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Can carbon taxes be progressive?☆

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ABSTRACT

Most studies have assessed the distributional impact of carbon taxes through their effects on commodity prices alone, while ignoring their impact on individual welfare brought about by changes in factor prices. Yet, the remunerations of capital and labor are not affected by these taxes similarly, and their shares in earned incomes are not uniform across households. This paper provides a comprehensive analysis of the incidence of carbon taxes on inequality by considering simultaneously the commodity and the income channels. We propose a decomposition of the change in individual welfare metrics. Then, we develop a general equilibrium model to assess the impact of carbon taxes on factor and commodity prices, and subsequently their distributional impact on households, using the Lorenz and concentration curves and the Gini index. Our results suggest that changes in factor prices and changes in commodity prices (especially those of energy commodities) have opposing effects on inequality. Carbon taxes tend to reduce inequality through the changes in factor prices and tend to increase inequality through the changes in commodity prices. Hence, we find a non-monotonic (U-shaped) relationship between carbon taxes and inequality. Our results suggest that the traditional approach of assessing the impact of carbon taxes on inequality through changes in commodity prices alone may be misleading. The findings cast light on the desirability of using both channels in the assessment of carbon taxes on inequality.

1. Introduction

In this paper, we provide a new assessment of the impact of carbon taxes on inequality. It is generally perceived that the imposition of carbon taxes may not proportionally affect the metrics of individual household welfare. Asking whether a carbon tax is progressive can be seen as a provocative questioning. The reality is that the impact of a carbon tax on households (progressive or regressive) is still questionable in light of the differences in its incidence on inequality, particularly when assessed from both the income and commodity sides of household welfare metrics.

Indeed, most studies have relied on the commodity channel in their assessments of the impact of carbon taxes on household welfare by examining their effects on relative prices of commodities. These studies generally point to the finding that carbon taxes are regressive. The main reason is that the increase in the prices of energy and energy-intensive goods, brought about by the imposition of carbon taxes, hurts the poor more than the rich, as the former spend a larger proportion of their income on those goods than the latter do. For example, Robinson (1985) finds that the incidence of an industrial pollution abatement tax is heavily regressive.[1] Similarly, Hamilton and Cameron (1994) analyze the distributional effects of a carbon tax on Canadian households and find that the consequences of the tax are regressive. Wier et al. (2005) and Dinan and Rogers (2002) find similar results for Denmark and the Netherlands, respectively. Kerkhof et al. (2008) and Shammin and Bullard (2009) further confirm these results for the U.S. economy. All these studies have ignored the impact of carbon taxes on factor incomes, and ultimately on inequality. As long as a carbon tax policy generates differentiated impacts on factor remunerations, the sources of income emerge as an important element in the assessments of carbon taxation and its effects on inequality. Taking into account the fact that the rich derive most of their income from capital, in comparison to the poor, an assessment of the impact of a carbon tax policy on inequality has the potential to provide completely new insights.

Within a general equilibrium setting, Fullerton and Heutel (2007) have shown that pollution control policies can harm the remuneration of capital more than that of labor. The main reason is that the polluting industries are relatively more capital intensive than other industries (see Hettige et al., 1992). Implementing policies that negatively affect the polluting industries will be detrimental to the factor they use most

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[1] See also Dubin and Henson (1988).

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intensively. Under these circumstances, and looking from the factor income perspective alone, implementing a pollution control policy could be progressive, as the incomes of the affluent households will be more negatively affected than those of the poor. It is important to note that we are not referring to the impact of the policy on social welfare, but rather on inequality; here, we are interested in its distributional impact. Even in the event that a carbon control policy reduces the welfare of all households, it can still be progressive, if the rich are more adversely affected than the poor. Moreover, note that the progressiveness of a carbon tax policy, which we are referring to, does not stem from a revenue-recycling approach as argued by Burtraw et al. (2009) and Bento et al. (2009).

Unfortunately, most studies found in the literature on the incidence of pollution control policies on inequality have exclusively considered the commodity channel, i.e., the impact of the policies on the relative prices of commodities alone.[2] Yet, individual household welfare depends not only on commodity prices, but also on income. This suggests that most analyses of the impact of carbon taxes on inequality are incomplete as they overlook an important channel, i.e., the impact of carbon taxation on inequality through factor incomes.

Our objective in this paper is to offer a more comprehensive analysis of the distributional impact of carbon taxes by considering both the commodity and the income channels through which a pollution control policy might have an incidence on individual welfare, and hence on inequality. When viewed from this more holistic perspective, there is no definitive answer as to the exact impact of pollution control policies on inequality. This is attributed to the presence of two opposing effects: a regressive impact via the commodity channel and a progressive impact via the income channel. The final impact is an empirical matter that deserves to be investigated.

In this study, we assess the possibility of a carbon tax being progressive, i.e., whether there exists some value of a carbon tax, where its positive impact on inequality through income outweighs its negative impact induced by commodity prices. We are not aware of any other paper that offers an analysis of the incidence of carbon taxes on inequality, while disentangling their differing effects channels on the relative prices of commodities and factor remuneration. To do so, we combine general equilibrium analysis with income distribution analysis.[3] Central to our analysis is the decomposition of welfare metrics into different components, which include initial total expenditures, the contribution of the changes in commodity prices, and the contribution of the changes in factor prices. For this purpose, we choose equivalent income as the main household welfare metric and assess the contributions of the last two components to the change in inequality.

More specifically, we examine the incidence of a carbon tax policy on income distribution by component as well as their contribution to changes in total inequality. To measure the effects of a carbon tax on income distribution we follow Kakwani (1977a, 1977b), who suggests that the incidence of a pollution tax through a component can be derived by comparing the Lorenz curve of initial equivalent income and the concentration curve of each component.[4] To measure the change in post-reform[5] income inequality by components, we apply the concentration indices approach. For this purpose, we first develop a static, multisector computable general equilibrium (CGE) model of the Canadian economy and run several simulations with different values of the carbon tax. The remainder of the paper proceeds as follows. The next section provides some theoretical background on the impact of carbon taxes on relative factor prices and on their incidence on inequality. We present the CGE model in the third section and discuss the results in the following section. The last section concludes.

2. Theoretical background

In this section, we present a theoretical framework to assess the impact of a pollution tax on the relative price of capital and labor. For this purpose, we introduce a very simple model that provides a good understanding of the impact of pollution taxes on factor prices. The model will later help in building intuition of the distributional impact of carbon taxes on household welfare. As argued before, a general equilibrium setting is the most appropriate framework for capturing the impact of a pollution tax on factor prices. The minimal representation of the economic environment required for this purpose consists of two firms, two production factors, and one household. The rationale for the sufficiency of one representative household at this stage rests on our assumption that households have Gorman preferences, whereby, without any loss of generality, a representative consumer's preferences can be used to compute total household demand.

In what follows, we consider a closed economy that consists of two firms, one representative household, and the government, which has a very basic role. All agents operate in a competitive environment. Each firm, operating with the same constant-returns-to-scale technology, produces a single good indexed by $i = (1$, the clean good, and, 2, the dirty good$)$ by combining capital and labor. For the moment, we abstract from the use of intermediate inputs in production activities.[6] Capital and labor are owned by the representative household and are supplied in fixed quantities. The representative consumer has homothetic preferences over the two goods and derives income from the ownership of primary factors and from tax revenue. Pollution is assumed to stem from the use of the dirty good by the representative household according to a fixed proportion rule.[7] The government's objective is to reduce pollution by imposing a tax on the use of the dirty good. For the sake of simplicity, we assume that the pollution tax is an ad valorem tax, t, which is imposed on the value of the dirty good. Alternatively, the pollution tax can be represented by the gross tax, $\tau = (1 + t)$.

To achieve our objective, we will first characterize the consumer's and firms' behavior and then assess in a general equilibrium setting the impacts of the pollution tax on the relative producer prices of the two goods and the relative factor price. As in most general equilibrium models, we are interested in the changes in relative prices; hence, our discussions below will mostly focus on the price and volume ratios, instead of their levels.

2.1. The consumer and the producer problems

We assume that consumer preferences can be represented by a well-behaved twice-continuously differentiable and homothetic utility function. Let X_1 and X_2 represent the consumer demand for goods 1 and good 2, and P_1 and P_2, be, their associated producer prices. Due to the presence of the tax on the dirty good, its producer price is different

[2] One notable exception to this is the recent paper by Araar et al. (2011) that analyzes the incidence of carbon mitigation policies on social welfare.

[3] A recent U.S. study by Metcalf et al. (2010) raises the issue of considering the income side in the analysis of the incidence of climate change policies. Nevertheless, their analytical framework is completely different from the one we suggest in this paper. They analyze the effects of different emissions and revenue allocating approaches on household welfare in terms of equivalent variation. In contrast, we consider equivalent income as the household welfare metric and stress the importance of the distributional impact by analyzing inequality through a decomposition method of those elements considered important in income and spending decisions of households.

[4] See also Blaylock and Smallwood (1982).

[5] Throughout this paper we interchangeably use the words *post-policy* and *post-reform*.

[6] We relax that assumption in a broader computable version of the model.

[7] This is a reasonable assumption, as there are no intermediate inputs used by firms.