Using the Market to Address Climate Change

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There is near-universal agreement among scientists and economists that climate is changing in ways that reduce economic well-being due in part to emissions of carbon dioxide (CO_2) during the combustion of fossil fuels. The price of these fuels does not reflect these effects, and this omission is a classic example of what economists call an externality. By definition, externalities are not corrected by the market—government intervention is required.[1]

Policymakers are discussing two forms of intervention to abate CO_2 emissions: carbon taxes and a cap and trade system. Both systems seek to reduce emissions toward their optimal level—the point at which the marginal benefit of burning fossil fuels equals the damage caused by its combustion. But this optimum is unknown and probably will never be known with a high degree of certainty. This uncertainty creates advantages and disadvantages for the two mitigation strategies that arise from the ways in which they reduce emissions.

Carbon taxes raise the price of fuels based on the amount of carbon they emit. Ideally, the tax rate is set by the marginal damage done by a unit of carbon emitted. Because this quantity is unknown, a carbon tax starts with a political decision about a tax rate per unit of carbon emitted. Emission rates vary for the different fossil fuels. One thousand BTUs of coal emit 26 grams of carbon, a thousand BTUs of oil emit 21.4 grams, and a thousand BTUs of natural gas emit 14.5 grams. Nonconventional fossil fuels, such as oil shale, emit even more carbon per BTU.[2]

Using these emission rates to tax fossil fuels changes their relative prices. Based on prices to U.S. electric utilities in 2007, a $100 tax on a ton of carbon emissions would raise coal prices by 14.6 percent, oil prices by 2.5 percent, and natural gas prices by 2.0 percent. (Surprisingly, even though natural gas emits less carbon than oil, the percentage rise in the prices of the two fuels is very similar. This is because natural gas is generally less expensive than oil, so a smaller nominal increase in price resulting from the tax can result in a larger percentage increase.)[3]

These price increases can lower energy use and carbon emissions in two ways. Consumers can reduce activities that use energy and emit carbon. Examples include driving fewer miles or turning down the thermostat for home heating (or raising it for air conditioners). Because this strategy lowers emissions by reducing activities that consumers enjoy, these actions often are considered a reduction in well-being.

A second strategy allows consumers to lower emissions while maintaining activity levels. This involves two forms of substitution. In one, consumers purchase more-efficient machinery or use more labor, which allows them to use less energy and hence

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emit less carbon. For example, buying a more-efficient car or installing insulation lets people maintain their driving habits or their comfort level while reducing emissions.

A second form of substitution, interfuel substitution, changes the mix of fuels away from those that emit large amounts of carbon per heat unit. Because a carbon tax raises the price of coal relative to oil or natural gas, consumers can reduce their energy costs and carbon emissions by substituting natural gas or oil for coal. Many industrial boilers, for instance, can switch among coal, oil, and natural gas relatively quickly.

The other major form of market intervention is a cap and trade system. As implied by its name, policymakers choose a cap or upper limit for the amount of carbon that can be emitted in a given period, most often a year. This cap is represented by an equal number of allowances. Individual allowances entitle the holder to emit a specified quantity of carbon. Allowances are then allocated to those included in the cap and trade system.

Allowances can be allocated using two general approaches. "Grandfathering" allocates allowances to emitters based on their emissions during some earlier reference period. Alternatively, allowances can be auctioned and sold to the highest bidder. These two mechanisms are not mutually exclusive—the U.S. cap and trade system for sulfur emissions made initial allocations using a combination of grandfathering and auctions. Once they are allocated, allowances can be bought or sold by participants.[4]

By issuing fewer allowances than the amount of current emissions, a cap and trade system forces individuals to make a simple decision: Should they reduce emissions and sell some allowances? Or should they buy allowances to cover all their emissions? The answer varies because the cost of reducing a unit of carbon emissions (by eliminating activities, using more energy-efficient machinery, or substituting among fuels) differs among individuals. If someone's cost of reducing emissions is less than the price of an allowance, the person will reduce emissions, sell a corresponding number of allowances, and make money by lowering emissions. If the cost of reducing emissions is greater than the price of an allowance, the person will buy allowances. Despite these purchases, the cost of compliance is typically less than a system in which all individuals are forced to lower emissions by a fixed amount or adopt a prescribed technology (known as a command and control strategy).

The price of allowances is determined by the market balance between buyers and sellers. When the market for permits is in equilibrium (the number offered for sale equals the number wanted by buyers), the market-clearing price will represent the marginal cost of abatement. In theory, the price for permits will be the same as the carbon tax rate that is required to reduce emissions by the amount specified by the cap. As such, carbon taxes are functionally equivalent to a cap and trade system, although the costs imposed by the latter are less visible, so a cap and trade system may be more politically palatable than a carbon tax.

But carbon taxes are not equivalent to a cap and trade system when it comes to real-world practicalities. One important difference concerns uncertainty. Because the price increase associated with carbon taxes is determined by the price per unit of carbon emitted, the increase is known at inception. What is not known is the quantity of emissions abated. This number is uncertain because economists have not quantified precisely how increases in energy prices affect energy demand—both directly via price elasticities and indirectly by altering rates of economic activity. These uncertainties are reversed by a cap and trade system. By printing a limited number of allowances, the quantity of abatement is known. Yet uncertainty about the cost of abatement and the effect of higher energy prices on economic activity makes it difficult to forecast the price of the allowances.

Recently policymakers have talked about reducing this uncertainty with a hybrid system. Under this scheme, cap and trade programs would have a "safety valve." When the market price for permits reaches a pre-established threshold, the government would sell an unlimited number of allowances at that price. This would in effect establish a backstop carbon tax—the price for allowances could not go beyond this maximum. But this hybrid approach would ease constraints on emissions and thereby introduce uncertainty about abatement.

The two systems also have different implications for inclusivity and costs. The number of consumers who will pay a carbon tax is likely to be greater than the number of consumers who buy and sell allowances in a cap and trade system. The efficiency of cap and trade depends in part on the technical sophistication of the participants and the cost of enforcement. Participants must be able to make economically rational decisions to buy or sell allowances and must have access to capital that would support economically rational investments to reduce emissions. These requirements imply that a cap and trade system is most likely to include only large energy consumers, such as manufacturers and electricity generators. A small subset of large emitters also reduces the costs of enforcement.

A cap and trade system is likely to have higher overhead costs. While carbon taxes can be implemented and collected through the existing infrastructure, cap and trade will require a monitoring system to ensure that those who emit carbon dioxide have the requisite number of allowances. To be efficient, there must be a market in which allowances can be bought and sold. Furthermore, firms will have to establish organizational structures that will allow them to participate in the program.

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Will these emissions be "grandfathered"?

This last set of costs may increase the effectiveness of a cap and trade system. Organizational structures for participation in such a system will have a mandate to quantify emissions and reduce them where economically effective. A carbon tax is less likely to generate such structures, and most firms do not have structures specifically aimed at evaluating options for reducing energy use. The lack of such structures may be one reason why the academic literature describes vast opportunities to save energy and money even though many of those opportunities go unrealized in the real world.

Finally, the way in which allowances are introduced highlights equity issues. If allowances are distributed free to existing emitters, these individuals or entities retain a property right, the right to emit carbon, that becomes valuable once the cap and trade system is implemented. As such, those receiving the allowances benefit. That property right and economic gain is confiscated by the government if emitters are forced to purchase their initial allocation. In this case, the government captures the economic value of this new property right. The capture of this property right lies behind the debate about whether the additional revenues raised by a carbon tax should be returned to taxpayers by lowering some other tax.

Even if permits are given away for free, equity issues arise regarding how they are distributed. If allowances are distributed based on previous levels of emissions, existing patterns are merely reinforced. That is, heavily polluting industries and affluent consumers have an advantage over newer industries or poorer individuals. Conversely, heavily polluting industries and affluent consumers bear the brunt of efforts to reduce emissions if allowances are distributed more evenly.

The relative magnitude of these advantages and disadvantages differs at various geographical scales. Equity issues associated with the initial distribution of allowances probably preclude a global cap and trade system. In an auction, consumers from industrial nations would largely outbid consumers from developing nations, and this would make it difficult for developing nations to expand their energy use, which is closely correlated with economic development. Conversely, a distribution scheme based on population would force significant reductions in existing emissions (or wealth transfer) from industrial nations, which would reduce their economic well-being.

For individual nations, a cap and trade system may be the most effective means for meeting emission targets. Equity issues are reduced because participants are drawn from a single nation, which minimizes differences in income, technical sophistication, or governance. In many nations, the population of large emitters is sufficient to justify the fixed costs of trading allowances.

A carbon tax probably would be most effective at the subnational scale, where the market may be too thin to establish a cap and trade system. Instead, the low overhead and wide incidence of a carbon tax would be consistent with the popularity of efforts that would be needed to generate climate change policy at a local level.

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