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ANALYSIS

Impact of cap-and-trade policies for reducing greenhouse gas emissions on U.S. households

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ABSTRACT

Proposals being considered by the U.S. Congress would establish a cap-and-trade system to cut greenhouse gas (GHG) emissions approximately 2% annually through 2050. Past cap-and-trade policies for other pollutants have distributed allowances free to the regulated companies, leaving consumers uncompensated for passed-through costs needed to achieve the required reductions. Social equity concerns were not a major issue because the total costs were relatively small. However, Americans currently spend about $1 trillion/year on energy, directly and indirectly via the goods and services they consume. If a cap on carbon emissions results in significant increases in energy prices, social equity concerns could quickly dominate the debate over climate policy. This paper confirms earlier studies that a traditional cap-and-trade policy is regressive and would cause the cost of reducing GHG emissions to fall disproportionately on low income households. This paper explores ways to ameliorate those effects, using highly disaggregated data available on consumer expenditures and energy-input–output analyses of the U.S. economy. Emissions are estimated based on direct and embodied energy use at the household level. Social equity concerns are taken into account and the consequences of cap-and-trade policies are assessed by quantifying the extent to which the expenditure patterns of the poor are significantly more energy intensive than those of the rich.

1. Introduction

Legislation pending before the U.S. Congress would establish a cap-and-trade system that would cut greenhouse gas emissions approximately 2% annually through 2050.[1] Even greater reductions may eventually be required by international treaties if the United States is to contribute its fair share of the 60–80% reductions needed globally to stabilize atmospheric concentrations of greenhouse gases (IPCC, 2007).

All cap-and-trade proposals have three elements: 1) the cap, or phase-out schedule; 2) tradable emission allowances to enable early implementation of the most cost-effective reductions; and 3) the formula for distributing the emission allowances. It is the latter feature that raises the most serious questions of equity and justice.

When greenhouse gas emissions are capped, the pollution allowances become scarce and therefore valuable. Tradable allowances assume a market value reflecting the marginal cost of compliance with the cap, whether they are distributed free or auctioned by the government. Distributing valuable allowances is equivalent to distributing the auction revenues. Thus a cap-and-trade system allows efficiency and equity issues to be handled separately, unlike other policy instruments (e.g. tax credits, grants, loan guarantees, regulations) in which they are inextricably linked. The underlying economic theory is described in general terms by Montgomery (1972) and Tietenburg (2003). Chameides and Oppenheimer (2007) point out that a properly implemented economy-wide cap on emissions and trading of emission allowances could have all the benefits of an equivalent carbon tax in addition to the distinct advantage of assuring that environmental goals would be achieved by a certain date.

The U.S. experience in implementing such programs is summarized and critically examined by Ellerman et al. (2003). Allowances have typically been distributed free to existing polluters to secure their support for legislation to phase out the emissions. When the magnitude of the greenhouse gas problem became apparent around 1990, suggesting that the value of emissions allowances (or auction revenues) could amount to several hundred billion dollars annually, attention shifted to the political economy of various distribution schemes (e.g. Stavins and Hahn, 1991). These early studies focused on the economic efficiency impacts of various schemes for distributing allowances or auction revenues. Intertemporal general equilibrium models were disaggregated on the producer and consumer sides to deal more explicitly with substitution possibilities (particularly within the fossil fuel and utility sectors), the existence of a backstop technology, foreign trade, and interactions with pre-existing taxes.

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[1] HR 5049; HR 5642; S 280; S 309; S 2191; S.3036 Congressional Record, 110th Congress, Washington DC 2007.

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This more detailed (13-sector) interindustry framework enabled evaluation of the extent to which recycling carbon tax or auction revenues could minimize welfare loss by reducing distortionary effects of existing taxes (Goulder, 1995; Bovenberg and Goulder, 1996). Parry et al. (1999) used a more aggregated static model to illustrate clearly how free distribution of tradable permits could cause far greater welfare losses than the alternative of capturing the rents and recycling revenues to reduce marginal tax rates.

Around the same time, attention turned to ways of dealing with the inherently regressive nature of carbon taxes. Metcalf (1999) used consumer expenditure data with results from a 40-sector input–output model to estimate initial impacts of pollution taxes on consumer prices. The additional disaggregation was needed to distinguish among carbon intensities of expenditure patterns of high- and low-income households. The results illustrated how the regressive impacts on household income distribution could be neutralized by rebating tax revenues (levied on carbon and other pollutants) through income and payroll tax reforms. The inherent limitations of this methodology are well-known — insights into distributional impacts are obtained by neglecting the general equilibrium effects cited above. Tax incidence is estimated with a static model by assuming that the entire tax is passed forward to final consumers, with price increases that reflect pre-tax production technologies and consumer expenditure patterns. However it provided a useful point of departure for subsequent investigations of distributional impacts of carbon taxes and allowance allocation schemes.

The two approaches began to merge as Dinan and Rogers (2002), working at the same 40-sector level of detail, estimated impacts on household income distribution resulting from carbon quotas and taxes with several revenue recycling scenarios. Their analysis employed a partial equilibrium approach to estimate aggregate deadweight loss due to lower fossil fuel use, and included tax interaction results from the general equilibrium analysis of Parry et al. (1999).

Recently a much more ambitious and comprehensive MIT study addressed the 50–80% emission reductions required by pending legislation in a dynamic general equilibrium framework (Paltsev et al. 2007). Like the earlier studies it was focused on economic efficiency, estimating welfare losses to the U.S. economy at <2% in 2050 while accounting for both the cost of abatement and general equilibrium effects, including those stemming from interactions with climate policies abroad. Annual auction revenues up to $500 billion were estimated under some scenarios.[2] These results were enabled by further disaggregation within the fossil fuel and utility industries to 15 sectors, and expanding the number of factors by adding 8 energy-related natural resources to capital and labor. It was not designed to evaluate distributional impacts; like Goulder's model it aggregates the non-energy industries into 6 sectors; and it lacks Goulder's analysis of 17 categories of consumer goods to simulate household consumption and savings decisions over time. However a subsequent analysis by Metcalf (2007) used the post-policy allowance prices and auction revenues to incorporate results from the MIT general equilibrium model, then estimated the near-term household-level welfare impacts by combining input–output model results with consumer expenditure data and assuming that the tax is passed fully forward to consumers. While this approach does not capture the full range of consumer substitution response, its first approximation of welfare impacts on households illustrated how a rebate scheme could be designed to have a near-neutral effect on income distribution.[3]

This paper employs a similar approach to estimating household-level impacts, but differs in several important respects. It uses the most detailed data available to differentiate among expenditure patterns of high- and low-income households, and their associated carbon intensities, based on a 491-sector input–output model and about 600 categories of consumer expenditures. This highly disaggregated set of interindustry transactions reveals a far richer spectrum of carbon intensities for goods and services than those calculated from more aggregated transactions data.[4] Moreover the carbon intensities are calculated for 11 primary and secondary energy products — allowing for more accurate estimates of indirect carbon emissions for non-energy goods and services.

The methodology detailed in Section 2 also uses a different way of estimating carbon emissions resulting from investments made by households, and focuses explicitly on questions of equity and fairness raised in the current policy debate.

Section 3 quantifies household-level distributional impacts of two cases in which government is assumed to capture the allowance rents by auctioning 100% of the allowances, and distributing them on a per-household or per-capita basis. The argument for distributing equally among households or individuals is based on the idea that a clean and stable atmosphere is a fundamental human right; if every person or household is entitled to an equal share, the scarce and valuable emission allowances (or auction revenues) should be allocated equally among all citizens.[5] Its legal underpinning is stated by Barnes and Pomerance (2000): "The public trust doctrine holds that the people's property (for which the state is trustee) can't be given away without fair compensation." They liken the traditional approach of giving the allowances free to existing polluters to giving away the airwaves to private broadcasters or selling timber from national forests at below market rates. Reich (2007) makes a similar argument for per-capita distribution, analogous to the Alaska Permanent Fund's distribution of oil royalties to citizens. Section 4 summarizes the conclusions and recommendations.

The impacts on household income distribution calculated in this manner provide a useful starting point for subsequent economic analyses of consumer response, not only to changes in relative prices but also to income transfers. And the extensive demographic data available for each household in the sample could facilitate exploration of other potentially important relationships (e.g. between population and per capita income) affecting greenhouse gas emissions, for example in considering impacts of per capita vs. per household rebates. At the international level where impacts of carbon allowance allocation schemes can be even more regressive and closely related to demographic transition patterns, O'Neill et al. (2004) emphasize how the burden on developing countries can be reduced by coordinating economic policy with population policy.

2. Method

This analysis estimates total energy-related carbon emissions[6] of U.S. households for 2003 by multiplying household expenditures in dollars by appropriate carbon intensities in pounds (lbs) per dollar. It builds on the work by Shammin et al. (2007), Shammin (2006), Herendeen et al. (1981) and others to track direct and indirect energy expenditures at the household level, and to quantify the extent to which the expenditure patterns of the poor are significantly more energy intensive than those of the rich. Other greenhouse gas emissions, which account for about

[2] Sensitivity analyses explored the effects of several variations on policy design, including sectoral coverage, banking and borrowing, and international trade restrictions among the 16 regions. As in the case of any simulation spanning four decades, the quantitative results rest on highly uncertain assumptions about technology, price and income elasticities, etc.

[3] Hassett et al. (2009) showed that analyzing impacts on annual income overstates the magnitude of regressive impact, suggesting that Metcalf's proposed tax reform may actually be progressive if evaluated within a lifetime income framework.

[4] As the non-energy sectors input output models are aggregated, their carbon intensities converge towards an "average" value, exacerbating the difficulty of distinguishing carbon intensities of different expenditure patterns.

[5] If allowances rather than auction revenues were distributed directly to households, producers and importers of coal and other fossil fuels would have to buy them from individuals who would cash them in at banks or other institutions.

[6] To facilitate compliance monitoring, carbon allowances can be most efficiently auctioned to the fossil fuel extraction industries. The analysis presented here assumes that all carbon will eventually enter the atmosphere as carbon dioxide emissions. Sequestration credits would be handled separately.