Carbon taxes, deficits, and energy policy interactions*

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CARBON TAXES, DEFICITS, AND ENERGY POLICY INTERACTIONS

Sebastian Rausch and John Reilly

The United States faces the challenge of bringing its federal budget deficit under control, while also reducing its greenhouse gas emissions. Current energy policy has not been very effective in reducing greenhouse gas emissions, although that has not necessarily been its sole purpose. And rather than raise revenue, much energy policy involves subsidies through the tax system that reduce revenue or regulatory policy that may indirectly reduce revenue through its effects on economic activity. This paper focuses on the role of a carbon tax as one option to raise revenue while also reducing greenhouse gases. We also examine the interaction with other regulatory policies, namely renewable portfolio standards, which have been implemented in many states, and the corporate average fuel economy standards.

Keywords: energy policy, carbon tax, greenhouse gas emissions

JEL Codes: H23, H25, Q52

I. INTRODUCTION

Putting a price on carbon — which is the most prevalent greenhouse gas (GHG) — has the potential to address two long-term problems. One is the problem of growing debt in the United States (and in many other countries) with potentially detrimental implications for economic growth. The revenue from a carbon tax could be used to reduce the deficit or to finance reductions in marginal rates of existing taxes while holding the deficit constant (or a combination of both). The other problem is the build-up of carbon dioxide in the atmosphere — the principal anthroprogenically-sourced GHG — contributing to global climate change derived from burning fossil fuels. Leaving this environmental externality unaddressed is expected to create costly damages. The 2008 financial crisis and ensuing global recession greatly exacerbated the deficit situation of the United States by reducing tax receipts and requiring large temporary increases in spending; however,

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even with a return to more "normal" conditions, the Congressional Budget Office (CBO, 2011a) estimates the debt-to-GDP ratio in the United States would rise to 77 percent by 2021, far above the roughly 35–40 percent that was maintained for most of the post-World War II period. Thus, significant budget cuts or additional revenue or some combination of the two are likely needed, and carbon tax revenue may be a partial answer.

In the meantime, energy policy, some of it with the aim of reducing GHGs, has focused on tax breaks for low carbon energy sources and regulatory policies such as corporate average fuel economy (CAFE) standards for vehicles and, at least at the state level, renewable portfolio standards (RPS). A recent National Research Council (2013) study found that the existing tax incentives generally have a very small effect on emissions (less than 1 percent reductions) but reduce tax revenue, which further worsens the deficit. Other recent work has concluded that broad carbon pricing could achieve several times the carbon reduction benefit, given the cost of proposed regulatory measures (Rausch and Karplus, 2014).

While any meaningful and politically feasible effort for debt consolidation in the United States will most likely have to involve some combination of revenue increases and spending cuts extending over the next couple of decades (Domenici and Rivlin, 2011), there has been renewed interest in the role of a carbon tax in the context of broader U.S. fiscal reform (CBO, 2012; McKibbin et al., 2012; Mathur and Morris, 2012; Carbone, Morgenstern, and Williams, 2012). A carbon tax potentially has multiple benefits:

(1) It would reduced carbon emissions, the principle reason for such a tax, but could also have other energy sector benefits such as reducing oil imports, or reducing other pollutants associated with fossil fuel combustion;

(2) Carbon tax revenue can allow revenue-neutral reductions of personal income taxes, corporate income tax, or payroll taxes for a given level of budget expenditure, where a large body of economic research on the interactions of environmental taxes and the broader fiscal system has demonstrated the potential for offsetting gains by reducing the deadweight loss associated with these taxes (Goulder, 1995a; Bovenberg and Goulder, 1996); and

(3) It could be used to directly offset potentially regressive impacts of such a tax by skewing a lump sum distribution of revenue towards lower income levels or cutting taxes in such a way that benefits lower income households.

We evaluate the tax revenue, efficiency, and distributional impacts of a carbon tax, depending on how revenue is used and how it may interact with existing energy policy including RPS and CAFE standards. In addition we consider the potential for such a tax to reduce carbon emissions and its impact on oil imports.

To investigate these issues, we employ a multi-commodity, multi-region, multi-household, recursive-dynamic numerical general equilibrium model of the U.S. economy. The key features of the model are briefly outlined below and described in detail in Rausch et al. (2010a) and Rausch et al. (2010b). This model is developed using a comprehensive energy-economic dataset that features a consistent representation of energy markets in physical units as well as detailed accounts of regional production, bilateral trade, and energy resources for the year 2006. The data set merges detailed state-level data for the United States with national economic and energy data. Social accounting matrices (SAM) in our hybrid dataset are based on IMPLAN data from Minnesota IMPLAN Group (2008) and U.S. state-level accounts on energy balances and prices from the Energy Information Administration (2009) as shown in Table 1.

The IMPLAN data provide consistent regional accounts of production, consumption, and bilateral trade for the 50 U.S. states and the District of Columbia. The dataset includes input-output tables for each state that identify 509 commodities and existing taxes. To improve the characterization of energy markets in the IMPLAN data, we use constrained least-square optimization techniques to merge IMPLAN data with data on physical energy quantities and energy prices from the State Energy Data System for 2006 prepared by the Energy Information Administration (2009). We aggregate the dataset into 12 U.S. regions, 10 commodity groups, and nine households grouped by annual income classes (Table 2). Our data set permits calculation of existing tax rates comprised of sector- and region-specific ad valorem output taxes, payroll taxes, and capital income taxes. The IMPLAN data has been augmented by incorporating regional tax data from the National Bureau of Economic Research TAXSIM model (Feenberg and Coutts, 1993) to represent marginal personal income tax rates by region and income class.

Energy supply is regionalized by incorporating data for regional crude oil and natural gas reserves (U.S. Department of Energy, 2009), coal reserves estimated by the U.S. Geological Survey (2009), and shale oil (Dyni, 2006). Our approach to characterize wind resources and incorporate electricity generation from wind in the model is described in detail in Rausch and Karplus (2014). We derive regional supply curves for biomass using data from Oak Ridge National Laboratories (2009) that describes quantity and price pairs for biomass supply for each state. Advanced energy supply options are specified as "backstop" technologies that enter endogenously if and when they become economically competitive with existing technologies.[1] Competitiveness of different technologies depends on the endogenously determined prices for all inputs, as those prices depend on depletion of resources, climate policy, and other forces driving economic growth.

The remainder of the paper is organized as follows. Section II reports on the baseline and tax scenarios we create. Section III reports the effects of carbon taxation on the macroeconomy. Section IV describes the effects of different uses of carbon tax revenue on households with different income levels. Section V concludes.

II. POLICY SCENARIOS

Table 3 describes the various scenarios examined in this paper. The top panel of Table 3 describes the three baseline scenarios, which include no other energy policy (RefNoPol), CAFE requirements (Ref CAFE), or RPS requirements (Ref RPS) and in all cases assume that the temporary payroll tax cuts and Bush tax cuts expire as

[1] Rausch and Karplus (2014) provide a list of advanced technologies represented in the model.

Table 1
Data Sources

Data and parameters	Source
Social accounting matrices	Minnesota IMPLAN Group (2008)
Bilateral trade	Gravity-based analysis (Lindall, Olson, and Alward, 2006)
Pooled energy trade	State Energy Data System (Energy Information Administration, 2009)
Physical energy flows and energy prices	State Energy Data System (Energy Information Administration, 2009)
Fossil fuel reserves and biomass supply	U.S. Geological Survey (2009)
	U.S. Department of Energy (2009); Dyni (2006); Oakridge National Laboratories (2009)
High-resolution wind data	Wind Integration Datasets (National Renewable Energy Laboratory, 2010)
Non-CO^2 GHG inventories and endogenous costing	(U.S. Environmental Protection Agency (2009); Hyman et al. (2002))
Marginal personal income tax rates	NBER's TAXSIM model (Feenberg and Coutts, 1993)
Trade elasticities	Narayana and Walmsley (2008) and own calibration
Energy demand and supply elasticities	MIT EPPA model (Paltsev et al., 2005)

Table 2
USREP Model Details

Sectors	Regions	Primary Production Factors
Non-Energy	Pacific (PACIF)	Capital
Agriculture (AGR)	California (CA)	Labor
Services (SRV)	Alaska (AK)	Coal resources
Energy-intensive products (EIS)	Mountain (MOUNT)	Natural gas resources
Other industries products (OTH)	North Central (NCENT)	Crude oil resources
Commercial transportation (TRN)	Texas (TX)	Hydro resources
Passenger vehicle transportation (HTRN)	South Central (SCENT)	Nuclear resources
Final demand sectors	North East (NEAST)	Wind resources
Household transportation	South East (SEAST)	Land
Other household demand	Florida (FL)	
Government demand	New York (NY)	
Investment demand	New England (NENGL)	
Energy supply and conversion	Household income classes ($1,000 of annual income)	
Fuels		
Coal (COL)	<10	
Natural gas (GAS)	10–15	
Crude oil (CRU)	15–25	
Refined oil (OIL)	25–30	
Electricity (ELE)	30–50	
Conventional fossil	50–75	
Existing nuclear	75–100	
Hydro	100–150	
Advanced energy supply technologies (see Rausch et al., 2010b)	>150	

scheduled under current law. We use estimates from the Committee for a Responsible Budget (2012) on the revenue effects of these tax changes in 2013 to adjust personal income tax rates upward proportionally. We include those items listed as tax cuts, AMT patches, and jobs measures, which correspond to $5,425 billion between 2012 and 2022.

The middle panel of Table 3 shows several "Central Carbon Tax Scenarios" that include cases where revenue is used to cut personal income taxes under the RefNoPol, Ref CAFE, and Ref RPS baseline scenarios, labeled CT, CT CAFE, CT RPS

Table 3

Scenarios

Name	Scenario
Baseline Scenarios	
RefNoPol	Current law with expired Bush tax cuts and payroll tax cuts[1]
Ref CAFE	RefNoPol with CAFE regulations[2]
Ref RPS	RefNoPol with RPS regulations[2]
Central Carbon Tax Scenarios	
CT	Carbon tax revenue used to reduce the personal income tax rates in RefNoPol
CT CAFE	Carbon tax revenue used to reduce the personal income tax rates in RefCAFE
CT RPS	Carbon tax revenue used to reduce the personal inc. tax rates in RefRPS
CT½	Same as in CT, with 1/2 of revenue diverted to investment
CT LumpSum	Carbon tax revenue with lump sum transfers skewed to low income households
Other Tax Cut Scenarios	
CT Corp	Carbon tax revenue used to reduce corporate tax rates
CT Payroll	Carbon tax revenue used to reduce payroll taxes
CT½ Corp	As in CTCorp with half of revenue diverted to investment
CT½ Payroll	As in CTPayroll with half of revenue diverted to investment
CT½ LumpSum	As in CTLumpSum with half of revenue diverted to investment

[1]This scenario is based on estimates of revenue impacts of these taxes made by Committee for a Responsible Budget (2012).
[2]This scenario is described and modeled in Rausch and Karplus (2014).

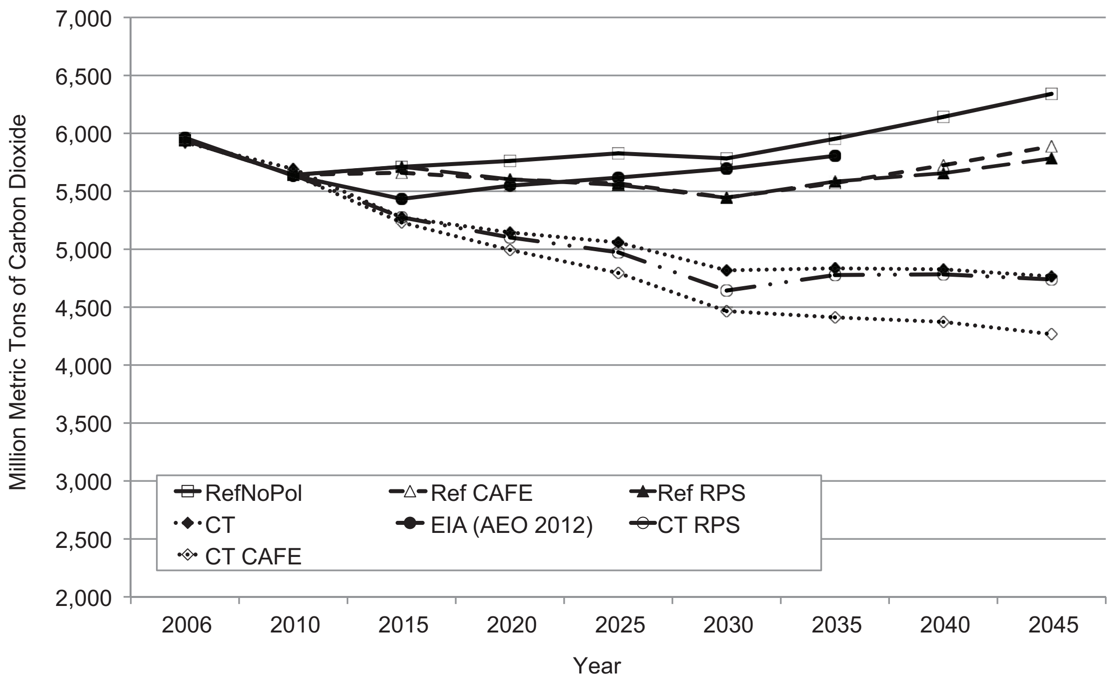
respectively, and then tax cases applied to RefNoPol to consider instead lump sum allocation of revenue (CT LumpSum), or to use one-half of the revenue to spur investment with the remaining used to cut personal income taxes (CT½). These allow us to compare broadly different uses of revenue and to investigate the efficiency of tax cuts compared with lump sum distribution of revenue, as well as interactions with other regulatory policies.

The bottom panel of Table 3 shows "Other Carbon Tax Scenarios" that are designed to illustrate the effects of cutting the corporate (Corp) and payroll (Payroll) tax rates, either using all available revenue for cutting taxes (denoted with CT) or diverting one-half of it to investment (denoted CT½). For completeness we also include a CT½ LumpSum scenario. In the lump sum scenario, the distribution of revenue is skewed toward lower income households by distributing it proportional to existing transfer payments (i.e., Social Security, Medicare, and Medicaid).

Carbon tax scenarios assume that taxes are implemented with a carbon tax of $20 per ton in 2012 U.S. dollars and rise at four percent in real terms to match the CBO baseline assumption (CBO, 2012). All values in USREP are in 2006 dollars and we thus use historical CPI estimates from the (CBO, 2011b) to adjust $20 in 2012 to 2006 dollars. To facilitate comparison with the CBO tax revenue projections estimated carbon tax revenue is adjusted for inflation using the rates assumed by CBO, although all solutions in the model are in real 2006 U.S. dollars. All of our carbon tax (CT) scenarios enforce revenue neutrality; specifically, they consider the loss of other tax revenue due to any reduction in economic activity caused by the carbon tax which implies that less revenue is available for cutting taxes or for lump sum distribution.

The rate of economic growth is based on historical data through 2011, drawn from the Annual Energy Outlook 2012 (Energy Information Administration, 2009) median forecast up to 2035, and then the 2035 growth rate is extended through 2050. For the 2006–2035 period, this produces an annual average growth rate of 2.2 percent for the U.S. economy, and we include an exogenous trend in energy efficiency improvement. The emissions projections in the baseline scenarios (Figure 1) are similar to those produced by the Energy Information Administration (2012). The RefNoPol case is, not surprisingly, somewhat above the EIA forecast because it does not include existing energy policies. The Ref RPS and Ref CAFE are very similar, and ultimately have somewhat lower emissions than the EIA central forecast; however, none of these scenarios achieve the target of 17 percent below the 2005 level by 2020 that the United States proposed in the Copenhagen meeting of the Framework Convention on Climate Change. Using a baseline without additional energy policies, the CT scenarios produce virtually identical emissions trajectories, achieving about 13 percent emissions reductions in 2020 relative to 2006. Adding a carbon tax on top of CAFE requirements (CT CAFE) results in emissions reductions of 15.9 percent in 2020 relative to 2006, thus almost fulfilling the 17 percent target. The RPS requirement added to the tax (CT RPS) does not reduce emissions much further than the CT scenarios (14 percent in 2020 relative to 2006), as much of the reductions with the carbon tax would be redundant with the RPS. Interacting the CAFE requirements with a carbon tax produces additional

Figure 1
Carbon Dioxide Emissions Over Time



Note: Table 1 provides the definitions of carbon tax scenarios. Other tax scenarios applied against RefNoPol show virtually identical emissions to the CT case.

emissions reductions, and hence lower absolute emissions, as compared to a case that interacts a RPS with a carbon tax. This occurs because a CAFE standard triggers relatively high-cost abatement opportunities in the private transportation sector that would not occur with a carbon tax, given cheaper abatement opportunities elsewhere in the economy, in particular those related to coal-fired generation in the electricity sector.

In terms of total revenue raised, our estimates are very similar to that of the CBO for a similar level of carbon tax (CBO, 2011a). In the CT scenario we estimate nominal values of \$114.3 billion in 2015 and \$146.0 billion in 2020, assuming the same inflation rate as the CBO (Table 4). This compares to CBO's estimate of \$105.3 billion in 2015 and \$144.4 billion in 2020. CBO did not estimate effects past 2020. In our estimates, revenue increases steadily through 2050, although a large portion of this occurs because we report the amounts in nominal dollars to compare with CBO. The more than 5-fold increase (to \$605 billion) by 2050 is, in constant dollars, only a 3-fold increase. Revenue in both the CT RPS and CT CAFE scenarios are reduced because the RPS and CAFE policies reduce emissions more than in the CT policy; however, the reduction in revenue is smaller for the CT RPS as compared to the CT CAFE scenario as the former is associated with higher emissions over time.

Table 4
Carbon Revenue ($Billion)

	2015	2020	2025	2030	2035	2040	2045	2050
CBO (nominal)	105.3	144.4						
USREP (nominal), CT	114.2	145.8	186.4	231.8	306.2	400.5	496.9	604.2
USREP $(2012), CT	108.9	128.4	154.0	177.0	215.9	260.9	299.0	335.8
USREP $(2012), CT CAFE	108.9	124.6	145.9	164.0	197.1	236.5	267.1	294.2
USREP $(2012), CT RPS	108.9	127.3	151.9	170.5	213.4	258.7	296.7	334.9

Sources: CBO revenue figures are from CBO (2011a). Inflation assumptions are based on the Consumer Price Index underlying the projections in CBO (2012). For periods after 2012, we assume an annual inflation rate of 1.6 percent.

The CBO assumed estimated 10-year (2012–2022) revenue of just under $1.25 trillion, a simple sum of nominal dollar revenue in each year. While we only solve every five years, if we linearly interpolate revenue using the three solution periods (2015, 2020, 2025) that span a 10-year horizon (2013–2023), we estimate the total carbon tax revenue to be about $1.5 trillion. One of the reasons this is higher than the CBO estimate is that a different period is analysed. We add the revenue for year 2023 (estimated to be about $173 billion through our interpolation) and subtract revenue for the year 2012 (estimated to be just under $100 billion). This change alone accounts for about $75 billion of the difference in the estimates. Given the variety of possible differences it is somewhat surprising how close we are to CBO's estimates of likely revenue generated. As noted earlier, all tax scenarios are forced to be revenue neutral, requiring a portion of the revenue to make up for losses of other revenue to the extent economic activity is affected. This can be substantial, as the adjustment varies by year but is in the range of 30–50 percent in our scenarios.

We implement the tax cuts as equal percentage point cuts in the marginal rates for each tax bracket. These tax cuts are endogenously calculated in our model to yield the revenue cost equal to the available carbon tax revenue. In 2015, the available revenue supports a 0.45 percentage cut in marginal personal income tax rates, a 1.16 percentage point cut in the payroll tax, and a 1.64 percentage point cut in the corporate tax rate when 100 percent of the revenue is available for recycling. These tax cuts change over time reflecting changes in the tax base for each category and the revenue available. For the cases where half of the revenue is used for the investment tax credit, the tax cuts are smaller because less revenue is available. There are also varying effects on economic activity and therefore the tax base and the revenue needed for revenue neutrality.

III. EFFECTS OF CARBON TAXES ON THE MACROECONOMY

A. Aggregate Effects on Economic Welfare

Table 5 shows the welfare effects of the Central Tax Case Scenarios, which are generally small in all of the cases. Consistent with the consensus in the literature,[2] the tax advantage effect alone does not produce a "strong double dividend," where the tax recycling benefit is more than the direct cost of the carbon tax policy creating a net benefit to the economy even without considering avoided climate damages. The welfare effect we find is a 0.05 percent loss in 2015, increasing to a loss of 0.27 percent in 2050, with a net present value loss of 0.07 percent over the entire period.[3] The CT RPS case

[2] Goulder (1995b) and Bovenberg and Goulder (1998) provide survey articles of the literature.

[3] Welfare is the change in aggregate market consumption plus the change in the value of leisure. Market consumption is the major component of GDP (i.e., GDP = Consumption + Investment + Government + Exports – Imports). Leisure time changes because of changes in employment. We report the change as a percent of total aggregate consumption rather than consumption plus leisure because the amount of time accounted for as "leisure" or non-work time is somewhat artificial, and is set to represent the potential labor force to be consistent with a calibrated labor supply elasticity.

Table 5

Central Carbon Tax Scenarios Results: Annual and Net Present Value Welfare Costs

	Annual Welfare Costs — Year					NPV
	2015	2020	2030	2040	2050	Welfare Costs
CT	0.05	0.05	0.08	0.08	0.27	0.07
CT RPS	–0.19	–0.11	–0.22	–0.20	–0.08	–0.12
CT CAFE	0.06	0.05	0.08	0.09	0.31	0.10
CT½	0.45	0.29	–0.01	–0.28	–0.42	0.02
CT LumpSum	0.02	0.04	0.08	0.09	0.31	0.05
CT½ LumpSum	0.26	0.20	0.06	–0.18	–0.20	0.03

Notes: Reported welfare numbers are expressed in percent relative to a no-carbon policy baseline.

shows net welfare gains over the entire period of 0.12 percent in net present value terms, attributable to further interaction with the RPS policy. USREP features adjustment costs to rapid expansion of new technologies such as wind power generation. The presence of the RPS expands the capacity to produce wind power ahead of the implementation of the carbon tax, and thereby reduces the adjustment cost of expanding wind capacity when it becomes economic under the carbon tax. In the recursive dynamic structure of USREP, producers do not look ahead and expand capacity in anticipation of the carbon tax (Morris, Webster, and Reilly, 2014). If the forthcoming carbon tax were perfectly anticipated and the later benefits of lower costs could be fully appropriated by private firms, then early investment to overcome later adjustment costs might well take place without the RPS. However, both assumptions — perfect foresight and full appropriation of later gains — are unlikely to hold. This result thus shows the potential for positive interaction of other energy policies with a carbon tax.

CT CAFE does not show such positive effects and shows a net present value loss of 0.10 percent, slightly larger than in the CT case. USREP has similar adjustment costs related to the build-up of capacity for alternative vehicles, but the CAFE standard implemented here does not improve welfare. While in principle it could, a CAFE standard is not closely targeted to getting new vehicles types in the fleet, and for such a policy to be welfare enhancing it would need to be carefully coordinated with the planned carbon tax. As shown with the RPS, other government interventions can be welfare enhancing. However, such a policy would need to be targeted carefully to ensure such a result, as it requires that the government agencies implementing the other energy policy actually know when and at what level the carbon tax will be implemented, as well as how the supported technology would develop with the early incentives.

The CT½ scenario has larger early welfare losses because revenue is diverted from consumption to investment, but these turn to net gains by 2030 because ultimately the economy can produce more with the larger capital stock created by diverting carbon tax revenue to investment. Results for CT LumpSum show almost the reverse. The welfare cost in the early years is less because the lump sum distribution is targeted to lower income households who spend more on consumption, but saving and investing less of the revenue means higher economic costs in the long run because the capital stock is smaller.

Table 6 shows the welfare effects of the Other Carbon Tax Scenarios. Absent the interaction with an RPS or CAFE policy, using the revenue to cut corporate or payroll taxes instead of personal income taxes does not make much difference in terms of the overall welfare effect. The most significant differences are between the CT and CT½ scenarios, and these differences remain no matter which tax is cut. In the CT½ variants, there are larger losses initially and gains by 2030 that continue to grow through 2050.

B. Effects on Oil Imports

As shown in Figure 2, without the climate policy the model projects a slight increase in oil imports through 2030, and then a more rapid increase through 2050. With the carbon tax, nearly all of the increase in oil imports is avoided, with imports remaining nearly flat through 2050.

C. Sensitivity of the Results to Key Assumptions

The mobility of capital, the labor supply elasticity, and energy substitution elasticities are important parameters of the model that affect the cost of abatement. However, in general, we do not find large effects on our estimates of welfare change when we vary these parameters from their reference values in USREP and none of the sensitivity

Table 6

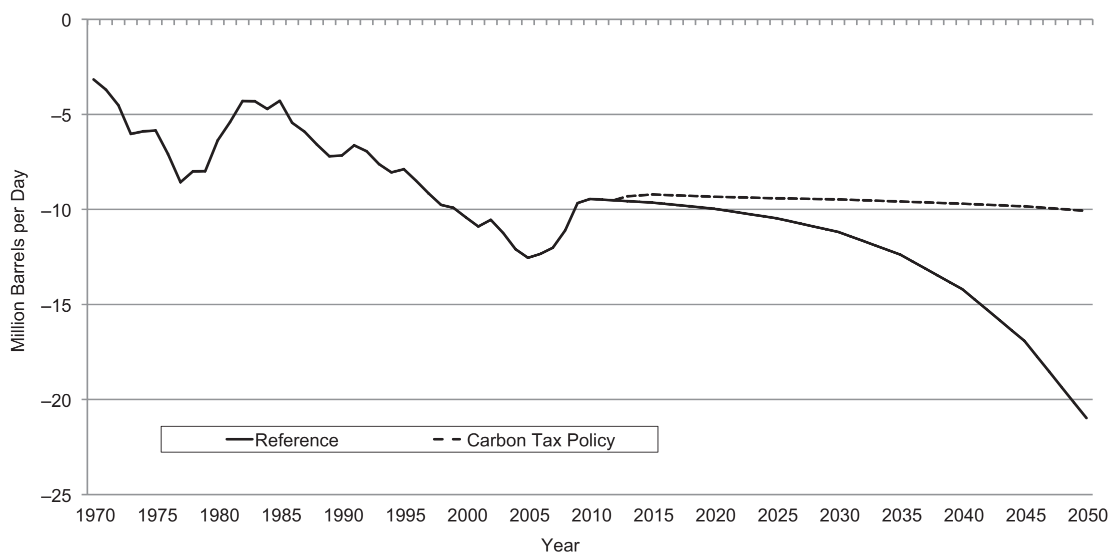
Other Carbon Tax Scenarios Results: Annual and Net Present Value Welfare Costs

	Annual Welfare Costs — Year					NPV
	2015	2020	2030	2040	2050	Welfare Costs
CT	0.05	0.05	0.08	0.08	0.27	0.07
CT Corp	0.04	0.04	0.08	0.09	0.31	0.05
CT Payroll	0.06	0.06	0.08	0.07	0.25	0.06
CT½	0.45	0.29	–0.01	–0.28	–0.42	0.02
CT½ Corp	0.44	0.28	–0.03	–0.29	–0.41	0.01
CT½ Payroll	0.45	0.30	–0.00	–0.27	–0.42	0.01

Notes: Reported welfare numbers are expressed in percent relative to a no-carbon policy baseline.

Figure 2

Oil Production Minus Consumption and Exports



Notes: Negative number indicates net imports. Figures for1970–2006 are based on historic data from the 2007–2050 model projection prepared by the Energy Information Administration (2012).

results produce a strong double dividend (Table 7). The assumption that most strongly affects our estimates is the degree of capital vintaging. Many models assume perfectly mobile capital, and with that assumption our welfare costs increase substantially. If we increase capital vintaging, our welfare costs fall; however, since vintaging is already significant in the model, if increased further welfare costs do not fall as much as the increase when we move to fully mobile capital. Higher labor supply and energy substitution elasticities result in a small reduction in the welfare effect estimated in our CT case with central values for these parameters.

IV. EFFECTS OF CARBON TAXES ON INCOME DISTRIBUTION

While there were not significant differences in aggregate economic effects regardless of which taxes were reduced, Figure 3 shows that there were substantial differences on how the different uses of revenue affect households with different income levels in 2015 and Figure 4 shows that the net present value welfare effect through 2050 were also different. Most notably both lump sum scenarios are progressive, benefiting lower income households, increasing welfare of the lowest income households by over 3 percent in 2015 in CT LumpSum. This effect weakens over time as is evident in the NPV calculations. Payroll tax cuts are fairly neutral from a distribution standpoint, except at

Table 7

Sensitivity of Results to Key Model Assumptions

	Annual Welfare Costs — Year					NPV
	2015	2020	2030	2040	2050	Welfare Costs
Central case (CT scenario)	0.05	0.05	0.08	0.08	0.27	0.07
Capital mobility/fraction of non-malleable capital						
High degree of capital vintaging[1]	0.03	0.03	0.05	0.07	0.30	0.04
Perfectly mobile capital[2]	0.10	0.12	0.20	0.31	0.38	0.18
High labor supply elasticity[3]	0.03	0.03	0.07	0.08	0.31	0.04
High substitution possibilities between energy and value added and non-energy inputs						
High capital/labor–energy subst. in production[4]	0.04	0.04	0.08	0.09	0.31	0.05
High energy-non-energy subst. in final private consumption[5]	0.03	0.02	0.06	0.04	–0.29	0.02

Notes: Reported welfare numbers are expressed as a percentage change relative a no-carbon policy baseline.

[1] This simulation assumes that the share of non-malleable capital for electricity and non-electricity sectors is increased by 30 and 200 percent relative to the central case, respectively.

[2] This simulation assumes that all capital is perfectly mobile across sectors and U.S. regions, i.e., the share of vintaged capital is zero.

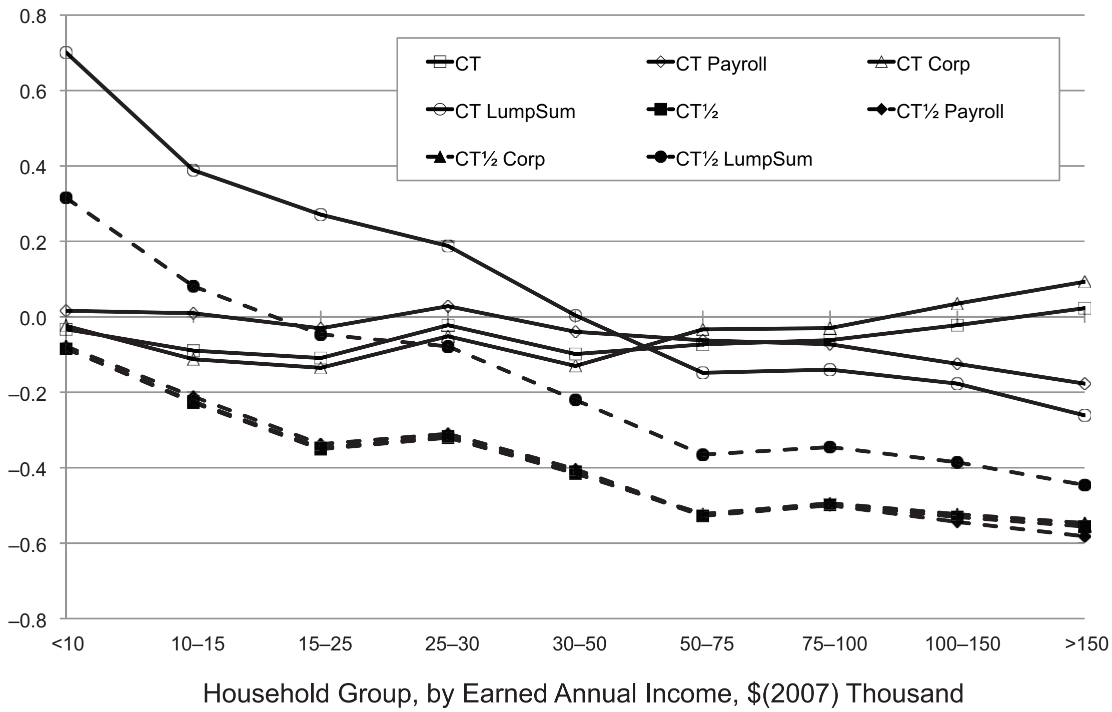
[3] This simulation assumes compensated and uncompensated labor supply elasticities are doubled relative to the central case assumptions.

[4] This simulation assumes that the elasticity of substitution between energy and value added in all sectors is doubled relative to the central case.

[5] This simulation assumes that the elasticity of substitution between energy and non-energy goods in final demand is doubled relative to the central case assumptions.

Figure 3

Welfare Effects by Income Group in 2015



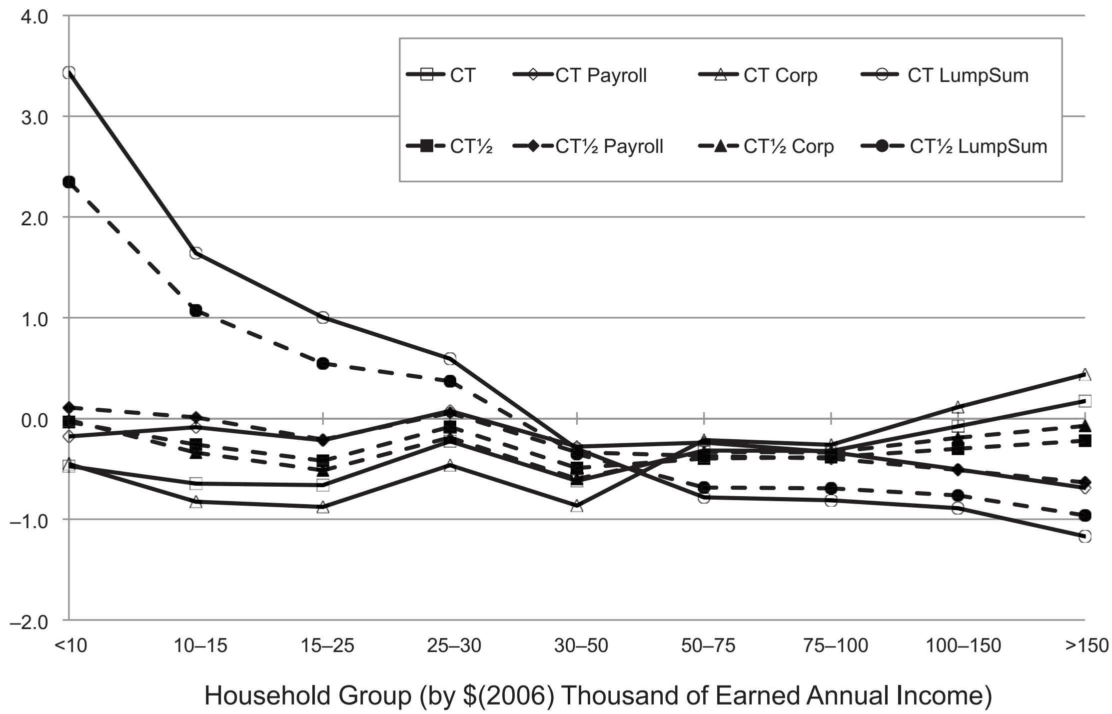
Notes: All revenue is used for tax relief or social programs. Income levels are defined by earned annual income only, excluding transfers, and are denominated in constant 2006 dollars.

the highest income levels. This result is not surprising as the payroll tax has an upper income limit so that benefits from tax cuts do not proportionally benefit those with incomes above the limit. Personal income tax cuts and especially corporate income tax cuts are regressive. Again, this is not a surprising result, as higher income households pay a larger share of their income directly as personal income taxes and indirectly in corporate income taxes because they derive more of their income from investments (e.g., stock and bond holdings).

The CT½ scenarios show the greatest difference between the 2015 results and the NPV results. In 2015, all income groups suffer welfare losses, and the effects are decidedly progressive with greater proportional losses for higher income households. However, the NPV change over the full period reverses that effect, with the results becoming neutral to slightly regressive. The results become more positive over time as the capital stock increases, and thus high-income households benefit more since capital income is a larger share of their income.

Elsewhere we have shown that the presumed regressivity of energy taxation obtained from partial equilibrium assessments generally does not hold when distributional effects

Figure 4
Net Present Value Welfare Effects by Income Group



Notes: All revenue is used for tax relief or social programs. Income levels are defined by earned annual income only, excluding transfers, and are denominated in constant 2006 dollars.

are estimated endogenously (Rausch, Metcalf, and Reilly, 2011). This stems from the fact that low-income households derive more of their income from social programs (e.g., Social Security) that are indexed by the price level. This indexation is essentially insured by our imposition of revenue neutrality, which insures that real government transfer payments are not affected by reductions in revenue. However, as shown elsewhere (Rausch, Metcalf, and Reilly, 2011), the range of effects within any income strata greatly exceeds the difference among income groups. Obviously, some low-income households benefit from transfers while some do not, and expenditures on energy and other factors vary greatly among households even with the same earned income.

V. CONCLUSIONS

The United States faces the challenge of bringing its federal budget deficit under control. There is general recognition that doing so will likely require both difficult budget cuts and enhancements to revenue. One option for revenue enhancement suggested in an earlier analysis (CBO, 2012), is the introduction of a carbon tax starting at $20 per ton and rising gradually over time. The CBO estimated that such a carbon tax could raise about $1.25 trillion over the 2012–2022 period. We find a similar, but somewhat higher, 10-year revenue gain of about $1.5 trillion. We have slightly higher revenue at the start of the period because we find a little less abatement and thus higher emissions. Because the period is extended we also gain from adding in revenue from the year 2023, when the carbon price and revenue is considerably higher than it would have been in 2012.

We use a reference case in which the Bush tax cuts and the temporary payroll tax cut expire, as under current law. We then evaluate the carbon tax assuming that the revenue from that tax allows us to avoid some of the general tax increases or is distributed in a lump sum fashion. The lump sum distribution is skewed among income classes to be proportional to the current distribution of transfer payments so that the distribution benefits lower income households. We investigate the interaction of carbon taxes with other energy policies, in particular CAFE and RPS requirements. We consider cases where the revenue is used to avoid increasing the personal income, corporate income, and the payroll taxes. We consider a similar set of cases where half of the revenue is used for an investment tax credit and the remainder is used for tax cuts or social programs.

In terms of aggregate welfare effects, we find low net present value costs to the economy (NPV welfare costs of 0.01 to 0.07 percent of total consumption through 2050). This variation was across different tax cuts and scenarios where one-half of the revenue was used to increase investment in the economy. There was a strong difference in the time profile of costs between scenarios where all revenue was used for tax cuts and one-half the revenue was used for investment. In the latter case there were stronger welfare losses in the near term as tax revenue was diverted to investment and away from consumption, but then these losses turned to net gains for the economy by 2030 so that the NPV results were similar. The effect of using revenue for lump sum distribution on welfare, in NPV terms, was similar to other cases (–0.05) but the time profile was quite different. In this case, welfare results were small in the near term as more of the tax revenue ended up as consumption because of the higher marginal propensity to consume of lower income households, but grew over time because saving and investment was somewhat lower.

We also found that the carbon tax policy interacted with existing energy policies. In the case of the RPS, there was a positive interaction, turning small net welfare losses to small gains. The presence of the RPS avoided later adjustment costs that would have been incurred if there had not been earlier development of renewable electricity capacity. In the case of CAFE, the effect was to slightly worsen the welfare effect, as the CAFE standard overshot reductions needed in vehicles and did not stimulate advanced vehicle technologies in an efficient manner, given the particular carbon tax policy we specified. These two sets of results show the possibility of beneficial policy interaction but the likely difficulty of targeting the early action correctly.

We also investigated the implications for households with different income levels. Here the effects were as one might expect. Personal income and corporate income tax cuts were most favorable for wealthier households, and the payroll tax cut was fairly neutral for most households, but slightly progressive at higher income levels. When half of the revenue was used for the investment tax credit we saw a more progressive effect in the short term because taxes were cut less, and wealthier households paid more in taxes, and there was less progressivity over the full time period of our study because wealthier households ultimately benefited from greater investment returns.

We should mention some caveats to these results. Our model approach assumes full-employment, and the economy currently remains in a situation of excess unemployment. While further study would be required, the current economic situation may further favor tax cuts as opposed to an investment tax credit, and especially adjustments that put more money in the hands of lower income households. The economy currently suffers from a lack of demand, and lower income households are more likely to spend than save. While saving and investment are ultimately good for the economy, in the current situation it is lack of consumption growth that appears to be holding back investment rather than a lack of funds to invest. However, in general, further investigation into how these results might change under different phases of the business cycle would be useful. Second, we impose absolute revenue neutrality in our model; this generally requires a larger share of revenue to be retained for this purpose than is required for budget scoring purposes.

In general, the Joint Committee on Taxation requires a 25 percent "haircut" on indirect tax revenue. Our estimate of the required haircut varies but on average is closer to 40 percent. Moreover, as described in CBO (2009) there are some situations where no haircut would be required. In particular, they argue that a cap and trade policy that gave away allowances to taxpaying entities would not require a haircut. In the proposals we examine, revenue is returned to taxpaying entities via tax cuts and thus may be viewed as requiring no haircut. If so, the revenue available for tax cuts may be greater than we estimate and thus we might see more positive effects on efficiency, although that would depend on the evaluation of the loss of benefits due to declines in real government spending.

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