U.S. POLICY

A CARBON TAX IN BROADER U.S. FISCAL REFORM: DESIGN AND DISTRIBUTIONAL ISSUES

CENTER FOR CLIMATE AND ENERGY SOLUTIONS

by

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FOREWORD Eileen Claussen, President, Center For Climate And Energy Solutions

Economists generally agree that a price on carbon would be the most efficient means of reducing the emissions that are the major cause of global climate change.

This report by Adele Morris and Aparna Mathur, economists with the Brookings Institution and the American Enterprise Institute respectively, examines the issues and options for designing one type of carbon pricing mechanism—a carbon tax. The authors find that a $16 tax on carbon could raise more than $1.1 trillion in the first 10 years and more than $2.7 trillion over a 20-year period. A broader tax base that included emissions of other greenhouse gases (e.g., non-energy carbon dioxide and methane) would raise even more revenue. This mechanism could be included in a revenue-neutral tax reform bill that reduces taxes on productive activities, such as labor, investment and saving, by establishing a tax on harmful pollution.

Several countries, as well as a number of sub-national governments around the world, have established carbon taxes, or energy taxes based on the carbon content of fuel. Several more are studying the idea because of its price certainty, revenue potential, and use of market forces to reduce emissions at the lowest-possible cost. In California, for example, the Senate President pro Tempore recently introduced a bill that would place a carbon tax on transportation fuels as an alternative to including the fuels in California's cap-and-trade program.

Other U.S. states may soon follow suit—the U.S. Environmental Protection Agency's regulation of carbon dioxide emissions from power plants could give states the choice between imposing traditional command-and-control regulations and establishing a more efficient pricing mechanism, such as a carbon tax.

At this point, political considerations, rather than economic analysis, are driving many policymakers' views of a carbon tax. We respectfully offer this report in the hopes of tipping the balance towards a more substantive debate of a topic with critical implications for our economy, environment, and national security.

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EXECUTIVE SUMMARY

Economists refer to the climatic damages of human-induced greenhouse gases as "external costs" because the emissions impose a cost on society that is not reflected in the prices of goods and services that produced them. Policymakers can correct this market failure by putting a price on greenhouse gas (GHG) emissions, for example by taxing GHG emissions, and thereby cost-effectively reducing emissions through market forces. A GHG emissions tax would reduce emissions by changing the relative prices of fuels and other goods and services according to their emissions intensity. Such a tax would also produce revenue, raising the option of including the measure in a broader package of fiscal reforms. The largest source of greenhouse gas emissions is carbon dioxide from the combustion of fossil fuels, so many economists particularly advocate an excise tax on the carbon content of those fuels, or a "carbon tax." (The terms "carbon tax" and "GHG emissions tax" are used interchangeably throughout this report, unless specified otherwise.)

This report examines the issues and options for designing a carbon tax in the United States. It reviews the rationales for a carbon tax in the context of broader fiscal reform, explains the design issues, describes the potential revenue and environmental benefits, and explores options for using the revenue. The paper's key points include:

A well-designed carbon tax could improve the long-run U.S. fiscal situation while reducing emissions. For example, estimates suggest that a tax on the carbon content of fuels in the energy sector that started at $16 per ton of carbon dioxide in 2014 and rose at 4 percent over inflation per year would raise more than $1.1 trillion in the first 10 years and more than $2.7 trillion over a 20-year period. A broader tax base that included emissions of other greenhouse gases (e.g., non-energy carbon dioxide and methane) would raise even more revenue. The long-term revenue and emissions reductions would depend on a host of hard-to-predict factors such as economic growth and the evolution of energy technologies.

The carbon tax with the least economic cost would be predictable, start modestly, ramp up gradually, and minimize administrative costs.

- Over the long run, the price on carbon should be consistent with the "social cost of carbon," as best as it can be estimated, and it can be updated as new information develops. A gradual and predictable policy would promote efficient turnover of long-lived industrial plants and equipment, allow households to adjust with minimal disruption, and incentivize innovation and deployment of new technologies. Some economists recommend that the real rate of increase in a tax should match the returns on relatively low-risk capital assets, which is about four or five percent above inflation.
- A tax applied as broadly as feasible to fossil fuels, non-energy sources of carbon dioxide emissions, and other greenhouse gases (based on their global warming potential relative to carbon dioxide) would deliver the same incremental incentive to reduce emissions in all sectors, and therefore be the most economically efficient.
- A carbon tax could be applied either "upstream," where the fossil fuels enter the economy, or "downstream," where the carbon is emitted to the atmosphere. An upstream tax on the carbon content of fossil fuels could price 80 percent of U.S. greenhouse gas emissions by taxing fewer than 3,000 entities, thus minimizing administrative costs while offering broad coverage.
- Carbon that is not emitted, for example because it is sequestered underground or embodied in long-lived products, should be eligible for a tax rebate or credit.

A carbon tax could create opportunities within a tax reform package that may not otherwise exist. Taxing something we do not want (e.g, greenhouse gas emissions) rather than something we want more of (e.g., productive labor and investment) could help lower the economy-wide cost of the program and may even have economic benefits in addition to its environmental benefits.

- The overall economy-wide effects of a carbon tax would depend on three factors: the price increases that result from the tax (i.e., who bears those prices and by how much); the final disposition of the carbon tax revenue (i.e., how the revenue is used); and how these changes would ripple through the broader economy.
- Including a carbon tax as part of a broader fiscal reform could ameliorate the potential regressivity of a carbon tax, which could result because lower-income individuals may spend a larger share of their income on energy. Directing about 15 percent of annual revenues toward households whose incomes fall below 150 percent of the poverty line would ensure that the poorest fifth of households would not be made worse off under a carbon tax. Regional variations in the burden of a carbon tax as a share of income would be modest due to regional patterns of fuel consumption and use, but some particularly coal-intensive states could face relatively larger burdens.
- Revenues from a carbon tax could fund reductions in other taxes. As seen in **Table ES,** policymakers could:
  - Reduce the U.S. statutory marginal corporate income tax, currently the highest in the developed world, while simplifying the tax provisions that allow most corporations to pay far lower effective rates.
  - Reduce payroll or personal income taxes, prevent cuts in social safety net spending, and reduce the federal budget deficit.

A carbon tax could reduce the need for other climate and energy policies. An appropriate tax would lower GHG emissions and spur clean energy innovation, making less-efficient energy and climate policies unnecessary.

- One scholar estimates that about $6 billion in annual direct and tax expenditures for clean energy deployment could be replaced with a modest carbon tax with the same impact on deployment.
- A broad national carbon tax could reduce greenhouse gas emissions more effectively and less expensively than sector-by-sector and state-by-state regulation under the Clean Air Act.
- Federal funding for basic research and development would remain important under a carbon tax because those activities would be under-funded by market forces alone.

Emissions leakage and concerns of energy-intensive, trade-exposed industries could be managed under a carbon tax. A number of approaches could apply:

- The carbon tax could start modestly, giving energy-intensive, trade-exposed (EITE) firms time to lower their carbon-intensity.
- A border carbon adjustment could tax select imports of EITE goods from countries with less ambitious climate policy goals.
- The carbon tax revenue could fund reduction in other taxes that make U.S. firms less competitive.
- The United States could use its policy as leverage to encourage other countries to take stronger climate action.

TABLE ES: Summary of Options for Using Carbon Tax Revenue

REVENUE USE	EFFECTS ON ECONOMY	PROGRESSIVE	COMPENSATES THOSE WHO BEAR CARBON PRICE?
Lump-sum rebates to households	Does not lower burden of tax system on the economy. Could boost consumption in a slack economy.	Yes	Likely under-compensates higher-income households.
Reduce federal budget deficit	Economy benefits from lower future tax burdens and greater investment now.	Maybe. Depends on structure of future tax system and who benefits from higher investment.	Maybe
Reduce (or prevent increases in) payroll or labor income taxes	Benefits economy to the extent it encourages more work. Benefits could be substantial.	Depends on implementation. Does not help those without earned income.	Depends. Could under-compensate higher-income households.
Give revenue to utilities to lower electricity rates	Increases costs by blunting incentives to conserve and driving abatement to costlier sectors.	Depends on how it is implemented by state utility regulators.	Yes for electricity consumers, but does not benefit consumers of other energy.
Reduce capital taxes (corporate income tax or capital gains tax)	Economic benefits could be substantial. Some think that using some revenue for an investment tax credit may be even better.	Likely not; the evidence on the incidence of corporate taxes is mixed.	Maybe
Fund climate, energy, and adaptation R&D	Could benefit economy if revenue goes to useful research the private sector would not do otherwise. In large sudden volumes it could bid up the price of research inputs. Total revenue is far more than would be appropriate to devote to only this category.	No	Maybe. Could lower costs of abatement in the future.
Give revenue to states or other sub-federal entities	Depends on what states do with it. Could benefit economy if they reduce deficits or other taxes.	Depends on what states do with it.	Depends on what states do with it.

I. INTRODUCTION

A full assessment of climate policy options requires understanding the policies' potential benefits and costs. Such an assessment necessarily draws from the different technical disciplines that study trends in global temperatures, model the potential impacts of increasing greenhouse gas (GHG) concentrations in the atmosphere, and assess the likely economic impacts of policies designed to abate GHG emissions—including macroeconomic outcomes and distributional impacts.[1] This paper examines the issues and options for designing an economically efficient policy for reducing GHG emissions and leaves the scientific case for such a policy to others.

We start with the premise that policies that charge emitters of GHGs in proportion to the damage caused by their emissions would create widespread market signals that efficiently lower emissions across the economy over time. The price signals would shift consumer demand, drive new investment, and encourage technology development toward less emissions-intensive goods and services. While other environmental policies, such as investments in basic research on low-emissions technologies, might be justified, economists widely agree that a price on GHGs, and carbon dioxide (CO_2) in particular, would be an important element in an economically efficient environmental policy portfolio.[2] There are multiple ways to put a price on carbon, but the two most comprehensive are an emissions tax and a cap-and-trade system. Given the recent focus on tax reform and deficit reduction in the United States, this paper explores the design options and implications of a carbon tax embedded in broader fiscal reform.

When economists talk about a GHG or carbon tax, they generally have several key features in mind. First, the tax would be an excise tax on the carbon content of fossil fuels. It would apply to other sources of CO_2 and non-CO_2 greenhouse gas emissions (with the tax scaled to those gases' heat-trapping properties relative to CO_2) to the extent emitters and emissions are readily identifiable and taxing them would be administratively feasible. Second, the tax would be applied to fossil fuels as they enter the economy, at the choke points in their distribution system so that a large share of emissions could be taxed via a minimum number of firms. Next, the price signal would start modestly (although views differ on what that means) and ramp up gradually in real terms. Finally, the policy would allow tax credits for carbon in fuels that is not subsequently emitted, for example because it is sequestered underground or embodied in a long-lived product, such as plastics. All in all, economists generally recommend that the excise tax be simple and comprehensive, with few exemptions, complications, and ancillary policies. Of course, in practice it may not be that simple. Legislation may diverge substantially from the economists' ideal, and some tax design details raise important challenges for which there is not a single obvious resolution, such as whether and how to address the burdens of the carbon tax on the poor.

This paper reviews options for the design of a GHG tax in the United States. It first surveys the possible justifications for establishing a carbon tax and discusses its potential role in a broader fiscal reform package.[3] We review evidence on how much revenue a carbon tax could raise, and by how much it could reduce emissions. We consider issues such as how to set the carbon price trajectory, options for using the revenue, and the likely distributional effects of different approaches. We also discuss how the tax could allow changes in command-and-control regulation of greenhouse gases and other energy policies, and how to prevent a U.S. carbon price from disadvantaging U.S. firms relative to their competitors in countries that do not equivalently control emissions.

II. RATIONALE FOR A CARBON TAX AND THE CONNECTION TO BROADER FISCAL REFORMS

An externality is a cost or benefit that is not transmitted through market prices. Human-induced greenhouse gas (GHG) emissions are a textbook example of a negative externality. The effect of GHG emissions on the environment will be felt by many individuals who did not directly engage in the activity that led to the emissions. Fossil fuels contain carbon and emit carbon dioxide (CO_2) into the atmosphere when burned. Without a charge for those emissions, the prices for those fuels reflect only the private costs to produce, distribute, and market them. Thus arises the case for an excise tax on the carbon content of those fuels to internalize those external costs and thereby ensure that market prices reflect the full social cost of emitting activities—including the estimated environmental damages of the emissions.[4]

One can compare a carbon tax to other ways of controlling GHG emissions.[5] A carbon tax that is consistent with a reasonable estimate of the marginal social damage from GHG emissions enhances economic efficiency by changing prices to more fully reflect the social costs associated with fossil fuels. In addition, studies have demonstrated that a tax is more efficient than command-and-control regulation in controlling carbon. A carbon tax is more efficient than a command-and-control regulation because it encourages many ways to reduce emissions at least cost, including through energy conservation and fuel switching in power plants.[6] In addition, a federal carbon tax would allow state- and local-level programs to reduce emissions further. In contrast, under a federal cap-and-trade system, additional GHG efforts in some states could free up allowances to allow greater emissions in other states.[7]

A carbon tax is also more efficient than subsidies for clean energy technologies for several reasons. First, it is very hard to target subsidies toward the most cost-effective abatement, both because the government does not know which technologies will be most cost effective and because it is hard to implement a program that is not prone to political favoritism. Second, it is nearly impossible to preclude subsidizing abatement that would happen anyway.[8] Clean energy subsidies can also have the perverse effect of increasing the overall supply of energy and making it cheaper, partly offsetting the benefits of the subsidies. In short, it is easier to be cost effective in discouraging things we do not want than encouraging things we do want.

A carbon tax also promotes pollution-abating innovation, both because it offers relatively higher and more predictable returns from new technologies and because it incentivizes innovation across an array of potential activities. A carbon tax can be straightforward to administer if designed properly, and because an exact dollar figure is assigned, it may indicate a transparent level of effort to other countries, potentially fostering international agreements on environmental policies. And some economic research suggests that given the different structures of the uncertainties in the incremental benefits and costs of an extra ton of GHG abatement, setting a carbon price trajectory may be a better bet than setting annual country-level emissions targets.[9] Of course, over the long run, it is important to ensure that cumulative emissions of all countries do not exceed levels that would risk undue damages.

Scholars have studied the idea of embedding a GHG tax in a broader fiscal reform package. To be sure, tax reform may be hard enough without introducing issues as contentious as a carbon tax. However, a carbon tax could create opportunities within a tax reform package that would not otherwise exist.

First, if we need revenue, taxing something we do not want (e.g., GHGs) rather than something we do want (e.g., productive labor and investment) intuitively makes sense. In other words, a well-designed carbon tax can be more economically efficient than other taxes because it helps correct a market failure as well as raise revenue. A few studies suggest that a carbon tax that substitutes for a more distortionary tax (such as income from investments or working) could even improve welfare irrespective of its environmental benefits by making the tax system more efficient.[10] Of course, there are drawbacks to a carbon tax, which is why embedding it as part of an overall package of fiscal reform is desirable. These drawbacks include the potential regressivity of a carbon tax, meaning it could impose a higher burden on low-income households as a share of their incomes than it would on high-income households. Further, the burden of the tax is likely to be higher in areas that are coal dependent than in areas that use other fuels for electricity. We discuss these and other issues, as well as the potential for a tax swap later in this paper.

Second, a carbon tax can raise significant revenue over at least several decades. How much revenue depends on the tax rate and how quickly emissions fall. For example, estimates suggest that a price on carbon starting at about $16 per ton of CO_2 in 2014 and rising at 4 percent over inflation would raise over $87 billion in the first year and increase to over $190 billion per year 20 years later.[11] The revenue would continue to increase through the following two decades or so, but eventually the decline of the tax base (i.e., emissions) would outpace the increase in the tax rate, and total revenue would fall. Such a decline in revenue could be a fiscal concern but it would also signal the environmental success of the program.

Third, a carbon tax may be regressive, and even if not, it would still burden poor households that can ill afford higher energy prices. It is more economically efficient to address distributional effects through a broader progressive tax reform or targeted spending policy than to rebate the revenue in lump-sum payments to all households. However, a small share of revenue, around 15 percent, targeted to the poorest 20 percent of households would ensure they are no worse off than without the carbon tax.

Fourth, a carbon tax could allow lower clean energy subsidies and less burdensome regulation. Numerous tax expenditures, loan guarantees, and other subsidies currently encourage deployment of renewable energy technologies and related research and development (R&D). With a carbon tax in place, some of those subsidies would compensate investors for what they would do anyway or distort investment toward higher cost abatement. Embedding a carbon tax in broader fiscal reform should allow lower federal direct and tax expenditures on those programs.

Also, without action by lawmakers, the U.S. Environmental Protection Agency (EPA) has started to regulate GHGs under its Clean Air Act (CAA) authority.[12] The CAA, with its emphasis on controlling pollution to specific emissions standards and state-level implementation, is ill suited to controlling GHGs at least cost. However, the CAA is the strongest existing authority the Obama Administration has, and EPA has plans underway to apply Section 111(b) of the CAA to control GHG emissions from new stationary sources and use Section 111(d) of the CAA to control GHG emissions from existing stationary sources.[13] Some analysts believe that innovative interpretations of the law could allow more cost-effective flexibility, but any flexibility measures would likely be tested at length in court.[14]

III. ESTIMATED REVENUE AND EMISSIONS REDUCTIONS

To take just a few of the many studies that have modeled carbon pricing in the United States, this section reviews evidence from five illustrative analyses of a U.S. carbon tax. Like many of the studies in this literature, these five studies estimate the tax revenue and emissions reductions relative to a scenario, called the baseline, in which there is no carbon tax. The results hinge on the tax rate, which greenhouse gas (GHG) emissions fall under the tax, and the particular economic model and assumptions the scholars use. As summarized in **Table 1**, the five studies use different computational economic models to simulate slightly different tax policy scenarios. The policy scenarios start in different years, the carbon taxes start at different levels, and some of the scenarios increase the tax levels at different rates. The studies are listed in order of stringency of the policy considered, going from the lowest price per ton of carbon dioxide (CO_2)-equivalent in 2015 to the highest:

- McKibbin et al. (2012a) use the G-Cubed model to simulate a tax that would equal about $18 per metric ton of CO_2 in 2015 and apply only to CO_2 from the energy sector.

TABLE 1: Illustrative Economic Studies of U.S. GHG Tax Policy Scenarios

STUDY	TAX RATE IN 2015 (PER METRIC TON CO_2-EQUIVALENT, 2012 U.S. DOLLARS)	ANNUAL TAX RATE INCREASE (PERCENT)	ANNUAL REVENUES IN 2030 ($ BILLIONS, 2012 U.S. DOLLARS)	PERCENT EMISSION REDUCTIONS, RELATIVE BASELINE IN 2030	TAX BASE	YEAR POLICY STARTS
McKibbin et al. (2012a)	17.76	4.0 real	196	11	CO_2 from fossil fuels used in the energy sector	2012
Paltsev et al. (2007)	21.16	4.0 real	276	31	CO_2 and other GHGs	2015
Rausch & Reilly (2012)	21.63	4.0 real	183	19	CO_2	2013
Shapiro et al. (2008)	27.27	Variable; Tax increases about $1.80 each year	331	30	CO_2	2010
Rausch et al. (2010)	28.99	4.0 real	295	25	CO_2 and other GHGs	2015

All values are converted to 2012 dollars using the CPI-U deflator. Values in 2015 dollars are converted to 2012 dollars by assuming inflation after 2012 is 2.5 percent per year, following Rausch et al. (2010). Shapiro et. al (2008) nominal carbon price comes from Table A.1 of their report. Metcalf (2010) reports the relevant data from Rausch et. al (2010) in a convenient format.

- Paltsev et al. (2007) use the EPPA model to estimate the tax trajectory necessary to achieve a cumulative emissions goal of 237 billion metric tons of CO_2-equivalent from 2012 to 2050.[15] The tax would equal about $21 per metric ton in 2015 and apply broadly to all GHGs.
- Rausch & Reilly (2012) use the USREP model to analyze a tax of about the same level as Paltsev et al. (2007), but it only applies to CO_2 and not other GHGs.
- Shapiro et al. (2008) use the NEMS model to derive a tax scenario that, if applied globally by 2030, would stabilize CO_2 concentrations in the atmosphere at 450 to 550 parts per million through the end of the 21st century. Instead of constant percent increase in the tax rate, the scenario assumes the each year the tax rate goes up by the same dollar amount.
- Rausch et al. (2010) use the USREP model to simulate congressional cap-and-trade proposals. The focus of the study is on the effect of the measures on households, but the results are also useful for comparison to the other policy simulations presented here.

REVENUES

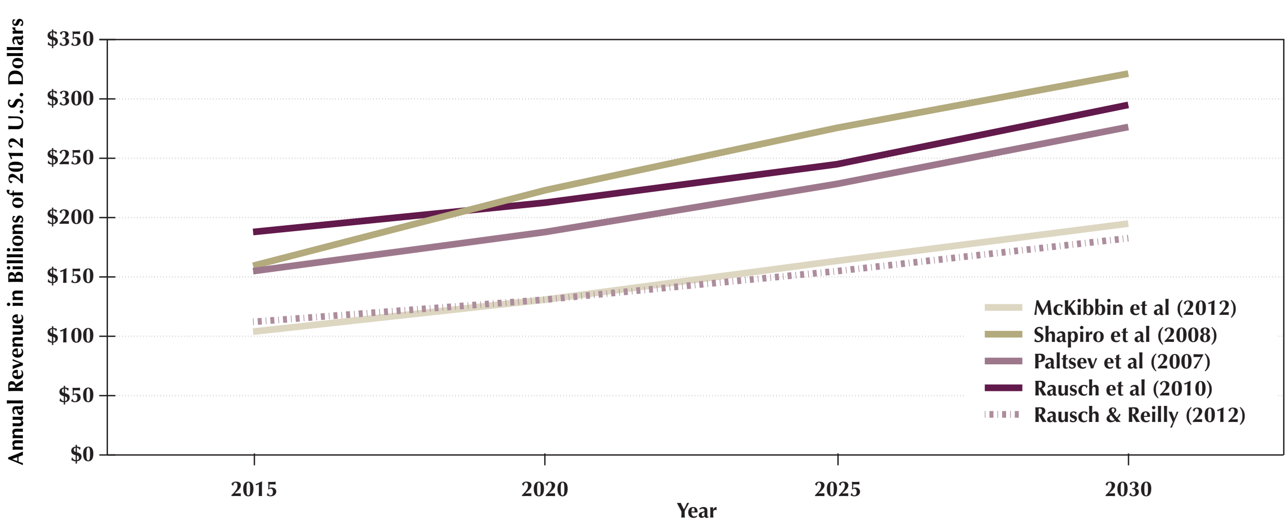
The studies' estimated trajectory of GHG tax revenues from 2015 through 2030 appear in **Figure 1**. All of the studies predict substantial and rising revenues. McKibbin et al. (2012a) estimate revenues of nearly $100 billion in 2015, and all other estimates are at least as high.

Comparing these studies suggests a couple of lessons. First, all else equal, including non-CO_2 gases under the tax will raise more revenue than taxing only carbon. For example, Shapiro et al. (2008) impose a significantly higher tax rate in 2015 than Paltsev et al. (2007) but predict similar revenue in 2015, in part because the Shapiro study taxes only CO_2.

Also, more recent studies predict lower carbon tax revenues than earlier studies because they account for recent trends in the U.S. energy sector and emissions. Two major factors have driven down U.S. emissions since the earlier studies: the great recession and the degree to which natural gas has displaced coal in electricity production. Despite a very similar tax rate, Rausch & Reilly (2012) estimate significantly less revenue than Paltsev et al. (2007). That is because the more recent study only taxes carbon and calibrates to more recent projections of fuel prices and emissions levels. Thus we can conclude that to some extent, the revenue and environmental performance of a carbon tax will depend on trends in the energy sector that are driven by factors other than the tax.

Unexpected technological developments, such as the recent widespread deployment of horizontal drilling and fracking to release large supplies of natural gas, can have a significant effect on emissions, both in the baseline and in the response to a carbon price. These technology developments (and more general macroeconomic trends) could work to make emissions goals harder or easier. One

FIGURE 1: Estimated Carbon Tax Revenue in Five Illustrative Studies



key advantage of the carbon tax relative to many other approaches is that it encourages new technologies exactly in line with their propensity to reduce GHG emissions. It is hard to estimate the returns from aligning technology incentives with abatement goals, but over a long period of time, it is likely to be very important.

Finally, comparing all of these studies suggests that even in the most modest scenario, a U.S. carbon tax could bring in substantial and rising levels of revenue through the first decades of the policy. Section VIII below considers in detail the economics of how to manage this revenue to the benefit of the U.S. macroeconomy and households.

EMISSIONS

Revenue is an important consideration, but the environmental performance of a carbon tax is another critical factor. **Figure 2** graphs the percent reduction in emissions relative to the baseline (for the taxed set of gases) estimated in the five studies.[16] All of the studies estimate significant abatement in taxed emissions by 2030. For instance, Rausch et al. (2010) predict that emissions will fall by about 15 percent in 15 years. With the lowest tax rate, McKibbin et al. (2012a) predictably finds the smallest reduction in emissions, but even in that study, emissions decline by 11 percent relative to baseline by 2030. Paltsev et al. (2007) find that non-CO_2 gas emissions decline at relatively low tax rates. Thus, including those gases under the tax makes sense to the extent that it is administratively feasible.

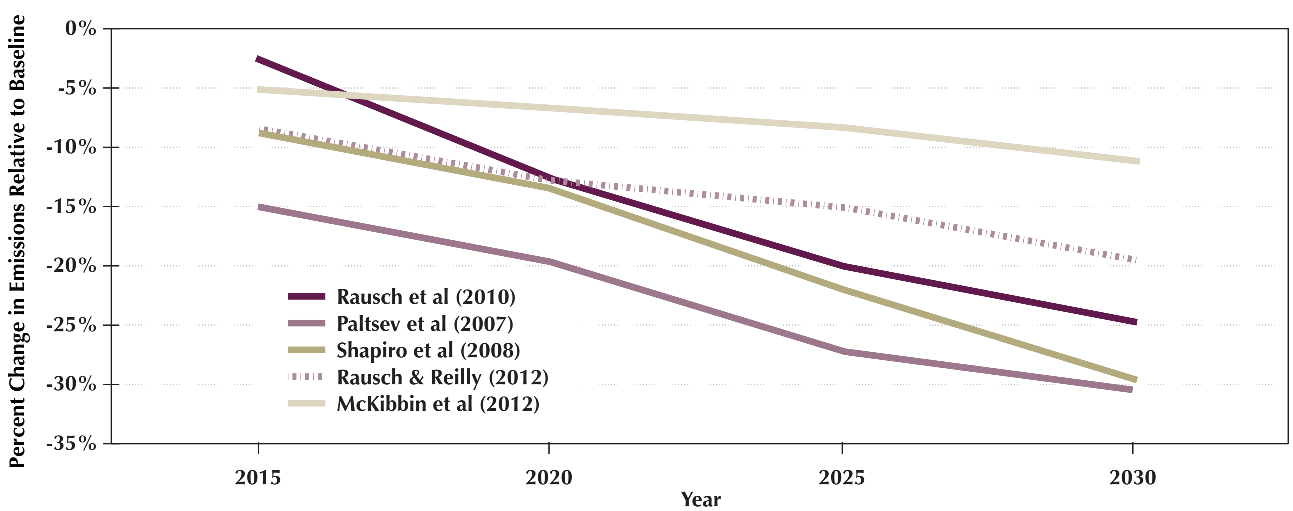
CARBON TAXES IN DEFICIT REDUCTION PROPOSALS

Given the revenue potential, it is no wonder that a number of prominent deficit reduction proposals have considered a carbon tax. One source of deficit-reducing ideas is the options paper by the U.S. Congressional Budget Office (CBO) (2011). In one revenue option, CBO considered a cap-and-trade system for cutting GHGs in which cap would be set so that allowances would trade at $20 per metric ton at first and then rise at a nominal rate of about 5.6 percent annually. This is equivalent to a carbon tax if the government auctions the allowances. CBO estimated that this policy would raise about $1.2 trillion from 2012 to 2021. It also estimated that emissions from the covered sectors would fall by about 20 percent from their projected amounts in 2025 and by 50 percent from their projected amounts in 2050.

Galston and MacGuineas (2010) recommend enacting a broad-based carbon tax in their comprehensive deficit plan. They would use some carbon tax proceeds to reduce the payroll tax and the rest to reduce the deficit. They propose a tax starting at $23 per ton of CO_2, increasing at 5.8 percent per year. They argue their proposed partial tax swap approach should foster growth in output and employment.

Of the six independent deficit reduction proposals commissioned by the Peterson Institute's Solutions Initiative (2011), four proposed a carbon tax. For example, the proposal from scholars at the American

FIGURE 2: Percent GHG Abatement Relative to Baseline in Five Illustrative Studies



Enterprise Institute, which appears in Antos et al. (2011), chose to "address environmental externalities in a more cost-effective and market-based manner," by replacing energy subsidies, tax credits, and regulations with a carbon tax. Their proposed tax would be similar to a tax version of CBO (2011). It would take effect in 2013 and phase in at a uniform pace over five years so that the 2017 tax equaled the level prescribed for that year in the CBO option, slightly more than $26 per metric ton of CO_2-equivalent, and increase at a nominal 5.6 percent annual rate through 2050.

The Bipartisan Policy Center's Debt Reduction Task Force chaired by Pete Domenici and Alice Rivlin also considered, but did not ultimately propose, a carbon tax of $23 per ton of CO_2 emissions starting in 2018, increasing at 5.8 percent annually. [17] The task force estimated that the carbon tax would have raised about $1.1 trillion in cumulative revenue by 2025, while resulting in carbon emissions in that year of 10 percent below 2005 levels.

In addition, a number of individual economists have offered detailed proposals for implementing a carbon tax to reduce the deficit and/or reduce other taxes.[18] For example, Morris (2013b) suggests an approach that would "within twenty years …reduce annual emissions by 12 percent from baseline levels, generate enough revenue to lower the corporate income tax rate by 7 percentage points, and decrease the deficit by $815 billion, all while protecting the poorest households from undue burden." Aldy (2013) offers a similar proposal. The conclusion here is that a well-designed carbon tax is a solid option for funding deficit reduction and tax reform, and it is supported by many experts.

IV. CONSIDERATIONS IN SETTING THE PRICE ON CARBON AND ITS TRAJECTORY OVER TIME

From an economic perspective, the appropriate price on carbon is a reflection of its external costs. The "external costs" are the damages to the environment that are projected to result from emitting greenhouse gases (GHGs) into the atmosphere. Ideally, as noted above, policymakers would globally internalize those costs by putting a price on emissions that approximates the present (monetary) value of the incremental damages from a ton of GHG emissions over its life in the atmosphere and subsequent absorption in terrestrial ecosystems and the ocean. This value is known as the "social cost of carbon," or SCC, and a large body of research has sought to understand it and value it. Another way to think about the SCC is that it captures the marginal benefit of controlling emissions, or equivalently, the net damages avoided.[19] While a full treatment of potential climate change outcomes is beyond the scope of this paper, the U.S. National Research Council (2012) describes the potential for increasing global mean temperatures, sea level rise, ocean ecosystem changes, and disruptions in precipitation patterns.

Several challenges to estimating the social cost of carbon arise in practice. First, many of the potential environmental and human health impacts are hard to monetize because their damages are not revealed in ordinary market outcomes. For example, what monetary value applies to the risk of disappearing arctic ice floes and the resulting extinction of polar bears in the wild? What if as the earth warms, vector borne diseases proliferate, and new populations become vulnerable to malaria? Researchers have developed some methodologies to estimate these damages, for example by assessing peoples' willingness to pay to avoid them, but different approaches can lead to wildly different estimates.[20] A related problem arises in trying to account for low probability but very high damage scenarios of climate disruption. Some scholars argue that even a very small probability of catastrophic outcomes justifies large carbon prices now.[21]

A particular challenge for estimating the SCC is accounting for potential damages in the distant future. Over long time horizons any non-negligible discount rate results in low present values, and all sorts of important ethical and analytical issues arise in determining what discount rates and inter-generational measures of well-being should apply.[22]

Finally, environmental damage derives from global concentrations of GHGs. The United States has diminishing control over those concentrations because the U.S. share of annual global emissions is falling as emissions from developing economies rise. So even if the United States adopted a carbon tax at "the correct" SCC, the actual resulting marginal benefits of the U.S. carbon price also depend on other countries' emissions. In this way controlling emissions is the ultimate "common property" challenge. This is absolutely not a reason not to control U.S. emissions. In fact, many other countries, including the European Union, Australia, and Sweden, have started to price carbon through cap-and-trade programs or carbon taxes. Nevertheless, many countries, especially rapidly developing countries, are far less likely to undertake ambitious action to reduce emissions if the United States does not. Leveraging U.S. action into action by other countries is central to achieving meaningful outcomes over the long run.

A number of studies have sought to estimate a SCC. A full literature review is beyond the scope of this paper, but one study that is particularly relevant for policy purposes is the exercise by the Obama Administration to develop SCC estimates for calculating the potential net benefits of the myriad federal regulations that affect GHG emissions. In a recent update, an interagency team examined the estimates from a variety of models that include outcomes that might be affected by climatic disruption: net agricultural productivity, human health, property damages from sea level rise, and the value of ecosystem services.[23] The interagency group identified four SCC estimates for 2015 that span the analyses they reviewed: $12, $38, $58, and $109 (in 2007 dollars) per metric ton of carbon dioxide (CO_2). The group based the first three estimates on the average SCC across several integrated assessment models and socio-economic and emissions scenarios using discount rates of 5, 3, and 2.5 percent, respectively. The high value of $109 represents the SCC under a scenario of higher-than-expected impacts from temperature change.

Some scholars believe that the "true" SCC is higher than the range cited in the report, and others believe that it is lower. Any estimate of the SCC necessarily involves important assumptions about the appropriate discount rate and how to monetize ecological and social outcomes, along with the use of models that themselves include many estimated parameters and assumptions. There are complicated debates around all of these methodologies. As this literature matures, one should view any SCC estimate as just that.

To stabilize GHG concentrations, economies across the globe must essentially de-carbonize.[24] To achieve any particular cumulative emissions target (or equivalently, concentration stabilization target) at least cost, it makes sense to incentivize abatement such that firms do not prematurely scrap expensive long-lived capital, but also do not delay deploying new less emissions-intensive capital. A full treatment of the inter-temporal optimization problem for abatement is beyond the scope of this paper.[25] However, many economists recommend that the real rate of increase in the tax be no higher than the returns on relatively low-risk capital assets, which is about 4 or 5 percentage points above inflation.[26] This would avoid the pitfall that rapidly rising taxes can accelerate emissions if fossil carbon resource owners speed up extracting their resources in anticipation of higher future taxes.[27]

Despite these complications in determining the SCC, we can safely say the marginal benefit from the United States abating GHG emissions is not zero, and it is not infinite. We also safely say that it is very uncertain.[28] Simplistically, the policy problem is to set a carbon price that reasonably captures our current best estimate of potential damages (but not so high it fails politically), ramp it up over time, and prepare to update it as new information develops.[29]

One challenge is determining that updating process. The more certainty and advance notice policymakers provide in the tax design, the more cost-effectively firms and households can adapt to the price changes. Given that electric power plants and major industrial facilities have lifetimes of 50 years or more, it makes sense to provide as much certainty and advance notice as feasible. And indeed, predictability of price is one of the key benefits of a carbon tax. Also, concentrations of GHGs change much more slowly than annual emissions, so abrupt changes in price signals and emissions are unwarranted. On the other hand, the scientific evidence could evolve and that could change the optimal policy. Giving firms notice of tax rates at least a decade in advance, for example with a rolling schedule of announcements, could strike a reasonable balance.

A related challenge surrounds not just how and when the carbon price should change, but who should decide and on what basis. Congress or a delegated agency could update the tax according to a formula that targets a particular long-run goal for U.S. emissions.[30] In general, though, congress eschews delegating tax rates to the executive branch or third parties, and it is hard to imagine an exception here. Reaching consensus on a long-run goal also adds another hurdle to the legislation, especially if the bill is focused on fiscal reform. Further, setting an economic variable like a tax rate by a formula with unknown future parameters could inadvertently impose politically infeasible stringency. Congress could insert some built-in discretion or orderly retreat from such stringency if necessary, but that would itself raise uncertainty about the environmental performance of the program along with introducing uncertainty in the price signal for investors. It may be most feasible to set a long-run trajectory for the tax and establish periodic congressional reviews of evidence provided by expert agencies on the economic and environmental performance of the tax, as well as new climate science. Congress and the president could revise the U.S. tax rate path accordingly as they see fit.[31]

Another way to approach carbon tax design is to think of it purely as a revenue instrument. In that case, policymakers would work backward from how much revenue the tax should produce. The tax rate would likely be higher or lower than its environmental merits dictate, but it would achieve its fiscal purpose. In that sense it would be more like a gasoline tax that funds transportation infrastructure than a measure designed specifically to address environmental externalities. Of course, tax rates lower than the SCC (assuming we knew the appropriate level) would be inefficiently low and external costs would not be fully internalized. Additional policy measures would be necessary to appropriately address the market failure of environmental damages, and in that case policymakers are likely choosing a less cost-effective approach than setting the carbon price at the SCC. Even if the government uses carbon tax revenues optimally and the price signal matches the SCC, however, there may be a political limit on the acceptability of higher energy prices, particularly in the short run before people have time to adjust.

Finally, the United States could look to other carbon pricing programs for examples. **Table 2** summarizes a number of benchmark carbon prices (primarily 2015 forward prices), including the SCC from the U.S. government report, sub-federal programs in the United States, and carbon prices abroad.[32] While all of these programs price carbon, a number of these do not price all fossil energy carbon. For example, the Australian's carbon tax excluded oil, and the Regional Greenhouse Gas Initiative only prices emissions from the power sector.

One problem with looking to other carbon pricing programs, such as the European Union's cap-and-trade program, for a benchmark on ambition is that those programs' prices can be depressed by ancillary policies, such as renewable mandates and efficiency standards that drive down emissions. Thus those countries may have policies that impose much higher costs of abatement than the trading price would suggest.

TABLE 2: Benchmark CO_2 Prices

CARBON PRICE BENCHMARK	PRICE PER METRIC TON OF CO_2-EQUIVALENT (2012 US$)
U.S. 2015 SCC, 5% discount rate*	12.18
U.S. 2015 SCC, 3% discount rate*	40.97
Trading price of allowances in the European Union's Emissions Trading System (EU ETS)**	9.20
Carbon tax in British Columbia, Canada***	29.70
Carbon tax in Australia, as of July 2012†	23.00
Carbon tax in Sweden††	151.08
EPA projection for CO_2 allowance trading price under H.R. 2454 in 2015, Scenario 3†††	14.95
Settlement price of California's GHG cap-and-trade allowances, advance auction of 2015 vintage‡	10.00
Regional GHG Initiative, Auction 18 clearing price for CO_2 allowances, December 5, 2012‡‡	1.93

Note: Using the average exchange rate for July 2012, foreign currency was converted into U.S. dollars where US$ 1 is equal to: EUR 0.91; CN$ 1.01; AUS$ 23; SEK 6.95.

* *U.S. Government Interagency Working Group on Social Cost of Carbon,* Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 *(Washington, DC: White House, 2013). http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf.*

** *"European Union Allowance," Thomson Reuters Point Carbon, last accessed March 25, 2014, http://www.pointcarbon.com*

*** *"How the Carbon Tax Works," Province of British Columbia, last accessed March 25, 2014, http://www.fin.gov.bc.ca/tbs/tp/climate/A4.htm.*

† *Center for Climate and Energy Solutions (2011).*

†† *Swedish Energy Agency,* Energy in Sweden 2011 *(Kungsgatan, Sweden: Swedish Energy Agency, 2012), https://energimyndigheten.a-w2m.se/FolderContents.mvc/Download?ResourceId=2609.*

††† *See Scenario 3 of EPA's* Analysis of the American Clean Energy and Security Act of 2009 H.R. 2454 in the 111th Congress *(Washington, DC: U.S. Environmental Protection Agency, 2009), http://www.epa.gov/climatechange/Downloads/EPAactivities/HR2454_Analysis.pdf.*

‡ *California Environmental Protection Agency Air Resource Board,* California Air Resources Board Quarterly Auction 1 *(Sacramento, CA: California Environmental Protection Agency, 2012), http://www.arb.ca.gov/cc/capandtrade/auction/november_2012/updated_nov_results.pdf.*

‡‡ *Potomac Economics,* Market Monitor Report for Auction 18 *(New York, NY: Regional Greenhouse Gas Initiative, Inc., 2012), http://www.rggi.org/docs/Auctions/18/Auction_18_Market_Monitor_Report.pdf.*

V. TAX ADMINISTRATION AND OTHER DESIGN ISSUES

The more sources that are covered, the broader the scope of the price signal and the more marginal costs of abatement will equalize across the economy. Equalizing abatement costs is the most economically efficient approach because it delivers the same incremental incentive to abate in all sectors and ensures that overall costs are as low as possible. As noted by Ramseur et al. (2012), the tax could apply at the "upstream" stage in the fuel distribution system, when the carbon-containing fossil fuel is first sold following production. Or, the point of taxation could be "downstream" where the pollution is released to the atmosphere. To get the broadest coverage with the fewest taxpayers and minimal administrative costs, the tax should be applied at the choke point in the energy distribution system, such as at the petroleum refineries for oil, wells or processing plants for natural gas, and for coal at mines or coal-fired power plants and industrial facilities. Imported fuels could also be taxed at the border. Metcalf and Weisbach (2009) show that collecting the tax upstream from fewer than 3,000 entities could cover 80 percent of U.S. greenhouse gas (GHG) emissions.

Other GHG emissions could also be taxed, but in general the broader the tax beyond the facilities mentioned, the more administratively challenging it would be. Certain carbon emissions from cement and steel manufacturing might be feasible to tax, but methane emissions from ruminant livestock may not be.

Carbon in fossil fuels that is not emitted should arguably not be subject to the tax. This would be particularly important to incentivize technologies that capture and store carbon, for example, when carbon dioxide (CO_2) is stripped from the combustion gases of a power plant and stored underground in an approved manner. Other examples of non-emitted carbon include petroleum distillates such as tar that are not burned, and carbon in plastic, waxes, and other non-combusted products made of fossil fuels. Producers of such goods could receive tradable tax credits that would compensate them for the carbon tax embedded in the prices of their feedstocks.

The United States exports some fossil fuels, particularly coal.[33] Policymakers could exclude carbon in those exported fuels from the tax, as Australia has, to ensure the competitiveness of U.S. exporters. Alternatively, they could tax carbon in exported fuels to raise more revenue and possibly lower emissions abroad.

EXISTING ENERGY TAXES

The design of a carbon tax could take into account the myriad existing levies on fossil fuels and other environmental taxes and incorporate a carbon tax in existing revenue instruments. The list of such levies is long. Some examples:

- The federal government imposes a motor fuels excise tax, which is $0.184 per gallon of gasoline. Of that, 0.1 cent is dedicated to the Leaking Underground Storage Tank Trust Fund and the remainder is earmarked to the Highway Trust Fund.
- In addition, congress enacted a gas-guzzler tax as part of the Energy Tax Act of 1978. It levies a tax on automobiles that achieve fuel mileage below 22.5 miles per gallon. Tax rates range from $1,000 to $7,700 per vehicle. In 2010, the gas-guzzler tax raised $85 million.
- The Energy Policy Act of 2005 resurrected the Oil Spill Liability Trust Fund tax at the original rate of 5 cents per barrel, and it rose to 8 cents per barrel in 2009. It falls on crude oil received at U.S. refineries as well as imported petroleum products. Domestic crude oil for export is also subject to the tax if the tax has not been previously paid.
- The United States also already has a small excise tax on coal, and it may be possible to superimpose a carbon tax onto it for some producers.[34] It funds the Black Lung Disability Trust Fund and applies to coal mined domestically, but excludes lignite. The tax is 4.4 percent of the sales price up to a limit of $1.10 per ton of underground coal and $0.55 per ton of surface-mined coal. According to the federal budget for fiscal year 2011, this tax raised $610 million in 2010.

- Gasoline for speedboats is taxed at the same rate as highway gasoline and diesel fuel, and the funds are allocated to the Aquatic Resources Trust Fund. Finally, commercial vessels using the inland waterway system pay a fuel tax of 20 cents per gallon of fuel sold and an additional 0.1 cent tax per gallon for the Leaking Underground Storage Tank Trust Fund.

In addition, states levy a variety of environmental taxes, including taxes on motor fuels. The rates vary across states, but they averaged 23.5 cents per gallon of gasoline, 24.5 cents per gallon of diesel fuel, and 23.4 cents per gallon of gasohol in 2012. States typically levy these fees through a general sales tax on purchases. State governments also levy a variety of pollution fees, hazardous waste charges, tire disposal fees, and other assorted charges.

In theory, it might be possible to add a carbon-based upcharge to these existing taxes, for example by separately raising the gasoline tax and the other fuel excise taxes. However, doing so would likely be less economically efficient than a single broad carbon tax applied across all fuels because not all carbon falls under an existing tax, and it would be hard to ensure that the increases in the various taxes properly reflect carbon content and rise in concert over time. In addition, raising any tax is politically difficult, and adding a carbon fee to a multitude of existing taxes would seem to make the political lift that much heavier. However, it could lower overall administrative costs to impose a separate carbon tax at the same point in the distribution system as other fossil fuel taxes.

So what should happen to these other taxes if the federal government institutes a carbon tax? Should the carbon tax sit on top of them, or should it replace them? Two considerations apply. The first is whether there are other external costs to each fuel besides GHG emissions. For example, many external costs apply to driving besides CO_2 emissions, including traffic congestion and emissions of non-GHG pollutants. Thus a case may be made for a tax on motor fuels that is greater than the carbon tax. However, some of those external costs, especially congestion, vary significantly by location and time and have little to do with the gasoline consumption of vehicles. Other policy measures, such as congestion pricing, could be better instruments to address those social costs.

The other consideration is how the government might fund the activities currently financed by those existing taxes, should they be eliminated. For example, if a carbon tax replaced the coal tax or the tax on motor vehicle fuels, would policymakers need to earmark some of the carbon tax revenue to assist black lung victims or fund highways? In the view of many experts, the Highway Trust Fund is already underfunded as the real value of the motor vehicle fuel tax declines and tighter fuel economy standards erode the tax base.

Although the United States imposes several individual taxes on fossil energy, in aggregate they are much smaller than energy taxes abroad.[35] Metcalf (2009) notes that the United States' reliance on these taxes is far below that of other developed countries.[36] The United States collects 0.79 percent of gross domestic product (GDP) in these taxes at the federal and state level. In contrast, the Czech Republic, Denmark, Turkey, and the Netherlands, among others, collect around 3 percent of GDP from environmental taxes and charges. If the United States relied on environmental taxes to the same extent as other countries in the Organization for Economic Cooperation and Development, it would collect far more revenue than it does. For example, if the United States collected 3 percent of GDP in environmental taxes, it would have brought in over $314.5 billion, a 250 percent increase from the $114.5 billion in actual revenue from those sources.

OFFSETS

Another issue in the design of a tax is whether or not the government should allow firms to comply with their tax obligations by surrendering tax credits generated by GHG offset projects. Offsets would be certified emissions reductions undertaken by entities not covered by the tax, such as landowners who plant carbon-sequestering forests. Providers of offsets and taxed entities can both benefit if abatement outside the taxed sectors is lower cost than within the taxed sectors. On the other hand, offsets are necessarily complicated. Offsets would reduce revenue to the government, require substantially more regulation and oversight, and introduce the prospect of giving credit toward abatement that would have happened anyway. Some offsets, such as those that promote conversion of farmland to forest, may also produce ancillary benefits (such as improved habitat) as well as unintended consequences (such as higher food prices).

Allowing offsets could result in vastly different investment patterns than would arise in a system that does not. For example, EPA analysis of the American Clean Energy and Security Act of 2009 (H.R. 2454 of the 111th Congress), also known as ACESA, estimated that in the early decades under a cap-and-trade system, unfettered access to offsets would induce U.S. firms to spend several times more on imported offsets than on domestic abatement.[37] Much of this investment would have been in the energy sectors of large developing countries, and it would have generated large and politically sensitive transfers to competing economies. Thus offsets, while possibly inducing additional low-cost abatement, could complicate tax administration and blunt incentives to transform the U.S. energy system. Other policies could take up the objective of encouraging cost-effective emissions abatement outside the taxed sources.

IMPROVING INCENTIVES TO RETAIN THE TAX

One critique of a carbon tax, as opposed to a cap-and-trade system, is that taxpayers always have the incentive to repeal it, and the incentive could grow along with the tax rate. Tradable emission allowance systems, in contrast, create a constituency of allowance holders that want to protect the program because it protects the value of their allowance assets.[38] Allowing firms to comply with future tax liabilities early could help this problem. For example, the government could allow firms to purchase tradable tax compliance credits by paying taxes now for a specified level of emissions in the future (at the tax rate in the law that applies in that future year).[39] The government would get the revenue early, and firms could procure tax compliance at known rates, insuring against future policy changes that raise tax rates above current levels. Firms who hold these credits are likely to support the continued implementation of the program, even its strengthening, since that would increase the value of their tradable tax credit assets. A strong political consensus for the continuation of the program increases investors' confidence the program will endure, and that strengthens incentives to invest in abatement and low-carbon technologies. Over the long run this can lower the overall costs of achieving environmental goals.

VI. THE COST OF A CARBON TAX

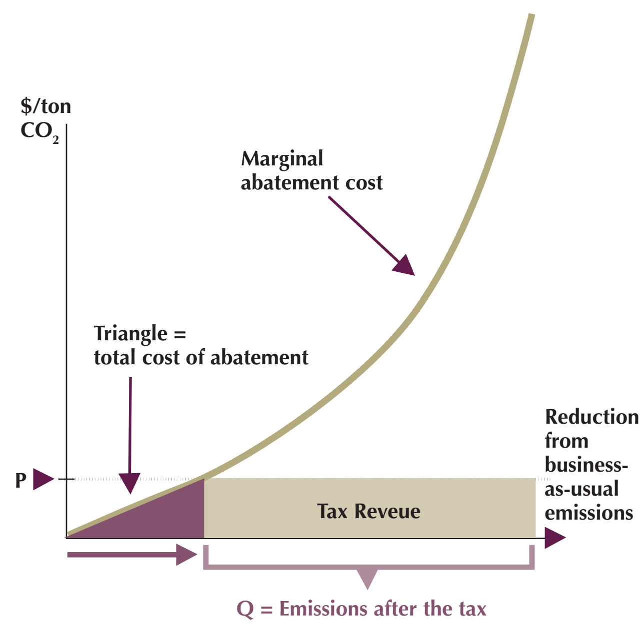
Policymakers are keenly interested in the likely effect of a carbon tax on their constituents and the U.S. economy. To be sure, when we talk here about the "cost" of the tax, we mean the overall cost to the U.S. economy of abating emissions, not accounting for the environmental and economic benefits that come with it. The cost of not taking action could be enormous, but analytically that falls under the benefits from mitigation. One should not infer anything about the net benefits of the carbon tax from the focus in this section on the costs of abatement and other economic effects of the tax, which include the broader macroeconomic shifts that flow from the particular policy approach to pricing greenhouse gases (GHGs).

Economists call all the ways people may be made better or worse off as a result of a policy its "economic incidence" or "distributional effects."[40] One often hears about how a particular policy approach might benefit or burden corporations as opposed to individuals or vice versa. Although the legal system treats firms as if they were people, the ultimate economic burdens and benefits of any policy fall not on legal entities but on the owners of firms (shareholders), workers, consumers, and other individuals.

To analyze the impacts of tax changes, economists use computerized economic models to estimate two scenarios. The first is the likely emissions and economic trajectory without the carbon tax. This is called the business-as-usual (BAU), baseline, or reference scenario. The policy scenario tracks the results from a specific policy intervention, and we usually compare a policy scenario to the baseline or another policy scenario. Depending on the nature of the policy scenario, analysts specify the tax policy and estimate its effects, or they derive the tax rates necessary to achieve a particular emissions target. Some models, called general equilibrium models, also estimate all the other changes in the economy that can result from a price on carbon, such as shifts in prices for goods and services, wages, terms of trade, and so on.

The overall economic effect of a carbon tax is the net result of three factors: the incidence of the price increases that result (i.e., who bears those prices and by how much), the final disposition of the carbon tax revenue, and all the changes that ripple through the broader economy. **Figure 3** below illustrates how a carbon tax reduces emissions. The curve sloping up illustrates the marginal abatement cost curve in a given year for the emissions covered by the tax. The vertical axis is the cost of abating one ton of carbon dioxide (CO_2). The horizontal axis is the amount of emissions reduction relative to BAU emissions. The incremental cost of abating a ton starts low for the first tons of abatement (the part of the curve near the origin). As the opportunities for low-cost abatement are used up, the marginal cost gradually goes up as emissions reductions increase, moving from left to right on the graph.[41] A tax on emissions of \$P per ton of CO_2 will reduce emissions until it is cheaper to pay the tax than reduce emissions more, so emissions fall

FIGURE 3: Abatement Cost and Tax Revenue are Different



by the length of the arrow. The width of the brace (Q) below the horizontal axis represents the emissions that remain after the tax of P is imposed. Thus the tax of $P is the cost of the last ton abated under the policy.

The shaded triangle pointing towards the origin shows the total abatement cost; it is the sum of the cost of abatement for all the tons reflected in the arrow, leading up to the last ton abated at a cost of $P. The rectangle labeled "Tax Revenue" is the price of emissions per ton (the tax rate) times their quantity Q (in tons). **Figure 3** shows that, depending on the level of abatement, the tax revenue (the rectangle) can be a lot larger than the overall costs of abatement (the triangle).

When the program goes into effect, prices go up to reflect the tax and abatement as costs of production. The rectangle is not a real resource cost, but rather a transfer from those who bear the burden of the tax payments and those who get the revenue.

Who bears the incidence of a tax? One might think that firms bear the full cost of the taxes they pay.[42] However, economic analyses estimate that in the long run taxed firms and other firms further down their supply chain will pass most of their costs to consumers through higher prices. Harberger (1962) pioneered the general equilibrium study of tax incidence, which considered not only what happens in the taxed sector but in all the ancillary sectors (that is what general equilibrium means). This shifting of tax burdens across sectors and economic actors is what economists mean when they talk about the transmission of "price signals." Put another way, the *statutory* incidence of a tax on carbon is not equal to the *economic* incidence.

Whether firms can pass through the entire cost of the tax and emissions abatement to their customers depends on how prices are determined in their market (e.g., how responsive demand and supply are to prices) and the time frame under consideration. In the long run, capital and labor are malleable and mobile. That means that factor markets will reallocate those resources in light of the new relative prices on fuels, energy, and everything else affected by the carbon price. Through this reallocation, competitive markets will pass most of the price signal along to consumers in higher retail prices for energy and other goods and services. Those higher energy prices are integral to the economic efficiency of the tax. They lower the cost of the program by inducing more efficient energy use and greater investment in developing energy-efficient technologies.[43]

Even if covered entities and other energy-intensive firms can eventually pass along most of their costs of meeting environmental goals in output prices, such a policy can affect shareholders and workers. Consider, say, coal producers, with highly specialized facilities and equipment. Even if they pass the price on carbon to their customers, they can be worse off because at higher prices they will sell less than they did before, meaning less revenue to cover their fixed capital costs. The owners of the firms can reallocate their capital over the long run, but in the short to medium run this is costly and time-consuming.[44] Likewise, workers with skills specific to coal mining may be let go as output falls. They may have to retrain or move in order to find work, and their new jobs may pay less than their old ones. Even more likely, some occupations will simply not be growth fields, and new workers will move in other directions.

As global efforts to control GHG emissions ramp up, we expect emissions-intensive production to shrink substantially. But falling output in those markets does not necessarily mean all those shareholders are hurt over the long run. As output falls and capital is redeployed, the costs of production fall along with output.[45] Unless stockholders were receiving above-normal profits, the capital deployed to the sector will fall without long-run damage to the returns to the last dollar still invested. The primary burden on owners of capital and workers in fossil industries will be from the adjustment costs they incur in moving to other sectors, unless they own immobile assets such as coal deposits.

The government can minimize adjustment costs by introducing the carbon price gradually and predictably, allowing time for efficient turnover of physical capital such as industrial plants and equipment. Key to reducing these adjustment costs is the formulation of credible long-run expectations around the price of carbon. Likewise, a predictable phase-in also allows fossil energy workers and the labor market more generally to adjust through attrition and retraining, without the need for layoffs and displacement. The gradual ramp up also allows consumers to shift their consumption patterns, for example by purchasing more energy-efficient appliances as their old ones die a natural death. Thus the incidence of the program can depend on the timing of emissions reductions as well as their level.[46]

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

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

So far, this discussion has focused on those who would be negatively impacted by a carbon tax. But just as owners of capital and workers in some sectors are made worse off in the short run as a result of a price on carbon, those in certain other sectors, such as renewable energy, could be made better off. But importantly, the winners are only winners in the short to medium run, because higher returns to capital attract new capital, which drives returns back down to long-run equilibrium levels. That is not to say that there will be no net costs. Depending on how high the tax is and how the revenue is used, broad measures of economic activity and welfare could indeed be lower under a carbon tax than the reference case as a result of the real resource costs associated with abating emissions. Rather, the differential effects of the policy in different sectors will dissipate over the long run.

Finally, the overall effect on the economy is not just the direct abatement costs and transfers depicted in **Figure 3**. A host of macroeconomic shifts can occur, and we turn to those in Section IX. Our key point is that reducing emissions is not likely to be a free lunch, but policymakers can minimize burdens by properly designing and implementing the policy.

VII. ECONOMIC INCIDENCE OF A CARBON TAX ACROSS HOUSEHOLDS AND REGIONS

If a policy burdens lower-income households relatively more than higher-income households as a share of household income or other measure of socioeconomic status, then economists call the policy regressive. In general, lower-income households spend a higher percentage of their income on energy and other goods whose prices would go up under a carbon tax. That suggests a carbon price could be regressive. However, its effect in reality is more complicated. As described above, some of the tax will be passed backward to producers through lower wages for workers and lower returns to shareholders. Moreover, congress is unlikely to impose a carbon tax in isolation, without other policy changes that also have distributional effects. And a carbon tax could replace alternative policies that would themselves have had distributional effects. For example, a carbon tax could substitute for other ways of reducing the federal budget deficit, such as cutting discretionary spending that disproportionately helps the poor. A carbon tax could also substitute for other ways of reducing GHG emissions. Almost no analysis has been done on the distributional effects of GHG regulations, mandates, subsidies, or standards. A carbon tax could be more or less regressive than other environmental policies, depending on exactly what they are.

The incidence of a carbon tax depends heavily on what happens to the tax revenue. For example, devoting the carbon tax revenue to lowering corporate income taxes is more likely to be regressive than sending the revenue back to households equally in rebate checks. In the next section, we look at the initial incidence of the tax and three particular objectives for using the carbon tax revenue: preventing the poor from becoming worse off; improving the economic efficiency of the tax system; and reducing the U.S. federal budget deficit.[47]

MEASURING REGRESSIVITY

Many analyses compare a carbon tax to a scenario of current policies without a carbon tax. Even this simplified approach results in mixed evidence because the measured effects of a carbon tax depend on a number of factors. These factors include what analysts assume happens to the revenue and numerous analytical details such as the sorting of households by income or other socio-economic characteristics (such as consumption levels) and whether the analysis takes into account households' size and sources of income.

Rausch and Reilly (2012) use a general equilibrium model to study the distributional effects of a number of different approaches to using carbon tax revenue. They find that nearly all but the richest households are better off in a scenario in which a carbon tax is used to reduce payroll taxes or for social programs than they are under baseline policy.[48] Like nearly all studies of this kind, they find that the most progressive approach is to hand out the revenue in lump-sum rebates to households. Most of their tax-swap scenarios come out either progressive or only mildly regressive, with the relative welfare changes of the poor about 0.4 percentage points greater than for the rich. Importantly, their work takes into account how households get their income as well as how they spend it. In particular, as Dinan (2012) notes, higher price levels trigger changes in other federal policies. Social security, other benefits, and income tax schedules are indexed to consumer price levels. Thus the price on carbon can trigger higher cost-of-living increases in government benefits and lower effective tax rates. Thus through the indexing of entitlement benefits to prices a carbon tax can increase federal spending and result in higher tax burdens on future taxpayers. Whether those will be high-income or low-income households depends on the tax structure in the future.

Other studies find that a carbon price could be regressive or progressive, depending on how the revenue is used. The Congressional Budget Office (CBO) (2009) estimates the effect of the cap-and-trade program that would have been established by the American Clean Energy and Security Act. The CBO estimated the effect on households' purchasing power as a result of the estimated price on carbon that the bill would have produced, which is similar to the outcomes we would see with an analogous carbon tax. Dividing the results by income quintile, the CBO found that the price on carbon by itself is regressive; the lowest quintile faced the highest percentage loss of after tax purchasing power—about 2.5 percent. After that CBO simulated rebating the value of allowances (akin to the potential tax revenue) and other effects of the program on household income, however, the poorest 20 percent of households showed a potential net gain of 0.7 percent to their after-tax income. In addition, all other income quintiles showed less than a 1 percent drop in their purchasing power.

Hassett et al. (2009) and others show that a carbon price is less regressive or proportional if analysts measure households' extra expenditure against their overall economic status over a lifetime rather than their incomes in a particular year, for example by measuring the burden against their consumption rather than their income in a particular year.[49] Using consumption in this way accounts for the fact that some people with relatively low annual income (such as students and retirees) may be in a stage of life where they have relatively low incomes despite a lifetime of reasonably good living standards. In the same vein, Mathur and Morris (2014) find that a carbon tax of $15 per ton of carbon dioxide (CO_2) (assuming no return of the revenue and no effect on consumption patterns) would have burdened the poorest 10 percent of households on average by about 3.5 percent of their annual income or about 2.1 percent of their annual consumption. The richest households' burden would be about 0.6 percent of annual income or 1.3 percent of annual consumption. If all the revenue is returned through lower income taxes, only the poorest 30 percent of households have a net burden higher than about 0.5 percent of income. The highest income households benefit the most from a tax swap because they pay proportionately more in income taxes than everyone else.

In a series of other papers, Hassett and coauthors explore how changing the incidence assumptions and allowing for rebate of carbon tax revenues changes conclusions about the regressivity of the tax. For example, Metcalf et al. (2012) allow both forward shifting of the price signal to consumers as well as backward shifting of the tax to suppliers of labor and capital, and they allow for revenues to be allocated to households in different ways. The paper concludes that distributing some or all of the value generated by the carbon price back to households—either directly or indirectly through industry—makes the policy progressive no matter how one ranks households.

Grainger and Kolstad (2010) investigate how the regressivity of a $15 tax on CO_2 could be ameliorated by returning the revenue in a progressive way. This could be done by targeted transfers, financing cuts in regressive payroll or excise taxes, targeting income tax cuts to lower-income groups, or by spending more on government programs targeted to lower-income groups. The authors estimate that the carbon tax could be made distributionally neutral by directing transfers (or income tax credits) in the amounts of $119, $112, $105, and $76 to individuals in the first four income quintiles, respectively. The net result of the carbon tax and transfers would burden individuals proportionately at around 1 percent of their net annual income. It would also offset the regressive effects of the carbon tax while leaving $49.6 billion in net revenues for the government.

HIGH-INCOME AND ENERGY-INTENSIVE HOUSEHOLDS

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

People who tend to use more energy and energy-intensive goods and services will be more burdened by the program than those with more energy-lean lifestyles, at least initially. This means, for example, that people who travel by air, drive long distances in large vehicles, own large and poorly insulated homes, and own old appliances will feel the pinch more than those who use public transport and live in smaller or more energy-efficient housing. Some patterns of consumption are easier to change than others, and different people will have different preferences and ability to pay. All of those factors go into a consumer's "price elasticity of demand" for energy.

Consumers who are "price inelastic," for example because they live in a rural area and must drive long distances to work and shop, will be burdened proportionately more than consumers who are "price elastic." Nearly everyone is more price elastic in the long run than in the short run. Given enough time (and certainty that higher energy prices are here to stay), we can change where we live, what we drive, where we work, and the equipment we use.

REGIONAL INCIDENCE

One other concern about a single national price on carbon is that areas of the U.S. heavily dependent on coal for electricity will be burdened more than other regions. And indeed coal use does vary a lot across the country. But regional analyses show that the burdens of a carbon tax as a share of income would not vary nearly as much as many fear.[50] That is because people in different regions use different mixes of fuels to heat and cool homes, and they also vary in their gasoline consumption. In other words, areas where electricity prices may go up most may be the same places where they use relatively less gasoline. For instance, gasoline consumption is highest in the East North Central region (Wisconsin, Illinois, Michigan, Indiana, and Ohio), electricity used more in the West South Central region (Texas, Oklahoma, Arkansas, and Louisiana), and home heating oil consumption is highest in New England. In addition, households in most regions consume similar baskets of non-energy goods, resulting in similar patterns of indirect energy consumption. Studies such as Morris and Mathur (2014) show that the immediate effects of a carbon tax could fall slightly harder than average on households in the East North Central states listed above because of their higher overall energy consumption as a share of income.

VIII. PROTECTING THE POOR, IMPROVING THE EFFICIENCY OF THE TAX SYSTEM, AND REDUCING THE DEFICIT

We observed above that consumers will ultimately bear most of the carbon price burden through higher prices and that the final economic incidence of the tax depends critically on what happens to the revenue. For example, using the revenue to reduce taxes on capital income would mean that whoever bears those taxes, mostly shareholders, would experience higher after-tax returns than they otherwise would while consumers pay higher energy and other prices.[51] The net effect on individuals depends on how they get and spend their income.[52]

PROTECTING LOW-INCOME HOUSEHOLDS

Whether or not the carbon price is regressive and by how much, the lowest income households are least able to afford energy price increases. Thus it is appropriate to consider ways to compensate poor households as part of the overall fiscal package. It would be hard to address the regressivity of a carbon price perfectly. The regressivity of a carbon tax also evolves over time as households adjust to new prices, and those adjustments might vary systematically by region, household demographics, rural/urban location, and other factors that influence households' consumption patterns. Thus a practical approach to address the regressivity of a carbon tax cannot exactly match the real-world variation in its incidence, but rather must endeavor broadly to hold the lowest income households harmless.

Mathur and Morris (2014) estimate that 11 percent of carbon tax revenue would be necessary to hold the bottom two deciles of households by income harmless, and 18 percent would be enough to protect the bottom three deciles. To account for some uncertainty in these estimates, policymakers could target about 15 percent of the revenue each year to households whose income falls below 150 percent of the poverty level, however that level is defined in each year, to ensure that roughly the poorest fifth of households remain no worse off.

Fifteen percent might be slightly larger than the burden of the tax borne by the lowest quintile, in part because the figure does not account for price-indexed safety net programs or any other benefits that quintile accrues from tax reform. However, some overcompensation is likely warranted to account for the large variability of energy costs across poor households and the vulnerability of low-income households above the poverty line.

BROADER ECONOMIC EFFECTS OF A CARBON TAX

As mentioned in Section VI the macroeconomic effects of a carbon tax come not only from its direct abatement costs. Important general equilibrium effects can arise in the U.S. economy as a result of the new relative prices of fuels and how those prices and related adjustment costs move through the economy. It can affect employment, wages, currency values, trade, and many other outcomes. For example, McKibbin et al. (2012a) show that a tax on carbon in the U.S. can create a complex chain of shifts in investment returns across the globe, changes in trade volumes and prices, the value of the U.S. dollar relative to other currencies, and so on. Some of these effects also depend on how monetary authorities respond to higher overall price levels.

Some studies suggest that policies that result in lower direct abatement costs might produce higher gross domestic product (GDP) losses than those that result in higher direct abatement costs, even for the same environmental performance. For example, McKibbin et al. (2012b) find that a price on carbon that is confined to the electric power sector could produce slightly lower GDP losses relative to baseline than a policy that achieves the same emissions reductions economy-wide. Their result arises because the economy-wide carbon price applies to oil, which is inelastically demanded, and that raises adjustment costs relative to a policy that focuses on the coal and natural gas used in the electricity sector, which are more substitutable.

IMPROVING THE EFFICIENCY OF THE TAX SYSTEM THROUGH A TAX SWAP

A carbon tax also raises the real price of nearly everything because fossil energy is embedded in the supply chain. Higher overall real price levels depress the returns to working and investing by shrinking the basket of goods people can buy with their earnings. Thus higher real price levels act like an income tax. Because income is already taxed (for example through income, payroll, and capital taxes), the carbon tax introduces another distortion on top of the ones already there. Evidence suggests that this piling on of distortions, known as the "tax interaction effect," could be even more costly than the direct abatement costs.[53]

The good news is that the carbon tax revenue can offset the tax interaction effect by reducing other taxes or the deficit, which would otherwise ultimately require higher taxes in the future. Taxes, in addition to raising revenue, cause what is called "excess burden." These are costs that arise from distortions in behavior that result from the tax. A simple example illustrates the idea of "excess burden." Consider a toll on a bridge. Some people pay the toll and cross the bridge. Others drive a longer distance to get where they want to go without crossing the bridge and paying the toll. The costs of that extra driving do not produce revenue, but they do burden the driver. That cost is the "excess burden" of that toll.

Income taxes reduce the returns of working and create a disincentive to work. Some people work slightly less than they otherwise would because to them that last hour of work just is not worth it once they factor in the taxes. The higher the marginal tax rate, the tax on the last dollar earned, the greater the disincentive to work. This tax-induced disincentive to work results in a lower-than-efficient amount of labor supply in the economy, and that inefficiency is costly. Likewise, taxes on capital income (like the corporate income tax) lower investment, and that reduces future consumption below what it would have otherwise been.[54] The excess burden produced by the last dollar of revenue can vary a lot across different kinds of taxes. Using carbon tax revenue to reduce other marginal tax rates thereby reduces the excess burden of the fiscal system, and it can greatly improve the economics of a price on carbon and environmental policy more generally.[55]

For it to work, though, this "revenue recycling" has to be in the form of lowering tax rates, not just giving money back to households in a lump-sum fashion. While rebates carry some political appeal, they do not reduce any of the existing distortions in the tax system, so they do not provide any efficiency gains to offset the tax interaction effect. The rebates are progressive and more than compensate the poor, but they would not lower the overall costs to the economy.

So what taxes should policymakers reduce? The usual suspects suggested by the literature include reducing corporate income taxes, payroll taxes, personal income taxes, and future taxes (by reducing the budget deficit). Each approach has advantages and disadvantages, which we consider next.

CORPORATE TAX REFORM

The most efficient form of revenue recycling would offset the most distortionary taxes, meaning the ones that create the greatest excess burden for the last dollar they bring in.[56] Some experts believe the most distortionary taxes are likely those on capital income, like dividend, capital gains, and corporate earnings.[57] With a federal corporate tax rate of 35 percent and an average state rate of 6.3 percent, the combined U.S. corporate income rate is roughly 39.1 percent, the highest statutory corporate tax rate in the developed world. For comparison, Hassett and Mathur (2011) show that the U.S. corporate tax rate was only slightly higher than the Organization for Economic Cooperation and Development median in 1981. By that measure, the United States is an extreme outlier in its tax treatment of corporate income, and many argue that the tax system is likely harming U.S. economic competitiveness and driving multinational corporations to shift taxable profits abroad.[58] Others point out that few corporations pay the highest corporate rate due to special depreciation rules, credits, and various tax avoidance strategies.

Nonetheless, modeling and econometric evidence support the hypothesis that a carbon tax/corporate income tax swap would be a smart revenue recycling strategy. Dinan and Lim Rogers (2002) find that using carbon revenues to reduce corporate income taxes could reduce the economic cost of limiting carbon emissions by about 60 percent. Analyzing a 15 percent cut in emissions from the carbon price associated with a cap-and-trade program, the Congressional Budget Office estimates that the downward hit to GDP could be reduced by more than half if the government sold allowances and used the revenues to lower corporate income taxes rather than to provide lump-sum rebates to households.[59]

Metcalf (2007a) considers how a carbon tax could be used to reduce capital income taxes through corporate tax integration, meaning a reform that would tax corporate earnings only when shareholders receive dividends and realize capital gains. He finds that the tax could improve the efficiency of the system and that price increases throughout the economy are likely to be modest. Using a general equilibrium model, McKibbin et al. (2012a) find that using the carbon tax revenue to buy down taxes on capital income could slightly boost GDP, employment and wages through the first few decades of the tax, in part as a result of the tax swap's beneficial effect on U.S. investment.

Rausch and Reilly (2012) model a number of different potential uses for the revenue of a carbon tax and find that the greatest long-run welfare gains arise from a scenario in which half the revenue is used to lower corporate income tax rates and half is used to provide investment tax credit.

Marron and Toder (2013) estimate that cutting the corporate tax rate from 35 percent to 28 percent would reduce U.S. tax revenues by about $800 billion over the next ten years. Cutting the rate from 35 percent to 25 percent would reduce tax revenues by about $1.15 trillion. While some of that lost revenue could be made up by expanding the corporate income tax base through elimination of corporate tax preferences of various kinds, these preferences have organized supporters who will oppose their elimination. Even if some tax preferences can be phased out, tax reform, whether it is corporate tax reduction or other desirable tax reform will likely require new revenue elsewhere in the budget, and a carbon tax could be a natural fit.

Morris (2013b) offers a specific proposal along these lines. She analyzes a tax that starts at $16 per ton of carbon dioxide (CO_2) and rises by 4 percent annually over inflation, along with a cut of $6 billion per year in energy subsidies. She finds it could finance a permanent reduction in corporate income tax rates from 35 percent to 28 percent and still reduce the deficit by over $800 billion over two decades, even after reserving 15 percent of revenue for the protection of the poor.

But lowering corporate income taxes would likely help rich households more than poor households. Put another way, the most economically efficient recycling benefits poor households (who pay very little in taxes) proportionately less than rich households (who pay much more in taxes). Thus there is an intrinsic tradeoff between optimizing the macroeconomic benefits of the tax reform and making it distributionally neutral or progressive.[60]

PAYROLL AND PERSONAL INCOME TAXES

Metcalf (2007b) proposes using a carbon tax to cut the income tax tied to payroll taxes paid by workers. Specifically, he proposes an environmental tax credit equal to the employer and employee portions of the payroll taxes paid by the worker in the current year, up to a cap. Capping the rebate makes the tax cut more progressive, and the payroll tax rate reduction is greatest for low-wage workers. Parry and Bento (2000) find that efficiency gains are particularly large when revenue recycling lowers taxes that favor some kinds of consumption (such as housing or health insurance) over others.

Rausch and Reilly (2012) compare payroll and personal income tax approaches to other carbon tax recycling options and find that of all the scenarios the payroll tax approach has the most evenly distributed benefits across households as a share of income. The payroll tax swap also makes all household groups better off than baseline policies.[61] However, using all the revenue for payroll tax cuts generated less aggregate welfare gain through 2035 than reducing corporate income taxes.

DEFICIT REDUCTION

Using carbon revenue to reduce the federal deficit could also make sense. The deficit raises the future tax burdens necessary to finance and repay the debt. Reducing the federal deficit increases current investment, because it reduces the competition for investment dollars from the federal government and the resulting upward pressure on interest rates.[62] It may also avoid some of the debates about who wins and who loses from a tax reform, since the beneficiaries of a lower deficit depend on what the tax system would have otherwise looked like in the future and not current beneficiaries. On the other hand, so far large deficits have not resulted in high interest rates, political momentum for deficit reduction waxes and wanes, and a lack of identifiable winners could be a liability rather than a strength.

In any case, a carbon tax cannot be the whole solution to the looming long-run fiscal imbalances from projected growth in Social Security and Medicare spending. First, a feasible carbon tax alone cannot solve this fiscal imbalance, and second, carbon tax revenues will eventually drop off as the tax changes behavior and erodes the tax base, i.e., reduces emissions (as intended). If the tax rate increases in real terms over time, however, it could become a growing source of revenues through 2030 to 2040, depending on the escalation rate and stringency of the program.

OPTIONS FOR THE REVENUE CAN INCREASE ECONOMIC BURDEN

There are ways to use the revenue from a carbon tax that undermine its environmental benefits. We saw such an approach in cap-and-trade proposals of the 111th Congress that would have given free allowances to local electricity and natural gas distribution companies (LDCs) with the proviso that they use the value to benefit consumers, i.e., lower their energy bills. To the extent that the LDCs benefit consumers in a way that reduces consumers' inclination to conserve energy, then that raises the overall cost to the economy of achieving the emissions goal. By reducing the abatement that would occur in the electricity sector, this approach would have driven abatement to more costly sectors.[63]

While such an approach may improve the political viability of a policy, it nonetheless worsens its economic efficiency by increasing the overall cost of meeting the program's goals, which could potentially hurt the very consumers one may wish to protect. Burtraw (2009) points out other implications of this approach. Since state public utility commissions control how LDCs would pass along the free allowance benefit, 50 different systems of redistribution could emerge. The same thing could happen if policymakers give carbon tax revenue back to households via credits on their energy bills. In general, if we are worried about effects on households, it is much better to return the revenue to them through a tax reduction or rebates, or for that matter pretty much any way other than through their energy bills.

From an environmental perspective, all abatement is created equal. Policymakers may opt to promote some kinds of abatement over others, for example by adopting a renewable electricity standard along with the carbon tax, directly subsidizing certain technologies with tax credits, or rewarding certain abatement with earmarked revenue. Even if they serve other goals, such policies raise the cost of achieving a particular emissions target if they distort incentives away from the least cost abatement options. If policymakers want to reduce emissions beyond what would be accomplished by a particular tax level, it is likely to be more efficient to raise the tax than adopt a set of less direct ancillary policies.[64]

EARMARKING THE REVENUE FOR SPENDING

Some ways to use the carbon tax revenue (or revenue from other taxes) could help lower the long-run costs associated with stabilizing greenhouse gas concentrations. In particular, even with a price on carbon, the private sector is likely to under-supply basic research and development on energy-efficient and low-carbon technologies. That is because such research represents a "public good," a market failure in which the developer of a new technology cannot appropriate all of the associated social benefits and therefore invests less in it than would be socially optimal.[65]

The federal government could retain some of the revenue to cover the federal government's own higher expenses on energy and greater spending on benefits for the poor, as discussed above. It could also distribute the proceeds to states, which could use it as they wish.[66] Finally, revenue could fund lower carbon technology research and development (R&D) or measures to help society be more resilient to extreme weather, both domestically and abroad.

Importantly, however, there is no particular connection between the amount of revenue a carbon tax raises and the appropriate level of spending on R&D, adaptation, or anything else except protecting the poor from higher prices. Thus earmarking carbon tax revenue for specific spending purposes is in general unlikely to be economically efficient. It may prove politically expedient, however, for policymakers to link the tax in some way to supporting popular programs that might otherwise be cut, such as Social Security. Such a linkage may also be desirable to address concerns about the distributional outcomes of the carbon tax, as discussed in Section VII.

At the risk of over-simplifying the rich and varied literature on the incidence and excess burden of different tax instruments **Table 3** provides an overview of the general options and implications of alternative uses of carbon tax revenue.

TABLE 3: Summary of Options for Using Carbon Tax Revenue

REVENUE USE	EFFECTS ON ECONOMY	PROGRESSIVE	COMPENSATES THOSE WHO BEAR CARBON PRICE?
Lump-sum rebates to households	Does not lower burden of tax system on the economy. Could boost consumption in a slack economy.	Yes	Likely under-compensates higher-income households.
Reduce federal budget deficit	Economy benefits from lower future tax burdens and greater investment now.	Maybe. Depends on structure of future tax system and who benefits from higher investment.	Maybe
Reduce (or prevent increases in) payroll or labor income taxes	Benefits economy to the extent it encourages more work. Benefits could be substantial.	Depends on implementation. Does not help those without earned income.	Depends. Could under-compensate higher-income households.
Give revenue to utilities to lower electricity rates	Increases costs by blunting incentives to conserve and driving abatement to costlier sectors.	Depends on how it is implemented by state utility regulators.	Yes for electricity consumers, but does not benefit consumers of other energy.
Reduce capital taxes (corporate income tax or capital gains tax)	Economic benefits could be substantial. Some think that using some revenue for an investment tax credit may be even better.	Likely not; the evidence on the incidence of corporate taxes is mixed.	Maybe
Fund climate, energy, and adaptation R&D	Could benefit economy if revenue goes to useful research the private sector would not do otherwise. In large sudden volumes it could bid up the price of research inputs. Total revenue is far more than would be appropriate to devote to only this category.	No	Maybe. Could lower costs of abatement in the future.
Give revenue to states or other sub-federal entities	Depends on what states do with it. Could benefit economy if they reduce deficits or other taxes.	Depends on what states do with it.	Depends on what states do with it.

IX. LINKING A CARBON TAX WITH CHANGES IN OTHER ENVIRONMENT AND ENERGY POLICIES

A price on carbon could lower greenhouse gas (GHG) emissions and spur innovation in low-GHG technology, and, therefore, a carbon tax could make many other, less-efficient energy and environmental regulations unnecessary. The question then arises which specific spending, tax, and regulatory measures would become redundant in the context of a carbon tax.

THE CLEAN AIR ACT AND STATE AND LOCAL POLICIES

In 2007, the U.S. Supreme Court ruled in *Massachusetts v. EPA* that carbon dioxide (CO_2) and other GHG emissions meet the definition of "air pollutants" under the Clean Air Act (CAA). With the definition confirmed, the Court then required U.S. Environmental Protection Agency (EPA) to determine whether emissions of GHGs from new motor vehicles (the specific sector cited in the lawsuit) cause or contribute to air pollution, which may reasonably be anticipated to endanger public health or welfare.[67] EPA determined that those emissions do pose a danger, and pursuant to that finding EPA can set other GHG emissions standards, such as for industrial facilities like power plants and refineries. EPA has begun imposing conditions on new or significantly renovated industrial facilities.[68] EPA is now working on a proposed rule to control GHG emissions from existing power plants, pursuant to instructions from President Obama in June 2013.[69]

Thus, without new legislation, EPA regulation of GHGs under the CAA is the likely path for U.S. climate policy.[70] Burtraw et al. (2011) review the possible legal approaches EPA could use and find that the ultimate cost of regulation under the CAA hinges on the stringency of standards and how much flexibility firms have in the way they comply. For example, a broad-based "tradable performance standard" limits GHG emissions per unit of energy consumed or electricity produced, and it would allow firms that over-comply with the standard to sell credits to firms who under-comply. Morris (2013c) suggests EPA could offer states the option to adopt an excise tax on the carbon content of fossil fuels used in the power sector. By allowing more abatement where it is cheapest, these approaches could significantly reduce the overall cost of achieving a collective emissions goal. However, such flexibilities require an innovative interpretation of the CAA and could face lengthy court challenges.

Inflexible emissions standards would be more costly than achieving the same reductions with a price signal. First, such standards prompt larger investments in energy-efficient technology than a carbon tax. Although that sounds like a good thing, it means that the equipment of a regulated source is cheaper to run and could be used more than it otherwise would be. Linn et al. (2012) estimate that this efficiency effect could undermine the standards' emissions benefits by about 11 to 13 percent. Second, an emissions performance standard does not necessarily provide efficient incentives to innovate. As Aldy and Stavins (2012) note, once a firm satisfies the standard, it has little incentive to develop cleaner technology. And where an innovative firm develops superior technology, there may be no incentive for others to deploy it. Furthermore, going above and beyond the standard may result in the government tightening the standard.

Policymakers adopting a carbon tax could partially or fully preempt EPA regulatory power over GHG emissions under the CAA. Some business interests would likely argue that some degree of CAA preemption is essential to the acceptability of a carbon tax. Such preemption is not without precedent. The American Clean Energy and Security Act (ACESA) would have preempted parts of EPA's GHG authority, limiting its ability to regulate GHGs from stationary sources.[71]

For example, EPA would have been prevented from regulating GHGs through a National Ambient Air Quality Standard, and would have been prevented from establishing a GHG performance standard for covered sources under the proposed cap-and-trade program (e.g., power plants). Additionally, EPA would have lost the authority to deem GHGs hazardous or international air pollutants solely on the basis of their climatic effects. The bill also would have preempted New Source Review for GHGs, another dimension of potential regulation of GHGs. On the other hand, ACESA would have preserved CAA authority over mobile sources of GHGs, such as passenger vehicles.[72]

Under certain assumptions about how ACESA would have been implemented, EPA predicted that the price on carbon would start at around $15 per ton of CO_2.[73] Some might argue that if CAA preemption was acceptable given the domestic performance of ACESA, then it should be acceptable for an even higher carbon tax. Others would argue that both CAA regulation and ACESA could produce much greater emissions abatement than a modest domestic carbon tax. That is because EPA could adopt very tight GHG emissions standards under the CAA, and ACESA would have prompted significant emissions abatement abroad through offset projects in addition to the domestic abatement at $15 per ton. Of course, it is unclear just how EPA will regulate GHGs under the CAA, and the regulations' performance will be a function of not just the standards but also how long it will actually take for them to enter into force. It could be more effective to adopt a modest, but increasing, carbon tax now than to pursue regulations that could take a decade or more to implement and reduce emissions.

That said, there may be good reasons not to completely preempt the CAA. Lessons from the Acid Rain Program suggest that if regulators do not update their goals when they learn more about the cost effectiveness of more stringent abatement, then market mechanisms may turn out inefficiently weak, leaving potentially large net benefits unrealized.[74] One way to balance these factors would be for congress to suspend, but not preempt, EPA's authorities to regulate GHGs from certain sources for a period of time, such as eight to ten years. This would ensure that congress has time to observe the performance of the tax for more than a decade before EPA initiates new CAA rules and closer to two decades before EPA rules and state implementation plans could be finalized.

In theory, the federal government could preempt state and local GHG policies. But this would prevent jurisdictions with higher willingness' to pay from exercising their preference for greater environmental protection. Indeed, one advantage of a carbon tax over a cap-and-trade system is that sub-federal policies have a better chance of actually reducing emissions beyond the abatement induced by the federal program. For example, if the federal government adopts a cap-and-trade system, then an especially ambitious state-level renewable electricity standard would simply allow other states to emit more by making more allowances available elsewhere via the tradable permit market. A federal carbon tax would incentivize abatement nationwide at the same marginal cost, even if some states adopt additional abatement policies.

Of course, retaining myriad state policies will result in inefficient disparities in the carbon price across the U.S. economy and a risk to businesses of multiple layers of regulation. Nonetheless, some would argue that states should have a right to take more stringent action if they wish, just as they can choose different tax rates and other regulatory policies. To avoid litigation from the states, the federal carbon tax legislation could make explicit its intent whether or not to preclude additional GHG measures by state, local, and tribal governments.

An economically efficient carbon tax policy would, however, require state utility regulators to preserve the carbon price signal to consumers through their regulated electricity prices and the law should specify this.

REVISING EXISTING REGULATIONS AND SUBSIDIES

Federal agencies have promulgated a host of regulations that control GHGs directly or indirectly, for example through energy efficiency standards and biofuel mandates. The federal government also directly subsidizes clean energy technology through myriad grants, tax expenditures, loan guarantees, and federal procurement policies.[75] A well-designed carbon tax would internalize the social costs of GHG emissions and address that market failure. Other market failures may remain that may justify continuing certain additional GHG policies, but they are importantly distinct from "market barriers." For example, a principal-agent problem (a type of market failure) applies if rental markets do not allow landlords to finance energy efficiency investments with higher rents. On the other hand, if people do not buy certain energy-saving products because they do not like the other features of the products, that is a market barrier, but not a market failure. The question arises how significant remaining true market failures would be with a price on carbon and whether the government can cost-effectively address them.

The net benefits of many energy-related regulations and mandates are hotly debated, with many economists on the skeptical side.[76] For example, Allcott and Greenstone (2012) find that the benefits of energy efficiency investments are lower than many engineering studies suggest, and that the benefits can vary widely across different kinds of energy users. Gayer and Viscusi (2012) examine the analyses that federal agencies undertake in setting energy efficiency regulations, and they find substantial methodological flaws and conclude that the costs of the rules are greater than the benefits. They note the obvious alternative to efficiency standards of educational programs like Energy Star, which give better information to consumers about the likely energy costs of owning certain products, like cars and appliances. Whatever the strength of the economic case for energy-related standards and mandates, it would be weaker in the context of a carbon tax.

A carbon tax could also weaken the case for directly subsidizing the deployment of clean-energy technology and some energy-efficient products. In general, subsidizing these investments in the presence of an efficiently set carbon tax would either compensate investors for what they would do anyway or distort their investment toward higher cost abatement. Neither is efficient. Morris (2013b) suggests that about $6 billion in annual direct and tax expenditures that support clean energy could be eliminated with the passage of a carbon tax, assuming that some policies that are set to expire would be extended in the absence of broader climate policy.

In contrast to the subsidies for deployment of clean energy, most economists argue that federal funding for basic research and development is justified even with an efficient price on carbon. The private sector under-supplies these activities because firms cannot capture their full social value, including positive technological spillovers.

X. ADDRESSING EMISSIONS LEAKAGE AND THE CONCERNS OF ENERGY-INTENSIVE, TRADE-EXPOSED (EITE) INDUSTRIES

So far, we have considered the case when a carbon tax is passed through to consumers via higher prices for the goods and services that have fossil energy in their supply chain. However, under certain market conditions, the carbon prices will not flow through to consumers, even in the long run. Some U.S. firms produce goods in a fossil fuel-intensive process, and they compete directly with firms in countries that do not regulate greenhouse gases (GHGs). We call these energy-intensive, trade-exposed (EITE) industries. All else equal, a carbon tax imposed in the United States and not in other countries could put U.S. EITE firms at a disadvantage if they cannot pass along their higher input costs without losing business to their competitors.[77] These competitive effects could lower the environmental benefits of a U.S. carbon tax by driving production and new investment to countries with less ambitious climate policy. This shift is known as emissions leakage.

Of course, all sorts of factors determine how competitive a particular firm is, but clearly this is a concern for certain EITE industries, notably metals, chemicals, glass, pulp and paper, and cement. The size of the carbon-tax-induced disadvantage correlates with how dependent a firm is on fossil energy (directly and indirectly), how exposed it is to foreign competition (including the supply elasticity of its competitors), and the environmental and tax policies applicable to competing firms. It also depends on how much U.S. firms can adapt to new relative prices to stay ahead of the competition, such as by developing new technologies, and how easily consumers can substitute from the domestic EITE goods to goods imported to the United States.

Another potential outcome of disparate global energy policies is called price-based emissions leakage. In theory, other countries' emissions could increase if the United States and other large economies adopt serious efforts to reduce their fossil energy consumption. As U.S. fuel demand shifts back, globally traded fuel prices could fall, and other countries' fuel consumption could increase.

Empirically, what do we know about the significance of leakage and competitiveness problems? It depends on a host of assumptions about U.S. policy and policies abroad, but some evidence suggests leakage from a carbon tax would be quite small. For example, McKibbin et al. (2012b) estimate the effects of a unilateral U.S. carbon tax that begins at $23 per ton of carbon dioxide (CO_2) in 2012 and rises at 4 percent over inflation to $46 in 2030. Using a general equilibrium model of the global economy, they find no evidence of energy-related emissions leakage, in part because they find that the price of oil in other currencies does not fall, despite significant reductions in oil consumption by the United States.

Aldy and Pizer (2009) review the literature on the effect of unilateral climate policy on manufacturing industries. They show that European industries, in particular lime, cement, iron, and steel, could experience an increase in production costs of about 20 percent for a price on CO_2 of about 20 Euros. Aldy and Pizer (2009) estimate the effects of a (unilateral) $15 per ton price on CO_2 on U.S. manufacturing industries. Their work sought to isolate the competitiveness effect of the policy from its broader effects on industry generally through declines in consumption. They found that overall, U.S. production shifted abroad by about 0.7 percent as a result of the policy. Looking specifically at EITEs, they found that industries with energy costs that exceed 10 percent of shipment value (e.g., metal foundries, cement, and lime) would expect at most a 1 percent shift in production overseas. The largest effect was in industrial chemicals, with a competitiveness-induced decline in production of 0.9 percent. The conclusion of this is that trade effects of a modest carbon price are likely to be small overall, but they could be important for industries with particularly emissions-intensive production technologies and strong foreign competition.

Before we launch in to the ways in which policymakers could address concerns of EITE industries, we should stress that the first, best outcome is for the United States to leverage its domestic action into analogous action by other countries. Any problems for EITE industries from a carbon policy derive directly from unequal efforts across countries.[78] And all major economies must reduce emissions to stabilize concentrations of GHGs in the atmosphere.

U.S. climate diplomats could do a number of things to promote equivalent efforts across major trading partners. For example, they could shape negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) so that countries can supplement their emissions targets with commitments in the form of carbon pricing, allowing compliance by either achieving their emissions targets or by demonstrating significant effort through imposing agreed price signals. McKibbin et al. (2012c) outline just such an approach. Price-based commitments would reduce the risk of inadvertent stringency or laxity, help achieve and document compliance, and allow parties to compare their efforts transparently. An international commitment to a specific price trajectory on carbon domestically would also create a hurdle for future congresses to unravel the tax and thus would reinforce the expected price signal. Finally, the United States could promote carbon pricing as a key low-carbon growth strategy. By sharing its views and experiences, the United States could demonstrate the pro-environment, pro-growth potential of carbon taxes that help keep more distortionary taxes lower. This would also foster cost-effective environmental protection in economies least able to afford the burdens of inefficient regulation.

Assuming the United States does all it can to foster carbon pricing abroad that is at least as stringent as its own, we now turn to the problems that could arise for EITE firms. The first is import competition. For example, U.S. steelmakers may be concerned that domestic buyers of steel would turn to foreign competitors, who could produce steel more cheaply with untaxed fossil fuels abroad. The second is export competition. For example, U.S. exporters of chemicals that use taxed fossil fuel inputs are less able to compete in their export markets with manufacturers that use inputs that are not taxed. In theory these problems are symmetrical, but the vagaries of World Trade Organization (WTO) rules may make the first problem easier to address than the second.

Fischer and Morgenstern (2009), Böhringer et al. (2012), and Fischer and Fox (2012) review the policy measures that have been proposed to reduce emissions leakage and competitive disadvantage. One is a border carbon adjustment (BCA), and WTO rules may limit this to imports. A BCA approach would tax imports of GHG emissions-intensive goods from less-regulated regions by an amount that reflects the difference between the carbon policy in the originating country and the United States. The idea would be to carefully specify the most intensely EITE goods (such as aluminum) and set import tariffs on those goods from countries with substantially weaker climate policy. This is less straightforward than it sounds because many countries adopt policies, such as renewable electricity mandates, that do not clearly equate to a carbon price. Further, the carbon intensity of an EITE good may vary a lot within a country, even within a firm. Moreover, introducing BCAs could give rise to unwieldy and protectionist policies if not carefully limited.

Another approach would either exempt EITE industries from the carbon tax or reduce its rate. However, this approach forgoes both revenue and the potential for cost-effective emissions abatement. It also introduces large returns to lobbying for the exemption. A third proposal involves transferring some of the carbon tax revenue to EITEs in proportion to their output. Output-based rebates, as this approach is known, operate as a subsidy to production and incentivize emissions-intensive firms to keep up production even as its input costs go up. This approach helps reduce the potential loss of jobs in those industries, but it also helps keep prices of energy-intensive goods lower than they would otherwise be, reducing the environmental benefits of the tax.

Finally, the real effect of the carbon tax on EITE firms depends on what happens to the revenue. An interesting line of research would explore how the carbon tax revenue could be used for tax reforms that would make U.S. firms more competitive. In principle, this could offset some of the competitive effects on EITE firms, even if the reform is not targeted just to them. And it may be possible to construct an efficiency-enhancing tax reform targeted to EITEs. If some kind of explicit measure to protect EITE firms is necessary, a carefully circumscribed BCA is probably the most efficient. Ideally, the tariff authority would last only as long as large and trade-distorting policy differences persist.

XI. CONCLUSIONS AND RECOMMENDATIONS

A carbon tax could, if designed correctly, improve the long-run U.S. fiscal situation while controlling U.S. greenhouse gas (GHG) emissions. If the United States uses revenue from a carbon tax to fund a long-term reduction in other taxes, the tax swap could potentially enhance the overall economic efficiency of the tax code. For example, revenue from a carbon tax could allow the United States to reduce its statutory marginal corporate income tax rate, which is currently the highest in the developed world, to a more internationally competitive level. It could also reduce payroll taxes or personal income tax rates. The carbon tax could also prevent cuts in social safety net spending and reduce the federal budget deficit. A price on carbon could also supplant more-costly and less-effective measures to reduce emissions, promote clean energy and energy efficiency, and drive innovation, saving both budget and regulatory costs. An important dimension to the adoption of a carbon tax is the extent to which congress suspends or preempts existing legal authorities to control GHG emissions at the federal and state levels.

Policymakers can adopt a number of approaches that could hold poor households harmless, including reserving a share of the carbon tax proceeds for targeted spending or rebates to qualifying households. Policies that return revenues to households in ways that blunt their incentives to reduce energy consumption, such as via rebates on energy bills, would be substantially less efficient in lowering emissions than policies that compensate households in other ways.

Several measures could mitigate any adverse effects of a carbon tax on energy-intensive, trade-exposed industries. First, the United States can pursue diplomatic efforts to leverage its action into analogous actions by major trading partners. Such efforts are also key to maximizing the global climate benefits of U.S. policy. Second, the United States can limit the effects of the tax by adopting a modest initial carbon price and raising it gradually. Third, revenue from the carbon tax can fund reductions in other taxes that make U.S. firms less competitive internationally. Finally, the United States could adopt limited border carbon adjustments to impose surcharges on imports of energy-intensive goods from countries with significantly less ambitious climate policy.

The proposal in Morris (2013b) illustrates one possible way to package these design elements in a way that could appeal to a variety of stakeholders. It estimates that a tax that starts at $16 per ton of carbon dioxide (CO_2) and rises at 4 percent over inflation each year could fund the long-term reduction in statutory corporate income tax rates from 35 percent to 28 percent and reduce the federal budget deficit by almost $200 billion in the next decade and about $815 billion over the next two decades, while reducing CO_2 emissions by 9.3 billion tons over 20 years. Using estimates from Mathur and Morris (2014), the proposal reserves 15 percent of the revenue to protect the welfare of the poorest twenty to thirty percent of households, or roughly the households with incomes at 150 percent of the poverty level and below.

Underpinned by sound science and thoughtful design, a carbon tax could fit into broader fiscal reform in a way that serves both environmental and economic goals.

ENDNOTES

1 For an in-depth overview of science of climate change and projected impacts, see the Center for Climate and Energy Solutions (2011).

2 Carbon is shorthand here for greenhouse gases generally because carbon dioxide comprises the lion's share of overall GHG emissions. Morris (2013a) cites polls of economists on the role of carbon pricing in climate policy.

3 Other reviews of carbon tax design include Ramseur et al. (2012), Metcalf and Weisbach (2009), and Metcalf (2008). This paper also draws from Morris (2009), which reviews the economics of allocating cap-and-trade allowances.

4 This concept goes back at least to Pigou (1952). For more theory of environmental taxation, see Bovenberg and Goulder (2002).

5 Aldy and Stavins (2012) contrast different approaches to GHG mitigation. For an overview of how market-based policies can achieve climate goals more cheaply and efficiently than other policy options, see Center for Climate and Energy Solutions (2012).

6 Hsu (2011) surveys arguments in favor of a carbon tax over other environmental policies.

7 Goulder and Stavins (2011) explore the interactions of state and federal climate policies.

8 McKibbin et al. (2011) use a general equilibrium model to compare energy efficiency subsidies to a carbon tax. They find that a carbon tax can reduce emissions by about twenty times more than the subsidy approach for similar fiscal footprints.

9 For example, see Pizer (1999).

10 Rausch and Reilly (2012).

11 McKibbin et al. (2012a).

12 In fact, EPA must do so pursuant to its 2009 decision that current and projected concentrations of greenhouse gases "threaten the public health and welfare of current and future generations." See U.S. EPA (2013a).

13 See Center for Climate and Energy Solutions (2014).

14 See Burtraw et al. (2011).

15 See Paltsev et al. (2007), Tables 4 and 6.

16 For studies that did not report this information directly, we estimate the values from the available graphs. For example, we estimate baseline emissions levels from Figure 4 in Rausch et al. (2010) and the corresponding policy scenario emissions from the table on page 2 of Metcalf (2010).

17 Domenici and Rivlin (2010), p. 41.

18 See for example Metcalf (2007), Marron and Toder (2013), and Morris (2013b).

19 The benefits of GHG mitigation also depend on the ancillary effects of mitigation, such as the co-control of other pollutants.

20 Estimates for the willingness to pay can even differ by how the abatement occurs. For example, Kotchen et al. (2011) find that American households have an average annual willingness to pay for climate change abatement of $79 for a cap-and-trade approach, $85 for a carbon tax, and $89 for a GHG regulation. Aldy et al. (2012) find that the average American is willing to pay $162 per year for a clean energy standard of 80% clean energy by 2035.

21 Examples of this literature are Weitzman (2011) and Nicholas H. Stern, *The Economics of Climate Change: the Stern Review* (Cambridge, UK: Cambridge University Press, 2007).

22 Discount rate is a type of interest rate that reduces or "discounts" the value of a future cash-flows to account for the time value of money.

23 See U.S. Government Interagency Working Group on the Social Cost of Carbon, U.S. Government (2013).

24 Some GHGs degrade or are taken up by the ocean or terrestrial ecosystems each year. This means *net* emissions must be zero to stabilize concentrations.

25 Metcalf and Weisbach (2009) review this literature and explain that the optimal rate of growth in the tax depends, among other things, on whether one wishes to maximize net social welfare or minimize the costs of achieving a particular environmental objective.

26 For example, Metcalf et al. (2008) find that for a given cumulative abatement, welfare costs are lower with a higher initial tax rate and a 4% annual tax rate increase than with a lower initial tax rate and a more rapid 10% real increase.

27 See for example Sinn (2008). Edenhofer and Kalkuhl (2011) show that this result can indeed arise if the initial carbon tax level is low and the tax rate grows faster than the discount rate of resource owners.

28 National Research Council (2010), p. 359 notes that the SCC could vary by two orders of magnitude.

29 Metcalf and Weisbach (2009) advocate this approach.

30 Such an approach appears in the Managed Carbon Price Act of 2012 (H.R. 6338 of the 112th Congress) introduced by Rep. Jim McDermott (D-WA) in August 2012. Carbon tax proposals of the 113th Congress have eschewed using a formula, see Center for Climate and Energy Solutions (2013a).

31 See Metcalf and Weisbach (2009), p. 520, for more discussion of this issue.

32 See Center for Climate and Energy Solutions (2013b).

33 For trends in U.S. coal production and export, see "Quarterly Coal Report," U.S. Energy Information Administration last modified, January 2, 2014, http://www.eia.gov/coal/production/quarterly.

34 Congress enacted the Black Lung Benefits Act of 1977 to compensate individuals with the disease known as pneumoconiosis or "black lung disease." See U.S. Internal Revenue Service, *Coal Excise Tax Audit Technique Guide* (Washington, DC: Department of Treasury, 2005), http://www.irs.gov/pub/irs-mssp/coal.pdf.

35 OECD (2013) shows that the U.S. has one of the lowest average effective federal tax rates on energy in the developed world.

36 Viard (2009b).

37 U.S. EPA (2009).

38 The Carbon Pollution Fee discussion draft—as released by Rep. Henry Waxman (D-CA), Sen. Sheldon Whitehouse (D-RI), Rep. Earl Blumenauer (D-OR), and Sen. Brian Schatz (D-HI) in March 2013—requires covered entities to purchase permits for the compliance year. For an overview of carbon tax proposals in the 113th Congress (2013-2014), see the Center for Climate and Energy Solutions (2013a), the Center for Climate and Energy Solutions (2014).

39 Examples of federal tradable tax credit programs include the Low-Income Housing Tax Credit, the New Markets Tax Credit, and the solar Investment Tax Credit.

40 This paper focuses on the incidence of abatement policy within the U.S.; the complex distribution of the global environmental benefits is important, but outside the scope of this paper.

41 Abatement supplied at a cost below zero implicitly appears in the reference scenario.

42 Here “firm” is shorthand for the owners of the firm, i.e., stockholders. Again, we focus on the distributional effects on *people*, not corporations—legal entities for which the concept of welfare makes no sense.

43 A detailed discussion of the relationship between energy efficiency and energy prices is beyond the scope of this paper, but an extensive literature explores the “energy efficiency gap,” the apparent underinvestment in energy-conserving technologies and practices.

44 Ho et al. (2008) examine the dynamics of the incidence of climate policy on firms, from the very short run to the long run.

45 If carbon capture and storage technology costs fall significantly, coal production might not shrink.

46 Lasky (2003) surveyed economic models and found that with 10 years notice before instituting a carbon constraint, consumers would initially bear between 94 and 96 percent of the burden of the carbon price.

47 Morris and Mathur (forthcoming) provides a more detailed review of the literature on the distributional effects of a carbon tax.

48 Rausch and Reilly (2012), Figure 8, p. 14.

49 A good introduction to these issues is Parry et al. (2007).

50 Morris and Mathur (2014) demonstrate this.

51 A share of capital taxation is likely to be borne by workers in taxed firms in the form of lower wages.

52 Rausch et al. (2010) review this literature.

53 Parry and Williams (2011) explain the tax interaction effect in more detail.

54 See Feldstein (2006) for more on the distorting effects of corporate income taxes.

55 Some estimates suggest that using carbon tax revenue to lower the deficit or other taxes can lower the overall costs of the program by 75%. See Parry (1997).

56 See Goulder et al. (1999), Parry et al. (1999), Parry and Oates (2000), Parry and Bento (2000), and CBO 2007.

57 Feldstein (2006).

58 Toder (2012).

59 Elmendorf (2009).

60 See Dinan and Rogers (2002).

61 Rausch and Reilly (2012), Figure 7, p. 15 and Table 3, p. 7.

62 See Rubin et al. (2004) for a more complete discussion of the downsides to a large federal budget deficit.

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

64 One exception would be instances where clear market failures remain.

65 Fischer and Newell (2008).

66 Equivalently, states could individually or collectively adopt a carbon tax, and the federal government could collect it for them.

67 A thorough analysis of EPA's regulatory trajectory appears in McCarthy and Park (2011). Also see Wallach (2012).

68 See U.S. EPA (2013).

69 Presidential Memorandum – Power Sector Carbon Pollution Standard, *Compilation of Presidential Documents*, DCPD-201300457, (June 25, 2013). http://www.gpo.gov/fdsys/pkg/DCPD-201300457/pdf/DCPD-201300457.pdf.

70 Anderson and Richardson (2012) survey a number of other statutes that provide (or conceivably could provide) authority for agencies to regulate GHGs, absent a specific preemption. For example, these include the Clean Water Act, which could be triggered if climate disruptions and/or acidification from CO_2 absorption extend to navigable waterways.

71 Holt and Whitney (2009).

72 Ibid. p. 55–56.

73 U.S. EPA (2009).

74 Burtraw and Szambelan (2009).

75 Morris et al. (2012) review the economics of these policies.

76 See Gayer and Viscusi (2012) for example.

77 The concerns of EITE industries do not apply only to a carbon tax; they can arise with other approaches to GHG regulation. Morgenstern (2010) notes that effects on EITE firms of CAA regulation of GHGs by EPA depend on how flexible EPA's compliance standards are.

78 Morris et al. (2013b).

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This report examines the issues and options for designing a carbon tax in the United States. Reviewing the rationales for a carbon tax in the context of broader fiscal reform, it explores design issues, environmental benefits and the options for using the resulting revenue.

The Center for Climate and Energy Solutions (C2ES) is an independent non-profit, non-partisan organization promoting strong policy and action to address the twin challenges of energy and climate change. Launched in 2011, C2ES is the successor to the Pew Center on Global Climate Change.

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