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Distributional Impacts of Carbon Pricing Policies in the Electricity Sector

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Abstract

The introduction of a price on carbon dioxide will have important effects on the U.S. economy, and especially important effects on the electricity sector, which currently accounts for about 40 percent of carbon dioxide emissions. This paper examines alternative approaches to the distribution of allowance value to the sector, including free allocation to consumers through electricity and natural gas local distribution companies (LDCs). Recent proposals in the U.S. Congress, including H.R. 2454, have suggested this option as a way to address impacts on consumers and potential regional inequities. We compare allocation to electricity LDCs with a system in which allowances are auctioned and revenues returned to households as a per capita dividend. We evaluate the outcomes under alternative assumptions about how LDCs, which are regulated entities, pass through the allowance value to final residential, commercial, and industrial customers. Our results show that the LDC approach raises the price of allowances and imposes greater costs on households than the per capita dividend option. We also evaluate a more complete characterization of H.R. 2454 and show that an incremental reform to that bill would greatly reduce costs and have more balanced impacts across households in different income groups and regions.

Key Words: cap and trade, allocation, distributional effects, cost burden, equity, regulation, local distribution companies

JEL Classification Numbers: H22, H23, Q52, Q54

Contents

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I. Introduction

It is well-recognized that a carbon tax or cap-and-trade program will have its greatest impacts on the electricity sector, which currently accounts for 40 percent of carbon dioxide (CO_2) emissions in the United States. The sector is also a focus of concerns over the costs that climate policy will impose on households. An average household spends approximately $1,315 per year on electricity, which is 31.2 percent of total direct energy expenditures (for electricity, gasoline, natural gas, and heating oil) and 2.25 percent of average household income. In some regions of the country, these numbers are even higher, and for lower-income households the expenditures make up a considerably larger fraction of the annual income (estimates updated from Burtraw et al. [2009]).

These factors have led researchers, advocates, and policymakers to suggest a variety of approaches to reducing the impacts of climate policy on consumers and alleviating regional disparities. These approaches include assorted ways of redistributing the revenue from auctioned allowances under a cap-and-trade system (or revenue from a carbon tax) and alternative means of allocating allowances under cap and trade. Most recently, H.R. 2454, the Waxman–Markey bill, has proposed that allocation of some portion of allowances under a cap-and-trade system go to electricity and natural gas local distribution companies (LDCs) based on current patterns of consumption and emissions. LDCs are retail providers that distribute energy to homes and businesses and are responsible for billing consumers for all the costs of delivered energy. For electricity, these costs include the costs associated with generation, transmission, and distribution, and for natural gas, they include well-head costs, transportation, and distribution. Because they are regulated entities, the thinking is that LDCs will act as trustees on behalf of

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consumers and will use the allowance value to lessen the burden of climate policy. Under H.R. 2454, electricity LDCs would receive about 30 percent and natural gas LDCs 9 percent of the value of emissions allowances over the next decade. The allocation would phase out between 2026 and 2030.

If LDCs indeed act as trustees on behalf of consumers, then we can expect the electricity and natural gas bills that customers see under this approach to be lower than they would be in a full auction of allowances. The question, then, is how exactly the bills are affected. If the variable price of electricity is lower, then electricity consumption will be higher than in a full auction, and other energy sectors such as transportation and industry will have to pick up the slack.[1] The price of CO_2 in this case will be higher than in the full-auction scenario. This leads to higher prices for all goods and services, making it unclear whether households in any given region or income group are actually made better off or worse off as a result of the decision to subsidize electricity consumption through allocation to LDCs.

It is possible, though, that electricity LDCs will pass on the value to customers through a fixed charge component rather than the variable electricity price. This would preserve the marginal price signal, providing a stronger incentive to reduce electricity consumption, while in principle providing lump sum relief through lower electricity bills. Electricity bills have a fixed-cost component that covers the cost of providing service to a customer and a variable-cost component that covers the cost of acquiring electricity from the wholesale market, but the extent to which monthly bills actually separate fixed from variable charges varies around the country. In most jurisdictions, in fact, very little of the fixed cost is actually placed in a fixed charge; in cases in which fixed and variable charges are separated, the fixed charges are typically recovered on a volumetric basis. Bill reform would be necessary to provide billing that recovered fixed costs in a separate accounting from variable costs, but this is the domain of state public utility commissions. Moreover, even if fixed and variable charges were separated, it is a behavioral issue whether households and businesses would distinguish changes in the overall bill from changes in the marginal price.

These issues highlight the uncertainties that exist with the LDC approach to allocation. In this paper, we analyze the effect of LDC allocation on households across a variety of scenarios

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[1] Alternatively, there may be a greater reliance on offsets, which are emissions reductions that are achieved outside the sectors covered by the cap-and-trade program. We do not address issues related to offsets in this paper.

and behavioral assumptions. We assess the distributional impacts across 11 regions of the country and 10 income groups. We first look only at the 30 percent of the allowance value that is to be allocated to electricity LDCs under H.R. 2454, and we compare three alternative scenarios. In one case, we assume conventional electricity pricing and behavior for all customer classes. All consumers—residential, commercial, and industrial—receive the allocation of allowance value to LDCs as a reduction in the variable price of electricity over the full-auction scenario. In a second case, we assume that LDCs are able to entirely separate the fixed and variable charges for industrial and commercial customers and that these consumers respond rationally; residential customers, meanwhile, are assumed to perceive the reduction in the fixed charge (and commensurately in their overall bill) as a reduction in the variable price of electricity. We compare theses two cases to a third in which there is no free allocation to LDCs at all, but rather the value is returned to households as a per capita, nontaxable dividend.

We investigate whether the LDC approach does a better job of protecting low- and middle-income households and/or reduces regional disparities. We also analyze if the benefits from lower electricity prices are offset by the higher allowance price and impacts in other sectors. The results shed light on a familiar trade-off between distributional and efficiency goals in policy design and allow us to describe the efficiency cost of this attempt to address distributional concerns.

Finally, we focus more narrowly on the specific design in the proposed legislation H.R. 2454. In addition to the allocation to electric LDCs, we incorporate the 9 percent allocated to natural gas LDCs, the 1.5 percent to home heating-oil providers, and the 15 percent that goes to low-income households. Together, these features of the bill account for an additional 26 percent of emissions allowances to bring the total to 56 percent. We compare this approach to full auction and per capita dividend, and to a more incremental reform for H.R. 2454 that preserves allocation to LDCs for residential-class customers only.

Our analysis suggests that households on net are made worse off as a consequence of the LDC allocation policy compared to one in which the revenue is distributed directly back to households on a per capita basis. Assuming that commercial and industrial customers respond rationally to the fixed/variable distinction reduces the burden somewhat, but even in that case, the LDC approach is more costly to households than an auction-and-dividend option. We also note some interesting regional differences in results between the LDC allocation scheme compared with auction and dividend. Finally, we find that an incremental reform—allocating some allowances to LDCs based on residential consumption and the remainder as a per capita dividend—does a better job of achieving the distributional and regional goals of H.R. 2454 than does the approach in the bill, which allocates more to electricity and natural gas LDCs, home heating-oil providers, and low-income households. Moreover, our reform does so at a lower efficiency cost.

We hasten to point out that our analysis focuses on household consumption behavior and the impacts of carbon pricing that are felt through higher prices and expenditures, as well as the impacts of the allocation schemes. In fact, the latter is our focus here. However, we do not assess any general equilibrium effects, impacts on specific industries, and impacts felt through worker dislocations. We also do not consider the benefits of reducing CO_2 emissions and the distribution of those benefits across income groups and regions. Furthermore, we focus on annual income as a measure of ability to pay, rather than a measure of lifetime income.[2] In our earlier work, we used a measure of lifetime income (Burtraw et al. 2009).

In the next section, we briefly discuss other literature that has assessed the distributional impacts of climate policy. Following that discussion, we review the evolution in policy with respect to allocation of emissions allowances and provide the rationale behind the LDC approach given the current landscape of electricity regulation in the United States. Section IV describes our data and methodology, including the Haiku electricity market model used to assess impacts of carbon pricing in the electricity sector. Section V presents results with respect to general approaches to allocation. In Section VI we consider in more detail the Waxman–Markey proposal (H.R. 2454) as a case study in current policy. Section VII provides concluding remarks.

II. Literature Review

It is now fairly well-established that putting a price on CO_2 emissions disproportionately harms low-income households. Pricing CO_2 increases energy prices; while higher-income households tend to spend more on energy than do low-income households, they spend less as a fraction of income. Thus, low-income households tend to be harmed relatively more when energy prices rise. Even accounting for the indirect effect on nonenergy goods and services, this finding tends to hold (Hassett et al. 2009). Agreement on this point has contributed to a focus in recent years on the allocation of allowance value in a cap-and-trade program or distribution of revenues raised with a carbon tax or auctioned allowances. Findings in the literature now emphasize the importance of allocation to the overall efficiency and equity of the program.

[2] See Fullerton (2009) for a discussion of the various distributional aspects of taxes.

Dinan and Rogers (2002) find that distributional effects hinge crucially on whether allowances are grandfathered or auctioned and whether revenues from allowance auctions, or from indirect taxation of allowance rents, are used to cut payroll or corporate taxes or provide lump sum transfers to households. For example, they estimate that households in the lowest-income quintile would see their average after-tax income reduced by 6 percent under grandfathered allowances, while households in the top quintile would see a gain of 1.2 percent. Grandfathering tends to benefit high-income households because the value accrues to shareholders, who are primarily in the upper-income groups. This result was also found in Parry (2004) in a calibrated analytical model. In contrast, Dinan and Rogers (2002) find that if allowances are auctioned with revenues returned in equal lump sum rebates for all households, then the distribution of costs across income levels would be reversed. Households in the bottom quintile would see average after-tax income rise by 3.5 percent while households in the top quintile would lose 1.6 percent. Using auction revenues to cut payroll or corporate taxes is found to be regressive, though less so than grandfathering.

Metcalf et al. (2008) assess the overall impacts of three recent CO_2 tax bills introduced in Congress, assuming that revenues are returned as per capita dividends. They focus on the question of whether the tax is passed forward to consumers or borne in part by producers. Specifically, they look at three scenarios: one in which the burden of the tax is fully passed forward to consumers in the form of higher energy and product prices and two scenarios in which a share of the burden is borne by producers, that is, shareholders of firms.[3] The tax alone, assuming full forward shifting, is highly regressive, but returning revenues lump sum makes it progressive; households in deciles 1 through 6 are actually better off with the policy, while only the two highest-income deciles experience a net loss. Shifting the burden back to shareholders also reduces the regressivity of the tax, as shareholders are predominantly in the higher-income groups.

Metcalf (2009) assesses the impact of a CO_2 tax coupled with a reduction in payroll taxes. Specifically, he gives each worker in a household a tax credit equal to the first $560 of payroll taxes; this would be equivalent to exempting from the payroll tax the first $3,660 of wages per worker. Metcalf (2009) finds that this option leads to an outcome that is approximately distributionally neutral. He then analyzes an option that couples this rebate with

[3] The backward-shifting analysis is informed by runs from the MIT Emissions Prediction and Policy Analysis model. See Paltsev et al. (2007) for a description of the model.

an adjustment to Social Security payments that benefits the lowest-income households. This makes the CO_2 policy more progressive. Finally, he compares these options to a lump sum redistribution of the CO_2 tax revenues and finds that this last option is the most progressive of all.

Studies that also analyze the regional impacts of climate policy include Hassett et al. (2009), Boyce and Riddle (2009), and Burtraw et al. (2009).[4] Hassett et al. (2009) use data from the Bureau of Labor Statistics' Consumer Expenditure Survey (CES) for 1987, 1997, and 2003 and assess the impacts of a carbon tax if it were enacted in each of those years. They find that the direct component of the tax—the impact felt through direct energy consumption—is significantly more regressive than the indirect component—the impact felt through consumption of energy-using goods and services. They also find, as have several other studies, that the regressivity of the tax is muted when a measure of lifetime income is used rather than annual income. The authors find only small differences in the incidence of the tax across regions. However, they only look at impacts on average households in each region and not across income groups.

Boyce and Riddle (2009) assess the state-by-state net impact on households of a cap-and-dividend option in which the government auctions all CO_2 emissions allowances and returns the revenue as a per capita dividend. The authors estimate state-level impacts by adjusting national-level CES data on the basis of state-level income, an estimate of emissions intensity of electricity consumption in each state, and information on regional consumption patterns from Burtraw et al. (2009). The authors conclude that differences across states are relatively small compared to differences across income brackets. They find that within each state, for a program with a $25 per metric ton CO_2 (mtCO_2) allowance price, at least 60 percent of households receive net benefits, that is, the per capita dividends more than offset the impact of carbon pricing on expenditures.

Burtraw et al. (2009) assess the incidence of a cap-and-trade proposal similar to the Lieberman–Warner proposal (S. 2191), which results in a $20.91/mt$CO_2$ allowance price, with five alternatives for distributing the allowance value: two cap-and-dividend scenarios, one in which dividends are taxed and one untaxed, and three options that would change preexisting taxes: reducing the payroll tax, reducing the personal income tax, and expanding the Earned

[4] Pizer et al. (2009) also look at regional impacts but do not consider differences across income groups. Moreover, they look only at direct energy use; the other studies described here, as well as our own, include both direct and indirect energy consumption.

Income Tax Credit (EITC). The authors find that the cap-and-dividend options and the EITC alternative reverse the regressivity of carbon pricing. Reducing payroll or income taxes, however, exacerbates the regressivity. Regional differences are small for average households for all of the options but are significantly larger for lower-income households.

The recent debate and passage of H.R. 2454 have resulted in analyses from the Energy Information Administration (EIA; 2009), the Congressional Budget Office (CBO; 2009), and the Environmental Protection Agency (EPA; 2009). These analyses differ from the aforementioned journal articles in that they narrowly analyze only the provisions detailed in the legislation. The EIA, CBO, and EPA all used different models and different underlying assumptions in those models. The studies yield average costs of $134 (EIA), $175 (CBO), and $105 (EPA) per household in 2020. These cost estimates are for the national average household in the United States, with only CBO providing a breakdown of effects across the income distribution. CBO finds that households in the lowest-income quintile would see a net benefit of $40, with households in the highest quintile experiencing a net cost of $245.

III. Allocation in Cap-and-Trade Programs

The economics literature finds significant efficiency advantages from distribution of emissions allowances through an auction rather than free allocation. Some benefits are qualitative: an auction is administratively simple, it helps to maintain transparency and the perception of fairness, and it leads to more efficient pricing of goods in the economy, which reduces the cost of the policy (Binmore and Klemperer 2002; Burtraw et al. 2007). In contrast, especially in regulated electricity markets, free allocation can move consumer prices away from the marginal social cost of production and therefore distort resource allocation in the wider economy away from the efficient optimum (Burtraw et al. 2002).

Another forceful reason why economists favor the use of an auction (or an emissions tax) is that it generates funds that can be used to help reduce the cost of policy. One use of funds might be to invest in program-related goals such as energy efficiency (Ruth et al. 2008). The public finance literature has focused on dedicating the use of revenue from an auction to reduce preexisting taxes. Like any new regulation, climate policy imposes a cost on households and firms that acts like a virtual tax, reducing the real wages of workers. However, revenue from an auction, if dedicated to reducing other preexisting taxes, can reduce this cost. This so-called revenue recycling would have substantial efficiency advantages compared with free distribution (Bovenberg and Goulder 1996; Parry et al. 1999).

In practice, however, most previous emissions trading programs have distributed emissions allowances for free. The most well-known example may be the so-called grandfathering of allowances in the sulfur dioxide (SO_2) trading program initiated under the 1990 Clean Air Act Amendments in the United States. This program freely allocates emissions allowances to incumbent emissions sources based on a formula that multiplies heat input during a base period (1985–1987) by a target emissions rate (measured in tons per million British thermal units heat input). The allocation does not adjust over time, which avoids creating incentives for investment behavior to deviate from what is otherwise efficient. However, that rule leads to the result that facilities that retire continue to receive their allocation decades into the future.

Other trading programs that freely allocate allowances, such as the NO_x budget program in the United States, typically have such adjustments. Individual states determine the allocation of NO_x allowances and most have set-asides for new sources, while sources that retire lose their allocations. Adjustments in the allocation to new sources or to remove allowances from retired sources also have been common in the European Union Emissions Trading Scheme (Åhman et al. 2007). The downside of this scheme is that it can bias investment toward higher-emitting generating sources because of the value of the subsidy received (Åhman and Holmgren 2006). Furthermore, the removal of allocations from sources that retire provides a financial incentive to continue the operation of existing facilities that otherwise would retire.

The suggestion of free distribution through grandfathering to incumbent emitters without adjustment should be the most popular approach for industry because it awards an asset worth tens of billions of dollars. In the electricity sector, which is the focus of our study, such an approach would lead to substantial net profits (windfall profits) as a result of climate policy (Burtraw and Palmer 2008). This occurs because the increase in revenues associated with the increase in electricity price would greatly outweigh the increase in costs resulting from compliance with the program when emissions allowances are given away for free. Experience in the E.U. system also indicates that the net profits that resulted from free allocation to the electricity sector emerged as one of the most politically controversial aspects of the program.

Nonetheless, the suggestion of free distribution through grandfathering to incumbent emitters poses a dilemma that has divided opinions within the electricity industry in the United States. The industry is split into two camps along geographic lines that correspond to regulatory status. Before the 1992 Energy Policy Act, the industry was fully regulated for all services including generation, transmission, and distribution, and typically these services were delivered by a single vertically integrated firm in each service territory. Under regulation, electricity prices are set to recover total costs, and although exceptions abound, the rule of thumb is that prices are set at the average cost of service. That is, total costs divided by total sales should equal the average electricity price.

Since the mid-1990s, roughly half the nation has moved away from cost-of-service regulation to the use of market-based prices for generation services. In these regions—the northeast states, Texas, and to varying degrees parts of the Ohio Valley—generation costs are determined by the marginal cost of providing power in the wholesale power market. The marginal cost can vary significantly over the time of day and season of the year as different generation units are brought into service that have different fuel costs and different emissions rates for CO_2.

The way prices are determined varies greatly under these two market structures, and consequently the effect of grandfathered allowances on electricity prices varies as well. In a competitive market firms are expected to recognize the opportunity cost of using an allowance for compliance even if they received the allowance for free, and that opportunity cost should be reflected in the marginal cost of providing electricity. Hence, in market-based regions, the price of power should increase to reflect not only the resource costs of reducing emissions, but also the value of allowances that are used for compliance, even if those allowances were received for free.

A different outcome results in regulated regions, where allowances are added to total recoverable costs at their original cost of zero under grandfathering. Hence, in these regions the cost of service would increase by the cost of achieving emissions reductions through fuel switching, using more efficient facilities, and so forth, but the cost would not include emissions allowances. The value of allowances is several times greater than the resource costs associated with reducing emissions, so the exclusion of that value in electricity prices means that prices would increase by much less than if the firm had to acquire their allowances in an auction.

As a consequence of the differences in regulation and market structure in different states, the effect on retail electricity prices of climate policy using grandfathering varies across regions. In fact, the difference in the change in prices depends much more on the regulation that is in place than on the actual emissions intensity of electricity. Paul et al. (2009a) estimate the effect on prices from the introduction of an emissions cap in the electricity sector commensurate with the Lieberman–Warner proposal as modeled by the EIA (2008). They find an auction would cause electricity prices to increase by $7/MWh in 2020 on average (2004$), with regulated regions experiencing an increase of $6.10 and market-based regions experiencing an increase of

\$8.50. However, under grandfathering the change in prices on average for the nation would be just \$2.70. Prices would actually fall by \$1 in regulated regions compared to the absence of climate policy, while they would rise by \$9.90 in market-based regions.

The difference in the potential price increases of grandfathering has fueled a dissonance in the industry, with widely divided views about the merits of climate policy. Over the last couple of years an alternative proposal has emerged that provided a way out of this dilemma for the industry: free allocation to electricity consumers rather than to electricity generators. The proposal also appeals to consumer advocates, and won the endorsement of the National Association of Regulatory Utility Commissioners (April 21, 2008). Free allocation to consumers could be achieved by allocating not to generation companies, which are the historic emitters, but to the LDCs that deliver retail power to households and businesses. These companies are regulated throughout the nation and charge electricity prices that are a combination of expenses incurred from purchasing generation and transmissions services and their own costs of distribution. Since these companies are regulated, they might be expected to act as trustees on behalf of customers and to pass on, in some form, the value of emissions allowances they receive for free. This proposal has emerged as a key piece of proposed legislation, including the Waxman–Markey proposal (H.R. 2454).

In effect, free allocation to LDCs looks like grandfathering for regulated regions of the country, because the value of CO_2 allowances is not reflected in prices in these regions under grandfathering. Moreover, this effect is carried over to market-based regions under free allocation to LDCs. Paul et al. (2009a) indicate that free allocation on the basis of population served by the LDCs would lead to no increase in electricity prices in regulated regions and to an increase of just \$1.80/MWh in competitive regions, with national average electricity prices increasing by just \$0.60/MWh by 2020. This difference in the change in prices is broadly consistent with the emissions intensity of generation in these regions, and hence would seem to offer a consistent economic signal.

A problem, however, is that the economic signal that is offered is weakened and does not provide adequate information about the opportunity cost of CO_2 emissions to electricity consumers. The award of free allowances to LDCs constitutes a subsidy to electricity consumption, resulting in lower prices and greater levels of electricity use. Consequently, other covered sectors are required to make additional, less efficient, reductions. For the same emissions, this raises the price of emissions allowances by roughly 15 percent (Paul et al. 2009a).[5] Ultimately LDC allocation provides both advantages and disadvantages that must be well understood and balanced if it is to be used.

The second issue associated with allocation to LDCs is how to determine the apportionment among LDCs of the allowance value to be distributed. Paul et al. (2009a) consider three possible metrics with apportionment on the basis of population, emissions, or electricity consumption, and they find that this choice can change the price impact in various regions by over $10/MWh. For example, regions that have relatively high population and relatively low emissions, such as California or the Northeast, would benefit from allocation on the basis of population, while regions with relatively high emissions would prefer allocation on the basis of emissions. These large regional effects are an important determinant of a national compromise.

The third issue associated with allocation to LDCs is exactly how they can be expected to act on behalf of consumers. The estimates are built on the assumption that the award of allowance value would be used by the LDCs to reduce the electricity price, which leads to expanded consumption. However, the way that the value is used will be determined at the state level, where public utility commissions have the prerogative to determine electricity rates for cost recovery of the LDCs. Language inserted into the Waxman–Markey legislation, which we discuss below, would attempt to ensure that all customers are treated fairly, or to get around the expected increase in electricity consumption associated with lower prices by directing value to be applied to reducing the fixed costs rather than variable costs in some cases. Whether this is plausible, and how that might be implemented, is an open question that in practical terms appears beyond the reach of Congress. Consequently, the outcome of allocation to LDCs is uncertain, and we explore the possibilities in our simulation analysis.

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[5] The EIA has targeted this provision in H.R. 2454 as both lowering the direct energy costs households face while simultaneously increasing the cost of the program. “The analysis shows that the free allocation of allowances to electricity and natural gas distributors significantly ameliorates impacts on consumer electricity and natural gas prices prior to 2025, when it starts to be phased out. While this result may serve goals related to regional and overall fairness of the program, the overall efficiency of the cap-and-trade program is reduced to the extent that the price signal that would encourage cost-effective changes by consumers in their use of electricity and natural gas is delayed” (EIA 2009).

IV. Data and Methodology

We base our analysis on CES data from 2004 through 2006. The population sampled in the CES includes 97,519 observations for 39,839 households; an observation equals one household in one quarter. We use these observations to construct national after-tax income deciles, but since we are interested in regional analyses we examine the CES data with state-level indicators. This leaves us with a sample for examining regional effects that includes 82,033 observations for 33,234 households in 43 states plus the District of Columbia. We aggregate the observations into 11 regions (the 21 regions in the Haiku model are mapped into these 11 regions). Although observations with missing state identifiers are not used in our regional-level calculations, they are included in our calculations at the national level.

We account for direct energy expenditures and indirect expenditures through the purchase of goods and services.[6] We focus the analysis on 2015, assuming that consumption patterns are the same as in our data period with two exceptions. One is personal transportation; we account for changes in the vehicle fleet expected to result by 2015 from the 2007 Energy Independence and Security Act. In addition, we allow for technological and economic changes in electricity markets that are expected by 2015. Our electricity consumption patterns are obtained from Resources for the Future's Haiku electricity model. The Haiku model solves for electricity market equilibria in 21 regions of the country, accounting for price-sensitive demand, electricity transmission between regions, system operation for three seasons of the year (spring and fall are combined) and four times of day, and changes in capacity investment and retirement over a 25-year horizon (Paul et al. 2009b). The Haiku model also captures differences in the regulatory environment across regions and allows us to model different behavioral assumptions corresponding to fixed and variable charges for residential, commercial, and industrial customers, as we explained in the introduction. Table 1 reports the electricity sector results for the 11 regions of the country that we model, with an indication of how states are aggregated into these regions.[7] National baseline emissions of 0.596 tons of CO_2 emissions per megawatt-hour reflect model results for 2015 in the absence of any climate policy. After the introduction of an emissions cap leading to a price of \$20.91/mtCO_2 (2006\$), the allowance price for 2015 predicted by EIA (2008) to result under the Lieberman–Warner proposal, emissions fall to 0.492

[6] Indirect consumption accounts for approximately 49 percent of an average household's carbon emissions.

[7] The 48 contiguous states and the District of Columbia are included in the electricity modeling, but as noted five states (Iowa, New Mexico, North Dakota, Vermont, and Wyoming) are dropped when calculating effects on households at the regional level. However, national estimates always include these five states.

tons/MWh. Table 1 also reports the change in electricity price on a regional basis and the change in consumption that is expected to result from the introduction of the price on CO_2 emissions.

Table 1. Haiku Modeling Results for 2015 under a Baseline and with the Introduction of a Price of $20.91/metric ton CO2

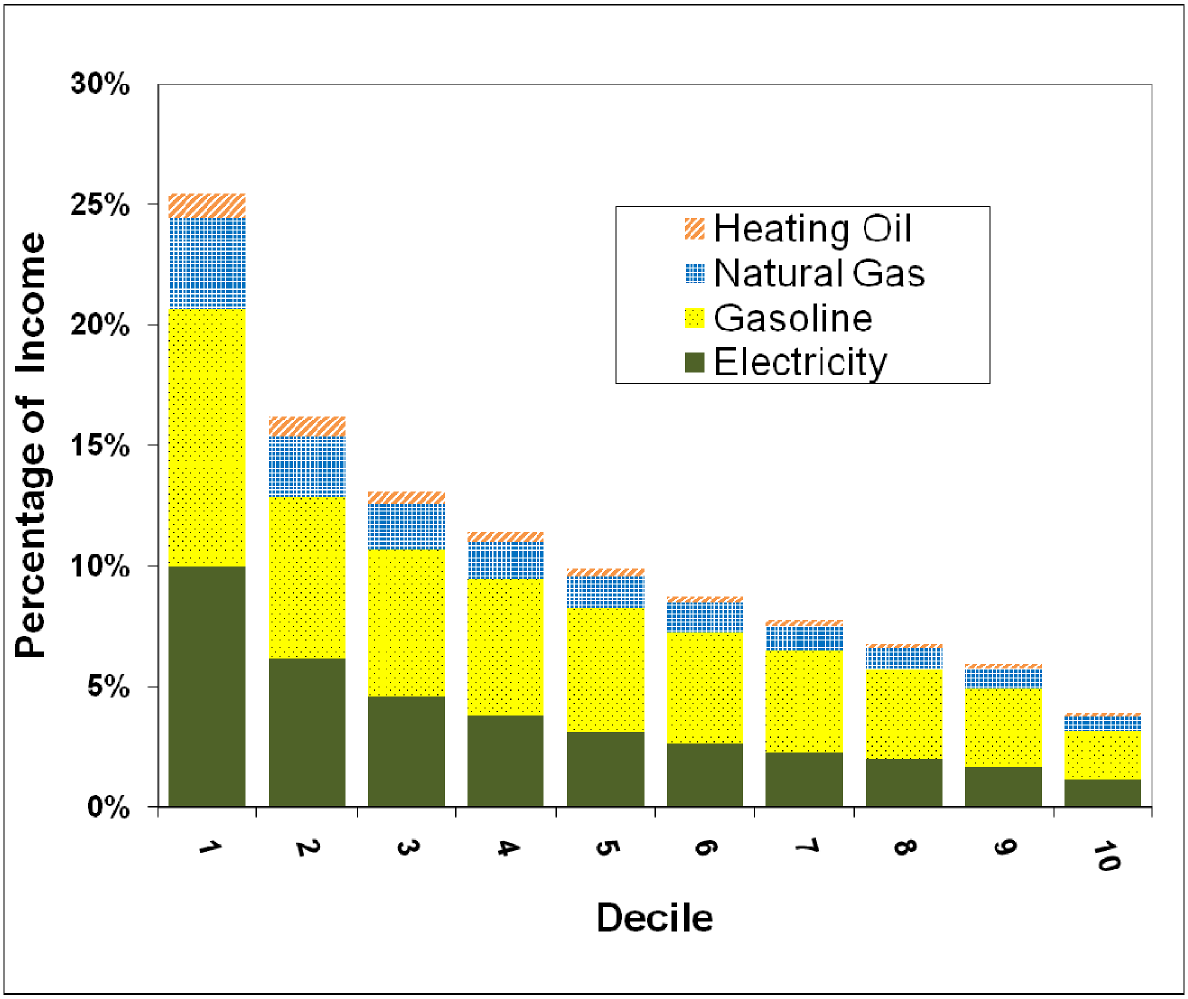
Region	States	Baseline CO2 Emissions Per MWh of Generation (Metric Tons CO2/KWh)	Post-Cap CO2 Emissions Per MWh of Generation (Metric Tons CO2/KWh)	Price Change	Change in Consumption
Southeast	AL, AR, DC, GA, LA, MS, NC, SC, TN, VA	0.583	0.464	13%	-5%
California	CA	0.170	0.166	7%	-2%
Texas	TX	0.549	0.549	15%	-5%
Florida	FL	0.538	0.448	15%	-4%
Ohio Valley	IL, IN, KY, MI, MO, OH, WV, WI	0.794	0.654	27%	-8%
Mid-Atlantic	DE, MD, NJ, PA	0.573	0.512	18%	-3%
Northeast	CT, ME, MA, NH, RI	0.372	0.317	12%	-4%
Northwest	ID, MT, OR, UT, WA	0.344	0.195	8%	-3%
New York	NY	0.308	0.288	16%	-1%
Plains	KS, MN, NE, OK, SD	0.835	0.749	20%	-9%
Mountains	AZ, CO, NV	0.627	0.471	18%	-7%
National		0.596	0.492	16%	-5%

Household direct energy expenditures include electricity, gasoline, natural gas, and heating oil. Figure 1 shows expenditures in each of these categories as a fraction of annual income for average households in each income decile. Spending on electricity does not vary substantially in absolute terms across deciles, but it does vary as a share of income, ranging from 10.0 percent for the lowest decile to 1.2 percent for the highest. On average, across all deciles, households spend 2.25 percent of income directly on electricity.

Regionally, we find some differences in spending as a fraction of income, but they are not large for average households. Results are shown in Figure 2. The average total expenditure ranges from a low of 6.4 percent of annual income in California to a high of 8.1 percent in Texas.

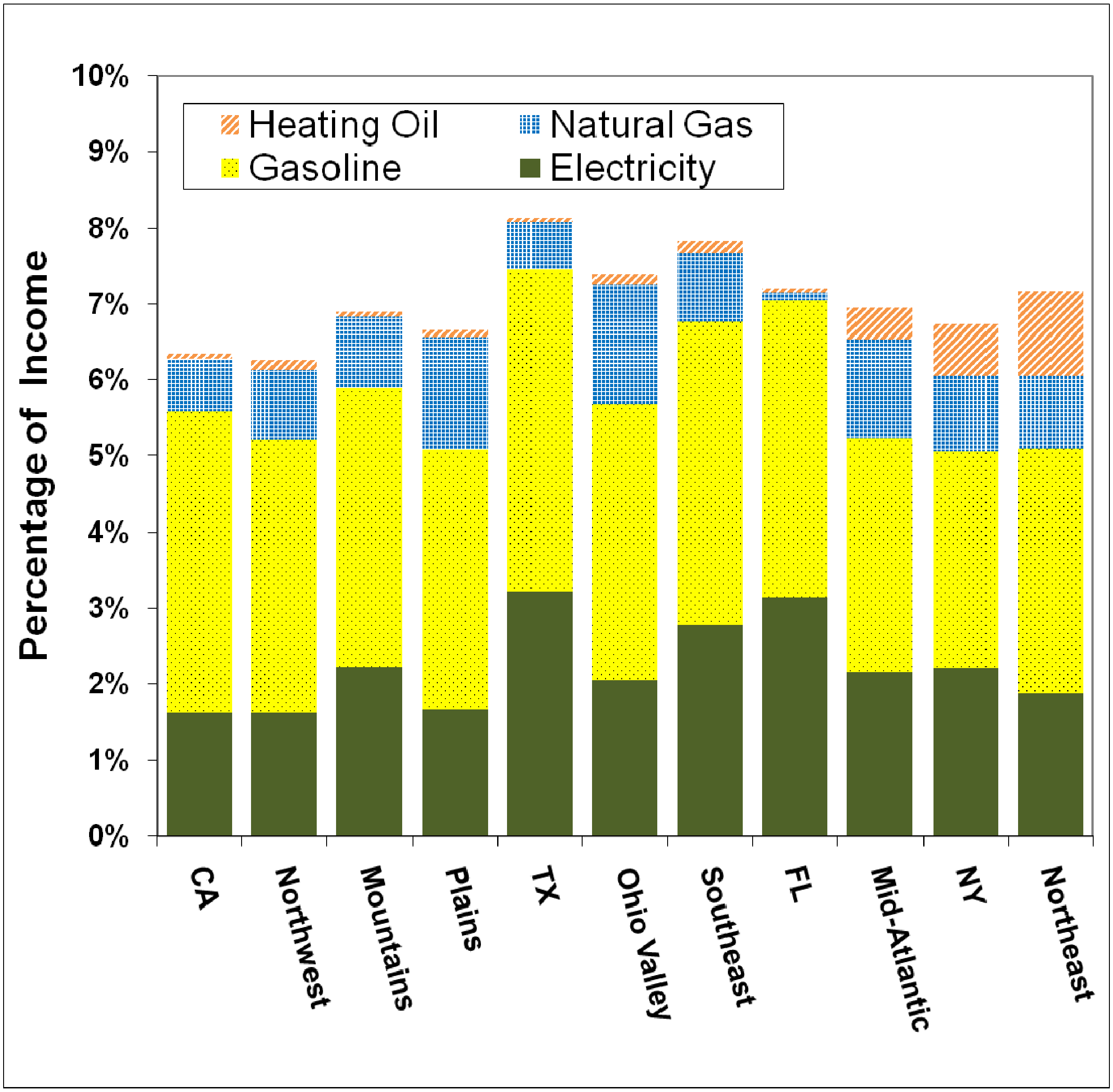
Categories of expenditure vary considerably across regions, however. For example, in New York and the Northeast, home heating contributes importantly to expenditures; electricity expenditures are substantially greater as a percentage of income in the South than for other regions, as are gasoline expenditures.[8]

Figure 1. Direct Energy Expenditure As a Percentage of Income by Decile



[8] In earlier work (Burtraw et al. 2009), we looked at the impacts by income decile within each region and showed that the regional differences are greater for low-income households. In this paper, our regional analysis focuses only on average households.

Figure 2. Average Direct Energy Expenditure as a Percentage of Income



Our model uses these consumption patterns by region and decile to estimate household-level emissions, which are scaled to per capita emissions from the EIA analysis of the Lieberman–Warner proposal (S. 2191) and from Haiku for the electricity sector. Per capita precap emissions are estimated to be 16.4 tons of CO_2 per year, with approximately 49 percent of this due to indirect consumption. Government accounts for an additional 2.7 tons of CO_2 per year.

The model also estimates household-level consumer surplus loss that results from a cap-and-trade program. Initial consumer surplus loss (before any revenue is returned) is scaled to total the area under the marginal abatement cost curve at the given CO_2 price as estimated by EIA in its Lieberman–Warner analysis for all sectors except electricity. The electricity sector marginal abatement cost curves are taken from Haiku and vary across scenarios. The initial consumer surplus loss is combined with estimates of the value of the allowances under the various distribution schemes to obtain our estimates of net consumer surplus loss.

V. Allocating 30 Percent of Allowances to LDCs

The primary set of scenarios is set up to isolate the effects of two potential LDC allocation outcomes and to compare the results to an auction case in which the allowance value is returned as per capita dividends. We analyze three approaches to distributing 30 percent of the total allowance value. In case 1, we assume conventional electricity pricing with the subsidy placed in the variable portion of the bill. It is equivalent for practical purposes to assume what we describe as conventional economic behavior. By this we mean that for all customer classes we assume that even if regulators try to preserve the CO_2 price as a component of variable prices and assign the allowance value to reduce fixed costs, customers are unable to distinguish between a change in their bill and a change in their price. Under what we characterize as conventional behavior, all customers perceive the allocation of allowance value to LDCs as a reduction in the variable price of electricity from the full-auction case.

In case 2, we assume that LDCs are able to entirely separate the fixed and variable charges and pass on the allowance value by lowering the fixed charge; variable electricity prices are assumed to rise, reflecting the CO_2 price, as in the auction case. We assume further in case 2 that industrial and commercial customers exhibit rational behavior, that is, they distinguish a change in their bill from a change in the price and do not change their electricity consumption in response to changes in fixed charges. They are assumed to pass on the value of the allowances to shareholders. Residential customers, on the other hand, continue to exhibit conventional behavior and do not perceive the fixed/variable difference, and respond as if electricity prices are lower (as in case 1). We compare these outcomes with a third scenario in which there is no free allocation to LDCs, and the same share of allowance value that would be given to LDCs is returned to households as a per capita, nontaxable dividend. We label this third case auction and dividend.

Impacts on Costs and Incidence across Income Groups

Table 2 shows the difference in net consumer surplus loss for cases 1 and 2 as compared with the auction-and-dividend scenario. The differences are shown for average households in each of ten income deciles as well as the national average across all households.[9] Keep in mind that these are the differences in net consumer surplus losses that result when 30 percent of the allowance value is distributed in alternative ways. Of the remaining 70 percent, we assume that 14 percent is withheld by government to account for its own changes in direct energy costs at the federal, state, and local levels; the remaining 56 percent is not accounted for in our model (e.g., it may include free allocation to emitters or be used to fund other government expenditures). The allowance price that results in each case is also shown in Table 2. The full consumer surplus loss before any of the allowance value is returned to consumers averages $829 per household when the allowance price is $20.91/mt$CO_2$.[10] This is the allowance price that obtains in the auction-and-dividend scenario that we examine as well. Although we focus on just 30 percent of the allowance value that might be distributed in various ways, for a point of comparison we note that if all of the allowance value is returned to households as a per capita dividend (except for the 14 percent retained by government), the net consumer surplus loss averages $130 per household.

[9] National averages include five states not included in the regions.

[10] All results are reported in 2006 dollars.

Table 2. Comparison of Costs of Climate Policy Under Alternative Allocation Schemes* (2006 Dollars)

National Income Decile	Average Household Income	Case 1: Value Applied to Variable Price	Case 2: Value Applied to Fixed Charge for Industrial/Commercial
		(Allowance Price = $26.90/mt CO_2)	(Allowance Price = $22.72/mt CO_2)
1	7,030	104	112
2	15,372	112	133
3	23,038	130	152
4	31,036	144	162
5	39,553	163	177
6	49,596	167	161
7	61,558	184	165
8	77,074	188	157
9	100,267	200	109
10	178,677	175	-673
Avg	58,321	157	66

Note: Deciles constructed at the national level.
* 30% of total permits are allocated to Cap and Dividend and LDCs respectively. The remaining revenue effectively disappears.

Case 1, in which all customer classes perceive a reduction in the price of electricity compared with the auction-and-dividend scenario, leads to the highest allowance price—$26.90/mt$CO_2$ as compared with $20.91/mt$CO_2$ with the per capita dividend. The higher allowance price results because electricity prices are held down in this scenario. Electricity consumption and emissions are consequently higher, and to achieve the same aggregate emissions economywide, emissions reductions must be achieved in other sectors of the economy in which they are more costly. This leads, in turn, to higher costs for other goods and services and raises the net consumer surplus loss of the average household by $157 compared with the auction-and-dividend scenario. Thus, although electricity expenditures are held down, the benefits to households are more than offset by higher costs elsewhere in their consumption bundle.

In case 2, in which only residential customers perceive a lower electricity price in comparison with the full-auction approach, industrial and commercial customers respond to their higher variable electricity price by reducing consumption and thus emissions. This leads to a smaller allowance price than in case 1 ($22.72/mt$CO_2$), but still raises the net consumer surplus loss for an average household over the auction-and-dividend case by $66.

As the third column of Table 2 makes clear, the difference in burdens between case 1 and the auction-and-dividend scenario grows as we move up the income distribution. However, as a fraction of household income, the numbers become smaller. Our earlier research showed that the auction-and-dividend approach is quite progressive in that households in the lower-income deciles see a net gain from climate policy once revenues are returned in a lump sum, per capita payment (Burtraw et al. 2009).[11] Moving to the LDC allocation approach dampens that progressivity by raising costs overall and redistributing some of the costs from higher-income to lower-income households.

This distributional effect is especially evident when comparing across the two LDC allocation scenarios. In case 2, the scenario with separate fixed and variable pricing, commercial and industrial customers are assumed to take the subsidy on the fixed portion of their bill and pay it out as a dividend to their shareholders. The higher variable costs, however, are passed on to their customers in the form of more expensive goods and services. While this impacts all households, the majority of shareholders are in the top income decile.[12] On the national level, the top income decile fares $673 better than under the auction-and-dividend allocation scheme. This increase is at the expense of households in the lowest five deciles, who do not own much equity, but are still faced with higher prices for goods and services. The average household in each of the lowest five deciles is worse off under case 2 than case 1 even though the average household overall is better off.

[11] It is important to note that the strong progressivity of cap and dividend in Burtraw et al. (2009) results from 86 percent of the revenue being returned as a dividend.

[12] Several studies have emphasized this point; see the analysis of grandfathering of allowances in Dinan and Rogers (2002) and Parry (2004), for example. We use the Federal Reserve Board’s 2004 *Survey of Consumer Finances* to determine allocations to shareholders (http://www.federalreserve.gov/PUBS/oss/oss2/2004/scf2004home.html).

Regional Impacts

A partial motivation for the LDC approach was to balance the impacts of climate policy across regions. As we explained in Section IV, differences in regulation across regions as well as differences in fuel mix are likely to create differences in costs for households. How the full effects play out once we account for consumption patterns across regions and the impact of the LDC approach on prices of all goods and services is unclear. Table 3 shows our findings by region. As in Table 2, we show the difference in net consumer surplus loss for case 1 and case 2 over the auction-and-dividend approach for average households; Table 3 shows the results for each of 11 regions of the country.

Table 3. Regional Comparison of Costs of Climate Policy Under Alternative Allocation Schemes* (2006 Dollars)

Region	Average Household Income	Case 1: Value Applied to Variable Price	Case 2: Value Applied to Fixed Charge for Industrial/Commercial
		(Allowance Price = $26.90/mt CO_2)	(Allowance Price = $22.72/mt CO_2)
Southeast	56,528	148	75
California	69,317	265	135
Texas	58,586	170	56
Florida	54,325	124	52
Ohio Valley	60,237	97	1
Mid-Atlantic	66,037	134	0
Northeast	69,702	185	52
Northwest	61,572	226	141
New York	66,930	168	25
Plains	63,131	145	58
Mountains	58,202	135	67
National	58,321	157	66

Note: Deciles constructed at the national level. Negative welfare losses reflect a net increase in welfare after CO2 revenues are redistributed

* 30% of total permits are allocated to Cap and Dividend and LDCs respectively. The remaining revenue effectively disappears.

There are substantial differences in the costs of the different approaches across regions. Average households in California and the Northwest are much worse off under the LDC approach, under either case 1 or 2 assumptions, than with a per capita dividend. The average household in California loses an additional $265 in consumer surplus in case 1 and the average household in the Northwest an additional $226. This compares to the average additional loss across all regions of $157. Similarly, in case 2, in which industrial and commercial customers experience a drop in fixed charges on their electricity bill and pass that on to shareholders, households in California and the Northwest are harmed relatively more. By contrast, average households in the Ohio Valley and Midatlantic regions fare equally under the LDC approach under case 2 assumptions and the auction-and-dividend approach.

The explanation for these disparities hinges in large part on the way that allowances are apportioned to the states and their LDCs. There are three main criteria by which allowances could be distributed: consumption, emissions, and population. Because each one would affect states differently, the allocation system can dramatically shape regional distributions. All cases in this paper use a 50/50 split between consumption and emissions as stipulated in H.R. 2454. Regions such as the Ohio Valley and the Midatlantic have among the highest emissions intensity of electricity generation (see Table 1), so placing 50 percent weight in the apportionment on emissions benefits these regions relative to others. Another factor affecting the distribution of effects is the portion of electricity consumption by each customer class. The Plains region has the nation's lowest share of consumption by residential customers compared to industrial and commercial classes; consequently relatively fewer of the benefits to residential-class customers under the LDC allocation accrue in this region.

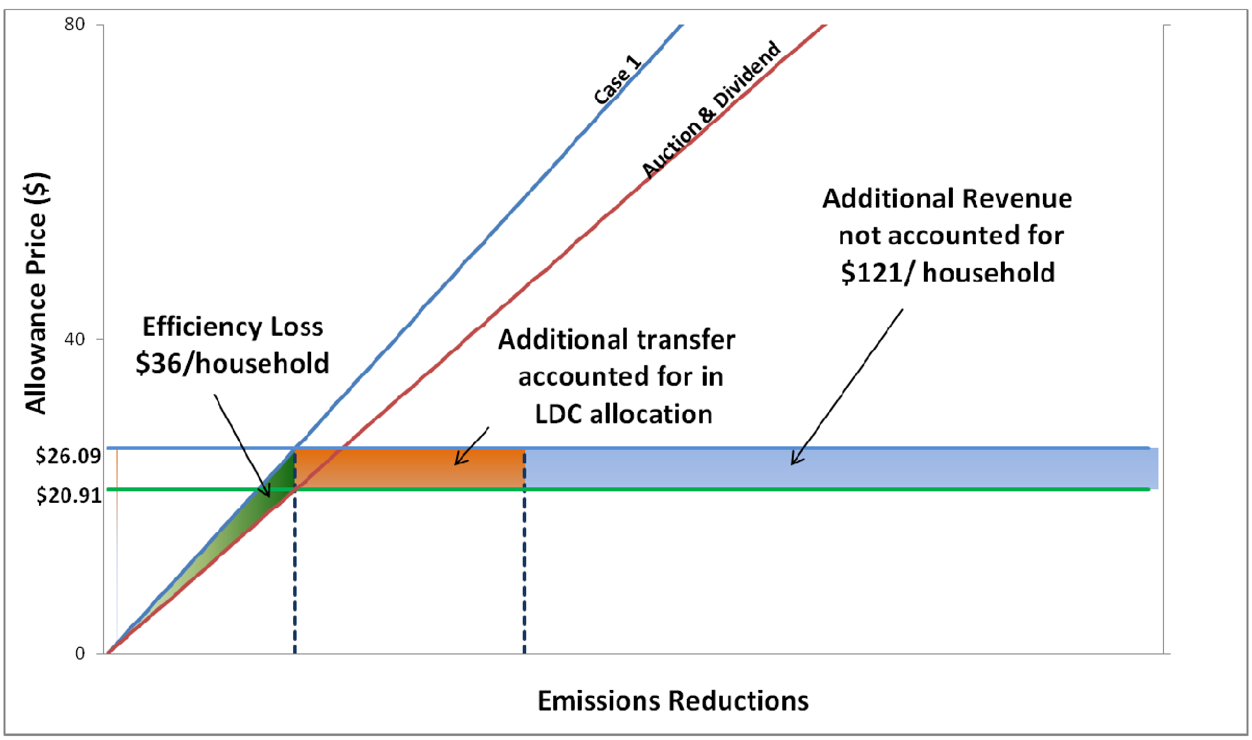
VI. Limitations of Analysis on only 30 Percent of Allowance Value

An important consideration is how the remaining revenue not directed to LDCs is allocated — e.g. the remaining 70 percent less the 14 percent to government. How one accounts for this portion of the allowance value affects the calculation of the burden on households. The reason is that its value changes under the different cases we evaluate. For example, allocating revenue to LDCs is likely to lower electricity prices, which leads to expanded electricity consumption. Greater electricity consumption leads to an increase in allowance prices. This consequently increases the total monetary value of the revenue not directed to LDCs. Thus, under an allocation to LDCs, the available potential rebate grows with the allowance price and can offset some of the increased burden felt by households. By focusing only on the 30 percent of allowance value, we ignore this impact.

The increased value of the revenue not directed to LDCs, however, does not totally offset the extra burden on households from the increase in the allowance price. The difference is the efficiency loss that results from other sectors having to make more expensive abatement decisions due to the expansion of consumption of electricity and greater emissions in the electricity sector. In case 1, the average additional welfare loss to households over the auction-and-dividend scenario is $157; of this amount, $36 constitutes a direct loss in efficiency. The remaining $121 is collected by the government.

Figure 3 illustrates the difference in revenue between case 1 in which full LDC allocation is used and the auction-and-dividend approach. The two scenarios have different slopes as a result of the less efficient abatement opportunities in case 1. The efficiency loss of $36 per household is signified by the green area between the two curves. The increased allowance price in case 1 generates revenue equal to the increase in the allowance price multiplied by the total emissions. The orange rectangle, equal to 30 percent of this new revenue, is dedicated to the electricity LDC allocation. The remaining 70 percent, or $121/household, represented by the blue rectangle, is additional revenue collected by the government.[13]

Figure 3. Change in Total Allowance Value with Free Allocation to Local Distribution Companies



[13] We are indebted to Terry Dinan for her comments on this point.

The additional funds resulting from the increase in the allowance price were not explicitly rebated in our analysis in order to isolate the impacts of the LDC allocation, and not to confound those impacts with the distribution of the additional revenue. However, our $157 per household estimate of the extra burden on households should be considered an upper bound on the true burden. Likewise, $36/household is the lower bound, assuming all of the additional revenue goes back to households. Without any specific direct rebate provisions, the distributional and regional impacts of this money remain uncertain as well.

VII. A Case Study in Current Policy: LDC Allocation in the Waxman–Markey Proposal (H.R. 2454) and Potential Incremental Reform

Thus far we have analyzed the impacts of the 30 percent of allowances that would go to electricity LDCs under H.R. 2454 without accounting for the remainder of the allowance value. In this section, we place this special treatment for the electricity sector in a broader context. In the bill, over the first couple of decades of the program, 56 percent of emissions allowances would be directed back to consumers and businesses in a way that is intended to rectify disparate impacts among income groups and regions. This allocation is directed to electricity LDCs (30 percent), natural gas LDCs (9 percent), home heating-oil providers (2 percent), and direct compensation to low-income families (15 percent). Although we now account for 56 percent of the allowance value, we do not account for the remaining 44 percent.

We characterize all of these provisions under the assumption in case 1 above, that is, that the allocation to LDCs is reflected in a reduction in the variable costs for all customer classes. In fact, the proposed legislation indicates that the allowance value may be directed to reduce the fixed part of the bill "to the maximum extent practicable," but it also indicates that notwithstanding this direction, for industrial-class customers the value may be applied to the variable part of the bill.[14] We assume broadly that residential-class customers would not be able to distinguish between changes in the price and the bill, and would behave in either case as though electricity is cheaper due to the LDC allocation. For commercial-class customers, the implementation of a reduction in the fixed part of the bill is problematic because it introduces

[14] The language says with respect to directing the allowance value to the fixed portion of the bill that "if compliance with the requirements of this title results (or would otherwise result) in an increase in electricity costs for industrial retail ratepayers of any given electricity local distribution company..., such electricity local distribution company—...may do so based on the quantity of electricity delivered to individual industrial retail ratepayers."

moral hazard in the form of incentives to split accounts and open new accounts. Consequently, we represent the allocation to LDCs as a reduction in the variable portion of the bill as the most likely outcome under the proposed legislation.

In this analysis we compare the results from the Waxman–Markey approach to an alternative incremental reform of the allocation of the 56 percent that limits allocation to LDCs on behalf of only residential consumers of electricity and natural gas. In the reform proposal, the allowance value that was scheduled to go to LDCs on behalf of commercial and industrial electricity and natural gas consumers, as well as the portion scheduled to go to home heating providers and low-income households, would instead be given directly to households in the form of a taxable per capita dividend. This incremental reform thus preserves some aspects of the LDC approach but reduces the allocation to LDCs and removes the other special provisions in favor of cap and dividend. This incremental reform thus allocates 15 percent of the allowance value to residential electricity and natural gas customers, consistent with H.R. 2454, and the remaining 41 percent as a per capita dividend.

Impacts on Costs and Incidence across Income Groups

The difference in the net loss in consumer surplus between the Waxman–Markey allocation and the reform proposal is reported in Table 4. On a national-average basis, the cost per household declines by $78 in the reform proposal due to the efficiency gain associated with limiting the allocation to LDCs. The allowance price falls from a value of $27.39 when accounting for 56 percent of the allowance value under Waxman–Markey to a value of $23.01 under the reform proposal.

Table 4. Differences in Cost per Household of Alternative Compared to H.R. 2454, By Decile (2006 Dollars)

National Income Decile	Average Household Income	Alternative: Residential Electricity and Natural Gas LDC Allocation (15%) with 41% dividend*
		(Allowance Price = $23.01/mt CO_2)
1	7,030	80
2	15,372	16
3	23,038	23
4	31,036	-53
5	39,553	-172
6	49,596	-219
7	61,558	-255
8	77,074	-247
9	100,267	-221
10	178,677	191
Avg	58,321	-78

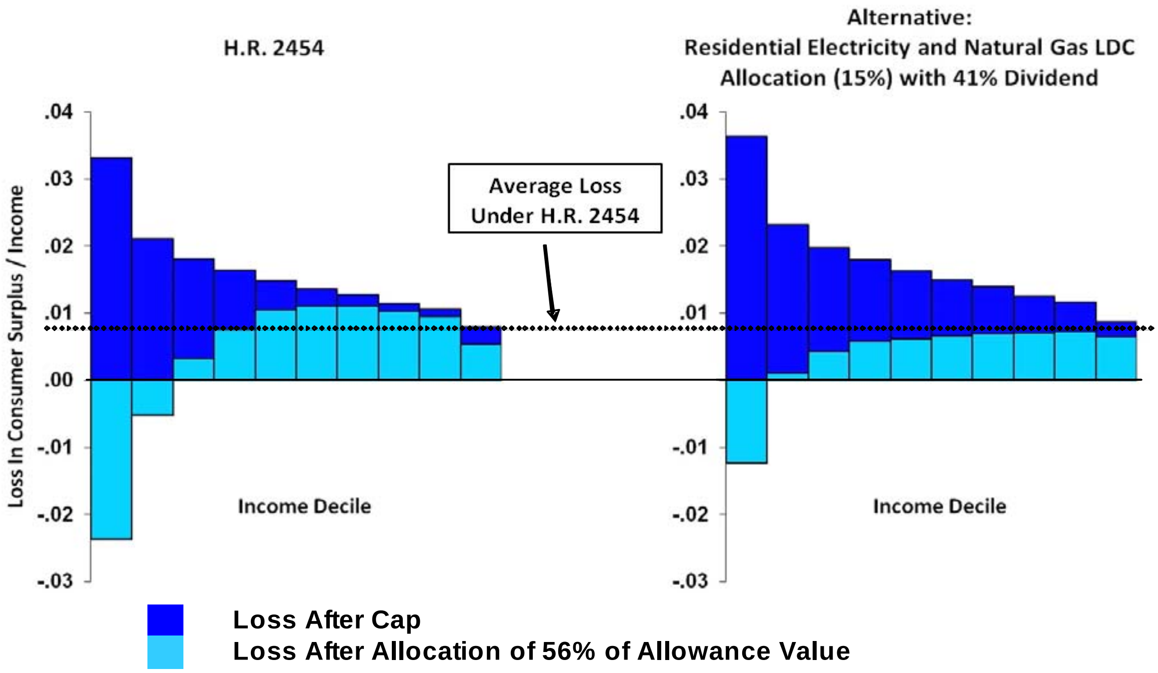
Note: All negative welfare losses reflect a net increase in welfare compared to H.R. 2454. Deciles constructed at the national level.

* Results only account for allocation of 56% of allowance value. The remaining revenue is not accounted for.

Across income groups the reform proposal raises the costs for the bottom three income groups and most significantly for the top income group, while it reduces the costs even more significantly for the middle six income groups. While the first income decile is $80 worse off under the reform proposal than with H.R. 2454, they still receive a net gain of $87 under the reform policy. The greatest benefit accrues to the seventh income decile, with an average income of $61,558. This group would see a reduction in costs of $255 compared to H.R. 2454.

The advantages of the reform are well illustrated in Figure 4, which shows the impact on households organized by income deciles. The status quo allocation of the 56 percent of allowances in H.R. 2454 is displayed in the left panel. The darker blue reports the loss to households from introducing a price on CO_2 before accounting for any of the allowance value. The lighter blue reveals the loss to households after accounting for the 56 percent that we model as a representation of the Waxman–Markey proposal. The lighter blue reveals an inverted U with respect to the distribution of costs across household income groups. The status quo allocation in Waxman–Markey would do a good job of protecting the bottom 20 percent of households and the top 10 percent. The dotted horizontal line represents the average loss that we estimate under the proposal.

Figure 4. Comparison of the Distributional Burden under Alternative Proposals



The right panel in Figure 4 displays the incremental reform, which would smooth out the burden across household income groups. Simultaneously, the reform proposal lowers the overall costs of the program, resulting in every income group performing "above average," that is, with costs below average, when compared to the average loss as a share of income (shown in the left-hand panel). Figure 4 also indicates that the reform proposal is somewhat less progressive with respect to the impact on the bottom three income deciles, but the bottom decile remains a net winner under the policy and the second decile nearly breaks even. On net, the proposal appears to do well in protecting low-income households and provides a potent correction to the inverted U that appears under the Waxman–Markey approach, thereby removing the appearance that climate policy imposes a disproportionate tax on the middle class.

Regional Impacts

Free allocation to LDCs may have a justification in reducing regional disparities. However, the reform proposal that would limit LDC allocation to residential customers only does at least as well in this regard. Table 5 indicates that the average household in all regions is better off due to the reform. Moreover, those regions with the greatest emissions intensity of electricity generation are among those that benefit the most from the reform. In particular, while costs fall by $78 on average for the nation, they fall by $91 in the Ohio Valley. Among other relatively emissions-intensive regions, costs fall by $68 in the Plains, less than the national average, and by $85 in the Mountain region, greater than average. In all of the regions household costs are reduced. On net the reform proposal appears to be sufficient to level the playing field across geographic regions as well as to protect low-income households, while reducing the overall costs of the program.

Table 5. Difference in Cost per Household of Alternative Compared to H.R. 2454, by Region (2006 Dollars)

Region	Avg Income	Alternative: Residential Electricity and Natural Gas LDC Allocation (15%) with 41% dividend*
		(Allowance Price = $23.01/mt CO_2)
Southeast	56,528	-69
California	69,317	-86
Texas	58,586	-129
Florida	54,325	-68
Ohio Valley	60,237	-91
Mid-Atlantic	66,037	-77
Northeast	69,702	-47
Northwest	61,572	-81
New York	66,930	-83
Plains	63,131	-68
Mountains	58,202	-85
National	58,321	-78

Note: All negative welfare losses reflect a net increase in welfare compared to H.R. 2454. Deciles constructed at the national level.

* Results only account for allocation of 56% of allowance value. The remaining revenue is not accounted for.

VIII. Conclusion

The introduction of a price on CO_2 will have important effects on the economy, and especially important effects on the electricity sector. This paper examines alternative approaches to the distribution of allowance value to the sector, including free allocation to consumers through LDCs and direct per capita dividends. Consideration of allocation to LDCs has emerged as an important possibility in just the last three years as the United States has struggled to identify a political compromise that would enable a majority opinion to support climate policy. Allocation to LDCs may contribute to that outcome, but because it represents special treatment of one sector of the economy it can be expected to raise the overall cost of climate policy.

Furthermore, there is uncertainty about how an allocation to LDCs might actually be implemented.

We present the results from a pairing of models. One is built on CES data and provides an understanding of how the introduction of a price on CO_2 will affect households in different regions and income groups. We pair that with a detailed model of the electricity sector, and use this suite of models to analyze the effects of allocation to LDCs.

Compared to an auction with revenues returned on a per capita basis, we find that allocating 30 percent of the allowance value to LDCs raises the allowance price by as much as 29 percent; however, the actual outcome will depend importantly on what is done with the remaining 70 percent of the allowance value. We directly compare two formulations of the way that allocations to LDCs may benefit households. In one case, the allowance value is used by LDCs to directly reduce electricity prices, and we find this would raise the average consumer surplus loss per household by $157 over a case with an auction coupled with a per capita dividend. In the other case the allowance value is directed toward reducing the fixed portion of electricity bills for industrial- and commercial-class customers, but is used to reduce the electricity price for residential-class customers. We find this would have less of an effect on the overall allowance price, raising it by just $66 over the auction-and-dividend case, suggesting the efficiency cost of this outcome would be less. However, because the reduction in the fixed part of electricity bills would work to the benefit of shareholders of the firms that constitute the LDC's industrial- and commercial-class customers, it has a regressive effect on the distribution of costs over the population, thereby undermining the objective of the allocation to LDCs.

In the last section we characterize a large part of the allocation scheme in the Waxman–Markey proposal, describing 56 percent of the allocation formula, including provisions that are specifically aimed at correcting income group and regional disparities. This exercise provides a useful insight to the cost of achieving distributional goals from the standpoint of raising the overall cost of the program, but even more importantly it indicates that the same goals can be substantively achieved at much less cost. The proposed reform we model would redirect 44 percent of the allowance value away from its narrowly defined constituents and direct it toward per capita dividends, leaving 15 percent to remain as allocation to electricity and natural gas LDCs that is targeted to residential-class customers only.

This incremental reform results in savings of $78 per year for the average American household compared to the allocation scheme in H.R. 2454. Further, it would protect households in the bottom quintile of the income distribution in a manner similar to H.R. 2454. The middle class, which bears a large portion of the burden under H.R. 2454, would receive substantial relief with the alternate approach. The reform also improves upon H.R. 2454 in addressing regional disparities by further compensating residential electricity consumers in the Ohio Valley region while reducing households burdens overall. The average household in the Ohio Valley region experiences savings of $91 under the reform proposal compared to H.R. 2454, which is even greater than the benefit on average across the nation from this incremental reform.

Another feature of this reform is that it better achieves administrative simplicity and consistency than H.R. 2454. It is unclear how LDC allocation on behalf of industrial and commercial customers will flow to them, or whether the benefits will accrue to shareholders or be reflected in lower prices of goods and services for households. The outcome depends heavily on regulatory decisions by state public utility commissions. The reform we model removes this uncertainty by directly rebating the money as a dividend. The simple approach of direct dividends also avoids the appearance of favoritism by distributing to households an equal share of the value of a new property right that is created under a cap-and-trade program.

There are important limitations to our model that could lead results to be misinterpreted, and we have tried to guard against that. The model does not directly replicate H.R. 2454. In the analysis of a reform to the proposed legislation, we use a characterization of LDC allocation that passes value through to all customer classes in the variable charge. Especially important, this analysis also does not account for the remaining 44 percent of the allowance value in any manner. If that value is returned as a per capita dividend or otherwise works to directly reduce the costs of the program for households, then it also lessens the impact of allocation to LDCs on overall cost. If the value is directed to other purposes, however, such as free allocation to industry or expenditure on unrelated programs, then it raises the cost of the allocation to LDCs. Further, we model a limited role for CO_2 offsets and hold that level constant across various scenarios when examining alternative approaches to allocation. Under H.R. 2454, expanded use of offsets early in the program shifts the costs associated with domestic abatement to later years. If the supply of offsets is elastic, then the use of offsets could expand in response to an increase in the allowance price, thereby offsetting part of that increase.

In conclusion, the way that emissions allowances are distributed will have significant efficiency and distributional effects. The way these effects are felt or perceived could have great consequence for the popularity and evolution of climate policy as well as the performance of the economy. This research illustrates that the allocation to LDCs poses a familiar trade-off between efficiency and distributional goals. While distributional outcomes may be worth the price, we find in our analysis of a reform proposal that similar distributional outcomes may be achieved at much less cost by incrementally substituting toward per capita dividends.

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