WORLD RESOURCES INSTITUTE

ISSUE BRIEF

PUTTING A PRICE ON CARBON: ENSURING EQUITY

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EXECUTIVE SUMMARY

A price on carbon—in the form of either a carbon tax or a cap-and-trade program—can play an important role in mitigating the risks of climate change. In this issue brief, we describe the variation across U.S. households in the effects of a carbon pricing policy. The most influential factor determining the variation across regions and socioeconomic groups is the use of the revenue generated by payments of the carbon price, variation that is entirely in the hands of policy designers. We show how revenues can be used to address regional disparities and ensure that unfair burdens are not imposed on households that cannot afford them. By using just a small portion of carbon pricing revenue to specifically target low-income households and coal communities, policy designers can ensure that these groups are better off under a carbon price than alternative policy pathways.

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To understand the distribution across households, it is necessary to first understand the effects of a carbon price on a given household, including through payments of the carbon price and the benefits received from both the carbon pricing revenue and reduced emissions. We divide the policy effects into the following four components:

1. *Effects on household expenditures*. A carbon price affects household expenditures through the price of carbon-intensive energy products and services like electricity, gasoline, and heating, and through the price of other goods and services that are energy-intensive to produce.
2. *Effects on household income*. Households' wages and investment incomes depend on the performance of companies across the economy. A carbon price affects the costs of inputs of carbon-intensive companies and the market share of these companies and their competitors, which affects the incomes of these companies' workers and investors.
3. *Carbon pricing revenue use*. A carbon price generates revenue that can be allocated to a variety of important purposes, including providing household rebates, reducing taxes, investing in clean energy, reducing the federal deficit, addressing regional disparities or compensating households that cannot afford to pay the carbon price.
4. *Environmental benefits*. Reduced climate change and local air pollution caused by a carbon price leads to improved health and economic outcomes.

Most households are affected by all four of the above in their various roles as consumers, workers, business owners, shareholders, taxpayers, recipients of government benefits, and residents of communities across the country. The magnitude of the various effects of a carbon pricing policy on a given household depend on the characteristics of the household and the details of the policy. Empirical analyses of the distributional effects of carbon pricing policies across U.S. households suggest the following broad patterns (these analyses include effects of the carbon price and the revenue uses but not the environmental benefits):

- As consumers, households are most affected by carbon prices where they are most reliant on carbon-intensive energy (electricity in particular). This includes communities in the Southeast, Midwest, Great Plains, and Mountain West regions.
- There is little regional variation in the effects of the carbon price on household income, but communities of coal industry workers will sustain a disproportionate burden (before accounting for the revenue use).
- Lower-income households see larger proportional increases in their expenditures because a larger share of their consumption is devoted to energy-intensive products.
- Higher-income households see larger proportional decreases in their incomes as a result of greater dependence on capital income, which is more affected by a carbon price than is income from wages or government transfers.

- The use of carbon pricing revenue is the most influential factor determining the policy's distributional effects.

The last point implies that the effects of a carbon pricing policy across regions and socioeconomic groups are in the hands of the policy designers. A strong carbon price would generate billions of dollars in annual revenue[1] that could be used in productive ways, and different revenue uses have very different distributional consequences. Distributing all revenue as equal household rebates would generate a policy disproportionately benefiting low-income households and poorer regions of the country, whereas using all revenue to reduce taxes on capital income would disproportionately benefit high-income households and more affluent and capital-intensive regions. In reality, policy designers are likely to divide the carbon pricing revenue into multiple uses in order to achieve multiple objectives, including a fair distribution of policy effects. *Consequently, a carbon pricing policy is not necessarily regressive or progressive, and it does not necessarily benefit or harm any region of the country.*

However, to ensure an equitable policy, policymakers must consider not only the aggregate or average effects on regions and socioeconomic groups but also the effects on smaller groups of vulnerable households. We argue that two vulnerable groups are in particular need of additional support. First, many low-income households may not be able to afford any increase in expenditures, and a carbon pricing policy should ensure that these households are not driven deeper into poverty. A recent proposal by the Center on Budget and Policy Priorities (CBPP) outlines a three-pronged approach using existing infrastructure to provide nearly all low-income households in the country with rebates to offset the effects of carbon prices: (1) a refundable income tax credit for low-income workers; (2) payments from state human service agencies through the electronic benefit transfer system used to deliver food stamp benefits; and (3) supplemental payments to beneficiaries of Social Security and other federally administered programs (Stone 2015). Studies have estimated that protection for low-income households can be achieved using about 10 percent of the total carbon pricing revenue (Morris and Mathur 2014).

Coal industry workers and their surrounding communities are the second group in need of support. The coal industry lost about 50,000 jobs between 2008 and 2012 alone (Haerer and Pratson 2015), and small rural communities are experiencing significant economic hardship as coal workers struggle to find new jobs. A carbon price would further accelerate the transition away from coal-fired electricity generation, thus compounding the significant problems already faced by communities of coal industry workers. But carbon pricing revenues also provide an important opportunity to assist these struggling communities by expanding unemployment and health benefits, providing job search assistance and job training, supporting community development and infrastructure projects, and providing direct monetary assistance. Various recent federal proposals to support coal communities could be funded or expanded using carbon pricing revenue—for example, legislation proposed by a bipartisan group of seven U.S. senators would ensure lifetime pensions and health benefits to coal miners and their families (U.S. Senate 2015b). Coal miners represent just 0.057 percent of total U.S. employment, with combined salaries of 1 to 5 percent of the revenue generated from a moderate carbon price (BLS 2015). Billions of dollars in annual investments to revitalize coal communities could be funded with a very small portion of carbon pricing revenue.

Further study of specific policy proposals may indicate that an equitable carbon pricing policy requires revenue to be allocated to additional workers and households. This may include workers in industries particularly vulnerable to foreign competition, or households in regions that are heavily reliant on coal-fired electricity. But such additional revenue uses will require a small portion of the total revenue. The majority of carbon pricing revenue will remain available to accomplish other objectives.

The United States has pledged to reduce its greenhouse gas emissions by 26–28 percent below 2005 levels by 2025, and by over 80 percent by 2050. In the absence of carbon pricing, other policies will be relied on to make progress toward these targets. Like carbon pricing, alternative policies have distributional consequences that would need to be addressed. For example, emissions standards often raise energy prices, and the benefits of government spending on subsidies for low-carbon or energy-efficient products may disproportionately accrue to the corporations that sell these products and the households that can afford to buy them. The distributional effects of a carbon pricing policy should be compared to realistic

alternatives rather than an unrealistic "no climate policy" scenario. While different approaches can be used with alternative policies, a large stream of government revenue is a powerful tool for easing distributional concerns, and thus a key advantage of pricing carbon.

These optimistic conclusions contrast starkly with much of the public rhetoric on the distributional effects of carbon pricing policies, which too often focuses on the effects on energy prices alone (see, e.g., Wall Street Journal 2009; and Galbraith 2009). When the policy as a whole is considered—including the revenue uses, which are the most influential driver of distributional effects—it is clear that pricing carbon need not harm particular regions of the country or socioeconomic groups. Policymakers can design an equitable carbon pricing policy that achieves cost-effective emissions reductions while addressing regional disparities and protecting the country's vulnerable households and workers.

1. INTRODUCTION

Last year, WRI published *Putting a Price on Carbon: A Handbook for U.S. Policymakers*, which provides a summary of the key issues associated with a national carbon price in the United States. Building on the general information provided in the handbook, we are publishing a series of issue briefs devoted to specific topics of importance. In January, we released an issue brief describing the specific ways a carbon price would encourage emissions reductions across the U.S. economy (Kaufman, Obeiter, and Krause 2016). Of course, there will be costs associated with achieving those emissions reductions, and costs should not be unfairly incurred by vulnerable groups of households across the country. In this issue brief, we describe the regional and socioeconomic variation in the effects of a national carbon pricing policy and explain how distributional concerns can be alleviated using the carbon pricing revenue.

The effects on households of a carbon pricing policy are not limited to the effects of the higher costs of carbon-intensive products. We divide the effects into four major categories: (1) effects on household expenditures of the carbon price; (2) effects on sources of household income of the carbon price; (3) benefits to households from the uses of carbon pricing revenue; and (4) environmental benefits. To understand the variation in effects across regions and socioeconomic groups, one must first understand all of the major effects on a given household.

First, pricing carbon changes the relative price to consumers of carbon-intensive goods and services. Most notably, energy produced by burning fossil fuels becomes more expensive. Households that spend less of their income on energy (including electricity, heating, gasoline, etc.) will be less affected than households that spend more. In the electricity sector, the effects of a carbon price differ across regions because of the carbon intensity of the fuel used to produce electricity.

Second, a carbon price affects the sources of household income through changes in companies' production costs and revenues. The effect on a given household depends on how it derives its income. Evidence suggests that effects of a carbon price on wages are small in the context of the economy as a whole but significant

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from the perspective of individual industries such as coal and renewable energy. While economic modeling shows that the overall effects on capital income (i.e., investment income) may be larger than the effects on wage income, these effects are cause for fewer distributional concerns, because capital income tends to be mobile, diversified, and held by higher-income households. Income from government transfers (e.g., Social Security payments) is somewhat protected from the effects of a carbon price, because transfer payments are often designed to increase with inflation.

Third, the distributional effects hinge critically on how policymakers choose to allocate the carbon pricing

BOX 1

OUR SCOPE AND DEFINITION OF DISTRIBUTIONAL EFFECTS

Unless otherwise stated, comparisons of carbon pricing effects are stated in percentage rather than dollar-value terms, such as effects on income in comparison to total household income. Like most similar studies, ours concentrates on the effects on households rather than firms, although we do discuss the effects on the workers of carbon-intensive firms and their competitors. We focus primarily on the short-run effects (within the first few years after policy implementation), because distributional effects are often transitional, and because economic models are notoriously unreliable at long-run forecasts. Still, many of the distributional effects will persist for longer periods, and perhaps in some cases increase (in contrast, households will have more time to adjust their behaviors and consumption choices in the long run).

Throughout this issue brief, we refer to studies that assess the effects of carbon pricing policies compared to a scenario that is otherwise identical except for the lack of a carbon price—in reality, the alternative to a carbon pricing policy may be a patchwork of different emissions reduction strategies, all of which would have distributional effects important to consider.

For a policy as far-reaching as a national carbon price, aggregate regional and socioeconomic groups will inevitably contain significant within-group variation. For example, the anticipated effects on a U.S. state will not be representative of all individuals and businesses in the state, and the average effects on the poorest households will not be representative of the effects on every poor household. Such comparisons across groups are still highly useful in understanding the distributional effects of a policy, but we are mindful of this caveat in drawing policy conclusions.

Finally, the overall economy-wide effects of a carbon pricing policy—such as effects on gross domestic product and employment—are outside the scope of this issue brief.

revenue (or allocate free allowances under a cap-and-trade program). For example, using revenues for equal per capita rebates disproportionately benefits the poor, while using revenues to lower corporate income tax rates disproportionately benefits the rich. Importantly, revenue can be targeted in ways that counteract the burdens of a carbon price on particular regions or socioeconomic groups. However, the more carbon pricing revenue that is used to compensate particular groups, the less is available to accomplish other objectives, such as tax reform or investments in clean energy.

Fourth, the primary objective of a carbon pricing policy is to reduce greenhouse gas emissions, and the policy would also decrease emissions of harmful local air pollutants. Relatively little systematic quantitative information is available on the distribution of environmental benefits from reduced emissions, and perhaps as a consequence, these effects are commonly excluded from policy assessments. But emissions reductions are likely to have significant distributional consequences. Less air pollution improves health outcomes, and these benefits may be stronger among coal communities and low-income households where pollution mortality and morbidity rates are highest (Hendryx and Ahem 2009; Lynn, MacKendrick, and Donoghue 2011). Similarly, yet over a longer time period, the largest beneficiaries of reduced (global) greenhouse gases are those who are unable to adapt to a changing climate. Consequently, studies that ignore environmental benefits are likely to understate the benefits of a carbon pricing policy for the most vulnerable U.S. households.

The remainder of this issue brief proceeds as follows. First, we provide detailed characterizations of the ways households across regions and socioeconomic groups are likely to be affected by a carbon pricing policy. Sections 2 and 3 describe the effects of paying the carbon price on household expenditures and household income, respectively, and Section 4 describes the effects on households of commonly discussed carbon pricing revenue uses. Section 5 provides estimates of the combined effects on households of carbon pricing payments and revenue uses, and in Section 6 we explain how a relatively small portion of the carbon pricing revenue can be targeted to alleviate distributional concerns. We focus less on environmental benefits because insufficient empirical information is available, but they are referenced throughout the issue brief.

2. EFFECTS ON HOUSEHOLD EXPENDITURES OF A CARBON PRICE

A carbon price shifts the costs associated with greenhouse gas emissions from society as a whole to those buying and selling carbon-intensive goods and services. Households will benefit from reduced air pollution and climate change and from the use of the carbon pricing revenue, and these benefits are paid for with higher prices on carbon-intensive goods and services (i.e., increased household expenditures) and lower returns on work and investment (i.e., reduced household income).

This section focuses on how a carbon price changes household expenditures. For households, higher prices imply reduced purchasing power, as well as a shift in purchasing behavior away from carbon-intensive goods and services. A well-designed policy will use carbon pricing revenue to offset the former effect but not the latter.

For a given household, two major factors determine the effect of a carbon price on expenditures: (1) the amount of energy the household uses, including "direct" energy use from purchasing goods like electricity and gasoline, and "indirect" energy use from the purchase of nonenergy goods that are energy-intensive to produce or transport (food, for example) (Burtraw, Sweeney, and Walls 2009); and (2) how much a carbon price changes the price of energy that the household pays. We first describe how these factors differ across U.S. households, and then we summarize the effects of a carbon price on household expenditures across regional and socioeconomic groups.

Amount of Energy Usage

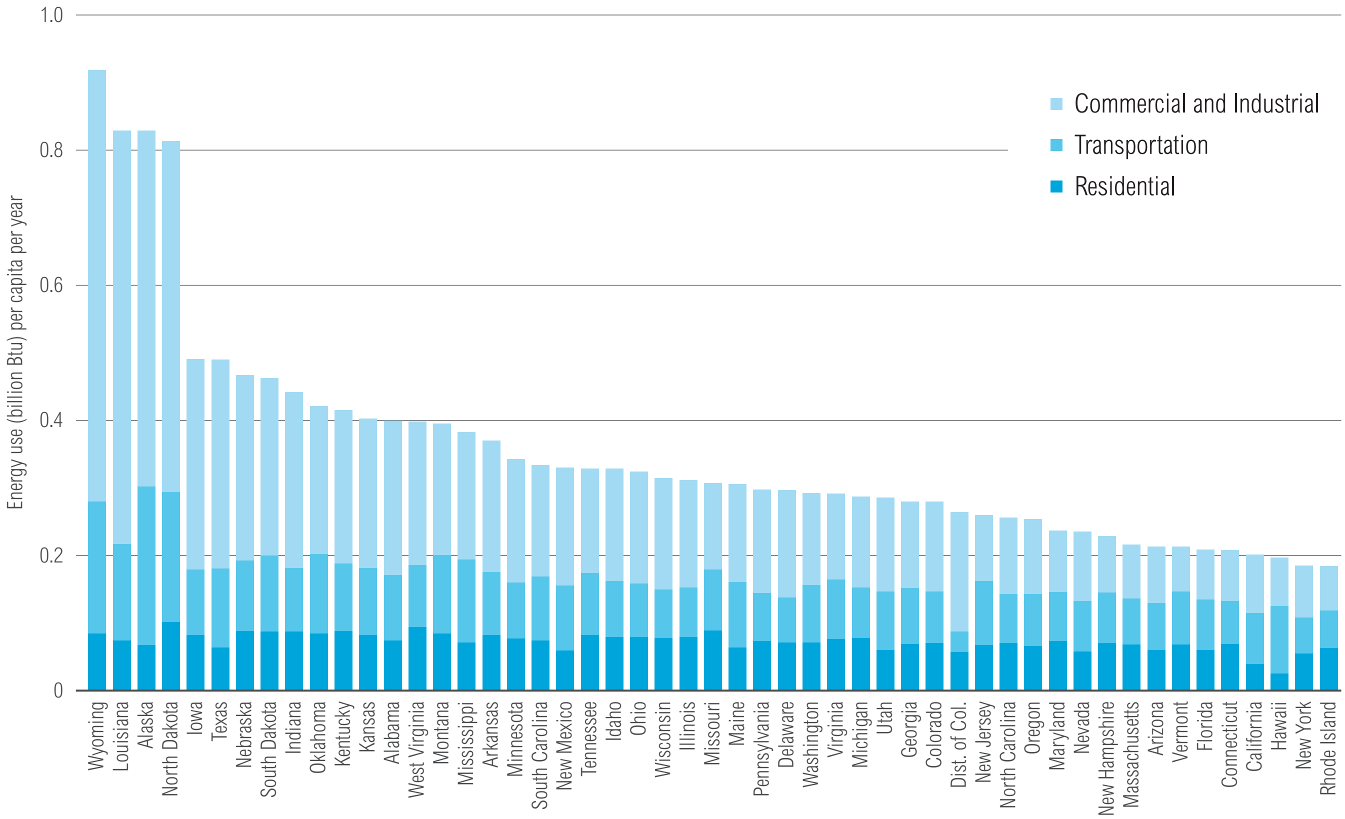
The more energy a household uses, the more its expenditures will be affected by a carbon price. Factors that cause variation in household energy use include wealth, regional differences in climate, population density, and public policy. Wealthier households tend to use more energy than poorer households (though, as discussed below, energy purchases account for a larger percentage of total expenditures for poorer households).[2] Rural households use more gasoline because they have less access to public transport and longer commutes (Williams et al. 2015). Households in the Southeast use more electricity because air conditioning is needed more often. Heating needs lead to greater usage of natural gas in the Midwest and fuel oil in the Northeast (Pizer, Sanchirico, and Batz 2010). States that have prioritized energy efficiency policies have lower per capita energy use than their climate or population density would indicate—for example, per capita electricity consumption has stayed flat in California since the mid-1970s, while it has increased by roughly 50 percent in the United States as a whole (NRDC 2013). "Indirect" energy purchases, in contrast, do not differ significantly across the country (Mathur and Morris 2012).

Figure 1 displays each state's per capita energy use, divided by user type. While total energy use varies quite a bit across states, the bulk of the variation can be attributed to commercial and industrial energy use in important energy-producing states (e.g., Wyoming, Alaska, North Dakota, Louisiana) and not to differences among households. When we consider only household energy use (which consists of residential and some portion of transportation energy use in Figure 1), the variation across states is far more modest.

The effect of a carbon price on expenditures is just one of the four major effects of a carbon price on U.S. households.

FIGURE 1

PER CAPITA ENERGY USE BY U.S. STATE



Source: WRI calculations using 2013 data from U.S. Energy Information Administration and the U.S. Census Bureau.

Changes in Energy Prices Resulting from a Carbon Price

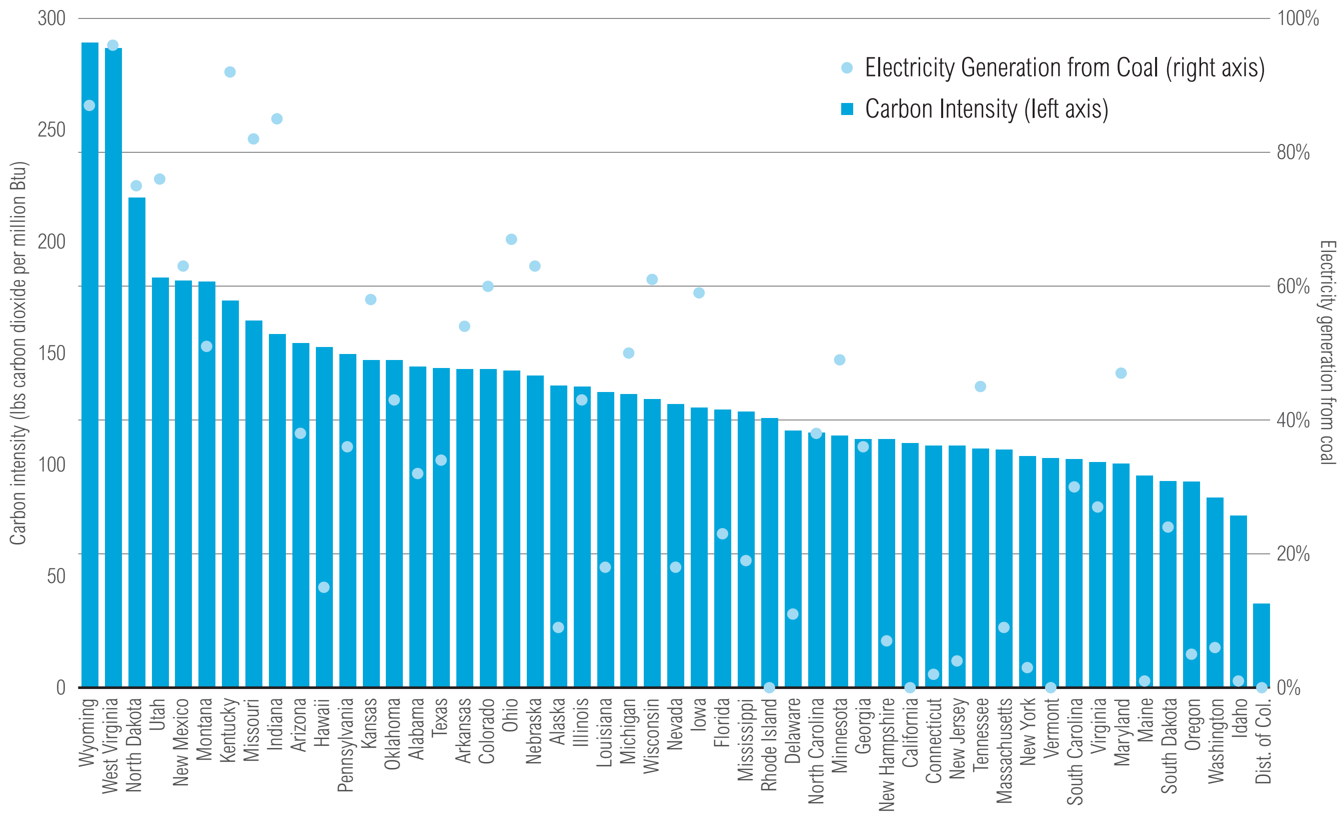
Carbon intensity refers to the amount of carbon dioxide emitted to produce a given amount of energy. The more carbon intensive is a household's energy use, the more a carbon price will change the energy prices that household pays. Burning coal is more carbon intensive than burning petroleum products, which is more carbon intensive than burning natural gas. Nuclear power and renewable energy are considered zero-carbon energy sources.

The carbon intensity of household energy use depends on how electricity is produced in the region and how a given household uses energy. In parts of the Southeast, Midwest, Great Plains, and Mountain West regions, for example, electricity is highly carbon intensive because it is produced in large part using coal. In contrast, electricity production from natural gas, nuclear, and renewables is more common in the Northeast and West (Mathur and Morris 2012). Households that use energy predominantly for driving (which typically requires burning petroleum products) will have different carbon intensities compared to households that use energy predominately for heating or electricity.

Figure 2 displays how U.S. states differ in the carbon intensity of their energy expenditures (the dark blue bars) as well as the percentage of their electricity generation from coal-fired power plants (the light blue dots). The states with the highest carbon intensities are those that rely most heavily on coal for electricity production (e.g., Wyoming, West Virginia), and those with the lowest carbon intensities use little coal (e.g., Idaho, District of Columbia). Figure 2 is an imperfect depiction of

FIGURE 2

CARBON INTENSITY BY U.S. STATE



Notes: State electricity generation, energy use, and fossil fuel consumption 2013 data is from U.S. EIA 2015b. Emissions rates are averages for major types of fossil fuels from U.S. EIA 2015c.

household carbon intensity because the data include emissions from commercial and industrial energy usage, but electricity sources do not differ markedly across customer classes in a given region.

Effects of a Carbon Price on Expenditures Across Socioeconomic Groups

We now turn to empirical estimates of the effects of a carbon price on household expenditures across socioeconomic groups. While energy use and carbon intensity are the major determinants of effects in dollar-value terms, the same dollar value effect is felt differently by households of different means. Simply put, poorer households are more vulnerable than wealthier households to changes in energy prices because energy represents a larger portion of their total expenditures. For that reason, effects on household expenditures are most commonly displayed in percentage rather than dollar-value terms—in economic jargon, the effects are "regressive" if the proportional effects on poorer households are larger and "progressive" if the proportional effects on wealthier households are larger.

Figure 3 displays findings of Mathur and Morris (2012), who estimate the short-run effect (i.e., assuming no change in household behavior) on total expenditures of a $15 per metric ton carbon price. U.S. households are separated into 10 evenly sized groups based on their level of annual household expenditures,[3] with poorer groups on the left. The dark blue and light blue bars show how a carbon price increases "direct" and "indirect" household energy expenditures, respectively.

The effects of a carbon price on total household expenditures range from 2.1 percent for the poorest household grouping to 1.3 percent for the wealthiest grouping. The regressivity is caused by the preexisting inequality in the country—since energy expenditures are a larger portion of total expenditures for poorer households,[4] any increase in energy prices will disproportionately harm poorer households. Effects in dollar-value terms are larger for wealthier households.

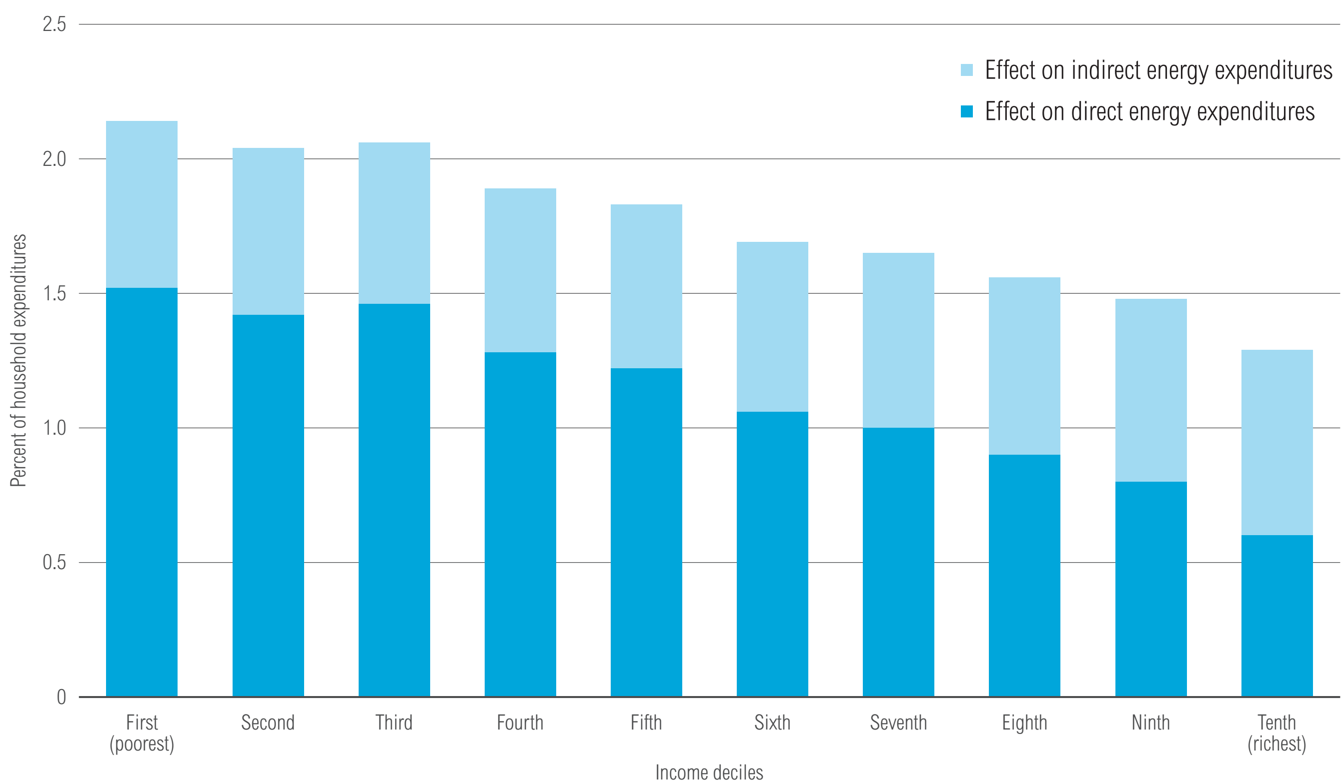
These results are broadly consistent with similar studies (see Hassett, Mathur, and Metcalf 2007; Bull, Hassett, and Metcalf 1994; and Grainger and Kolstad 2010), although studies that focus only on direct energy expenditures (electricity, gasoline, etc.) tend to show larger disparities across groups. As seen in Figure 2, the variation across socioeconomic groups results primarily from the effects on direct energy expenditures (see Bull, Hassett, and Metcalf 1994; Morris and Mathur 2014; and Hassett, Mathur, and Metcalf 2007).

Effects of a Carbon Price on Household Expenditures Across Regions

Similar studies have estimated the effects of a carbon price on household expenditures across U.S. states and regions. As noted above, regional variation in "indirect" energy expenditures is small (Mathur and Morris 2012), so we focus here on the regional variation in direct energy expenditures.

FIGURE 3

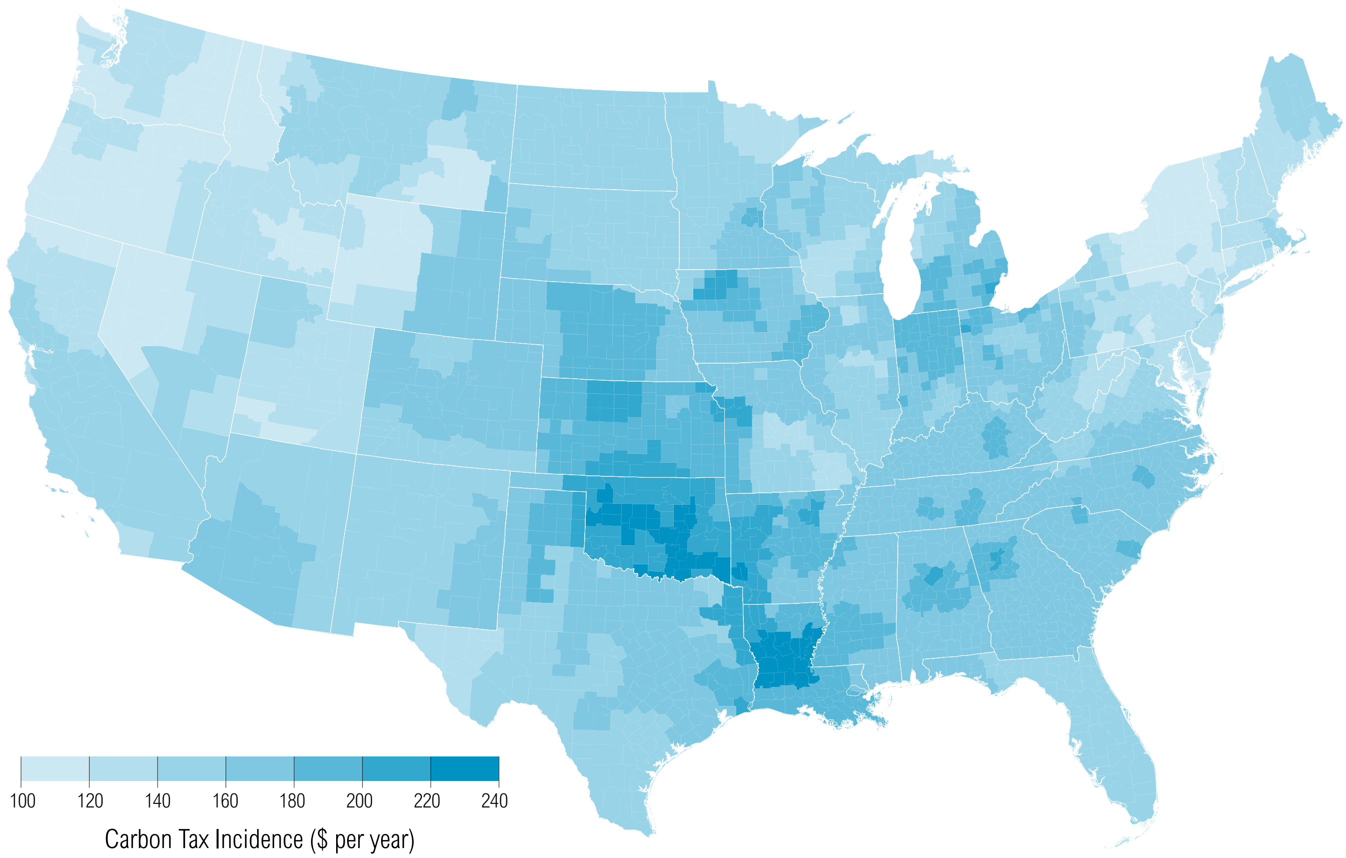
EFFECT OF A CARBON PRICE ACROSS EXPENDITURE GROUPS



Source: Mathur and Morris 2012.

FIGURE 4

ANNUAL EFFECTS OF A CARBON PRICE ON DIRECT ENERGY EXPENDITURES ACROSS U.S. COUNTIES



Source: Pizer, Sanchirico, and Batz 2010.

Figure 4 shows the findings of Pizer, Sanchirico, and Batz (2010), who evaluated the effects on direct energy expenditures of a $10 per ton carbon price for an average household at the county level. Darker shaded counties indicate larger effects on expenditures.

Major causes of regional variation include the source of electricity generation and the need to purchase vehicle fuel. Effects range from under $100 per household per year in certain counties in New York, to over $200 per year in certain counties in Louisiana. Expenditures increase most in rural counties in southeastern, midwestern, and Great Plains states, whereas the Northeast and West are less affected (Williams et al. 2014; Mathur and Morris 2012; and Hassett, Mathur, and Metcalf 2007). Many of the poorest counties in the country are located in the most affected regions, compounding the distributional concerns.

The results of other studies are consistent with these findings—for example, Rausch, Metcalf, and Reilly (2011) find that the central states, ranging from the Dakotas to Texas, would see the largest effects, while the northeastern and western states would be least affected. However, studies with less regional granularity

tend to find less variation, because multiple effects offset one another. For example, households in rural communities must drive farther and have fewer public transit options than those in densely populated areas (Morris and Mathur 2014), so rural communities tend to spend more on motor gasoline and other forms of direct energy goods than their urban counterparts (Williams et al. 2014). But the effects on rural and urban households resulting from differences in gasoline usage are averaged together in state- or regional-level analyses.

Some important caveats are worth mentioning. First, the regions most affected by a carbon price tend to have relatively low electricity prices (Rausch, Metcalf, and Reilly 2011), in part because these prices do not include the full costs of greenhouse gas emissions (Mathur and Morris 2012). To some extent, policymakers may therefore view the regional variation displayed above as "correcting" the artificially uneven distribution of electricity prices across the country. In addition, while there is little quantitative information available on the benefits of carbon pricing across regions, it is likely that the short-term benefits of reduced air pollution will accrue to some of the same communities near coal power plants that see the largest increases in expenditures.

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Of course, assessing the average effects across regions and income groups does not give us all the information we need to design an equitable policy. For example, a recent study found that minorities tend to devote more of their incomes to electricity and natural gas consumption than other populations, so these groups could face a relatively larger burden from a carbon price (Rausch, Metcalf, and Reilly 2011).

Still, understanding how a carbon price affects expenditures across income groups and regions is a necessary first step. This section showed that when the effects on expenditures are isolated, real concerns emerge about the disproportionate burden of carbon pricing on low-income households and on rural and coal-dependent regions. However, the effect on expenditures is just one of the four major effects of a carbon price.

3. EFFECTS ON HOUSEHOLD INCOME OF A CARBON PRICE

A carbon price shifts the costs of climate change from the broader society to those responsible for the emissions, including carbon-intensive businesses. By changing the costs of inputs, a carbon price affects the profits of companies with carbon-intensive production and their lower-carbon competitors, and thus the wages and jobs available at these companies. Household incomes include wages from and investments in these same companies. In this section, we describe how these effects on income differ across households associated with different industries, geographic regions, and socioeconomic groups. Importantly, the full impacts of a carbon price on household incomes also depend on how the carbon pricing revenue is allocated (and the reduced pollution as well), so the effects described in this section do not reflect the entire picture.

For our purposes, it is useful to divide the sources of household income into three categories:

1. Income received from wages (or "labor income")
2. Income received from assets such as investments and land (or "capital income")
3. Income received from the government (or "government transfers")

We first discuss the effects of a carbon price on each income source individually and then combine the three sources to assess the effects across regional and socioeconomic household groups.

Labor Income

Companies that pay the carbon price will pass some of the cost along to their workers in the form of lower wages. The shifting demand for carbon-intensive products and their lower-carbon competitors may also affect the workers in these industries.

The effect of a carbon price on wages receives considerable attention because of the large consequences (positive and negative) for a few professions. The largest losses in jobs and wages will be in the coal industry, whereas jobs and wages will increase for companies that provide low-carbon substitutes (CBO 2010). This represents an acceleration of trends already occurring in the energy sector.[5]

As we discuss in Section 6, the loss of coal industry jobs is already causing significant hardship for workers and their surrounding communities, and a carbon price would exacerbate these problems. Fortunately, the

BOX 2

EFFECT OF A CARBON PRICE ACROSS INDUSTRIES

Multiple factors determine the extent to which firms may be affected by a carbon price, including:

- Carbon intensity of production (compared to competitors)
- Ability to substitute with lower-carbon inputs
- Customers' response to price changes
- Vulnerability to foreign imports (Bassi, Yudken, and Ruth 2009)

NERA Economic Consulting (2013) used a model of the U.S. energy system and economy to forecast the effects of a carbon tax across U.S. industries. The study considered a $20 per ton carbon tax, with revenues used to reduce personal income tax rates and the federal deficit. Figure 5 displays the effects of a carbon price on sector output (dollar value) for the first year of implementation, where the energy sector is separated by fuel types. The negative short-run effects are concentrated within the coal industry because of coal's high carbon content and electricity producers' ability to rapidly switch to less carbon-intensive alternatives (CBO 2010). Output in the electricity sector increases as a result of somewhat higher prices, and the natural gas sector increases in response to substitution away from coal. The effects on other industries are not appreciably different from zero. Perhaps surprisingly, this includes the oil and petroleum product industries—despite their carbon intensity, there are relatively few competitive substitutes for gasoline and diesel, so consumers are relatively unresponsive to price changes in the short run (Kaufman, Obeiter, and Krause 2016).

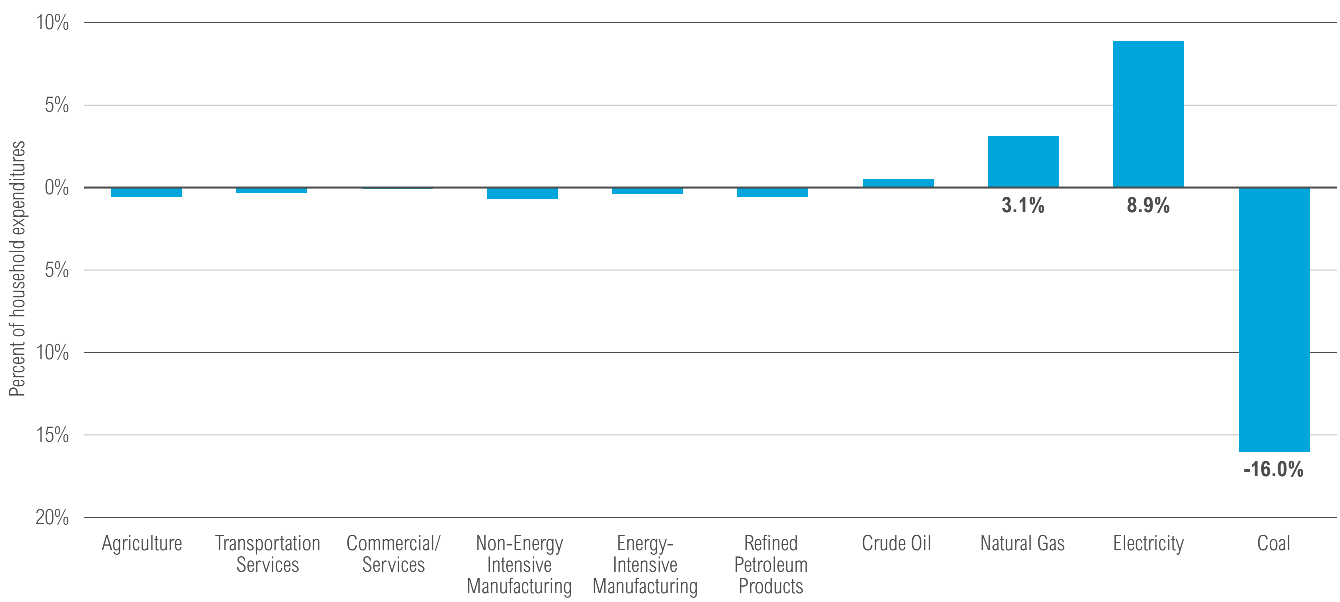
The long-run effects are likely to be quite different than those displayed in Figure 5. For example, renewable energy will expand significantly over time as a carbon price accelerates the growth of solar and wind energy (Kaufman, Obeiter, and Krause 2016).

The effects on manufacturing industries appear small in Figure 5, but individual companies and subsectors may see larger effects over time. According to Ho, Morgenstern, and Shih (2008), the manufacturing sectors that would experience the largest declines are chemicals and plastics, primary metals, and nonmetallic minerals.

The impacts on any industry (or subindustry) can be alleviated by using the carbon pricing revenue to compensate the industry.

Industries that are both energy-intensive and subject to foreign competition (often referred to as energy-intensive trade-exposed [EITE] industries) may be particularly vulnerable if their competitors are not subject to similarly stringent climate regulations. The effects on trade-exposed industries and the methods for alleviating these effects and/or compensating these companies are beyond the scope of this paper. However, it is worth noting that studies have found these effects to be small—Aldy and Pizer (2011) concluded that a $15 per ton carbon price would cause EITE industries to lose roughly 1 percent of output to foreign competition—and a relatively small portion of carbon pricing revenue could be used to mitigate these effects using tax credits or free emissions allowances (Weber and Peters 2009; Aldy and Pizer 2011). As more countries and subnational regions institute climate change regulations, the possibility that a carbon price will place disproportionate regulatory burdens on U.S. companies decreases.

FIGURE 5 | SHORT-RUN EFFECTS OF A CARBON PRICE ON U.S. SECTOR OUTPUT



Source: Data from NERA Economic Consulting 2013.

carbon pricing revenues represent a unique opportunity for substantial investments in coal communities that are struggling with or without a carbon price.

For most industries, a modest carbon price will bring only minor short-run effects (see Box 2), caused by changes in the cost of carbon-intensive inputs. Consequently, the effect of a carbon price on labor income for the vast majority of households will be close to zero, though slightly negative on average (before accounting for revenue uses) (Rausch, Metcalf, and Reilly 2011).

Capital Income

While the effects on jobs and wages receive the headlines, recent studies indicate that the effects of a carbon price on capital income are larger than the effects on labor income (Rausch, Metcalf, and Reilly 2011). In other words, households will experience a larger proportional change in their investment income than in their wages. Why? Carbon-intensive production is more capital intensive and less labor intensive compared to the rest of the economy (Cole and Elliott 2005). A shift to a less carbon-intensive economy increases demand for labor relative to capital, and therefore decreases returns on capital (i.e., investment income) relative to returns on labor. These effects are small: Rausch, Metcalf, and Reilly (2011) show that a $20 per ton carbon tax causes capital incomes to fall by less than 1 percent. They find effects on labor income that are even smaller.

Effects on capital income cause fewer distributional concerns compared to the effects on labor income. Wealthier households tend to own more capital than low-income households, and while wage income is typically derived from a single sector, households tend to receive their capital income from a diversified portfolio of investments (that can be changed relatively easily), so very few households will see large effects on their capital income as a result of a carbon price (Elmendorf 2009). Large shareholders of coal companies are an exception.

Income from Government Transfers

A carbon price will cause labor and capital income earners to lose a small amount of purchasing power, because the increased cost of carbon-intensive inputs leads to a small increase in prices across the economy. In contrast, recipients of a large percentage of government transfer income—notably Social Security payments, Supplemental Social Security payments, and veterans' benefits—receive annual cost of living adjustments that preserve their purchasing power. Fullerton, Heutel, and Metcalf (2012) estimate that over 90 percent of government transfer payments are indexed to the overall price level. Therefore, recipients of government transfers largely will not lose purchasing power when prices increase.

Effects of a Carbon Price Across Socioeconomic Groups

Figure 6 separates U.S. households into ten evenly-sized groups by annual income ("income deciles"), with the poorest households on the left. For each grouping, the portion of total income from wages, capital income, and government transfers are displayed. Government transfers represent over 50 percent of the income of the poorest two groups, whereas capital accounts for a large share of total income only for the richest group. Wage income is significant across all groups, and it accounts for the largest portion of income for middle-class households.

> The finding that a carbon price may not be regressive even before accounting for the revenue is noteworthy, and contrary to the conclusions of prior studies that focused on expenditures alone.

In analyzing the effects of a carbon price, recent studies have isolated the effects on sources of income alone (i.e., ignoring effects on expenditures, uses of revenues, and environmental benefits), and these studies have found that the effects on household income are progressive (Rausch, Metcalf, and Reilly 2011; Fullerton, Heutel, and Metcalf 2012). The results of Rausch, Metcalf, and Reilly (2011) are displayed in Figure 7, where

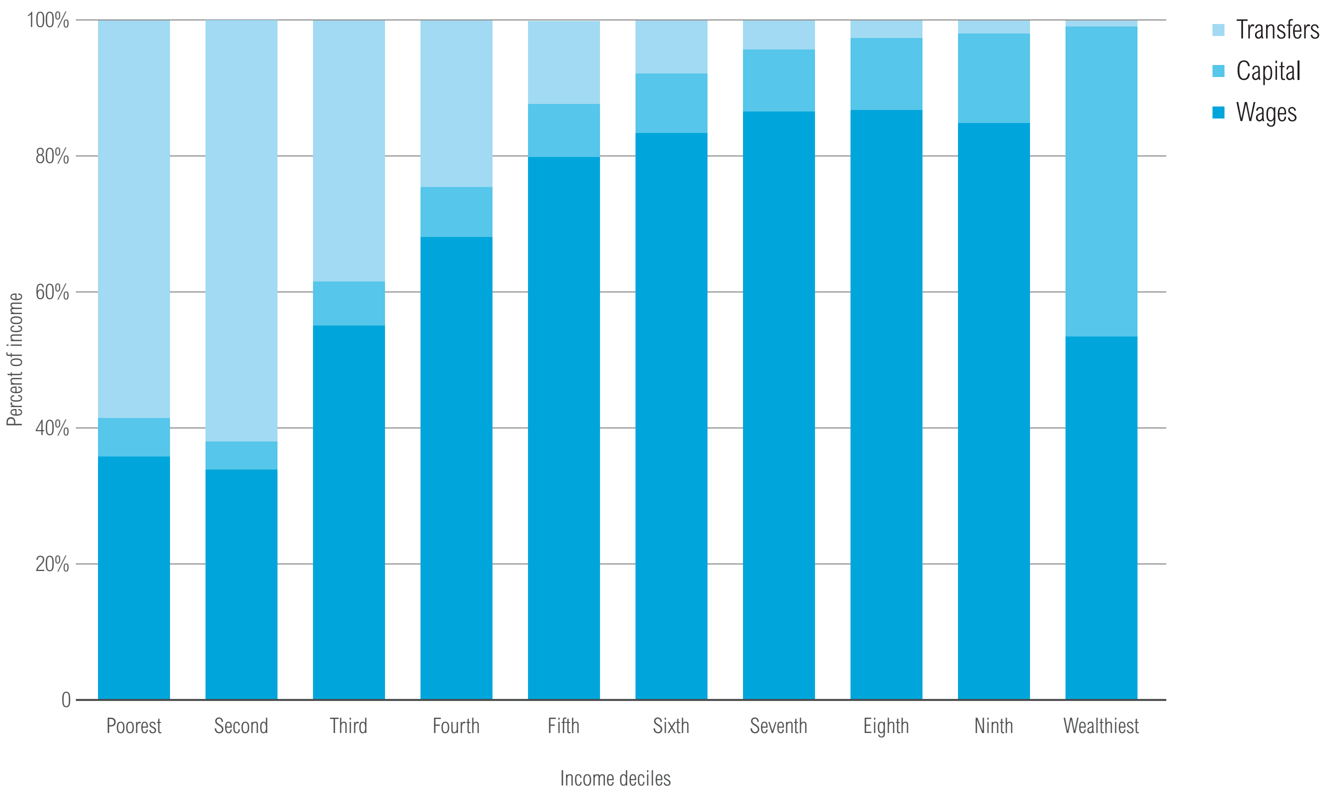
households are again divided into 10 evenly-sized income groupings. The dotted dark blue line shows effects of a $20 per ton carbon price on sources of income alone (as a portion of total household income). This line increases from left to right, indicating a smaller burden on poor households due to their reliance on transfer income, whereas higher-income households are somewhat worse off because of their greater reliance on capital income. Rausch, Metcalf, and Reilly (2011) also isolated the effects on household expenditures, which are represented in Figure 7 by the solid light blue line for comparison.

The authors found that the distributional effects of a carbon price on household expenditures and household income roughly offset each other, so that the combined effect of a carbon price (ignoring revenue uses) is roughly even across socioeconomic groups.

These results should not be interpreted to mean that all poor households are well positioned to cope with the effects of a carbon price, or that measures to protect poor households from increased expenditures are unnecessary. Of the 10 percent of Americans with the lowest annual expenditures, one-third do not receive government transfers and thus are likely to be worse off than these results imply (Fullerton, Heutel, and Metcalf 2012). In addition, the majority of government transfers are payments for Social Security, and while recipients of Social Security may technically be low-income households, many are living off considerable savings; in contrast, recipients of unemployment benefits or food stamps are more likely to be poor, and these payments do not increase automatically with the price level.

FIGURE 6

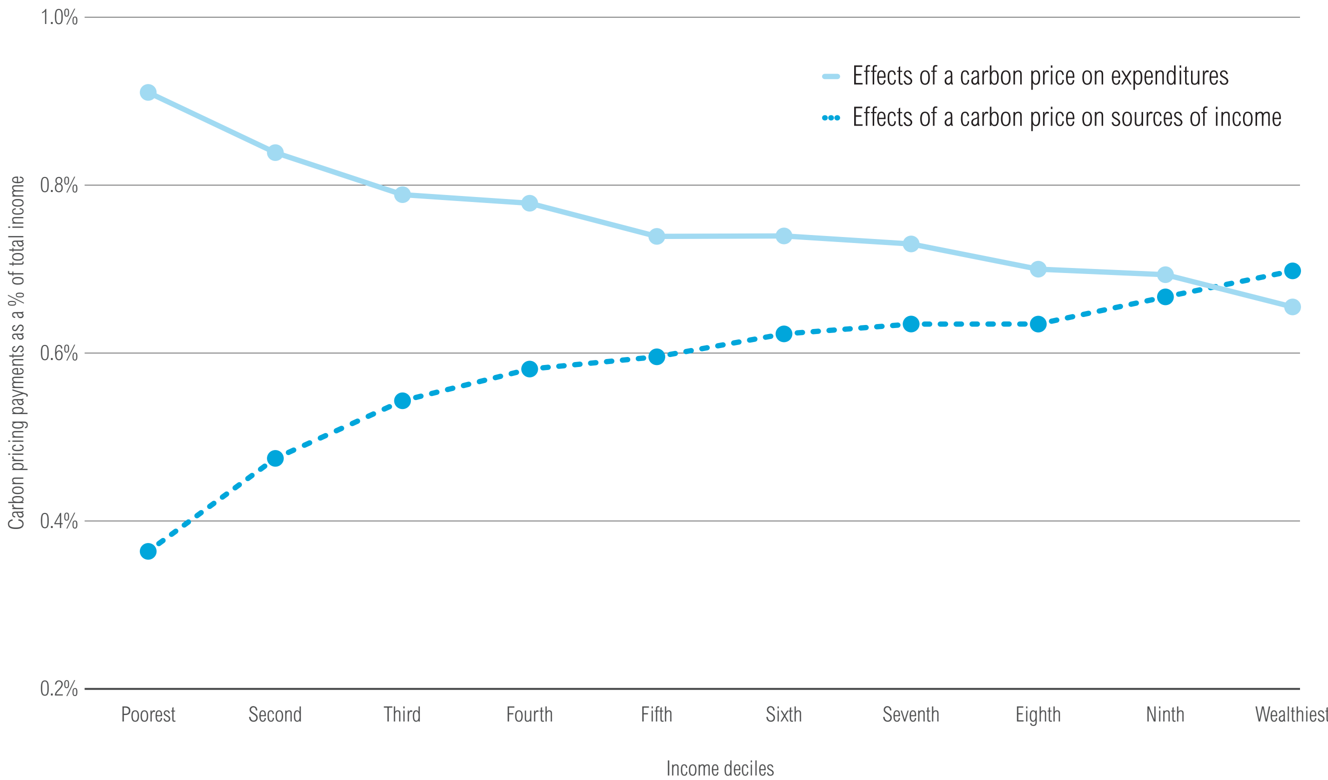
SOURCES OF INCOME BY ANNUAL INCOME DECILES



Source: Fullerton, Heutel, and Metcalf 2012.

FIGURE 7

EFFECT OF A CARBON PRICE ON SOURCES OF INCOME AND EXPENDITURES (IGNORING REVENUE USES)



Source: Rausch, Metcalf, and Reilly 2011.

In addition, as we discussed above, households with income dependent on carbon-intensive industries like coal are likely to be worse off than the average household.

Still, the finding that a carbon price may not be regressive even before accounting for the revenue use is noteworthy, and contrary to the conclusion of prior studies that focus on expenditures alone (see, e.g., Parker 2014). It suggests that offsetting the burden of a carbon price on poor households is more manageable than previously feared.

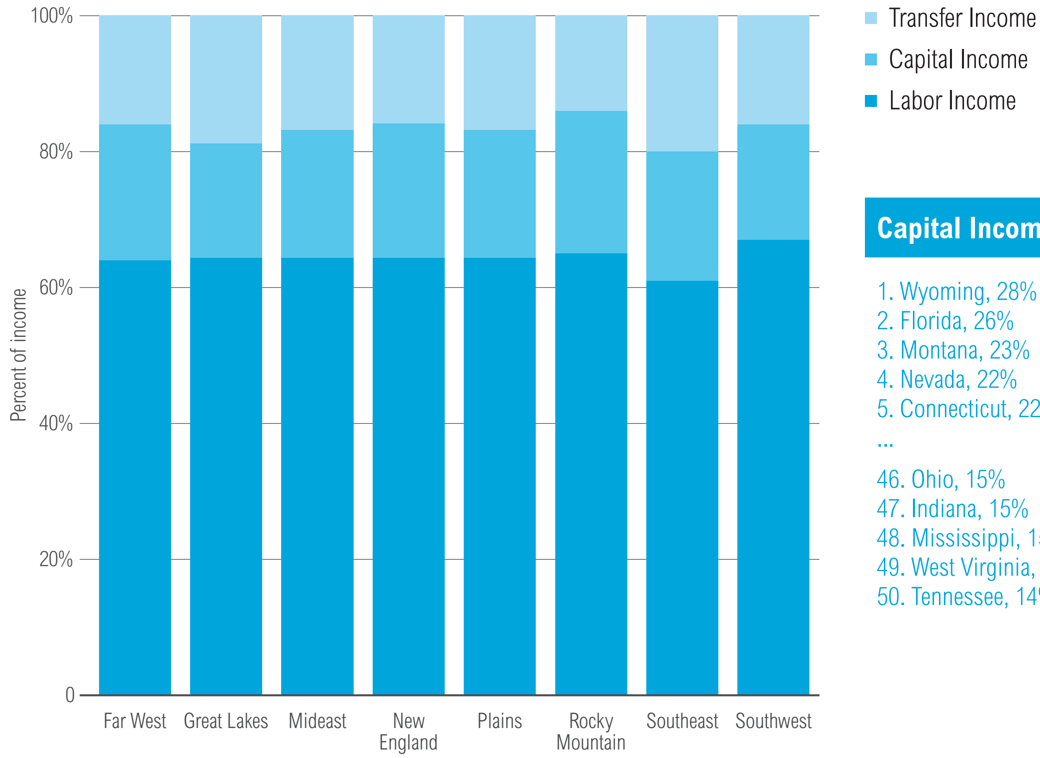
Sources of Income Across Regions

The foregoing discussion suggests that a dependence on different income sources (i.e., investments, wages, transfers) will make some regions of the country more vulnerable to carbon prices than others. However, empirical data suggest the regional variation in the effects of carbon price on household income is likely to be relatively small.

Using data from the Bureau of Economic Analysis, Figure 8 summarizes the components of personal income across U.S. regions and states. The Southeast relies somewhat more on transfer income than other regions, which (at least to some extent) counteracts the larger effects of a carbon price on expenditures in that region. There is more variation at the state level, but in every state, the

FIGURE 8

SOURCES OF INCOME BY U.S. REGION



Capital Income	Transfer Income
1. Wyoming, 28%	1. West Virginia, 27%
2. Florida, 26%	2. Mississippi, 25%
3. Montana, 23%	3. Kentucky, 24%
4. Nevada, 22%	4. Arkansas, 23%
5. Connecticut, 22%	5. Maine, 23%
...	...
46. Ohio, 15%	46. Maryland, 13%
47. Indiana, 15%	47. Virginia, 13%
48. Mississippi, 15%	48. Colorado, 13%
49. West Virginia, 14%	49. North Dakota, 12%
50. Tennessee, 14%	50. Wyoming, 12%

Source: WRI calculations using data from U.S. Bureau of Economic Analysis.

majority of income is derived from wages. West Virginia is least reliant on capital income and most reliant on transfers, whereas Wyoming is in the opposite position.

Figure 8 shows that regional differences in household income are small and thus unlikely to be a major cause for distributional concerns. These data also suggest that studies assuming all effects of carbon price are incurred through household expenditures will overstate the variation in regional effects.

The more important geographic variation is likely to take place at the level of towns and communities, particularly where the effects on the coal industry are hardest felt (Elmendorf 2009). Designing an equitable carbon price will require addressing these localized effects, as we discuss in Section 6.

4. EFFECTS ON HOUSEHOLDS OF CARBON PRICING REVENUE

The payments of a carbon price become government revenues in the form of either carbon tax payments or auction allowance proceeds (in the case of a cap-and-trade program with an auction). The government can use these revenues in a variety of productive ways—for example, to reduce taxes or the federal deficit, to invest in renewable energy or climate

change adaptation, or to address any distributional concerns arising from a carbon price. This is a key advantage of carbon pricing over alternative emissions reduction policies—while all policies have distributional consequences, revenue allocation is a built-in mechanism available to carbon pricing policy designers to alleviate distributional concerns. The distributional effects of a carbon pricing policy cannot be evaluated accurately without considering how the revenue is used.

In this section, we discuss the effects across regions and socioeconomic groups of commonly proposed uses of carbon pricing revenue, focusing on the four introduced in Table 1 and discussed below. Of course, policies need not allocate revenue for a single purpose, and many possible revenue uses are omitted from Table 1 (deficit reduction and clean energy investments, to name two).

Rebates to Households

The first option we consider is to return the carbon pricing revenue to U.S. households in the form of equal "lump-sum" rebates. Among other possibilities, this could be accomplished with a refundable income tax rebate or by periodically sending checks to households, similar to what was done as part of the 2008 "economic stimulus" bill (Williams 2008). Ensuring that all households receive the rebate is not straightforward, particularly for low-income households—this problem is discussed in detail in the next section.

The distributional effects of a rebate approach depend to some extent on how the payments are determined (for example, does each individual receive equal payments, or each household?). Regardless of the details, if all socioeconomic groups and geographic regions are treated similarly, then rebating carbon pricing revenues to households creates an overall carbon pricing policy that is highly beneficial to lower-income households (Morris and Mathur 2014). Why? Wealthier households pay a disproportionate portion of the carbon price in dollar terms (recall that the results in the previous two sections were largely displayed in percentage terms). With equal rebates and smaller carbon pricing payments, lower-income households get back far more than what they paid.

For the same reason, poorer regions of the country fare better when carbon pricing revenues are rebated to households (Williams et al. 2014). Regions that are wealthier and more reliant on capital income fare worse because they pay more for the carbon price. In studying the distributional effects of a $21 per metric ton carbon price with equal per capita rebates, Burtraw, Sweeney, and Walls (2009) found that the poorest 20 percent of households in every region benefit (as a group) from the policy, and the

TABLE 1

COMMON CARBON PRICING REVENUE USE ALTERNATIVES

Revenue Use	Possible Mechanisms	Rationale
Household rebates	Periodic checks Income tax rebates	Returns payments to households Highly progressive
Labor income tax swap	Reduced payroll tax rates Reduced personal income tax rates on wage income	Returns payments to workers Increases incentives to work and develop skills
Capital income tax swap	Reduced corporate income tax rates Reduced personal income tax rates on capital income	Returns payments to capital owners Increases incentives to invest and work
Rebates to regulated entities	Freely allocated allowances Tax exemptions	Returns payments to businesses

gains range from $361 per year for poor households in Texas to $87 per year for poor households in northeastern states.

Labor Income Tax Swap

Another possibility is to use carbon pricing revenue to displace the government revenue earned from other taxes, thus enabling the government to lower tax rates (this is often referred to as a "tax swap"). Decreasing taxes on labor income would increase workers' after-tax incomes.

Unlike the household rebate approach, the rationale for using carbon pricing revenue for a labor income tax swap is generally unrelated to distributional concerns. Reducing labor tax rates can encourage workers to work more and to invest in their skills, because they are able to retain a larger portion of their pretax incomes. Increased workforce participation leads to a stronger overall economy (Dinan 2015).

The distributional consequences of a labor income tax swap depend on which tax rates are reduced. One common proposal is to exempt wage income up to a certain level from payroll taxes, so that the benefits would accrue to virtually all workers (Metcalf and Weisbach 2009; Williams et al. 2015). Studies have shown that such a tax swap could be distributionally neutral, or perhaps even progressive if the applicable income is capped at a relatively low level (because the income cap represents a far larger portion of total income for poorer households) (Morris and Mathur 2014; Metcalf 2007). This approach would not benefit those out of the workforce—of the poorest 20 percent of U.S. households, nearly half would not receive any benefit from payroll tax rate reductions (Dinan 2015).

Other approaches to labor income tax swaps could have very different distributional consequences. If labor income tax rates were lowered across the board, the largest benefits would accrue to households that rely most on wage income and those that pay the most labor income taxes (in dollar-value terms). As shown in Section 3, middle-class households are most reliant on labor income. Because the U.S. tax code is highly progressive—the richest 0.1 percent of U.S. households pays 37.9 percent of total U.S. income taxes (Desilver 2015)—higher-income households pay a disproportionate share of labor income taxes. So, while workers across the socioeconomic spectrum would benefit from the reduced tax rates, middle- and high-income households would receive larger benefits in dollar-value terms. Still, a labor income tax swap could result in a roughly even distribution of effects across income groups, because the payments of the carbon price are larger for middle- and high-income households as well.

The regional variation in the effects of a labor income tax swap is largely driven by the socioeconomic effects. In other words, if a policy benefits higher-income households, it will tend to benefit more affluent regions of the country. Because of its potential to provide large benefits to middle-class workers, studies have found that the labor income tax swap can provide a more even distribution of effects across U.S. states and households compared to the alternative revenue uses assessed in this section (Burtraw, Sweeney, and Walls 2009; Williams et al. 2014).

Capital Income Tax Swap

Carbon pricing revenue could also be used to fund reductions in taxes on capital income, for example, by reducing the corporate income tax rate, the capital gains tax, or the tax on dividends. Marron and Toder (2015) found that a carbon price starting at $20 per metric ton could fund a reduction in the corporate income tax rate from 35 percent to 25 percent.

The rationale for a "capital income tax swap" is similar to that for the labor income tax swap. Increasing after-tax investment returns provides incentives for increased investments across the economy. By encouraging work and investment, reductions in capital income tax rates can provide a strong boost to the economy (Williams et al. 2014; Williams and Wichman 2015). (In fact, most studies show that the benefits to the overall economy of reducing capital taxes are larger than the benefits of reducing labor taxes [Williams et al. 2015].)

The primary beneficiaries of reduced capital income taxes are those who own capital, and capital is disproportionately owned by the richest households (Bovenberg and Goulder 2001). Lower-income households own little capital and thus receive little benefit from reduced capital income taxes (except perhaps for the indirect benefits of a stronger economy). As a result, while capital income tax swaps may be the most beneficial to the overall economy, they are highly regressive (Williams et al. 2014).

The regions and states that benefit most from a capital income tax swap are those with a large share of capital income (of course, the benefits

would not automatically accrue to all residents of these states). Capital income is more unevenly distributed throughout the country than labor income, so the benefits of capital income tax swaps will accrue more unevenly across states (Mathur and Morris 2012).

Rebates to Regulated Entities

The final alternative we consider in this section is to rebate carbon pricing revenues to regulated entities, such as carbon-intensive energy producers, manufacturers, and importers. Under a cap-and-trade program, this could be achieved by freely allocating emissions allowances. In that case, the value of the allowance would still be factored into the prices of carbon-intensive products—thus causing the desired shift in purchasing behavior—but producers would not have to pay for their emissions. This was the approach taken by most early pollution pricing programs, such as the Acid Rain Program for sulfur dioxide emissions in the United States. Under the European Union Emissions Trading System (EU ETS), the manufacturing industry received 80 percent of its allowances for free in 2013, which will decrease annually to 30 percent by 2020 (European Commission 2013).

This approach compensates carbon-intensive companies and can smooth the transition to paying the carbon price, thus reducing the propensity of regulated companies to cut costs in their production processes and lay off workers. Allocating free allowances can also protect U.S. businesses from unfair competition with foreign companies not subject to similarly stringent regulations, and it may buy valuable political support from the regulated industry.

However, rebating all (or a large percentage) of the carbon pricing revenue to regulated entities is likely to significantly overcompensate them, because a substantial portion of the carbon price is paid by households (via increased expenditures) rather than businesses. Indeed, in multiple European countries in the early years of the EU ETS, electricity companies earned windfall profits by charging their customers for the "opportunity cost" of allowances they received for free (Brown, Hanafi, and Petsonk 2012).

Providing rebates to specific regulated entities would likely be highly regressive, with regional and socioeconomic effects similar to the capital income tax swap (Rausch, Metcalf, and Reilly 2011), but without the associated improvements in economic efficiency. The largest beneficiaries would be owners of fossil fuel companies and the geographic regions in which they are concentrated. Like other capital, these companies are primarily owned by affluent households.

For these reasons, while providing vulnerable industries with free emissions allowances may be politically attractive, this usage of carbon pricing revenue should be temporary and targeted to specific purposes.

5. COMBINED EFFECTS ON HOUSEHOLDS OF CARBON PRICE AND REVENUES

In this section, we combine the effects of a carbon price on (1) household expenditures; (2) sources of household income; and (3) revenue use. We rely primarily on the results of two recent studies by scholars at Resources for the Future (Williams et al. 2014, 2015) that forecast the effects on U.S. households across regions and income groups of a \$30 per ton carbon price with three different revenue allocations: (1) rebates to households (with equal per capita rebates); (2) reduced labor taxes (on all labor income); and (3) reduced capital taxes (on all capital income). The simulation model accounts only for short-term changes in price and behavior, and not for any long-term adjustments to the economy resulting from the carbon pricing policy. The benefits of reduced climate change and local air pollution are also omitted.

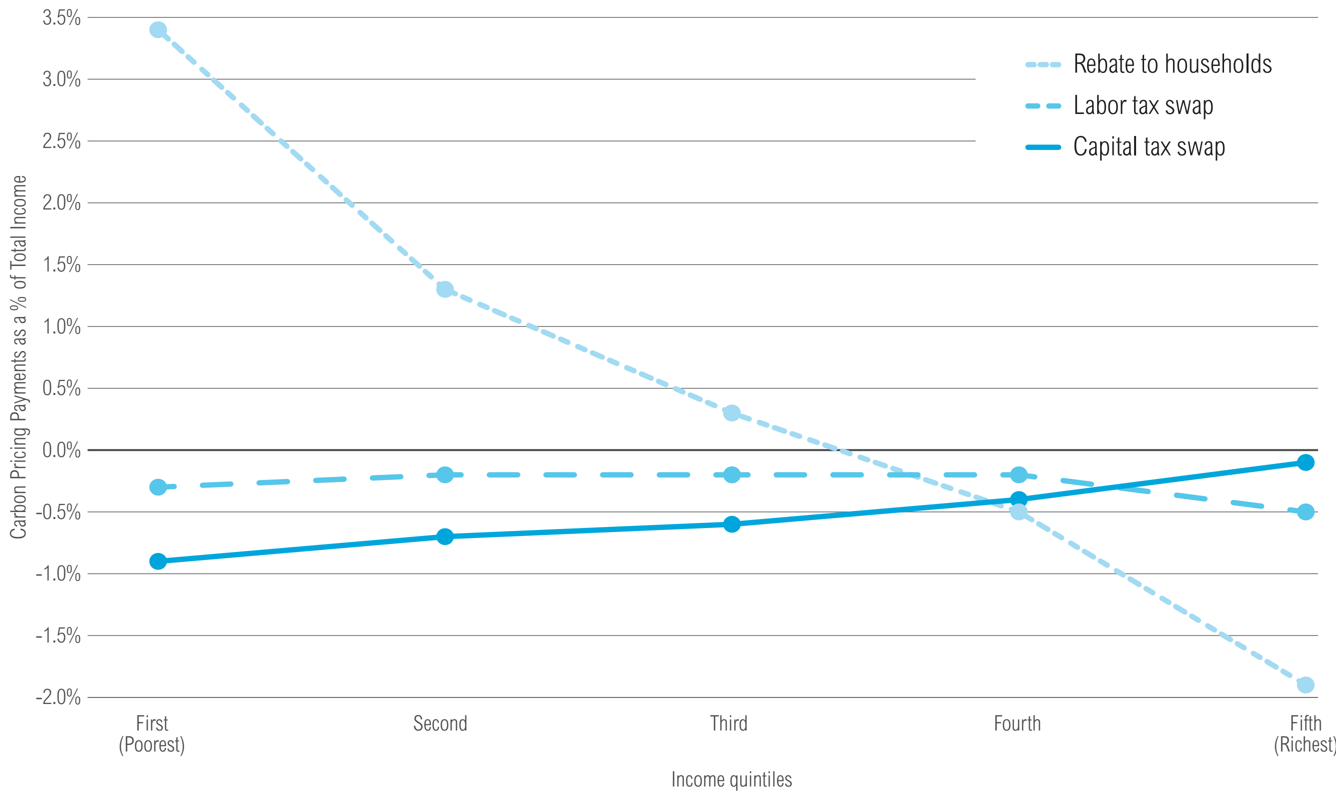
Effects of a Carbon Pricing Policy Across Socioeconomic Groups

Figure 9 summarizes the effects on total income for households divided into five evenly-sized income groupings, with the poorest households on the left. The impacts of a \$30 per ton carbon price are small—less than 1 percent of total income in most cases. The capital tax swap is somewhat regressive, with effects ranging from a 0.9 percent decrease for the poorest group to a 0.1 percent decrease for the richest group. The household rebate scenario is highly progressive—the average household in the lowest three income groupings benefits from the policy, whereas the average household in the richest group sees income fall by just under 2 percent. The effects of the labor tax swap are relatively even across the income groups.

Other studies have come to the same conclusions—rich households fare best under tax swaps, while poor households benefit most from a rebate approach. For example,

FIGURE 9

EFFECTS OF THREE CARBON PRICING POLICIES ON TOTAL INCOME ACROSS SOCIOECONOMIC GROUPS



Source: Data from Williams et al. 2015.

Rausch, Metcalf, and Reilly (2011) find that a per capita rebate is progressive across the income distribution, whereas lowering personal income tax rates (which includes capital and labor income) is mostly regressive.[6] Mathur and Morris (2012) find that a labor income tax swap is regressive across the income distribution and a capital income tax swap is mostly regressive.[7]

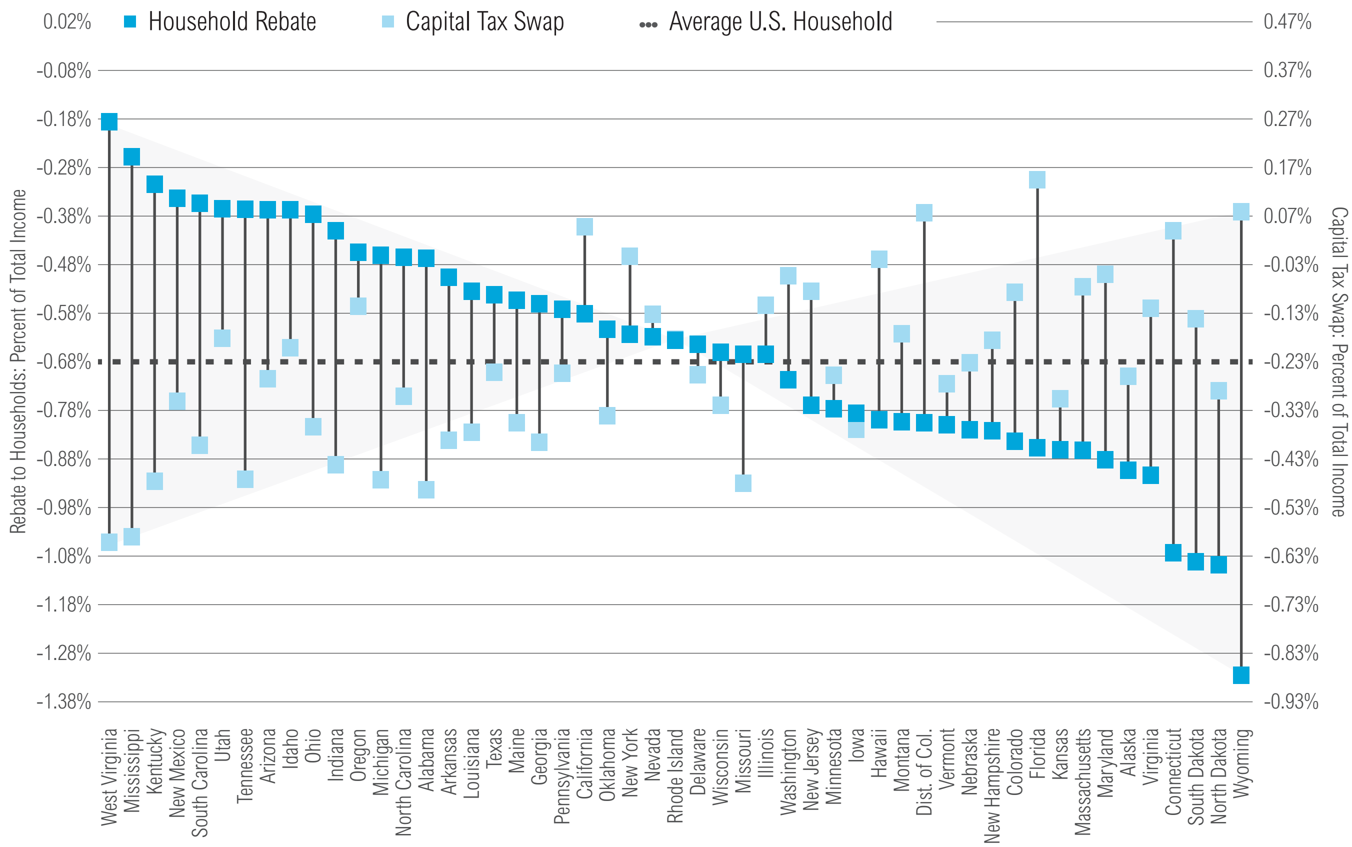
Effects of a Carbon Pricing Policy Across U.S. States

Williams et al. (2014) estimated the corresponding effects of the same $30 per ton carbon price on incomes in all 50 states and the District of Columbia. Figure 10 displays the results (in terms of percentage of total income) for the capital tax swap and household rebate approaches (displayed as light blue boxes for the capital tax swap and dark blue boxes for the household rebate)—dotted black line in the center denotes the performance of the United States as a whole, with markers above the line indicating that the state performed better than the country as a whole.

With revenues used for household rebates, effects on income range from a loss of 0.3 percent for West Virginia to a loss of 1.3 percent for Wyoming. Relatively less affluent and less capital-intensive states fare

FIGURE 10

EFFECTS OF TWO CARBON PRICING POLICIES ON TOTAL INCOME ACROSS U.S. STATES



Source: Data from Williams et al. 2014.

best—this includes most southern and midwestern states. Using revenues for a capital income tax swap, effects on income range from a gain of 0.7 percent for Florida to a loss of 0.6 percent for West Virginia. This approach is most beneficial to relatively affluent states (such as those in New England, the mid-Atlantic, and the western regions) and capital-intensive states like Florida and Wyoming. Similar to the results on income groupings, Williams et al. (2014) found that the labor income tax swap produces a more even distribution across states than the two alternatives displayed in Figure 10.

Figure 10 clearly shows that the use of carbon pricing revenue is more influential in determining the regional effects of the policy than the payments of the carbon price. States that fare better than the country as a whole with the household rebate approach tend to fare worse under a capital tax swap, and vice versa. Over 40 states perform better than the United States as a whole under one of these two approaches, and no state performs considerably worse than the country as a whole under both approaches.

It is worth noting again that the state-level results are not indicative of how all residents within the state will fare. For example, the overall income gains to the state of West Virginia under the household rebate

approach or the state of Wyoming under the capital tax swap approach would be a small consolation to affected coal workers in these states.

***

These findings show that the distributional effects of carbon pricing policies cannot be assessed comprehensively without accounting for the uses of revenue—a carbon price is not inherently regressive or progressive, and it does not need to disproportionately burden any U.S. state. In fact, the distributional consequences of the revenue uses tend to outweigh the distributional consequences of the payments of the carbon price. This is great news for policymakers trying to design an equitable carbon pricing policy, because, unlike with the distributional effects of the carbon pricing payments, policy designers have a large degree of control over the distributional consequences of the revenue use. In the next section, we discuss how carbon pricing revenues can be targeted efficiently to ensure an equitable outcome, while leaving the majority of revenue to accomplish other important objectives.

6. ADDRESSING DISTRIBUTIONAL CONCERNS WITH CARBON PRICING REVENUE

In the previous section, we showed that different revenue uses can result in very different distributional consequences for a carbon pricing policy as a whole. Furthermore, the potential revenues are sufficiently large to more than offset the adverse effects of paying the carbon price on any particular region or socioeconomic group. This section focuses on how revenues can be targeted to address distributional concerns, and how much of the carbon pricing revenue needs to be allocated to distributional concerns to produce an equitable policy. By using revenues efficiently, policymakers can retain the vast majority of the revenue to accomplish other important policy objectives.

We start with a few general points. First, there is no "right answer" to the question of how to allocate carbon pricing revenue. Combinations of possible revenue uses are virtually infinite, and the ideal allocation depends on the priorities of policy designers and their constituents. For our purposes, we assume that the goal of policy designers is not to create outcomes that are identical for every household, or even distributionally neutral, but rather to ensure that the policy does not unfairly impose costs on households that cannot afford to pay them. However, a carbon price cannot and should not be seen as a cure for all preexisting distributional concerns—other policies will be needed to solve problems that carbon pricing did not cause. In addition, while we assume the carbon pricing revenue alone can be used to "correct" for distributional concerns caused by the carbon price, in reality, such relief could also come from other policies or by adjusting the wider tax code (Metcalf 2007).

Finally, if a carbon price may adversely affect a group of individuals or businesses, this does not in itself mean the group should be compensated. A carbon price corrects a market failure—by imposing the costs associated with greenhouse gas emissions on producers and consumers responsible for emissions rather than on the broader society—and the government should not provide support for all companies that can no longer compete once this correction is made. After all, old technologies are replaced by new technologies all the time, and the process of "creative destruction" is a key tenet on which our economic system is based.

The distributional consequences of the revenue uses tend to outweigh the distributional consequences of the payments of the carbon price. This is great news for policymakers trying to design an equitable carbon pricing policy.

Support for low-income households and the workers in vulnerable industries is a different matter, however. These groups should be protected from disproportionate harm not only because compassion toward the poor and the unemployed is a worthy policy objective in itself but also because having concentrations of unemployed workers or households that cannot pay their electricity bills harms the economy. In the remainder of this section, we discuss how targeted revenue uses can provide support for these groups.

Fortunately, with regard to vulnerable workers, we have shown that large adverse effects of a carbon price are likely to be primarily limited to the coal industry in the short run. Effects on other industries tend to be smaller and more gradual.

Support for Low-Income Households

According to government statistics, about 15 percent of Americans live in poverty (U.S. Census Bureau 2010). Many simply cannot afford any price increases, including those that accompany a carbon price. To compensate low-income households with carbon pricing revenue as efficiently as possible, policymakers should be guided by the following set of objectives:[8]

- The revenue use should specifically target low-income households (as opposed to all households).
- The revenue use should reach as many of the country's low-income households as possible.
- The administrative costs required to implement the approach should be minimized.
- The revenue use should not interfere with the price signal that causes emissions reductions.

There is no "silver bullet" that is best across all criteria (Dinan 2015), but a patchwork of revenue uses can effectively target a large portion of low-income households at a relatively low cost. For example, a recent proposal by the Center on Budget and Policy Priorities (Stone 2015) recommends a three-pronged delivery mechanism for efficiently delivering a cash rebate to low-income households:

1. Lower-income working households would receive their rebates through a refundable income tax credit (similar to the Earned Income Tax Credit).
2. Beneficiaries of Social Security and certain other federally administered benefit programs (many of which are likely to be missed by the tax credit mechanism) would receive their rebates as supplements to their regular payments.
3. Very low-income families would receive their rebates as payments through state human service agencies using the electronic benefit transfer (EBT) system used to deliver food stamp benefits—many of these households would not receive either the tax credit from #1 or the federal benefits from #2.

Stone (2015) finds that the CBPP approach would automatically cover about 95 percent of the poorest U.S. households. Of course, coordination among agencies would be needed to ensure that households do not receive duplicative payments.

The amount of carbon pricing revenue needed to protect low-income households depends on the details of the policy. A similar program proposed under the "Waxman-Markey" cap-and-trade bill would have been funded with 15 percent of total carbon pricing revenue, and studies found that the policy would have disproportionately benefited low-income households (Stone 2009). Recent studies by Morris and Mathur (2014) and Dinan (2015) indicate that the poorest one-fifth of households could be made whole using 11 and 12 percent of total carbon pricing revenues, respectively. Neither of these studies account for the progressive effect of a carbon price on sources of household income (explained in Section 3), so 11 to 12 percent of revenue may be more than necessary.

An approach similar to the CBPP proposal has certain key advantages over other commonly discussed alternatives for compensating low-income households:

- *Using all revenue for equal household rebates.* As shown in Section 4, the equal household rebate approach would disproportionately benefit lower-income households. But the majority of rebates would go to middle- and higher-income households, so this approach does not efficiently target low-income households. As a result, less revenue is available for other objectives—this sacrifices a major benefit of carbon pricing.
- *Reducing energy bills.* Given that consumers will pay a large portion (although not nearly all) of the carbon price through their home energy bills, it is tempting

BOX 3

HOW CARBON PRICING POLICIES AND PROPOSALS HAVE PROTECTED LOW-INCOME HOUSEHOLDS

Special provisions to protect low-income households have commonly been incorporated into carbon pricing policies and proposals around the world, although each program has used a different approach.

California passed the Global Warming Solutions Act in 2006, creating (among other policies) a statewide cap-and-trade program that launched in November 2012. In 2012, the state passed another law (SB 535) requiring that at least 25 percent of cap-and-trade revenues be directed to programs that benefit disadvantaged communities. The California Environmental Protection Agency and California Air and Resources Board developed a unique environmental justice mapping tool to identify the most disadvantaged communities to which funding is directed. These communities are areas with disproportionately high levels of pollution, poverty, unemployment, and low levels of educational attainment (Sanchez 2015). The first round of California's SB 535 funding allocated $272 million to programs benefiting disadvantaged communities, including investments in public transit, affordable housing, weatherization for homes, renewable energy, cleaner vehicles, and urban forestry (Greenlining Institute 2014). For example, one project in Sacramento received $90 million in funding to install rooftop solar for over 1,600 low-income families, with the objectives of providing savings on energy bills as well as work training and employment opportunities to low-income workers (Sanchez 2015).

British Columbia's carbon tax is required by law to be revenue-neutral, so all revenue generated through the tax must be used to offset other taxes. The British Columbia Low Income Climate Action Tax Credit is designed to offset the burden of the carbon tax on low-income households. The size of the tax credit is based on household size and adjusted net income, so it decreases as a household's income increases (Government of British Columbia 2015). In the 2013–14 fiscal year, about 16 percent of the carbon tax revenue ($194 million) was directed toward low-income tax credits. Studies of the distributional effects of the British Columbia carbon tax have concluded that it has been highly progressive (Beck et al. 2015).

The Waxman-Markey cap-and-trade program (which passed the U.S. House in 2009 but failed in the Senate) was designed to protect low-income households in two ways. First, the policy created a rebate program that would deliver electronic monthly payments using the same debit cards states used for food stamps and other benefits. Low-income households were eligible to apply for the rebate, and households were automatically enrolled if they received food stamps or if they participated in the Supplemental Security Income (for elderly and disabled low-income households) or Medicare prescription drug programs. Second, recognizing that a significant number of low-income nonelderly workers without children may not participate in the rebate program, the policy compensated these individuals by expanding the portion of the Earned Income Tax Credit (a subsidy to income paid by the IRS) for workers without children. Analysis indicates that the Waxman-Markey cap-and-trade bill (as well as the "Kerry-Lieberman Bill," the major cap-and-trade bill considered by the U.S. Senate) would have overcompensated low-income households as a group for their payments of the carbon price (Rausch, Metcalf, and Reilly 2011; Stone 2009). This does not mean that all low-income households would have benefited; for example, Stone (2009) notes that renters of poorly insulated apartments would not have been fully compensated for their payments of the carbon price.

Finally, two current proposals for carbon taxes in the U.S. Congress each contain provisions that target low-income households for relief. The bill proposed by Senators Sheldon Whitehouse (D-RI) and Brian Schatz (D-HI) provides an annual tax credit to all workers of the lesser of 6.2 percent of earned income or $500 (or $1,000 for joint returns), and it allocates up to $20 billion per year to individual states that can only be used to assist low-income and rural households (U.S. Senate 2015a). Under the carbon tax proposed by Congressman John Delaney (D-MD), low-income households would receive lump-sum rebates to offset increased energy bills (U.S. House of Representatives 2015).

to consider directly returning money to consumers by way of rebates on their energy bills—low-income consumers could be targeted specifically by using the existing Low Income Home Energy Assistance Program. But doing so would "hide" the price change from the consumer, thus dampening (or even reversing) the incentive to use less electricity.[9] Under a carbon tax, this would imply fewer emissions reductions compared to alternative revenue uses. Under cap-and-trade, it would increase the costs of achieving the emissions cap. Allocating revenue to electric utilities to pass along to their customers would be a similarly inefficient approach—higher-income customers (including businesses) would benefit, and utilities might pass along a portion of the revenue to their shareholders as well.

Support for Coal Industry Workers

A carbon pricing policy will accelerate the progress and market penetration of low-carbon technologies to the detriment of carbon-intensive technologies, and jobs will inevitably be gained and lost in the process. While economists continue to debate the net effect of carbon pricing on jobs in the economy, that debate is irrelevant to the need to support vulnerable workers, because the workers losing jobs in the coal industry are rarely the same people as those gaining jobs in solar and wind. Studies suggest that a moderate carbon price could cause a loss of 10 to 20 percent of coal industry jobs in the initial years of the policy (see CBO 2010; NERA Economic Consulting 2013), and workers at companies in the coal supply chain would likely be affected as well.

Over half of the coal miners in the country are concentrated in rural communities in West Virginia, Kentucky, and Pennsylvania, where the adverse effects of job losses could spread through local economies (NMA 2013). Households in these communities also rely on pensions from coal companies and government support funded by coal severance taxes. These communities are already struggling with higher unemployment rates (Hendryx and Ahem 2009) and poorer health outcomes (Hendryx and Ahem 2008, 2009) compared to the rest of the country, and a carbon price has the potential to make a bad situation even worse.

At the same time, the revenue from a carbon price represents a unique opportunity to help coal communities. Support could come in many forms, and a certain degree of flexibility may be wise given that the effects of market-based regulations are impossible to predict with precision. Important components may include expanding unemployment and health benefits, providing job search assistance and job training, supporting community development and infrastructure projects, and providing direct monetary assistance. In addition, to the extent that coal industry communities are populated with low-income households, these communities will benefit from the support for low-income households through the approaches described above (though for families with workers who have lost their jobs, this assistance alone will surely be insufficient).

Recent proposals to protect coal industry workers and their communities could be funded with carbon pricing revenue. For example:

- In July 2015, a bipartisan group of U.S. senators (including Joe Manchin [D-WV], Shelley Capito [R-WV], Bob Casey [D-PA], Sherrod Brown [D-OH], Tim Kaine [D-VA], John Warner [D-VA], and Pat Roberts [R-KS]) introduced the Miners Protection Act, which would ensure lifetime pensions and health benefits for coal miners and their families, even when their former employers go bankrupt or become insolvent. Under the proposal, the funds would be taken from a government program that cleans up abandoned mines (U.S. Senate 2015b).
- In 2015, Senators Bernie Sanders (I-VT), Jeff Merkley (D-OR), and Ed Markey (D-MA) proposed legislation that included $41 billion in job transition assistance for coal, oil, and gas workers. The funding would come from tax payments of fossil fuel and other corporations (U.S. Senate 2015c).
- In 2015, as part of its annual budget, the Obama administration proposed the POWER+ Plan to provide transitional assistance to coal communities. The plan would provide over $55 million in job transition assistance and "economic diversification strategies" to coal communities, $1 billion to the reclamation and economic revitalization of abandoned mine land communities, and $2 billion to tax credits and incentives for the deployment of carbon capture technology (White House 2015).

- Hillary Clinton's presidential campaign has proposed a $30 billion plan to revitalize coal communities with a wide array of support and investments (Hillary for America 2015).
- Multiple states, including coal-reliant states like West Virginia and Wyoming, have established trust funds for state residents financed by severance taxes on the extraction of natural resources (Richardson 2015).

Carbon pricing revenues could provide a large and stable source of revenue for the funds and proposals mentioned above or for other measures to support coal communities.

Compared to the size of the economy, the coal industry is small. The coal mining industry employs about 75,000 workers (U.S. EIA 2015a), or 0.057 percent of the U.S. workforce. The combined annual salaries of these workers are about $4.5 billion.[10] For comparison, a carbon price of $30 per metric ton is likely to generate annual revenues in the neighborhood of $150 billion per year (Williams and Wichman 2015). Thus, carbon pricing revenue is likely to be over 30 times larger than the combined salaries of all workers employed in the coal mining industry.

Detailed studies of specific policies are needed before determining an appropriate amount of carbon pricing revenue to allocate to coal industry workers. But all recent carbon pricing proposals have included some degree of support for coal workers. Representative Delaney's carbon tax proposal allocates up to 2 percent of revenues to pay for worker retraining, relocation expenses, early retirement, and health benefits (U.S. House of Representatives 2015). The carbon tax bill proposed by Senators Whitehouse and Schatz takes a slightly different approach, allocating up to $20 billion per year to states to assist low-income and rural households, including transition assistance for coal workers (U.S. Senate 2015a). The Waxman-Markey bill would have created a program called Climate Change Worker Adjustment Assistance, operated by the U.S. Department of Labor. This program would have offered 156 weeks of cash benefits, job training and search assistance, and a subsidy for healthcare costs to workers who lost jobs as a result of the bill's provisions (CBO 2009). In addition, similar to most cap-and-trade programs, the legislation would have supported the industry by freely allocating emissions allowances to regulated entities.

Coal communities are struggling across the country without carbon pricing, and short-term outlooks are not promising (see, e.g., Gutman 2015). According to the U.S. EIA (2015a), total coal industry employment decreased 10.5 percent between 2012 and 2013 alone, and this downward trend is likely to continue as more coal plants retire and total production decreases. While a carbon pricing policy would raise the price of coal, it would also provide an important opportunity to support these vulnerable communities with carbon pricing revenues, and get workers back on their feet.

7. DISCUSSION

In this issue brief we have described the multiple effects of a national carbon price on households, and how these effects vary across regions and socioeconomic groups (summarized in Table 2 below).

As consumers, households are affected through their expenditures on energy products and services like electricity, gasoline, and home heating, as well as their spending on other goods and services that are energy-intensive to produce. As workers and investors, household incomes are affected through the performance of companies that produce carbon-intensive products.

Carbon pricing revenues can be used to counteract these effects, and policymakers are likely to allocate revenue in multiple ways (e.g., tax reductions, investments in clean energy, rebates), each of which will have very different consequences on households across regional and socioeconomic groups. Finally, while we have focused primarily on the costs of the policy, the significant health and economic benefits of reduced climate change and local air pollution are likely to differ across regional and socioeconomic groups.

Studies of the distributional effects of carbon pricing policies have identified various trends across regions and socioeconomic groups, which we summarize in Table 2. But the most important finding of empirical studies is that the carbon pricing revenue is the most influential factor determining the policy's overall distributional effects. In other words, the effects of a carbon price on households across regions and socioeconomic groups depend on the design of the policy. Congress can design a policy that does not disproportionately burden any region of the country or major socioeconomic group.

TABLE 2

SUMMARY OF MAJOR EFFECTS OF A CARBON PRICE ON HOUSEHOLDS ACROSS REGIONS AND INCOME GROUPS

	Determinants of variation across households	Summary effects of carbon price across income groups	Summary effects of a carbon price across U.S. states/regions
Household expenditures	■ Amount of energy consumed ■ How energy is used ■ How much the price of energy changes (based on carbon intensity of energy use)	■ Regressive for "direct" energy expenditures ■ No major trend in "indirect" energy expenditures	■ Coal-dependent regions are most affected ■ Rural households see larger effects than urban households ■ No major trend in "indirect" energy expenditures
Sources of household income	■ Labor income (wages) ■ Capital income (interest, dividends, profits) ■ Government transfers	■ Likely progressive because of reliance of high-income households on capital income and low-income households on government transfers	■ Wealthier states see larger effects than poorer states ■ Capital-intensive states are most affected
Revenue use	■ (Depends on policy design)	■ Rebates to households are progressive ■ Capital tax swaps and rebates to regulated entities are regressive ■ Labor tax swaps can be progressive or regressive ■ Relief targeting low-income households can be highly progressive	■ Rebates to households benefit poorer regions ■ Capital tax swaps benefit wealthier regions ■ Labor tax swaps have similar effects across regions ■ Targeted relief could benefit coal communities and low-income regions

In order to design an equitable carbon price, however, we will need to consider more than the average household across regional and socio-economic groups, because this focus misses important variation within the groups. Of particular concern are the effects on two vulnerable groups: (1) coal industry workers and (2) low-income households.

A carbon price will accelerate the transition away from the use of coal to produce electricity. The decline in coal production will cause job losses for workers dependent on the industry, compounding the serious problems coal communities already face. Fortunately, these effects are small compared to the carbon pricing revenue, and the revenue provides an opportunity to develop a multi-billion-dollar annual rescue package to support struggling coal workers and their communities and help them transition to new livelihoods.

Recent studies suggest that contrary to previous findings, payments of the carbon price (as a proportion of total income) may be similar for households across the income spectrum. Nevertheless, many low-income households cannot afford any increase in expenditures, and carbon pricing revenues should be used to ensure the policy does not drive any household deeper into poverty. Studies suggest that efficiently targeting a small portion of revenue (perhaps as low as 10 percent) to low-income households can fully offset their payments of the carbon price.

Depending on the policy design, revenues may need to be targeted to alleviate other distributional concerns as well. But that will not change the general conclusion that a small portion of carbon pricing revenues is sufficient to offset the distributional concerns caused by a carbon price. The vast majority of the revenue can be used for other important purposes.

The United States has pledged to reduce its greenhouse gas emissions by 26–28 percent below 2005 levels by 2025, and by over 80 percent by 2050. In the absence of carbon pricing, other policies will be relied on to make progress toward these targets. Like carbon pricing, alternative policies have distributional consequences that would need to be addressed. For example:

- Emissions standards for energy producers often lead to higher energy prices, and thus similar effects as a carbon price on household expenditures (but typically without producing government revenue).
- The benefits of government spending on low-carbon subsidies often accrue to corporations and higher-income households that can afford the subsidized products (e.g., electric vehicles).
- Similarly, the benefits of government spending on energy efficiency programs often accrue to higher-income households that purchase more of a given product or appliance.

The distributional effects of a carbon pricing policy should be compared to realistic alternatives rather than to an unrealistic "no climate policy" scenario. While different approaches can be used with alternative policies, a large stream of government revenue is a powerful tool for easing distributional concerns, and thus a key advantage of pricing carbon.

These conclusions are uplifting and contrary to much of the public rhetoric on carbon pricing, which typically focuses only on how energy prices are affected. A carbon pricing policy is not inherently regressive, and it need not harm any particular region of the country. Pricing carbon generates revenues, and policy designers can use this revenue to alleviate distributional concerns and create an equitable carbon pricing policy.

A carbon pricing policy is not inherently regressive, and it need not harm any particular region of the country.

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ENDNOTES

1. Under a cap-and-trade program, emissions allowances can be given away for free, in which case no revenue would technically be generated. But this is conceptually identical to raising revenue and then allocating it to those who receive the free allowances.

2. Grainger and Kolstad (2010) estimate that an average household in the poorest 20 percent of households would pay around $325 per year, while an average household in the wealthiest 20 percent would pay around $1,140 per year under a $15 per ton carbon tax. However, because low-income households spend a larger portion of their incomes on energy (see Morris and Mathur 2014), the poorest households' burden as a portion of their annual expenditures is 1.4 times that of the wealthiest households.

3. It is also common for studies to divide the expenditure effects by household income. But annual consumption is generally considered a better proxy for lifetime earnings than annual income, because households that do not have high yearly earnings are not necessarily poor. Retired individuals and graduate students tend to consume similar quantities of goods during low-income years as they would during high-income years, so using annual income as a measure of affluence skews the relative wealth of these populations. See Rausch, Metcalf, and Reilly (2011); Hassett Mathur and Metcalf (2008); and Mathur and Morris (2012).

4. For example, while the poorest 10 percent of households spend about 5.8 percent of their incomes on electricity and 2.2 percent on natural gas, the wealthiest 10 percent only spend 1.8 and 0.8 percent of their incomes on electricity and natural gas, respectively. Thus, these energy-related expenditures are a much larger portion of the poorest households' total budgets (Rausch, Metcalf, and Riley 2011).

5. For more information, see New Climate Economy 2014.

6. The one exception is that the poorest income decile fares slightly better than the second-poorest income decile (Rausch, Metcalf, and Reilly 2011).

7. Mathur and Morris (2012) find that for a capital tax swap, between the fourth and seventh income grouping (out of 10 total income groups), the higher-income households fare worse on average; otherwise, the distribution of effects across the income groupings is regressive.

8. These objectives are based on the criteria used by the CBO to evaluate different revenue-use options. See Stone (2015); and Dinan (2015).

9. Consumers could be provided with a lump-sum rebate to their energy bills that does not affect the marginal price of energy and therefore, in theory, does not encourage increased energy use. In reality, it seems likely that the behavior of many or most consumers depend on their total energy bill rather than the marginal price of electricity.

10. According to the U.S. Bureau of Labor Statistics, the average annual salary of all occupations in the coal mining industry is $55,740.

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ABOUT WRI

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Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

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CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

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