Understanding the Welfare and Inequality Impacts of Carbon Tax Policies

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Carbon Tax Proposals in the US

- 14+ proposals over the last 3 years
- Similar tax: $25-$50
- Most call for some revenue to be recycled back to households
- Differ in the way the revenue is recycled
  - Efficiency instruments: tax swaps
  - Equity instruments: lump-sum payments, income-dependent payments

This Paper: Solve For Welfare-Maximizing Rebate

Quantitative OLG model with three pieces of heterogeneity

1. Age: model full lifecycle
2. Income: idiosyncratic labor productivity shocks
3. Energy: non-homothetic preferences over energy

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$40 carbon tax, broad set of rebate instruments

- Efficiency instruments: uniform reduction in capital and labor taxes
- Equity instruments: lump-sum payment, income-dependent payment, increase in the labor-tax progressivity
- Any combination of instruments

The Welfare-Maximizing Rebate of $40 Carbon Tax

- Return $\approx 2/3$ of revenue through decrease in capital tax
  - Unwind pre-existing distortions
- Return $\approx 1/3$ of revenue through increase in labor-tax progressivity
  - Increase equity
  - Labor-tax progressivity is better than other progressive rebates

Previous Literature: Efficiency or Equity

Efficiency: double dividend

- e.g. Parry (1995), Goulder (1995), de Mooij and Bovenberg (1998), Bovenberg (1999)
- Focus on economic surplus, reduce pre-existing distortionary taxes
- Like double dividend lit, optimal policy includes reduction in capital tax

Equity: distributional effects of carbon taxes

- e.g., Parry (2004); Fullerton and Heutal (2007); Metcalf (2007); Chiroleu-Assoline and Fodha (2014); Parry and Williams (2010); Williams et. al (2015); Fried, Novan, and Peterman (2018); Jacobs and van der ploeg (2019)
- Can use lump-sum rebate to offset regressive effects of carbon tax
- Like equity lit, optimal rebate increases equity, but not through lump-sum rebates

Overview

Heterogeneous agents

- Consume a generic consumption good and energy
- Non-homothetic preferences over energy
- Save in physical capital

Perfectly competitive firms

- Produce final good from capital, labor, and energy
- Produce energy from capital and labor

Government

- Taxes HH income to finance unproductive govt consumption
- Runs Social Security system

Environment

- Abstract from environmental benefits

Agents: Non-Homothetic Preferences Over Energy

Utility

$$U(\tilde{c}_{i,j,t}, h_{i,j,t}) = \frac{\tilde{c}_{i,j,t}^{1-\theta_1}}{1-\theta_1} - \chi \frac{h_{i,j,t}^{1+\frac{1}{\theta_2}}}{1+\frac{1}{\theta_2}}$$

- $\tilde{c}_{i,j,t} = c_{i,j,t}^{\gamma}(e_{i,j,t}^{c} - \bar{e})^{1-\gamma}$

Calibration

- γ: match residential energy consumption share relative to total
- $\bar{e}$: match energy share differences across income distribution

Government Taxes

- Carbon tax, τ^c
- Flat capital tax, τ^k
- Progressive labor tax function
  - Benabou (2002); Heathcote, Storesletten, Violante (2017); Guner, Kaygusuz, Ventura (2014)

$$\text{average labor-tax rate} = 1 - \lambda_1 \left(\frac{\tilde{y}^h_{i,j,t}}{\bar{\tilde{y}}^h_t} \right)^{-\lambda_2}$$

- Calibrate tax parameters to matching existing US tax system

Quantitative Experiment

- Carbon tax: \$40 per ton CO_2 (CLC, 2019)
  - Carbon tax revenue $\approx$ 1.6 percent of GDP
- Return all revenue back to households
  - Policies differ in how revenue is returned to households
- Focus on long-run welfare outcomes
  - Compare stationary equilibria

Rebate Instruments

Efficiency instruments

- Uniform decrease in the labor tax
- Uniform decrease in the capital tax

Equity instruments

- Uniform lump-sum rebate
- Income-dependent rebate
- Increase the progressivity of the labor-tax function

Policymaker can use any combination of rebate instruments

Reduction in Labor Tax Rate

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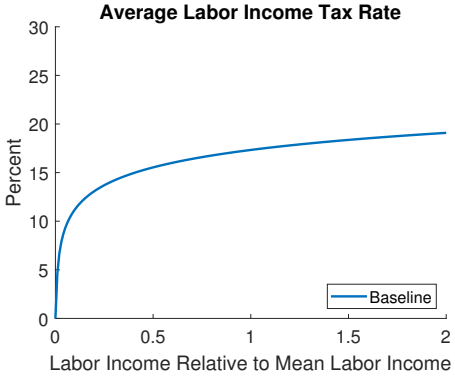

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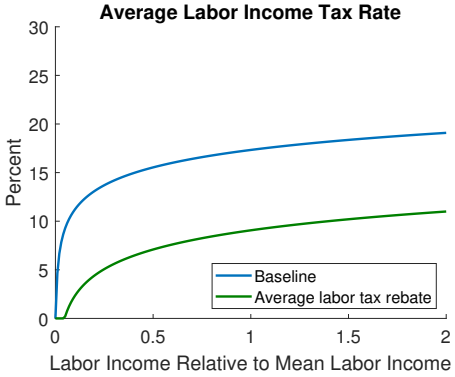

Increase in Labor Tax Progressivity

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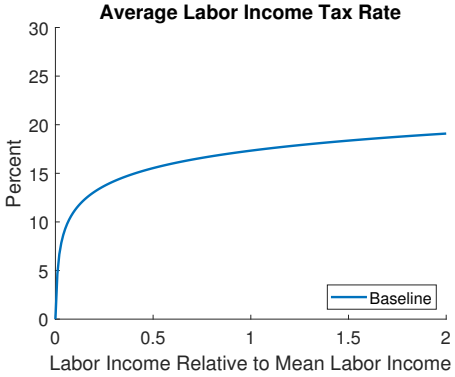

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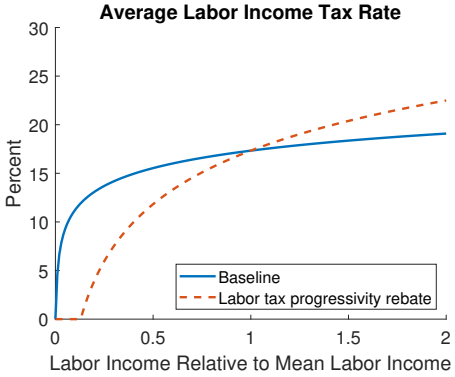

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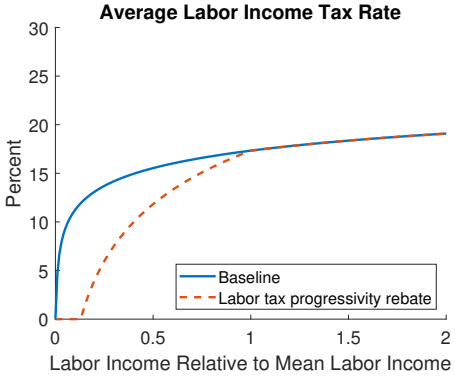


Welfare Measure

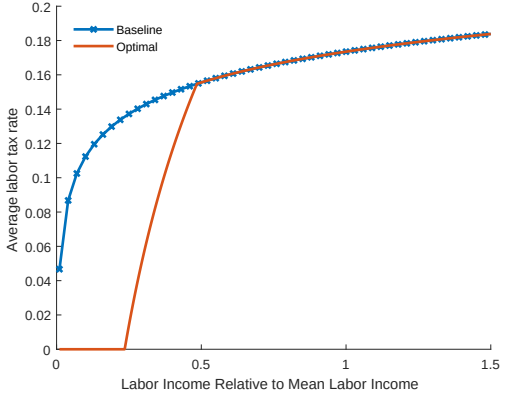
- Measure using CEV between baseline and policy equilibria
- Ex-ante, expected lifetime utility of a newborn in stationary equilibrium
- Incorporates inequality impacts through the veil of ignorance

$$\mathbb{E}\left\{\sum_{k=1}^{J}\beta^{k-j}\prod_{q=j}^{k-1}\psi_q\left(\frac{[((1+\Omega)\dot{c}_{i,j,t})^{\gamma}(\dot{e}^{c}_{i,j,t}-\bar{e})^{1-\gamma}]^{1-\theta_1}}{1-\theta_1}-\chi\frac{\dot{h}^{1+\frac{1}{\theta_2}}_{i,j,t}}{1+\frac{1}{\theta_2}}\right)\right\}$$
$$=\mathbb{E}\left\{\sum_{k=1}^{J}\beta^{k-j}\prod_{q=j}^{k-1}\psi_q\left(\frac{[\hat{c}^{\gamma}_{i,j,t}(\hat{e}^{c}_{i,j,t}-\bar{e})^{1-\gamma}]^{1-\theta_1}}{1-\theta_1}-\chi\frac{\hat{h}^{1+\frac{1}{\theta_2}}_{i,j,t}}{1+\frac{1}{\theta_2}}\right)\right\},$$

Welfare-Maximizing Rebate (1)

- Reduce capital tax rate from 36 to 31 percent
- Increase labor-tax progressivity

Rebate from increase in labor-tax progressivity



Welfare-Maximizing Rebate (2)

	CEV	Percent change in			
		Welfare Gini	Output	Capital	Energy
Optimal	-0.11	-2.4	-0.4	-0.5	-31.2

- Increase in labor-tax progressivity dominates other equity instruments
- If increase in labor-tax progressivity is not available, return all revenue through reduction in capital tax

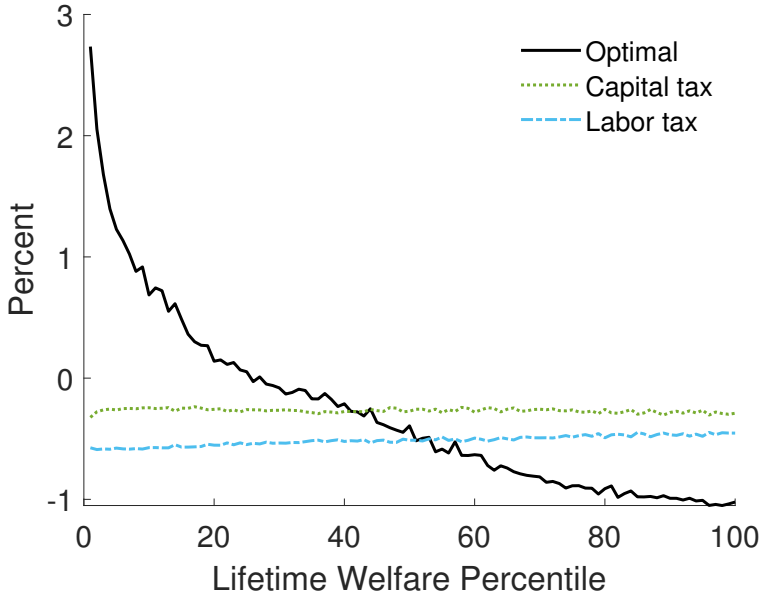
Comparison of Simple Equity Rebates

	CEV	Percent change in			
		Welfare Gini	Output	Capital	Energy
Optimal	-0.11	-2.4	-0.4	-0.5	-31.2
Lump sum	-0.64	-1.1	-1.1	-3.4	-32.0
Labor progressivity	-0.13	-3.7	-1.6	-3.8	-32.4
Income dependent	-1.57	-2.8	-2.5	-7.7	-33.5

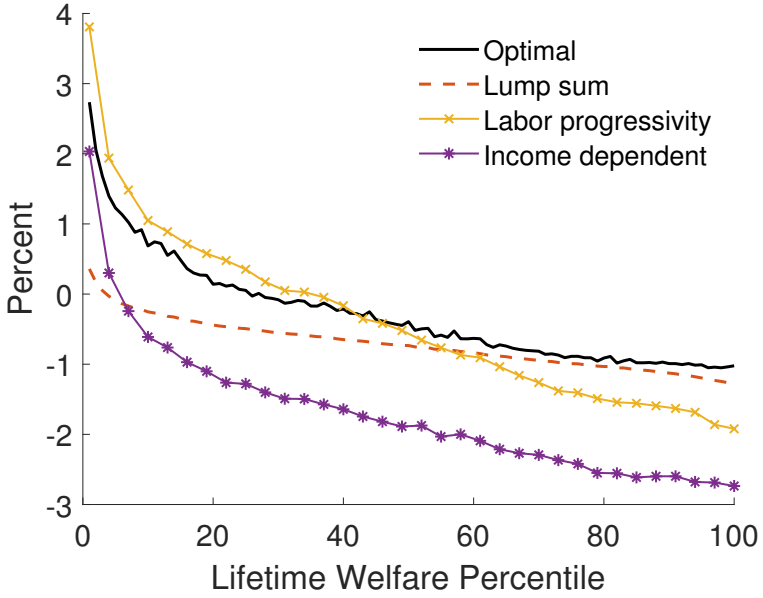
Role of the Lifecycle

	Lump sum payments	Income dependent payments	Labor progressivity payments
Corr. with marginal utility			
Working agents	0	0.63	0.59
Retired agents	0	0.70	na
Full population	0	0.25	0.57
% of revenue to retired	18	40	0

Distributional Implications of Policies (1)



Distributional Implications of Policies (2)



What's Special About a Carbon Tax?

- Raising revenue from a given source could affect how you want to return it
- Suppose revenue instead comes from an exogenous source
- How does the welfare-maximizing rebate differ?

Carbon Tax vs. Exogenous Revenue

Fraction of revenue for each use

Source of revenue	↓ Capital tax	↑ Labor progressivity
Carbon tax	0.64	0.36
Exogenous	0.37	0.63

Intuition

- Carbon tax depresses the capital stock
- $\Rightarrow$ use more revenue to decrease capital tax

Sensitivity

	Fraction of revenue used to reduce the capital tax	Percent change in the welfare Gini
Subsistence energy: $\bar{e}$		
$\bar{e} = 0$	0.65	-2.36
$\bar{e} = 0.0013$	0.64	-2.35
$\bar{e} = 0.0026$	0.62	-2.33
Carbon tax: τ^c		
\$30/ton CO_2	0.60	-2.21
\$40/ton CO_2	0.64	-2.35
\$50/ton CO_2	0.66	-2.38

What If the Economy Starts at the Optimal Tax System?

- Solve for optimal baseline policy without carbon tax
  - Baseline capital tax: 36%
  - Optimal tax on capital: 11.6%
- Optimal rebate beginning from the optimal tax system
  - Still reduce capital tax and increase progressivity of labor tax
  - Only use 40% of revenue to reduce capital tax instead of 64%

Conclusion

- Welfare-maximizing rebate uses revenue to reduce pre-existing distortions and increase equality
- Increase in labor-tax progressivity is a much less costly way to increase equality than lump-sum or income dependent payments
- Same combination of rebate instruments if start at the optimal tax system

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Thank you!