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How to make a carbon tax reform progressive: The role of subsistence consumption

David Klenert [a,b,c,*], Linus Mattauch [a,b]

[a] *Mercator Research Institute on Global Commons and Climate Change (MCC), Germany*

[b] *Technical University of Berlin, Germany*

[c] *Potsdam Institute for Climate Impact Research (PIK), Germany*

HIGHLIGHTS

- Poor households spend a larger share of their income on carbon intensive goods.
- Therefore carbon taxation is often considered regressive.
- We use a small analytical model in which we analyze this hypothesis.
- We compare the distributional impacts of 3 distinct designs of a carbon tax reform.
- A carbon tax reform can be both re- or progressive, depending on its design.

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ABSTRACT

This letter analyzes the distributional effects of a carbon tax reform when households must consume carbon-intensive goods above a subsistence level. The reform is progressive if revenues are recycled as uniform lump-sum transfers, in other cases it is regressive.

1. Introduction

Mitigating climate change requires substantial reductions in carbon emissions, which can be achieved most cost-effectively by carbon pricing (Tietenberg, 1990). An important obstacle to introducing carbon pricing are distributional concerns: Pricing emissions in developed countries is often believed to harm the poorest part of the population due to the higher share of their income these households spend on carbon-intensive goods (Grainger and Kolstad, 2010; Fullerton, 2011; Combet et al., 2010).

Grainger and Kolstad (2010) show, for the case of the US, that there is a subsistence level for most carbon-intensive goods and that a price increase in these goods is the main driver behind the regressivity of carbon taxes. This mechanism, has received scarce attention in the theoretical literature on the distributional implications of carbon tax reforms.

Analyzing the distributional effects of a carbon tax reform while accounting for a subsistence level of carbon-intensive goods is the

* Correspondence to: Mercator Research Institute on Global Commons and Climate Change (MCC), Torgauer Str. 12-15, D-10829 Berlin, Germany. Tel.: +49 0 30 3385 537 253.

E-mail addresses: klenert@mcc-berlin.net (D. Klenert), mattauch@mcc-berlin.net (L. Mattauch).

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purpose of the present note. We use a stylized analytical model that features two consumption goods, one of which is assumed to be carbon-intensive. Households differ only in their productivity and must consume a minimal amount of the carbon-intensive good to survive. We are only concerned with the short-term distributional effects of a carbon tax reform, i.e. how setting a price on carbon impacts inequality,[1] which we believe to be decisive for political decision making.

We find three main results. First, when the tax revenue is returned to the households via linear income tax cuts, or in proportion to their productivity, the overall effect of the tax reform is regressive. Second, for the case of uniform lump-sum recycling, the overall effect of the tax reform is progressive. Finally, we show that when setting the subsistence level of carbon-intensive consumption to zero, regressive policies appear to be distribution-neutral.

Previous literature either relies on large numerical models (Rausch et al., 2010, 2011) or on rather specific modeling assumptions (Fullerton and Monti, 2013; Chiroleu-Assouline and Fodha, 2014).[2] In fact, there seems to be some disagreement in the theoretical literature on the extent to which the regressivity of a carbon tax can be reduced by the recycling of its revenues: Fullerton and Monti (2013) show that in a model with household heterogeneity in skills, "returning all of the revenue to low-skilled workers is still not enough to offset higher product prices" (p. 539). On the other hand, Chiroleu-Assouline and Fodha (2014) demonstrate that an environmental tax can always be designed to be Pareto-improving if the revenue is used for a progressive reform of the wage tax. They use a model in which pollution is a by-product of capital and hence interpret a capital tax as an environmental tax. Households differ in skill level and age. Both studies mention a subsistence level of polluting consumption as at least partially responsible for the regressivity of a carbon tax, but refrain from modeling it by means of non-homothetic preferences.

A large body of literature confirms that low-income households spend a higher percentage of their income on carbon-intensive goods than high-income households, notably on heating, electricity and food (see e.g. Grainger and Kolstad, 2010; Flues and Thomas, 2015 and Wier et al., 2001).[3] In the following we analyze the distributional impacts of a carbon tax reform when this mechanism is modeled explicitly.

2. The model

We use a two-sector model in which N households are distinguished by their productivity. Households need to consume a minimum amount of the polluting good. Since we only consider the short term (i.e. structural change is negligible), we use a static model. Furthermore we assume that commodity prices are fixed. Sources-side effects, which are likely to be progressive (Dissou and Siddiqui, 2014), are hence ignored and all the tax burden is assumed to rest on the consumers.[4]

Households: The households are distinguished only by their productivity ϕ_i, $i = 1 \dots N$. Each household is endowed with one unit of a production factor. A share l_i of the production factor is used at home and can be interpreted as leisure. For the remaining share $(1 - l_i)$, the household receives a rental rate w, so the households' incomes I_i are given by

$$I_i = \phi_i w (1 - l_i)(1 - \tau_w^0 + \tau_w). \tag{1}$$

Here τ_w^0 denotes the income tax before the carbon tax reform and τ_w is a potential (linear) income tax reduction financed by carbon tax revenues. We normalize the household productivities so that $\sum_{i=1}^{N} \phi_i = 1$.

Households derive utility from the consumption of clean goods C_i, polluting goods D_i and leisure l_i. They have identical non-homothetic preferences (due to the minimum-consumption requirement D_0 for the polluting commodity) and maximize utility, given by

$$U(C_i, D_i, l_i) = C_i^{\alpha} (D_i - D_0)^{\beta} l_i^{\gamma}, \tag{2}$$

with $\alpha, \beta, \gamma > 0$. We assume that $\alpha + \beta + \gamma = 1$ to obtain more tractable formulas, but our findings also hold for $\alpha + \beta + \gamma \neq 1$. The utility function is not defined for $D_i < D_0$. The budget equation is given by

$$C_i \cdot p_C + D_i \cdot p_D \cdot (1 + \tau) = I_i + L_i, \tag{3}$$

with τ denoting a tax on the polluting commodity and L_i a lump-sum transfer. We assume constant commodity prices.

Maximizing utility (2) subject to the budget constraint (3) yields the first-order conditions of the households, which can be transformed to obtain explicit expressions for C_i, D_i and l_i:

$$C_i = \frac{\alpha}{p_C} \left(\phi_i w (1 - \tau_w^0 + \tau_w) + L_i - D_0 p_D (1 + \tau) \right), \tag{4}$$

$$D_i = \frac{\beta}{p_D (1 + \tau)} \left(\phi_i w (1 - \tau_w^0 + \tau_w) + L_i - D_0 p_D (1 + \tau) \right) + D_0, \tag{5}$$

$$l_i = \frac{\gamma}{\phi_i w (1 - \tau_w^0 + \tau_w)} \left(\phi_i w (1 - \tau_w^0 + \tau_w) + L_i - D_0 p_D (1 + \tau) \right). \tag{6}$$

Government: The (non-optimizing) government has a fixed spending requirement G, which is financed by the (pre-existing) income tax τ_w^0. Additional revenue from the carbon tax can either be returned to the households via lump-sum transfers L_i or via reductions in the income tax τ_w. The government's budget constraint thus reads:

$$G + \sum_{i=1}^{N} L_i + \sum_{i=1}^{N} \phi_i w (1 - l_i) \tau_w = \tau \cdot D \cdot p_D + \sum_{i=1}^{N} \phi_i w (1 - l_i) \tau_w^0. \tag{7}$$

3. Results

We analyze the distributional implications of three carbon tax reforms. Each reform consists of introducing a carbon tax combined with a revenue recycling-scheme. We consider recycling through
(i) lump-sum transfers in proportion to household productivities,
(ii) linear income tax reductions and (iii) uniform lump-sum transfers.

We show in Proposition 1 that in the first and second case, inequality increases. In the third case, inequality is reduced (Proposition 2). Finally, we demonstrate in Proposition 3 that recycling the revenues as in the first and second case is distribution-neutral when the subsistence level of polluting consumption equals zero.

[1] This permits us to abstract from major factors usually discussed in the context of climate policy, such as environmental damages and structural change.

[2] A parallel strand of literature studies the interplay of carbon and income taxes in optimal taxation frameworks (Cremer et al., 1998; Jacobs and De Mooij, 2015; Klenert et al., submitted for publication). Optimal carbon tax reforms under equity constraints are analyzed by Kaplow (2012).

[3] This might not be the case for developing countries, see Sterner (2011).

[4] For a study that also includes sources-side effects, see our more extensive numerical analysis (Klenert et al., submitted for publication). However, accounting for potentially progressive effects of endogenous prices below would likely make our result stated as Proposition 2 stronger, while the effect on the result stated as Proposition 1 is unclear.