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Macroeconomic Analysis of Federal Carbon Taxes

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Key Points

- A carbon tax can substantially reduce carbon emissions at a relatively low cost.
- How the carbon tax revenue is used matters. Using the revenues to reduce existing taxes, such as the corporate income tax, significantly reduces the cost of the policy compared to lump-sum rebating of the revenues to households.
- The welfare cost per ton of carbon dioxide reduced is significantly below central estimates of the social cost of carbon when the carbon tax revenues are used to reduce corporate income taxes.
- Based on our estimates, using carbon tax revenues to reduce corporate income taxes would pass a cost–benefit test by a significant margin.

Background

A tax imposed on the emission of carbon dioxide (CO_2) into the atmosphere (a carbon tax) serves to reduce those emissions by making the use of carbon-bearing energy more expensive, thereby stimulating conservation and a search for technological alternatives. Given the current heavy reliance of the US economy on fossil energy, an increase in the cost of that energy can be expected to impact households and firms.

The purpose of this policy brief is to report some results from a modeling exercise of an economy-wide tax on CO_2 emissions where the tax level is designed to be in line with recently

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revised estimates of the social cost of carbon. The exercise was performed using the E3 computable general equilibrium (CGE) model of the United States with international trade. The E3 model, developed by Lawrence Goulder of Stanford University and Marc Hafstead of RFF, divides US production into 35 industries, with a particular emphasis on energy-related industries such as crude oil extraction, natural gas extraction, coal mining, electric power (represented by four industries), petroleum refining, and natural gas distribution. The model provides a detailed tax treatment, allowing for interactions of environmental policy and preexisting taxes on capital and labor.

Structure of the Analysis

The analysis reported here is based on three scenarios. The first is a "base case" (or baseline case) where no carbon taxes are imposed. We calibrate the base case scenario such that the E3 model's CO_2 emissions profile over time is in line with the emissions profile generated by the Energy Information Administration's *Annual Energy Outlook 2015*.

The second and third scenarios impose a revenue-neutral carbon tax with the following provisions:

- The tax is imposed on all fossil fuels (coal, petroleum, and natural gas) combusted within the United States.
- The tax is based on the carbon content of these fuels.
- The tax is applied at a rate $45 per ton (in 2013$) of CO_2 emitted in the combustion process.
- The tax is initially imposed in 2016.
- The tax rate rises each year by 2 percent.

In the second scenario, the revenue raised by the tax is distributed back to each US household in equal shares. This form of revenue recycling is often described as a "carbon fee and dividend" policy. Economists generally refer to this form of revenue recycling as lump-sum rebating.

The third scenario employs the same carbon tax structure as the second, but uses most of the revenues to reduce the corporate income tax rate by 6 percentage points, with the remaining revenues recycled through lump-sum rebates. Both recycling methods—lump-sum rebating and the corporate tax cut/rebate mix—are "revenue-neutral" in that the revenue increase from the carbon tax is exactly offset by the drop in revenue caused by the rebates and/or tax cuts. Policies that use revenue to pay for cuts in other taxes are termed "revenue-neutral tax swaps."

Many other revenue-neutral tax swaps are possible: the carbon tax revenues could instead be used to finance reductions in other taxes, such as payroll taxes or personal income taxes. We chose a partial corporate income tax swap—the policy could finance reductions in

the corporate rate of more than 6 percentage points—to demonstrate the differential impact that recycling revenues to cut another tax has relative to full lump-sum rebating.

Results

We present three sets of results below. In each set we compare outcomes from one of the two revenue-neutral tax scenarios with outcomes in the base case.

Tables 1 and 2 below display the impacts of the carbon tax on the prices and quantities of goods and services consumed by households. Table 1 reports changes in the prices of consumer goods under the revenue-neutral tax swap compared to the base case. (We have not reported a similar table for the lump-sum rebating option because the price changes for consumer goods are quite similar.) The energy goods see the largest real price increases, reflecting their high carbon intensity. Their prices rise relative to less carbon-intensive goods.

Table 2 reports quantity results. The pattern across goods reflects the price effects displayed in Table 1. Households respond to the higher prices of energy goods by shifting their consumption away from those goods to other sectors of the economy.

The next set of results reports estimates of impacts on overall consumption and welfare. Table 3 displays the year-by-year change in "full consumption" (the value of goods and services consumed plus the value of non-work time), for each of the two recycling options. This table shows that the effect of emissions reductions on full consumption depends on the form of revenue recycling. In the third scenario, with a corporate tax rate cut, the drop in consumption is larger in the near term but lower over the longer term than in the second scenario, with lump-sum rebates. This occurs because the corporate income tax cuts encourage saving and investment: thus, in the short run, households consume less and save more than with lump-sum rebates, and that saving and investment pays off in higher consumption over the long term.

Table 4 reports the present discounted cost (in terms of reduced full consumption) per ton of emissions reduced over the entire future, as opposed to year-by-year. Again, the relative costs differ between the two scenarios. The overall welfare cost of emissions reductions in the lump-sum rebate scenario is about $46 per ton, whereas the welfare cost in the case with a corporate income tax cut is about $31 per ton. This cost equates to 0.81 percent or 0.53 percent of total discounted household spending between 2016 and 2030.

Three key conclusions emerge from Tables 3 and 4. First, reducing CO_2 emissions with a carbon tax scaled to central estimates of the social cost of carbon causes relatively small reductions in full consumption. As shown in a separate analysis, a similar tax would cause 2030 CO_2 emissions to fall more than 40 percent below 2005 levels while causing a loss of consumption of less than 0.18 percent.

Second, the welfare costs per ton in the corporate income tax cut scenario are significantly below the central estimates of the social cost of carbon, the measure of the climate-related benefits. Based on these estimates of the environmental benefits, this policy

would pass a cost–benefit test by a significant margin. In the scenario with lump-sum rebating of the revenues, the cost is marginally higher than the central estimate of the social cost of carbon.

Third, the method of revenue recycling matters. Using carbon tax revenues to reduce existing distorting taxes in the US economy significantly reduces the cost of the policy compared to one with lump-sum rebating. While not reported here, revenue-neutral recycling using taxes other than the corporate income tax yields a similar result; that is, welfare losses are smaller when revenues are used to reduce other distorting taxes within the economy.

Tables

TABLE 1. CHANGES IN REAL CONSUMER GOODS PRICES IN 2030

Motor vehicles	-0.9%
Furnishings and household equipment	-0.8%
Recreation	-1.1%
Clothing	-1.0%
Health care	-0.7%
Education	-0.8%
Communication	-2.1%
Food	-0.8%
Alcohol	-0.8%
Motor vehicle fuels (and lubricants and fluids)	7.8%
Fuel oil and other fuels	7.6%
Personal care	-0.7%
Tobacco	-0.6%
Housing	-0.1%
Water and waste	-0.9%
Electricity	15.0%
Natural gas	11.9%
Public ground	0.0%
Air transportation	0.9%
Water transportation	1.0%
Food services and accommodations	-0.7%
Financial services and insurance	-0.7%
Other services	-0.7%
Net foreign travel	1.3%

TABLE 2. CHANGES IN CONSUMER GOODS CONSUMPTION IN 2030

Motor vehicles	0.3%
Furnishings and household equipment	0.3%
Recreation	0.6%
Clothing	0.5%
Health care	0.2%
Education	0.3%
Communication	1.6%
Food	0.3%
Alcohol	0.2%
Motor vehicle fuels (and lubricants and fluids)	-7.7%
Fuel oil and other fuels	-7.6%
Personal care	0.2%
Tobacco	0.1%
Housing	-0.5%
Water and waste	0.4%
Electricity	-13.5%
Natural gas	-11.1%
Public ground	-0.6%
Air transportation	-1.4%
Water transportation	-1.5%
Food services and accommodations	0.2%
Financial services and insurance	0.2%
Other services	0.2%
Net foreign travel	-1.8%

TABLE 3. CHANGE IN FULL CONSUMPTION

Year	Lump Sum Rebating	Corporate Tax Cuts
2020	0.01%	-0.11%
2021	-0.02%	-0.12%
2022	-0.05%	-0.13%
2023	-0.08%	-0.13%
2024	-0.11%	-0.14%
2025	-0.13%	-0.15%
2026	-0.16%	-0.15%
2027	-0.18%	-0.16%
2028	-0.21%	-0.16%
2029	-0.23%	-0.17%
2030	-0.25%	-0.18%

TABLE 4. WELFARE COSTS

	Lump Sum Rebating	Corporate Tax Cuts
Per Ton	$-46.06	-$30.88
As Pct of Expenditures	-0.81%	-0.53%

Find more analysis by RFF experts on the impacts of a US carbon tax:

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