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Tax Policy Issues in Designing a Carbon Tax†

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A carbon tax is a promising tool for discouraging the greenhouse gas emissions that cause climate change. In principle, a well-designed tax could reduce the risk of climate change, minimize the cost of emissions reductions, encourage innovation in low-carbon technologies, and raise new public revenue. But designing a real-world carbon tax poses significant challenges. We analyze those challenges from a public finance perspective, emphasizing three tax policy design issues: setting the tax rate, collecting the tax, and using the resulting revenue. The benefits of a carbon tax will depend on how policymakers address those issues.

I. Setting the Tax

Climate change is a classic externality. Businesses, consumers, and governments emit carbon dioxide and other greenhouse gases by burning fossil fuels, making cement, raising cattle, and other activities. Those emissions accumulate in the atmosphere, alter the climate, and impose potential economic and environmental costs including property damage from increased storm risks, threats to human health, changes to agricultural productivity, and ecosystem deterioration. Taxing greenhouse gas emissions is one way to reduce those harms.[1] But how big should the tax be? The Pigouvian tradition offers one answer: the optimal tax on carbon dioxide, the most important greenhouse gas, should be equal to the marginal social cost of carbon emissions. A tax at that level would internalize the externality and maximize conventional measures of social welfare.

This approach has great conceptual appeal, but estimating the social cost of carbon is difficult. Carbon dioxide emissions stay in the atmosphere for decades. Their environmental and economic impacts depend nonlinearly on the stock of greenhouse gases, which will depend on future economic developments, domestic climate policies, and policies elsewhere in the world. Estimating the marginal social cost of carbon thus requires complex modeling and assumptions about the trajectory of carbon emissions, climate sensitivity, and the impacts of any climate changes, all of which are uncertain. The cost may depend critically on controversial assumptions, such as what value to place on low-probability, catastrophic outcomes and what discount rate to apply in valuing damages far in the future.

Estimates of the social cost of carbon thus vary widely. In a survey of 75 studies, Tol (2013) found 588 estimates based on different integrated assessment models, policy assumptions, and discount rates. The mean social cost of carbon in those studies was \$196 per ton in 2010 dollars with a standard deviation of \$322, with the larger estimates reflecting very low discount rates. Controlling for differences in discount rates narrows that uncertainty but does not eliminate it. At a 3 percent real discount rate, the mean social cost was \$25 per ton with a standard deviation of \$22.

The social cost approach also raises a profound conceptual issue: should policymakers focus on worldwide impacts or domestic? Climate change is a global phenomenon with emissions affecting all nations. A coordinated international response should focus on worldwide impacts. If a nation considers unilateral

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[1] Another way to price carbon would be to limit emissions and let sources trade them. Goulder and Schein (2013) compare the two approaches and note several ways a carbon tax may work better than a cap-and-trade system.

action, however, it must decide whether to focus on domestic costs and benefits or to consider other nations as well. The difference is large. Greenstone, Kopits, and Wolverton (2013) estimate, for example, that the United States bears only 7 to 10 percent of the worldwide marginal social costs of carbon. If each ton of new carbon dioxide emissions imposes $30 in worldwide damages, only $2 to $3 would fall on the United States. They argue that the United States ought to use the global measure when evaluating regulatory policies, but this view is not universal. Indeed, policymakers often take a US-only view when evaluating other energy and environmental policies that have international spillovers.

The social cost approach thus faces significant challenges. A competing view is that the carbon tax should be calibrated to hit future emissions or climate targets. The selection of the target would be informed by concerns about the impact of climate change but might also reflect international negotiations, concerns about tail risk, or other considerations. This approach would be less informationally demanding, since policymakers would not need to estimate the marginal social cost of carbon. The resulting tax would not necessarily be socially optimal—that would depend on the chosen target—but would be a way of cost-effectively achieving that target.

Under either approach, policymakers must also decide how the tax rate will change over time. Most analysts recommend that it increase in real terms. One reason is that the social costs of carbon will increase as the stock of greenhouse gases in the atmosphere builds. A ton of carbon dioxide emitted in 20 years will do more harm than a ton emitted today. A trajectory of rising tax rates, if credible, would also encourage innovation in low-carbon technologies that will reduce future costs, while avoiding needlessly expensive reductions in the near term. In addition, starting the tax at a relatively low level reduces transition costs, allows people to prepare for upcoming changes, and may make a carbon tax more politically feasible.

II. Collecting the Tax

A. *Taxing Carbon Emissions*

In theory, the best way to tax carbon dioxide would be to monitor all emissions and tax them at a uniform rate. This approach would create a consistent and comprehensive incentive for emitters to shift to less carbon-intensive production and households to shift to less carbon-intensive consumption. Unfortunately, such monitoring would be prohibitively expensive given the large number of sources. One fallback would be to focus on large sources that can be easily monitored, as is often done in regulating other pollutants, but that would miss many emissions.

Another approach would be to identify proxies for carbon emissions that could be effectively taxed instead. In principle, one could look for proxies anywhere in the supply chain, from extraction of raw materials to retail sale of final products. In practice, it makes most sense to focus on the carbon content of fossil fuels. Fossil fuel combustion accounts for more than 90 percent of carbon dioxide emissions in the United States, primarily in electricity generation, transportation, industrial production, and residential and commercial heating (EPA 2013), and the chemistry of combustion creates essentially a one-for-one relationship between carbon content and resulting carbon dioxide emissions. As a result, the carbon content of fuels can be a broad proxy for carbon dioxide emissions.

Leaving aside international trade concerns, the best place to impose the tax would be at a point in the supply chain where carbon content could be easily measured and the number of taxpayers relatively small (Metcalf and Weisbach 2009). For coal, this would be at the mine, for petroleum at the refinery, and for natural gas at processing facilities or, for those that bypass them, the wellhead. Going upstream to oil wells and importers would expand administrative and compliance burdens without increasing the effectiveness of the tax, while going downstream from these points would weaken the link between the tax and actual carbon emissions.

International trade complicates the analysis (Metcalf and Weisbach 2009; Metcalf 2013; McLure 2014). A domestic carbon tax could encourage production of carbon-intensive goods to shift to low–carbon tax jurisdictions, placing some US firms at a competitive disadvantage, and would encourage US consumers to purchase carbon-intensive goods from lower-tax jurisdictions. One response would be to adjust the carbon tax for imports and exports. Such border-adjusting would be relatively simple for the fuels themselves; the United States could tax imports of coal and refined products like gasoline at the domestic tax rate and give a rebate on exports. This would not violate trade neutrality and would likely be acceptable under World Trade Organization rules. The more difficult problem is adjusting for differences in the carbon tax imposed on domestic and foreign high-carbon intermediate and final products. This is both a technical problem in measuring the carbon content of traded goods and a legal problem because it is doubtful that duties on imported goods or subsidies on exported goods would be acceptable even with a difference in carbon taxes.

Taxing final consumption of energy-related goods at the retail level (e.g., residential consumption of electricity, natural gas, and oil and consumer gasoline purchases) would avoid these international concerns because it would automatically tax final consumption irrespective of its import component and exempt exports. But taxing energy at the retail level fails to provide incentives to use less carbon-intensive production methods, especially for electric generation, and would exempt the carbon content of other goods and services.

Finally, another option would be to use selective subsidies instead of taxes to promote certain forms of fuel substitutability, such as the use of renewables in electric power generation. This approach, widely used in current policy, shifts the burden of paying for reduced carbon use from electricity consumers to taxpayers in general and encourages consumption overall rather than discouraging it. This approach may make sense in limited circumstances if the goal is to protect the competitive position of domestic industries that rely heavily on electric power.

Considering these pros and cons, Metcalf and Weisbach (2009) recommend using an origin-based tax at the refinery and mine level, while making selective adjustments for the relatively small number of energy-intensive and trade-exposed industries that may suffer adverse effects from a carbon tax. This judgment strikes us as reasonable, but we note that a combination of mine-, refinery-, processor-, and wellhead-level taxes and credits may be the best available policy combination, giving the level and informational constraints on implementing border adjustments.

B. *Other Changes in Carbon Emissions*

A truly comprehensive carbon tax must address activities other than fossil fuel consumption that may increase or decrease carbon emissions. First, the tax base should also include carbon emissions that result from industrial processes such as iron and cement manufacture, but this would require a separate administrative structure to monitor emissions and collect the tax. Second, the tax base should exclude any uses of fossil fuels that do not result in carbon emissions, such as the use of petroleum as a feedstock or capture and storage of carbon dioxide at a power plant. In such cases, a tax rebate would be appropriate, rewarding firms for carbon purchases that do not cause emissions. This could be administered through a series of downstream tax credits, analogous to the credits now available to taxpayers who use gasoline and diesel off highway. Finally, a cost-effective policy should give credit through tax rebates or tradable tax credits for sequestration of carbon dioxide already in the atmosphere, for example by planting trees on lightly vegetated land. Doing so, however, poses significant enforcement challenges since sequestered carbon must be measured against an uncertain baseline of what would have happened otherwise.

C. *Taxing Other Greenhouse Gases*

Tax discussions focus on carbon dioxide because it is the most prevalent greenhouse gas, accounting for 84 percent of US emissions in 2011 (EPA 2013). Cost-effective opportunities to reduce emissions of methane, nitrous oxide, and other greenhouse gases exist, however, so policymakers should consider including them in the tax. In doing so, they must address two basic challenges. First, including these gases would expand the universe of activities subject to tax. Most methane comes from natural gas systems, cattle, and landfills, for example, and nitrous oxide comes mostly from agriculture (EPA 2013). Incorporating these activities would expand the administrative burden of collecting the tax. As Metcalf and Weisbach (2009) discuss, policymakers will have to strike a balance between administrative costs and potential emission reductions in deciding which activities are worth taxing. Second, these gases have different properties. Methane, for example, traps more heat, gram-for-gram, than does carbon dioxide. A cost-effective tax would reflect that difference, increasing the tax rate to reflect greater potency. The climate community generally uses a measure of global warming potential for such comparisons, with methane having a potential 28 times that of carbon dioxide and nitrous oxide 265 times (IPCC 2013). By those measures, a \$20 per ton tax on carbon dioxide would imply a \$560 per ton tax on methane and \$5,300 per ton on nitrous oxide. That scaling is not without controversy—global warming potentials do not reflect several factors relevant to setting a tax—but the inefficiencies of imperfect weighting appear relatively small (O'Neill 2003).

III. Using the Revenue

A carbon tax could raise substantial revenues. The Congressional Budget Office (2013) recently estimated that one possible tax—\$25 per ton on most carbon dioxide emissions in energy production plus some other gases emitted in manufacturing, increasing at 2 percent real each year—would raise about \$1 trillion over the next decade. A key question is what to do with it. One possibility is to offset some or all the burden created by the new tax.

Analysts generally assume that a carbon tax would be passed forward to consumers both directly in higher prices for their energy purchases and indirectly in higher prices for other goods and services based on the carbon-intensity of production (Dinan and Rogers 2002; Mathur and Morris 2012; Marron and Toder 2013). Labor and capital in carbon-intensive industries might also bear some of the short-run burden, but analysts typically focus on the long run when most costs will be passed on to consumers. Like other taxes on consumers, a carbon tax would be regressive: its burden would be higher as a share of income for low-income households than for high-income ones because low-income households consume a greater share of their income and spend relatively more on carbon-intensive goods and services. Mathur and Morris (2012) find, for example, that consumption is 165 percent of income in the bottom income decile, but only 48 percent in the top decile, and that a carbon tax averaging 1.7 percent of consumption imposes a burden of 2.1 percent of consumption in the bottom decile, but only 1.3 percent in the top decile.

The regressivity of a carbon tax varies depending on how it is measured. One common approach measures the burden by comparing the tax paid to current income. A second approach compares the tax paid to current consumption. Pioneered by Poterba (1989), this approach reflects Friedman's (1957) insight that current income includes transitory fluctuations and that current consumption may be a better proxy for permanent income than is current income. A third approach, developed by Toder, Nunns, and Rosenberg (2012), measures the fully phased-in burden of a consumption tax by distinguishing its effects on sources and uses of income. On the sources side, a consumption tax reduces the real value of earnings, super-normal profits, and wage-indexed transfer payments, while on the uses side, relative price changes redistribute net income from groups who consume relatively more of taxed goods to those who consume relatively less. (Upon introduction, a consumption tax would be more progressive because it would also tax individuals consuming out of existing wealth but would exempt current recipients of price-indexed Social Security benefits.)

In Table 1, we compute these distributional measures by combining recent carbon tax estimates by Mathur and Morris (2012) with the most recent Toder, Nunns, and Rosenberg (2013) estimates for a consumption tax. To highlight the different distributional patterns, we normalize the three measures so they report the same overall burden. We find that a carbon tax is regressive under all three methods, but by different degrees. Compared to the Toder, Nunns, and Rosenberg (2012) measure, the traditional approach using current income overstates regressivity because of transitory income shocks, while the alternative comparing to current consumption as a proxy for permanent income understates regressivity because it fails to account for the exemption of capital income under a consumption tax.

Tax relief could offset the disproportionate effect of the tax on the poor and reduce the economic distortions of the existing tax system. Relief could take the form of lower income or payroll taxes or new tax credits. But there is a tradeoff. Options that are more beneficial to low-income taxpayers (e.g., a refundable per capita credit) generally have the least benefit for economic efficiency because they don't reduce the distortive effects of existing taxes.

Table 1—The Burden of a Carbon Tax under Three Approaches (*percent*)

Income group	Current income	Permanent income[a]	Toder et al.
Bottom quintile	3.0	1.4	2.1
Second quintile	1.8	1.3	1.7
Third quintile	1.4	1.2	1.4
Fourth quintile	1.0	1.1	1.2
80–90th percentiles	0.9	1.0	1.0
Top decile	0.6	0.8	0.6
All	1.1	1.1	1.1

Note: [a]Assumes average permanent income is equal to average current income.

Sources: Mathur and Morris (2012); Toder, Nunns, and Rosenberg (2013); and authors' calculations.

Conversely, the options that offer the largest efficiency benefits (e.g., reducing the corporate tax rate) generally do the least to benefit low-income households. Marron and Toder (2013) estimate that offsetting 50 percent of carbon tax revenues with a refundable tax credit and 50 percent with a cut in the corporate income tax rate would leave both low-income and upper-income households better off but raise net taxes on middle-income households. Adding payroll tax cuts to the mix would redistribute some of these benefits to the middle class.

Of course, offsetting tax reductions are not the only potential use for carbon tax revenue. Transitional assistance might be offered to communities and workers who would be particularly hard hit by a carbon tax, such as those involved in coal mining. Others have recommended using some of the revenue for environmental remediation, clean energy investments, or research on new energy technologies, while still others see a carbon tax as a way to reduce future deficits. Selecting among these options will be essential to building a political coalition for enacting a carbon tax and would play a primary role in determining the net benefits of such a policy.

IV. Conclusion

A carbon tax offers many potential advantages in combating climate change. But designing and administering a carbon tax that aligns incentives correctly will not be easy, and practical compromises will be necessary. Economists are advancing the policy discussion not merely by endorsing carbon taxes in the abstract, but also by offering insights about how policymakers can address those practical tradeoffs.

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