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Carbon Taxation: Environmental Efficacy and Economic Impacts

Over the past few years, global warming has become an issue of significant public concern. Mounting evidence of the anthropogenic contribution to rising temperatures, as well as greater scientific understanding of the potentially disastrous consequences that climate change might bring, have led several countries to begin taking action to reduce their greenhouse-gas (GHG) emissions. One approach to this effort is the carbon tax—a tax on emissions of carbon dioxide and other GHGs. This paper explores the theoretical rationale behind carbon taxation and the economic advantages that it can have over other climate-change policies. In addition, it demonstrates that carbon taxes can effectively reduce GHG emissions, impart substantial ancillary benefits, and raise significant revenue, and that adverse impacts on GDP and the poor are relatively small.

The idea of a carbon tax arises from basic economic theory. Carbon dioxide, like all pollutants, is a "negative externality"—a cost imposed on society that is not borne directly by producers. Since firms do not include the externality in calculating their private costs of production, they produce beyond the socially optimal level of output. One way to address the problem is to "internalize the externality"—that is, to make producers pay the full social costs of production—so that output will fall back to a more socially favorable level. This can be accomplished by a "Pigovian" or "corrective" tax on producers. The idea is that since taxes inherently discourage something, society may as well design them in such a way that they discourage undesirable things (Summers 289).

Ideally, the amount of corrective tax should be equal to the magnitude of the negative externality; however, doing this is not so easy in practice, considering the enormous uncertainties involved in estimating the extent of global climate change and the individual contribution of a certain emission to it (Cuervo and Gandhi 17). Still, as Lawrence Summers points out:

> If someone weighs 300 pounds, it is really not very important for him to decide whether 220 or 180 would be an optimal weight. In just the same way, action with respect to carbon taxes should not await a fuller understanding of the "greenhouse effect," or a fuller calculation of its costs and benefits. (290)

Thus, despite continuing imprecision in calculations of the social costs of climate change, some countries have begun to impose modest carbon taxes. Finland, Denmark, the Netherlands, Norway, and Sweden introduced various taxes on energy and emissions in the early 1990s (Japan), and the United Kingdom and Switzerland have also taken steps in that direction (New Zealand, Implementing 9). In May 2005, New Zealand announced its intention to adopt the world's first true carbon tax by 2007, starting at NZ$15 (US$11) per emitted ton of carbon dioxide or its equivalent in other GHGs. In contrast to prior European taxes that did not apply to all fossil fuels, the New Zealand proposal would be truly based on total GHG contribution ("Kiwis"). However, New Zealand's government has recently announced that it will review the carbon-tax proposal before moving forward, meaning that the initiative may not go into effect after all ("Greenhouse").

According to economic theory, carbon taxation bestows several advantages over alternate methods of attenuating GHG emissions. For one thing, taxes on carbon are more direct and comprehensive than attempts to curb specific forms of energy use. To take an example, a tax on gasoline alone may simply encourage people to use more coal and natural gas, rather than to reduce their total energy consumption (Information). In contrast, a tax on all types of fossil fuels at once, weighted in proportion to their carbon content, would ensure that consumers cut back on consumption generally and shift towards those fuels that actually are most benign.

Secondly, carbon taxes guarantee static efficiency—cost minimization given current technology—because firms will reduce their carbon output up to the level at which marginal cost of abatement equals the tax rate. Firms that can reduce carbon emissions at lower cost will undertake more carbon abatement than those with higher cost (Cuervo and Gandhi 13). In contrast, a specified cap on emissions might force companies to reduce pollution beyond what is economically sensible, or alternatively, it could inhibit companies from taking easily achievable steps that go beyond what is required (Information). Further, taxation rates tend to be more flexible than regulatory standards, making them more appropriate for areas, such as carbon abatement, in which science changes constantly (Pearce 942).

In addition, carbon taxes are dynamically efficient, as they provide greater incentive for firms to invest in development of new carbon-abatement technologies (Cuervo and Gandhi 13). Research-and-development subsidies can serve the same purpose. However, one study indicates that such payments—while effective in advancing improved technologies—do little by themselves to tangibly reduce GHG emissions; only policies like carbon taxes that address environmental externalities succeed in bringing about substantial pollution attenuation (Popp 2).

Development and implementation of new technologies certainly helps the environment, but it may also benefit companies in the long run. One reason is that carbon-limitation policies are likely to grow increasingly rigorous in the coming years, so companies that have already invested in cleaner methods of production will have an easier time coping than those caught off guard (New Zealand, Implementing 5). This suggestion is bolstered by the so-called "Porter hypothesis"—based on Michael Porter's 1990 book, The Competitive Advantage of Nations—which argues that if environmental measures successfully spur innovation, companies that are forced to comply ultimately develop more efficient processes, giving them absolute competitive advantages in the long run (Baranzini, Goldemberg, and Speck 401-2, 412).

Carbon taxes may have several theoretical economic advantages, but how effective are they at actually cutting GHG emissions? Empirical studies and theoretical predictions show moderate to strong efficacy. The Norway Central Statistics Bureau has estimated that introduction of a carbon tax in 1991 caused a 3-4% drop in GHG emissions from fixed sources (e.g., factories) and nonfixed sources (e.g., vehicles) each year between 1991 and 1993 (Japan). In 1990, Sweden reformed its energy-taxation system and introduced a carbon tax (Johansson 3). According to a 1997 study by the Swedish Ministry of the Environment, these changes caused a 14% decline in carbon-dioxide emissions over what they would otherwise have been in 1995, and predicted that they would cause 18-23% reductions by 2000 (Johansson 7-8). The tax reforms also triggered a marked increase in demand for biomass fuels for the Swedish district heating systems (Johansson 1). Burtraw and Portney estimate that the US could cut its carbon-dioxide emissions 5% and nitrogen-oxide emissions 10% by 2014 if it enacted the following carbon tax: \$5 per metric ton of carbon equivalent (mtce) in 2006, \$10/mtce by 2008, and \$15/mtce by 2010 (20-21).

By cutting use of fossil fuels generally, carbon taxes have the incidental effect of decreasing the amount of sulfur dioxide, nitrogen oxide, and other deleterious pollutants in the atmosphere (Carbon), which in turn reduces health-care costs and acid rain. In addition, lowered automobile use means less traffic congestion and fewer accidents (Summers 291). These ancillary benefits of carbon taxation can be quite substantial (see Figure 1).

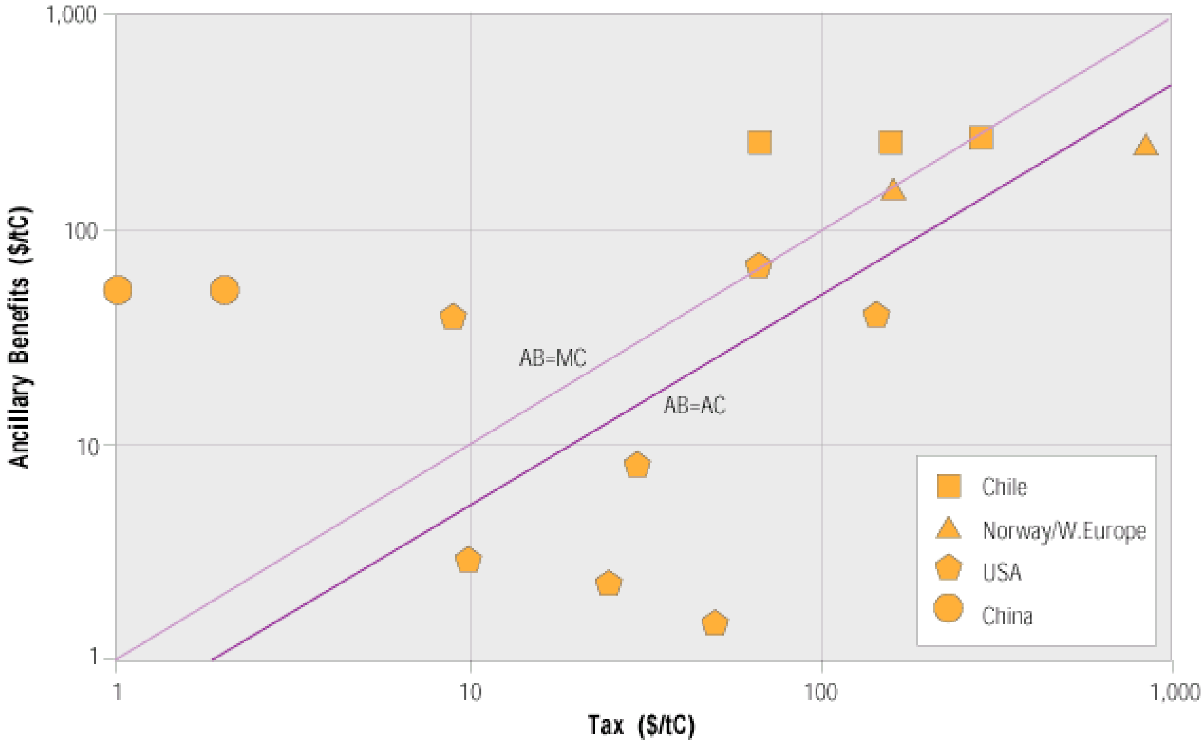

Figure 1. Ancillary benefits ($/ton of carbon) versus tax rates ($/ton of carbon) as measured by various studies in different countries, from Hourcade, Jean-Charles, et al., "Chapter 8: Global, Regional, and National Costs and Ancillary Benefits of Mitigation," Climate Change 2001: Mitigation, 2001, Intergovernmental Panel on Climate Change, 27 Nov. 2005 <http://www.grida.no/climate/ipcc_tar/wg3/pdf/8.pdf>, page 532.

The lighter diagonal line (AB = MC) represents the points at which marginal abatement costs (the tax rate) equal average ancillary benefits (which also equals marginal ancillary benefits if marginal ancillary benefits are roughly constant). The darker line (AB = AC) gives the points at which average abatement costs equal average ancillary benefits; studies located above this line found net benefits to a carbon tax when only the two given factors were considered. This graph does not show either long-range benefits of carbon abatement itself or social costs beyond private mitigation costs, such as deadweight loss to the economy (Hourcade, et al. 532).

In addition to attenuating pollution, carbon taxes can raise significant revenue. The proposed New Zealand tax would be expected to generate a net value of $322 million per year (New Zealand, Carbon). Burtraw and Portney predict that their suggested tax for the US—$5/mtce in 2006, with increases of $5/mtce every other year—would raise $26 billion (1% of federal tax revenue) in 2010; by 2020, the tax would reach $40/mtce and would yield $75 billion each year (21). If carbon taxes are applied in a revenue-neutral fashion, they make it possible to lower taxes on labor and capital, thereby actually reducing distortions in the economy (Information). Distortionary taxes that might be offset by carbon revenues include taxes related to consumption, labor, social security, and capital gains; the burden and amount of distortion of different taxes in different countries would have to be determined on a case-by-case basis (Cuervo and Gandhi 20).

Some predict that reducing distortionary taxes in this way would expand output and increase employment, thereby furnishing a "double dividend" consisting of both environmental and economic benefits (Baranzini, Goldemberg, and Speck 400). For instance, a 1997 study performed on behalf of the Minnesota state legislature predicted that the pollution tax then under consideration would bring up to 12,000 new jobs and expand the state's economic output by $350 million on account of reductions in other taxes that would become possible ("Carbon").

However, the double-dividend effect has not been verified consistently in the economic literature (Baranzini, Goldemberg, and Speck 401). Indeed, estimates of the impact of carbon taxes on GDP are typically negative, although not by very much. The government of New

Zealand, for example, projected that its carbon tax would lower GDP by about .03% in 2010 (New Zealand, Implementing 7). In 1999, the Energy Modeling Forum of Stanford University compiled a number of predictions by various modeling teams for the percentage by which the US GDP would decline by 2010 as a consequence of implementing a carbon tax sufficient to satisfy Kyoto-Treaty requirements. Expectations ranged between .42% and 1.96%, but these were probably high inasmuch as the models assumed lump-sum recycling of revenues, rather than systematic reduction of distortionary taxes (Hourcade, et al. 514).

Carbon taxes also give rise to a welfare concern: they are generally supposed to be regressive, because the poor tend to spend a larger portion of their income on energy than the wealthy (Information). However, this simple analysis ignores some important factors. First, it assumes that most of the increase in cost for households would take the form of higher energy prices, when in fact, carbon taxation would elevate the prices of all types of consumer goods (Summers 291). Second, if the demand curve for energy is not completely inelastic, some of the tax burden will be borne by the energy companies rather than end consumers (Cuervo and Gandhi 25). Third, low-income people may have the most to gain from the ancillary benefits of a carbon tax, forasmuch as they tend to live in more heavily polluted areas (Hourcade, et al. 522). Finally, the price increase resulting from a small carbon tax would be rather mild. The proposed New Zealand tax, for example, would be expected to raise energy prices by 6% for the average consumer, translating into a loss of around $4 a week for the average household (Fallow). A $25/mtce tax in the US would increase the price of gasoline by $0.06 per gallon, the price of electricity by $0.003 per kilowatt-hour, and the price of natural gas by $0.036 per million Btus used (Burtraw and Portney 21-22).

According to a review of economic literature by Hourcade, et al., carbon taxes have generally been found to be regressive—although study results ranged from strongly regressive to highly progressive under various circumstances. However, many studies concluded that this regressivity can largely be palliated by using some of the tax revenues to aid those most affected (521-22). In the US, this might take the form of expanding the Low Income Heating Assistance Program or increasing the Earned Income Tax Credit (Burtraw and Portney 21-22). In addition, the tax itself could be designed to include a floor for household energy use, below which no taxes would be paid. Such a system would allow people to maintain their most essential uses of energy without penalty, while simultaneously continuing to spur reductions in more wasteful forms of consumption. This approach is already employed in the Dutch tax system, which exempts entirely some low-energy-use consumers (Baranzini, Goldemberg, and Speck 405). In short, properly designed compensation measures can largely alleviate the adverse distributional impacts of a carbon tax.

The idea of taxing GHG emissions emerges from a very basic theoretical concept—internalizing externalities—yet it turns out to have some very successful real-world results. Compared with other measures to attenuate emissions, carbon taxes are often more systematic, flexible, and statically and dynamically efficient. Moreover, they have often proved highly effectual in reducing both GHG emissions and immediately detrimental air pollutants. Finally, they generate revenue that can be used to offset more distortionary taxes elsewhere in the economy. While carbon taxes do typically entail adverse macroeconomic and distributional impacts, these effects are relatively small and can be offset by appropriate compensatory measures. Thus, carbon taxation represents an effective and economically viable option for countries beginning to address the reality of global climate change.

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