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What is the role of carbon taxes in climate change mitigation?

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This note argues that a carbon tax system is more practical to implement, monitor and enforce than tradable permit-based approaches to global climate-change action. It suggests that a sensible design would be an upstream carbon tax on the fossil fuel supply chain, which could also include other major non-CO_2 greenhouse gases (GHGs). While risks such as fiscal cushioning exist, a tax-based system would be more transparent and offer the appropriate incentives for participation and compliance.

"I prefer carbon and/or gasoline tax measures to permit systems or heavy regulatory approaches because the latter are more likely to be economically inefficient and to be regressive." **—Lawrence Summers**, former U.S. Treasury Secretary, currently Professor at Harvard University

"Frankly, a Kyoto-type framework—one with global quantitative emissions targets allocated among countries […] is not feasible. The only approach that will fulfill the conditions and relieve countries' apprehensions regarding sovereignty and free riding is one in which all countries agree to penalize their carbon emissions in such a way that, over time, an internationally harmonized carbon price prevails. If you're worried about climate change but don't like carbon taxes, think about the messy or even impossible alternatives!" **—Ernesto Zedillo**, former president of Mexico, currently Director of the Center for the Study of Globalization at Yale University

The alternative instruments most favored by economists for controlling emissions of GHGs are CO_2 taxes and systems of tradable CO_2 permits. Most of the policy discussion has focused on cap-and-trade systems, given that this policy was embodied in the European Union's Emissions Trading Scheme (ETS), and it is also the centerpiece of most climate bills currently pending in the U.S. Congress.

However, there is a potentially strong case for carbon taxes, if revenues are used productively. Moreover, even if CO_2 taxes are not implemented in the near term, it is important to assess the possible case for transitioning to a tax-based system over the longer haul. Thus, it is important to understand how CO_2 taxes might be designed at a domestic and international level, and their advantages and disadvantages compared with permit-based approaches.

The choice among alternative control instruments for CO_2 emissions is inherently difficult as it involves multiple criteria of concern to policymakers. These criteria include economic efficiency—i.e., maximizing environmental benefits less mitigation costs—or more broadly, cost-effectiveness—that is, minimizing the costs of achieving near- and long-term goals for emissions reductions. Other criteria include minimizing the risks of excessive abatement, or of excessive emissions releases, in presence of uncertainty over abatement costs. A further criterion is that of incidence: the distribution of costs borne by different household income groups, and by industries, especially those with political clout.

The Discussion Paper accompanying this PREM Note discusses in detail how well carbon tax and cap-and-trade systems are likely to perform according to these criteria. One especially prominent result is that when

there is large uncertainty about the costs of emissions abatement, then carbon taxes could be significantly less costly that cap-and-trade systems. Nevertheless, whether or not there is a strong case for preferring taxes to cap-and-trade systems hinges critically on how those policies are actually designed. If cap-and-trade programs incorporate provisions to contain permit price volatility, and to transition to full allowance auctions as rapidly as politically feasible, with judicious use of the resulting government revenues, there would not be a strong case for overhauling such systems in favor of an emissions tax. However if, for whatever reasons, the only viable type of permit system is of the pure form, without these provisions, (revenue-neutral) CO_2 taxes seem a better alternative.

Domestic Carbon Taxes

Besides the basic choice between emissions taxes and cap-and-trade systems, and how government revenues might be used to meet a variety of competing criteria of concern to policymakers, there is wide range of further practical issues in the design of a domestic CO_2 mitigation policy. Most fundamental is the emissions price (or level of emissions control under a permit system), and how it should be adjusted over time. In addition, there are issues related to the point of regulation, what if anything can be done to deter emissions leakage through outsourcing, how to incorporate non-CO_2 greenhouse gases and downstream sequestration activities, and to what extent emissions control policies should be complemented with additional instruments to promote emissions-saving technologies.

At a domestic level, designing a CO_2 tax is fairly straightforward, especially if imposed upstream in the fossil fuel supply chain. In principle, the marginal costs of emissions reductions across all options will be equated when all firms and households face prices for fuels and energy-intensive products that reflect the costs of the embodied carbon, while receiving credits for any offsetting downstream sequestration activities. These cost-minimizing conditions could be largely achieved under a CO_2 tax applied upstream in the fossil fuel supply chain, with corresponding tax credits for sequestration. This tax, which would be levied in proportion to a fuel's carbon content, would be largely passed forward into the price of coal, natural gas, and petroleum products, and therefore ultimately embodied into the price of electricity and other energy-intensive products. Incorporating at least some non-CO_2 greenhouse gases into the tax system is quite feasible, as is providing incentives for downstream geological and biological CO_2 sequestration.

The most critical issue is deciding the tax level. Standard welfare-maximizing theory recommends that the appropriate CO_2 tax should reflect marginal damages, or the discounted value of worldwide damages from the future global warming caused by an additional ton of CO_2 emissions. These damages include, for example agricultural impacts, the costs of rising sea levels and increased storm intensity, health effects, ecological disruptions, the risks of major disruptions to world output from more extreme climate scenarios, and so on. Predicting and valuing these impacts is extremely difficult and controversial. Mainstream estimates, using market discount rates, put the damage per ton of carbon at around $30 or more—equivalently, upwards of $8 per ton of CO_2.

An alternative approach is to assess near-term emissions prices that are consistent with ultimately stabilizing expected global warming at "acceptable" levels. A (global) price of $10 per ton of CO_2 in the near term is broadly consistent with an emissions price path to ultimately limit expected warming to 3°C above current temperatures. But if the goal is to limit expected warming to 2°C, a much more aggressive policy is required, pricing near-term CO_2 emissions in the order of $25 to $70 per ton.

Choosing how to use carbon tax revenues is also critically important. There are potentially large gains in economic efficiency from using them to lower the rates of other distortionary taxes, like income taxes. And recycling can be tilted towards lower income groups to partly address the distributional consequences of higher energy taxes. Allowing some infra-marginal emissions to be exempt from the tax for a period may also help with political feasibility.

International Taxes

Reaching international agreement over a quantity-based approach to emissions control is potentially difficult and contentious. In a Kyoto-like system, countries have to agree on a set of national emissions targets. Initially, these targets can be set relative to actual emissions in a recent 'reference' year; this reference was chosen to be 1990 in the Kyoto Protocol. However, a problem is that, moving forward, baseline emissions—i.e., emissions that would have occurred in the absence of a CO_2 control policy—may grow at very different rates in different countries leading to difficulties in updating country emissions quotas over time.

In contrast, under a tax-based regime there is only variable to negotiate over—the tax rate on CO_2 that every country should impose, along with a rule for adjusting it over time. This avoids the haggling over country-level targets that is inherent in a Kyoto-style approach.

One concern about a system of international emissions taxes is that it could be undermined by 'fiscal cushioning,' that is, the reduction of other taxes borne by sources of greenhouse gas emissions to offset the burden of a CO_2 tax. For example, when Sweden introduced its CO_2 tax in 1991, it cut energy taxes by 50 percent. In some cases, offsetting reductions in other energy taxes are transparent (e.g., a reduction in gasoline tax), but not in others (e.g., complex tax loopholes for expensing of capital or technology investments). One possible response to this problem is to develop a broader measure of a country's CO_2, taking account of pre-existing energy taxes or subsidies. For example, the $0.40 per gallon tax on gasoline in the U.S. would amount to a pre-existing tax of $9 per ton of CO_2, given that a gallon of gasoline produces 0.009 tons of CO_2 and gasoline accounts for one-fifth of nationwide CO_2 emissions. Similarly, estimated revenues forgone to the government from the favorable tax treatment of energy industries could be expressed per ton of CO_2. In principle, all countries might be required to increase this broader CO_2 tax at the same rate over time. Therefore, any reductions in other energy taxes would need to be offset by a higher formal tax on CO_2.

The potential for rent extraction by the OPEC cartel is greater when facing a cap set by energy-importing countries than when facing an importer carbon tax. The cap could become an effective coordination mechanism. Relatedly, for a carbon tax, the upstream principle could be interpreted to suggest that the tax ought to be levied at the fossil fuel source—i.e., levied on oil producers. However, as with a VAT, exports could obtain credits for taxes paid and carbon taxes would be then levied on the carbon content of imports by the importing country.

An alternative approach would be to monitor each country's emissions, in addition to their formal CO_2 tax. Countries might be required to satisfy an, albeit relatively slack, target for emissions, which puts a floor under the emissions reductions. Exemptions to meeting the floor might be granted only in the event that a country can credibly demonstrate exceptional circumstances—e.g., unexpectedly rapid productivity growth.

International Climate Policy Architecture

Pursuing a purely efficient and cost-effective carbon tax policy may not necessarily be the most equitable approach to international climate policy. The extra stock of carbon in the atmosphere that may be responsible for anthropogenic climate change is the counterpart to past economic development activities of today's richer nations. In this context, imposing the same carbon tax rate on the consumption of energy in countries substantial differences in per capita incomes may be viewed as regressive and unfair.

The equitable approach to emission targets in the Kyoto Protocol suggests a fairly progressive assignment of stringency by incomes among industrialized countries. A carbon tax, by design, does not create endowments (like emission permits) that can be allocated to lower-income countries as a means of compensation. At the risk of undermining cost-effectiveness in the near term, a system of graduation could be employed in which only countries that have cleared a specified income threshold would be expected to implement a carbon tax.

Alternatively, direct side payments from wealthier nations to poorer ones could easily be made, based on an agreed formula that takes into account per capita income and historical emissions. This would help to build broader support for a carbon tax approach to international climate policy. Some funds could support technology transfer to developing countries or various adaptation efforts and promote better institutional capacity in developing countries to cope and adjust to changing climate and sea levels.

A carbon tax could provide for some appropriate incentives for participation and compliance. First, the cost of this policy instrument is much more transparent than a quantitative emission target. Second, the withdrawal of a country from a global harmonized carbon tax does not risk the contagion that could occur via international permit markets under a system of quantitative targets. Third, a domestic carbon tax policy might make it simpler to employ a border tax adjustment consistent with the World Trade Organization on imports from countries failing to impose carbon taxes than under a cap-and-trade based policy. Fourth, reliance on the revenue streams will promote the establishment of domestic constituencies in support of maintaining carbon taxes.

These issues suggest several policy elements necessary in implementing a global carbon tax. First, systematic and regular reviews of countries' carbon tax policies are necessary. These reviews would assess whether governments undertake explicit (by changing other tax laws) or implicit (by foregoing revenue collection) fiscal cushioning for various sources subject to the carbon tax policy. Second, a review of the aggregate effect of carbon tax policies can inform consideration of whether this approach adequately mitigates the risks posed by climate change. Such a review can guide negotiations about the level of carbon taxes. Third, these evaluations should determine whether the tax level is a sufficient measure of the comparability of effort across countries. Countries may implement complementary policies—such as fuel economy standards, renewable portfolio standards, biofuel mandates, etc.—that result in additional emissions abatement (and abatement costs) than under a tax-only approach. Such evaluations may also be valuable in cases when some countries only tax a subset of their greenhouse gas emission sources.

This brief draws from J. E. Aldy, E. Ley, and I. Parry, (2008), "A Tax-Based Approach to Slowing Global Climate Change," PREM Economics of Climate Change Discussion Papers.

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The PREM note series on the Economics of Climate Change is part of the effort conducted by the Poverty Reduction and Economic Management Vice Presidency of the World Bank to raise awareness on poverty, distributional, financial, fiscal, and trade related issues that tend to be underestimated in the more scientific and political debates surrounding Climate Change. The notes do not necessarily reflect the view of the World Bank, its board or its member countries. However, they do reflect the content of some of the internal debates among economists interacting traditionally on emerging or overlooked economic consequences of environmental policies.

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