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Distributional impacts of carbon pricing: A general equilibrium approach with micro-data for households

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ABSTRACT

Many policies to limit greenhouse gas emissions have at their core efforts to put a price on carbon emissions. Carbon pricing impacts households both by raising the cost of carbon intensive products and by changing factor prices. A complete analysis requires taking both effects into account. The impact of carbon pricing is determined by heterogeneity in household spending patterns across income groups as well as heterogeneity in factor income patterns across income groups. It is also affected by precise formulation of the policy (how is the revenue from carbon pricing distributed) as well as the treatment of other government policies (e.g. the treatment of transfer payments). What is often neglected in analyses of policy is the heterogeneity of impacts across households even within income or regional groups. In this paper, we incorporate 15,588 households from the U.S. Consumer and Expenditure Survey data as individual agents in a comparative-static general equilibrium framework. These households are represented within the MIT USREP model, a detailed general equilibrium model of the U.S. economy. In particular, we categorize households by full household income (factor income as well as transfer income) and apply various measures of lifetime income to distinguish households that are temporarily low-income (e.g., retired households drawing down their financial assets) from permanently low-income households. We also provide detailed within-group distributional measures of burden impacts from various policy scenarios.

1. Introduction

Carbon pricing, whether through a cap and trade system or a tax, can have widely varying distributional impacts. Variation in impacts arises for three reasons. First, households differ in how they spend their income. Carbon pricing will raise the price of carbon intensive commodities and disproportionately impact those households who spend larger than average shares of their income on these commodities. In a general equilibrium setting, carbon pricing also impacts factor prices. Households which rely heavily on income from factors whose factor prices fall relative to other factor prices will be adversely impacted. In the public finance literature on tax incidence, the first impact is referred to as a *uses of income* impact while the latter a *sources of income* impact (see, for example, Atkinson and Stiglitz, 1980, for a discussion of incidence impacts). Third, regional differences in the composition of energy sources affect the carbon content of various commodities, most notably electricity.

In previous work, we have used a new general equilibrium simulation model of the U.S. economy (the MIT USREP model) to explore distributional implications of various ways of distributing allowances from a cap and trade system (Rausch et al., 2010b) and alternative schemes for returning revenues from an auctioned cap and trade system or equivalently a carbon tax (Rausch et al., 2010a). This paper is similar in spirit to Rausch et al. (2010a) but employs a variant of the USREP model that endogenously incorporates 15,588 households as individual agents within a general equilibrium framework. This allows us to explore distributional impacts of carbon policy over a number of new dimensions that previously have not been explored.

We find the following. First, the use of revenues that can be raised through carbon pricing affects both the efficiency and equity of the policy. Analyses that focus solely on the impacts of carbon pricing without considering the use of revenues can lead to seriously misleading results. Second, the use of a model with a large number of households allows us to consider distributional impacts over different sub-populations. It also drives home the point that variation in impacts from a carbon pricing policy within sub-groups may swamp the variation across groups. Third, we provide two measures that proxy for lifetime income and find little evidence that the use of annual income biases carbon pricing towards greater regressivity. Finally we find interesting variation across racial and ethnic groups that have not been addressed in the literature to date.

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We turn next to some background on the measurement of the burden of carbon pricing. Section three describes the model and the following section presents results. We conclude in Section 5.

2. Background

Carbon pricing through a cap-and-trade system has very similar impacts to broad based energy taxes – not surprising since over 80% of greenhouse gas emissions are associated with the combustion of fossil fuels (U.S. Environmental Protection Agency, 2009).The literature on distributional implications across income groups of energy taxes is a long and extensive one and some general conclusions have been reached that help inform the distributional analysis of carbon pricing. First, analyses that rank households by their annual income find that excise taxes in general tend to be regressive (e.g. Pechman, 1985, looking at excise taxes in general and Metcalf, 1999, looking specifically at a cluster of environmental taxes).

The difficulty with this ranking procedure is that many households in the lowest income groups are not poor in any traditional sense that should raise welfare concerns. This group includes households that are facing transitory negative income shocks or who are making human capital investments that will lead to higher incomes later in life (e.g. graduate students). It also includes many retired households which may have little current income but are able to draw on extensive savings.

That current income may not be a good measure of household well being has long been known and has led to a number of efforts to measure lifetime income. This leads to the second major finding in the literature. Consumption taxes – including taxes on energy – look considerably less regressive when lifetime income measures are used than when annual income measures are used. Studies include Davies et al. (1984), Poterba (1989, 1991), Bull et al. (1994), Lyon and Schwab (1995) and many others. Most of these studies look at a snapshot of taxes in one year relative to some proxy for lifetime income – often current consumption based on the permanent income hypothesis of Friedman (1957).

The lifetime income approach is an important caveat to distributional findings from annual incidence analyses but it relies on strong assumptions about household consumption decisions. In particular it assumes that households base current consumption decisions knowing their full stream of earnings over their lifetime. While it is reasonable to assume that households have some sense of future income, it may be implausible to assume they have complete knowledge or that they necessarily base spending decisions on income that may be received far in the future. We report results in this paper using both an annual income measure and a lifetime income measure.

Turning to climate policy in particular a number of papers have attempted to measure the distributional impacts of carbon pricing across household income groups. Dinan and Rogers (2002) build on Metcalf (1999) to consider how the distribution of allowances from a cap and trade program affects the distributional outcome. Both these papers emphasize that focusing on the distributional burden of carbon pricing (either a tax or auctioned permits) without regard to the use of the revenue raised (or potentially raised) from carbon pricing provides an incomplete distributional analysis. How the proceeds from carbon pricing are distributed have important impacts on the ultimate distributional outcome.

The point that use of carbon revenues matters for distribution is the basis for the distributional and revenue neutral proposal in Metcalf (2007) for a carbon tax swap. It is also the focus of the analysis in Burtraw et al. (2009b). This latter paper considers five different uses of revenue from a cap and trade auction focusing on income distribution as well as regional distribution. A similar focus on income and regional distribution is in Hassett et al. (2009). This last paper does not consider the use of revenue but does compare both annual and lifetime income measures as well as a regional analysis using annual income. Grainger and Kolstad (2009) do a similar analysis as that of Hassett et al. (2009) and note that the use of household equivalence scales can exacerbate the regressivity of carbon pricing. Finally Burtraw et al. (2009a) consider the distributional impacts in an expenditure side analysis where they focus on the allocation of permits to local distribution companies (LDCs). Rausch et al. (2010b) also investigate the welfare costs of allocations toLDCs and find that allocations that lead to real or perceived reductions in electricity prices by consumers have large efficiency costs.

With the exception of the last paper, all of the papers above assume that the burden of carbon pricing is shifted forward to consumers in the form of higher energy prices and higher prices of energy-intensive consumption goods and services. That carbon pricing is passed forward to consumers follows from the analysis of a number of computable general equilibrium (CGE) models. Bovenberg and Goulder (2001), for example, find that coal prices rise by over 90% of a $25 per ton carbon tax in the short and long run (Table 2.4). This incidence result underlies their finding that only a small percentage of permits need be freely allocated to energy intensive industries to compensate shareholders for any windfall losses from a cap and trade program. See also Bovenberg et al. (2005) for more on this issue.

Metcalf et al. (2008) consider the degree of forward shifting, as a result of higher consumer prices and backward shifting, as a result of lower factor returns, over different time periods for a carbon tax policy begun in 2012 and slowly ramped up through 2050. The tax on carbon emissions from coal are largely passed forward to consumers in all years of the policy in roughly the same magnitude found by Bovenberg and Goulder (2001). Roughly 10% of the burden of carbon pricing on crude oil is shifted back to oil producers initially with the share rising to roughly one-fourth by 2050 as consumers are able to find substitutes for oil in the longer run. Interestingly the consumer burden of the carbon tax on natural gas exceeds the tax. This reflects the sharp rise in demand for natural gas as an initial response to carbon pricing is to substitute gas for coal in electricity generation. By 2050 the producer price is falling for reasonably stringent carbon policies.[1]

Fullerton and Heutel (2007) construct an analytic general equilibrium model to identify the various key parameters and relationships that determine the ultimate burden of a tax on a pollutant. While the model is not sufficiently detailed to provide a realistic assessment of climate change impacts on the U.S. economy it illustrates critical parameters and relationships that drive burden results. The general equilibrium models discussed above all assume a representative agent in the U.S. thereby limiting their usefulness to considering distributional questions. Metcalf et al. (2008) apply results from a representative agent model to data on U.S. households that allows them to draw conclusions about distributional impacts of policies but the household heterogeneity is not built into the model.

Rausch et al. (2010b) does an explicit CGE analysis of carbon pricing in a single-period CGE model. That analysis considers a variety of possible allocations of the revenue and/or allowances from cap-and-trade system and finds that the use of revenues affects the overall progressivity of the policy substantially. It also finds that a significant portion of the carbon price is passed back to factors of production – most notably owners of natural resources and capital. This contributes to a greater progressivity of carbon pricing than found in literature that assumes full forward shifting. This paper builds on that earlier analysis but with considerably more households.

[1] Any shift from coal or oil to natural gas in the near term would blunt the sources-side impacts to the extent that capital returns in the gas industry rise. This gives rise to capital inflows to equilibrate capital returns across sectors.