A Triple Dividend? Quantifying the Welfare and Equity Effects of Carbon-Tax Policy

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The Welfare and Equity Effects of Carbon-Tax

Carbon tax discussed as way to reduce greenhouse gas emissions

- Generates revenue: leads to multiple policy options
  - What to do with revenue?
- How to evaluate the policies?
  - Maximizing expected utility (implicitly includes inequality)
  - Tax itself is regressive: **source of public resistance**
  - Can redistribute tax revenue to unwind regressivity

Question: Can carbon tax raise welfare and reduce inequality?

Motivation and Findings

Previous findings:

- Double Dividend
  - Maximize welfare: unwind current distortionary tax (capital/labor)
  - Tends to exacerbate inequality
- Lump-sum rebates
  - Unwinds inequality but reduces welfare

Our findings:

- Policy can achieve **Triple Dividend**
  - Increase welfare and reduce inequality
  - Lower capital tax and increase labor tax progressivity
- Previous Research: more parsimonious set of instruments
  - Do not examine using combination of policies
  - Do not consider labor tax progressivity

Model

General Equilibrium heterogenous life cycle model

- Idiosyncratic labor productivity shocks
- Consume energy and generic good

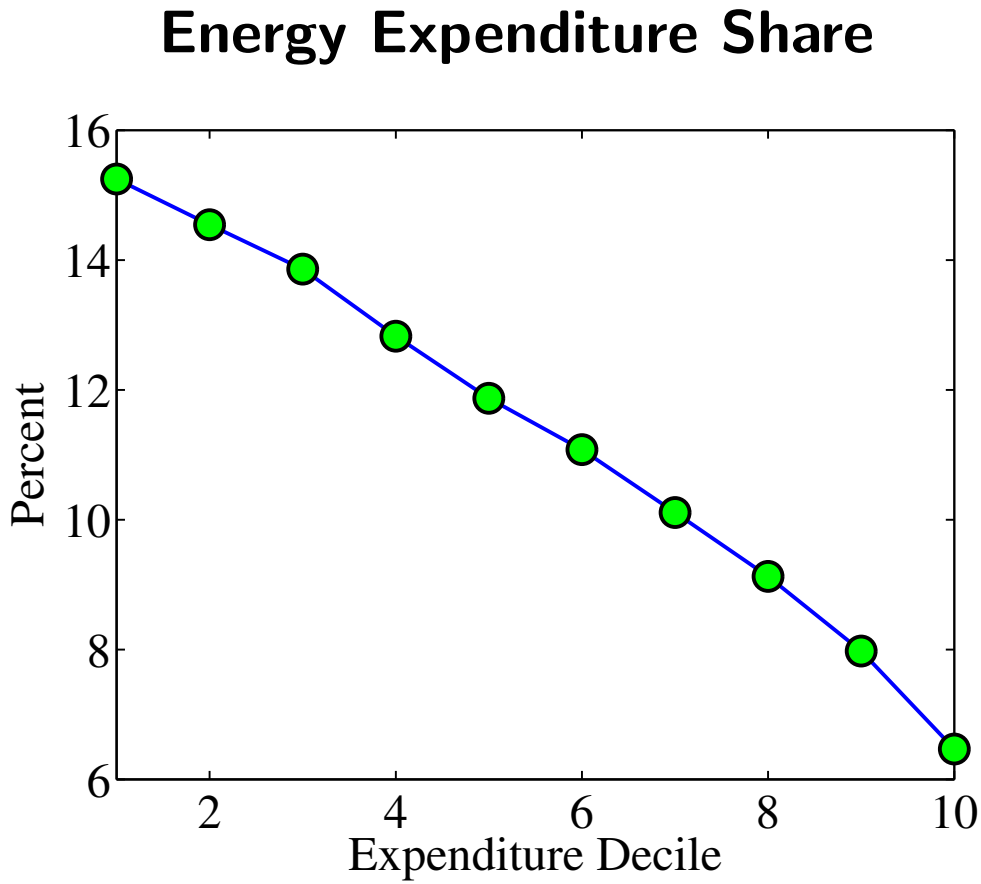
Production: two sectors

1. Energy production
   - Use capital and labor
2. Non-energy production
   - Use capital, labor, and energy

Government

- Raises revenue for consumption (w/ taxes)
- Runs social security program

Energy Consumption



Energy expenditure share falls with expenditures

Energy Consumption

- Utility function: $U(\tilde{c}, h) = \frac{\tilde{c}^{1-\sigma_1}}{1-\sigma_1} - \chi \frac{h^{1+\frac{1}{\sigma_2}}}{1+\frac{1}{\sigma_2}}$

- $\tilde{c} = c^{\gamma}(e^c - \bar{e})^{1-\gamma}$
- c - generic consumption
- e^c - household energy consumption
- $\bar{e}$: "subsistence energy"

Calibrate:

- γ: average energy budget share
- $\bar{e}$: decline in expenditure share on energy
- calibrate to match the average energy share and slope

Production

Two production technologies:

Energy production:
$E = A_e K_e^{\alpha_e} N_e^{1-\alpha_e}$

Non-energy production:
$Y = A_{ne} K_{ne}^{\alpha_{ne}} N_{ne}^{1-\alpha_{ne}-\psi} E_p^{\psi}$

Government

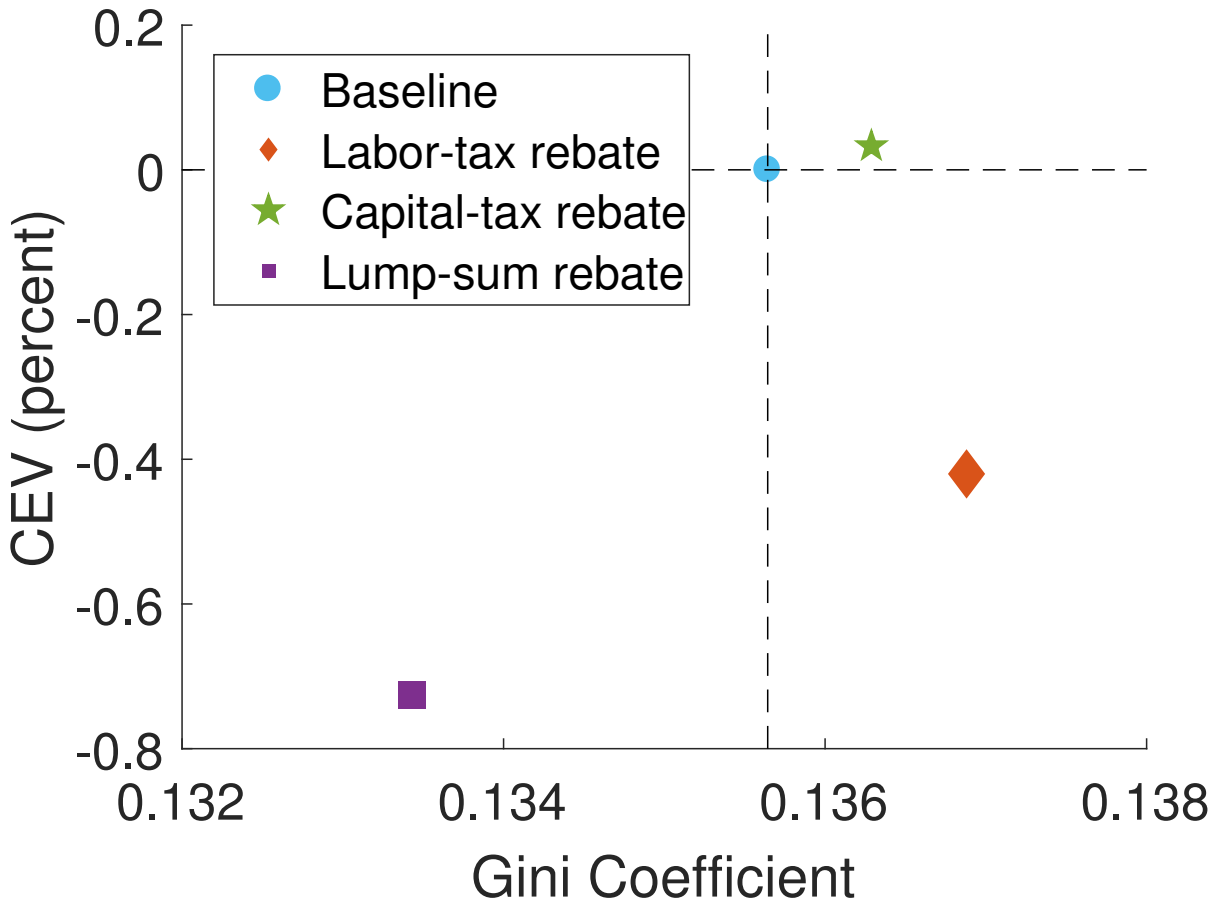
- Government consumption
  - 15.5% of output
- Tax income to raise revenue
  - Flat tax on capital of 36% (τ_k)
  - Progressive labor tax $= (1 - \lambda_1 \frac{\text{income}}{\text{avg. income}}^{-\lambda_2})\text{income}$

Experiment

Experiment

- Introduce carbon tax set at \$35 per ton CO_2
- Rebate revenue through multiple sources
  1. **Reduce capital tax (τ_k)**
  2. **Equal lump sum rebate** (Υ_1)
  3. **Reduce average labor tax (λ_1)**
  4. Increase progressive labor tax (λ_2)
  5. Progressive lump sum rebate (max[$\Upsilon 1 - \Upsilon_2$ total income,0])
- **Parsimonious set:** only 1-3
- Rigorous set: add 4, 5, and combination of rebates
- Rebating carbon revenue: no increase of taxes (i.e. progressive)

Parsimonious Policies



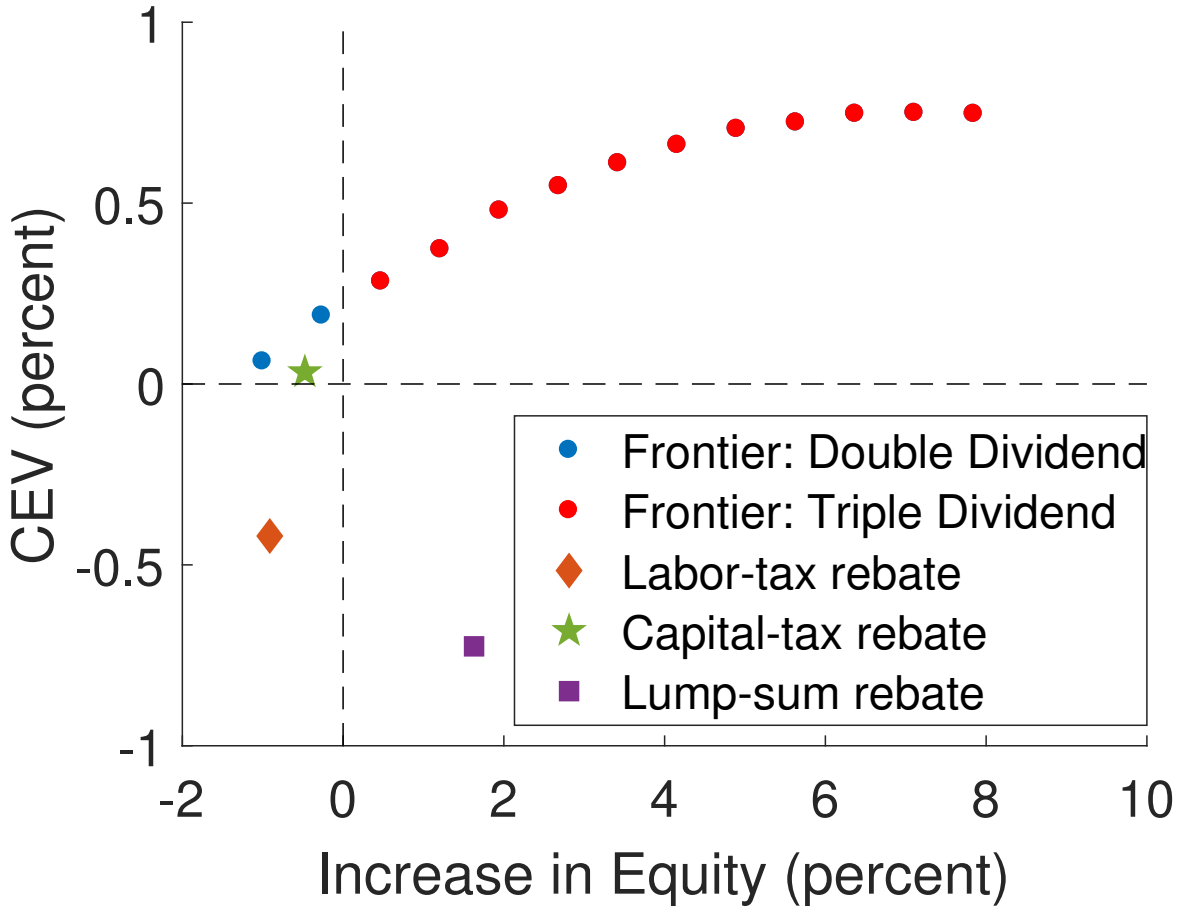
With limited policies: increase welfare or decrease inequality

Rigorous Set of Instruments

What if we allow more policy instruments?

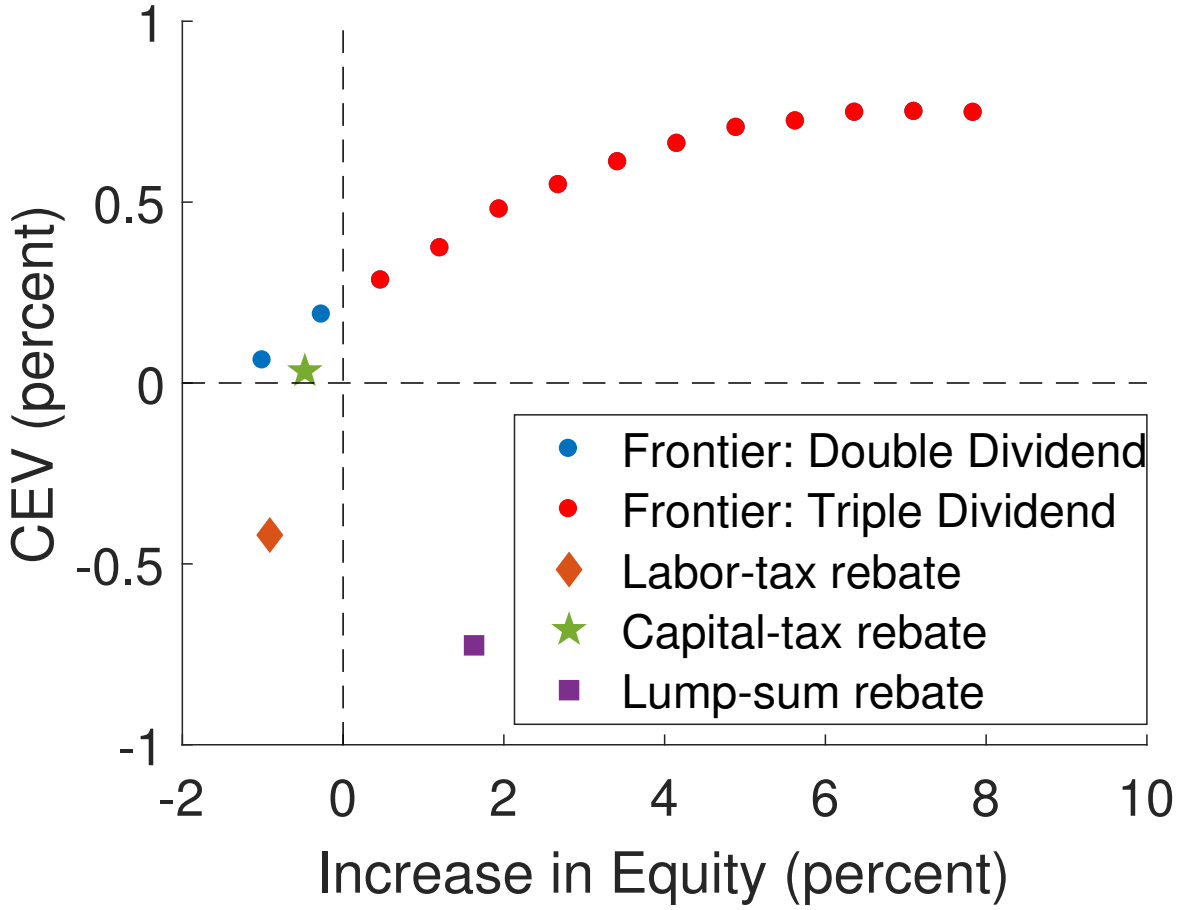
- Add progressive labor tax, progressive lump sum, and combinations of policies
- For each change in equality find welfare maximizing policy
  - $\Rightarrow$ welfare equality frontier

Rigorous Policy Frontier



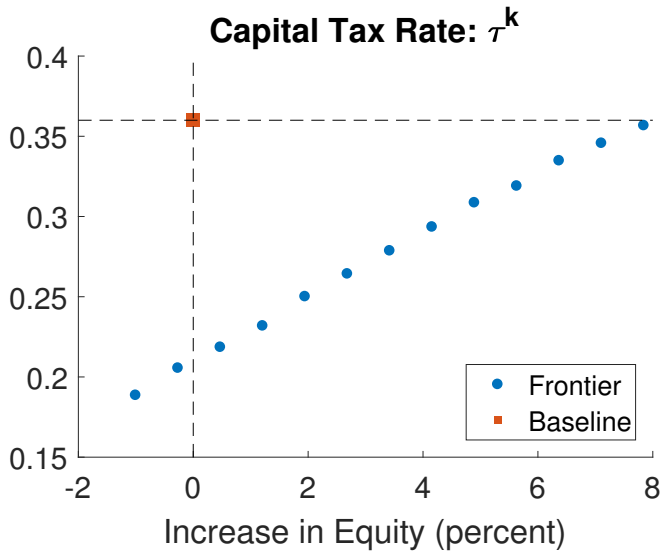
Additional policies: much better outcome

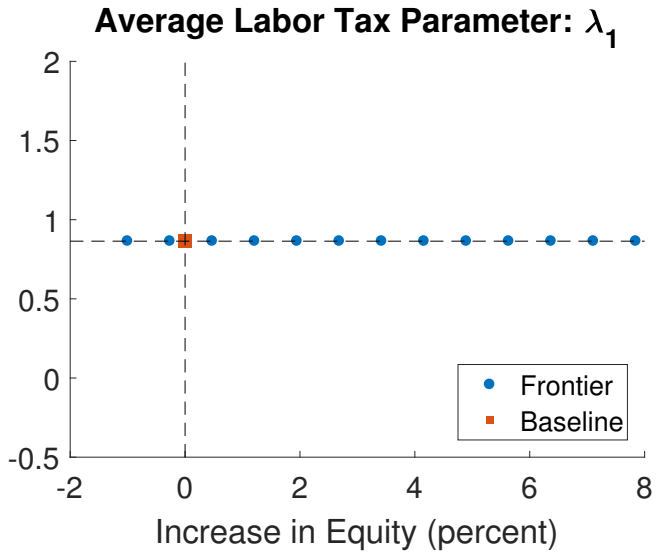
Rigorous Policy Frontier

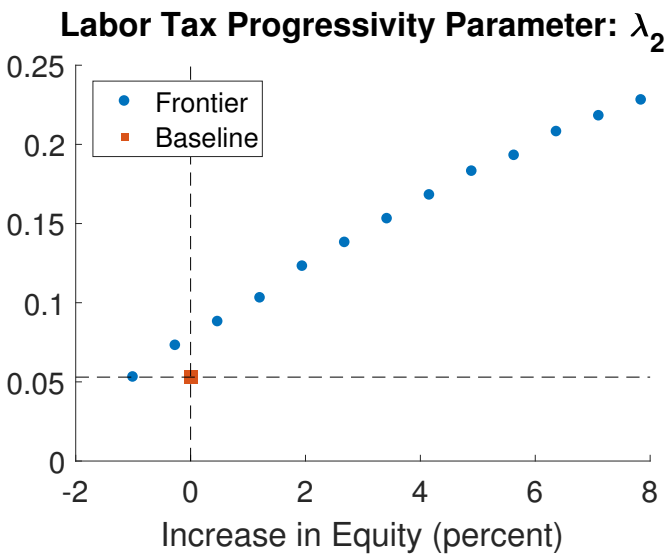


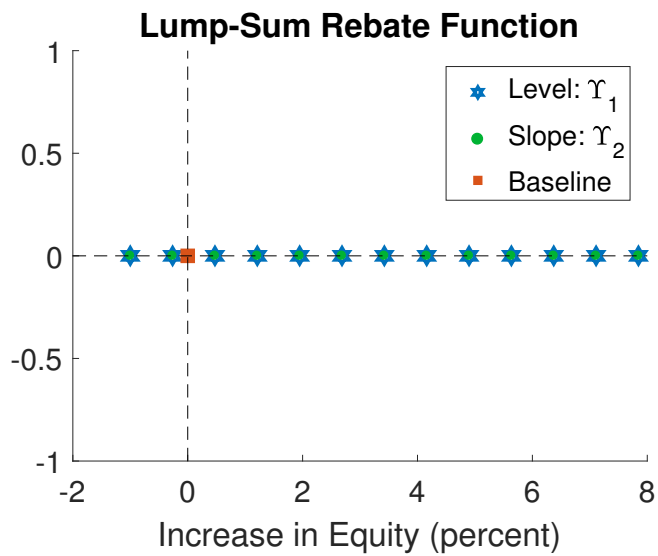
Can simultaneously increase equality and welfare

What Policies on Frontier



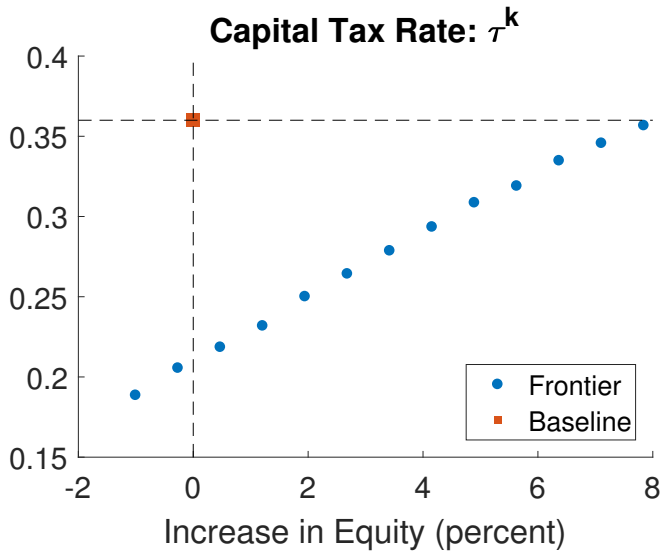


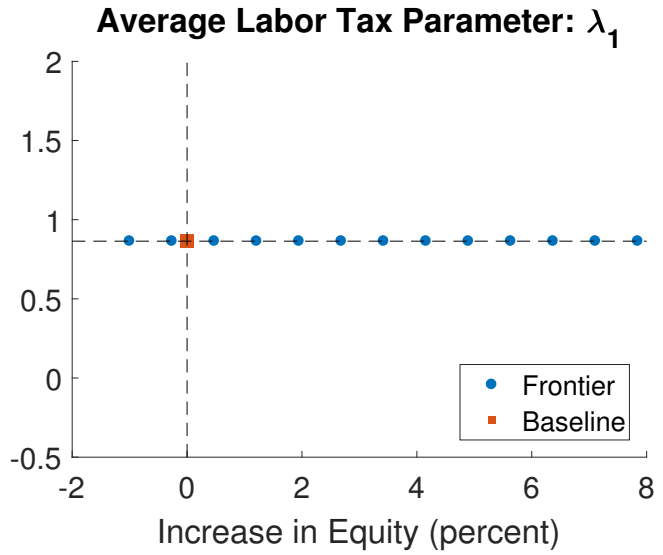


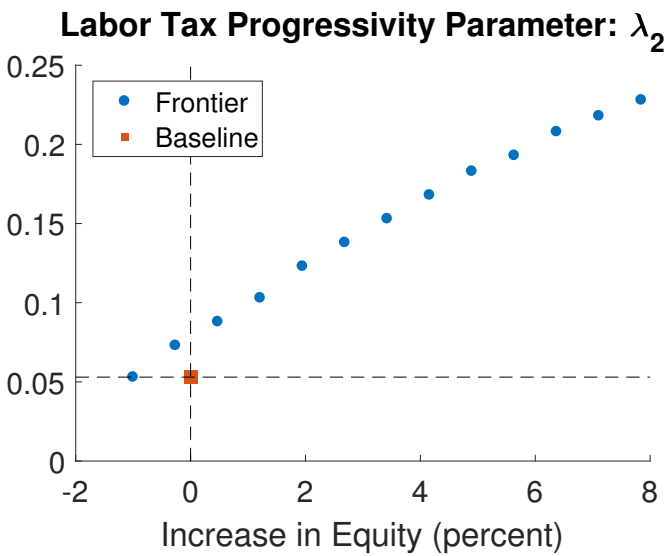


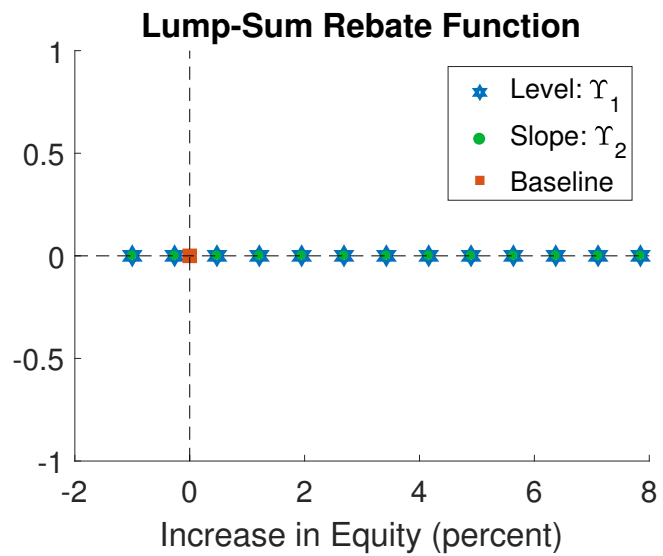
Rebate with progressive parameter and capital tax

What Policies on Frontier



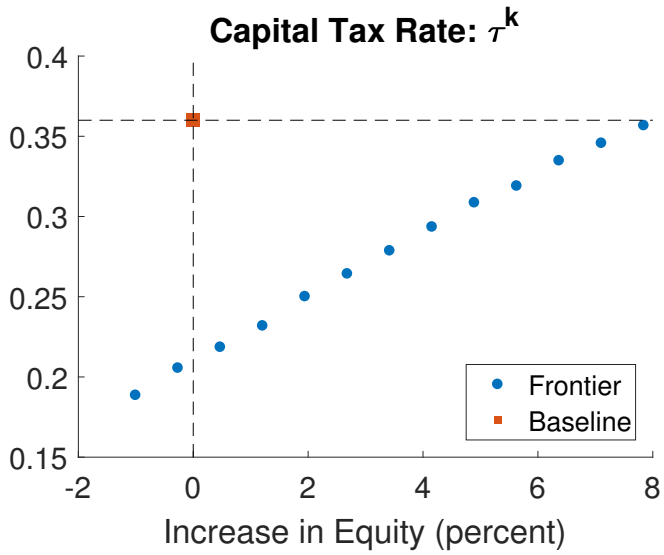


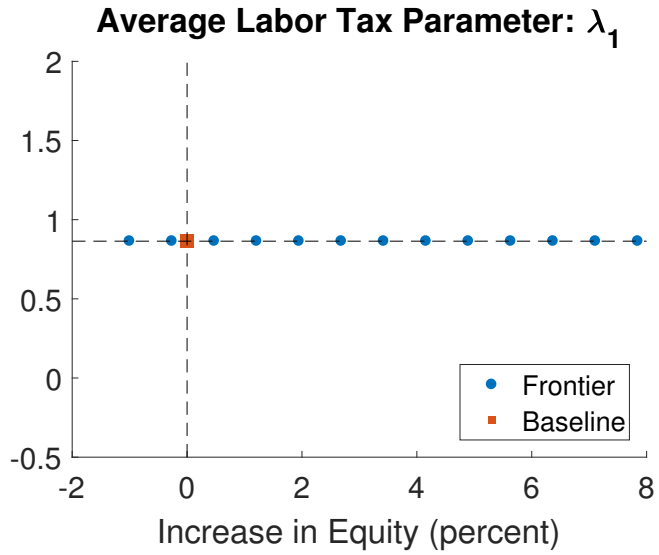


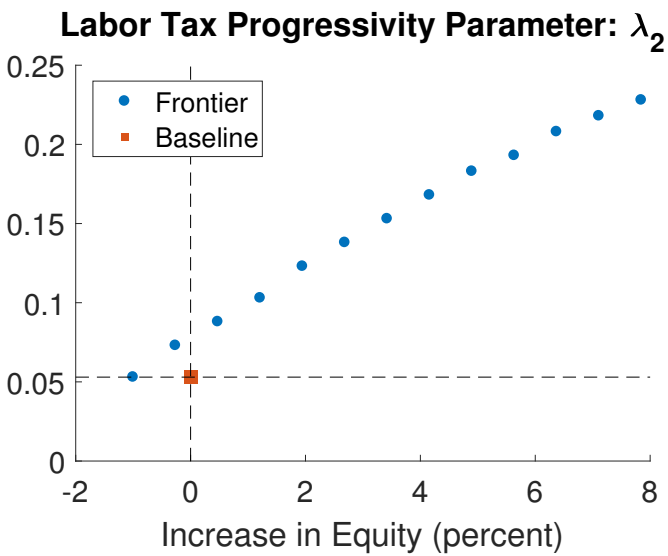


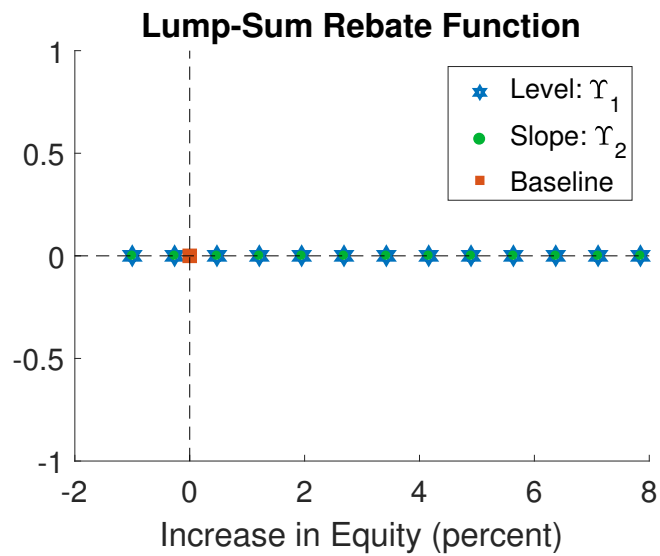
To reduce inequality: increase progressivity parameter

What Policies on Frontier









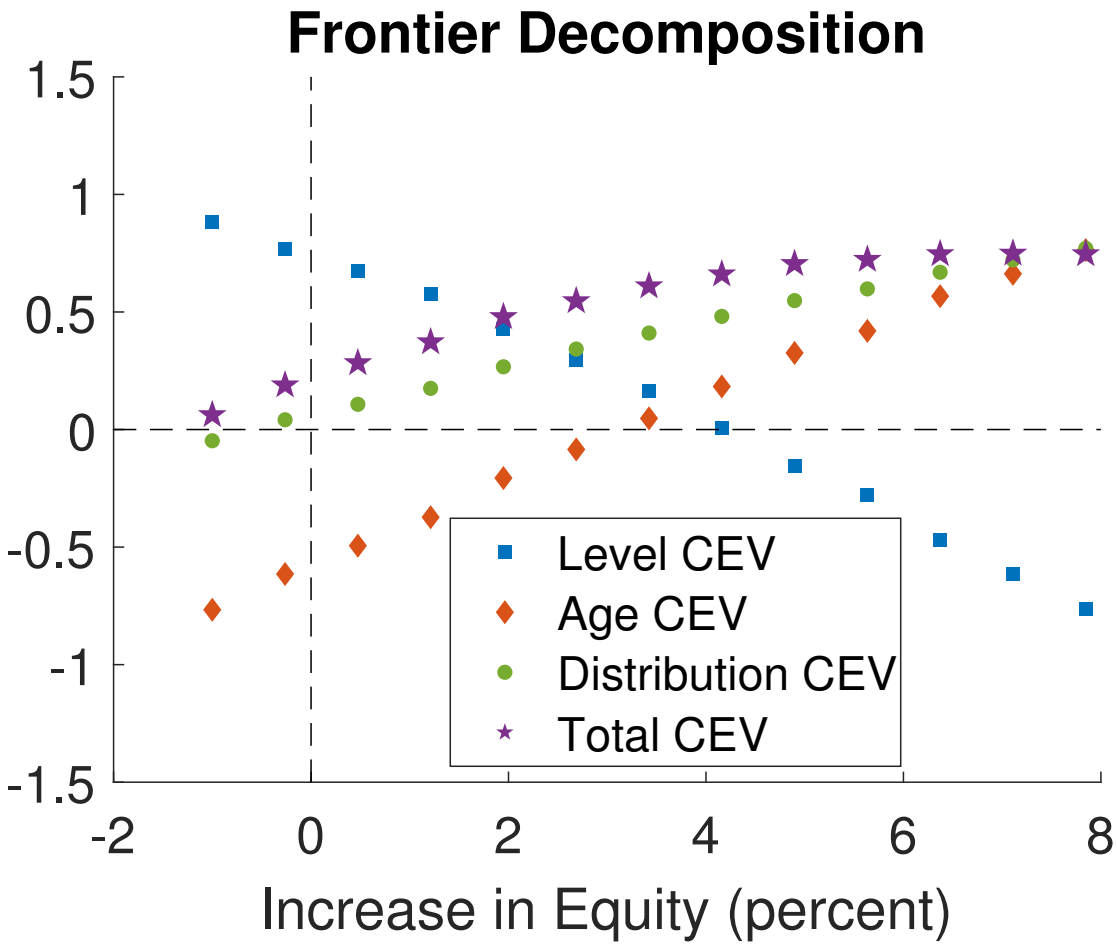
Leaves less to rebate with capital tax

Source of Welfare Gain?

Welfare (CEV):

- Percent change in expected per-period consumption
- Decompose into three parts:
  1. **Level effect:** difference in welfare from change in aggregate consumption and hours
  2. **Age effect:** difference in welfare from change in average consumption and hours across ages
  3. **Distribution effect:** residual change which is largely difference in distribution of consumption and hours

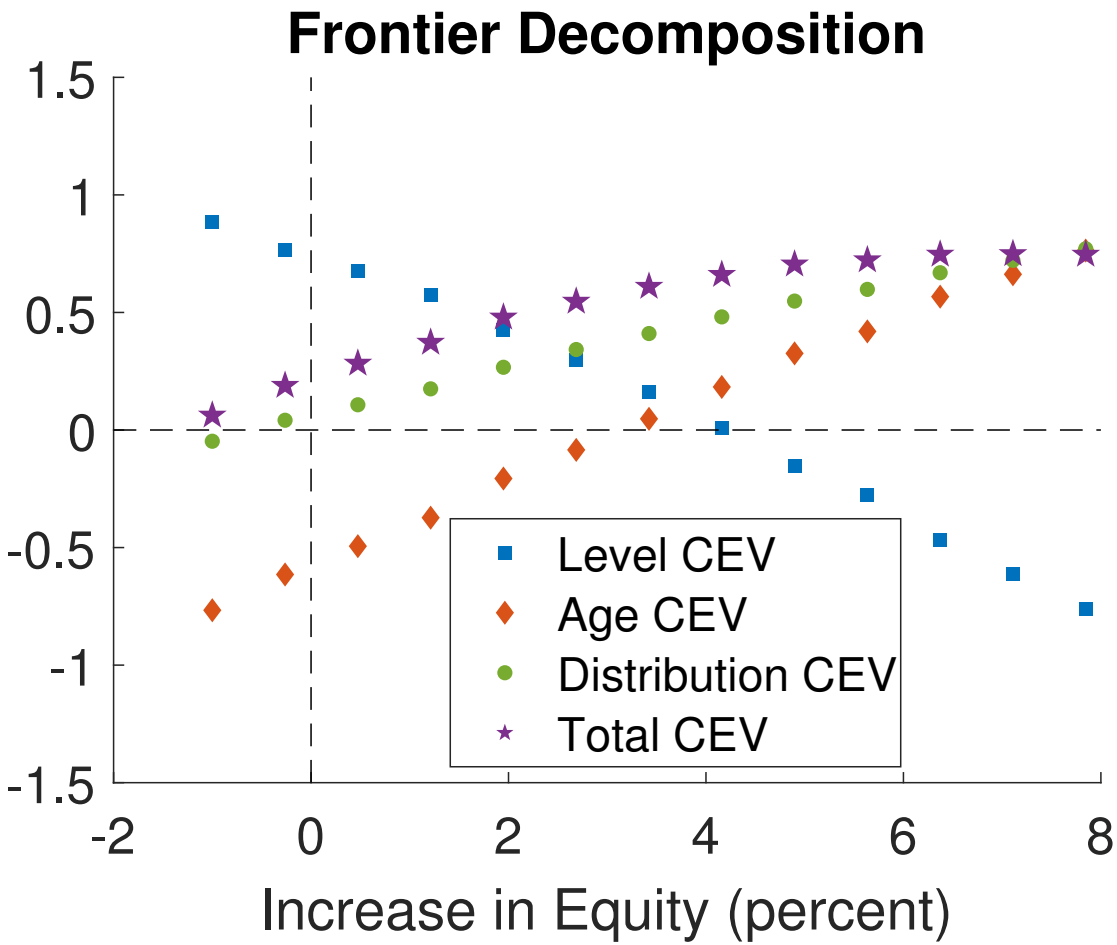
Source of Welfare Gain



Overall welfare gains:

- LHS: level dominates
- RHS: distribution dominates

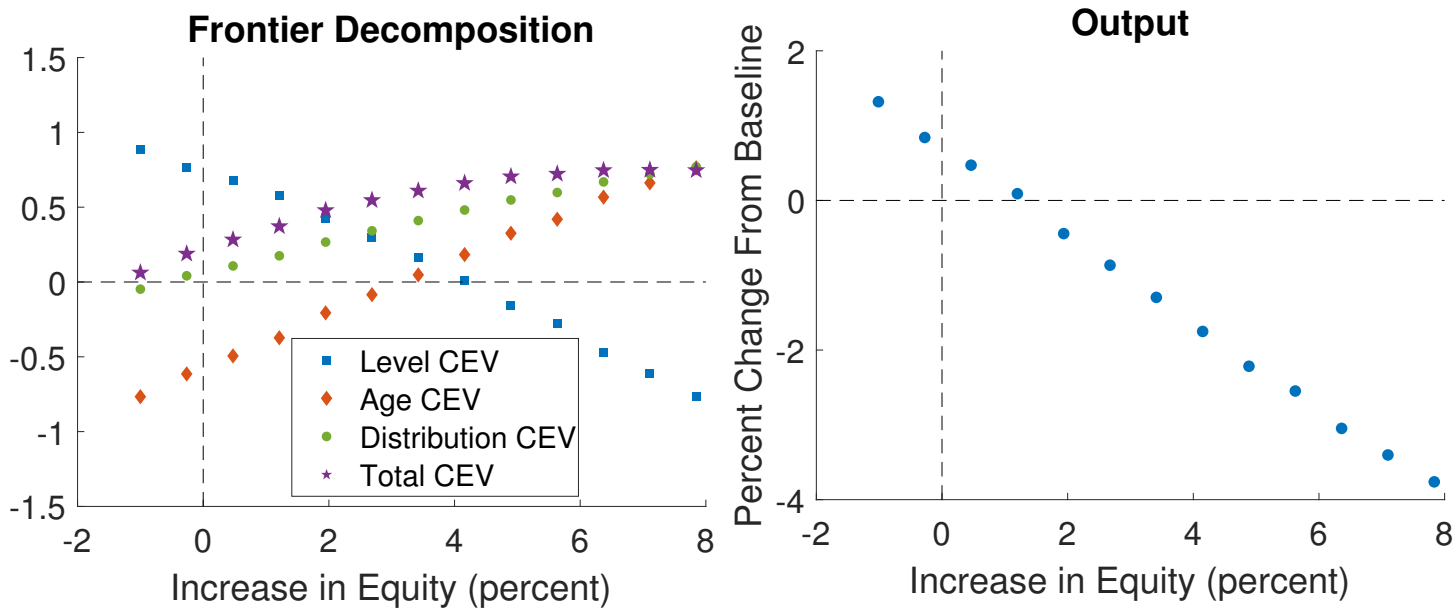
Source of Welfare Gain



Slope:

- Age and distribution dominate level

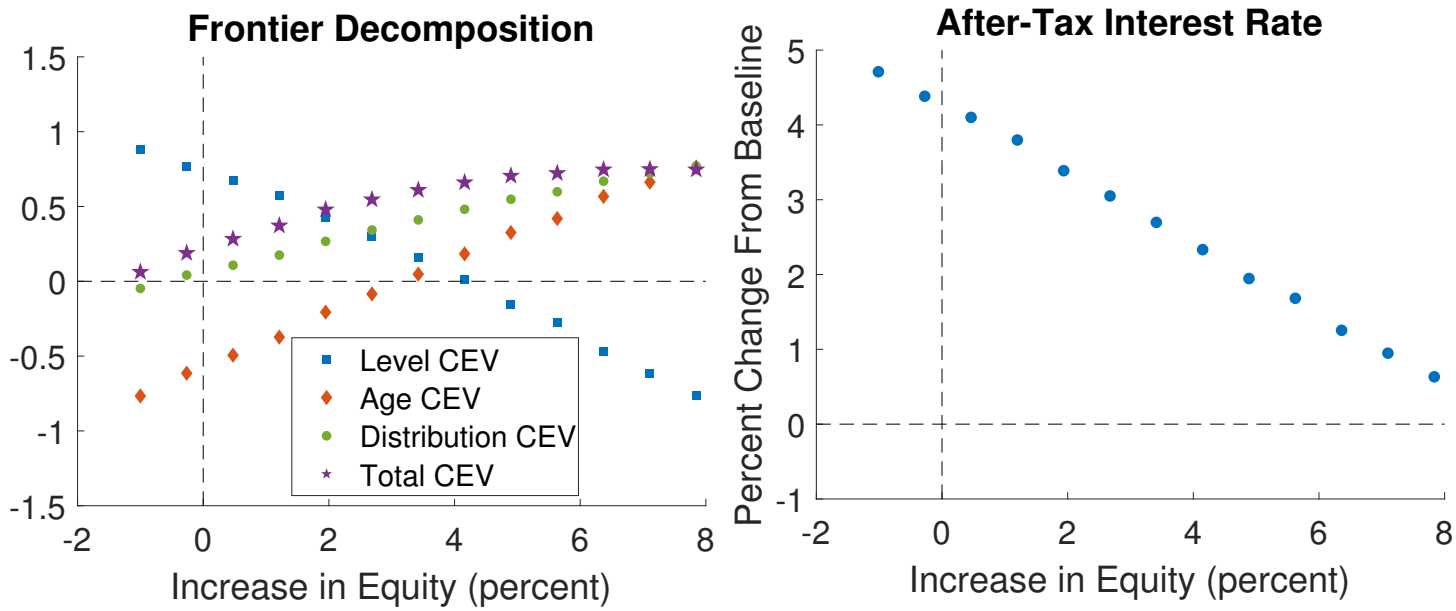
Source of Welfare Gain



Level:

- LHS: Unwinding capital tax reduces distortions
- Moving to RHS: $\Uparrow$ capital tax $\Uparrow$ distorts economy

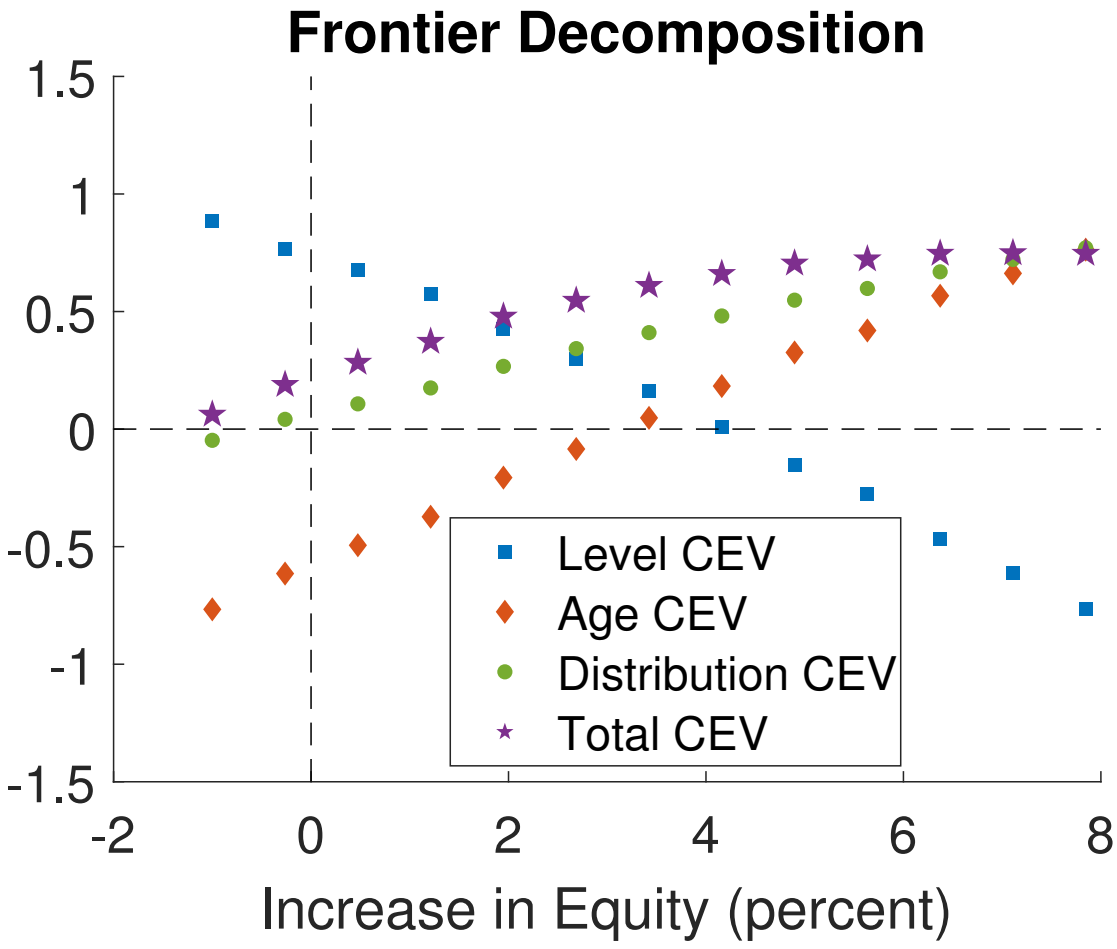
Source of Welfare Gain



Age:

- LHS:
  - Higher interest rate (steeper consumption profile
- Moving to RHS:
  - Decrease after-tax return (flatter consumption profile)
  - Lower burden when young (reducing liquidity constraints)

Source of Welfare Gain



Distribution: progressive tax reduces inequality $\Uparrow$ welfare

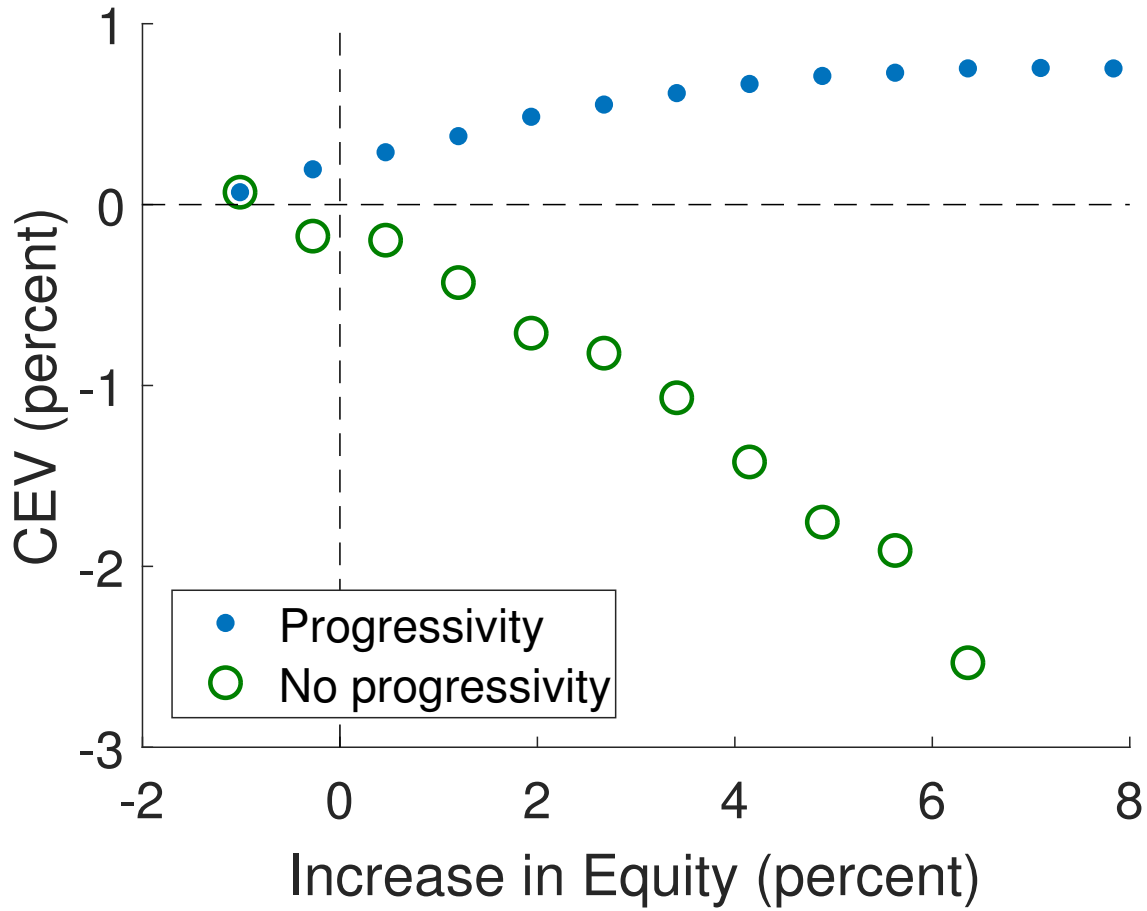
Lifecycle and heterogeneity

Lifecycle and heterogeneity important:

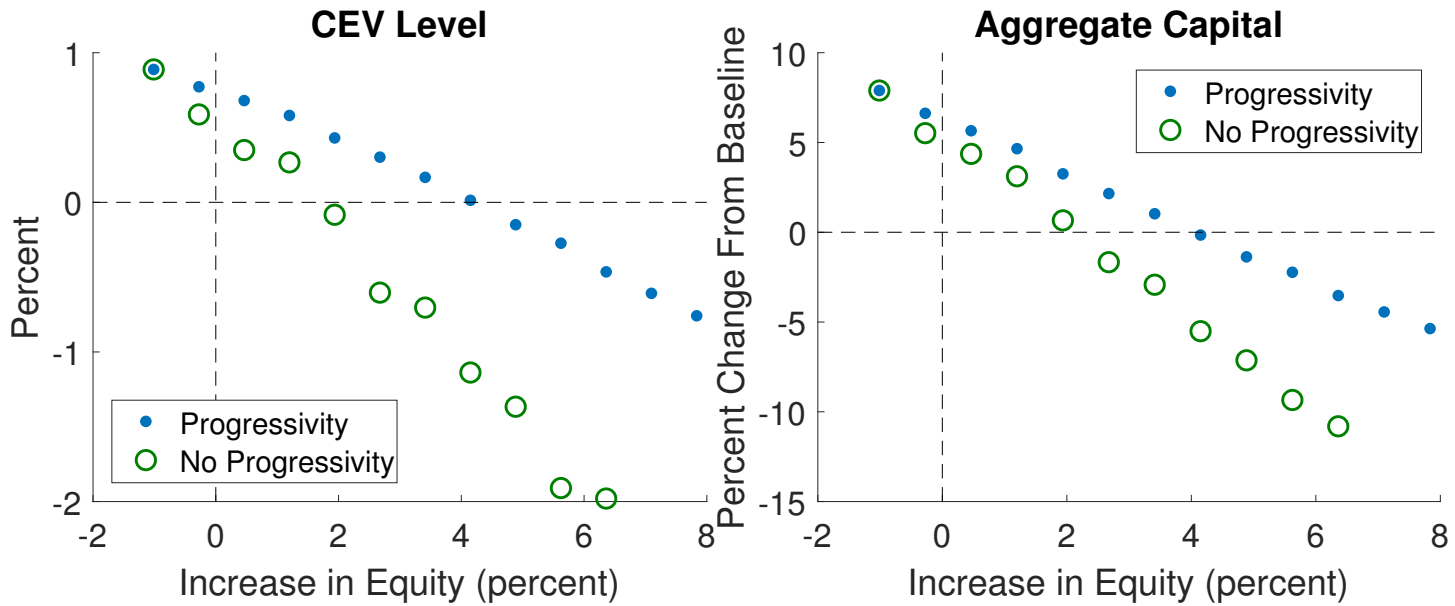
- More equal outcome improves welfare from distribution effect
- Also leads to increase in welfare from age effect

Policy Frontier

What if labor progressivity cannot be used?

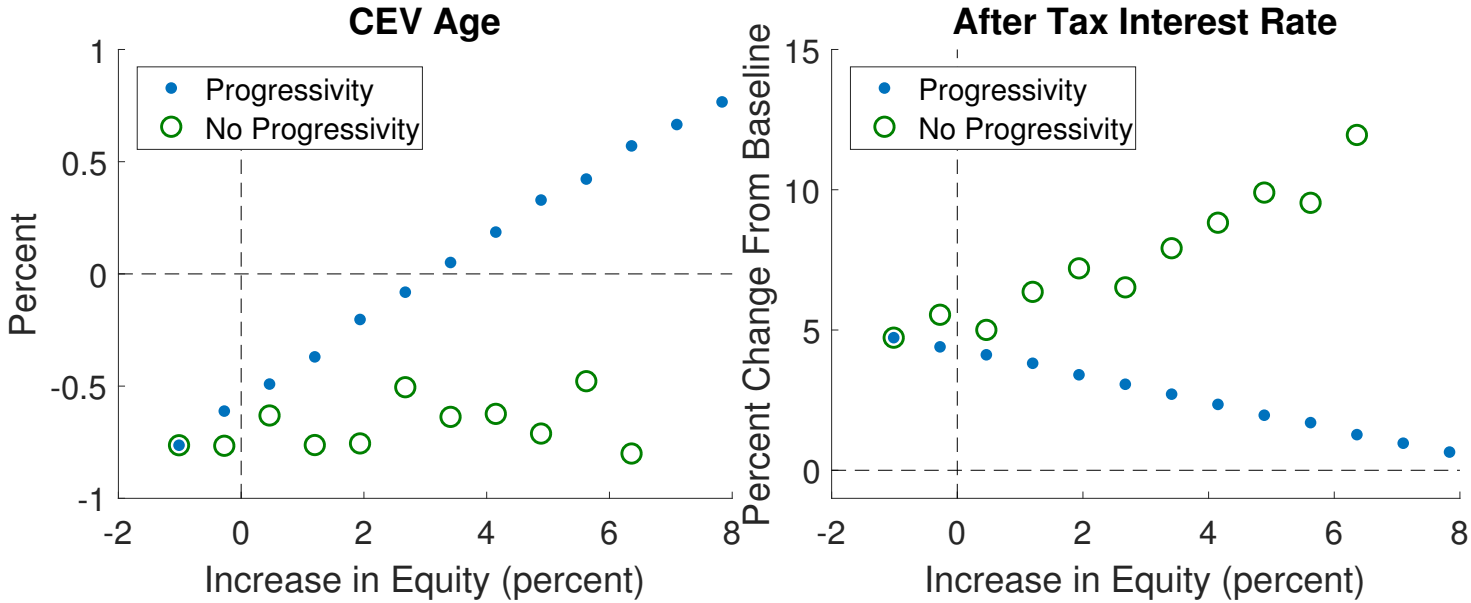


Different Sources of Welfare Gain



Level: much steeper decline b/c lump sum crowds out capital

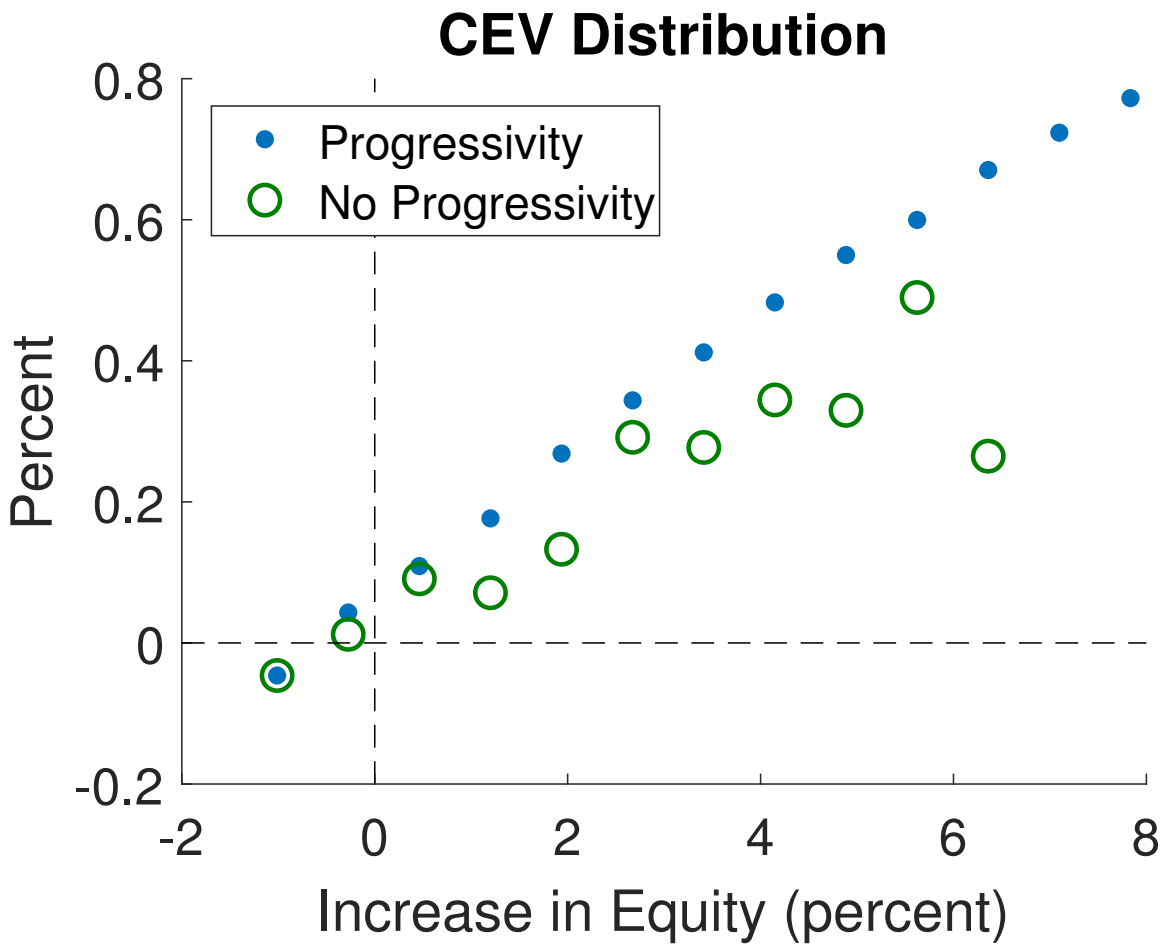
Different Sources of Welfare Gain



Age:

- Higher after-tax return (steeper consumption profile)
- Lump sum less effective at lowering young tax burden

Different Sources of Welfare Gain



Distribution: fairly similar

Conclusion

- Carbon tax can raise welfare and reduce inequality
  - Progressive labor tax improves allocation over lifetime decreases inequality
- Different findings than previous studies
  - Allow for more rigorous rebate schemes
  - Including heterogeneity and life cycle