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Cap and Trade: Does it Matter How Companies Get the Permits?

Among the most contentious elements of the design of cap-and-trade systems for emissions trading is the allocation or assignment of the emissions credits themselves. Policy-makers are trying to satisfy a range of goals through the allocation process, including easing the transition costs for high-emissions firms, reducing leakage to unregulated regions, and mitigating the impact of the regulations on product prices such as electricity.

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In their paper "Regulation, Allocation, and Leakage in Cap-and-Trade Markets for CO2" (CSEM Working Paper #183), James Bushnell (University of California, Berkeley) and Yihsu Chen (University of California, Merced) develop a detailed representation of the U.S. western electricity market to assess ongoing plans for a cap-and-trade market for carbon dioxide (CO2). These markets are being developed under the dual initiatives of California's greenhouse gas reduction bill, AB 32, and the broader Western Climate Initiative (WCI), which encompasses 7 U.S. states and several Canadian provinces. Bushnell and Chen approach this question by using hourly data to build a simulation model that recreates the conditions of the electricity market throughout 2007. They then ask how the market would have differed in 2007 if various forms of carbon cap-and-trade had been in place. Specifically they examine the differences in the market if a 15% reduction in carbon emissions were required.

A key concern with the design of any cap-and-trade market is the potential for "leakage," the movement of production to regions outside of the cap. Bushnell and Chen assess just how much leakage one might expect from the electricity industry if a cap were applied to just California, or just the WCI states. If the cap were just applied to the "sources" of carbon emissions (e.g., the power plants themselves), the authors find that even with the extension of the cap to seven western states, almost one third of apparent emissions reductions would be offset by emissions increases in states outside of the cap. Figure 1 illustrates the changes in CO2 emissions by regions from an initial scenario of no cap in any region to a cap only in California and then as the cap expands to the 7 WCI states and finally to the entire western region of the U.S. This may overstate the problem somewhat, as there are plans to count the emissions impacts of power imports, as well as other sources within capped states. Bushnell and Chen plan to assess those proposals in future work.

The focus of this research is on the potential impacts of various proposals for the allocation of emissions permits. Several proposals involve the "contingent" or "updating" allocation of permits, where the allocation of permits is tied to the

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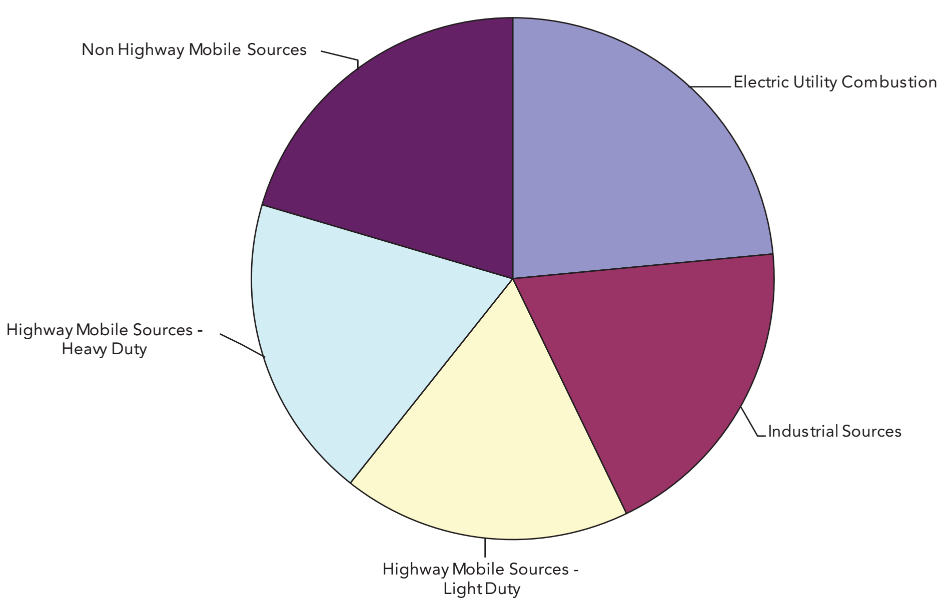
The Cost of Regulating Piecemeal

As environmental regulations become more stringent and compliance costs increase, regulators are under increasing pressure to rationalize - and minimize - the costs of meeting emissions reduction targets. There's usually more than one way to reduce pollution from any given source. And there's more than one way to reduce the same pollutant when it comes from different sources.

But, for a variety of reasons - jurisdictional, political, practical - different regulations are often applied to the same pollutant, particularly when it is emitted by multiple sources. Is this the most cost-effective way to reduce a pollutant? Can we use our scarce resources for pollution abatement more effectively if we take a broader approach to regulating a given pollutant? Three eminent energy researchers were intrigued with the situation where the man-made pollutant nitrogen oxides (NOx) face different regulations depending on the source of the emissions. Are we more heavily, and at a higher cost, regulating one source of NOx over another?

For decades, economists have emphasized the efficiency gains associated with market-based environmental policies, such as cap-and-trade. Indeed, the large-scale shift away from the more traditional "command-and-control" approaches for regulating air pollution from stationary sources, such as power plants, has largely been justified on these grounds. A similar transition to market-based policy instruments has not occurred for mobile sources of pollution such as passenger vehicles. Since the health and environmental damages caused by a specific amount of a given pollutant at a given location at a given point of time are generally the same regardless of the source of that pollutant, efficient regulation of the pollutant would equalize the costs of reducing the pollutant across sources. Very little research to date has evaluated how efficiently abatement activity is coordinated across regulatory programs and industry sectors. A new CSEM paper, "Sacred Cars? Optimal Regulation of Stationary and Non-Stationary Pollution Sources" (CSEM Working Paper #181) by Meredith Fowlie (University of Michigan), Christopher Knittel (University of California, Davis) and Catherine Wolfram (University of California, Berkeley) aims to measure the cost of separately regulating different sources of NOx emissions.

FIGURE 1: NOx EMMISIONS BY SOURCE



Source: National Emission Inventory (NEI) Air Pollutant Emissions Trends, http://www.epa.gov/ttn/chief/trends/

Nitrogen oxides (NOx) form when fuels are burned at high temperatures and can come from a variety of mobile and stationary sources. In 2002, prior to implementation of the two programs the authors study, motorized passenger vehicles were responsible for 18% of man-made NOx emissions, while electricity generation contributed 23%. (See Figure 1.) The authors measure the extent to which current U.S. environmental policy regarding NOx deviates from the theoretical optimum by comparing the marginal costs of reducing NOx emissions from power plants to the marginal costs of reducing NOx emissions from passenger vehicles. The authors compare the cost of reducing NOx under the Federal Tier 2 passenger emissions reduction program, which sets an exhaust emissions standard, to the cost of reducing NOx at power plants subject to the NOx Budget Program, which is a cap-and-trade program.

Fowlie, Knittel and Wolfram construct marginal cost estimates of reducing pollution for power plants using detailed engineering data and compare them to the marginal cost estimates for light-duty car and truck NOx reduction based on engineering analyses performed by the U.S. Environmental Protection Agency.

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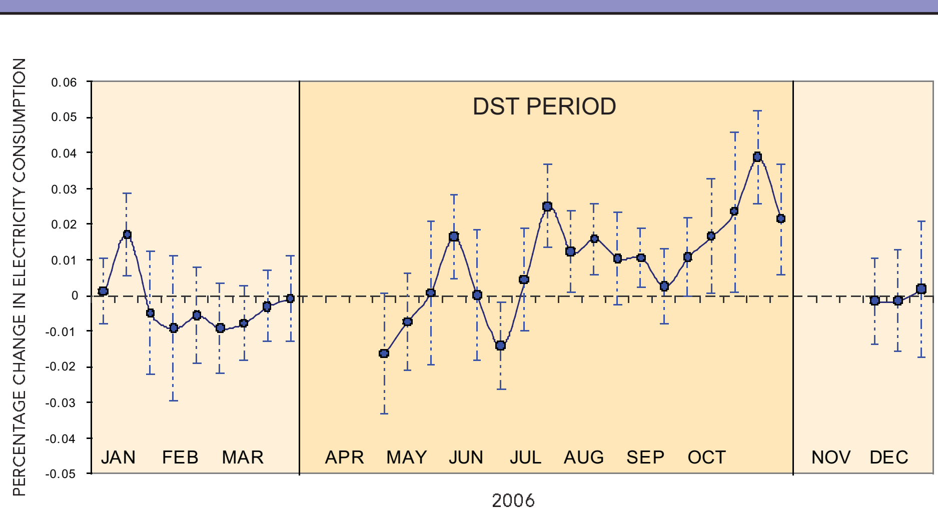
Springing Forward, Falling Back: Does it Save Energy? What We Can Learn from Indiana

Ever since Benjamin Franklin came up with the idea to move the clock back an hour in the summer, it has been assumed that such tinkering with time would save energy. Nevertheless, there is surprisingly little evidence that daylight saving time (DST) actually saves energy.

Given the widespread adoption of DST both within the U.S. and around the world, it is important to know if this policy actually achieves its claimed goals. Although there have been a few studies that try to test the energy savings assumption, none in the last thirty years have used actual U.S. household level electricity consumption data to see how electricity usage really changes under DST.

Professor Matthew Kotchen and Laura Grant at the University of California, Santa Barbara were able to take advantage of the unique history of DST in Indiana and a data set of monthly electricity bills for seven million Indiana households to test the impact of DST on electricity consumption. Prior to 2006, some counties in Indiana had not adopted DST, while others had implemented DST many years earlier. However, in 2005 Indiana approved a law that required all counties to adopt DST in 2006. In effect, this policy change created a "natural experiment" where the electricity consumption of households that suddenly went on DST in 2006 (the treatment group) could be compared to that of the households that had been on DST prior to 2006 (the control group). In their paper, "Does Daylight Saving Time Save Energy? Evidence from a Natural Experiment in Indiana" (CSEM Working Paper #179) Kotchen and Grant provide the first empirical estimates of DST effects on electricity demand in the United States since the mid 1970s. Another valuable feature of the research design is that they are able to estimate an annual DST effect and monthly effects throughout the year over the entire DST period, including the periods of transition.

FIGURE 1: DST IMPACT ON ELECTRICITY CONSUMPTION IN INDIANA
(ESTIMATES AND 95% CONFIDENCE INTERVALS)



Using sophisticated regression techniques, Kotchen and Grant were able to estimate the difference in electricity demand in 2006 for those homes that had always been on DST and those homes that had just adopted DST. The importance of measuring the actual change in electricity usage is it captures any behavioral changes in the households that may derive from going onto or off of DST. Getting up an hour earlier or an hour later may change how one uses electricity and comparing these two groups of households gives an estimate of what that change is. The researchers accounted for other influencing variables such as weather. Kotchen and Grant find that the overall DST effect results in a one percent increase in residential electricity consumption but that the effect is not constant throughout the period. In particular, DST causes the greatest increases in consumption later in the year, with October estimates ranging from an increase in two to nearly four percent. Note the generally insignificant change in consumption outside the DST time of year. (See Figure 1.)

Kotchen and Grant wanted to know more about the impact of DST on electricity usage; specifically, they wanted to know why DST caused electricity usage to rise. To find out, they ran simulations based on a U.S. Department of Energy simulation model of a building's energy demand. Using parameters representative of a single family residence in southern Indiana, they ran the model with and without the option to implement DST. From their simulation results, the authors are able to corroborate Benjamin Franklin's original hypothesis but discover that is not the

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A core strength of their paper is that the engineering data allow the authors to calculate not only the marginal cost of pollution abatement that corresponds with the level of NOx reductions mandated by the regulations they study, but also the costs of abatement options that provide too little or too much pollution reduction. With this cost information, the authors can create a "supply curve" of pollution reduction options for both mobile and stationary sources and estimate the efficiency losses from the current policy approach to regulating NOx emissions.

The researchers find that there is considerable scope for efficiency gains. In fact, they find significant differences in the marginal abatement costs with the marginal cost of reducing NOx emissions from cars less than half of the marginal cost of reducing NOx emissions from power plants. Their preferred estimates of marginal abatement costs suggest that inefficiencies amount to $1.7 billion, or nine percent of the total costs incurred to comply with both programs. These results highlight the importance of increasing the sectoral scope of cap-and-trade programs, a concept that is often met with considerable resistance. For example, the current framework for California's greenhouse gas cap-and-trade program excludes transportation and subjects it to a different regulatory program.

There are a number of reasons to believe that the authors' estimates are conservative. First, there is strong evidence to suggest that other mobile sources, such as on- and off-road diesel vehicles, have even lower marginal abatement costs than passenger vehicles. In addition, a market-based regulatory approach to regulating NOx emissions from passenger vehicles, such as a "NOx tax," might uncover a number of less expensive abatement strategies like driving fewer miles or retiring older vehicles. These lower cost regulatory options would increase the cost spread between the mobile and stationary sources of NOx emissions.

These findings are particularly relevant to the ongoing debate over how to design policies to address climate change. There is tremendous pressure on regulators to find ways to keep the economic costs of achieving proposed greenhouse gas reduction targets to a minimum. In theory, an economy-wide tax or cap-and-trade program should ensure that marginal abatement costs are equal across all sources of pollution. Several of the proposed pieces of climate change legislation would have point and mobile sources of greenhouse gas emissions regulated under the same market-based regulatory program. Others have argued that the transportation sector, which accounts for 27 percent of total U.S. greenhouse gas emissions, should be regulated separately from large stationary sources. This paper illustrates the potential for inefficiency when sectors and source types are regulated separately.

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whole story. They find that DST did decrease electricity used for lighting but it also increases usage of electricity for heating and cooling. The changes in average daily consumption are far greater for cooling than heating, which follows because air conditioning tends to draw more electricity and DST occurs during the hotter months of the year. Moving an hour of sunlight from the early morning to the evening (relative to clock time) increases electricity consumption for cooling because (i) demand for cooling is greater in the evening, and (ii) the build-up of solar radiation throughout the day means that the evening is even hotter.

Using these results, the researchers calculate that DST implies an average increase in electricity bills of $3.29 per household per year. Extrapolating to the entire state yields a cost of nearly $9 million per year in residential electricity bills due to DST. Since coal is the predominant source of electricity generation in Indiana, Kotchen and Grant also calculate that DST could be responsible for between $1.7 million and $5.5 million per year in social costs due to increased pollution emissions.

It is worth considering how the results from Indiana households might be generalized to other parts of the U.S. The fact that the researchers could identify the underling tradeoff between artificial lighting and cooling suggests that the DST effect is likely to be even stronger in the more populated, southern regions of the U.S. Further south, the days are shorter during the summer, meaning that the decreases in electrical use from lighting are likely to be smaller, and air conditioning is more common and intensively used, meaning that increases in electricity for cooling are likely to be bigger.

While there may be many other reasons to adopt or extend daylight saving time, this research indicates that energy savings is not a valid reason. In fact, this unprecedented research makes the case that DST can actually increase energy usage. In addition to this insight on the impact of DST on energy consumption, the Kotchen-Grant research illustrates the value of using real data to test and verify the impact of policy assumptions prior to their wholesale adoption. The availability of a "natural experiment" allowed the researchers to identify the impact of DST on electricity consumption. Natural experiments are hard to come by but given the invaluable insights they can provide, policymakers should consider implementing policy changes in such a way as to create a control group and a test group. This information would then allow for a factual analysis of the impact of the policy change and an objective measure of the success of the policy.

CAP AND TRADE: WHAT DOES IT MATTER HOW COMPANIES GET THE PERMITS?

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output, or in some cases fuel use, of plants. The allocations change as the market share of the output changes or as the relative fuel intensity changes. For example, if Firm A produces a larger share of the electricity market, then it will receive more permits.These allocation proposals are designed with the goals of limiting the pass-through of carbon costs to product prices, mitigating leakage, and mitigating both the costs of carbon-regulation to high-emissions firms and the windfalls produced by such regulations to low-emissions firms. Previous theoretical work indicates that by rewarding firm production with additional permits, "output-based" allocation can both mitigate leakage and reduce electricity prices. This is because the allocation process becomes, in effect, a subsidy of "local" electricity production. These subsidies provide firms with an incentive to keep their production local, i.e., within the cap, (mitigating leakage) and to try to increase their output, thereby lowering prices. As can be seen from Figure 2, carbon emissions in uncapped "non-WCI" regions increase dramatically (9 mmTons) under a WCI cap with no updating. In effect, without updating, the WCI cap provided strong incentives for leakage that were manifested in increased electricity production and emissions in the uncapped regions. CO2 emissions in the non-WCI regions drop when the WCI region cap involve either output- or fuel-based updating.

One concern with output-based allocation is that it greatly rewards low-emissions firms, while not doing much to ease the burden for high-emission firms. This is because the allocations are based upon megawatt hour (MWh) production, and not tied to the carbon intensity of that production. One way to address this would be to skew the awards of emissions permits more heavily in favor of plants using high-carbon fuels, such as coal. However, Bushnell and Chen demonstrate that allocation based upon fuel use can greatly inflate permit prices, thereby

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FIGURE 1: IMPACT OF EXTENDING CAP TO DIFFERENT REGIONS

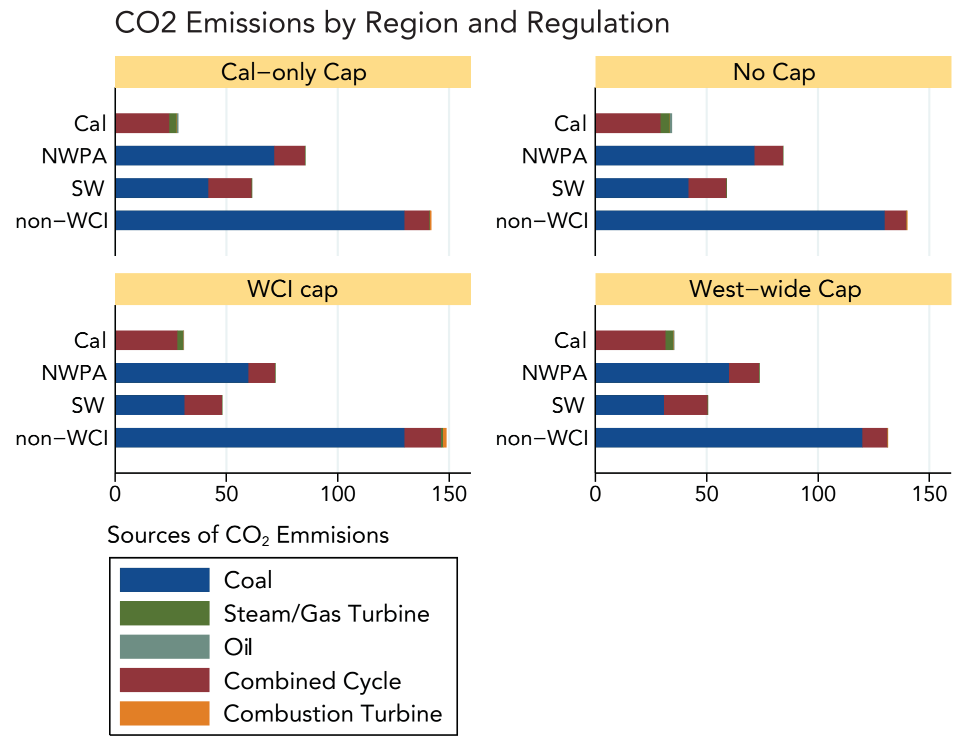
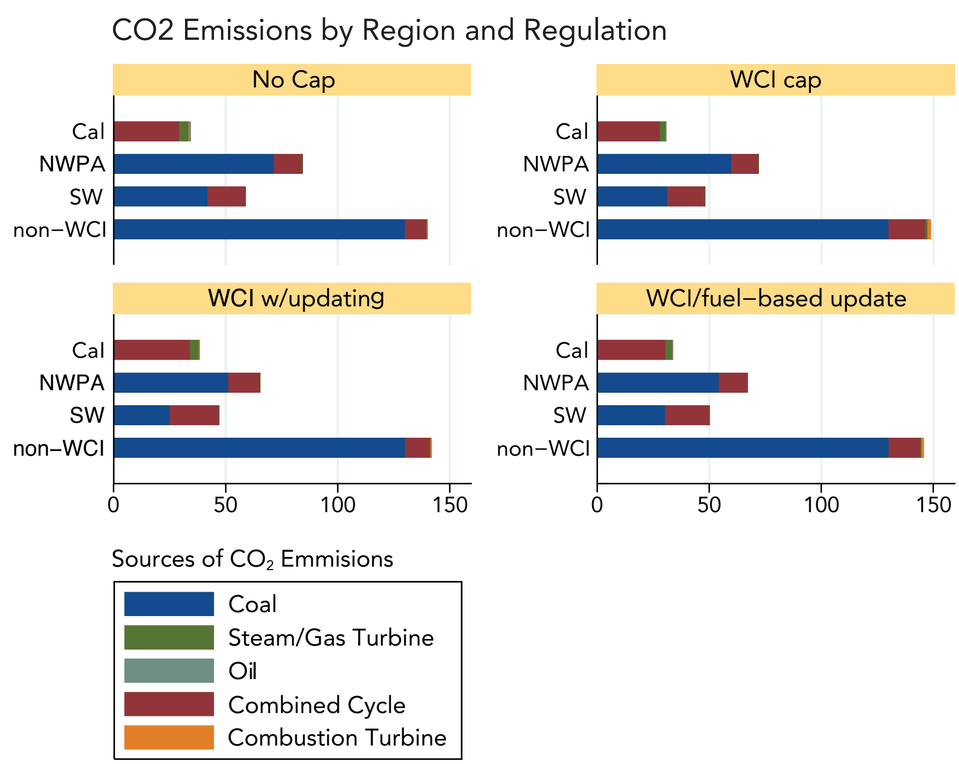


FIGURE 2: IMPACT OF UPDATING POLICIES



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limiting the benefits of such schemes to high emissions firms. Although coal-intensive firms such as Los Angeles Department of Water and Power and PacificCorp receive relatively more emissions permits under such an approach, they pay dramatically more for any additional permits they have to acquire to fully comply with the regional cap.

Bushnell and Chen perform an evaluation of the full impacts of the allocation proposals on the revenues, emissions and fuel costs of firms. Under fuel-based allocation, the net operating profit of high-emissions firms can actually be lower than under a 100% auctioning of credits. This is due to the fact that electricity prices (and therefore revenues) are lower under an allocation process but overall compliance costs are relatively comparable between an auctioning and an allocation process.

Overall, it is likely that policy-makers cannot achieve every goal with the single tool of emission permit allocation. Some of these goals, such as keeping electricity prices low and helping producers, are in conflict with each other. In addition, an allocation scheme that inflates permit prices for some firms, or some industries, but not for others risks skewing the distribution of carbon reductions across firms and industries. If allocations to the electric sector result in dramatically higher permit prices, for example, it is far more likely that firms will resort to purchasing "offsets" outside of the formal market rather than pursuing actual reductions within the capped industries. Bushnell and Chen argue that careful attention must be paid to the equilibrium effects of any allocation proposal. The "benefits" from more complex allocation schemes may be far less than policy-makers expect, while the negative impacts remain a serious concern.