The Economics of Green Subsidies

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Outline

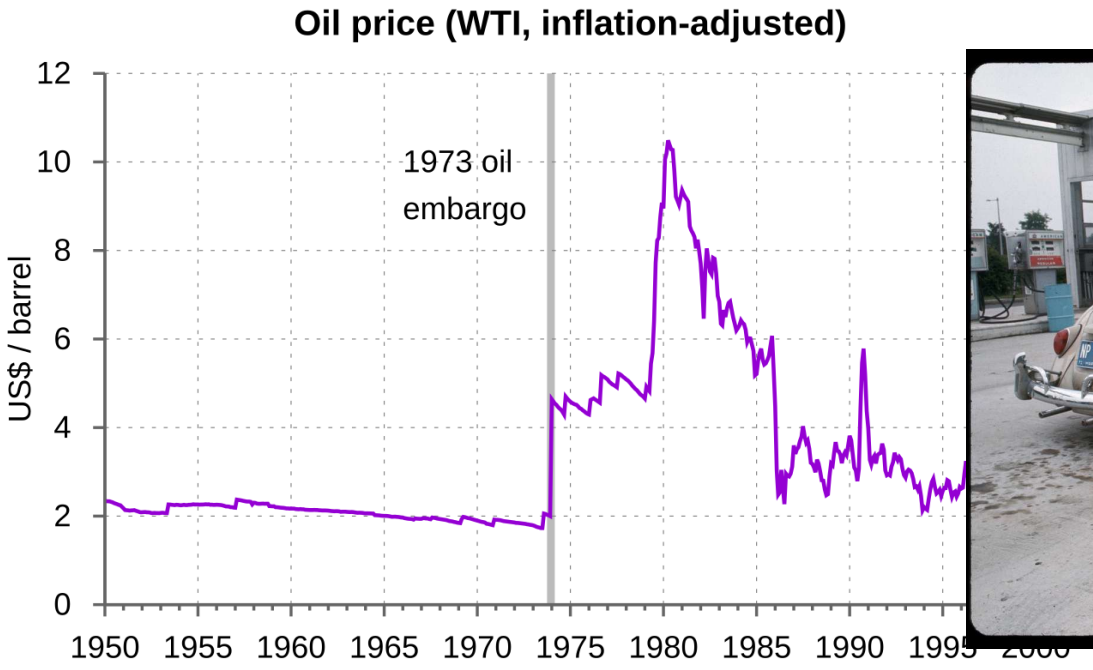
- Background
  - Renewables
  - Policy
- Subsidies vs taxes
  - Efficiency
  - Revenue
- Subsidy targeting
  - Marginal emissions
  - Input vs output subsidies (wind)

History of US “climate” policy

History of US climate policy

1970s: Federal energy efficiency policy targets appliances, autos and buildings

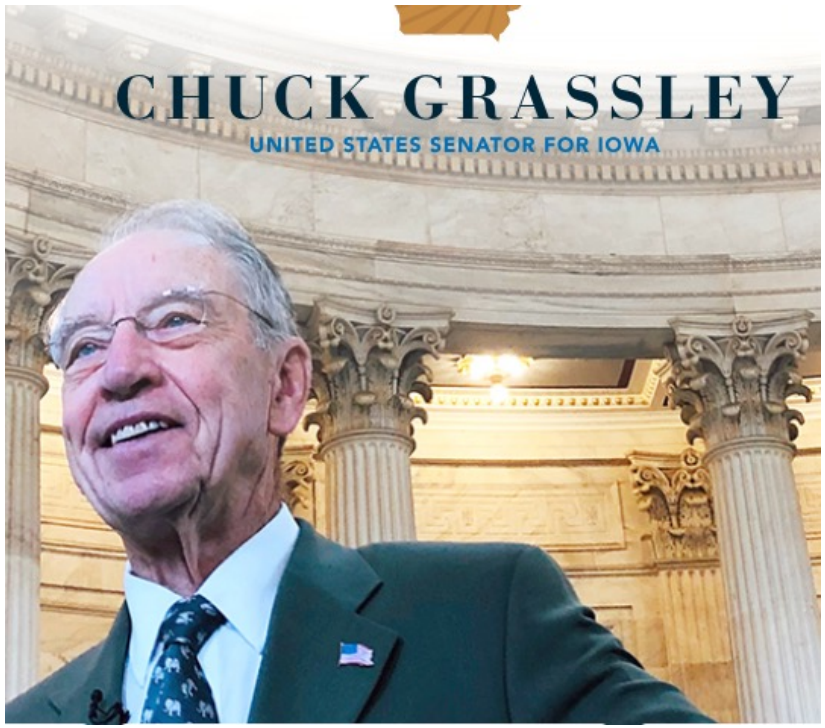
- initially motivated by energy price spikes (OPEC), but main motivation today is climate change



History of US climate policy

1992: Senate approves U.N. Framework Convention on Climate Change

- Renewable energy production tax credit (PTC) added to 1992 Energy Policy Act (by Sen. Chuck Grassley (R-IA))
- Largest federal renewable spending to date



Clinton admin fostered global climate agreement

1997: Kyoto Protocol – cap and trade system on largest polluters (target ~ 5% reduction of 1990 levels)

- Spearheaded by Al Gore and signed by Clinton
- US Senate failed to ratify treaty (97-0). W. Bush crossed off Clinton's name.

US climate policy under Obama admin

2009: American Clean Energy and Security Act (aka "Waxman-Markey") narrowly passes House

- set **cap** on total US emissions 2012-2050
- Senate fails to pass a related measure
- Clear there is no **appetite for a carbon price** in Congress

2014: Clean Power Plan proposed

- Obama admin decided to use **executive authority**
- Note: Some feel this action was *required* by *Massachusetts vs EPA (2007)*, where SC ruled EPA required to regulate CO2 under the Clean Air Act

2016: Obama admin pledges US action in Paris, with CPP as the centerpiece

Trump Reversed Course on Most Fronts

- Clean Power Plan Scrapped
- New CAFÉ standards suspended
- US formally exited Paris Agreement

Biden admin orchestrates a subsidy first approach that gets through Congress

Biden signs Inflation Reduction Act into law


By Maegan Vazquez and Donald Judd, CNN
Updated 10:29 PM EDT, Tue August 16, 2022

Mandel Ngan/AFP/Getty Images

US President Joe Biden speaks during a signing ceremony for H.R. 5376, the Inflation Reduction Act of 2022, in the State Dining Room of the White House in Washington, DC, on August 16, 2022. (Photo by MANDEL NGAN / AFP) (Photo by MANDEL NGAN/AFP via Getty Images)

Key climate provisions in the Inflation Reduction Act?

Clean electricity	Cost in billions
New tax credits for emissions-free electricity sources and storage Including wind, solar, geothermal, advanced nuclear, etc.	$62.7
Extending existing tax credits for wind and solar power	$51.1
Tax credit for existing nuclear reactors To prevent them from closing	$30.0
Extend energy credit Through 2024	$14.0
Clean energy rebates and grants for residential buildings Rebates for installing heat pumps and retrofitting homes	$9.0
Financing for energy infrastructure Updates and expands lending programs to make energy generation and transmission more efficient	$6.8
Tax credit for carbon capture and storage	$3.2

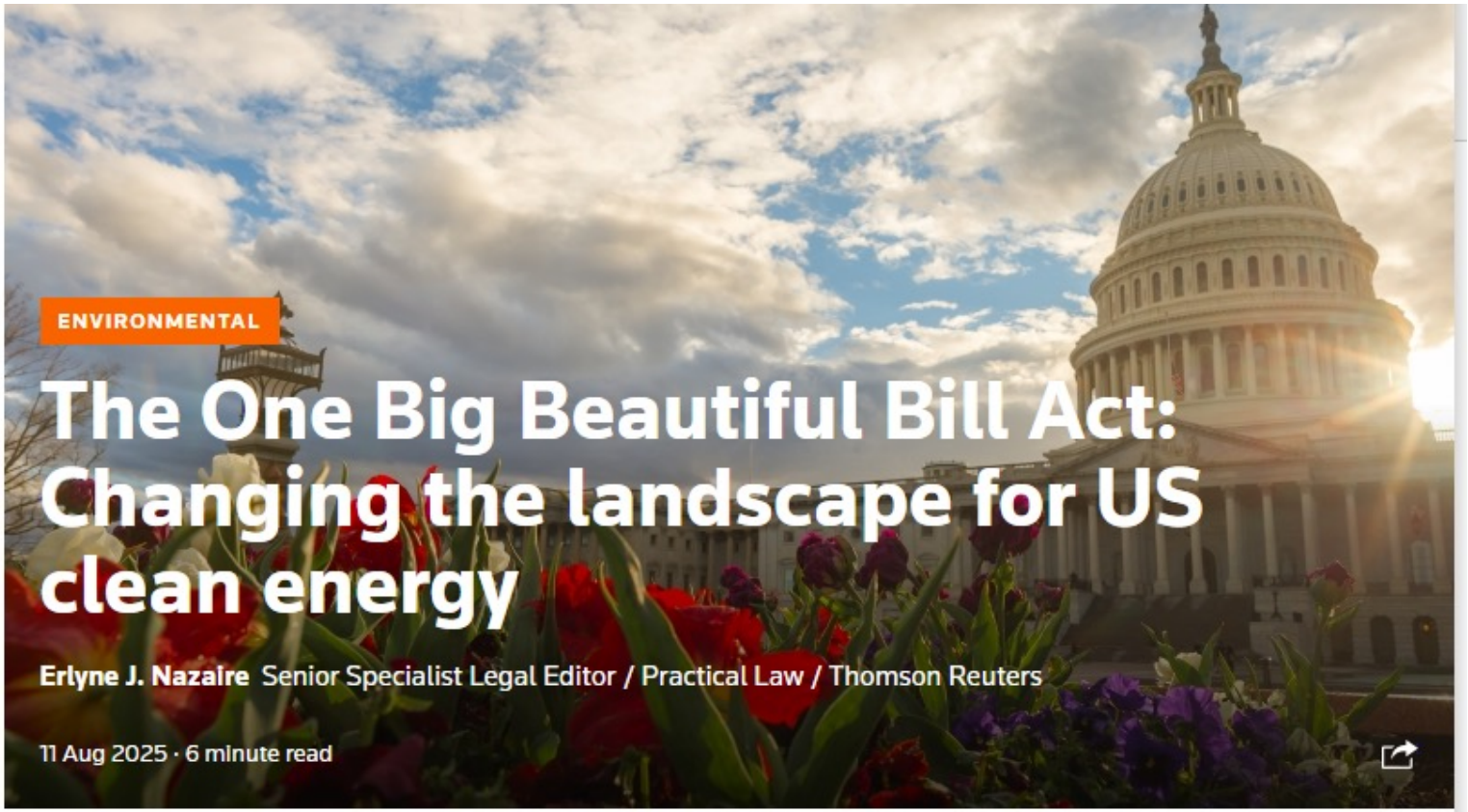
What are the key climate provisions in the Inflation Reduction Act?

Individual clean energy incentives	**Cost in billions**
Green energy credits for individuals Extends and increases tax credits for energy-efficient properties	$36.9

Clean fuel and vehicles	**Cost in billions**
Tax credits for new and used electric cars Incentives for purchasing emissions-free vehicles, with income limits, and for installing alternative fueling equipment.	$14.2
Clean hydrogen production	$13.2
Fuel tax credits Creates new credits for low-carbon car and airplane fuels, and extends credits for biodiesel and other renewable fuels	$8.6
Financing for clean energy vehicles Loans and grants for the production of hybrid, electric and hydrogen fuel cell cars	$2.9

Air pollution	**Cost in billions**
"Green bank" for energy investments For investments in clean energy projects, particularly in poor communities	$20.0
Other air pollution reduction Includes funding for monitoring and reducing pollution, and grants for disadvantaged neighborhoods	$14.8

OBBBA repealed most important subsidies



The OBBBA introduced stricter foreign ownership and sourcing requirements, tighter project deadlines, and heightened compliance challenges for those looking to take advantage of the new and expanded clean energy tax credits

Some econ questions about subsidies

- Economist's prescription for climate crisis is to price the externality.
- Politically, this seems like a non-starter now.
- Does this matter from a econ perspective?
  - Are subsidies just as "good"?
- How to design subsidies
- How *cost effective* has policy been?
  - Was policy well designed or wasteful?

Subsidies vs Taxes: Theory

How to promote renewable energy?

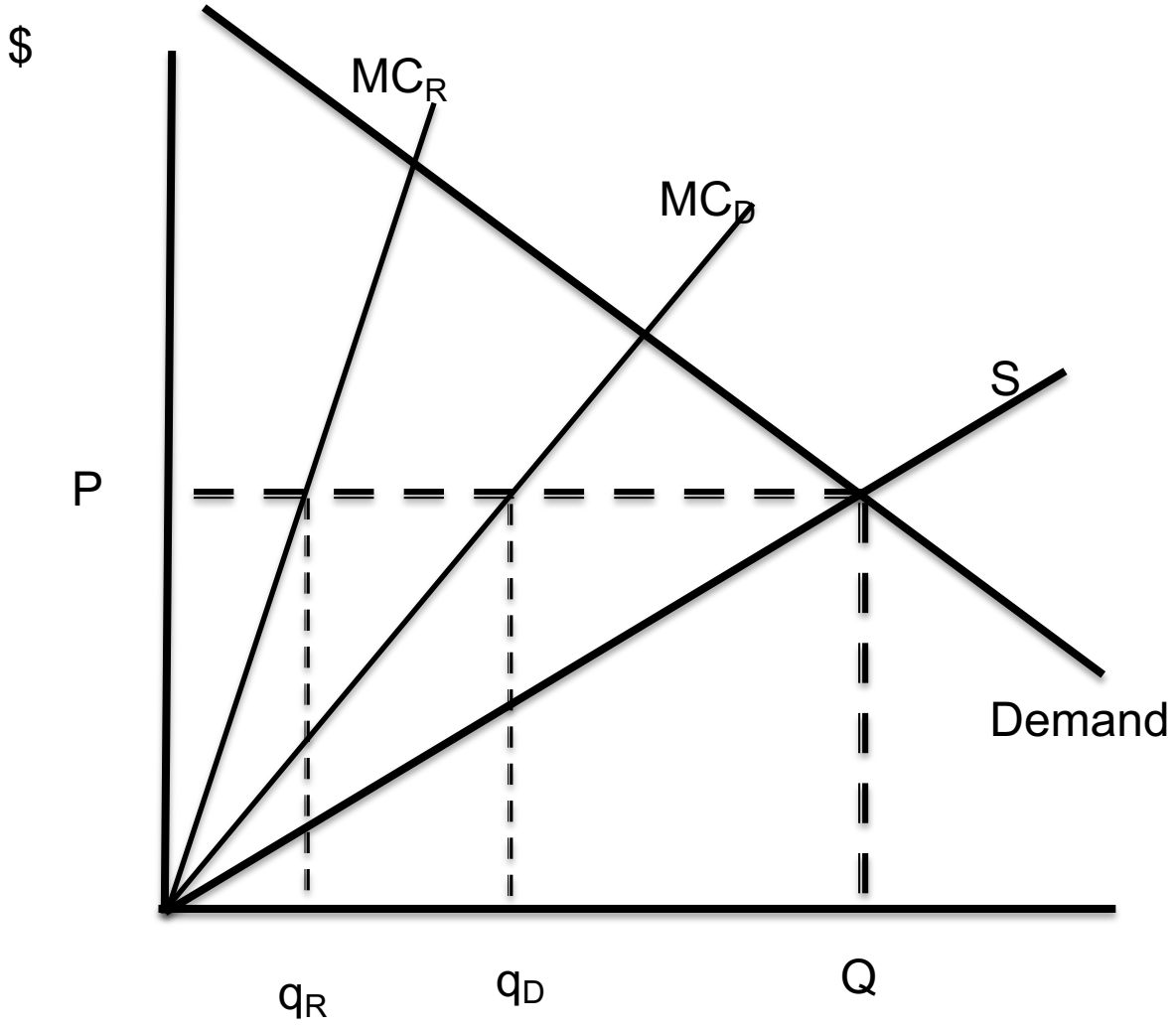
- Best policy would be to place a price on emissions equal to their social cost.
  - **Few countries do this.**
- Instead, many countries prefer to **subsidize clean energy**
  - Many countries around the world use **feed-in tariffs**
  - US has federal tax credits (going back to 1992)
- How do these "second best" policies compare?
- Is it just as good to subsidize renewables as it is to tax oil or coal?

Thinking about the efficient outcome

- Most energy consumed in the United States comes from fossil fuels
- Consuming these fuels emits carbon-dioxide. And, in most states, there is no fee associated with these emissions.

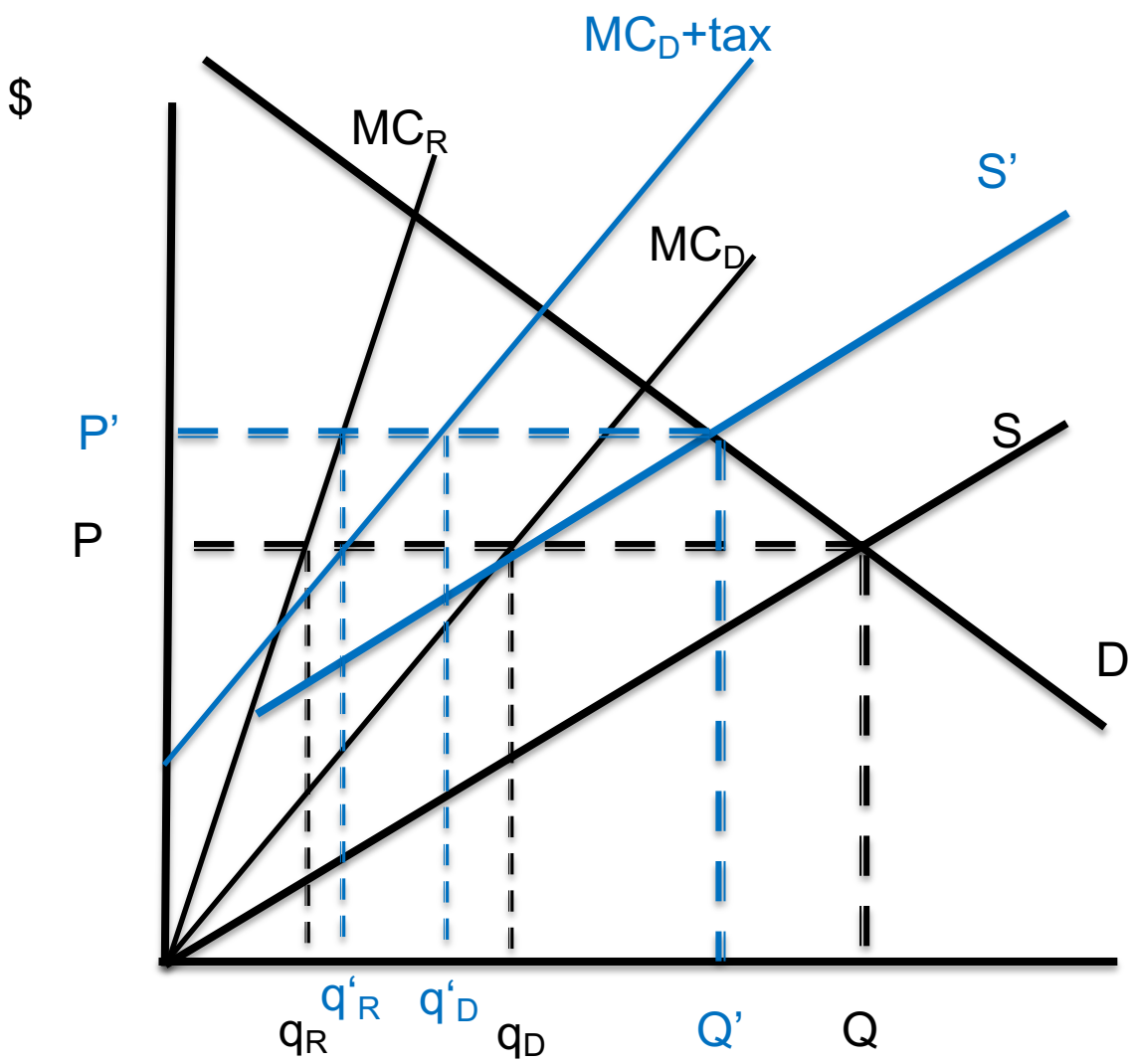
- **Questions:**
  - Relative to the socially efficient levels, do you think US energy prices are too high or too low?
  - What about consumption? Are we consuming too much or too little energy in the US?

Taxes vs subsidies



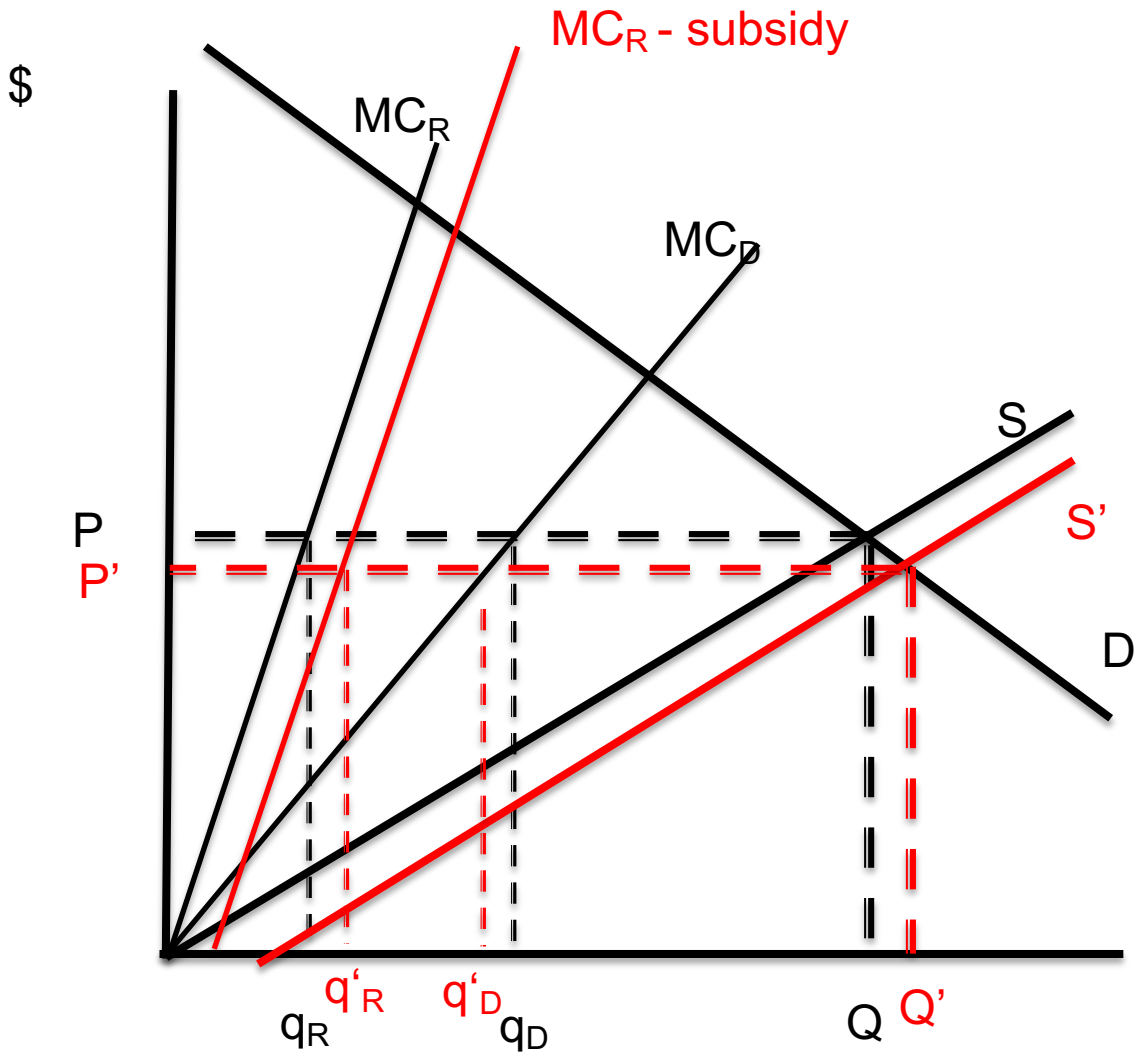
- Two sources of energy, renewable (R), and dirty (D)
- Horizontal sum to get the aggregate supply curve
- This intersects with downward sloping demand to determine price P
- Which in turn determines how much each technology produces

How does a tax on carbon affect energy consumption?



- Now imagine we tax dirty energy at it's social cost.
- This shifts the dirty supply curve **up**
- Which shifts the aggregate supply curve **up**
- Which gives us new prices and quantities
  - Higher MC *reduces* dirty supply
  - The higher price *increases* renewable supply
  - But total consumption **declines**
- Note this raises tax revenue = q'D * tax

What if we try to achieve the same outcome by subsidizing renewables?



- Let's pick a subsidy that will give us the same q'R
- This shifts the aggregate supply curve **down**
- So total quantity Q must go **up** (people use more energy)
- Which in turn means that dirty supply is **higher** than with the tax (but still lower than the baseline)
- Note that unlike the tax, we also have to **spend** subsidy cost q'R * subsidy

Taxes vs subsidies summary

- Market failure due to dirty energy externality
- When we internalize this externality, we use less energy. Some dirty energy switches to substitutes.

- Politically, it is appealing to try to just jump to this outcome by subsidizing clean energy
- But this actually *subsidizes* energy (with no corresponding externality justification)
  - Coal consumption will go down, but will still be above the social optimum
- Bottom line: Green subsidies can **never** be efficient

Additional concern: Taxing vs Spending

- Public finance concerns
  - Politicians like subsidies and hate taxes. But subsidies must be paid for somehow.
  - Does this matter?

Review: DWL from (non Pigouvian) taxes

- Keeping everything else constant, subsidizing green behavior must involve taxes elsewhere. This has DWL
- Estimates are approx 5 – 7 cents per dollar.
  - ie a $100M solar subsidy costs us $107M

Conversely, Pigouvian taxes, raise money

- Policymakers often earmark carbon tax revenue for green spending.
- But could just use it to cut taxes elsewhere
- This is sometimes called the "Double Dividend" of Piguovian taxes
  1. Tax in polluting market restores efficiency
  2. Balanced budget reduction in other taxes (ie lable) reduces DWL from taxation in those markets

Congress faces shutdown showdown as budget deadline looms

With the US budget deadline near, Congress risks another shutdown – echoing past battles where politics, not budgets, drove the fight

by J 'Masharubu' Strauss – 26-09-2025 17:17 in Politics, World Reading Time: 7 mins AA

Subsidy Targeting

Additional concerns: Targeting

- CO2 taxes penalize exactly the margin of the relevant externality
  - Cost of these goods goes up, so people buy less / use them less, and emissions go down.
- Green subsidies work through **substitution:** CO2 emitting goods become *relatively* more expensive, so people buy less / use less.
- This only works well if the green goods subsidized are really close substitutes for polluting goods.

Example: Fuel consumption

Escalade

- 17 MPG
- Emissions per 10,000 miles: 5.2 tons

Prius

- 57 MPG
- Emissions per 10,000 miles: 1.5 tons

Cost increase under a $180/ton carbon tax

Escalade

- Emissions per 10,000 miles: 5.2 tons
- Annual tax: $940

Prius

- Emissions per 10,000 miles: 1.5 tons
- Annual tax: $280

Carbon tax is perfectly targeted – dirty goods pay more

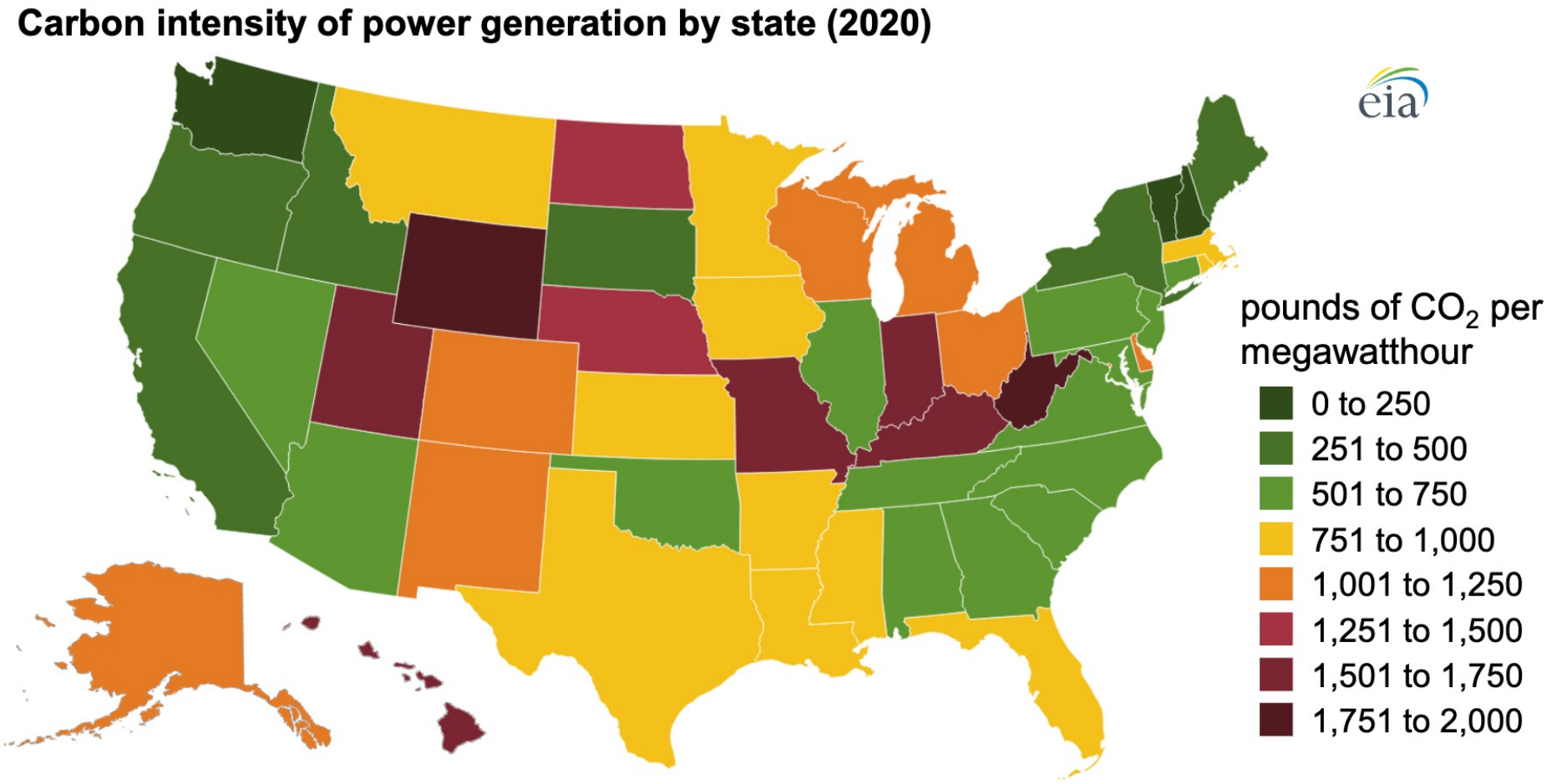
How much should we pay someone to switch to an EV?

- Assume EV is really "zero" emissions
  - Is this a good assumption?
- If alternative is Escalade, saves society ~ $1000 per year.
- If it's a Prius, only saves ¼ of that
- Current subsidy up to $7500 **for any** EV

What about electricity?

Should we subsidize renewable energy more in Hawaii, or Indiana?

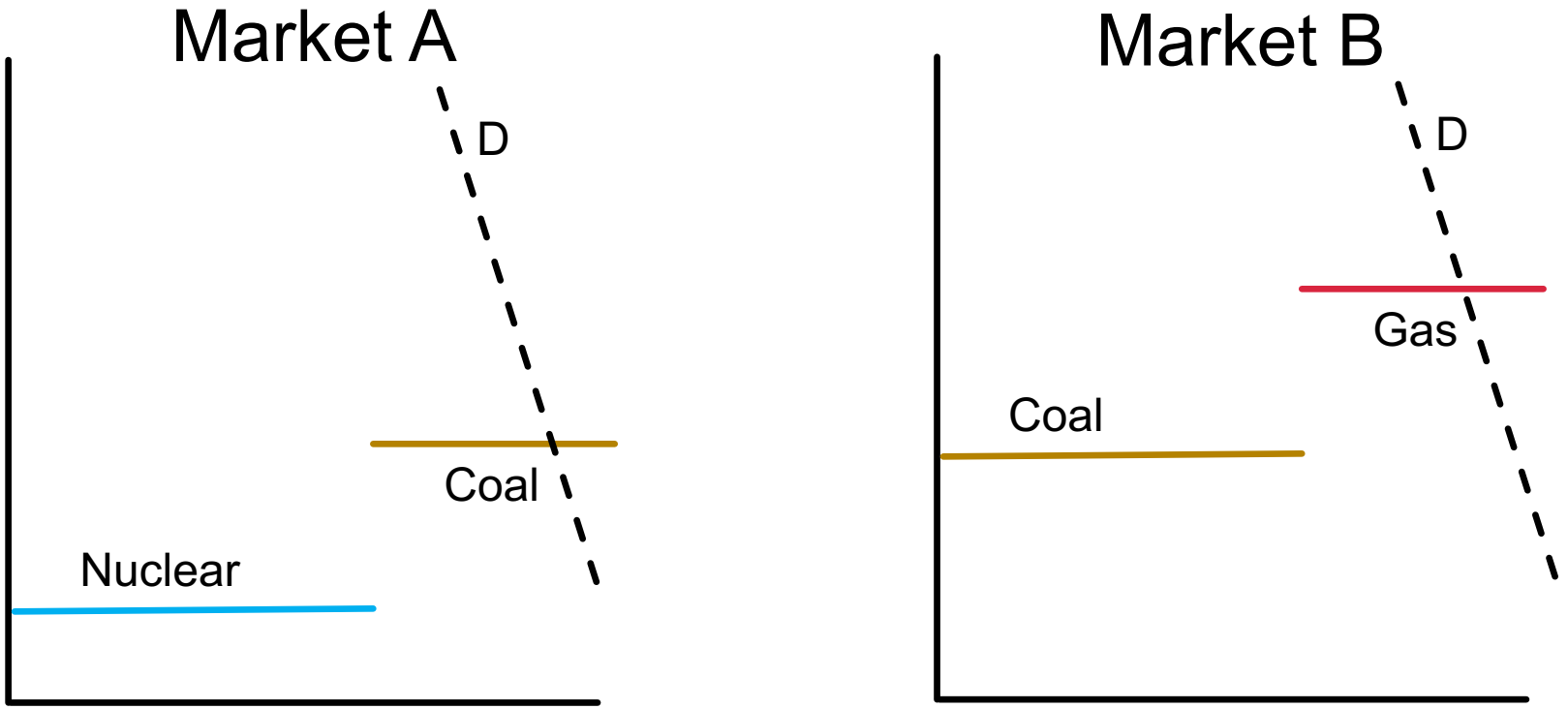
Current subsidies pay the same amount regardless of where the plant is sited



Data source: U.S. Energy Information Administration, *Power Plant Operations Report*

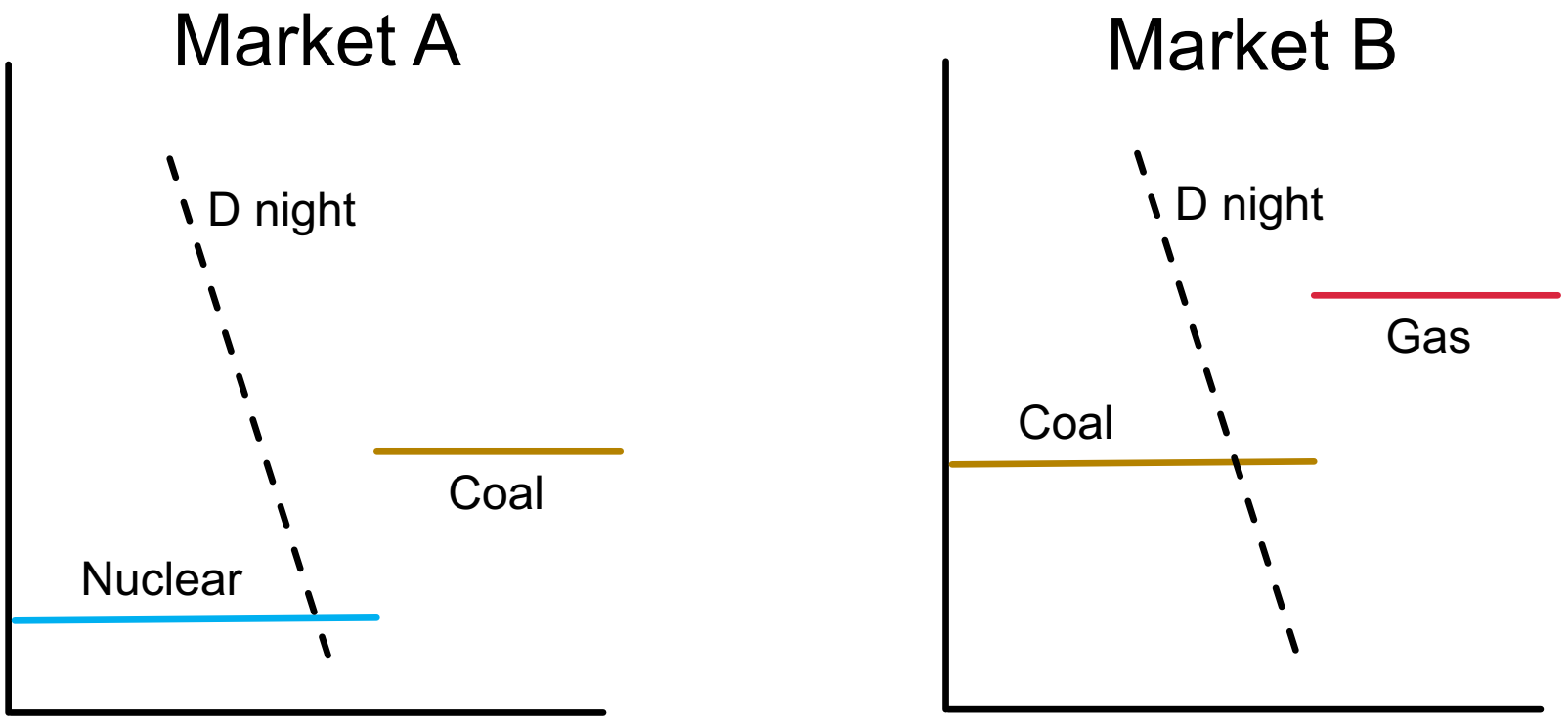
Note this shows **average** emissions. Is that what we want?

Where should we site renewable plants?



- Which market has higher **average emissions?**
- If you could add a small amount of renewable energy to one market, which would reduce CO2 more?

Wind is typically more productive at night



- Marginal emissions vary across time within the same market as demand changes.
- Solar more productive during day/ summer; wind night / winter.

What should we be subsidizing?

What "margin" to subsidize

- CO2 taxes are easy: taxes the externality generating activity at its marginal external cost
- Subsidies involve more choices
  - Should be subsidies EV's, or subsidize electricity when charging EV's?
- We know that **no subsidy** margin is efficient the way that a tax is
- But some might be more **cost-effective:**
  - We want to maximize the amount of green output / carbon dioxide emission reductions per $ spent

Investment versus Output Subsidies: Implications of Alternative Wind Power Incentives

Joseph Aldy[1] Todd Gerarden[2] Richard Sweeney[3]

[1]Harvard Kennedy School

[2]Cornell Dyson

[3]Boston College

Are investment or production subsidies more cost-effective?

- Wind historically subsidized by the production tax credit (PTC)
  - Pays wind farm owner a subsidy every time the plant sends power to the grid
- Solar historically subsidized by an investment tax credit (ITC)
  - Pays 30% of up front investment costs. After that the plant is on it's own.
- A 2009 "natural experiment" offered wind developers the option to tax either
- Which "margin" is better? Why might it matter?

Economics of Wind Power

- Large initial capital investment
  - Siting, financing, procurement, etc.
  - Long lead times – average time in MISO queue $>$ 3 years
- Once online, generation each period is a function of wind speeds
- ... and managerial / operational decisions
  - Is the wind turbine available?
    - downtime after failure
  - State of operational efficiency
    - maintenance frequency and quality
  - McKinsey (2008) - "improved O&M could account for a nearly 20% increase in the equity IRR"
- Marginal effort can increase performance

Research Question

Are wind farms less productive if they receive an investment subsidy rather than an output subsidy?

Methods

- Use natural experiment introduced by ARRA
- Instrumental variables approach (fuzzy RD)
- Matching + "difference-in-differences"

Results

- Wind farms selecting the investment subsidy are 10-12% less productive than they would have been (under the PTC)
- Back of the envelope calculation suggests US paid 17% more per unit of wind output under 1603

Instrumental Variables Results

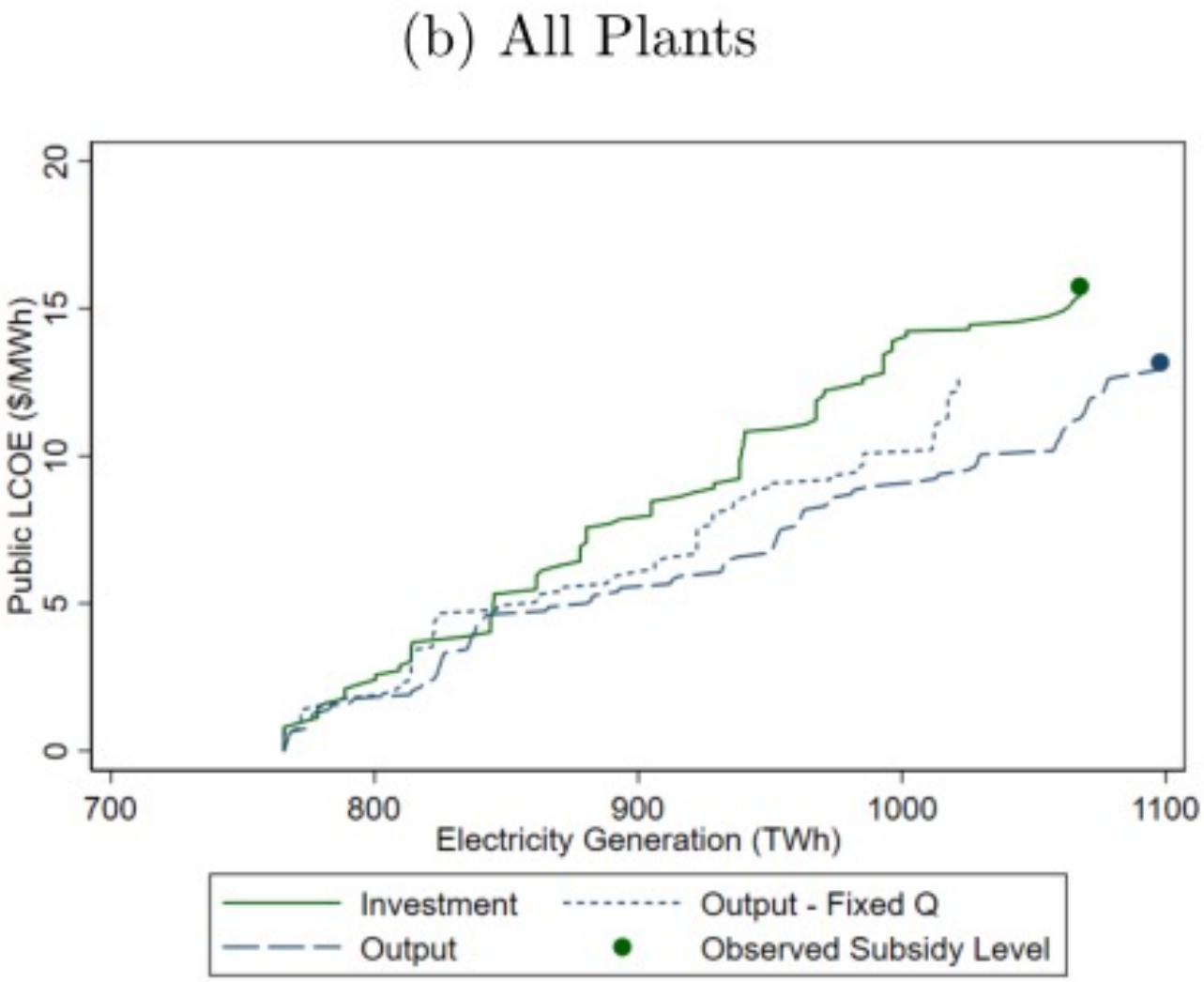
	(1)	(2)	(3)	(4)
1603 Grant	-3.63***	-2.84***	-2.89**	-3.16***
	(0.90)	(0.83)	(1.24)	(1.17)
Regression Type	OLS	OLS	2SLS	2SLS
Controls	Y	Y	Y	Y
State FE	N	Y	N	Y
R-sq.	0.557	0.660	-	-
N	8752	8752	8752	8752
First-stage F-stat.			169	113

Controls: Regulated, PPA, IPP, Potential Capacity Factor, wind variance, and log capacity. Standard errors clustered at the plant level presented in parentheses.

Average 1603 Plant Capacity Factor $\sim$ 30

Preferred estimate $\sim$ 10% reduction

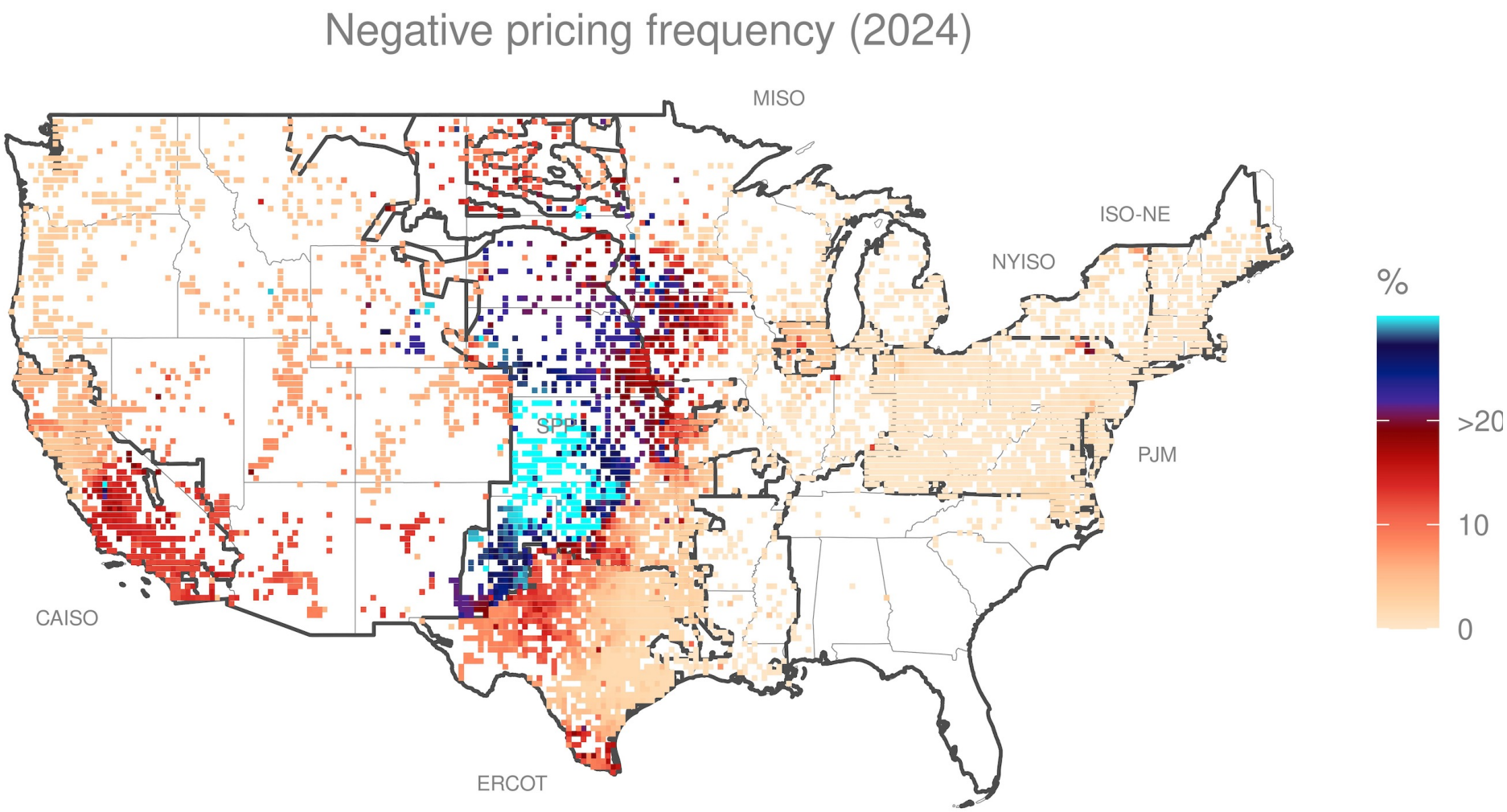
Cost-effectiveness: Wind subsidy supply curve



Will the subsidy margin effect how wind farms bid in the power market?

- Imagine the PTC is $25/MWh. Will that change how a wind farm bids?
- What about the ITC? Assume it is 30% of capital costs.

Due to the PTC (and other subsidies), electricity prices are often negative



Summary on green subsidies

- Know difference between subsidies and taxes.
  - Efficiency
  - Public revenue
  - Targeting
- Be able to think through what would change (prices, quantities, emissions, etc) in response to a subsidy.
  - Know both graphical results and intuition.
- Some subsidy designs better than others. Cost-effective subsidies achieve policy target at lowest public cost