The Effects of "Buy American": Electric Vehicles and the Inflation Reduction Act

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Inflation Reduction Act: environment + industrial policy

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- Key feature: marries environmental goals with industrial policy
  - Green subsidies with domestic preferences

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- Motivating concern: China dominates global EV sales, manufacturing, and supply chains
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Research questions:

- What are the efficiency and distributional effects of the IRA’s new EV tax credits over the first few years?
- What are the tradeoffs between environmental vs. trade objectives?

This paper

Approach:

1. **Event study analyses**: what happens when vehicles gain or lose tax credit eligibility
2. **Structural model**: short-run welfare effects of counterfactual policies

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Short-run evaluation of IRA's first few years

- Not intended to capture important potential long-run effects: supply chain adjustments, new EV models, learning-by-doing externalities

Literature

- **Clean vehicle tax credits**
  - Policy overviews: Bown (2023), Buckberg (2023)
  - Evaluations of past state/federal credits: Chandra et al. (2010), Sallee (2011), Gallagher and Muehlegger (2011), Jenn, Azevedo, and Ferreira (2013), Jenn, Springel, and Gopal (2018), Clinton and Steinberg (2019), Sheldon and Dua (2019), Xing et al. (2021), Muehlegger and Rapson (2022), Lohawala (2023)
  - Ex-ante evaluations of IRA credits: Cole et al. (2023), Slowik et al. (2023), Bistline, Mehrotra, and Wolfram (2024), Hahn et al. (2024)
  - Long-run benefits: Head et al. (2024), Linn (2022), Barwick et al. (2023, 2024)
- **Auto market environmental regulation**
  - Goldberg (1998), Bento et al. (2009), Fowlie et al. (2012), Jacobsen (2013), Knittel and Sandler (2018), Jacobsen and van Benthem (2015), Gillingham et al. (2021), Jacobsen et al. (2022)
- **Non-tariff trade barriers** such as domestic content restrictions
  - Conconi et al. (2018), Head, Mayer, and Melitz (2022), Cox and Acosta (2023), Bombardini et al. (2024)

Agenda

1. Background
2. Data
3. Event studies
4. Structural model
5. Counterfactuals

Background

Background: Clean Vehicle Credits

Internal Revenue Code Section 30D (2008):

- Non-refundable income tax credits up to $7,500 for new plug-in EVs under 14,000 pounds
- Available to buyers (on personal taxes) or lessors (on corporate taxes)
- ARRA (2009) limited eligibility to the first 200k EVs sold by each manufacturer
  - Tesla & GM over 200k in 2018/2019, Toyota & Ford in 2022, Stellantis & BMW in 2023

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Inflation Reduction Act (August 16, 2022):

- Amended Section 30D
  - January 1, 2023: max buyer income $300k (married), $225k (household head), $150k (all other)
    - IRS + NVES survey data: ~ 2/3 of EV buyers income-eligible
  - Vehicle eligibility changes over time (next slide)
- New Section 45W: commercial credit
  - January 1, 2023: available to lessors
  - No eligibility restrictions (“leasing loophole”)
- New Section 25E: used EV credit
  - See Kwon, Snyder, and Allcott (2024)

30D credit eligibility over time

Eligibility group	Models	Pre-IRA	8/17/22 - 12/31/22	1/1/23 - 4/17/23	4/18/23 - Late 2023
		Exclude if sales > 200k	Exclude if assembled outside North America	Re-include if sales > 200k; exclude if MSRP > $55k/$80k	Exclude foreign battery minerals/components
Excluded Aug 2022	**Audi** (Q4 e-tron, Q8 e-tron); **BMW** (i4, iX); **Hyundai** (Ioniq 5, Kona); **Kia** (EV6, Niro); **Lexus** (NX PHEV); **Mercedes-Benz** (EQB); **Nissan** (ARIYA); **Polestar** (Polestar 2); **Porsche** (Taycan); **Subaru** (Solterra); **Toyota** (RAV4 PHEV, bZ4X); **Volvo** (C40, XC40, XC60 PHEV, XC90 PHEV)	$7,500			
	BMW (530e PHEV); **Kia** (Sorento PHEV, Sportage PHEV); **Toyota** (Prius PHEV)	$3,750 - $7,500			
Included Jan 2023	**Chevrolet** (Bolt, Bolt EUV); **Tesla** (Model 3, Model Y)			$7,500	
Excluded/reduced Apr 2023	**Ford** (E-Transit, Mustang Mach-E); **Jeep** (Grand Cherokee PHEV, Wrangler PHEV); **Rivian** (R1S, R1T)	$7,500			$3,750
	Ford (Escape PHEV)	$3,750 - $7,500			$3,750
	Audi (Q5 PHEV); **BMW** (X5 PHEV); **Nissan** (Leaf)	$7,500			
Excluded Jan 2023	**Lucid** (Air); **Mercedes-Benz** (EQS)	$7,500			
Always included	**Chrysler** (Pacifica PHEV); **Ford** (F-150 Lightning); **Volkswagen** (ID.4)	$7,500			
Always excluded	**Tesla** (Model S, Model X)				

Data

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Submodel $\times$ **month panel** of new light-duty vehicles from January 2022–December 2023

- "Submodel": make $\times$ model $\times$ trim $\times$ powertrain
- k: submodels, t: months

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- Prices:
  - Dealership transaction microdata (Cox Automotive)
    - 31% of US new vehicle transactions
    - Includes dealership rebates and lease terms
    - *Lease price*$_{kt}$ $:=$ PDV of lease payments + residual value
    - *Relative lease price*$_{kt}$ $:=$ *lease price*$_{kt}$ $-$ *purchase price*$_{kt}$
    - No coverage of direct-to-consumer (DTC) brands (Tesla, Rivian, Lucid)
  - California registration microdata (CA DMV)
    - 32% of US new vehicle transactions
    - 0.99 correlation with Cox prices at kt level
  - Tesla prices and lease terms (Tesla website)

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Second choice survey data (National Vehicle Experience Survey)

Event studies

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Empirical questions:

1. How much of the incidence of new EV tax credits is on consumers vs. producers?
2. How elastic is substitution between purchases and leases?

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Approach: event studies around 30D and 45W eligibility changes in submodel $\times$ month panel

- Control group: gasoline vehicles
  - All vehicles affected in market equilibrium $\implies$ we estimate relative effects
- Weight submodels by average monthly registrations
- Cluster standard errors by model

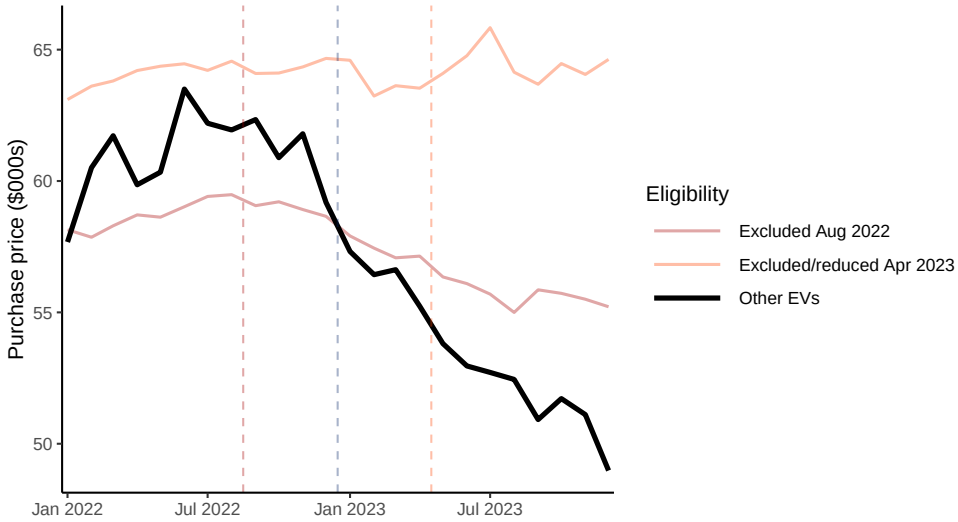
Economic incidence: purchase prices

Economic incidence: purchase prices

Setup:

- Section 30D purchase credits claimed by buyers
- No purchase price change when credit eligibility changes $\implies$ incidence fully on consumers
- Context: inventory highly constrained in 2022, surplus in 2023

Purchase price trends



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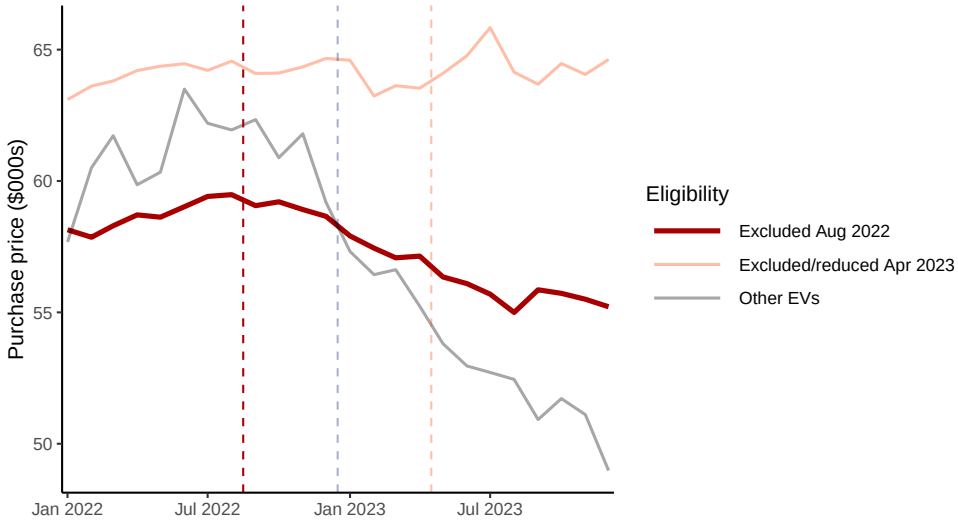

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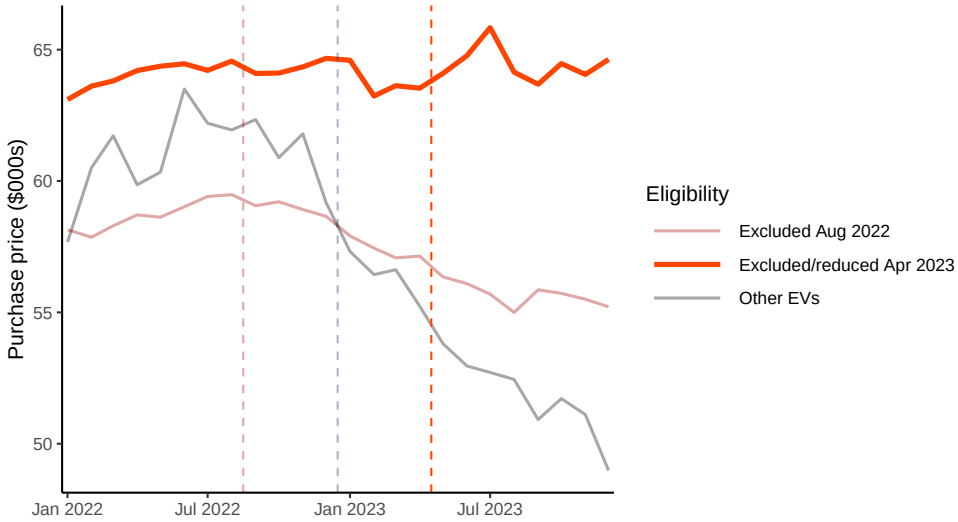
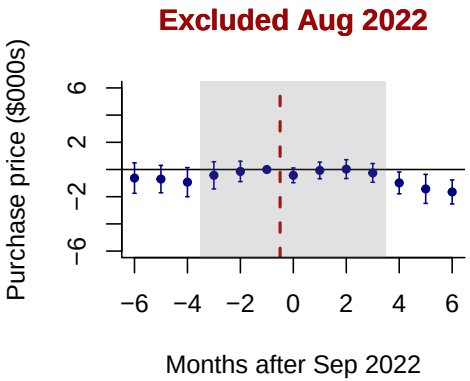
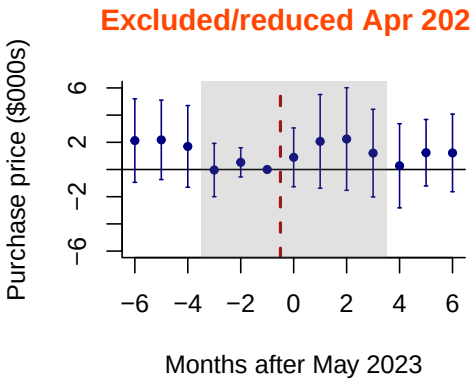


Purchase price event studies





- Periods -3 to +3, pooled: reject price decreases more than $385
- $\implies$ almost all short-run incidence is on consumers

Economic incidence: relative lease prices

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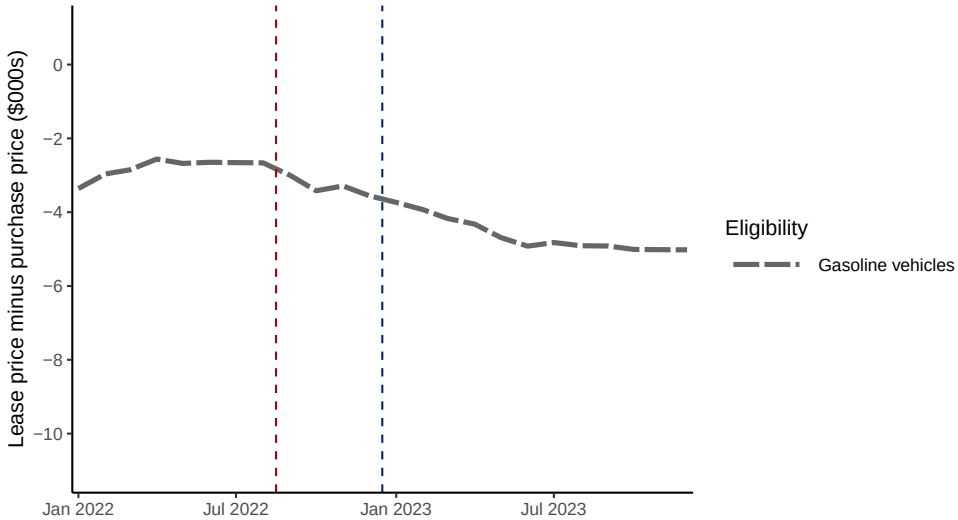
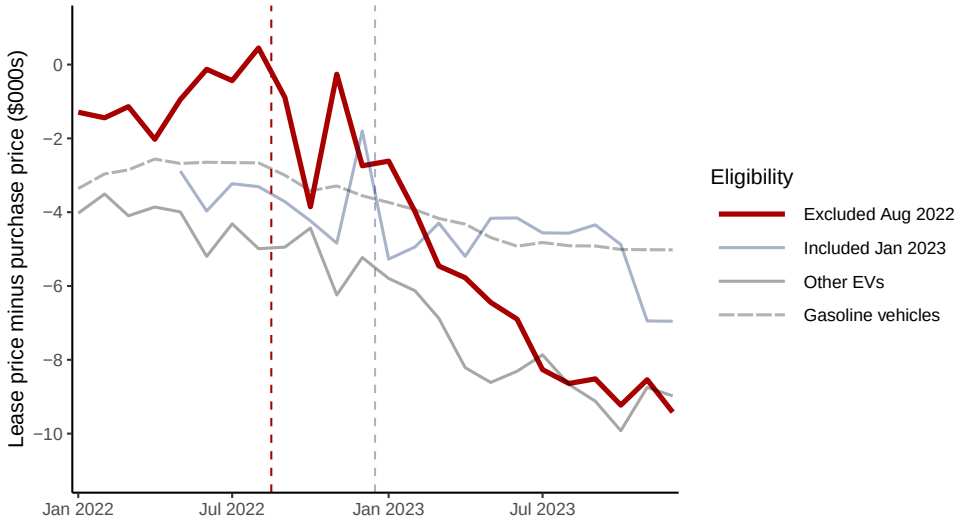
Setup:

- Starting January 1, 2023: Section 45W credits available to lessors
- Test for changes in *relative lease price* (i.e., lease price – purchase price)

Gasoline vehicle relative lease prices drop as market softens



Relative lease price trends



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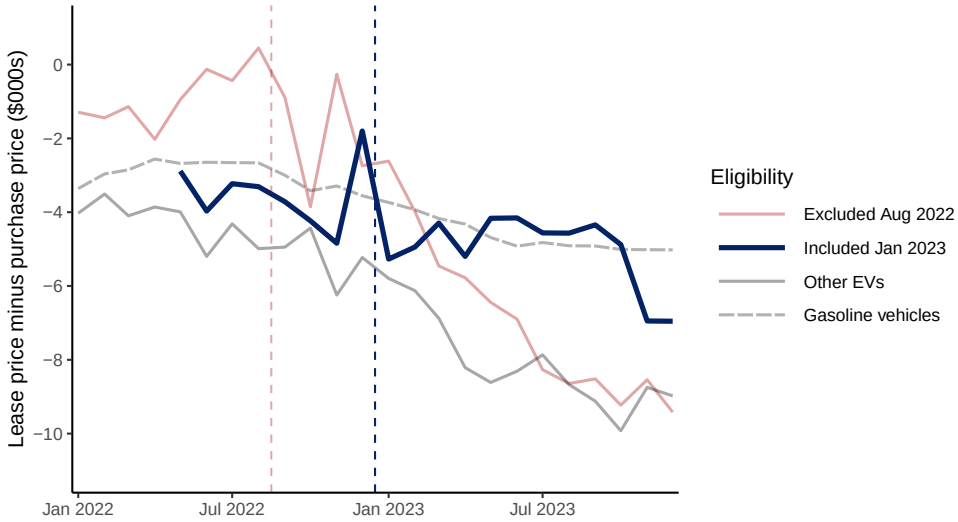

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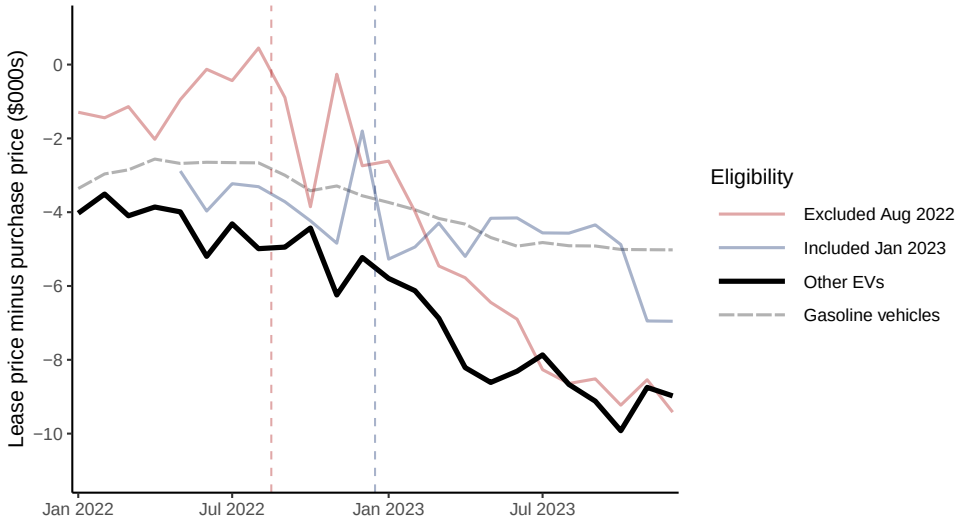
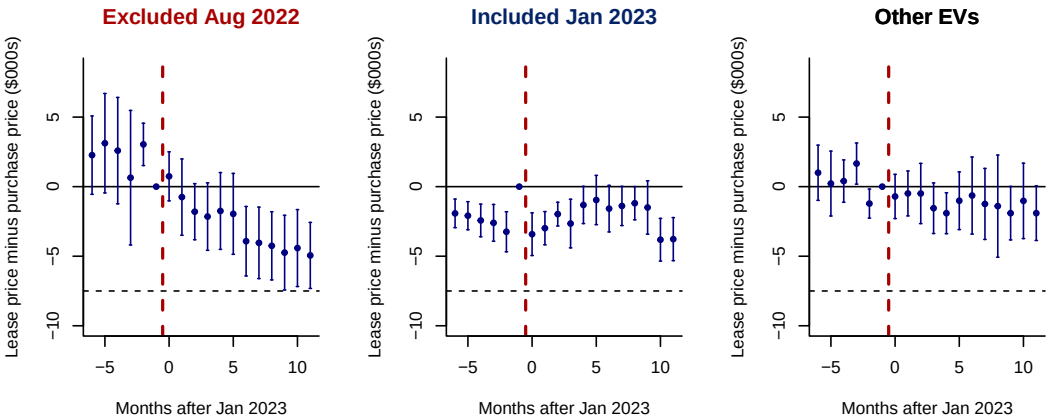


Relative lease price event studies



- Aug 2022 & Jan 2023 groups: relative lease prices drop by $2k - $5k
- $\Longrightarrow$ short-run incidence split between firms and lessors

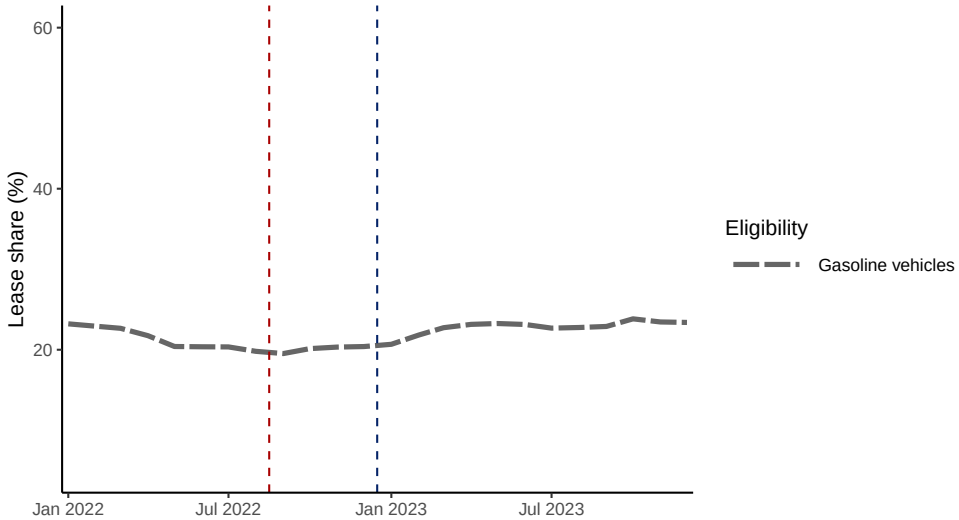
Purchase-lease substitution

Purchase-lease substitution

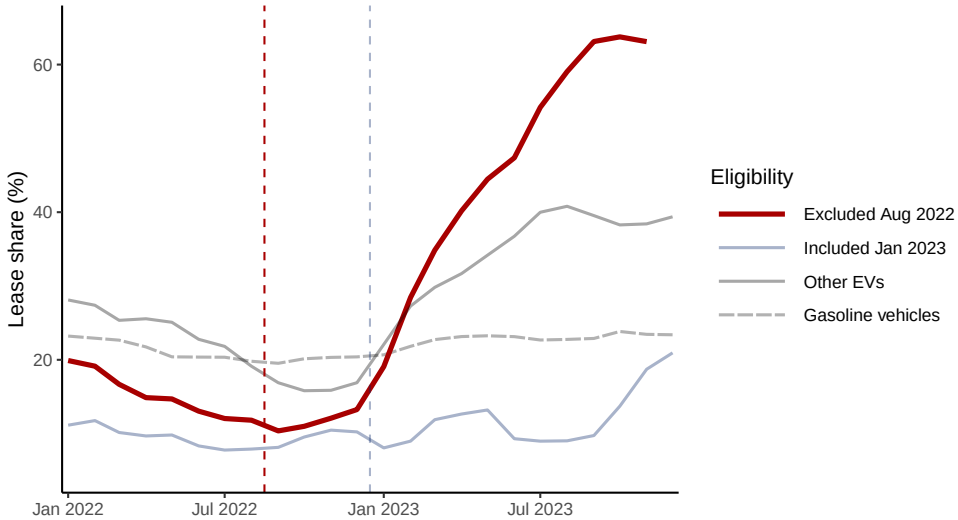
Setup: expect two effects on lease shares in 2023

1. Price effect: relative lease prices decrease
2. Buyer eligibility effect: high-income buyers lose 30D eligibility

Gasoline vehicle lease shares increase slightly over 2023



Lease share trends by eligibility group



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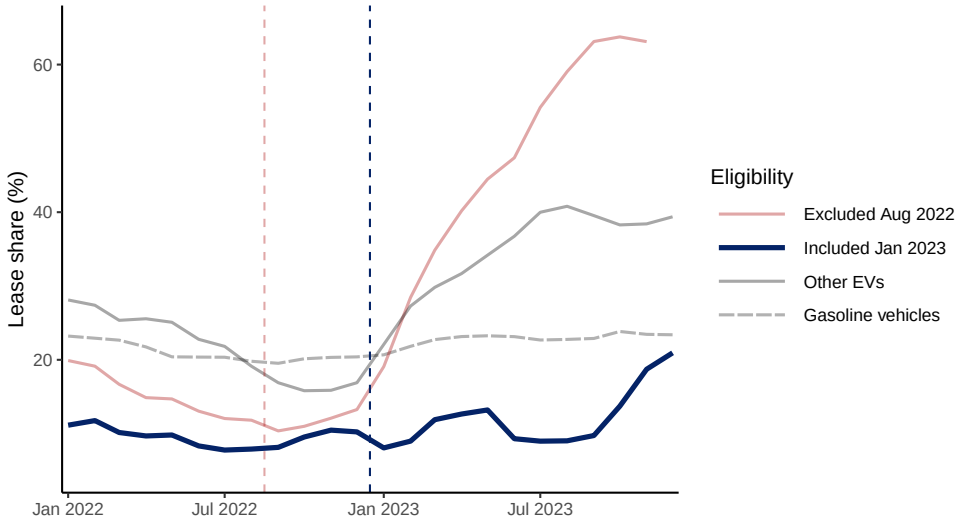

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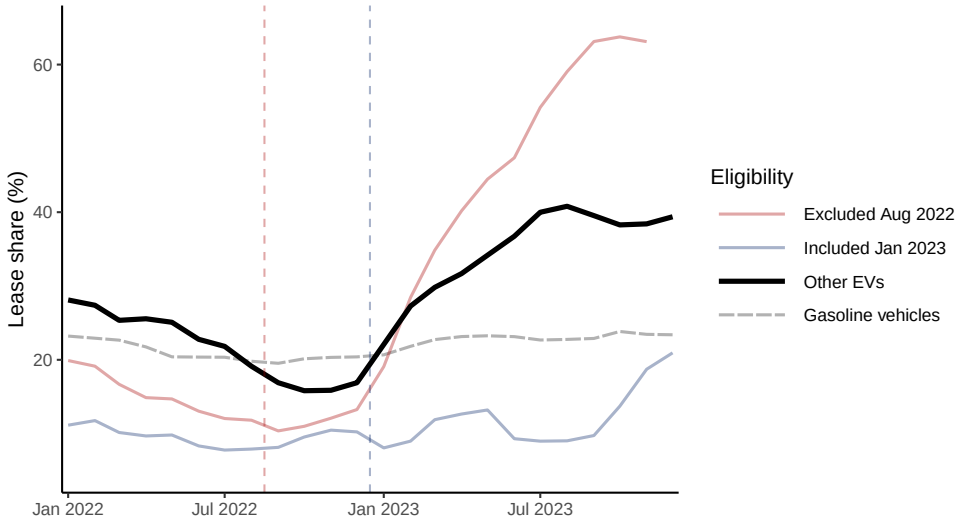

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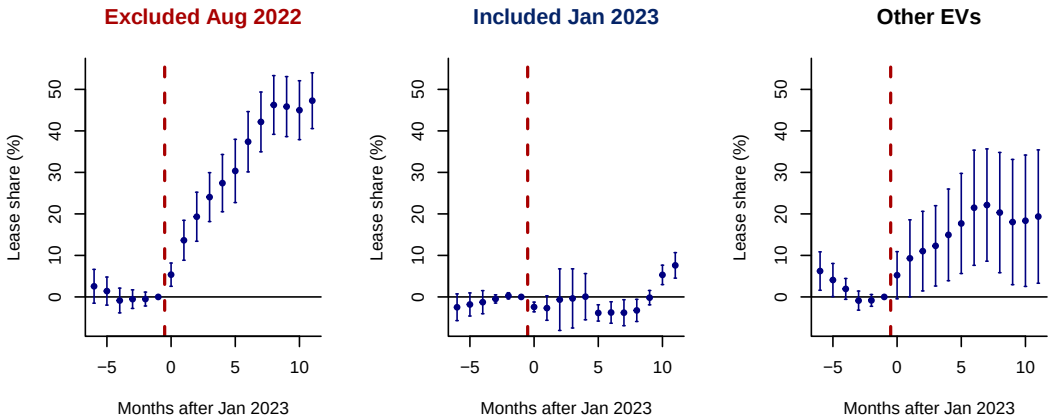

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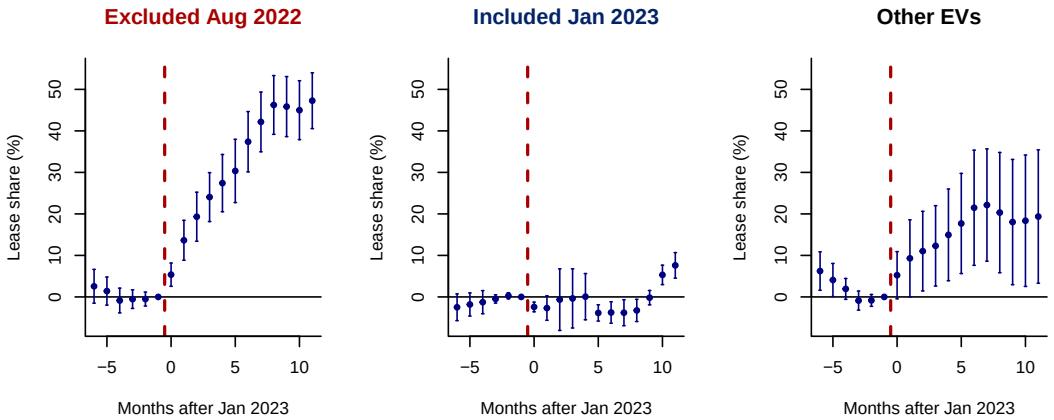

- Aug 2022 group: semi-elasticity of substitution ≈ 45% / -$5k relative price ≈ -10% / $1000

Structural model

Model overview

Question: what would be the short-run effects of counterfactual EV tax credit designs?

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Approach:

- Static, partial equilibrium, quasilinear utility, lump-sum revenue recycling (MCPF = 1)
- Nested logit demand, Nash-Bertrand supply
- Choice set: 2023 new vehicle submodels + outside option

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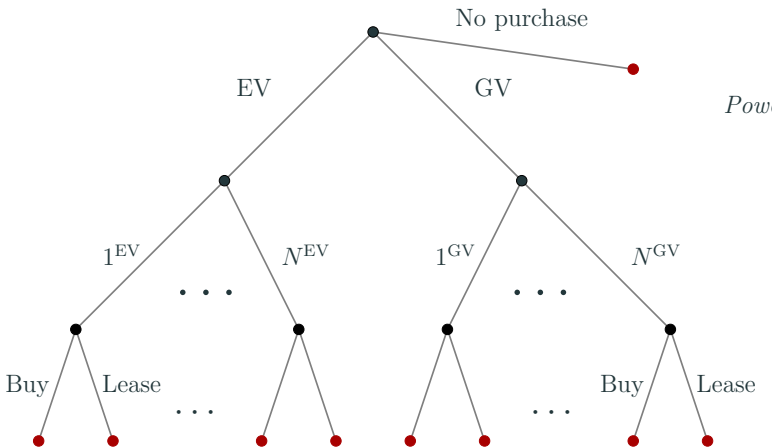
Comments:

- Today: one income type, so no income eligibility restrictions
- Short-run model
  - Not informative about very short-run (inelastic supply) or long-run (entry of new models, supply chain adjustment, learning-by-doing)
  - See Linn (2022), Head et al. (2024), Barwick et al. (2023, 2024)
- Ignore interactions with other policies, e.g. CAFE/GHG standards
  - See Linn (2022)

Demand: nested logit



Powertain/purchase decision

Submodel

Purchase type

Identification and estimation

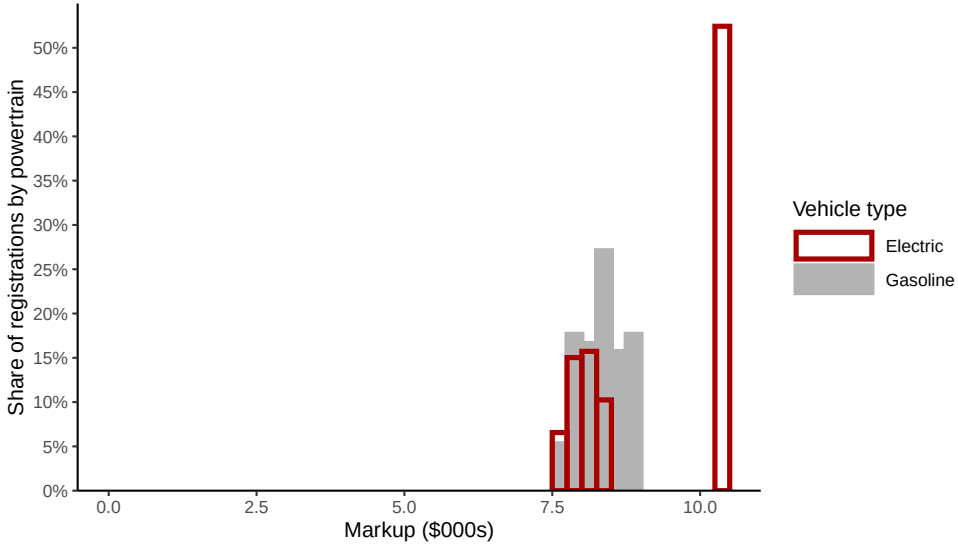
- Set outside option share so that new vehicle demand elasticity $\approx$ -1 (BLP 2004, Allcott et al. 2024)
- EV-GV substitution: match second-choice data
  - 52.3% of EV buyers have another EV as second choice
- Substitution across models: match model-level own-price elasticity = -5.36 (Grieco et al. 2023)
- Purchase-lease substitution: match event study estimates
  - EV lease shares increase 40 percentage points with a $-4,829 decrease in relative lease prices
- Non-price attributes: match 2023 market shares

Market failures

Market failures

1. Imperfect competition $\Longrightarrow$ markups
2. Unpriced externalities

Distribution of model-implied markups by powertrain



Externality assumptions

Goal: submodel-specific lifetime externalities for sales marginal to counterfactual policies

- Assume 150,000 mile lifetime (EPA 2014)
- Social cost of carbon = $241 (EPA 2023)

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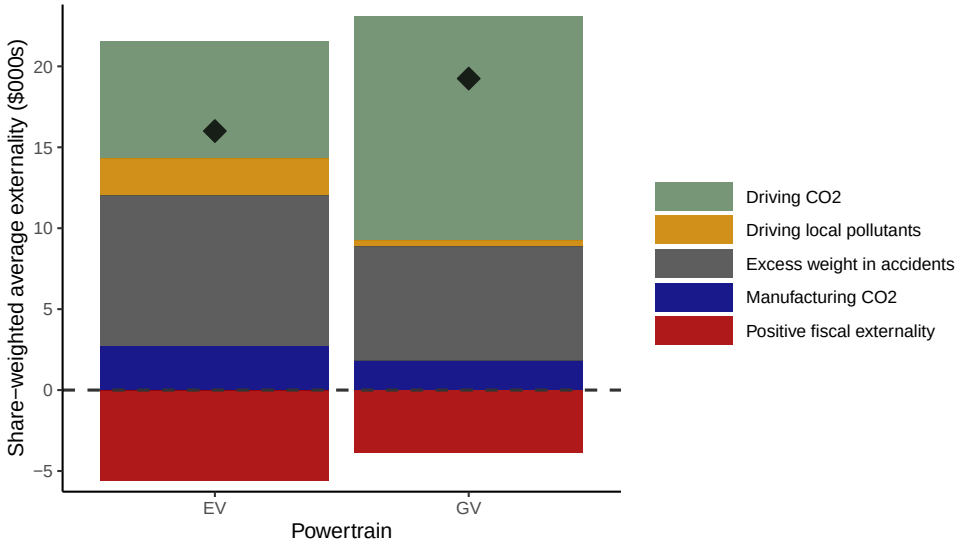
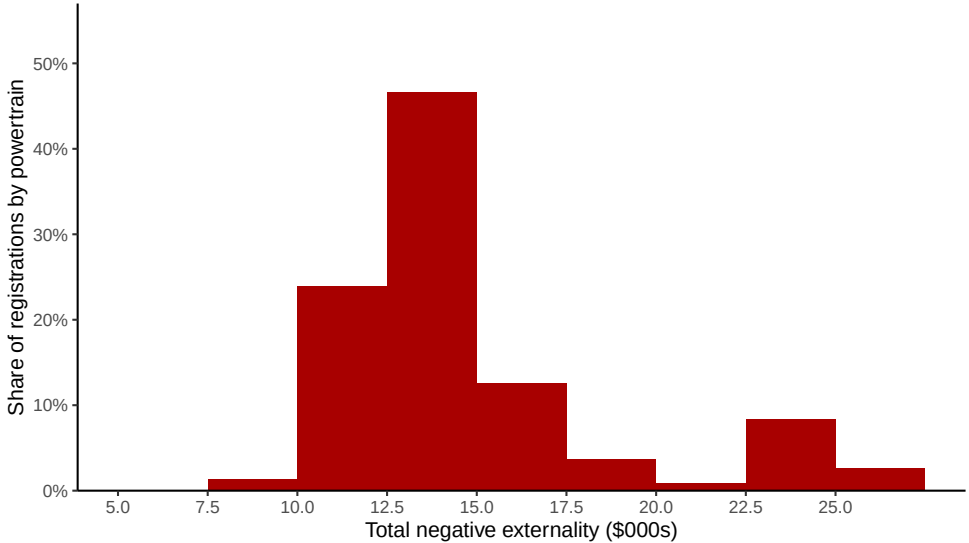
Externality types:

- **Manufacturing CO2**
  - By powertrain, from EPA (Kelly et al. 2022)
- **Driving CO2 and local air pollution**
  - Follow Holland et al. (2016), with updated SCC and GV emissions test data (EPA 2024)
    - Short-run marginal emissions from electricity changed little from 2010–2019 (Holland et al. 2022)
- **Excess weight in accidents**
  - Follow Anderson (2011), with $13.2 million VSL (US DoT 2024)
- **Positive "fiscal" externalities**
  - 12 cent/kWh electricity markup (Borenstein and Bushnell 2022), 64 cent/gallon gas tax

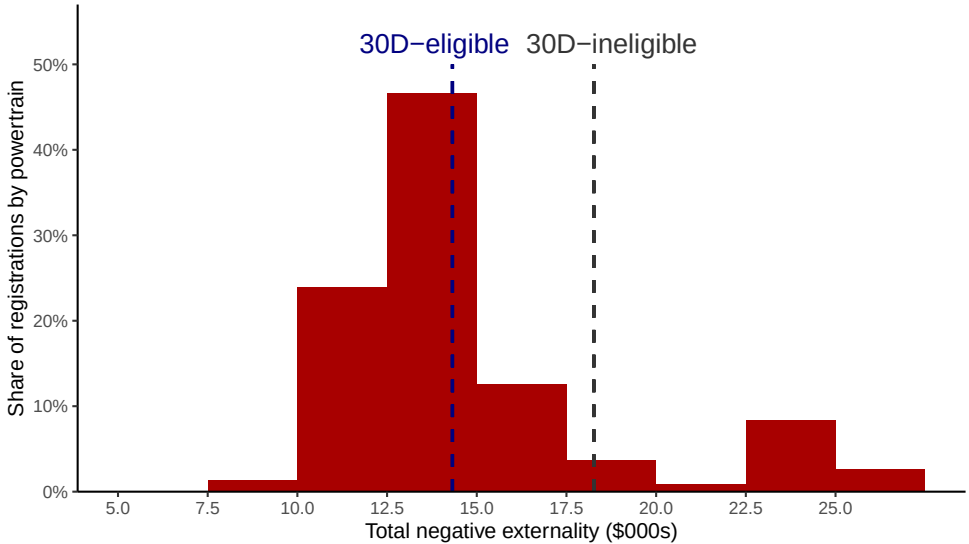
Market share-weighted average externalities



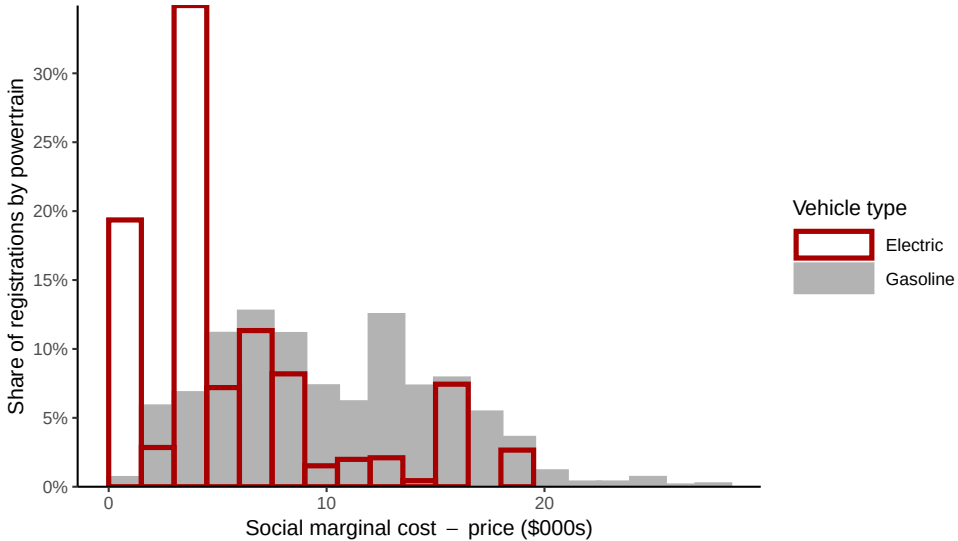
Wide dispersion of externalities across EVs



30D-ineligible ($\approx$ foreign-made) vehicles have larger negative externalities



Wide dispersion of social marginal cost – unsubsidized price



Counterfactuals

Counterfactuals: IRA vs. no IRA

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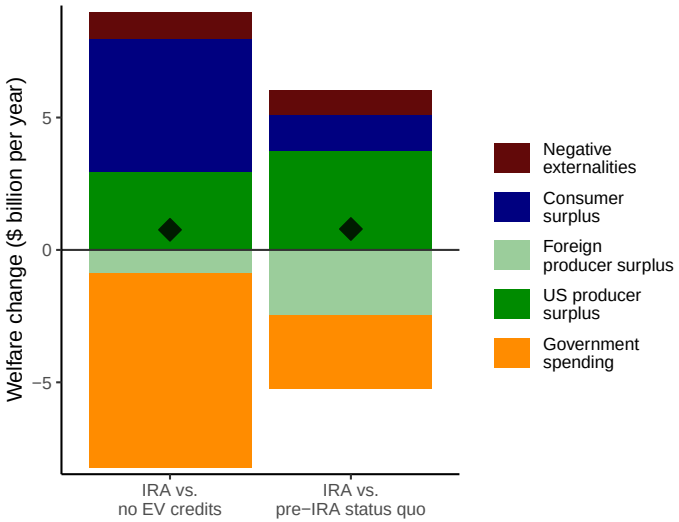
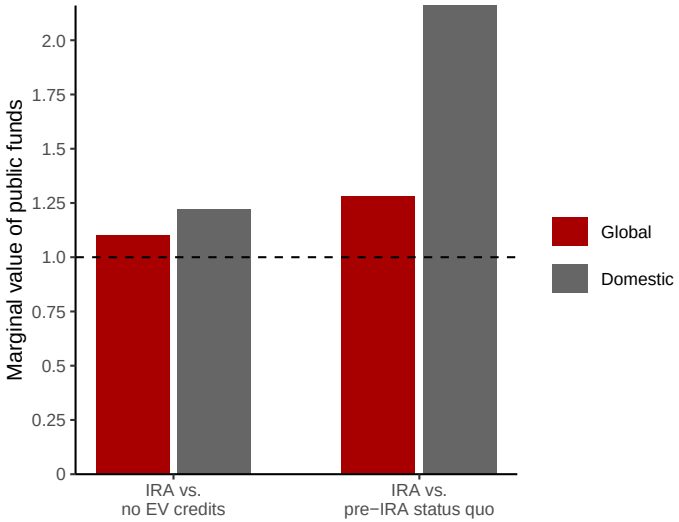
Scenarios:

1. **IRA**: April–December 2023 eligibility
2. **No EV credits**
3. **Pre-IRA credits with phaseout**:
    - Tesla & GM: no credits
    - Toyota & Ford: $7500 / 4
    - BMW & Stellantis: $7500 / 2
    - All others: full $7500

Distributional effects of IRA vs. no IRA



MVPFs of IRA vs. no IRA



Counterfactuals: relaxing trade restrictions

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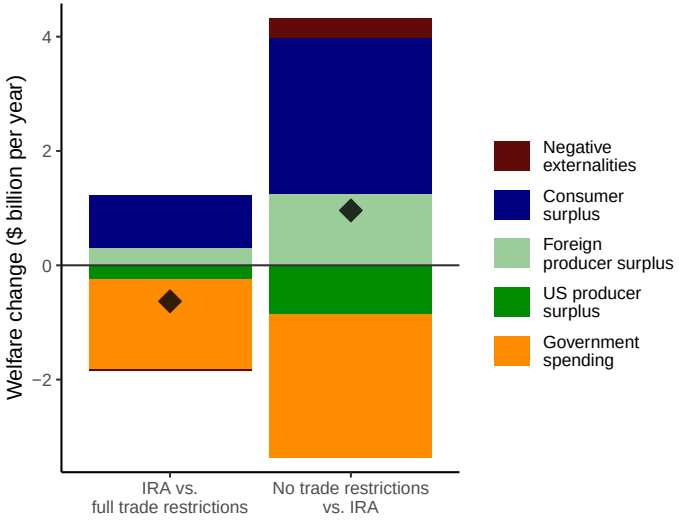
Scenarios:

1. **Full trade restrictions**: both lease and purchase credits have 30D trade-related eligibility requirements
2. **IRA**:
   - (2) vs. (1) $\implies$ gov't spends money to add leasing loophole
3. **IRA, no trade restrictions**
   - (3) vs. (2) $\implies$ gov't spends more money to fully relax trade restrictions

Distributional effects of relaxing trade restrictions



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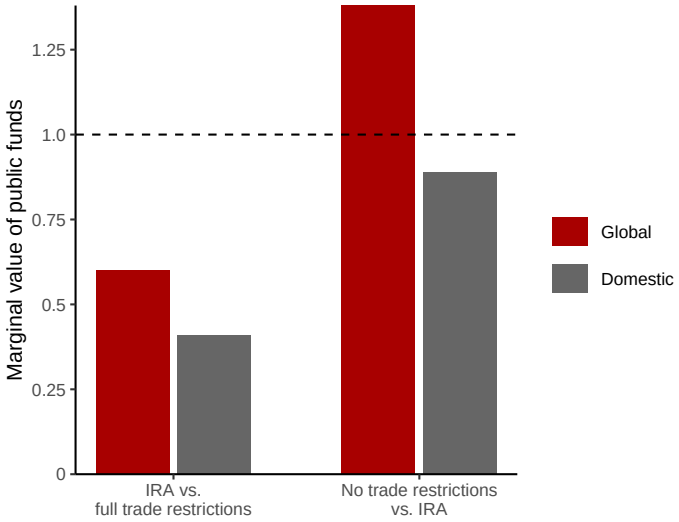


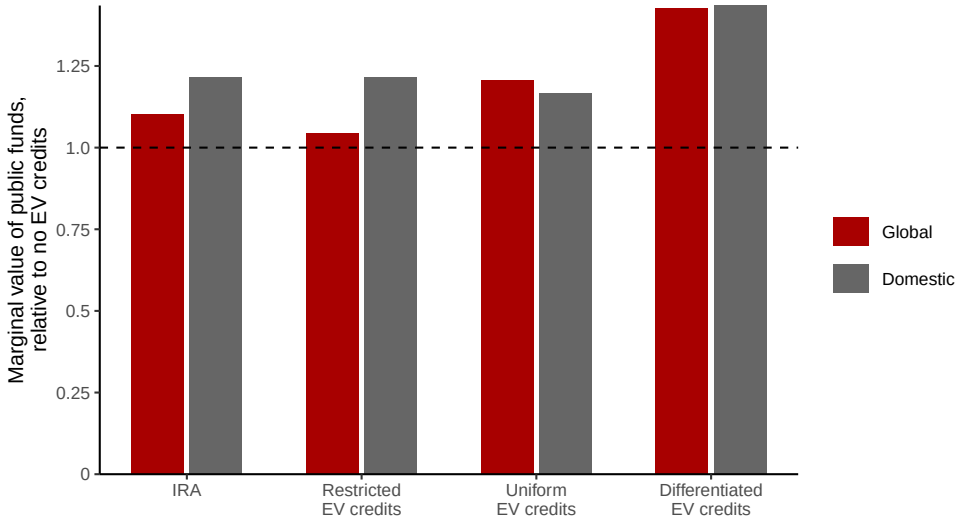
Counterfactuals: Optimal EV tax credits

Counterfactuals: relaxing trade restrictions

Scenarios:

1. **No EV credits**
2. **IRA**
3. **US-optimal restricted EV subsidy**: maximize domestic TS, uniform EV subsidy subject to 30D trade restrictions
4. **Optimal uniform EV subsidy**: maximize global TS, uniform EV subsidy
5. **Optimal differentiated EV subsidy**: maximize global TS, submodel-specific EV subsidy

MVPFs of optimal EV subsidies



Conclusion

Conclusion

- Motivation: evaluate IRA's high-stakes marriage of environmental goals with industrial policy
- Event studies:
  - Much of the economic incidence on consumers
  - Highly elastic substitution to leasing
- Structural model:
  - IRA EV credits increase total surplus and shift significant profits from foreign to domestic firms
  - "Leasing loophole" has low MVPF
  - Additional welfare gains from differentiated EV tax credits (or directly pricing externalities)