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

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July 23, 2024
Inflation Reduction Act: environment + industrial policy

- Inflation Reduction Act (IRA): “most ambitious investment in combating the climate crisis in world history” (White House 2023)
- Key feature: marries environmental goals with industrial policy
  - Green subsidies with domestic preferences
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- Electric vehicle (EV) tax credits: $390 billion projected spending through 2031 (Bistline, Mehrotra, and Wolfram 2023)
- Motivating concern: China dominates global EV sales, manufacturing, and supply chains
  - EV purchase tax credits have trade restrictions
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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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1. **Event study analyses**: what happens when vehicles gain or lose tax credit eligibility
2. **Structural model**: short-run welfare effects of counterfactual policies

**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
• Clean vehicle tax credits
  • Policy overviews: Bown (2023), Buckberg (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

• 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: 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

**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)
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### 30D credit eligibility over time

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

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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**Data**

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

- “Submodel”: make × model × trim × powertrain
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- New vehicle registration counts (Experian)
  - \( \text{Lease share}_{kt} := \frac{\text{leases}}{\text{registrations}} \)

- Prices:
  - Dealership transaction microdata (Cox Automotive)
    - 31% of US new vehicle transactions
    - Includes dealership rebates and lease terms
    - \( \text{Lease price}_{kt} := \text{PDV of lease payments + residual value} \)
    - \( \text{Relative lease price}_{kt} := \text{lease price}_{kt} - \text{purchase price}_{kt} \)
    - 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)
Submodel \( \times \) month panel of new light-duty vehicles from January 2022–December 2023

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Second choice survey data (National Vehicle Experience Survey)
Event studies
Event studies

**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?
Event studies

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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 $\Rightarrow$ incidence fully on consumers
• Context: inventory highly constrained in 2022, surplus in 2023
Purchase price trends

Eligibility:
- Excluded Aug 2022
- Excluded/reduced Apr 2023
- Other EVs

Graph showing purchase price trends from Jan 2022 to Jul 2023.
Purchase price trends

- Excluded Aug 2022
- Excluded/reduced Apr 2023
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Purchase price trends

Eligibility
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Purchase price ($000s)

Jan 2022 | Jul 2022 | Jan 2023 | Jul 2023
Purchase price event studies

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

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

Eligibility
- Excluded Aug 2022
- Included Jan 2023
- Other EVs
- Gasoline vehicles
Relative lease price event studies

- Aug 2022 & Jan 2023 groups: relative lease prices drop by $2k - $5k
- \[ \implies \] 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

- Excluded Aug 2022
- Included Jan 2023
- Other EVs
- Gasoline vehicles
Lease share trends by eligibility group

<table>
<thead>
<tr>
<th>Eligibility</th>
<th>Jan 2022</th>
<th>Jul 2022</th>
<th>Jan 2023</th>
<th>Jul 2023</th>
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Eligibility
Lease share event studies

- **Excluded Aug 2022**
- **Included Jan 2023**
- **Other EVs**

- Aug 2022 group: semi-elasticity of substitution $\approx \frac{-5}{45} \%$ / $-$5k relative price
  $\approx \frac{-10}{-10} \%$ / $+$1000

- $\frac{26}{45}$
• Aug 2022 group: semi-elasticity of substitution $\approx 45\% / -$5k relative price $\approx -10\% / $1000
Structural model
Model overview

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

**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

**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)
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Demand: nested logit

Figure 1: Nested logit structure

- No purchase
- EV
- GV
- 1EV
- NEV
- 1GV
- NGV
- Buy
- Lease
- 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
1. Imperfect competition $\Rightarrow$ markups
2. Unpriced externalities
Distribution of model-implied markups by powertrain

Vehicle type
- Electric
- Gasoline

Share of registrations by powertrain

Markup ($000s)
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
Wide dispersion of externalities across EVs
30D-ineligible (≈ foreign-made) vehicles have larger negative externalities
Wide dispersion of social marginal cost – unsubsidized price
Counterfactuals
Counterfactuals: IRA vs. no IRA
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

-5
0
5
IRA vs.
no EV credits
IRA vs.
pre-IRA status quo
Welfare change ($ billion per year)

Negative externalities
Consumer surplus
Foreign producer surplus
US producer surplus
Government spending
MVPFs of IRA vs. no IRA

IRA vs. no EV credits
IRA vs. pre-IRA status quo

Marginal value of public funds

Global
Domestic
Counterfactuals: relaxing trade restrictions
Counterfactuals: relaxing trade restrictions

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

<table>
<thead>
<tr>
<th>Welfare change ($ billion per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRA vs. full trade restrictions</td>
</tr>
<tr>
<td>No trade restrictions vs. IRA</td>
</tr>
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</table>

- Negative externalities
- Consumer surplus
- Foreign producer surplus
- US producer surplus
- Government spending
MVPFs of relaxing trade restrictions

[Graph showing comparisons of marginal value of public funds under different trade restriction scenarios.]
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
Bar chart showing the marginal value of public funds, relative to no EV credits, for different EV credit schemes and restrictions.
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)