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

Climate Future Initiative, Princeton, 16 April 2015

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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

**The Wall Street Journal**

**Carbon-Income Inequality**

Obama’s new energy rule is a huge tax on the poor and middle class.

President Obama vowed last year that he wouldn’t wait on Congress to bless his anticarbon agenda, and the rule his Environmental Protection Agency proposed on Monday is equal to that promise. The agency is bidding to transform and nationalize U.S. energy the way ObamaCare is doing to medicine, but in this case without even the pretense of democratic consent.

“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\textsubscript{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\textsubscript{2} tax reform is most efficient when accompanied by an income tax reform
  - More equal societies achieve a higher optimal carbon tax level
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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 CO₂ 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 $\rightarrow$ 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

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

Pre-existing lump-sum and income taxes

Carbon tax financed tax cuts
A model of subsistence consumption

Government

• Maximizes total welfare $W$ for different recycling schemes

\[
W = \sum_{i=1}^{N} U(C_i, D_i, l_i, Z_C, Z_D) \quad \text{s.t.}
\]

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

• 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

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

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

• Government sets tax on polluting input directly

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

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

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

\[
\tau_Z = \frac{\partial F_D(T_D, Z_D)}{\partial Z_D}
\]
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
Results: Optimal income taxation with a CO$_2$ 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 CO₂ tax

- Determine optimal CO₂ tax and corresponding welfare levels and Gini coefficient for each mechanism

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Welfare</th>
<th>Optimal CO₂ tax (%)†</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 CO₂ tax rates.

† 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
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)
  1. Uniform lump-sum transfers and differential inc. tax cuts are feasible government policies.
  2. 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
  1. A weak double div. still occurs also for an optimal pre-existing tax system.
  2. 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 CO₂ and income taxes?
  - The model implies that CO₂ tax revenue should be used for a progressive reform of the tax system, to offset the regressive incidence of the CO₂ 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 CO₂ 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 CO₂ 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.

• More equal societies obtain higher optimal levels of a carbon tax.
Optimal pre-existing income taxes

<table>
<thead>
<tr>
<th>Quintile</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income tax (%)</td>
<td>-285.1</td>
<td>-81.4</td>
<td>-31.3</td>
<td>0.5</td>
<td>42.1</td>
</tr>
</tbody>
</table>
Indirect taxation (backup)


- Optimal taxation literature: Indirect taxes are unnecessary (Atkinson and Stiglitz 1976). Cremer et al. (2001) generalize their model to endowment heterogeneity and show that
  - Indirect taxation can play a role in an optimal tax system
  - Indirect taxes have a progressive effect
Corrective taxes (backup)

- Baumol (1972), Pigou (2013): correcting externalities by taxing the generator of the externality increases welfare.

- Additional revenue: substituting more distortive taxation with the taxation of sugar, rum and tobacco “[...] would both increase the numbers and improve the circumstances of the labouring poor.” (Adam Smith, 1776)
Pigouvian taxes often have a regressive effect. (CO₂ tax: Bento 2013, alcohol and cigarettes: Lyon & Schwab 1995)
Corrective taxes – CO₂

- Mechanism for a CO₂ tax: Poor households spend a larger fraction of their income on carbon-intensive consumption (Metcalf 1999, Grainger and Kolstad, 2010).