How Does the Public Charging Network Fuel Plug-in Electric Vehicle Uptake?

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Policy action targeting plug-in vehicle sales and use

- Bipartisan Infrastructure Bill (2021)
  - $7.5 billion investment in charging stations
  - Expect a network of a half million charging stations by 2030

- Inflation Reduction Act (2022)
  - Light-duty plug-in electric (PEV) tax credit/subsidy
  - EV charging equipment tax credit

New investments prioritize:
- Public charging in low-income, rural, and multi-family housing regions
- Fast-charging network along the highway/interstate corridor

!! First round of funding under the CFI program released recently
Questions we ask

1. How does public charging affect EV sales? Distinguish the effects of level-2 and level-3 (DC) fast-chargers.

2. How strongly do low-income and rural vehicle buyers respond to public charging stations?

To answer these questions

- We use household level survey data from 2010 to 2020
- Estimate an econometric model to predict consumer choices

Policy evaluation

- Predict the future demand based on the current rounds of investment
- Cost-effectiveness of the scheme and other ways of subsidizing consumers
Survey data of new car buyers from 2010-2020, including:
  - Details of the new vehicle purchased, transaction price, and vehicle attributes
  - Household demographics and residential zipcode
  - Info on other vehicle holdings and other vehicle(s) considered

Annual new registrations by state and vehicle

Public charging stations with location, service date, and characteristics
Data Coverage

- Total obs=2.26 million
  - Sample represents about 1.7% of the new car buyers from 2010-2020
  - Weight observations to account for non-random response

- Overall, the data capture 74% of the total sales from 2010-2020
  - 73% of the total PEV regs
  - Some states/automakers aren’t included
    → For example, Tesla buyers from AZ, PA, and some other states
Infrastructure and PEV sales growth

Figure: Public charging points

Figure: PEV market share
Public charging density in 2020

Figure: Level-2 charging

Figure: Level-3 charging
Plug-in electric vehicles per household by zipcode in 2020

Figure: Uptake of EVs
PEV market share in 2020

Figure: by regions

Figure: by income groups
Trends in the PEV market

- Number of models
  - Battery electric: solid line
  - Plug-in hybrid: dashed line

- Sales-weighted range
  - Battery electric: solid line
  - Plug-in hybrid: dashed line
Charging stations and demographics

**Charging Network and PEV Adoption**

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**a) Non-Tesla charging network**

- % Black
- % White
- % Asian
- Median income
- Home ownership rate
- Housing units/sq.mile
- Commute time to work

- Level 2 chargers
- Level 3 chargers

**b) Tesla charging network**

- % Black
- % White
- % Asian
- Median income
- Home ownership rate
- Housing units/sq.mile
- Commute time to work

- Level-2 chargers
- Level-3 chargers
Endogeneity of Charging Stations
Chicken and egg problem

- Charging station availability affects EV adoption
- Higher EV adoption leads to increased demand for charging infrastructure
- More charging stations encourage further EV purchases

⇒ Feedback loops in the EV market
⇒ Makes it challenging to accurately model the relationship
We build an econometric model

→ distinguishing between the demand for Tesla and non-Tesla plug-ins
→ assuming investments in charging stations depend on historic sales and expected future sales

We predict the probability of buying a plug-in EV as a function of

- availability of level-2 and level-3 charging points
- household income and other demographics
- residential location characteristics
- travel patterns, regional gas price
- other national shocks and trends
Results

Effect of chargers on Tesla and non-Tesla plug-ins

![Graph showing the semi-elasticity with respect to charging points for Level 2 and Level 3 chargers for Tesla EVs and Non-Tesla plug-ins. The graph includes error bars for 95% CI.]

Tesla vs non-Tesla buyers
Results (contd)

Effect of chargers on Tesla and non-Tesla plug-ins

If we include counts of charging points within 15 miles, 15-35 miles, and 35-80 miles from the centroid of the residential zip code.

![Graphs showing semi-elasticity of charging points for different radius ranges and charger types, with error bars indicating 95% confidence intervals.](image-url)
Heterogeneous effects of charging availability

**Figure:** by household income

**Figure:** by residential area type
Heterogeneous effects of charging availability (contd)

Figure: by household race
To sum up

Main findings:

- Level 3 chargers have a stronger effect on the PEV demand
- The effect of public chargers diminishes with the distance
- Stronger impact on higher-income, urban and suburban demographics
  → demand disparity in PEV adoption
- Demand for Tesla vehicles is more responsive to its chargers
Future work

- Tesla opened access to its Supercharger network to other EVs → Implications on the demand for non-Tesla plug-ins
- Estimate charging side of the market
- Predict the effect of CFI & NEVI program → across regions by share of households in multifamily housing
- Additional suggestions? → other forms of heterogeneity → other policy scenarios to consider
Thank you

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Appendix
Designated US EV charging corridor

Source: U.S. DoT Federal Highway Administration
Income distribution of households with Tesla and non-Tesla PEVs