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A growing international trend is for governments to shift the burden of taxation away from productive activities and onto pollutants. This trend is rooted in the recognition that taxes not only raise necessary revenue for governments, but also discourage the taxed activity. When levied on productive activities, taxes place an extra burden on the economy, whereas when levied on pollution, taxes help to control it. These principles are simple and powerful, but they come with a suite of ancillary issues, including concerns about fairness, economic efficiency, jobs, and disruption during the period of transition to the new taxes.

Recent proposals for tax reform in the United States have centered on the relative merits of taxes on labor, capital, wealth, and consumption. But all of these tax bases stem from generally constructive activities, which the proposed taxes penalize and discourage. For example, taxing labor income tends to discourage employment by making labor more expensive to employers and employment less profitable for workers.

At the same time, the United States faces costly problems of environmental pollution and natural resource depletion at local, national, and global scales. The methods of addressing these problems have often involved regulations that are sometimes inefficient, as well as direct government expenditures of tax dollars. The United States also faces the threat of losing jobs in traditional manufacturing sectors due to technological change and increasing international competition, especially from countries with low production costs. Many Americans have also experienced a trend of declining wages, and disparities in income between rich and poor have increased.

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Alternative taxes that shift the burden of taxation away from the useful products of the economy and onto undesirable byproducts have been proposed by numerous authors (Kaufmann 1991, Agostini et al. 1992, Repetto et al. 1992, Von Weizsacker and Jesinghaus 1992, Anderson 1993, Jorgenson and Wilcoxen 1993, Kohn 1993, Nordhaus 1993, Repetto et al. 1993, Oates 1994, Goulder 1995, Hammond et al. 1997, Repetto and Austin 1997). Such "ecological" tax reform has the potential to ease both the burden of taxation on parts of the economy and the burden of the economy on the environment. Given the potential benefits of such a tax shift, we believe that it deserves serious consideration as an alternative to the current tax structure.

In this article, we have incorporated input from a broad cross-section of interests to develop the general outline of a nearly revenue neutral ecological tax reform package that would shift some of the burden of taxation away from economic "goods" and onto economic and ecological "bads." Our intention is to stimulate further discussion and refinement of the ideas. The policy guidelines we outline are designed to serve multiple objectives, including reducing pollution, improving the cost-effectiveness of pollution control, creating jobs, boosting wages, and preserving or increasing the progressivity of the tax structure.

Historical perspective

The argument that polluters should pay for the damage they inflict dates back at least to the 1920 writings of the economist Arthur C. Pigou. Pigou argued that a pollution tax should be set such that an increment of pollution would incur a tax that is equal to the costs that the pollution imposes on others, including costs to health, property, and the environment (Pigou 1920). Requiring individual polluters to pay for the economic costs that their pollution imposes on society provides them with an appropriate incentive to reduce their own pollution. This incentive also allows polluters maximum flexibility in deciding how to control pollution; consequently, it is sometimes more cost-effective than some other pollution control policies.

Recent analyses have emphasized that pollution taxes can not only curb pollution, but also fund cuts in other levies, raising the prospect of benefits to both the economy and the environment. Recent work on the possibility of such a "double dividend" shows that the relationships between tax shifts and the performance of the economy are intricate; they are difficult to predict and are sensitive to the distortions of preexisting taxes. In particular, the potential effect on economic efficiency of a tax shift onto pollution is difficult to anticipate. A growing body of research indicates that the effect could range from a small net reduction in efficiency to a small net

increase, not counting the benefits of reduced pollution (Oates 1994, Bovenberg and Cnossen 1995, Felder and Schleiniger 1995, Goulder 1995, Schob 1996, Repetto and Austin 1997). Thus, the benefits of reduced pollution can be achieved with a small efficiency loss to the rest of the economy or, perhaps, an even efficiency gain.

Cutting taxes on wages increases real income and also tends to stimulate employment (Pearce and Turner 1990, Oates 1991, Gee 1994, Goulder 1995, Majocchi 1996). In western Europe, for example, where reducing unemployment is a top priority, lowering wage taxes would encourage the hiring of workers. In the United States, where unemployment rates are lower but wages are falling for many workers, tax cuts could be targeted at the first dollars of wage income. These tax cuts would help to reverse the trend of declining wages for a broad cross-section of wage earners, including the working poor.

Some ecological taxes have already been implemented, giving economists sufficient experience with these taxes to justify considering their more widespread use. For example, the Montreal Protocol of 1987 set production caps on ozone-depleting substances, which the Environmental Protection Agency (EPA) first attempted to enforce with a system of tradable permits. The US Congress subsequently passed into law a tax on chlorofluorcarbons (CFCs) and other ozone-depleting chemicals; this tax rises annually by $0.45 per pound of CFC equivalent. This 1989 law is an example of a tax that has both raised substantial revenue and effectively controlled pollution: It has raised several billion dollars in revenue while rapidly depressing the production of ozone-depleting chemicals and stimulating the production of more benign alternatives. Even with the regulatory caps in place, dramatic declines in CFC production in the United States coincided with the imposition of the tax, strongly suggesting that it was the tax—and not the regulatory cap—that spurred this dramatic decline. The tax has, moreover, curbed production of ozone-depleting chemicals at a pace that exceeds the more stringent 1990 Adjustments and Amendments to the Montreal Protocol. Instead of dictating a specific means of pollution control, the tax provides an incentive for industry to respond to market forces to control ozone-depleting chemicals in cost-effective ways (Hoerner 1995).

Several market-oriented approaches to pollution control have been adopted outside of the United States. These approaches, especially those used in northern Europe, reflect a growing trend to use taxes creatively as a tool to stimulate appropriate kinds of economic development. The Netherlands, for example, places a levy on industrial discharges into waterways according to biological oxygen demand and concentrations of heavy metals in the effluent. The levy was first developed to pay for water treatment, but it has also encouraged more than two-thirds of the affected industries to develop private treatment processes and dramatically reduce their effluents (Hotte et al. 1995). These new taxes are part of a trend throughout all of Scandinavia of increasing reliance on "green" taxes. Some of the new taxes have served not as supplements to preexisting taxes, but as partial replacements. In 1991, for example, Sweden moved US$2.4 billion, or 1.9%, of its total tax base onto sulfur dioxide and carbon dioxide emissions. The tax on sulfur dioxide had an immediate effect, with emissions falling 16% in the first year. In 1993 and 1995, Denmark enacted a suite of ecological taxes, including ones on carbon dioxide emissions, water use, pesticides, and batteries (Roodman 1997).

As another example of a market-oriented approach to pollution control, in 1993 Sweden placed a broad-based tax on net carbon dioxide emissions equivalent to approximately US$75 per ton of coal. The tax has since been raised, with certain reductions for industry. Because many factors contribute to carbon dioxide emissions, attributing the problem to any single factor is difficult. Energy taxes, especially those on motor fuel, have helped to stimulate energy efficiency and the development of other sources of fuels, and these taxes are, in part, responsible for 25 years of declining rates of carbon dioxide emissions in Sweden even though industrial output has grown (Olivecrona 1995). The efficiency improvements in Sweden and other countries with broad-based energy taxes strongly suggest that these taxes are more effective at curbing emissions than more narrow regulations on individual energy-consuming processes and products, such as those in the United States (Von Weizsacker and Jesinghaus 1992).

A proposal for ecological tax reform

The following general proposal for ecological tax reform draws on many current concepts. It addresses the objectives of economic performance, reduced pollution, and tax progressivity. This proposed ecological tax reform would help to move the economy toward natural resource efficiency, technological innovation, and new investment opportunities. The tax reform would also spur on and give direction to technological innovation, encouraging clean technologies. This stimulation would, in turn, create opportunities for export and help the work force to move into emerging industries. The ecological tax reform policy would contain provisions to ease the burden of transition on communities while maintaining near revenue neutrality. These proposed changes to the tax structure are designed to advance the protection of the environment while maintaining economic efficiency and maintaining or increasing the progressivity of the tax system.

Levy taxes on pollution (e.g., particulates, carbon dioxide, ozone precursors, and other noxious substances). Taxes on carbon dioxide and other pollutants of both air and water have been shown to be administratively workable and also effective at raising revenue and curbing pollution. As a supplement to some regulations and as an alternative to others, these taxes allow both industries and individuals a broad spectrum of options to control pollution in cost-effective ways.

Rebate this revenue to the taxpayers in a way that would maintain a progressive tax structure. For example, reduce payroll taxes on labor (both employee and employer contributions) by removing payroll taxes from the first dollars of wage income. Income taxes are progressive in that the average tax, as a percentage of income, rises as income rises. Consumption taxes tend to be more regressive than income taxes because the average tax

rate does not necessarily rise with increases in consumption. Taxes on pollution are a form of consumption tax and so tend to be more regressive than taxes on income. Taxes related to energy use are especially regressive because people with low incomes tend to spend disproportionately more of their income on energy than do people with higher incomes. A zero tax bracket on wage income could be structured to offset the regressivity of the pollution tax or even to enhance the overall progressivity of the tax system. Wage earners with low incomes would thus be protected as a class from a net increase in taxes. As with any tax shift, some individuals within each income class would fare better than others, but the overall effect would be to preserve or increase the progressivity of the tax structure. By easing the payroll tax burden from the first dollars of wage income, a broad class of wage earners would benefit from the increase in income, including those with low incomes.

Phase the tax shift in gradually and predictably over a number of years to help ensure an orderly, low-cost transition. An important concern of business and industry is to be able to anticipate and plan for investment. A second concern of the government is to maintain a reasonably stable and predictable stream of revenue from the new taxes. Because the tax base would shrink as less pollution is produced, the taxes could be adjusted upward or gradually broadened over time to make up for the lost tax revenue. A phase-in period announced well in advance would stimulate a smooth, more efficient response to the tax shift. A 10-year phase-in would take advantage of some normal capital replacement and reduce the transition cost. As examples, the US ozone-depleting chemicals tax, with its predictable annual rise, and the German tax on lead in gasoline, with its 10-year phase-in, have allowed industry time to plan accordingly (Schnutenhaus 1995).

As an initial step, part of the tax burden could steadily be shifted away from income and onto carbon dioxide. Although a 10-year phase-in period would allow business and industry to plan ahead, a review of economic models by the Stanford Energy Modeling Forum includes scenarios with a 50-year phase-in period. If the tax on carbon dioxide emissions were initially set at $22.50 per ton of carbon and raised to $250 per ton of carbon over a 50-year period, the equivalent tax on gasoline would rise from its initial $0.06 per gallon to $0.69 per gallon over that period. The models indicate that the tax would stabilize the carbon dioxide concentration in the atmosphere at approximately 65% above pre-industrial levels (John Weyant, Stanford University, manuscript in preparation). A revenue-neutral, phased approach to a carbon dioxide tax is increasingly popular among those advocating ecological tax reform (e.g., Bach et al. 1994, Hammond et al. 1997).

Figures from the Congressional Budget Office (CBO) put the magnitude of the tax in perspective. The CBO estimates that a US tax of $19.50 per ton of carbon would raise approximately $14.3 billion in 1998 (CBO 1997). Returned to 146.6 million workers through a reduction in their payroll tax, the rebate would average approximately $97.50 per worker (Social Security Administration, Washington, DC, manuscript in preparation). The carbon tax and corresponding reduction in payroll taxes could then be scaled up over time. If the tax were $50 per ton, the rebate would be approximately $250 per worker.

In addition to the potential carbon tax, CBO estimates of potential revenue from a suite of taxes on air pollutants and water pollutants total $47.4 billion in 1998. The potential taxes on water pollutants, which cover biological oxygen demand and five categories of toxic pollutants, would yield $1.4 billion in 1998. For air pollutants from stationary sources, CBO estimates that taxes of $300 per ton of sulfur dioxide, $3000 per ton of nitrogen oxides, $1900 per ton of particulate matter, and $4000 per ton of volatile organic compounds would raise $2.4 billion, $15.2 billion, $2.2 billion, and $26.2 billion, respectively, in the first year (CBO 1997).

Use a small fraction of the tax revenue to provide transitional assistance for communities, workers, and pollution-intensive industries that are strongly affected by the tax and to support the development of clean technologies. Even if the tax shift is phased in predictably over time, some workers would be displaced as industries shift to less polluting practices. Communities that have many jobs in polluting industries would be affected most strongly. This transitional assistance would provide job training and job placement, and it would facilitate the creation of new jobs in clean industries. It would also accelerate the transition to a cleaner economy.

Address the implications for international competitiveness of those industries that are most affected by the tax. Provisions could include international coordination, tariff adjustments at the border to compensate for the tax, resource efficiency investment credits, or other mechanisms. A tax shift in the United States would be in step with sentiment within the European Union and would follow a broader international trend toward the use of ecological taxes (Hoerner and Muller 1993). Any tax shift would have some effect on the international competitiveness of some industries. To address this effect, a compensatory import tariff could be levied on goods manufactured in countries with less stringent environmental policies. A compensatory tax rebate on exports would go further to ensure competitiveness, but it would undermine the effectiveness of the tax.

Conclusion

The strength of this proposal is the immutable logic of taxing what we would like to get rid of instead of taxing productive activities. Transitional costs and other concerns are a part of this intricate issue of shifting the burden of taxation. An important component of the proposal is its near revenue neutrality, which tends to reduce adverse effects on macroeconomic performance and to preserve tax progressivity.

The challenge of developing a workable tax reform package is one of finding common ground among disparate concerns. Our proposal reflects our concerns for the environment, jobs, income, productivity, and other dimensions of economic perfor-

mance. They also reflect a degree of compromise, which is necessary to find common ground on this intricate topic.

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