Carbon Taxes, Inequality and Engel's Law - The Double Dividend of Redistribution

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Outline

1. Motivation
2. Literature
3. Model
4. Results
5. Conclusion
Motivation

- Often used argument against a CO$_2$ tax: increase of 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.”
Motivation

- $CO_2$ 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). Strong variations in the extent of this effect.

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?

- Low income households consume a higher share of polluting goods than high-income households (Grainger and Kolstad 2008, U.S., Wier et al. 2001, Denmark; Peet et al. 1985, New Zealand; Weber and Fahl 1993, Germany, ...)


- Based on this they model the burden to income ratio of a CO₂ tax
Motivation: Environmental Engel’s curve

- Environmental Engel’s curve: relates a household’s income with the pollution embodied in its consumption (Levinson and O'Brien 2015)
Research Questions

- What is the optimal combination of CO$_2$ and income taxes?
- What does accounting for subsistence consumption imply for the design of carbon tax policies?
- What is the distributional implication of a carbon tax reform, as proposed in the double dividend literature?
- How does the optimal carbon tax level compare to the optimal carbon tax level determined in a first-best world?
- Are there additional welfare gains of redistribution?
Results

- Review previous work on the distributional effects of a CO$_2$ tax reform
  - Existence of a weak double dividend is doubted (in a Mirrlees model)
- Mirrlees-type model for a simultaneous carbon and income tax reform
  - Analyze different revenue recycling options (lump-sum, income tax reform)
- Optimal tax setting: non-linear tax cuts outperform lump-sum transfers
  - Weak double dividend occurs
- High-inequality setting: using revenue for a progressive income tax reform reduces inequality below initial levels
  - *Double dividend of redistribution*
- Bottomline:
  - A CO$_2$ tax reform is most efficient when accompanied by an income tax reform
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The ‘old’ double dividend hypothesis

- **Weak** double dividend: using the carbon tax revenue for a uniform cut in the pre-existing tax system enhances efficiency more than lump-sum recycling and thus reduces the gross costs of a CO$_2$ tax reform. *(Strong D.D.: gross costs of a carbon tax reform are negative)*

- Trade-off between equity and efficiency (Bovenberg, 1999): Revenues can *either* be used to cut distorting taxes (efficiency) *or* for lump-sum transfers (equity).

- Distributional effects analyzed ex-post. Only one representative agent Lump-sum transfers ruled out as a non-distortionary “first best” instrument.
The ‘new’ double dividend hypothesis

• Jacobs and De Mooij (2015): Modeling agent heterogeneity explicitly enables (i) the use of uniform lump sum transfers, (ii) the use of income class-specific tax cuts.

• Mirrleesian-type partial equilibrium model:
  • If the pre-existing tax system is optimal, a weak double dividend does not occur.

• Intuition: The optimum, in a Mirrlees framework, is specified by a distinct level of inequality. Levying a CO₂ tax affects all households in the same way – inequality is not increased. Returning the revenues via income tax cuts would not be superior anymore as compared to lump-sum recycling, since further redistribution would be non-optimal. ➞ no weak double dividend occurs.
The role of subsistence consumption

• Jacobs and De Mooij (2015) neglect that a carbon tax has a strong regressive impact on the household side.

• However, the empirical literature shows the existence of this effect due to a subsistence level of polluting consumption.

• Modeling such a subsistence level (non-homothetic preferences) restores the weak double dividend in an optimal taxation framework and leads to a strong double dividend in a setting with suboptimal levels of inequality.
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A model of subsistence consumption

General equilibrium, static

Households
- Two consumption goods, clean (C) and polluting (D)
- Minimum consumption level $D_0$ of the polluting good for each household (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
- Can only observe income of each household $\Gamma_i$ incentive compatibility constraints
A model of subsistence consumption

Households

- Utility

\[ U_i = U(C_i, D_i, l_i, Z_C, Z_D) = C_i^\alpha (D_i - D_0)^\beta l_i^\delta - \xi (Z_C + Z_D)^\theta \]

- Budget

\[ C_i \cdot p_C + D_i \cdot p_D = I_i + L_0 + L \]

- Income

\[ I_i = (1 - (\tau_w^0 + \tau_{w,i}))\phi_i w(T - l_i) \]

- Pre-existing lump-sum and income taxes
  \[ L_0, \tau_w^0 \]

- Carbon tax financed tax cuts
  \[ L, \tau_{w,i} \]
A model of subsistence consumption

Government

• Maximizes total welfare $W$ for different recycling schemes

$$W = \sum_{i=1}^{N} U(C_i, D_i, l_i, Z_C, Z_D)$$

$$G = -\sum_{i=1}^{N} (L_0 + L) + \sum_{i=1}^{N} (\tau_{w,i}^0 + \tau_{w,i}) \phi_i w(T - l_i) + (\tau_{Z}^0 + \tau_{Z})(Z_C + Z_D)$$

• Incentive compatibility constraint

$$U(C_{i+1}, D_{i+1}, T - \frac{I_{i+1}}{1 - (\tau_{w,i+1}^0 + \tau_{w,i+1})\phi_{i+1} w}) \geq U(C_i, D_i, T - \frac{I_i}{1 - (\tau_{w,i}^0 + \tau_{w,i})\phi_{i+1} w}) \quad \forall i < j$$
A model of subsistence consumption

Firm

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

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

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

- Government sets tax on polluting input directly

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

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

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

\[
\tau_Z = \frac{\partial F_D(T_D, Z_D)}{\partial Z_D}
\]
The analyzed scenarios

We assume that the government is constrained to real-world policy instruments; it thus does not have access to non-distortionary individualized lump-sum transfers.

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.

IV. Uniform lump-sum transfers and differential income tax cuts
   • Necessary for obtaining optimal outcome (Jacobs, 2015).
Model calibration

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

- Productivities \( \phi_i \) are calibrated to match income shares of U.S. Quintiles:

<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>

- Non-optimal setting: Pre-existing income taxes calibrated to U.S. data on tax burden (CBO, 2013).

† U.S. Census Bureau ‘Income, Poverty and Health Insurance Coverage in the U.S. 2011’, pre-tax distribution
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Results: Optimal income taxation with a CO₂ tax

- Determine optimal pre-existing tax system by maximizing welfare without taking the environment into account
  \[ L_0, \tau_{w,i}^0 \]

- Introduce a CO₂ tax, let government redistribute revenues with the four recycling schemes

![Graph showing the relationship between Gini coefficient (utility) and carbon tax (in % of 1st best)]
Results: Optimal income taxation with a CO\textsubscript{2} tax

Welfare effects of the carbon tax reform for different recycling mechanisms

- Welfare increases strongly due to the correction of the environmental externality
- Differences between recycling schemes: Combination of ULS and differential income tax cuts fares best, the classic double dividend, i.e. uniform tax cuts perform worst.
Results: Optimal income taxation with a CO$_2$ tax

- Determine optimal CO$_2$ tax and corresponding welfare levels and Gini coefficient for each mechanism

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Welfare</th>
<th>Optimal CO$_2$ tax (%)$^\dagger$</th>
<th>Gini coeff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Uniform income tax cuts</td>
<td>6.8338</td>
<td>102.6</td>
<td>0.397</td>
</tr>
<tr>
<td>2. Differential inc. tax cuts</td>
<td>6.8562</td>
<td>103.6</td>
<td>0.351</td>
</tr>
<tr>
<td>3. Uniform lump-sum transfers (ULT)</td>
<td>6.8561</td>
<td>103.1</td>
<td>0.354</td>
</tr>
<tr>
<td>4. Differential inc. tax cuts and ULT</td>
<td>6.8608</td>
<td>103.5</td>
<td>0.344</td>
</tr>
</tbody>
</table>

- Mechanisms 2 and 4 lead to higher welfare levels than lump-sum recycling weak double dividend

- Classic double dividend (i.e. uniform inc. tax cuts) performs worst.

- A carbon tax-financed progressive reform of the income tax system (mechanisms 2 and 4) leads to higher optimal CO$_2$ tax rates.

$^\dagger$ in percent of the first-best optimal carbon tax level
Results: The double dividend of redistribution

- Address the widespread concern of rising inequality (OECD, 2011; Piketty, 2014)
- Different initial scenario: taxes are calibrated to empirical data

Inequality is decreased below its suboptimally high levels

Double dividend of redistribution
Results: Intuition

- Accounting for a subsistence level of polluting consumption causes the direct incidence of a carbon tax to be regressive.

- This leads to suboptimally high levels of inequality and thus to a welfare loss.

- Recycling the CO$_2$ tax revenues such that this regressive effect is offset will increase welfare.

- In a (third best) scenario in which initial inequality levels are suboptimally high, a carbon tax reform can decrease inequality even below the initial level and thus leads to a strong double dividend.
Summary

• The double dividend literature mainly evaluates distribution ex-post.
• Jacobs and De Mooij (2015) show than when heterogeneity is modeled explicitly (in a Mirrleesian type model)
  (i) Uniform lump-sum transfers and differential inc. tax cuts are feasible government policies.
  (ii) A weak double div. does not occur for an optimal pre-existing tax system.
• We complement their results by using a similar model in which a subsistence level of polluting consumption is modeled explicitly and find
  (i) A weak double div. still occurs also for an optimal pre-existing tax system.
  (ii) If the pre-existing tax system is non-optimal, we obtain, reforming the income tax system in a progressive way, can reduce inequality below its non-optimal initial levels.
Research questions revisited

- What is the optimal combination of CO$_2$ and income taxes?
  - The model implies that CO$_2$ tax revenue should be used for a progressive reform of the tax system, to offset the regressive incidence of the CO$_2$ tax.

- What does accounting for subsistence consumption imply for the design of carbon tax policies?
  - Provides a micro-foundation for the regressivity mechanism behind carbon taxes.
  - A carbon tax should be accompanied by a budget-neutral progressive reform of the tax system.

- What is the distributional implication of a carbon tax reform, as proposed in the double dividend literature?
  - Uniform income tax cuts lead to the worst outcome both in terms of welfare and equity. They perform worse than uniform lump-sum transfers.

- How does the optimal carbon tax level compare to the optimal carbon tax level determined in a first-best world?
  - Optimal tax levels are higher than in the first-best setting, since the carbon tax is also used as a revenue-raising instrument for inequality-reducing progressive income tax cuts.

- Are there additional welfare gains of redistribution?
  - If inequality is suboptimally high – a carbon tax reform could reduce it below the initial level.
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Conclusion

• Accounting for a subsistence level of polluting consumption is a necessity when assessing the distributional impacts of a CO$_2$ tax reform.

• No matter if the pre-existing tax system is optimal or not, using at least part of the revenue for a progressive reform of the income tax system to alleviate the regressive effects of a CO$_2$ tax, leads to the highest welfare levels.

• For the plausible assumption that inequality in the initial economy is suboptimally high, a carbon tax-financed progressive reform of the income tax system decreases inequality below sub-optimal initial levels.
Literature