government would need to give them only 15 percent of the allowances needed to cover their emissions from those fuels, or the value thereof. Coal producers would need only about 4 to 5 percent. The reason that these firms need such a small share of the allowance value to preserve stock values is that they can shift most of the cost onto their customers, even from the start of the program.

As Viard (2009) points out, even if stockholders do experience a hit to their stock values from cap-and-trade, that by itself is not an argument for compensating them. As residual claimants, shareholders are affected by all sorts of tax, regulatory, and environmental policy changes for which they are not compensated. Moreover, one can argue that some have benefited from the existence of a market failure that is now being corrected.

So far, this discussion has focused on the losers. But just as owners of capital and workers in some sectors are made worse off in the short-run as a result of a price on carbon, those in certain other sectors, such as renewable energy, could be made better off. But importantly, the winners are only winners in the short to medium-run as well, because higher returns to capital attract new capital, which drives returns back down toward long-run equilibrium levels.

Although some will be made better off by the policy, the policy will have a net negative economic effect (again not counting environmental benefits). Broad measures of economic activity and welfare will be lower under cap-and-trade than under the reference case as a result of the real resource costs associated with abating emissions. The differential effects of the policy in different sectors will dissipate over the long-run.

The Distribution of Costs

Of course, we don't just care about overall macroeconomic costs. We also care about the distribution of costs across different household groups, in particular across different income classes and geographic regions. If a policy burdens lower-income households relatively more than higher-income households as a share of household income, then economists call the policy regressive. Economic research shows that the regressivity of a cap-and-trade program depends a lot on the definitions of burden and income. In general, lower income households spend a higher percentage of their income on energy and other goods whose prices will go up. That suggests a carbon price will be regressive. However, Hassett et al (2009) show that some of this regressivity disappears when the extra expenditure is measured against overall economic status over a lifetime rather than income in a particular year.[10]

[10] A good introduction to these issues is Parry et al. (2007).

Whether or not the carbon price is regressive, the lowest income households are least able to afford energy price increases. Often capital constrained, the poor may also be unable to avoid higher prices by investing in new energy-efficient appliances and windows and the like. Thus it is appropriate to consider ways to compensate poor households as part of the overall cap-and-trade system. For example, ACESA reserves 15 percent of the allowance value for transfer to low-income households. CBO (2009) estimates the effect on households' purchasing power as a result of ACESA. Dividing the results by income quintile, CBO found that the price on carbon was regressive; the lowest quintile faced the highest percentage loss of after tax purchasing power—about 2.5 percent. But after CBO included the value of allowances and other effects of the program on household income, the poorest quintile showed a potential net *gain* in purchasing power of 0.7 percent of after tax income. All other quintiles showed less than one percent drop in purchasing power.

The CBO report notes that some important effects on households derive from how higher price levels trigger changes in the incidence of other federal policies. For example, social security benefits and income tax schedules are indexed to consumer price levels. Thus the price on carbon can trigger higher cost of living increases in benefits and lower effective tax rates. This benefits some households, but all else equal, it can increase the federal budget deficit and result in higher tax burdens on future taxpayers.

Even if the burden on higher-income households is a relatively small share of their income, they will pay more of the total costs. Wealthier people use more energy and consume more emissions-intensive goods, like air travel and manufactured products, just as they consume more in general. Thus compensation that is directed primarily at the lowest income households isn't really compensating those who bear greater levels of burden. Rather, it's compensating those whose burden *proportional to their income* is higher.

People who tend to use more energy and energy-intensive goods and services will be more burdened by the program than those with more energy-lean lifestyles. This means, for example, that people who travel by air, drive long distances in large vehicles, own large leaky homes, and own old appliances will feel the pinch more than those who use public transport and live in energy-efficient housing. Of course, some patterns of consumption are easier to change than others, and different people will have different preferences and abilities to pay. All of those factors go into a consumer's "price elasticity of demand" for energy. Consumers that are "price inelastic," for example because they live in a rural area and must drive long distances to work and shop, will be burdened proportionately more than consumers who are "price elastic." Nearly everyone is more price elastic in the long-run than in the short-run. Given enough time (and certainty that higher prices are here to stay), we can change where we live, what we drive, where we work, and the equipment we use.

Some fear that areas of the US heavily dependent on coal for electricity will be hit much worse than other regions. But an analysis of the distribution of burdens across the country shows that households in different regions will likely bear similar burdens as a share of income. That is because people in different regions use different mixes of fuels to heat and cool their homes, and they also vary in their gasoline consumption. The Hassett et al study cited above indicates that these differences tend to even out the impact of the price on carbon. In other words, areas where electricity prices go up most may be areas where expenditures on transport fuels are relatively low. In addition, households in most regions consume similar baskets of non-energy goods, resulting in similar patterns of indirect energy consumption. However, the study estimates that a carbon tax could fall a little harder than average on households in Eastern Central states because of their higher overall fuel consumption as a share of income.

Another way in which the design of the program affects its distributional effects is in the treatment of offsets. Including offsets in the program can significantly lower the overall cost of the program (see EPA, 2009), by effectively widening the scope of the program to non-covered sectors, like agriculture and forestry. Providers of offsets could profit by undertaking abatement and selling the resulting credits to covered firms. The US economy, in turn, would achieve the cap at lower overall cost than if all abatement were achieved from abatement by covered entities themselves; households would be better off than they otherwise would be. But some offsets may produce unintended consequences. For example, if farmers take land out of production to plant trees to generate offset credits, they could lower food output and raise the prices of the crops the farmers would have otherwise produced. This may be a natural result of the land finding a higher and better use in raising terrestrial carbon stocks rather than crops, but it could affect the welfare of subsistence households.

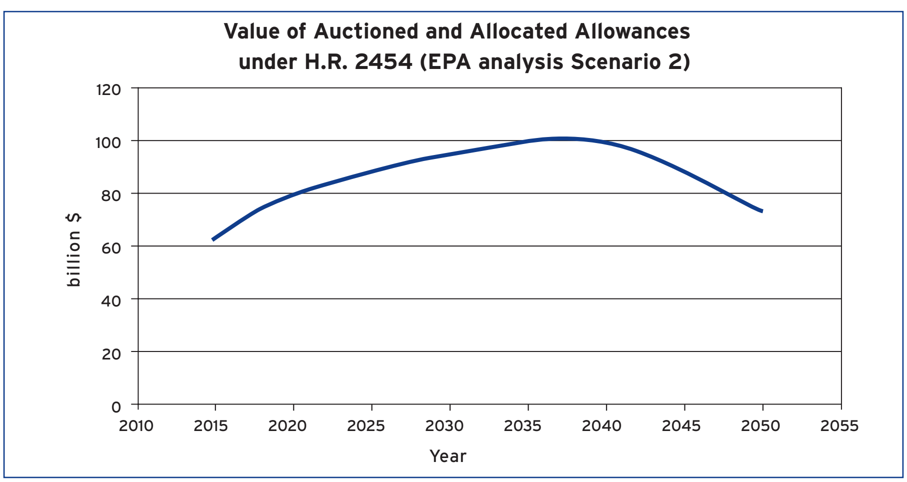
Allowance Distribution and the Incidence of Climate Policy

The distributional story is much more than the incidence of the price signal. This section explains how the final economic incidence of the program depends heavily on who receives the allowances or the revenue from an allowance auction. Since each allowance covers one ton of CO_2 emissions, all allowances will trade for the same price at a given time. Thus the total "allowance value" the government devolves each year is the prevailing price of allowances times how many it issues. The government can use the allowance value to address the regressive burden of the program, compensate those who bear the costs, or enrich those who don't. It can also raise or lower the overall cost of the program, as the next section explains. **Table 1** summarizes the options for managing the value of allowances, along with their distributional and economic efficiency effects.

The number of allowances hitting the market falls each year, and the price of allowances goes up. Thus the total value of allowances devolved each year changes over time. **Figure 3** below illustrates how the value of each year's allowance pool could evolve through 2050. The results come from the Environmental Protection Agency's analysis of ACESA (EPA, 2009). The graph shows that in the early years, the increasing allowance price drives up the overall value of allowances. As the cap ratchets down over time, eventually the lower cap dominates the higher price and the total value falls. The value peaks around 2040 at about $100 billion in 2005 dollars.

Figure 3

Illustrative Total Value of Allowances in a Cap-and-Trade Program (source: EPA, 2009)



Other studies suggest that both the allowance price and aggregate allowance value could be much higher than the EPA study suggests, depending on the design of the program. Using their economic model, MIT researchers studied three different possible caps (Paltsev et al., 2007). The caps correspond approximately to the range in stringency of three Congressional proposals. The most stringent bill they model was proposed by Senators Sanders and Boxer, and it included targets similar to the ones President Obama has supported. MIT's allowance value estimates ranged from about $100 billion to over $450 billion, depending on the stringency of the scenario and the timeframe. **Figure 4** below shows what the study found.

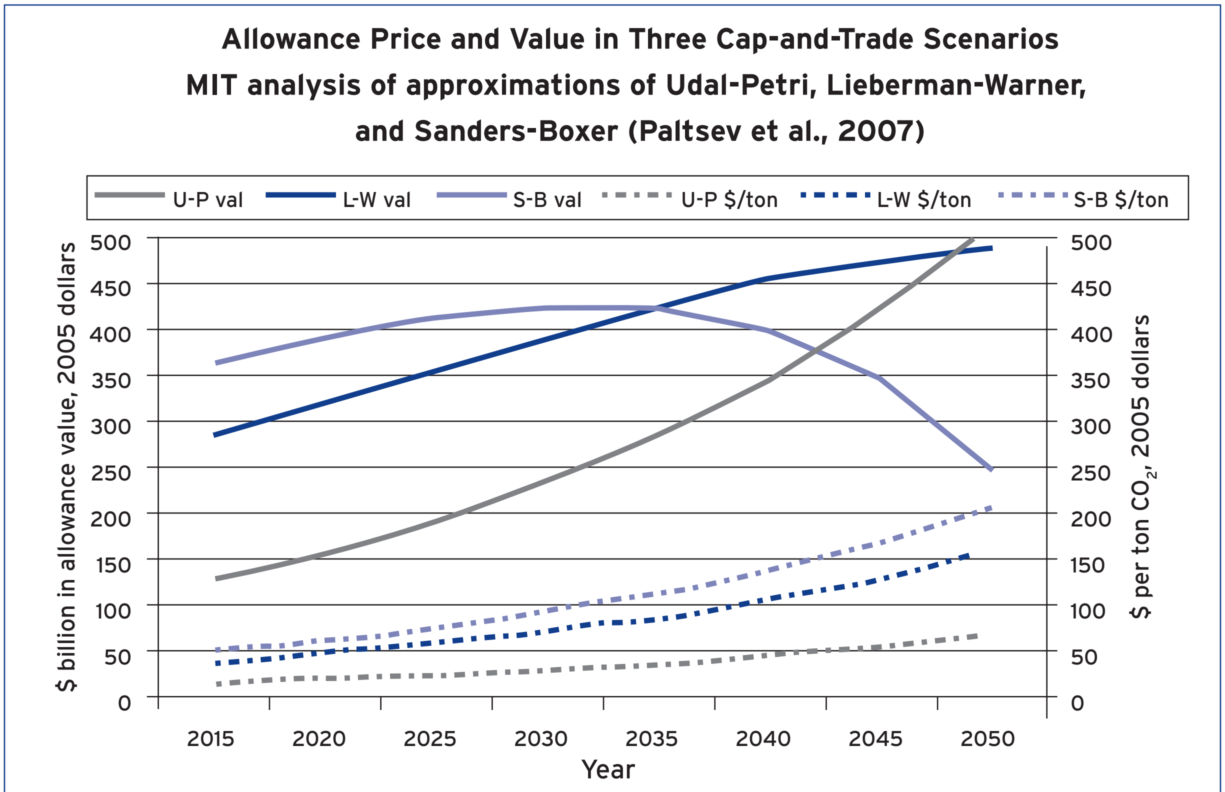
Comparing **Figure 3** with **Figure 4** illustrates how different cap-and-trade scenarios, analyzed by different models with different assumptions, can result in quite different estimated allowance prices and allowance values.

Section 2 described who bears the price on carbon and explained that the incidence of the price signal includes the cost of abatement and value of allowances. We saw that in the long-run, consumers will bear that burden through higher prices. It is tempting to stop there and think of this burden on consumers as the cost of the program. But the true net cost to the economy must account for the fact that somebody receives those higher prices. The share of the higher consumer prices that goes to acquiring allowances (the shaded rectangle in **Figure 1**) is not a cost to society overall, it's a *transfer*.

If the government auctions the allowances, the government receives revenue that it can spend or

FIGURE 4

Auction Revenue and Carbon Prices Depend on the Cap



rebate to taxpayers, for example by lowering other taxes or issuing dividend checks. The revenue represents a transfer from whoever bore the burden of paying for the allowances at auction (consumers, ultimately) to whoever benefits from the government revenue. This is a transfer that will likely redistribute income, but it doesn't incur real resource costs to the overall economy.[11]

Giving the allowances for free to firms will result in a different redistribution of income. Firms will receive both the allowances and the higher prices for their products that reflect the scarcity of the rights to emit. However costly to consumers, this represents a transfer and not a net cost to the economy. Shareholders will experience higher returns and consumers will pay higher prices, and the net result depends on each individual's mix of shareholding and consuming.

In contrast, the cost of abating emissions is a real resource cost, not just a transfer. The total abatement cost will be the sum of the costs of each successive ton of abatement—the sum of countless investments that will reduce energy use and lower emissions. These are the costs that are minimized through the trading of allowances, since firms that have higher abatement costs can purchase allowances from firms with lower abatement costs. Thus, the price people pay for allowances from the government affects the cost to those people, but not the overall burden on the economy. In particular, giving away allowances for free doesn't lower the overall cost of the program, and auctioning them doesn't raise the cost of the program.

This is such an important and underappreciated part of cap-and-trade design that it's worth a little more discussion. Regardless of who gets the emissions allowances, less total fossil fuels can be burned, and therefore the price of those fuels to consumers will be higher. It's like a quota, only it applies to all fuels, not just imports, and it applies to the carbon content of the fuel.[12] Usually, the whole point of a quota is to keep prices high to benefit producers. This is true both for import quotas and for agricultural quotas, such as the now-defunct US peanut program. By limiting how many peanuts could be grown, peanut quotas raised the price of peanuts to consumers. Just as free allowance allocations won't keep energy prices low, farmers did not charge different prices for their peanuts depending on whether they inherited or bought their quota rights to grow peanuts. In the case of carbon, as long as the "quota" on fossil fuels is binding, prices will go up regardless of how the government hands out those limited rights to use them.

In the first few decades of the program, the aggregate market value of allowances in each year's cap is higher, perhaps much higher, than the cost of the program. **Figure 1** shows this situation in theory; the area of allowance value is much bigger than the triangle of abatement costs. **Figure 5** below shows more results in the MIT study cited above. The solid lines are the same allowance values plotted in **Figure 4**. The dotted lines in **Figure 5** (same scale) are the measures of overall welfare loss from the program (again, not counting climate benefits), with the colors of the solid and dashed curves corresponding to the same policy scenario.[13] For the first decade or two of the program, the value of allowances is much higher than the welfare losses from the price on carbon. Eventually the cap becomes tighter and the real resource costs of abatement surpass the transfers of allowance value.

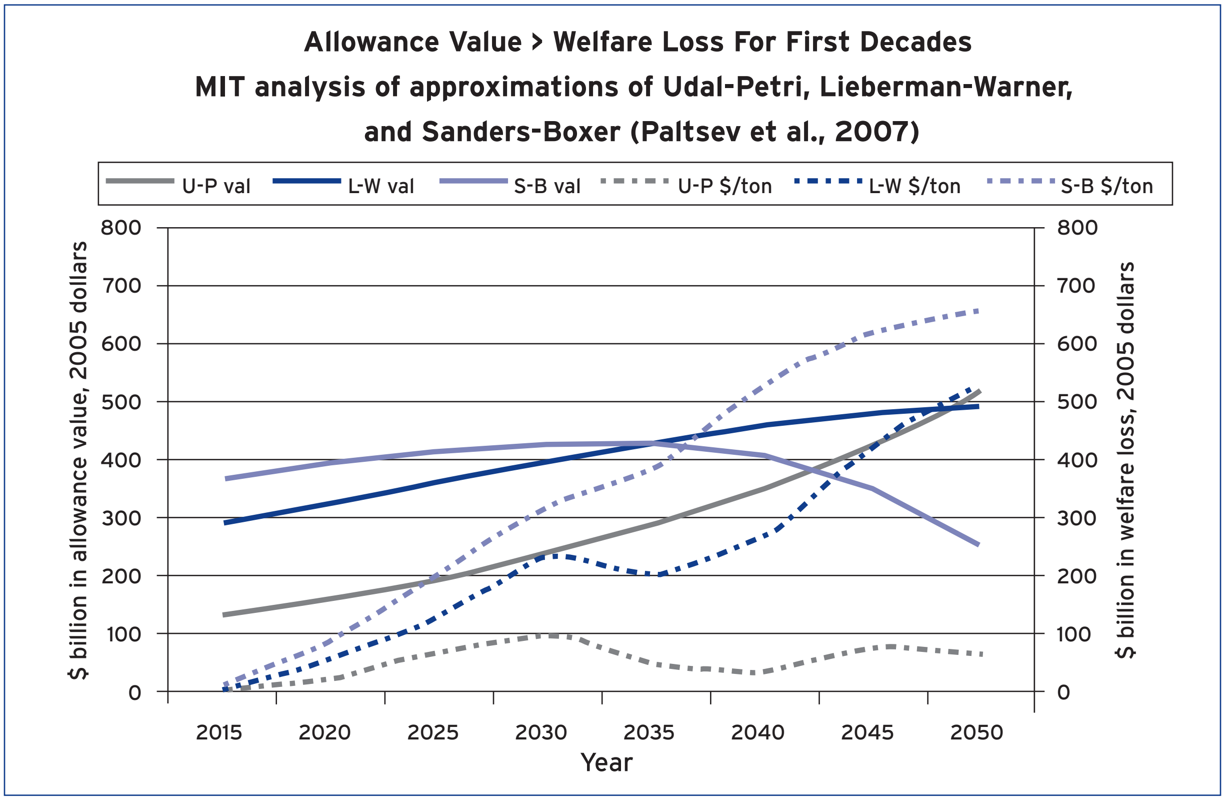
[11] Politicians and others often similarly blur the potential revenues from a carbon tax and its economic cost. The revenues are not net costs to the economy, but rather transfers from those who pay the tax to those who get the revenue.

[12] If someone can figure out how to use the fuels without releasing carbon (such as carbon capture and storage), then they can use all they want.

[13] Welfare losses are a broader measure of cost than the direct abatement costs in Figure 1.

Figure 5

Allowance Value and the Cost of the Program



The government has to decide how to divide up the rectangle in **Figure 1**, or the height of the curve in **Figure 3**. If it auctions all the allowances, then the total auction revenue will be the gray rectangle in **Figure 1**, and policymakers must decide how to use that revenue. If the government gives the allowances away for free (with no strings attached), then the recipients get the same total value in marketable assets. Either way, the secondary market for permits will trade at the indicated price, and the direct abatement cost will be the triangle in **Figure 1**.

Auctioning allowances offers several potential economic advantages. As Section 4 discusses, auctioning allowances raises revenue that can (but doesn't necessarily) reduce the deficit or other distortionary taxes, thereby lowering the overall cost of the program, perhaps dramatically. The government can also rebate the revenue to households, which can compensate them for the higher prices they pay. Auctioning also makes the transfers inherent in a cap-and-trade system more transparent and accountable, and it offers a simple way to implement a price floor on the allowance value because the government can set a reserve price at the auction.[14]

But free allocation also has its adherents, most notably covered entities and other energy-intensive

[14] If the price floor is high and/or auctioned allowances are a small share of the total cap, then secondary market prices could fall below the "price floor."

[15] Others support free allowance allocation to firms because they do not believe the government would use the auction revenue productively

industries.[15] Owners and workers in these firms will bear a small share of the costs in the short-run, but large or sustained allocations are likely to overcompensate them. The share they bear, and costs generally, can be reduced by beginning the program gradually and predictably. However, giving away some free allowances may gain industry support for the program. Aside from the relatively narrow competitiveness reasons cited in Fisher and Morgenstern (2009), there is little economic reason to allocate free allowances to firms other than to accelerate adoption of the program and thereby reduce the need for a more stringent program later. The substantial opportunity cost of free allowances in the form of forgone tax reforms and compensation for consumers would argue for minimizing the allocation of free allowances subject to actually implementing the program.

The way in which allowance value is distributed may create vested interests that make future policy changes difficult. For example, ACESA would over time reduce the share of allowances that is distributed freely to incumbent emitters and increase the share that is auctioned. This may be a reasonable compromise between full auction and full free allocation. However, experience from farm and other government programs shows that in fact it may prove politically difficult to reduce large transfers once they are begun.

In sum, the effect of the cap-and-trade program on the prices of energy and other goods and services will be the same whether the government auctions the allowances or gives them away with no strings attached. As Section 4 discusses, however, even if different ways of managing allowances produce the same price on carbon, they can affect the program's overall cost to the economy.

Allowance Allocation and Overall Program Cost

This section explains how the government's devolvement of allowances can affect not only the distribution of costs but also the overall level of costs to the US economy. First, the government can significantly lower the overall burden of the program by auctioning allowances and using the revenue to reduce other taxes or the federal debt, both drags on the economy. Using allowance value this way is called revenue recycling. Second, the government can increase the costs by devolving allowances in a way that incentivizes relatively high-cost abatement. This section examines both of these issues in greater detail.

The costs of a cap-and-trade program come in two parts. The first is the direct costs of abating emissions, which as Section 2 discusses, raises prices of energy and the other goods and services that embody energy or non-CO_2 greenhouse gas emissions (a large share of total goods and services). Direct abatement costs include the cost of more expensive fuels and the net cost of energy-conserving technologies and equipment. Higher prices lead to the other part of the costs.

The Tax Interaction Effect and Revenue Recycling to Lower Costs

Higher overall real price levels depress the returns to working and investing by shrinking the basket of goods people can buy with their earnings. Thus higher prices act like an income tax. Because income is already taxed (for example through income, payroll, and capital taxes), the cap-and-trade system introduces another distortion on top of the ones already there. This piling on of distortions, known as the "tax interaction effect," can be even more costly than the direct abatement costs.

The good news is that the revenue that the government can raise from auctioning allowances can offset the tax interaction effect by reducing other taxes. Taxes, in addition to raising revenue, cause what's called "excess burden." These are costs that arise from distortions in behavior that result from the tax. A simple example is the excess burden from a toll on a bridge. Some people pay the toll and cross the bridge. Others drive a longer distance to get where they want to go without crossing the bridge and paying the toll. The costs of that extra driving don't produce revenue, but they do burden the driver. That cost is the excess burden of that toll.

Income taxes reduce the returns to working and create a disincentive to work. Some people work slightly less than they otherwise would because that last hour of work just isn't worth it to them once they factor in the taxes. The higher the marginal tax rate, the tax on the last dollar earned, the greater the disincentive to work. This tax-induced disincentive to work results in a less-than-efficient amount of labor supply in the economy, and that inefficiency is costly. Likewise, taxes on capital income (like the corporate income tax), lower investment and that reduces future consumption below what it would have otherwise been.[16] The deadweight loss produced by the last dollar of revenue that a tax instrument collects is called its "marginal deadweight loss," and the size of the marginal deadweight loss can vary a lot across different kinds of taxes. Using revenue from allowance auctions in a way that reduces marginal tax rates reduces the excess burden of the fiscal system. This is called "revenue recycling," and it can greatly lower the overall cost of the program. Some estimates suggest that using allowance auction revenue to lower the deficit or other taxes can lower the overall costs of the program by 75% (Parry, 1997).

For it to work, though, revenue recycling has to be in the form of lowering tax rates, not just giving money back to households in a lump sum fashion. For example, the government could auction all the allowances, divide the revenue evenly across households, and send them all checks. But rebates like that don't reduce any of the existing distortions in the tax system, so they don't provide any efficiency gains to offset the tax interaction effect. The rebates are progressive and more than compensate the poor, but they won't lower overall costs.

The most efficient form of revenue recycling would offset the most distortionary taxes, meaning the ones that have the highest marginal deadweight loss. A number of scholars have examined this, but the tax system is so complex that economists have not identified one definite optimal policy.[17] Analyzing a 15 percent cut in emissions, CBO estimates that the downward hit to GDP could be reduced by more than half if the government sold allowances and used the revenues to lower corporate income taxes rather than to provide lump-sum rebates to households or to give the allowances away (Elmendorf, 2009). Parry and Bento (2000) find that efficiency gains are particularly large when revenue recycling lowers taxes that favor some kinds of consumption (such as housing or health insurance) over others. Feldstein (2006) argues that the distortions from the tax system are greater than most people realize, resulting in costs of about $.76 for every dollar the federal government raises. Without doubt, reducing those distortions can be an important way to lower the overall burdens imposed by the cap-and-trade system.

One complication of pursuing the most efficient revenue recycling could be the distributional results. Some of the most distortionary taxes are on high personal incomes and corporate income. So lowering those marginal tax rates is regressive, even while it provides the greatest efficiency gains and minimizes the cost of the program. Put another way, efficient recycling benefits poor households (who pay very little in taxes) proportionately less than rich households (who pay much more in taxes). Thus there's an intrinsic tradeoff between minimizing the cost of the program and making it distributionally neutral or progressive (Dinan and Rogers, 2002).

Using allowance auction revenue to reduce the federal deficit makes good economic sense. It reduces the future tax burdens necessary to finance and repay the debt. Reducing the federal deficit also increases current investment, because it reduces the competition for investment dollars from the federal government and the resulting upward pressure on interest rates.[18] It

[16] See Feldstein (2006) for more on the distorting effects of corporate income taxes.
[17] For a deeper discussion, see Goulder et al. (1999), Parry et al. (1999), Parry and Oates (2000), Parry and Bento (2000), and CBO 2007.
[18] See Rubin et al (2004) for a more complete discussion of the downsides to a large federal budget deficit.

also avoids some of the debates about who wins and who loses from a tax reform, since the beneficiaries of a lower deficit depend on what the tax system would have looked like in the future. However, allowance auction revenues probably cannot fully address the looming long-run fiscal imbalances from projected growth in Social Security and Medicare spending. That is because allowance revenues, as illustrated by **Figure 3**, will eventually drop off as the lower cap dominates the higher price of each allowance. They could be a growing source of revenues through 2030 to 2040, depending on the stringency of the program, but if caps become as stringent by 2050 as ACESA requires, revenues would drop significantly at that point.

One reasonable compromise would be a portfolio of efficiency-enhancing and equity-enhancing measures. The government could use some allowance revenues to lower payroll taxes (the taxes that fund Social Security and Medicare), some to benefit those without taxable earned income (students, retired people, and the poor), and some to reduce the deficit.

Allowance Allocations that Increase Costs

Recent proposed legislation would affect abatement and investment incentives in several ways, for several different purposes. ACESA would allocate free allowances to local electricity and natural gas distribution companies (LDCs) with the requirement that they use the value to benefit consumers. To the extent that the LDCs benefit consumers in a way that reduces consumers' inclination to conserve energy (for example, by lowering electricity bills), then this allocation scheme can raise the overall cost to the economy of achieving the cap. By reducing the abatement that would occur in the electricity sector, this approach drives abatement to more costly sectors.[19] This worsens the overall burden and could ultimately hurt the very consumers one may wish to protect. Burtraw (2009) points out other implications of this approach. Since state public utility commissions control how LDCs would pass along the free allowance benefit, then 50 different systems of redistribution could emerge.

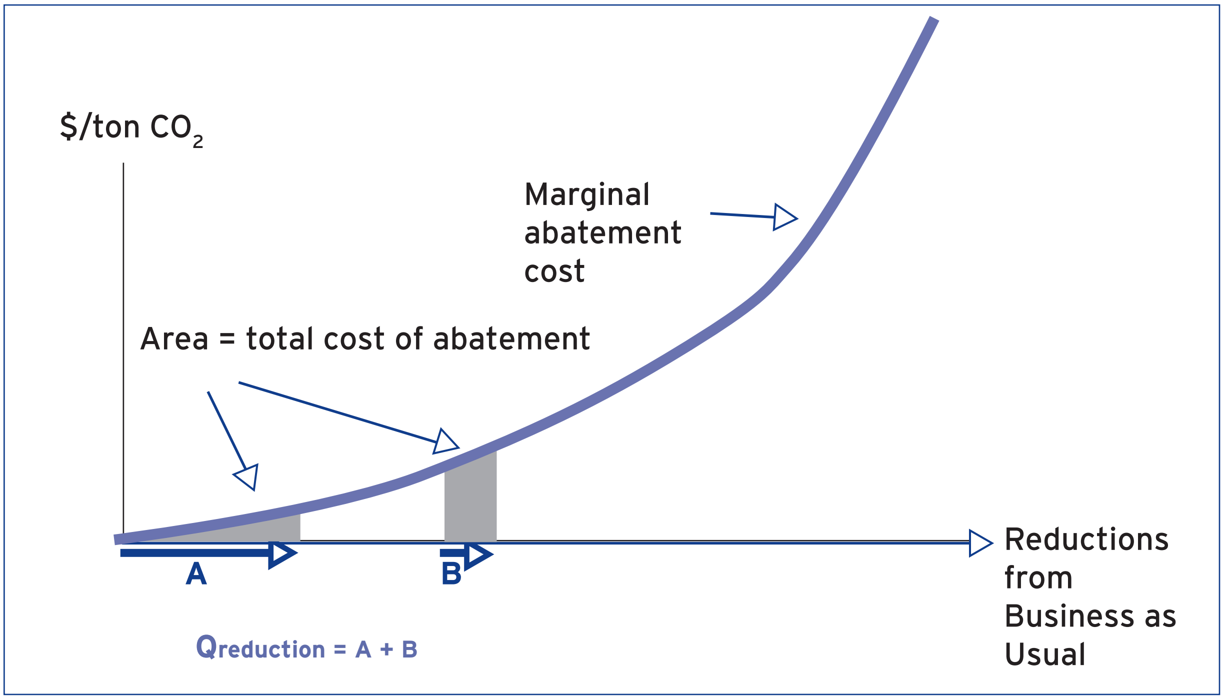
From a climate perspective, all abatement is created equal. Yet policymakers may opt to promote some kinds of abatement over others. They could use several approaches to do this, such as adopting a renewable electricity standard along with cap-and-trade (as ACESA does), directly subsidizing certain technologies with tax credits, or rewarding certain abatement with free allowances (as ACESA does for CCS). All of these approaches drive abatement in more costly directions than an unfettered allowance market. For example, Burtraw et al (2001) discuss three alternative allocation mechanisms and their resulting distributional impacts on consumers and producers. They show that if allowances are allocated based on a generation performance standard, then that subsidizes electricity production. This increases overall costs compared with allocation through auction.

Figure 6 below demonstrates what happens when the allocation system induces more abatement in higher-cost sectors. By moving some of the necessary reduction away from the origin, part of what would have been in the triangle is shifted further out; the total abatement stays the same, but some of it falls along higher parts of the cost curve. This is clearly inefficient. Either more abatement could be achieved for the same cost, or the same amount of abatement could be achieved for less cost.

[19] A similar effect could arise if allowances are distributed freely to price-regulated utilities if regulators do not allow the price signal of the carbon constraint to be passed through to retail consumers.

Figure 6

Abatement Cost Rises if Allowance Allocation Affects Incentives



ACESA would also give allowances to firms that undertake carbon capture and storage (CCS), whereby CO_2 is stripped from waste gases and stored underground indefinitely. By itself, the carbon price boosts the economics of generating electricity with CCS, but some are concerned that given its high development costs, CCS technology may not compete with, say, lower cost renewables. Economic efficiency would dictate that if other abatement strategies are cheaper than CCS, then those should be used to meet the environmental goals. Others argue that given the current state of the technology, it's not possible to tell how competitive CCS will be without further investment. Moreover, given the strong dependence of the electricity sector on coal (and the dependence of certain communities on producing it), it behooves us to invest in ensuring a future for coal by promoting CCS regardless of its current economic attractiveness.[20] The key is to find a way to invest in CCS without unduly distorting the efficiency of the allowance market.

Other Uses for Allowance Value

In addition to the auctioning and free allocations discussed above, the government can use the value of allowances for other purposes. For example, the government could use allowances to address potential competitive losses of domestic firms to firms in countries without carbon control (c.f. Fischer and Morgenstern, 2009). It could also direct auction revenues to international forestry projects (for example, to pursue additional abatement abroad), devolve allowances to states to distribute, or retain some of the revenue to cover administering the program and the federal government's own higher expenses on energy.

[20] In other words, the argument is that distributional concerns should trump efficiency.

In addition, the government could swap federal allowances for state or regional cap-and-trade emissions allowances as the new federal program replaces sub-federal programs. Finally, auction revenue could fund measures to help society adapt to climate change, both domestically and abroad. Current projections show the climate is likely to change further even at current concentrations of greenhouse gases, and adaptation will be an important strategy to limit the damages.

The value of individual allowances and the total cap are uncertain and will fluctuate over time as a result of changing supply and demand, so the formula for allowance earmarks is important. If the program earmarks the allowances themselves (or shares of the cap) for certain purposes, such as to offset firms' direct abatement costs or to fund research, then the dollar value of the earmarks could vary in ways that are unrelated to their purpose. Auctioning the allowances and appropriating the revenue as policymakers wish is arguably more rational, transparent, and accountable than free allocation.

Although most allowance earmarks forgo the revenue recycling benefits discussed in Section 4, some ways to use allowance value (or ordinary revenue) could help lower the long-run costs associated with stabilizing greenhouse gas concentrations. In particular, even with a price on carbon, the private sector is likely to under-supply basic research and development on energy-efficient and low-carbon technologies. That is because such research represents a "public good," a market failure in which the developer of a new technology cannot appropriate all of the associated social benefits and therefore invests less in it than would be socially optimal (Fischer and Newell, 2005).

The timing of allowance allocation can also affect the costs of the program. In particular, devolving some allowances that won't be valid until later years may lower costs by increasing the credibility of the program. People who hold these allowances (either from auction or from free allocation) are likely to support the implementation of the program, even its strengthening, since that would increase the value of their assets. A strong political consensus for the continuation of the program increases investors' confidence that the program will endure, and that strengthens incentives to invest in abatement and low-carbon technologies. Over the long-run this can lower the overall costs of achieving the environmental goal.

Conclusion

Serious climate policy can have large distributional effects, and a cap-and-trade system necessarily transfers wealth from those who bear higher energy and other prices to those who receive those prices and the value of allowances. In managing these distributional effects, the federal government must strike tradeoffs across many competing interests. Unless the system makes a concerted effort otherwise, consumers are likely to bear most of the costs. There are reasonable ways to compensate consumers, but there are important tradeoffs in how this is done. The overall cost to the economy could be up to 75% lower if the allowances are auctioned and the revenue used to reduce the federal deficit or other distortionary taxes.

Along with the carbon price, the value of free allowances (as a quantity or as a share of the total) will vary, making the earmarked benefits uncertain and opaque. A more transparent approach would be to auction allowances and appropriate funds for the same purposes. Perhaps the most costly approach is to distribute allowances in a way that dilutes incentives to reduce emissions, for example by subsidizing consumer electricity bills. It reduces incentives to conserve and requires greater abatement in more costly sectors to achieve the emissions cap.

A reasonable outcome could be a portfolio of efficiency-enhancing and equity-enhancing measures. For example, to help current consumers, the government could use some allowance revenues to lower payroll taxes (the taxes that fund Social Security and Medicare). It could use some revenues to benefit the poor and consumers without taxable earned income (students, retired people, and the poor). Policymakers could channel allowance value to the poor through direct rebates or by expanding existing programs that benefit the poor, such as the Earned Income Tax Credit. The bulk of the revenue could reduce the federal deficit, which lowers future tax burdens and improves the current investment climate. From a government accountability perspective, the disposition of allowance values should be subject to analysis and oversight no less rigorous than equivalent direct federal spending.

Table 1

A Simplified Summary of Allowance Revenue Options*

Revenue Use	Will it affect the cost of GHG regulation?	Progressive?	Compensating those who bear costs?
Lump sum rebates to households	No.	Yes.	Likely under-compensates higher income house-holds.
Reduce federal budget deficit	Lowers costs. Benefits largely accrue in the fu-ture from lower future tax burdens and greater investment now.	Maybe. Depends on struc-ture of future tax system and who benefits from higher investment.	Maybe.
Lump sum tax credits for workers	May lower costs, but only to the extent that it en-courages people to work who otherwise wouldn't.	Yes, especially if it's refundable to those with low earned income.	Likely under-compensates higher income house-holds.
Reduce payroll or labor income taxes	Yes, to the extent it encourages more work. Benefits could be substan-tial.	Depends on implemen-tation. Doesn't help the poor with no earned income.	Depends. Could under-compensate higher income households.
Give to utilities to lower electricity rates	Increases costs by blunt-ing incentives to conserve and driving abatement to costlier sectors.	Depends on how it's implemented by state util-ity regulators.	Yes for electricity con-sumers, but penalizes con-sumers of other energy.
Reduce capital taxes (corporate income tax or capital gains tax)	Lowers costs. Benefits could be substantial. Some think that using some $ for an investment tax credit may be even better.	Likely not; the evidence on the incidence of corpo-rate taxes is mixed.	Maybe.
Fund climate, energy, and adaptation R&D	Could lower costs if $ go to useful research the private sector wouldn't do otherwise. In large sud-den volumes it could bid up the price of research inputs.	No.	Maybe. Could lower costs of abatement in the future.
Reward selected abate-ment activities	Raises costs by reducing effort in lower cost but unsubsidized sectors.	No.	No.
Give $ to states or other sub-federal entities	Depends on what states do with it. Yes, if they reduce deficits or taxes.	Depends on what states do with it.	Depends on what states do with it.

* Provided at the risk of oversimplifying the rich and varied literature on the incidence and excess burden of different tax instruments.

References

Bovenberg, A. Lans and L. H. Goulder. 2001. "Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does it Cost?" in *Behavioral and Distributional Effects of Environmental Policy* (Carlo Carraco and Gilbert E. Metcalf, eds.) Chicago: University of Chicago Press.

Burtraw, D. 2009. Testimony at Climate Change Legislation: Allowance and Revenue Distribution: Hearing before the US Senate Committee on Finance, 111th Congress, August 4, 2009.

Burtraw, D., K. Palmer, R. Bharvirkar and A. Paul. 2001. "The Effect of Allowance Allocation on the Cost of Carbon Emissions Trading." Discussion Paper 01-30. Washington, D.C: Resources for the Future.

CBO 2009. "The Economic Effects of Legislation to Reduce Greenhouse-Gas Emissions," Washington, D.C.: Congressional Budget Office.

CBO 2007. "Trade-Offs in Allocating Allowances for CO_2 Emissions," Economic and Budget Issue Brief, Washington, D.C.: Congressional Budget Office.

Dinan, T. M. and D. L. Rogers. 2002. Distributional effects of carbon allowance trading: How government decisions determine winners and losers. *National Tax Journal* 55: 199-221.

Elmendorf, D. W. 2009. *The Distribution of Revenues from a Cap-and-Trade Program for CO_2 Emissions*. Testimony before the US Senate Committee on Finance, 111th Congress, May 7, 2009.

EPA 2009. Analysis of H.R. 2454 in the 111th Congress, the American Clean Energy and Security Act of 2009. Washington, D.C.: US Environmental Protection Agency.

Feldstein, M. 2006. "The Effect of Taxes on Efficiency and Growth," NBER Working Paper No. 12201, Cambridge, MA: National Bureau of Economic Research.

Fischer, C. and R. Morgenstern. 2009. "US Industry and Cap-and-Trade: Designing Provisions to Maintain Domestic Competitiveness and Mitigate Emissions Leakage," Energy Security Initiative Policy Brief 09-06. Washington, D.C.: The Brookings Institution.

Fischer, C. and R. Newell. 2005. "Environmental and Technology Policies for Climate Mitigation." Working Paper. Washington, D.C.: Resources for the Future.

Goulder, L. H., I. W. H. Parry, R. C. Williams III and D. Burtraw. 1999. The cost-effectiveness of alternative instruments for environmental protection in a second-best setting. *Journal of Public Economics* 72: 329–60.

Harberger, A. C. 1962. "The Incidence of the Corporation Income Tax," *Journal of Political Economy* 96: 339-57.

Hassett, K., A. Mathur and G. Metcalf. 2009. The incidence of a US carbon tax: A lifetime and regional analysis. *The Energy Journal* 30:155-178.

Ho, M. S., R. D. Morgenstern and J-S Shih. 2008. "Impact of Carbon Price Policies on US Industry." Discussion Paper 08-37. Washington, D.C.: Resources for the Future.

Lasky, Mark. 2003. "The Economic Costs of Reducing Emissions of Greenhouse Gases: A Survey of Economic Models," Technical Paper Series #2003-3, Washington, D.C.: Congressional Budget Office.

Mignone, B. K. 2009. "Emissions Targets in Cap-and-Trade: Choosing Reduction Goals Compatible with Global Climate Stabilization," Energy Security Initiative Policy Brief 09-02, Washington, D.C.: The Brookings Institution.

Paltsev, S., J. Reilly, H. Jacoby, A. Gurgel, G. Metcalf, A. Sokolov and J. Holak. 2007. "Assessment of US Cap-and-Trade Proposals," Report no. 146 of the MIT Joint Program on the Science and Policy of Global Change. Cambridge, MA: Massachusetts Institute of Technology.

Parry, I. 1997. "Reducing Carbon Emissions: Interactions with the Tax System Raise the Cost," *Resources*. Washington, D.C.: Resources for the Future.

Parry, I. and A. M. Bento. 2000. Tax deductions, environmental policy, and the 'double dividend' hypothesis. *Journal of Environmental Economics and Management* 39: 67-95.

Parry, I. and W. E. Oates. 2000. Policy analysis in the presence of distorting taxes. *Journal of Policy Analysis and Management* 19:603-614.

Parry, I., H. Sigman, M. Walls and R. Williams. 2007. "The Incidence of Pollution Control Policies." in *International Yearbook of Environmental and Resource Economics 2006/2007* (T. Tietenberg and H. Folmer, eds.). Northampton, MA: Edward Elgar.

Parry, I. W. H., R. C. Williams III and L. H. Goulder. 1999. When can carbon abatement policies increase welfare? The fundamental role of distorted factor markets. *Journal of Environmental Economics and Management* 37: 51–84.

Rubin, R., P. R. Orszag and A. Sinai. 2004. "Sustained Budget Deficits: Longer-Run US Economic Performance and the Risk of Financial and Fiscal Disarray," Paper presented at the AEA-NAEFA Joint Session, Allied Social Science Associations Annual Meetings, The Andrew Brimmer Policy Forum, "National Economic and Financial Policies for Growth and Stability," Sunday, January 4, 2004, San Diego, CA.

Viard, A. 2009. Testimony at Climate Change Legislation: Allowance and Revenue Distribution: Hearing before the US Senate Committee on Finance, 111th Congress, August 4, 2009.