National and Regional Carbon-Pricing Instruments

Jacob Bradt

Section 9

ECON 1661 / API-135: Spring 2022

April 1, 2022

Announcements

- Office hours today from 3:00-5:00pm EDT
- Problem set #4 due Wednesday, April 13 at 12:00pm EDT
- Midterm grades and solutions posted

Outline

Outline

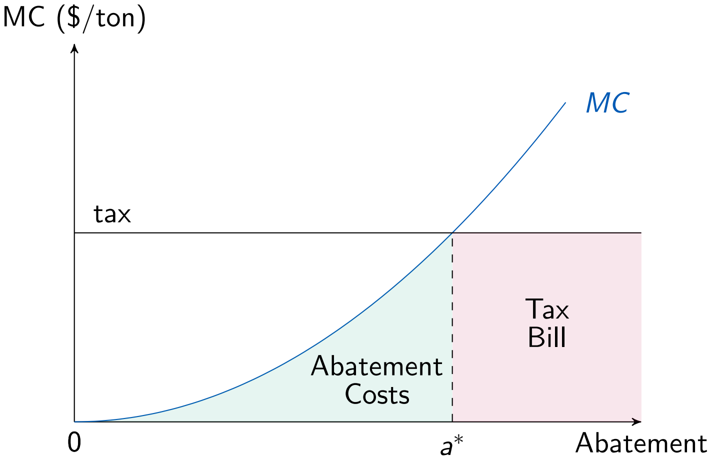
Review: Theory and Intuition behind Carbon Pricing

Designing Carbon Pricing Policies

Carbon Pricing, Market Failures, and Complementary Policies

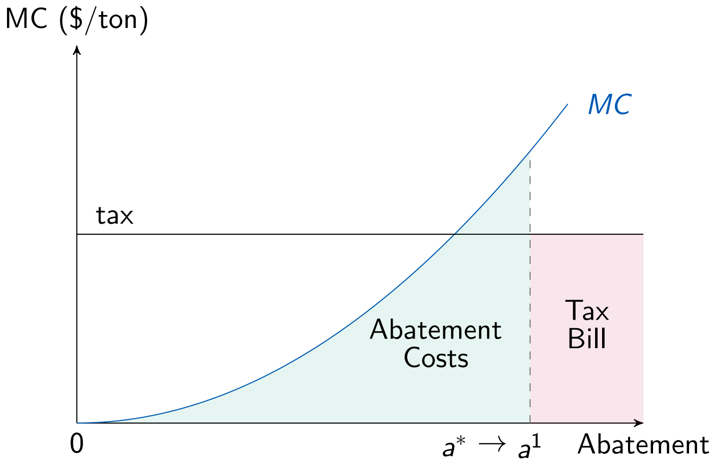
Distributional Impacts of Carbon Pricing

Review: National carbon tax



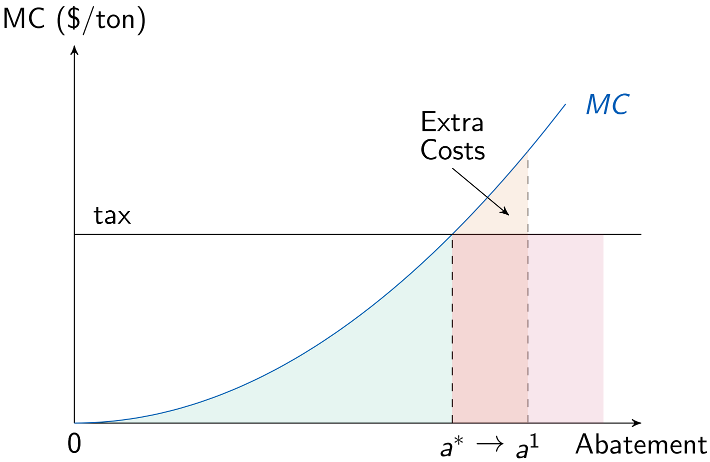
- Upstream tax on carbon-content of coal, natural gas & petroleum
  - Places a tax on the carbon content of fossil fuels
- Tax automatically generates revenues, which can be used for various purposes
- **Certainty** in compliance cost (carbon price), but **uncertainty** in total emissions abatement
- Cost-minimizing control where MC = tax

Review: National carbon tax



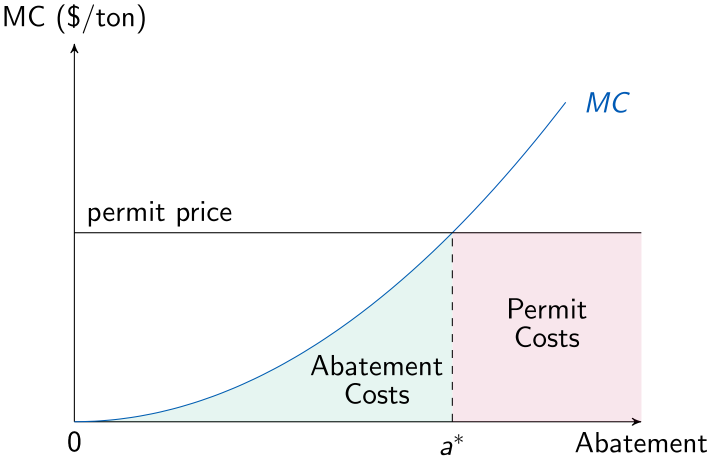
- Upstream tax on carbon-content of coal, natural gas & petroleum
  - Places a tax on the carbon content of fossil fuels
- Tax automatically generates revenues, which can be used for various purposes
- **Certainty** in compliance cost (carbon price), but **uncertainty** in total emissions abatement
- Cost-minimizing control where MC = tax

Review: National carbon tax



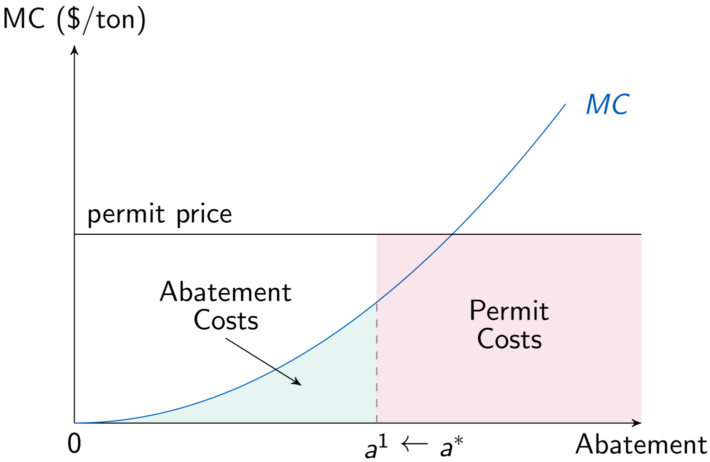
- Upstream tax on carbon-content of coal, natural gas & petroleum
  - Places a tax on the carbon content of fossil fuels
- Tax automatically generates revenues, which can be used for various purposes
- **Certainty** in compliance cost (carbon price), but **uncertainty** in total emissions abatement
- Cost-minimizing control where MC = tax

Review: National cap-and-trade



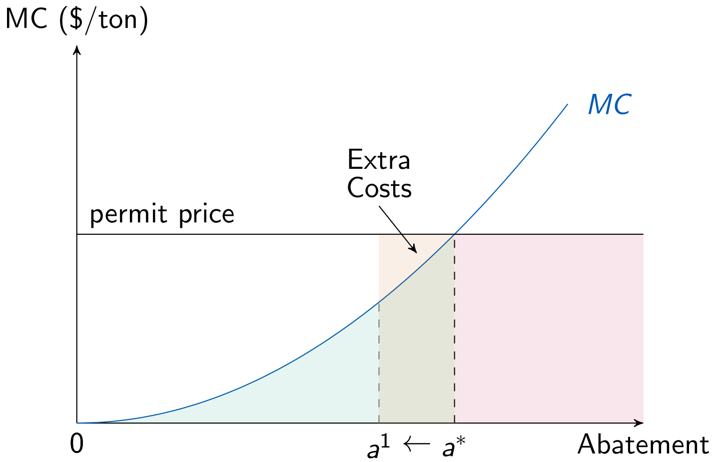
- Upstream regulation on carbon-content of coal, natural gas, & petroleum
  - Allocates allowances for the carbon content of fossil fuels
  - Supply and demand for allowances generates a price
- If allocation occurs via auction, it can also generate revenues
- **Certainty** in quantity of emissions abatement, but **uncertainty** in costs
- Cost-minimizing control where MC = equilibrium permit price

Review: National cap-and-trade



- Upstream regulation on carbon-content of coal, natural gas, & petroleum
  - Allocates allowances for the carbon content of fossil fuels
  - Supply and demand for allowances generates a price
- If allocation occurs via auction, it can also generate revenues
- **Certainty** in quantity of emissions abatement, but **uncertainty** in costs
- Cost-minimizing control where MC = equilibrium permit price

Review: National cap-and-trade



- Upstream regulation on carbon-content of coal, natural gas, & petroleum
  - Allocates allowances for the carbon content of fossil fuels
  - Supply and demand for allowances generates a price
- If allocation occurs via auction, it can also generate revenues
- **Certainty** in quantity of emissions abatement, but **uncertainty** in costs
- Cost-minimizing control where MC = equilibrium permit price

Outline

Designing carbon pricing policies

- If well-designed, a carbon tax and a cap-and-trade program can be quite similar in terms of their impacts
- Both encourage least-cost abatement for given abatement objective ("first-best" solution)

⇒ Specific design of carbon taxes and cap-and-trade programs is more consequential than the chosice between the two instruments

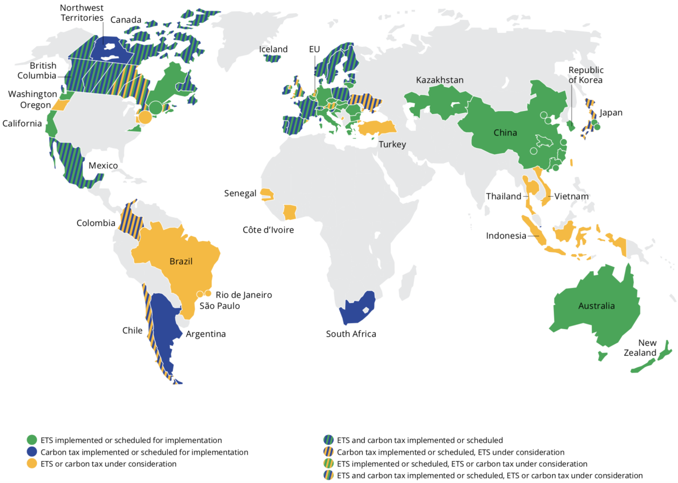
Hybrid policy instruments

- Definition: a hybrid or "safety-valve" policy instrument refers to a combined cap-and-trade and tax system
- Price ceiling: government can announce in advance that it is willing to sell (an unlimited number of) additional allowances at a specific price (the "trigger" price)
- Price floor: government can announce it will buy allowances at a specific price or set a minimum allowance price at auctions
- Combination of a price ceiling and price floor creates a "price collar" $\Longrightarrow$ limits the volatility of permit prices
  - As the difference between the price ceiling and price floor goes to zero, the cap-and-trade system becomes a tax

Policy design choices

- Choice of instrument: tax, cap-and-trade, or hybrid
- Point of regulation: upstream vs. downstream
- Scope of regulation: across geographies, industries, GHG's
- Allocation of policy rents: allocation of permits, use of revenues
- Price volatility: price collar, banking/borrowing

Carbon pricing in practice

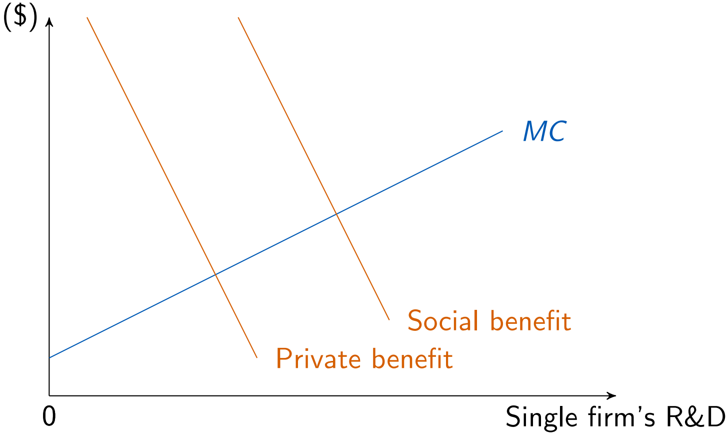


- Through 2020: 61 carbon pricing initiatives implemented/scheduled
- 31 ETS, 30 carbon taxes
- 46 national, 32 subnational jurisdictions
- Covers 22% of global GHG emissions (12 $GtCO_2e$)

Outline

Carbon-pricing as *necessary*, but not *sufficient*

- Other market failures likely: (1) Principal-agent problems; (2) Public good nature of information spillovers



- Result is under-investment in R&D relative to what might be socially optimal
  - Will depend on the size of information spillovers across firms
- BUT: incentives for technological innovation still stronger with carbon-pricing than command-and-control

Example problem: Carbon-pricing and innovation incentives (1/3)

The EPA wants to reduce emissions of CO_2 and is deciding between an equivalent performance standard and carbon tax. First, how can we design a performance standard and a carbon tax to be equivalent in terms of the level of aggregate abatement achieved?

- Pollution taxes require firms to pay a tax on each unit of pollution emitted $\Rightarrow$ firms will abate up to the point where MC = tax
  - Key then is to set the tax equal to firms' marginal costs such that the total of individual firms' abatement sums to the aggregate target

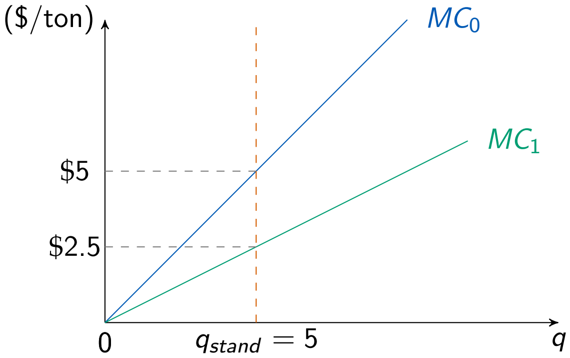
- There are several ways to design the performance standard:
  - If all we care abaout is equality in terms of aggregate emissions abatement, we can set a uniform standard across all firms that sums to our aggregate abatement target
  - To get the identical outcome of our tax, we can assign each firm a specific abatement level such that marginal costs are equal across firms

Example problem: Carbon-pricing and innovation incentives (2/3)

Under a performance standard, the EPA requires Stavins Enterprises to abate 5 units. The firm has the following marginal cost curves:

$$MC_0 = Q \qquad\qquad MC_1 = 0.5Q$$

where MC_0 and MC_1 are the firm's abatement costs w/o and w/ technological innovation. What are the cost savings from innovation under the standard?



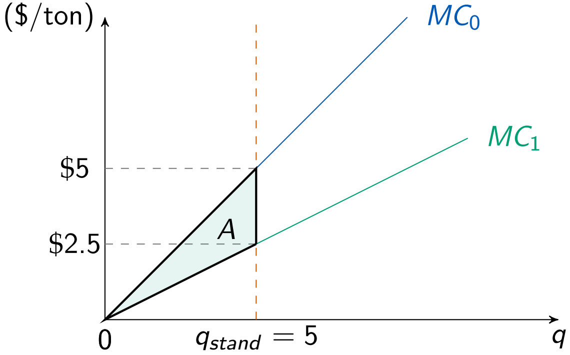
- MC_1 is everywhere below MC_0
- q remains unchanged, but for each marginal unit of abatement, the incremental cost is less

Example problem: Carbon-pricing and innovation incentives (2/3)

Under a performance standard, the EPA requires Stavins Enterprises to abate 5 units. The firm has the following marginal cost curves:

$$MC_0 = Q \qquad\qquad MC_1 = 0.5Q$$

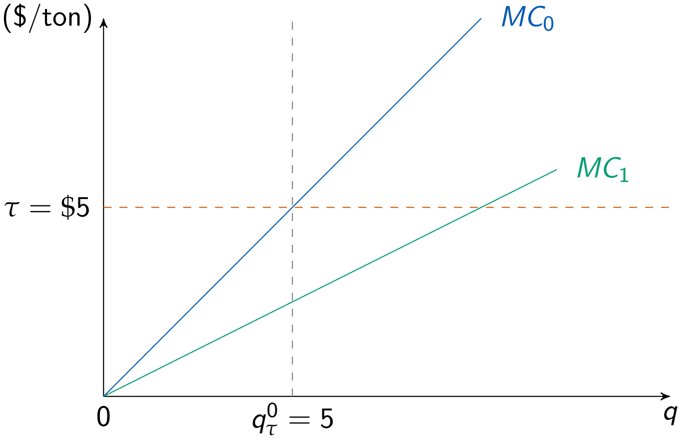
where MC_0 and MC_1 are the firm's abatement costs w/o and w/ technological innovation. What are the cost savings from innovation under the standard?



- MC_1 is everywhere below MC_0
- q remains unchanged, but for each marginal unit of abatement, the incremental cost is less
- Area between MC_0 and MC_1 represents cost savings: $\frac{1}{2}(2.5)(5) = 6.25$

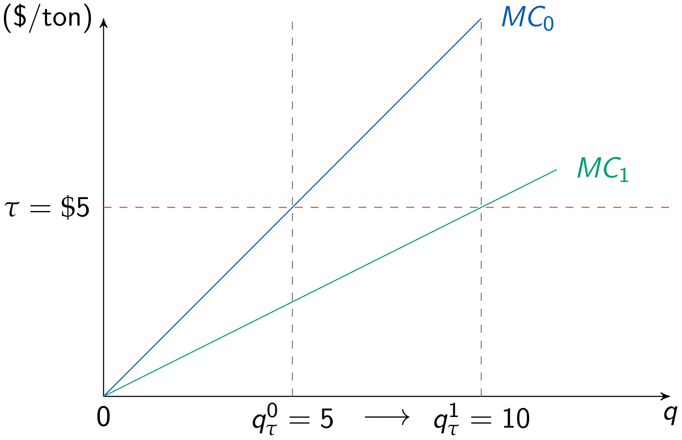
Example problem: Carbon-pricing and innovation incentives (3/3)

The EPA only knows MC_0 and sets a tax that results in 5 units of abatement based on this knowledge. What are the cost savings to the firm from innovation under the tax?



Example problem: Carbon-pricing and innovation incentives (3/3)

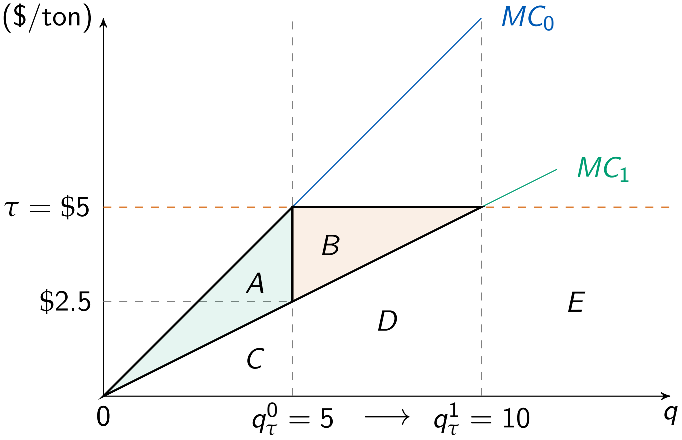
The EPA only knows MC_0 and sets a tax that results in 5 units of abatement based on this knowledge. What are the cost savings to the firm from innovation under the tax?



- With innovation, $q \uparrow$ b/c will abate until $MC_1 = \tau$

Example problem: Carbon-pricing and innovation incentives (3/3)

The EPA only knows MC_0 and sets a tax that results in 5 units of abatement based on this knowledge. What are the cost savings to the firm from innovation under the tax?



- With innovation, $q \uparrow$ b/c will abate until $MC_1 = \tau$
- Abatement done w/o innovation is now cheaper $\Rightarrow$ save area A
- Tax bill also $\downarrow$, b/c it is cheaper w/innovation to abate some of the firm's emissions w/o innovation $\Rightarrow$ save area B
- $A + B = \frac{1}{2}(2.5)(5) + \frac{1}{2}(2.5)(5) = 12.5$

Outline

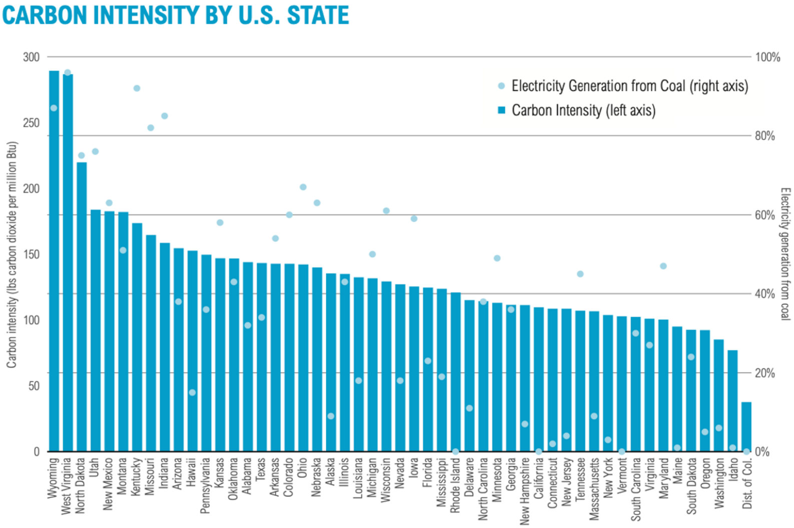
Review: Theory and Intuition behind Carbon Pricing

Designing Carbon Pricing Policies

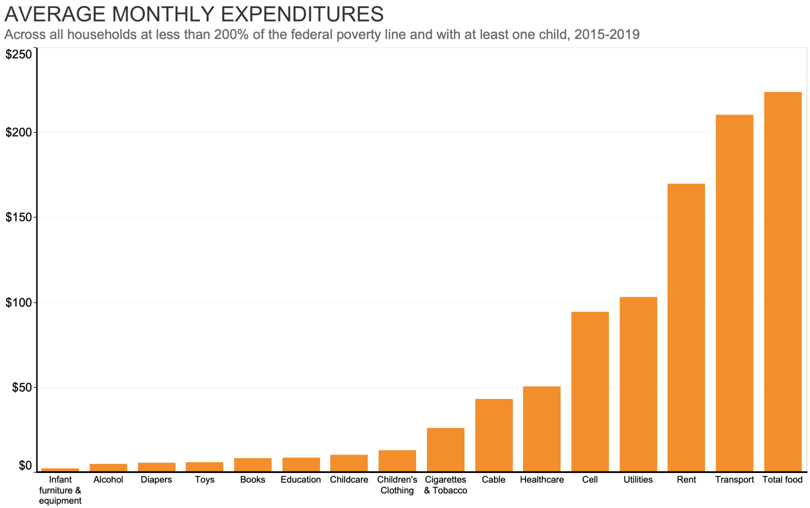
Carbon Pricing, Market Failures, and Complementary Policies

Distributional Impacts of Carbon Pricing

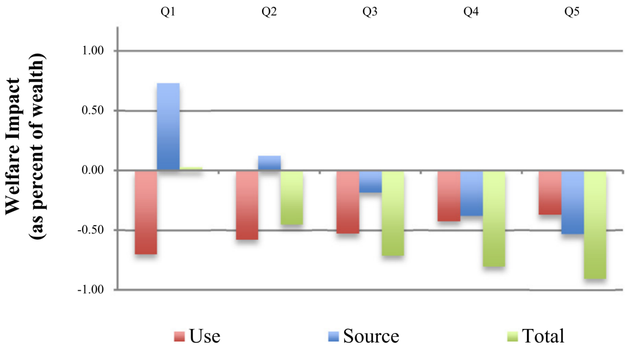
Prior wisdom about distributional impacts: Regressive



Prior wisdom about distributional impacts: Regressive



Equity-efficiency trade-off of a US carbon tax: Goulder et al. (2019)[1]



- CGE model with two types of impacts:
  - "Source side:" how the tax affects wage, capital, and transfer incomes
  - "Use side:" how the tax alters the prices of goods and services
- Find that absent revenue recycling:
  - Source side impacts are progressive
  - Use side impacts are regressive

[1] Goulder, L.H., M.A.C. Hafstead, G. Kim and X. Long. 2019. "Impacts of a carbon tax across US household income groups: What are the equity-efficiency trade-offs." *Journal of Public Economics*, 175: 44-64.

What about the revenues?

- The overall distributional impact (and cost) of a carbon-pricing policy will depend on what is done with the tax (or auction) revenues

- Many of the *direct* effects of a carbon price are likely regressive

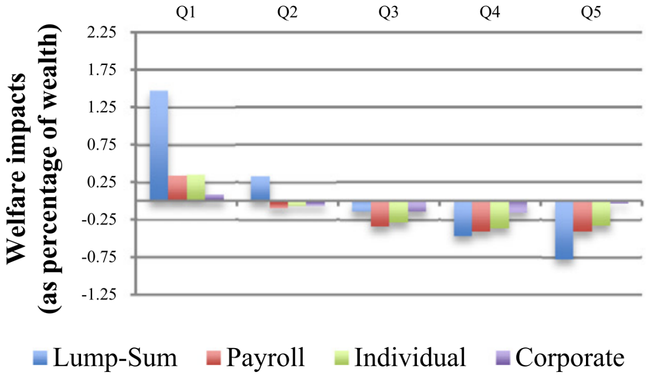
- Options for revenue use:
  - Cut other distortionary taxes (e.g., income taxes)
  - Lump-sum rebates to households
  - Invest in energy efficiency and/or R&D
  - Compensate workers/regions disproportionately impacted

- Key question: can we use revenues to make carbon pricing more equitable or politically acceptable?

What about the revenues?

Revenue use	Possible mechanisms	Rationale
Household rebates	Periodic checks; income tax rebates	Returns payments to households; highly progressive
Labor income tax reduction	Reduced payroll tax rates; reduced personal income tax rates on wage income	Returns payments to workers; increases incentives to work and develop skills
Capital income tax reduction	Reduced corporate income tax rates; reduced personal income tax rates on capital income	Returns payments to capital owners; increases incentives to invest and work
Rebates to regulated entities	Freely allocated allowances; tax exemptions	Returns payments to businesses

Equity-efficiency trade-off of a US carbon tax: Goulder et al. (2019)



- Use their model to study the effect of different revenue recycling programs
- Shows that recycling does matter: impacts are sensitive to the way in which revenues are recycled
- Caveats: only one sociodemographic measure (income); more granular differences; variation across settings

Concluding thoughts

- With 60+ carbon pricing initiatives implemented or scheduled, there is substantial variation in design in practice
- Key take-aways:
  - Design decisions more important than given instrument choice
  - Carbon-pricing as *necessary* but not *sufficient*
  - In a holistic sense, distributional impacts of carbon-pricing may not be as substantial as we thought
- Next week: while the important underlying economic principles hold in all settings, many of what are ultimately the most important political factors are context-specific:
  - → Leakage/competitiveness concerns
  - → Distributional concerns w/ correlated air pollutants
  - → Political economy considerations