RFF REPORT

Deficit Reduction and Carbon Taxes: Budgetary, Economic, and Distributional Impacts

Considering a Carbon Tax: A Publication Series from RFF's Center for Climate and Electricity Policy

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DEFICIT REDUCTION AND CARBON TAXES: BUDGETARY, ECONOMIC, AND DISTRIBUTIONAL IMPACTS

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Executive Summary

This report looks at both the efficiency and distributional implications of introducing carbon dioxide (CO_2) taxes, either as part of revenue-neutral tax reform or as one of a series of measures to address the long-term budget deficit. It uses a newly developed dynamic general-equilibrium, overlapping-generations model of the US economy, combined with a more disaggregated model of near-term distributional impacts.

We find that CO_2 taxes can generate substantial revenues, $1.6 trillion to $3.6 trillion over a decade. When the issue of a rising national debt is ignored and the tax proceeds are used to support revenue-neutral reductions in capital taxes (i.e., corporate taxes or personal income rates on interest, dividends, or capital gains), we find that the net social costs, even without considering the environmental benefits, are close to zero: gross domestic product rises slightly, though a more comprehensive measure of economic effects shows a small net cost. Recycling the revenues via reductions in payroll taxes or personal income taxes is slightly less economically efficient than via capital tax cuts. Recycling via lump-sum rebates is worse than the other options in terms of economic efficiency. The intergenerational impacts of these different revenue-recycling options also vary significantly, with some options aiding younger generations and others aiding older ones. In terms of near-term distributional impacts, low-income households benefit most from the lump-sum rebates, whereas middle- and upper-income ones gain most from capital and labor tax swaps. The distribution of effects across regions of the United States is generally less substantial than across income groups.

Another set of simulations addresses the prospect of using the CO_2 revenues to reduce the deficit. In these cases, which also assume comparable cuts in government spending, the revenues offset increases in capital, labor, or consumption taxes that would otherwise be required to meet long-term budgetary objectives. The general pattern of results among the options is similar to the revenue-neutral case: usingCO_2 revenues to offset capital tax hikes provides the most economic benefits, followed by labor taxes, consumption taxes, and lump-sum dividends. In addition, using carbon tax revenues to offset increases in some taxes aids some generations and harms others. The near-term distributional impacts also vary along the lines of the revenue-neutral swaps.

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A final set of simulations, also focusing on deficit reduction, uses a $30-per-ton CO_2 tax as a down payment in advance of the larger spending reductions and tax hikes required to bring the long-term deficit down to a sustainable level. In this set of simulations, a CO_2 tax makes it possible to start paying down the deficit sooner, and thus reduces the need for other tax increases in the future. This contrasts with the previous sets of simulations, which maintained the same deficit path both with and without a CO_2 tax. In this case, the CO_2 tax can generate substantial economic efficiency gains, even when environmental benefits are ignored. At the same time, the intergenerational consequences may make this the most politically difficult, as every generation currently old enough to vote is worse off with the early introduction of the CO_2 tax, whereas today's very young and future generations benefit.

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1. Introduction

Despite the widespread view among economists and policymakers that the US federal tax system needs reform over the long term, there is little consensus on the specifics. The system is less efficient than it could be, excessively distorting the economy for the amount of revenue raised. The notion of lower marginal tax rates and a broader base has wide appeal, but no politically feasible path to achieve such goals is apparent. Further, short of substantial cuts in federal programs at a scale and scope not being seriously considered, the need for at least some more tax revenues over the long term seems almost inevitable. How and when those revenues should be raised are open questions.

Accounting for recent tax hikes, the sequester, and other spending cuts, current projections by the Congressional Budget Office (CBO) show a substantially lower near-term federal deficit, now projected at $560 billion for 2014 and $378 billion for 2015. Nonetheless, the long-run fiscal forecast is quite gloomy. CBO expects the federal deficit to start rising again in 2016, with debt levels reaching 73.6 percent of gross domestic product (GDP) by 2023, almost twice the 2000 ratio, and to continue growing thereafter. It is widely understood that such a path is unsustainable over the long term and that credit markets would eventually force a paydown of the debt.

At the same time, the world faces the challenge of reducing emissions of carbon dioxide (CO_2) and other greenhouse gases to limit the effects of global climate change. Introducing a CO_2 tax as one element of tax reform can both provide revenue and reduce carbon emissions. This report introduces a modeling framework that enables the consideration of the budgetary, economic, distributional, and environmental implications of including such a measure as part of a fiscal reform initiative. Our focus is strictly on federal tax policy and the effects that alternative sources of revenue have on economic activity. The analysis does not consider the benefits of reducing greenhouse gas emissions. We examine three general directions for tax and deficit changes involving a CO_2 tax.

In a first set of simulations, we generate “revenue-neutral tax swaps,” by substituting a carbon tax (in a revenue-neutral manner) for existing capital, labor, and consumption taxes or by returning carbon tax revenues via lump-sum rebates. We also look at how emissions reductions vary based on the tax swap. In a second set of simulations, we study the effect of including a carbon tax in a package of measures to reduce the budget deficit. In a third set, we look at the carbon tax as a deficit-reduction tool by itself, with the tax revenue serving as a down payment on deficit reduction.

Previously, the economics literature has considered possible interactions between environmental taxes and the broader fiscal system, largely in the context of budget-neutral changes that use the new revenues to fund cuts in other taxes or increases in spending. Although policy interest in the use of environmental taxes for deficit reduction can be traced at least to the Clinton administration’s 1993 Btu tax proposal, the economics modeling community has devoted only limited attention to using environmental taxes to help reduce the deficit, as such an effort requires methodological tools that differ from those used in a revenue-neutral approach. Thus, we build a dynamic general-equilibrium overlapping-generations (OLG) model of the US economy, which includes detail on government taxes and expenditures and substantial energy-sector information. The key feature of this model is its more realistic depiction of households’ decisions about work, savings, and consumption over their lifetimes. It contrasts with other frameworks, which either model people as living forever or involve a one-time snapshot of households.

This OLG approach has several advantages. First, it is particularly well suited to examining the effects of changes in the timing of taxes or spending because, unlike most other models, which imply that government borrowing is fully offset by private sector saving (a concept referred to in the economics literature as “Ricardian equivalence”), this is not the case in an OLG model. Instead, we account for an accumulation of debt and anticipate the eventual impact that debt would have on the economy. Second, the assumptions in other models imply infinitely elastic capital supply, whereas an OLG model enables a more realistic analysis of the effects of tax policy on capital accumulation. This is obviously crucial when considering capital taxation, but is also important for analyzing other taxes that may indirectly affect capital, such as a carbon tax. Third, the OLG structure permits us to examine how different generations—baby boomers, new labor market entrants, and even future generations—are affected by policy reforms, including their behavioral response to the policies.

Each of these three features is widely used in economics, but to our knowledge, no other model combines all of them, as is needed to address key questions about carbon taxes and fiscal policy. Although this model is designed primarily to look at broad, longer-term issues, as opposed to shorter-term emissions or abatement costs, it can also provide useful estimates for the nearer term. Finally, we link the OLG model to a household-level model to examine the net burdens of the various reform options based on income and region of the country in the near term. Such impacts are especially important because it is current voters who will determine the choices that are made. Detailed descriptions of the OLG model and the near-term household model are available on request from the authors.

The revenue-neutral reforms use the revenues from a carbon tax to reduce rates on a range of existing taxes:

- capital taxes, which include the corporate income tax and personal income taxes on interest, dividends, and capital gains;
- labor taxes, which include payroll and personal income taxes on labor; or
- consumption taxes, which cover state sales taxes.

In addition, we consider an option wherein the revenue is returned as a nontaxable lump-sum annual dividend payment, providing every adult an equal dollar rebate. Each of these policies is revenue-neutral over the long term, though they differ very slightly in the path that revenues take over time. Three alternative carbon tax scenarios are considered: $20, $30, and $50 per ton of CO_2 (in 2012 dollars), beginning in 2015, and remaining constant in real terms thereafter. Similarly, the offsetting tax cut or dividend also begins in 2015 and remains constant thereafter. Although not explicitly modeled in this report, phasing in CO_2 taxes and/or ramping them up over time are also possible.[2]

In both deficit-reduction simulations, the noncarbon taxes considered are the same as those in the revenue-neutral case; namely, combinations of levies on capital, labor, and consumption as well as lump-sum dividends—all matched to meet the same long-term revenue targets. Both the baseline and debt-reduction scenarios use equal combinations of revenue increases and spending cuts, matching the 50–50 split embodied in the widely discussed *Domenici–Rivlin Debt Reduction Task Force Plan 2.0* (Bipartisan Policy Center 2012; see also Bipartisan Policy Center 2010). The key difference between the revenue-neutral tax reform and deficit-reduction scenarios is that in the former, we use the carbon tax revenues to reduce noncarbon taxes or to provide rebates, whereas in the latter case, which recognizes the need for additional revenues, we compare a carbon tax to various noncarbon taxes and rebates as alternative means of raising revenues. A final set of simulations, also focusing on deficit reduction, uses a carbon tax as a down payment in advance of the larger spending reductions and tax increases required to bring the long-term deficit down to a sustainable level. In this set of simulations, a carbon tax makes it possible to start paying down the deficit sooner (and thus reduces the need for other tax increases in the future), whereas the previous set of simulations compares policy options with and without a carbon tax, but with the path of the deficit the same in both options.

The plan of this report is straightforward. Following this brief introduction, the next section contains a detailed description of the base case assumptions and the policy simulations examined for the deficit- (revenue-) neutral tax reform cases and presents the key results. Section 3 provides comparable information for both deficit-reduction scenarios, including the case where the CO_2 tax provides a down payment toward additional deficit reductions at a later time, and compares them to the deficit-neutral cases. Section 4 briefly considers the impact of the currently lower natural gas prices compared to those prevailing a few years ago. Section 5 concludes and offers a series of summary observations.

2. Revenue-Neutral Tax Reform

Many in Washington emphasize the importance of revenue neutrality in any tax reform measure. One argument for this approach is that it separates the tax reform issue from the political difficulties associated with deficit reduction, in particular the contentious determination of the appropriate mix of spending cuts and revenue increases. Another argument holds that any spending cuts or tax increases should await a stronger economic recovery. We take no position on these propositions, but due to the widespread interest in revenue-neutral reform, we begin by considering a series of revenue-neutral tax swaps.

One often-discussed reform option is to reduce tax loopholes and tax expenditures to fund growth-enhancing marginal reductions in income tax rates. Despite the potential economic gains from such an option, the political challenge to enacting changes on a scale sufficient to finance meaningful rate cuts seems overwhelming, at least for now. From the modeling perspective,

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[2] By holding the carbon tax rate constant over time, these simulations differ from most policy proposals for a carbon tax, which typically involve a tax rate that rises over time. We do this for simplicity: it is easier to understand and to explain the effects of a constant carbon tax rate than the effects of a carbon tax rate that changes over time. Similarly, many proposals would announce the carbon tax prior to when it is imposed, so that the economy has some time to adjust before the policy takes effect. Again, for simplicity, we assume that the tax swap is implemented immediately, without any preannouncement.

detailed information on the precise nature of loophole and tax expenditure changes would be required to conduct rigorous analysis of the potential impacts. Notwithstanding the substantial benefits of CO_2 reduction, the political challenges of enacting a carbon tax at this time are also significant. At a minimum, the affected interest groups and ideological perspectives of loophole closing versus carbon taxes are quite different.

In practice, any reform is likely to combine marginal rate cuts across more than one of the revenue-recycling options considered here; for example, changes in both business and individual taxes. But for simplicity, we consider them separately. One can get a good idea of what a more complex package would do by simply combining the results from these scenarios. For example, a bill that devoted half of the carbon tax revenue to cuts in capital taxes and half to cuts in labor taxes would have results roughly halfway between the results from a pure capital tax–cut scenario and a pure labor tax–cut scenario.

In each of these scenarios, we hold spending and taxes constant in real terms, and thus also hold constant the long-run path of real debt levels, which implies a path that is unsustainable over the long run. As noted, in CBO's most recent analysis, the publicly held debt reaches 73.6 percent of GDP in 2023. In our model, debt continues to grow, reaching 168 percent of GDP in 2050. In the real world, this would lead to substantial negative effects on the economy, but because the focus here is on revenue-neutral reforms, we do not model those effects.

2.1. Revenue-Neutral Tax Reform Scenarios

We consider a total of 12 revenue-neutral scenarios: three alternative carbon tax rates and four options for returning the funds to the economy. In each case, we present the results for that revenue-neutral combination (the carbon tax plus the tax cuts or nontaxable lump-sum payment) relative to the status quo.

Table 1 displays the percentage-point reductions in average tax rates for the three categories of existing taxes, along with the annual per-adult lump-sum rebates that could be supported by the alternative CO_2 taxes. Thus, a \$20-per-ton CO_2 tax would allow reductions of 3.5 percentage points in capital taxes, 1.05 points in labor taxes, 0.67 points in consumption taxes, or a per capita annual rebate of \$633.33 for every adult. For comparison purposes, a \$20-per-ton CO_2 tax is equivalent to about 20¢/gallon of gasoline and approximately 1.4¢/kilowatt-hour of electricity. The \$30- and \$50-per-ton CO_2 taxes are equivalent to proportionately larger fuel and electricity price increases. We model these tax changes as cutting marginal rates by the same percentage-point amount in every tax bracket (implying that the percentage-point changes in marginal and average rates are the same), though in practice the cuts could be distributed differently across tax brackets.

Table 1. Changes in Tax Rates in the Revenue-Neutral Scenarios

CO_2 tax rate	Change in percentage points			Annual per capita lump-sum transfer (2015–2025)
	Capital	Labor	Consumption	
$20/ton	–3.412	–1.014	–0.645	$613.82
$30/ton	–4.823	–1.413	–0.893	$876.44
$50/ton	–7.297	–2.100	–1.315	$1,347.49

For two reasons, the percentage-point cut is biggest for the capital tax and smallest for the consumption tax. First, the tax base is biggest for the consumption tax (consumption is more than either labor or capital income by itself) and smallest for the capital tax (capital income is a substantially smaller share of the economy than labor income). In the absence of any behavioral responses to the tax change, a given amount of revenue can fund a larger percentage-point cut for a tax with a smaller base. Second, to the extent that the tax cut results in a behavioral response (and thus an efficiency gain), that will imply a smaller revenue loss from any given rate cut—or a larger cut for any given revenue loss. The capital tax is the most distortionary of these three taxes, whereas the consumption tax is the least distortionary.

2.2. Revenue Impacts

Table 2 displays the revenues generated by the three alternative carbon taxes analyzed, assuming revenue-neutral reductions in labor taxes, expressed as the average annual revenues over the 2015–2025 budget window (2012$). The $20-per-ton CO_2 tax yields revenues averaging $158 billion/year or $1.58 trillion over the first decade. The higher CO_2 tax rates yield higher revenues, although revenues rise less quickly than the tax rate as the higher tax rates result in greater decarbonization of the economy.

Although not displayed, comparable revenue estimates are available for the cases where the carbon tax revenues are used to fund cuts in capital or consumption taxes or to provide lump-sum rebates. Revenues are slightly higher in the case of capital tax cuts, primarily reflecting the higher GDP growth induced by such tax reductions (discussed below). The comparable revenues for consumption tax cuts and lump-sum rebates are slightly lower, driven largely by the lower GDP growth induced by those measures.

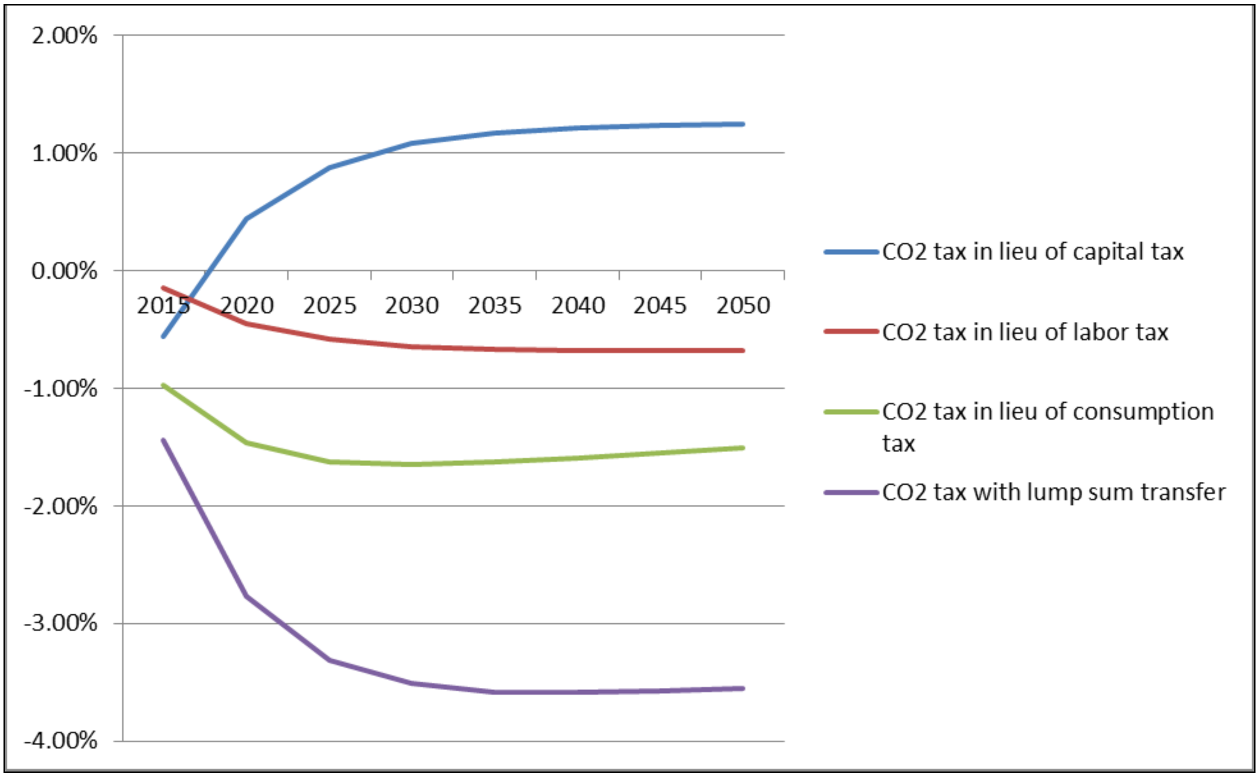
Table 2. Revenues from Deficit-Neutral Cases, Assuming Labor Tax Cuts, Average Annual Values 2015–2025 (Billions 2012$)

$20/ton	$30/ton	$50/ton
$157.57	$226.03	$350.47

2.3. Economic Growth

Figure 1 displays the time path of percentage differences in GDP associated with introducing a $30-per-ton revenue-neutral carbon tax and recycling the revenues via alternative means. Note the focus on differences in GDP *levels,* not *growth rates.* Although the overall differences among the recycling options are relatively small in absolute terms, they merit discussion. As shown, after some small initial losses, the capital tax cuts yield small GDP gains over time, rising above 1 percent by the middle of the next decade. In contrast, using the carbon tax revenues to reduce labor taxes, which has a smaller adverse impact initially, results in modest GDP losses over the time period, maxing out at about a 0.5 percent reduction. The other two options for recycling revenues have somewhat larger adverse GDP impacts. In the case of lump-sum rebates, which do not alter marginal incentives for work, saving, or investment, the losses exceed 3 percent by the middle of the next decade, rising slowly to 3.5 percent by 2035 and leveling out thereafter.

Figure 1. Percentage Difference in GDP: $30/ton Revenue-Neutral CO_2 Tax Relative to Base Case



2.4. Emissions

Table 3 displays the percentage CO_2 emissions reductions below baseline induced by the different combinations of CO_2 taxes and revenue-recycling options for 2025. With the assumed constancy of real CO_2 tax rates, these percentage reductions are also relatively constant over time. Although higher CO_2 taxes clearly yield larger emissions reductions, the results are distinctly nonlinear: the additional reduction in emissions from any given increase in the carbon tax gets smaller as the carbon tax gets larger. This reflects the increasing difficulty of moving away from fossil fuels: at low tax rates, emissions reductions come from relatively low-cost shifts in production and consumption (e.g., shifting away from coal in electricity generation), but as the tax rate rises, the easy emissions reductions are exhausted, and further reductions become more difficult.

Emissions also vary based on the method of recycling the carbon tax revenue, though these differences are relatively small compared to the differences in emissions for different carbon tax rates. In general, for any given carbon tax rate, the emissions reductions are smallest (i.e., emissions levels are highest) when the carbon tax revenues are used to cut capital taxes, with labor tax recycling yielding larger reductions, consumption tax recycling yielding larger reductions still, and lump-sum transfers giving the largest emissions reduction. This primarily reflects the differences in economic growth across the different cases: the larger the boost in growth from any given method of revenue recycling, the smaller the emissions reduction in that case. Despite its many other benefits, more economic growth results in more emissions. However, this effect is relatively small compared to the differences across carbon tax rates.

Table 3. Percentage Reduction in Emissions (from Business as Usual) Due to a Carbon Tax in 2025

	Capital	Labor	Consumption	Lump sum
$20/ton	–11.18	–11.49	–11.68	–12.33
$30/ton	–14.92	–15.39	–15.66	–16.61
$50/ton	–20.67	–21.36	–21.73	–23.14

2.5. Intergenerational Impacts

As noted earlier, a key feature of the new OLG model is its more realistic depiction of households' decisions about work, savings, and consumption over their lifetimes. It contrasts with other frameworks, which either model people as living forever or involve a one-time snapshot of households. This framework helps provide more realistic estimates of the effects of changes in tax rates and budget deficits. It also allows us to look at how policy changes affect individuals across different generations.

Figure 2. Intergenerational Impacts of a Revenue-Neutral $30 CO2 Tax by Birth Year

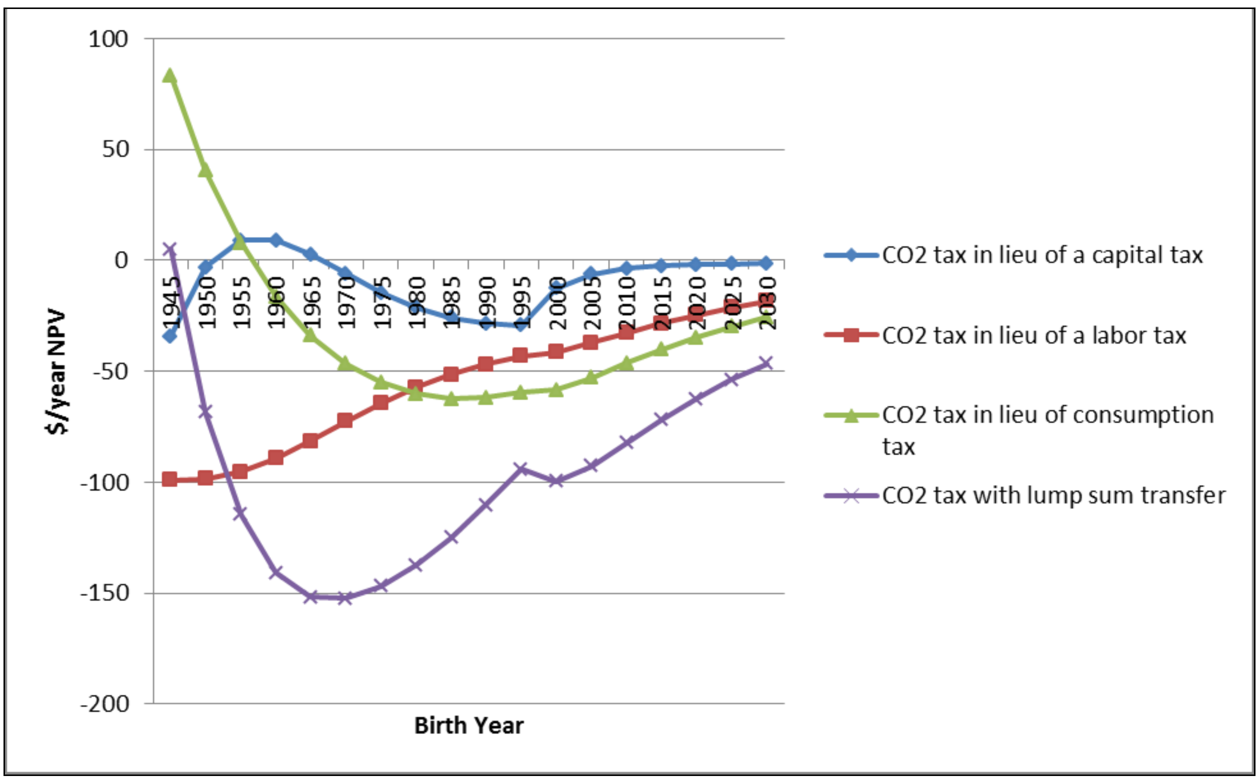


Figure 2 displays the intergenerational effects of the different revenue-recycling options, expressed in terms of changes in economic welfare for individuals across birth cohorts. Although this metric does not include the benefits of CO_2 reductions (or any other environmental implications of the policy), it is otherwise a complete measure of economic effects.[3] For example, it shows the effect of a carbon tax–labor tax swap as –$50 for individuals born in 1985. This means that the net economic effect of that tax swap on the average person born in 1985 is the equivalent of losing $50/year starting when the policy takes effect and continuing for the remainder of that individual's life.[4] In all cases, this graph ignores any potential benefits from lower carbon emissions.

Perhaps the most important interpretation of this figure is that the effects are relatively small. The largest cost for any policy, for any generation, is roughly $150/year, and in most cases the effects are much smaller than that (for the CO_2 tax–capital tax swap, for example, no generation gains or loses more than $40/year). This indicates that the cost of a CO_2 tax—net of the effect of revenue recycling—is modest. And the differences among the various revenue-recycling options are also relatively modest in absolute terms—though in relative terms, they are still quite large (the cost of a carbon tax with lump-sum recycling is several times as large as the cost with recycling via capital tax cuts).

Looking more closely at the differences among the revenue-recycling options reveals substantial variation (at least in relative terms) in the overall economic costs of the different options. Using the revenue to fund cuts in capital tax rates yields the lowest cost overall. The economics literature has generally found that cutting capital taxes yields a substantial economic efficiency gain per dollar of revenue lost, and we find the same result here. Cutting labor taxes yields smaller efficiency gains. Thus, the overall cost in that case is somewhat higher. Cutting consumption taxes produces an efficiency gain similar to (but slightly smaller than) cutting labor taxes, and thus the overall efficiency cost in this case is higher. And using the carbon tax revenue for a lump-sum dividend does nothing to change incentives to work or save, and thus produces no efficiency gain—so that case has the highest economic efficiency cost.

We also find substantial variation across generations. For very young generations—those that have only recently entered the labor force as well as those that haven't yet entered it (or haven't been born)—the effect essentially reflects the overall efficiency differences among policies. Using the CO_2 tax revenue to fund cuts in the capital tax yields the best outcome for these generations, with labor tax cuts, consumption tax cuts, and lump-sum transfers (in that order) yielding worse outcomes—the same ranking we find in the overall efficiency analysis. Because these generations go through an entire (or nearly entire) economic lifetime after the policy takes effect, they are affected in much the same way as the overall economy. But for older generations, the ranking can be very different.

Although using the CO_2 tax revenue to reduce the consumption tax is a relatively inefficient option overall, it provides large net benefits for generations that are relatively older at the time of the tax swap. Generations born in 1955 or earlier are made better off in this case, even ignoring any environmental benefits. These generations are spending more than their current labor and capital income (both because of government transfers such as social security and because they are

[3] In contrast, a measure such as gross domestic product (GDP) focuses only on the production of goods and services, and thus omits many things that people care about. For example, GDP ignores the value of time spent in leisure or nonmarket production. If a worker chooses to retire early, GDP would measure this as a pure loss (because production falls), whereas economic welfare captures the value of both sides of the trade-off that decision entails: production (and therefore income) goes down, but the worker now has more time for leisure.

[4] For generations that have not yet entered the labor force, the effect is discounted back to the present from the year that generation enters the labor force.

spending down their savings), so they benefit more from the lower consumption tax than they would from cuts in labor or capital taxes. The CO_2 tax also pushes up the price of consumption, but because some of the burden of the CO_2 tax shows up as lower wages and lower returns to capital, the CO_2 tax puts less burden on consumption than the consumption tax does. Thus, the net effect is to make the generations that are oldest at the time of the swap better off. But younger generations do substantially worse.

The general pattern across generations is similar if the revenue is used for a lump-sum transfer. Again, older generations do relatively well, because they bear a relatively small burden from the CO_2 tax but still receive the same lump-sum transfer as younger generations. Generations that are middle-aged when the policy starts have the biggest loss in this case: the CO_2 tax hits during their peak earning years, and the lump-sum transfer only partially compensates for it. The youngest generations also fare poorly in this case, reflecting the relatively high overall efficiency cost of this policy option (though they still do better than those that are middle-aged when the policy starts).

Although the oldest generations do very well under the consumption tax cut or lump-sum transfer, they do substantially worse when the CO_2 tax revenue is used to finance cuts in the labor tax rates. Most people in these generations are nearing retirement or already retired, so they are deriving most of their income from capital and from government transfers. Thus, they get very little benefit from the labor tax cut, but still bear a significant burden from the CO_2 tax. So this is the least beneficial revenue-recycling option for the older generations. But younger generations—that is, people with much more time remaining in the labor force—do relatively well under this option.

The distribution of welfare changes across generations in the capital tax–swap case is the most complex (and perhaps the most interesting). The oldest individuals alive when the policy starts (those born in 1950 and earlier) are made worse off by the swap, those who are somewhat younger (those born from 1955 to 1965) are made better off, whereas those who are younger still (born in 1970 and later) are made worse off.

For the oldest generations, the reason is fairly simple: these generations are getting relatively little income from capital, having already started spending down their savings. Thus, these generations get relatively little benefit from the lower capital tax rate compared to the higher costs they bear as a result of the CO_2 tax. Slightly younger generations (those individuals who are nearing retirement but not yet retired when the policy starts) have more assets, and thus benefit more from the lower capital tax rate and are made better off overall. Still younger generations derive somewhat less benefit from the lower capital tax rate, and thus are worse off, on average.

However, all generations do relatively well under this option: all but the oldest generations fare better than under any of the other revenue-recycling options considered thus far, and even those oldest generations are not substantially worse off.

2.6. Cost to Households

Households are affected by the tax policy alternatives in several ways. The introduction of a tax on CO_2 raises the cost of energy. More than half of this cost increase is experienced by households through their direct consumption of natural gas, heating oil, gasoline, air travel, and electricity.[5] The rest is experienced indirectly through the consumption of other goods and services, including services from governments and institutions that require energy in various ways. Consequently,

[5] In our framework, bus and train travel and the transport of goods are represented as an indirect consumption of energy.

households will be affected differently depending on their consumption patterns. For example, a household in a mild climate or one that drives or flies less will experience a relatively smaller impact of a CO_2 tax in its direct energy purchases. Conversely, a household with a large income or one with many members is likely to consume more of all goods and therefore experience a larger impact through the consumption of other goods and services.

Figure 3 illustrates the diversity in direct energy consumption on a per capita basis for each state. Separate elements of consumption are displayed as components of the bar graph. The largest category is expenditure on gasoline, which constitutes more than half of the total, but the diversity across states appears to be relatively small. The diversity in electricity expenditures is somewhat greater, and it is greatest in the categories of natural gas and other fuels (primarily heating oil). On a per capita basis, the greatest level of spending on direct energy consumption is in the northeastern states. New York is an exception to this because of a relatively small amount of spending on gasoline. Overall, the total diversity in direct energy consumption across states is less than one might anticipate. Importantly, the number of persons per household varies by state, age, and income level, so the effect on the representative households varies from what is represented in the figure for the representative individual.

Figure 3. Direct Energy Consumption by Fuel, on Per Capita Basis by State

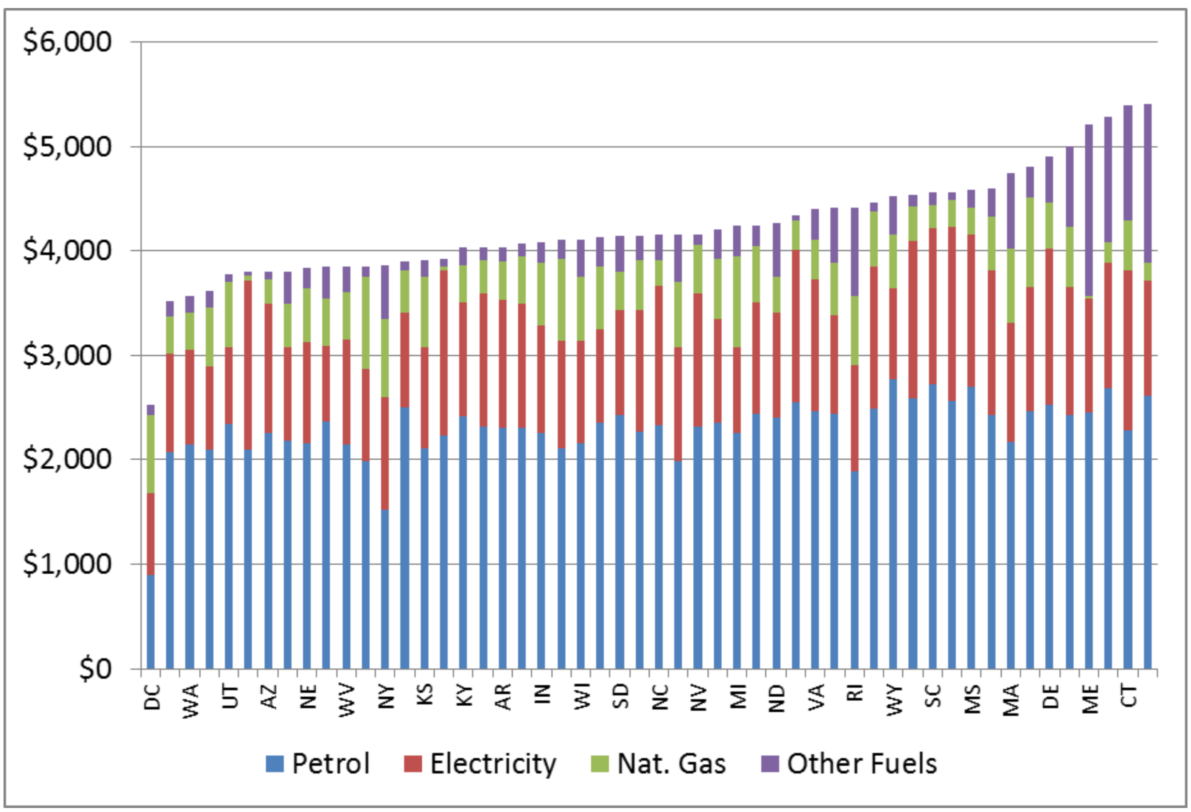


Figure 3 does not directly represent the distribution of costs associated with a tax on CO_2 because the carbon content of these energy categories differs. In addition, the fuel used in electricity generation varies across the nation, so the impact of the tax will also vary. Before the imposition of the tax, however, many of the states that have the greatest use of coal in electricity generation—which might expect to see a relatively large increase in energy costs—start out with overall costs that are less than the average for the nation. Hence, the diversity of spending on energy might be lessened with the introduction of a CO_2 tax, compared to the baseline.

The changes in expenditures appear to be more evenly distributed across geography than across the income distribution (if measured as a share of annual income). The effects are somewhat more evenly spread across the income distribution if measured as a share of annual expenditures.[6] Naturally, lower-income households consume less of every commodity, but they spend a greater portion of their income on direct energy consumption; consequently, they may be especially adversely affected by the CO_2 tax.

Another way in which the tax policy alternatives affect households is through their effects on sources of income. As consumers and producers change their behavior in response to the new tax system, economic consequences will ripple through the economic system. In addition to pushing up the prices of carbon-intensive goods, a carbon tax might also push down the demand for labor in carbon-intensive industries, thus leading to a drop in wages. To the extent that this occurs, it will impose costs on households that rely heavily on labor income, particularly in the regions or occupations that are most affected.

Owners of energy resources and energy-intensive capital enterprises also may experience a loss of income due to the introduction of a price on CO_2. Agents in the economy will switch to less energy-intensive activities, reducing the value of energy-related assets and the income that comes from those assets. Again, how much a particular household is affected will depend on how much it relies on capital income and on the industries from which that capital income is derived.

The third major source of income we consider is transfers from government, such as social security payments. Because most government transfers are indexed to inflation, a CO_2 tax has relatively little impact on the magnitude of transfers in real terms, and may increase their magnitude in nominal terms (Blonz et al. 2012).[7]

In addition to the effects on the prices of consumer goods and on household incomes caused by the CO_2 tax itself, the way in which the CO_2 tax revenue is used will also have effects. Indeed, the effects of that revenue recycling on households can easily be more important than the effects of the CO_2 tax itself (Burtraw et al. 2009). For example, using the CO_2 tax revenue to fund cuts in labor taxes will disproportionately help households that depend on labor income. Similarly, capital tax cuts will primarily help households with substantial capital income. If revenue is returned on a lump-sum basis, this will appear as an increase in government transfers, providing an expanded source of income to all households. The benefit measured at the household level depends on whether the dividend is returned on a per capita basis or to adults only, but in either case, it will tend to disproportionately help lower-income households (because the transfer will be largest as a share of income for the lowest-income households). Consequently, the decision over the use of the revenue is a driving concern in understanding the incidence, or distribution of costs, of the climate policy.

[6] This occurs, in part, because many households with low annual incomes consume more than they earn, such as retired households spending down their savings, student households, or households with unusually low incomes in a given year (e.g., those temporarily unemployed). Similarly, many households with high annual incomes consume less than they earn, such as households that are saving for retirement or households with unusually high incomes in a given year (e.g., those who realized large one-time capital gains).

[7] Due to the increased cost of energy and potential reduction in economic activity, however, there may be a reduction in government services. In the policy simulations we discuss in this report, the overall level of government activity is held constant in real terms.

The OLG model calculates the impacts of all of these interactions within the economy for the average (representative) household in each age cohort in each year. But the effects on actual households may vary widely from that average. To investigate the distribution of costs across society, we use a partial-equilibrium, static (one-year) incidence model (IM). This model preserves the distribution of consumption patterns across income groups, geography, and age groups and preserves the distribution of sources of income across income groups.

Furthermore, although the policy will affect many future generations in the model, the near-term impacts of the policy are especially important to understand because the citizens alive today are the ones who will decide the policy. This suggests that the incidence of the policy that is relevant to the short-run policy dialogue will depend primarily on the capital stock in place when the policy takes effect rather than the changes that occur in future years.

The IM can investigate the diversity of impacts for citizens alive today by refracting the changes predicted at the national level for the first year of the policy in the OLG model onto the underlying population of households, accounting for the diversity in consumption patterns and sources of income across levels of income and geography. The short-run analysis makes use of a variety of data sources, including the Consumer Expenditure Survey, which is maintained by the Bureau of Labor Statistics and reports the general market basket of consumption across household types; the State Energy Data System (maintained by the Energy Information Administration), which provides comprehensive state-level data on energy consumption; census data that report levels of income; and tax return summary data about sources of income for different income groups.

Building the bridge from the OLG model to the detailed IM poses several challenges. First, the use of natural gas has expanded in recent years beyond what is represented in the data used to calibrate both models. Second, the OLG model provides a comprehensive general-equilibrium measure of changes in welfare that may differ from the partial-equilibrium measure used in the IM. To rectify this, the welfare cost from the IM (measured as the sum of the change in consumer surplus for each consumer good, the change in producer surplus for labor and capital, and the change in government transfers to households) is scaled proportionately so that the aggregate welfare change matches the change in welfare in the OLG model (which is measured by the concept of equivalent variation). This approach assigns the overall change in welfare to individual goods, and ultimately to households, based on their underlying pattern of consumption and income.

As we finalize the model linkages, permitting a full analysis of the distributional effects of the tax policy alternatives, we observe that the decision about how to use the revenue from the climate policy has a greater effect on the distribution of outcomes across households than do substantial changes in the stringency of the CO_2 tax. We emphasize that the effects we measure are short-term effects on the current population of citizens, although these are, arguably, the most important for a variety of reasons. Finally, these effects—like all of the effects measured in this report—do not include the environmental benefits of introducing a tax on CO_2.

3. Deficit-Reduction Packages

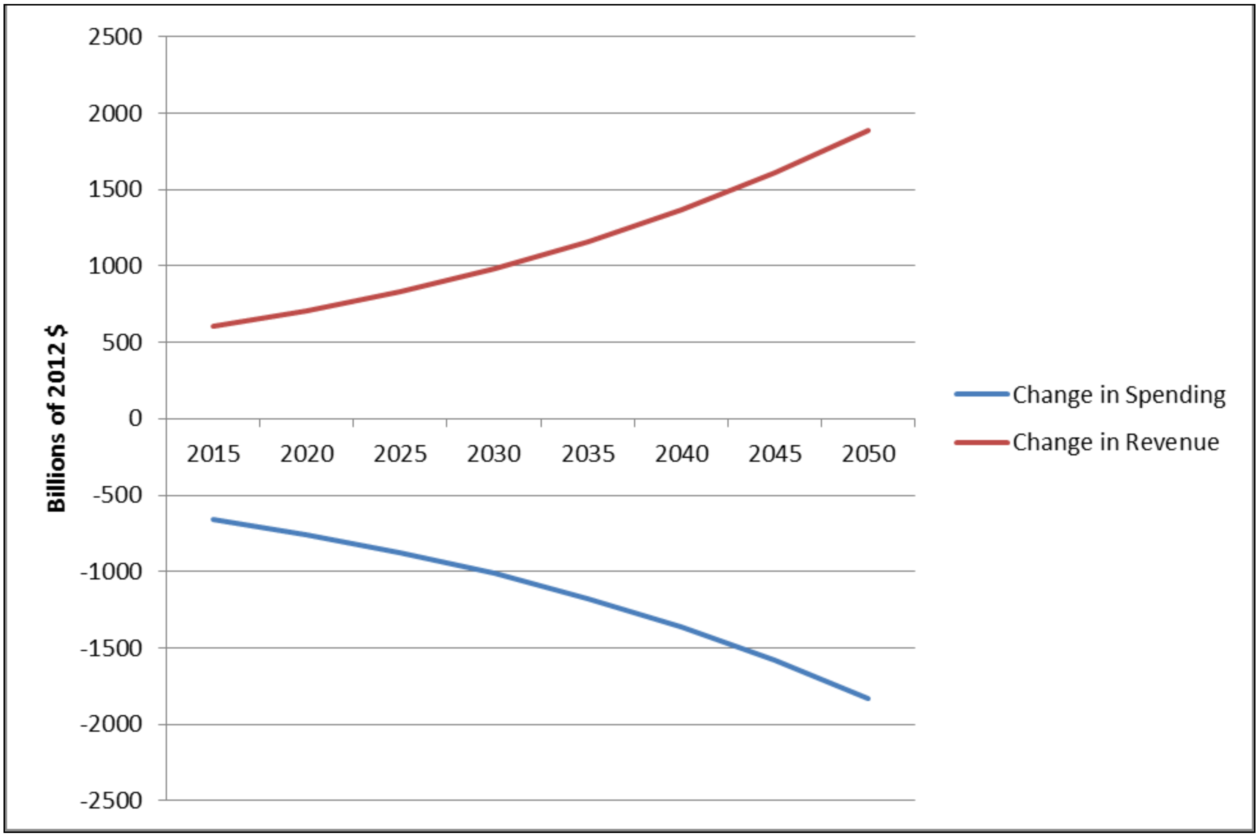
Unlike the analysis in the previous section of revenue-neutral tax reform, the focus in this section is on deficit-reduction strategies. Such strategies should be understood as responses to the projected, unsustainable path of federal debt, expected by CBO to begin rising again as a percentage of GDP in 2016. In modeling the impacts, a key challenge is to make specific assumptions about the hypothetical paths that government debt could take to get off of the unsustainable path to reach acceptable levels. We consider two alternative deficit-reduction paths.

In the first set of deficit-reduction simulations, we assume that the government acts quickly to address the debt, with substantial debt-reduction packages that start taking effect in 2015. These packages consist of a balance between spending cuts and tax increases, as shown in Figure 4, that put the debt on a sustainable path, such that it declines gradually over time to reach a 60 percent debt-to-GDP ratio by 2115. In these simulations, we compare packages that include a carbon tax to packages without a carbon tax, keeping the overall increase in revenues, cuts in spending, and deficit path the same across the comparisons. More specifically, we use a baseline in which the revenue increases come from a mix of consumption, labor, and capital tax increases (with one-third of the revenue increase coming from each tax). We then look at four packages that add a carbon tax to that baseline package; three use the carbon tax revenue to offset some revenue from one of the other three taxes (thus permitting a smaller increase in that tax), whereas the fourth uses the carbon tax to fund a lump-sum dividend to each adult.

In the second set of deficit-reduction simulations, we assume that any broad-based action to address the debt is postponed for 20 years. Thus, in the baseline for these simulations, the national debt remains on its current trajectory until 2035, at which time the government implements a more aggressive deficit-reduction package designed to reach the same 60 percent long-term debt-to-GDP goal by 2115. This package is similar to those in the first set of simulations—it consists of a 50–50 mix of tax increases and spending cuts, with the tax increases coming equally from tax increases on capital, labor, and consumption, and puts the debt on a long-run path that achieves the long-term debt-to-GDP goal—but because of the delay, it requires more drastic tax increases and spending cuts. We then compare this to a policy that implements a carbon tax in 2015 and uses the revenue as a “down payment” on the debt, thus permitting smaller tax increases in 2035. Unlike the previous simulations, this case makes a comparison that varies both the carbon tax and the path of the budget deficit, thus directly tying the carbon tax and deficit reduction together.

In the sections that follow, we review the results for revenues, GDP, emissions, economic welfare, and the cross-sectional distributional impacts in the debt-reduction simulations. We look first at the cases in which the government is assumed to act quickly to address the rising debt levels. The general picture is quite parallel to the analogous results for the revenue-neutral simulations, though we note key differences where they occur.

Figure 4. Sources of Financing Debt Reduction



3.1. Policy Scenarios for Substantial Debt Reduction Beginning in 2015

Our approach to modeling the debt-reduction scenarios is to substitute the alternative CO_2 taxes examined for a portion of the revenues from *increased* labor, capital, or consumption taxes that would otherwise be needed to meet the debt-reduction targets. This contrasts with the revenue-neutral scenario, in which the CO_2 tax revenues are used strictly to *reduce* capital, labor, or consumption taxes or to provide lump-sum rebates without reducing overall debt levels. As noted, the debt-reduction scenario consists of decreasing the size of the debt gradually through increases in the taxes on labor, capital, and consumption while simultaneously reducing government spending by an equal amount. The alternative CO_2 taxes examined are the same as in the revenue-neutral cases: $20, $30, and $50 per ton of CO_2, beginning in 2015, then remaining constant in real terms thereafter. As described below, each of these CO_2 tax levels allows the rate of the tax being offset to decrease by a different amount. In the case of the lump-sum dividends, we assume that the higher taxes on capital, labor, and consumption remain in place while the carbon tax revenues are returned to households on a lump-sum basis.

Table 4 displays the average reductions in labor, capital, and consumption tax rates, as well as the corresponding lump-sum rebates, that could be supported by the alternative CO_2 taxes considered for the initial decade of the new policies (2015–2025). Due to the assumed constancy of the CO_2 tax rates (in real terms) after 2025, the out-year rate changes are quite similar to those for the first decade. Thus, a $20-per-ton CO_2 tax would allow for a reduction of 3.24 percentage points in average taxes on capital, 1.08 percentage points in average taxes on labor, and 0.54 percentage points in average taxes on consumption. Alternatively, a $20-per-ton CO_2 tax would support a $616.28 annual lump-sum rebate to adults.

This set of scenarios is generally similar to the revenue-neutral cases, in that the CO_2 tax revenue finances a lower rate for some other tax. The key difference is that, in this case, "lower" means a smaller increase, not an actual decrease. Thus, these reductions do not represent cuts below current rates. Rather, they are reductions below the higher rates needed to achieve long-term deficit reduction in the different scenarios. Put differently, this is still a tax swap—it's just a tax swap from a baseline that includes potentially large tax increases and spending cuts. Overall, tax rates (and revenues) are higher in these cases, consistent with the long-term deficit-reduction goals. The small differences in the rate cuts (or rebates) between the tax reform and deficit-reduction cases reflect the higher GDP growth in the former scenario. Arguably, these are artificial differences because of the highly stylized assumption in the deficit-neutral case that markets will ignore the growing deficit indefinitely.

Table 4. Tax Rate Changes Affecting CO_2, Labor, Capital, Consumption, and per Capita Rebates, 2015–2025 (2012$)

CO_2 tax rate	Change in percentage points			Per capita lump-sum transfer (2015–2025)
	Capital	Labor	Consumption	
$20/ton	–2.881	–0.921	–0.457	$565.95
$30/ton	–4.010	–1.275	–0.629	$808.42
$50/ton	–6.001	–1.890	–0.921	$1,244.85

3.1.1. Revenue Impacts

Table 5 displays the revenues generated by each of the alternative CO_2 taxes considered, assuming that the revenues are used to offset labor tax hikes that would otherwise occur, expressed as the average annual revenues, 2015–2025 (2012$). As shown, the $20-per-ton CO_2 tax could finance the reduction of $156.1 billion in labor taxes per year in the initial decade. Over the entire decade, that amounts to $1.6 trillion. Correspondingly, annual revenues from a $30-per-ton CO_2 tax average $223.88 billion over the decade, and the $50-per-ton tax yields $347.24 billion in annual revenues. Note that the patterns of differences across the different rate cases are virtually identical to the revenue-neutral cases, and the overall revenues are almost as much. The small observed differences are primarily accounted for by the lower GDP growth experienced over the period in the deficit-reduction case (which, as previously noted, is an artifact of the assumption in the revenue-neutral case that GDP growth would be unfettered by the continually rising debt levels).

Comparable revenue estimates are available for the cases in which the CO_2 tax revenues are used to offset increases in capital or consumption taxes or to provide lump-sum rebates. Revenues are slightly higher in the case of capital tax cuts, primarily reflecting the higher GDP growth induced by such tax reductions (described below). The comparable revenues for consumption tax cuts and lump-sum rebates are slightly lower, arising largely from the lower GDP growth induced by those measures.

Table 5. Revenues in Deficit-Reduction Cases, Assuming Labor Tax Offsets, Average Annual Values 2015–2025 (Billions of 2012$)

$20/ton	$30/ton	$50/ton
143.7324	206.1697	320.0952

3.1.2. Economic Growth

Figure 5 illustrates the effects that each of the previously described debt-reduction policies has on GDP levels over the period 2015–2050 for the case of a $30-per-ton CO_2 tax and alternative rebate mechanisms. As in the deficit-neutral cases, we focus on GDP *levels* not *growth rates*. We have intentionally magnified the vertical scale to highlight even the smallest of differences. In fact, GDP levels vary by a maximum of only 1.5 percent across all the scenarios considered. Other than the lump-sum tax, they vary by about 1 percent, a difference often ignored in aggregate analyses.

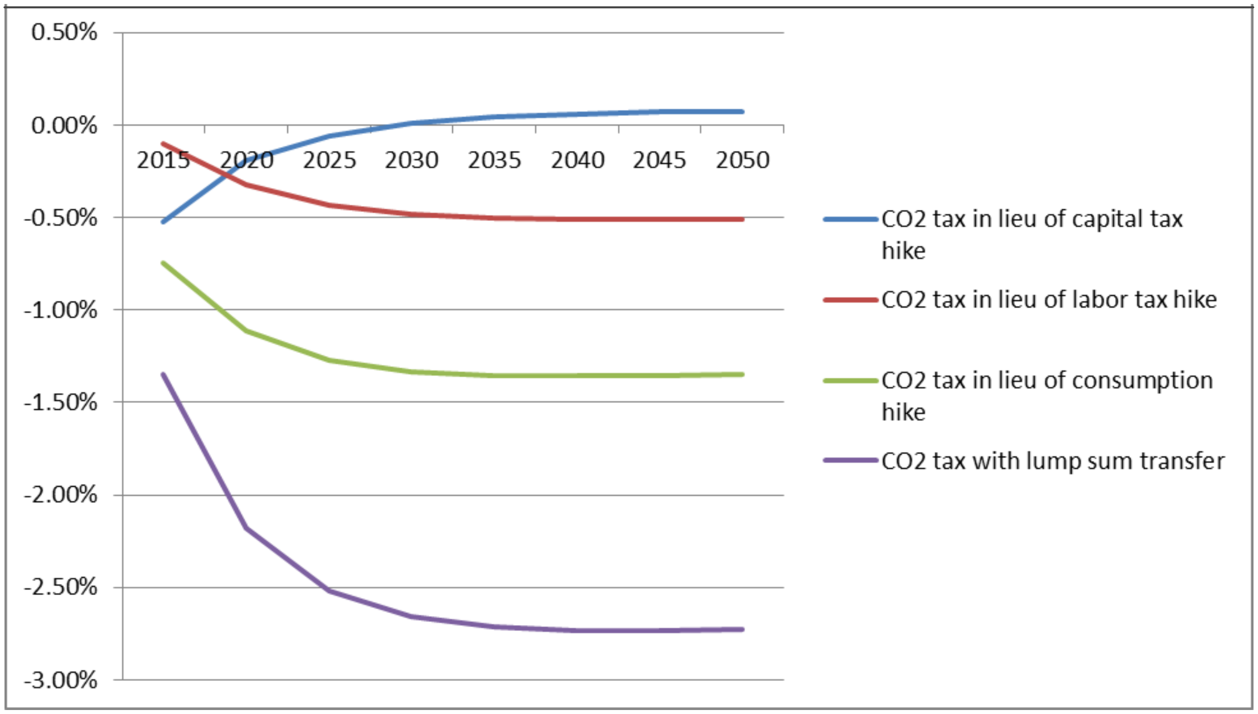
Among the recycling options analyzed, where a CO_2 tax is introduced in lieu of a portion of the higher taxes required for long-term deficit reduction, the CO_2 tax–capital tax swap results in very small GDP reductions in the early decades and even smaller increases in the out years. If the CO_2 tax substitutes for higher labor taxes, the GDP losses are slightly greater than for capital, rising to 0.6 percent by 2050. Hikes in consumption taxes are costlier still, with GDP losses rising to 1 percent by 2050. Allowing for the use of the CO_2 tax revenues to fund lump-sum rebates is the most costly overall, as GDP losses reach 1.5 percent by 2050.

Similar to the impact patterns observed for the deficit-neutral cases, the GDP impacts in these deficit-reduction scenarios are quite small, and the ordering across the alternative recycling options is identical. Rebating via cuts in capital taxes yields either small positive or small negative GDP impacts, suggesting a possible "strong double dividend."[8] Among the other rebating options, all are slightly negative, and the lump-sum rebates are the most negative.

The one noteworthy difference between the deficit-neutral scenario and this first deficit-reduction scenario involves the time path of the impacts. For the deficit-neutral case, the CO_2 tax–capital tax swap is slightly negative at the outset, before the incremental investment induced by the capital tax cuts kicks in. The opposite pattern applies for the CO_2 tax–labor tax swap, as the initial positive effect of cutting labor taxes is later counterbalanced by the negative growth impacts of the CO_2 tax. For the deficit-reduction scenarios, we see no such pattern as tax rates are rising over time in the baseline to meet the long-term deficit-reduction targets.

[8] A strong double dividend claim is that revenue-neutral swaps of environmental taxes for ordinary distortionary taxes involve zero or negative gross costs. Our simulations also indicate a weak double dividend in all cases. The weak double dividend means that returning tax revenues through cuts in distortionary taxes leads to cost savings relative to the case in which revenues are returned as lump-sum rebates.

Figure 5. Percentage Difference in GDP of Debt-Reduction Scenarios with a \$30/ton CO_2 Tax Relative to Debt Reduction without a CO_2 Tax



3.1.3. Emissions

Table 6 displays the 2025 emissions reductions resulting from the different carbon tax cum revenue offset options. Overall, the pattern of emissions reductions is quite similar to the deficit-neutral cases. Higher carbon taxes result in larger emissions reductions, although the results are distinctly nonlinear, reflecting the impacts of both slower economic growth and the increasing cost of decarbonizing the economy at higher tax rates.

Because the lump-sum rebates have somewhat more adverse impacts on GDP growth than the other policies, the emissions reductions induced by the carbon tax are slightly greater when expressed in percentage terms. Conversely, the other policies, which have less adverse impacts on GDP growth, result in lower emissions reductions, with the CO_2 tax–capital tax offset resulting in the smallest decrease in emissions. In reality, the economy is growing faster when the CO_2 taxes are substituted for capital, labor, or consumption taxes, and this, in turn, is causing the slightly smaller emissions reductions. In other words, the lump-sum payment has the largest effects on emissions because of the adverse impact on economic growth. Not surprisingly, the three tax offsets all result in smaller emissions reductions as they correct for some market distortions that lead to more economic activity than the lump-sum transfer. Of the three, offsetting capital taxes results in the smallest emissions reductions, whereas offsetting consumption taxes leads to the largest.

Table 6. Percentage Reduction in Emissions (from Business as Usual) Due to a Carbon Tax in 2025

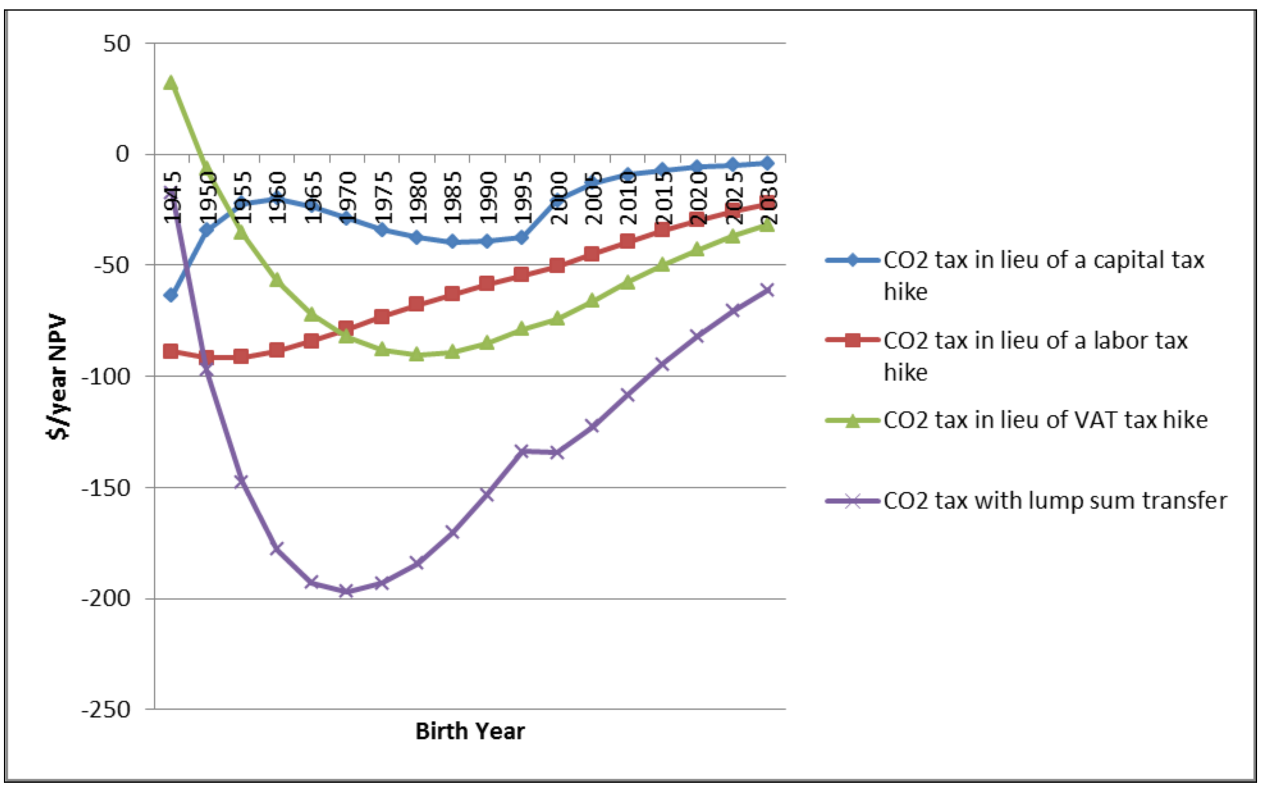
	Capital	Labor	Consumption	Lump sum
$20/ton	–11.87	–12.17	–12.43	–13.18
$30/ton	–15.78	–16.17	–16.51	–17.56
$50/ton	–21.60	–22.13	–22.61	–24.15

3.1.4. Intergenerational Impacts

Figure 6 shows how the policy change affects individuals in different generations. It parallels Figure 2, which showed the analogous results for the revenue-neutral tax swaps, and yields results that are generally similar. The overall efficiency ranking of the options is the same: using the carbon tax revenue to prevent capital tax increases is the most economically efficient of the options; second-most efficient is avoiding labor tax increases, followed by avoiding consumption tax increases. Using the revenue for a lump-sum transfer is the least efficient. Similarly, the oldest generations fare better than younger generations when the revenue is used for a lump-sum transfer or to prevent a consumption tax increase, and they fare worse when the revenue is used to prevent a labor tax increase.

This similarity in results is what one would expect. In the revenue-neutral case, the carbon tax revenue is used to cut other taxes, whereas in this case, it is used to prevent increases in those other taxes. But in either case, what the carbon tax revenue buys is another tax rate that is lower than it otherwise would have been.

Figure 6. Intergenerational Impacts of a Deficit-Reducing $30/ton CO_2 Tax by Birth Year



This case is substantively different from either the revenue-neutral case or the deficit-reduction case previously considered. In each of those cases, the level and time path of the deficit were the same with and without a carbon tax. In contrast, in this case, the carbon tax revenue actually changes the time path of the deficit. At the same time, as with the other scenarios, because current and future tax changes are announced in advance, consumers and investors are able to anticipate the future tax regime which, in turn, affects their spending, working, and saving patterns.

Unsurprisingly, the initial revenue and emissions impacts associated with the introduction of CO_2 taxes beginning in 2015 are roughly comparable to those calculated for the earlier debt-reduction scenarios. Specifically, a $30-per-ton CO_2 tax yields $224 billion in average annual revenues (2015–2025), or about $2.24 trillion over the decade, while CO_2 emissions are reduced by 16 percent below baseline.

Most interesting are the longer-term impacts, particularly the effects on GDP and economic welfare. Figure 7 displays the percentage difference in GDP in the down-payment scenario, relative to a case where debt reduction is postponed until 2035 (at which point, only non-CO_2 taxes—i.e., capital, labor, and consumption taxes—are raised to meet the long-term debt-to-GDP target). Similar to the earlier debt-reduction scenarios, we find a small decline in GDP in the early years. The declines max out at 0.60 percent and 0.95 percent for the capital and labor taxes, respectively, but then reverse and start increasing in 2025–2030. In the case of the capital tax offsets, the positive GDP effects reach 1.5 percent by 2045. For labor tax offsets, the GDP gains are smaller, rising to a positive 0.15 percent by 2050.

The early-year GDP declines are driven by the CO_2 tax itself. Thus, the results for the three different taxes are essentially identical for 2015 and 2020. But for later years, the effects of avoiding large tax increases in 2035 become important. Interestingly, even though the three policies are identical until 2035, their effects differ even before that, because households and firms start changing savings, consumption, work, and investment decisions in anticipation of the changes in 2035. This is particularly evident for the capital tax, for which the effect of the smaller tax increase is visible as early as 2025.

Figure 7. Percentage Difference in GDP of Debt-Reduction Scenario with a $30/ton CO2 Tax "Down Payment"

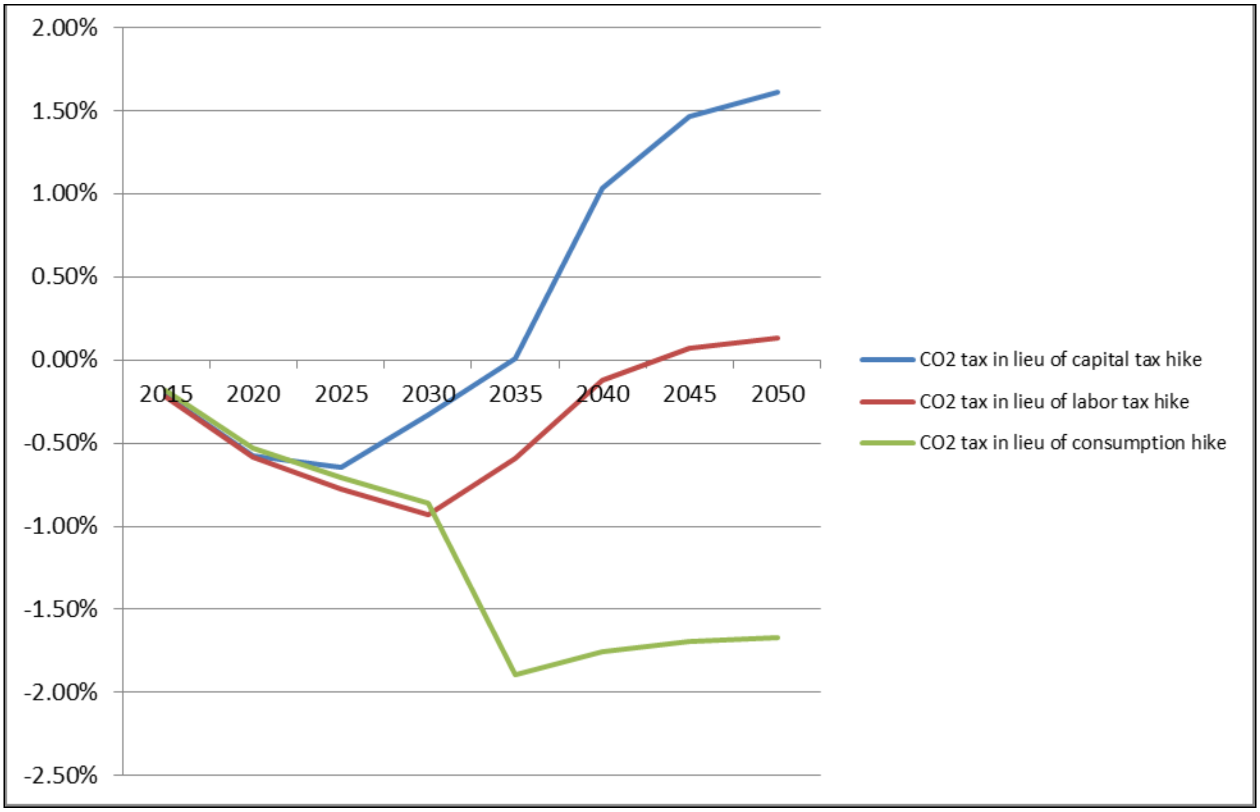
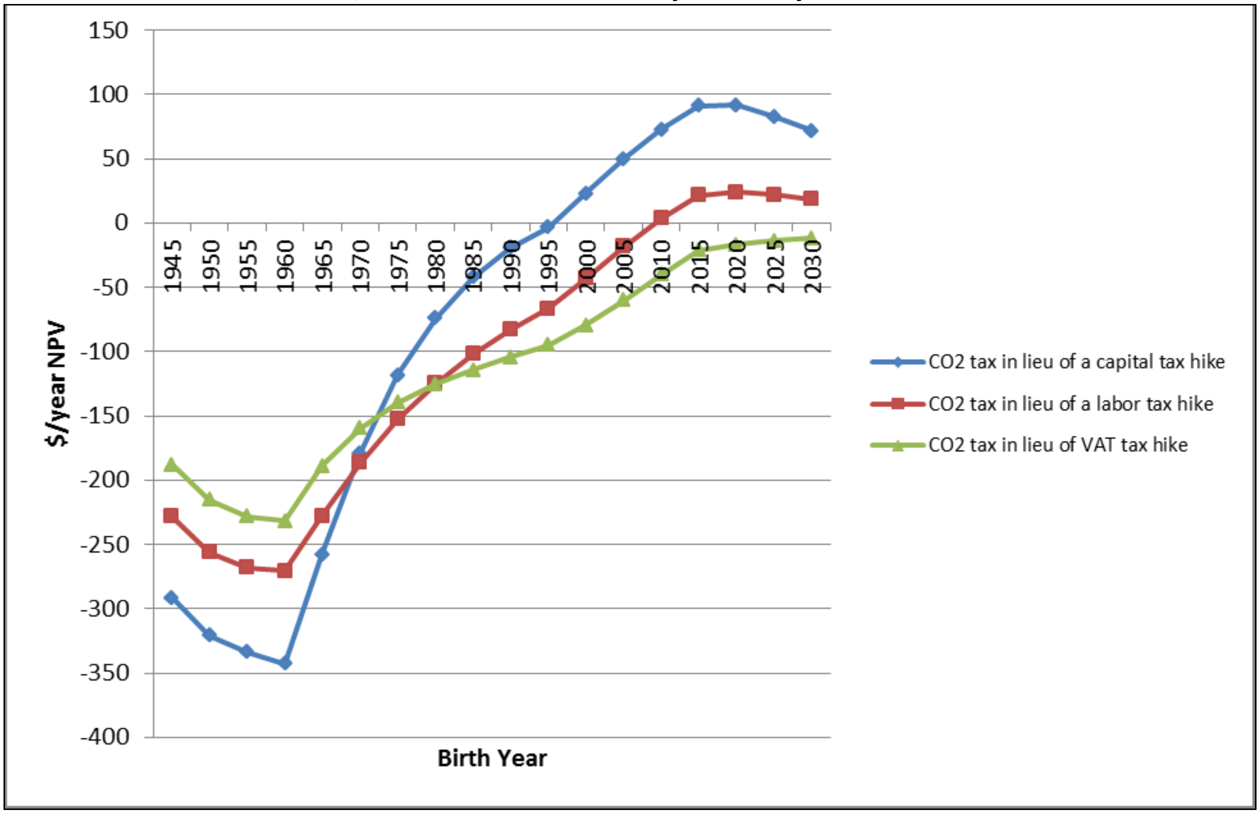


Figure 8 shows the effects on different generations of using carbon tax revenue for deficit reduction, thus permitting smaller future tax increases. Here we see quite interesting results.

Figure 8. Intergenerational Impacts of a Debt-Reduction $30/ton CO2 Tax "Down Payment" by Birth Year



The intergenerational effects in this case are dominated by the effect of paying down the deficit sooner rather than later. This makes older generations worse off (more of the deficit reduction occurs during their lifetimes) and younger generations better off (less of the burden of paying down the deficit falls on them). Consequently, all of the alternative tax options show the same general pattern. The swings are greatest for the capital tax offset, where negative NPV impacts reach $350 for individuals born in 1960 before turning positive for those born in 1995 and thereafter. For labor tax offsets, negative NPV impacts reach $270 for individuals born in 1960 before turning positive for those born in 2010 and thereafter. For consumption tax swaps, the swings are less dramatic; however, they do not actually turn positive over any of the observed generations.

One important implication is that enacting such a policy will be politically difficult unless current generations are altruistic. Although this case is more efficient overall than a revenue-neutral policy, it also makes every current generation (all of those currently old enough to vote) worse off, while making future generations better off.

4. Effects of Natural Gas Supply Changes

How important is the shale gas revolution to the possible introduction of CO_2 taxes? Views on the matter are all over the map. Some suggest that the lower natural gas prices now in effect and projected for the future will actually *raise* the cost of a CO_2 tax because market forces will drive low-cost coal-to-gas substitution even before the CO_2 tax is in place, leaving only higher-priced mitigation options. Others suggest that the fuel substitutions induced by the lower gas prices will reduce the net revenues generated by a CO_2 tax, reflecting the declines in the carbon intensity of the economy that have already occurred.

All of the results displayed so far in this report are based on 2012 natural gas prices and the Energy Information Administration's projections contained in the 2012 *Annual Energy Outlook.* One way to examine the issues associated with lower gas prices is to ask what difference the imposition of a CO_2 tax would make if we were still facing the higher natural gas prices projected just a few years ago. Thus, as an experiment, we rerun the simulations considered herein, substituting the 2004 *Annual Energy Outlook* gas price projections for the 2012 projections.

The results are quite interesting. Although the differences in outcomes using the 2004 versus the 2012 *Annual Energy Outlook* are generally small, they show that the economic cost of the CO_2 tax swaps are consistently *lower* with the new gas price regime, and both federal revenues economic welfare are consistently *higher*. Overall, it appears that the shale gas revolution has lowered the cost of introducing a carbon tax regime, although not by a large amount.[9]

5. Conclusions

This report investigates the effect of using a CO_2 tax for revenue-neutral tax reform or for deficit reduction. Using a newly developed OLG model of the US economy, we perform three sets of policy simulations. The first set of simulations examines a series of revenue-neutral tax swaps that impose a CO_2 tax and lower one of the other taxes in the model, keeping the present discounted value of tax revenue the same as in the benchmark equilibrium. In the second and third sets of simulations, we model a series of deficit-reduction packages and examine the effects of including a CO_2 tax in the mix. The second set of simulations keeps the deficit-reduction path the same with and without a CO_2 tax. In the third set of simulations, the CO_2 tax makes it possible to start paying down the deficit earlier than without a CO_2 tax. We draw the following conclusions from our modeling analysis.

- Holding all other taxes in the economy constant, the imposition of CO_2 taxes represents a potentially substantial revenue source for the United States, on the order of $160–$360 billion in gross revenues per year, or $1.6–$3.6 trillion over the decade (2012$).
- The revenues from such CO_2 taxes could be used to support revenue-neutral tax reform, deficit reduction, lump-sum rebates (dividends) to households, or any number of alternative uses.
- Among the revenue-neutral tax reform options (which ignore the growing debt burden) we find that using the CO_2 tax revenues to cut noncarbon taxes has a range of effects.
    - Cutting capital taxes (i.e., corporate taxes or personal income rates on interest, dividends, or capital gains) produces the largest economic efficiency benefits, roughly offsetting the economic cost of the CO_2 tax. Without considering the environmental benefits from CO_2 reductions, the net social costs are close to zero, depending on which measure of cost of used. We find that GDP rises slightly, but a

[9] This result might well change if we were to examine substantially higher carbon dioxide (CO_2) tax rates. Lower natural gas prices make it easier to switch from coal to natural gas (the transition that is relevant at low to moderate CO_2 tax rates). But lower gas prices also make it harder to switch away from natural gas to nonfossil energy sources (the transition that is relevant at high CO_2 tax rates).

more comprehensive measure shows a slight cost. Either way, the net costs are close to zero.

    - Recycling the revenues via reductions in labor taxes (in the form of either payroll tax cuts or personal income tax reductions) is less economically efficient than recycling via capital tax cuts, though the differences are relatively modest.
    - Recycling the revenues via lump-sum rebates is worse for economic efficiency than any of the options that involve tax rate cuts. At the same time, as discussed below, such rebates are most progressive in terms of their income distribution impacts.

- We also consider how the different revenue-recycling options affect individuals in different generations.
    - Using carbon tax revenues to fund lump-sum transfers or cuts in sales tax rates benefits older generations at the cost of younger generations.
    - Using the revenues to fund cuts in labor tax rates has the opposite effect: younger generations do better than older generations under this option.
    - Using carbon tax revenues for capital tax cuts yields net costs that vary relatively little across generations.
- Distributional impacts in the near term are especially important to understand because the citizens alive today are the ones who will decide the policy. Looking across the different policies, the outcome for any given expenditure quintile varies significantly.
    - Part of the effect of a CO_2 tax on households comes through higher product prices. For those price increases, roughly half of the cost increase comes from direct consumption of natural gas, heating oil, gasoline, air travel, and electricity; the rest comes from indirect energy consumption (the purchase of products that require energy to manufacture) and increased costs of services provided by institutions (e.g., government agencies and hospitals).
    - Lower-income households spend a greater portion of their income on direct energy consumption; consequently, they may be especially adversely affected by the carbon tax.
    - The largest category of spending on energy is for gasoline, for which the diversity across states appears to be relatively small. The diversity in electricity expenditures is somewhat greater, and it is greatest in the categories of natural gas and other fuels (primarily heating oil). On a per capita basis, the greatest level of spending on direct energy consumption is in the northeastern states.
    - Before the imposition of the carbon tax, many of the states with the greatest use of coal in electricity generation have electricity (and overall energy) costs that are less than the average for the nation. However, they might expect to see a relatively large increase in energy costs with a carbon tax.
    - The CO_2 tax may also affect household incomes by changing wages and returns to capital (particularly in energy-intensive sectors of the economy). These changes are important, though they are more difficult to model than changes in product prices.

- The effects of the revenue recycling on households are likely to be more important than the effects of the CO_2 tax itself. Using revenues to fund capital tax cuts (or to prevent capital tax increases) disproportionately helps higher-income households. Returning revenue via per capita rebates disproportionately helps lower-income households. Cutting labor or consumption taxes falls somewhere in between.

- Turning to the deficit-reduction simulations, these analyses should be understood as responses to the projected, unsustainable path of federal debt, expected by CBO to begin rising again as a percentage of GDP in 2016. Following *Domenici–Rivlin* (Bipartisan Policy Center 2012), we assume that federal expenditures will be cut and federal revenues increased in equal amounts. The simulations focus strictly on revenue-side options: the use of CO_2 taxes versus capital, labor, or consumption taxes or lump-sum rebates to raise the required revenues.
- Unsurprisingly, the general pattern of results among the options is very similar when we consider the effect of including a carbon tax in a deficit-reduction package (that is, when we compare two packages, each of which reduces the deficit by the same amount, one with a carbon tax and one without) rather than a revenue-neutral policy.
    - Offsetting capital tax hikes provides the most economic benefits, followed by labor and consumption taxes and the provision of lump-sum dividends.
    - In terms of intergenerational impacts, using carbon tax revenues to offset increases in consumption tax rates benefits older generations at the cost of younger generations, using the revenues to offset labor tax rate hikes aids younger generations the most, and using carbon tax revenues to offset capital tax hikes yields net costs that vary relatively little across generations.
    - Parallel distributional impacts also arise in terms of distribution across income groups and regions of the country, although in the absence of household-level reductions in marginal rates or the provision of lump-sum dividends, the economic welfare impacts are all likely to be negative.

Finally, we present initial results for a somewhat different approach, which might be described as an early down payment on debt reduction, involving an initial round of CO_2 taxes, which are followed by smaller increases in other taxes than would otherwise have been required to meet long-term deficit-reduction goals.

- The results are quite striking: The CO_2 tax is consistently better for economic efficiency in this down-payment case than it is in the revenue-neutral case. Indeed, if the CO_2 tax down payment results in less need to increase capital taxes later, then the net cost of the CO_2 tax is negative (even ignoring any environmental benefits). This shows the substantial efficiency gains from addressing the budget deficit sooner rather than later. The intergenerational consequences may make this politically difficult, however: although this case is good for economic efficiency, it also makes every generation old enough to vote today worse off, on average, while benefitting all future generations.
- Arguably, we could have modeled any type of tax hike for the initial round (i.e., capital, labor, consumption, or CO_2 taxes). For simplicity, we focus on carbon taxes. However, we strongly suspect that the pattern of economic gains and losses and the intergenerational

impacts would be generally similar: the results for the down-payment case are driven by the effect of taking action now to reduce the deficit.

We emphasize that in all cases, we are not considering the benefits of CO_2 emissions reduction, nor are we addressing short-term macroeconomic issues (i.e., whether the economy is strong enough to endure tax hikes and spending cuts now versus five years in the future). Moreover, many other important climate policy issues are beyond the scope of this report. For example, we have not looked closely at the effects of policy on energy-intensive, trade-exposed industries. Nor have we considered a range of international issues, such as CO_2 leakage (or policy options to address it, such as border tax adjustments), international agreements, or technology transfers.

Tax policy has various competing goals, such as generating sufficient revenues for government while promoting economic growth and fairness. Tax policies can also be used to enhance the environment. So far, despite recent efforts, calls for broad-scale tax reform and/or deficit reduction have failed to yield substantial results. Introducing a CO_2 tax adds a new element to the mix, unambiguously augmenting revenues and reducing CO_2 emissions. How the new revenues are used matters a great deal. Some options can enhance economic welfare and GDP growth, others impede it. At the same time, some options, if not well designed, may introduce inequities across generations, income groups, and/or regions of the country. In fact, decisions on the use of the revenues can have bigger effects on the distribution of outcomes across households than would substantial changes in the CO_2 tax rate. Arguably, a CO_2 tax lessens the trade-offs among the multiple goals and unambiguously advances environmental objectives.

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