The distributional incidence of carbon taxation: The double dividend of redistribution

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Motivation

- Often used argument against a CO2 tax: it increases inequality.

“Obama‘s new energy rule is a huge tax on the poor and middle class .[...] The lowest 10% of earners pay three times as much as a share of their income for electricity compared to the middle class.”

David Klenert, Potsdam Institute for Climate Impact Research
Motivation

• Developing countries: CO2 tax not regressive (Yusuf & Resosudarmo 2007, Sterner 2011)

• CO2 tax can be regressive in industrialized countries (Wier et al., 2005; Hassett and Metcalf, 2009; Bento, 2013)

• ...recycling the carbon tax revenues can render a carbon tax reform neutral or progressive (Metcalf 1999, Bento 2009)
Motivation: Mechanism behind regressivity

- Mechanism (Poterba 1991): Low-income households spend a larger share of their income on carbon-intensive goods than high income households.

- Is there an Engel’s law for certain types of carbon intensive goods? (Engel, 1857)
Motivation: Is there an Engel’s law for certain types of carbon consumption?

- Wier et al. (2001), Denmark, U.S. (Herendeen et al., 1981), New Zealand (Peet et al., 1985), Germany (Weber and Fahl, 1993), ...

- CO2 intensities vary strongly between consumption goods.
- Low-income cohorts: mainly consume carbon-intensive necessities
- High-income cohorts: "luxury" items with a higher service component.

Outline

• What are the implications of explicitly modeling a subsistence level of polluting consumption when assessing the distributional consequences of a CO2 tax in combination with different recycling mechanisms?

• What is the effect of this assumption in a standard Double Dividend type of model?

• Result preview:
  • Subsistence assumption changes distributional effects of certain revenue recycling mechanisms.
  • Uniform tax cuts (Double Div.) increase inequality and thereby reduce efficiency -> Other mechanisms preferable
  • Optimal level of a carbon tax depends on the recycling mechanism.
Double Dividend - a reminder

• “Weak“ Double Dividend: using the revenue from carbon taxation to cut distorting taxes (instead of lump-sum recycling them)
  ➢ reduces pollution AND
  ➢ renders the tax system more efficient.

It thus reduces the gross cost of climate policy. 
Bovenberg (1999), review in Siegmeier et al. (2014).

• We follow the standard Double Dividend approach, but introduce a subsistence level of polluting consumption.
A model of subsistence consumption

Households
• Two consumption goods, clean (C) and polluting (D)
• A minimum level $D_0$ of the polluting good has to be consumed by each household (Stone 1954, Geary 1950)
• $n$ different households, distinguished only by their productivity $\phi_i$
• Households have a choice between working and enjoying leisure time $l_i$

Firms
• Cobb-Douglas, with labor time $T$ and pollution $Z$ as inputs
• The price on pollution is set by the government

Government
• Maximizes the sum of all utilities minus disutility from pollution
• Has a fixed budget, which has to be financed by labor income or pollution taxation
A model of subsistence consumption

Households

- Labor leisure choice, income tax

\[ U(C_i, D_i, l_i) = C_i^\alpha (D_i - D_0)^\beta l_i^\delta \]

\[ C_i \cdot p_C + D_i \cdot p_D = (1 - \tau_w)I_i + L_i \]

\[ I_i = \phi_i w(T - l_i). \]

Government

- Maximizes total welfare W for three different recycling schemes

\[ W(C_i, D_i, l_i, Z_C, Z_D) = \sum_{i=1}^{N} U(C_i, D_i, l_i) - \xi (Z_C + Z_D)^\theta \]

\[ \text{const.} = p_C C_G + p_D D_G = \sum_{i=1}^{N} L_i + \tau_{w,i} I_i + \tau_Z (Z_C + Z_D) \]
A model of subsistence consumption

Firm

- Cobb-Douglas, labor and pollution \((Z_c, Z_d)\) as production inputs

\[
F_C(T_C, Z_C) = A_C T_C^\gamma Z_C^{1-\gamma}
\]

\[
F_D(T_D, Z_D) = A_D T_D^\epsilon Z_D^{1-\epsilon}
\]

- Government sets price on polluting input directly

\[
w = \frac{\partial F_C(T_C, Z_C)}{\partial T_C}
\]

\[
w = \frac{\partial F_D(T_D, Z_D)}{\partial T_D}
\]

\[
\tau_Z = \frac{\partial F_C(T_C, Z_C)}{\partial Z_C}
\]

\[
\tau_Z = \frac{\partial F_D(T_D, Z_D)}{\partial Z_D}
\]
Model calibration

- Number of households $N=5$ (quintiles)

- $\phi_i$ is the share of total income, calibrated to US Data†:

<table>
<thead>
<tr>
<th>Quintile</th>
<th>lowest</th>
<th>second</th>
<th>middle</th>
<th>fourth</th>
<th>top</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income share</td>
<td>3.2</td>
<td>8.4</td>
<td>14.3</td>
<td>23.0</td>
<td>51.1</td>
</tr>
</tbody>
</table>

† U.S. Census Bureau ‘Income, Poverty and Health Insurance Coverage in the U.S. 2011’, pre-tax distribution
The analyzed scenarios

I. Classic Double Dividend
   • Recycling occurs through a *uniform* cut in income taxes

II. Progressive Double Dividend
   • Recycling occurs through *differential* cuts in income taxes

III. Uniform lump-sum transfers
   • Each household receives the same lump-sum transfer
Results: Distribution

- Classic Double Dividend (Unif. Tax cuts) increases inequality
- Progressive Double Dividend (Diff. Tax cuts) reduces inequality the most
- Uniform lump-sum transfers are somewhere in between
  - Are these results due to the assumption of a subsistence level of polluting consumption?
Results: Distribution

Deactivating the subsistence level of polluting consumption (i.e. $D_0 = 0$) for the case of uniform income tax cuts.

The assumption of a subsistence level of polluting consumption is necessary to show that the classic Double Dividend enhances inequality.
Results: Welfare

- A progressive Double Dividend (Diff. tax cuts) yields the highest welfare levels, the classic Double Dividend (Unif. tax cuts) yields the lowest.
- Optimal tax levels depend on the recycling of the revenues:

<table>
<thead>
<tr>
<th></th>
<th>tau_Z</th>
<th>Welfare</th>
<th>Gini (U)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progressive Double Div.</td>
<td>0.885</td>
<td>5.157</td>
<td>0.220</td>
</tr>
<tr>
<td>Uniform lump-sum trans.</td>
<td>0.879</td>
<td>5.120</td>
<td>0.344</td>
</tr>
<tr>
<td>Classic Double Dividend</td>
<td>0.859</td>
<td>4.984</td>
<td>0.440</td>
</tr>
</tbody>
</table>
Results: Summary

• Accounting for a subsistence level of polluting consumption, changes the effect some revenue recycling mechanisms have on the distribution.

• The classic Double Dividend increases inequality.

• Equity and efficiency not separable: the more progressive the revenues of a carbon tax are redistributed, the higher total welfare levels become.

• Optimal carbon tax levels depend on recycling scheme: the more equity-enhancing the recycling, the higher the optimal tax level.

• Conclusion: Using the revenues from CO2 taxation for a progressive reform of the income tax system, enhances efficiency and equity (and yields higher optimal CO2 tax levels)
Results: Policy implications

- Equity and efficiency considerations are not separable when it comes to carbon taxation:
  - Implementing a carbon price requires thinking about revenue redistribution.
  - The model suggests, that differential income tax cuts are the preferred revenue recycling option, since they enhance equity and efficiency.
  - This might be (at least partially) responsible for the unpopularity of implementing a carbon tax: to be efficient and not regressive, it requires a readjustment of the existing income tax system.

- If, for whatever reason, differential income tax cuts are not feasible, lump-sum transfers are still a more viable option than uniform income tax cuts. (As is already done in Switzerland (Imhof, 2012))
Thank you for your attention.

Bento 2013 “Equity Impacts of Environmental Policy” [...] 

Bento 2009 “Distributional and efficiency impacts of increased US gasoline taxes”


Chiroleu-Assouline and Fodha 2011 “Environmental tax and the distribution of income among heterogeneous workers” [...] 

Chiroleu-Assouline and Fodha 2014 “From regressive pollution taxes to progressive environmental taxation” European Economic Review [...] 

Engel, Ernst (1857). "Die Productions- und Consumtionsverhältnisse des Königreichs Sachsen"

Fullerton 2010 “Six distributional effects of environmental policy” [...] 


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