Why are electric vehicles driven so little?

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New Directions in Transportation Economics
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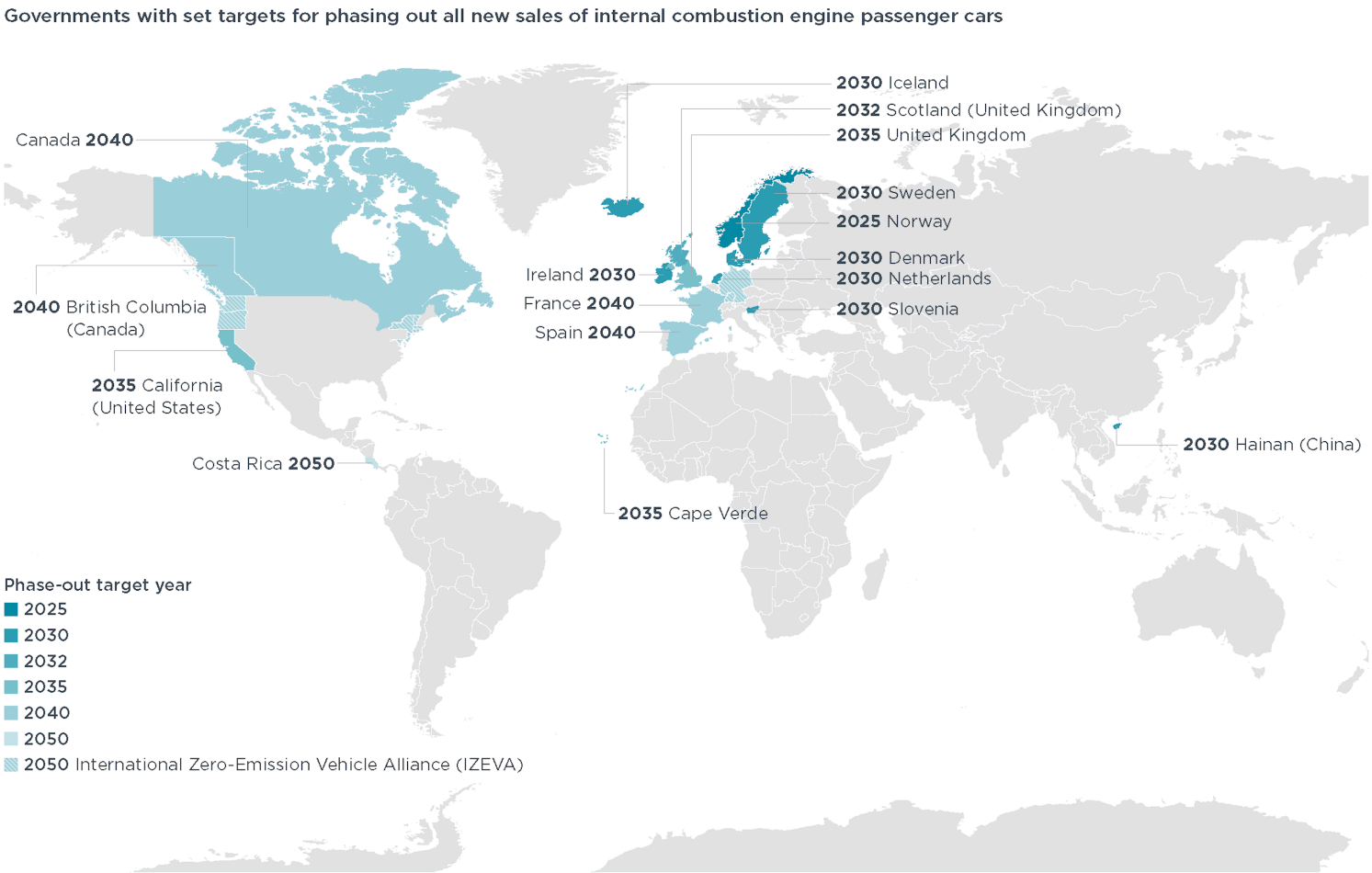
We're going "all in" on EVs



Biden's infrastructure plan: $>$ $150 billion for EVs

New empirical evidence on EV driving

Today:
How much are EVs driven?
What explains low EV usage?

This question is:

- *Important for policy:* climate; grid planning; local pollution
- *Difficult to answer:* Existing data are very limited
- *Scratching the surface:* Many important economics questions relate to transportation electrification

We overcome previous hurdles with restricted-access data

We combine utility data and DMV data to map cars to consumption

Utility data

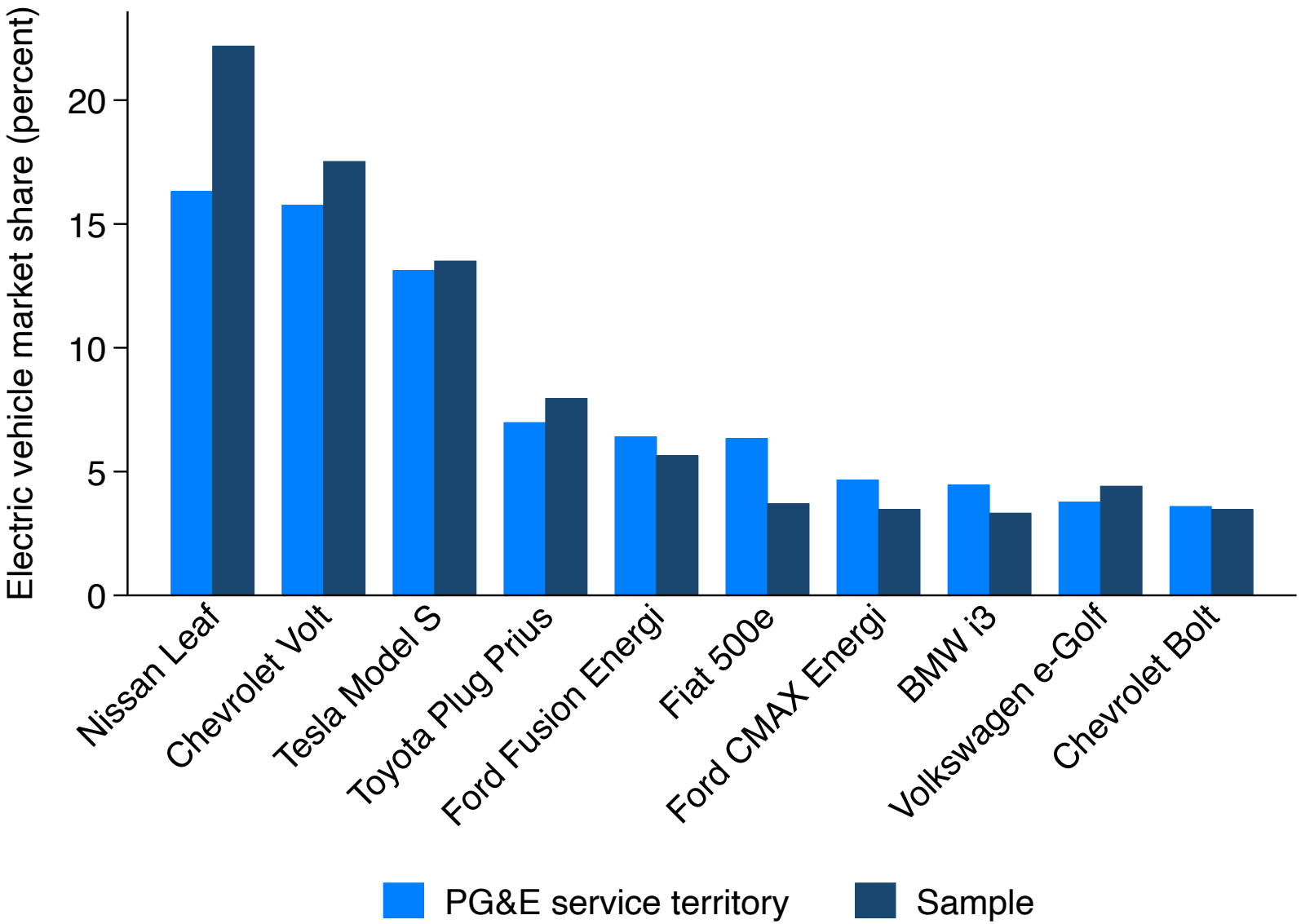
- 10% of PG&E's service territory (sample designed to target high-EV areas)
- Data from 2014 – 2017
- Nearly 12 billion hourly electricity use observations
- Customer details, including address and tariff

DMV data

- Address-level registration info for universe of CA EVs, 2009-2019
- Registration dates allow us to estimate timing of arrival
- Detailed info from VIN stems on car characteristics

$\rightarrow$ We match more than 57,000 cars to households on address

Our sample of EVs is (largely) representative of PG&E



We employ a panel fixed effects research design

To estimate the causal effect of EV adoption on load, we estimate:

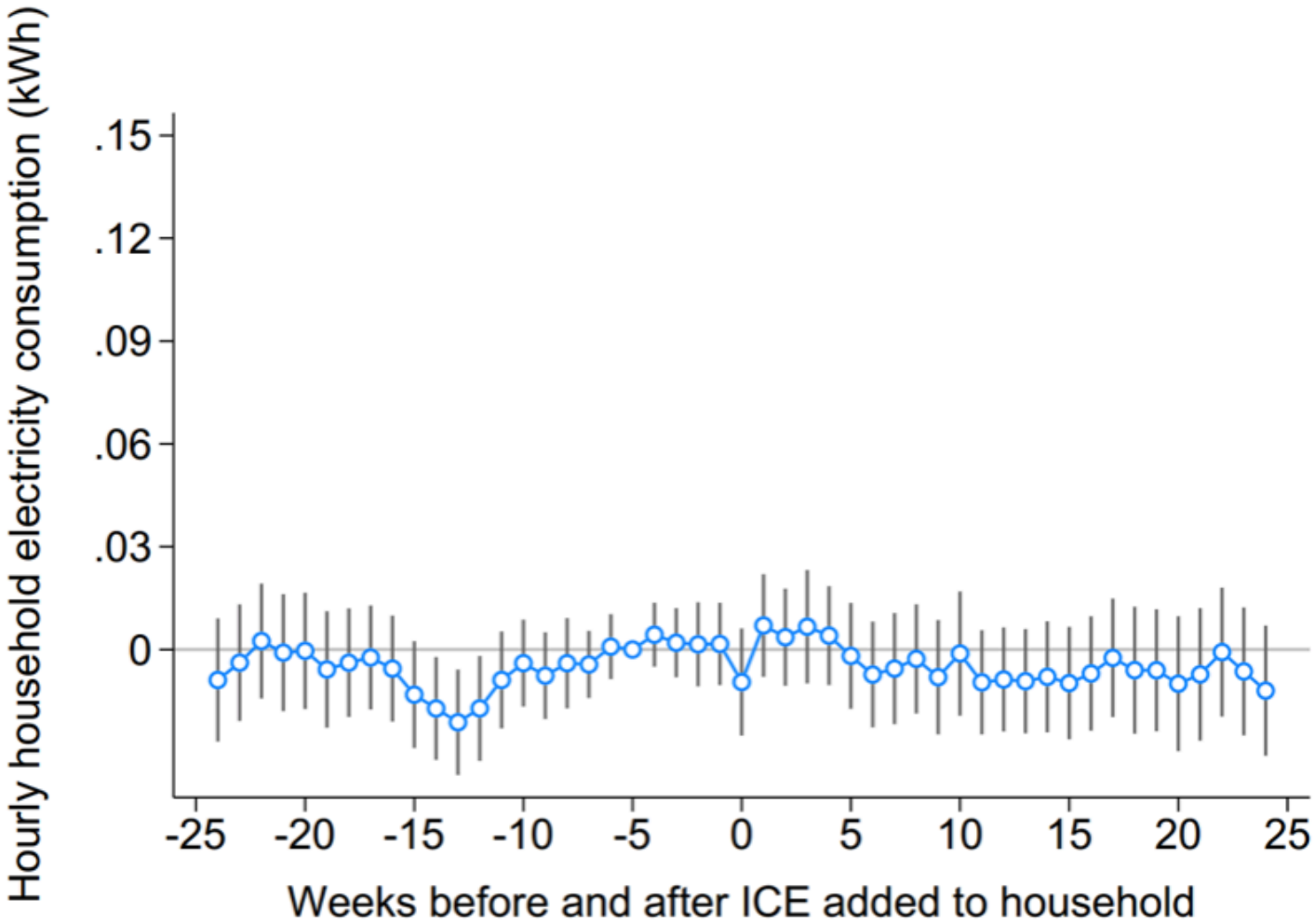
$$Y_{ith} = \beta EV_{it} + \gamma Solar_{it} + \alpha_i + \delta_t + \varepsilon_{ith}$$

where:

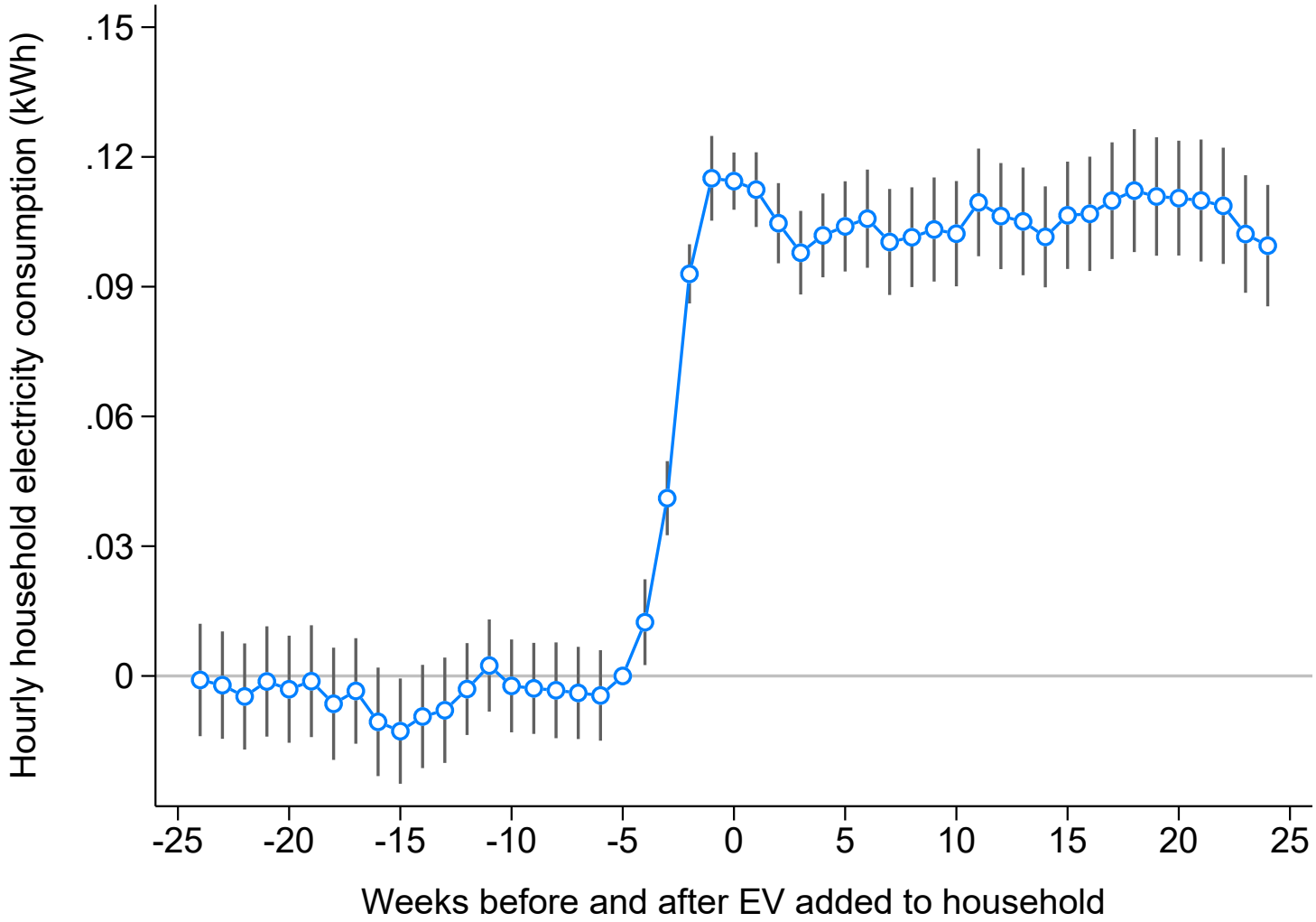
- Y_{ith} is kWh/hr at household i in week t in hour-of-day h
- EV_{it} is the count of EVs
- $Solar_{it}$ is a solar indicator
- α_i are household FE (can be more flexible)
- δ_t are week-of-sample FE (can be more flexible)
- ε_{ith} is an error term, two-way clustered at CBG and week-of-sample

Identifying assumption: Conditional on FE, the timing of EV adoption is as good as random (and no other contemporaneous changes)

Falsification test: ICE vehicles don't impact electricity use

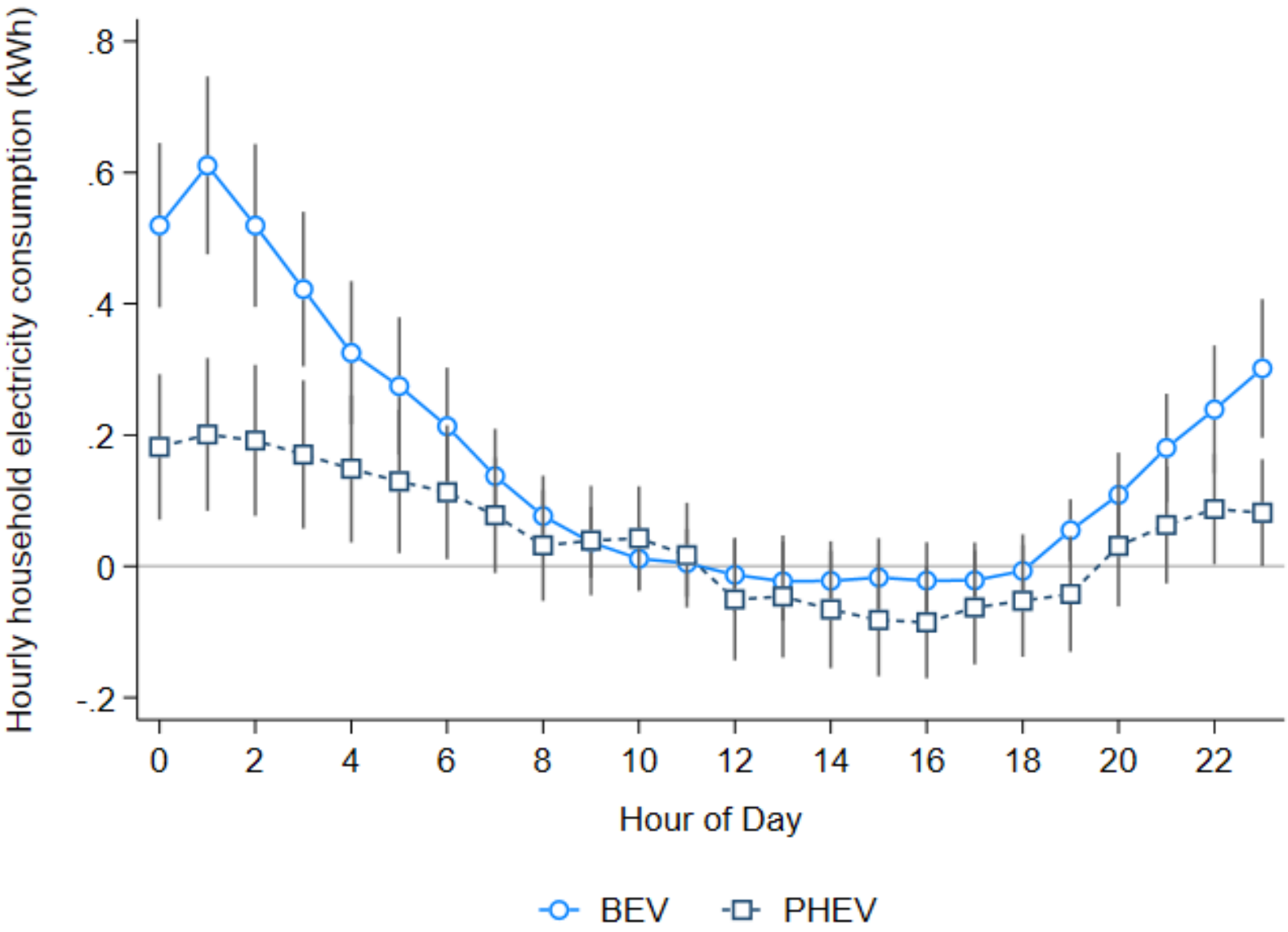


EVs increase kWh, but not as much as expected



Our estimates are approximately half the sizes of IOU projections

BEVs charge more at home than PHEVs



What does this imply for eVMT?

Our kWh of home charging is much lower than previous estimates

To translate to eVMT:

- Calculate home-charged eVMT with model-specific MPGe
- Assume 33% of charging happens away from home
  - More generous than CARB / LCFS (15% away-from-home)
- Assume PHEVs do no home charging $\rightarrow$ put all kWh into BEVs

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We estimate:
BEVs drive 6,700 eVMT per year
PHEVs drive 1,700 eVMT per year
Both much lower than ICE vehicles (9,800 VMT)

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$\rightarrow$ For EVs to drive as much as ICEs, need 2x as many unreported kWh as (heavily incentivzed) reported kWh!

What explains low EV driving? We present hypotheses

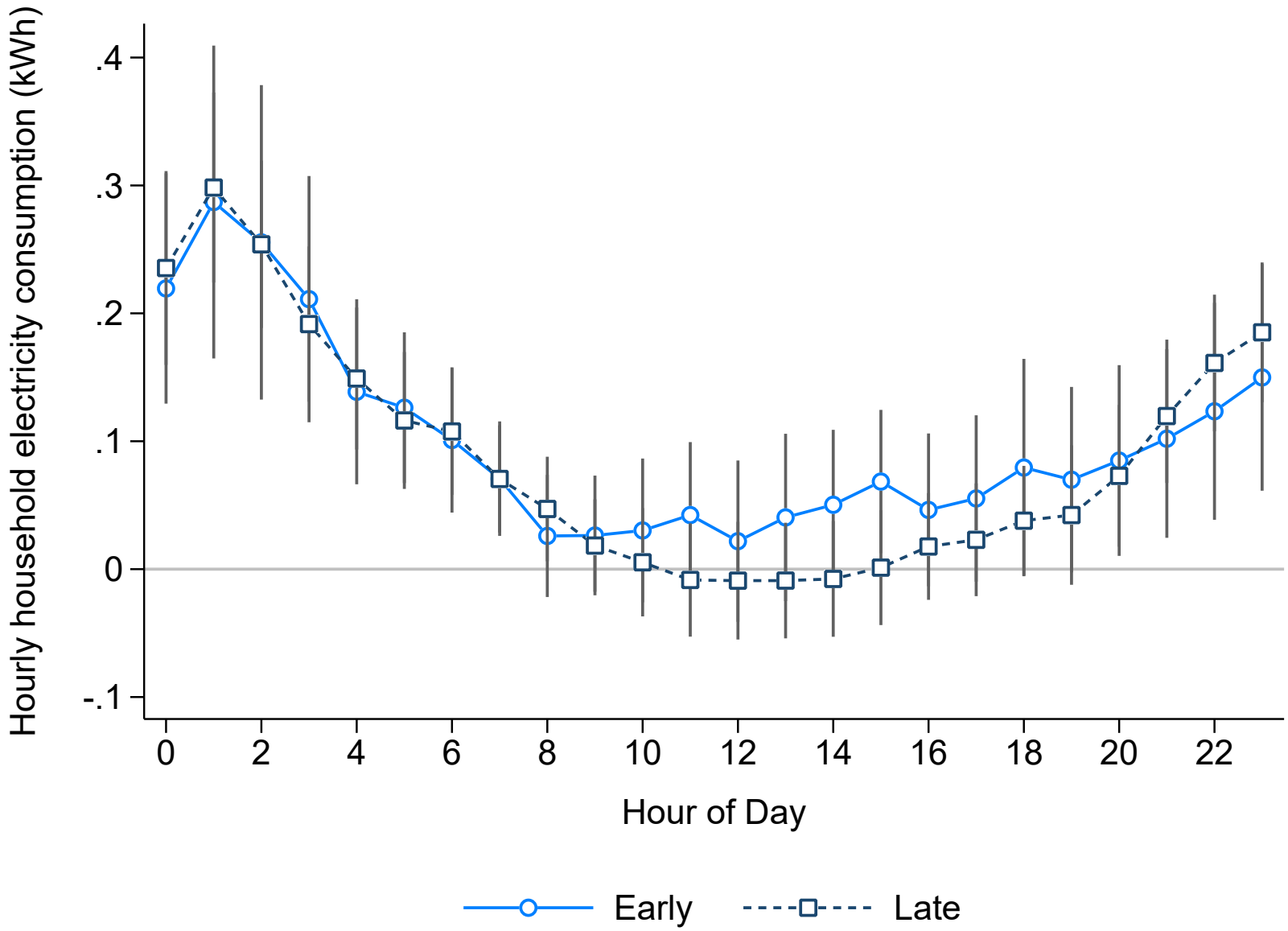
Today:

1. Missing away-from-home charging?
2. Are early adopters different from later adopters?
3. Does battery capacity explain our effects?
4. Do EV drivers just drive less?
5. Are EVs are complements, rather than substitutes, for ICEs?

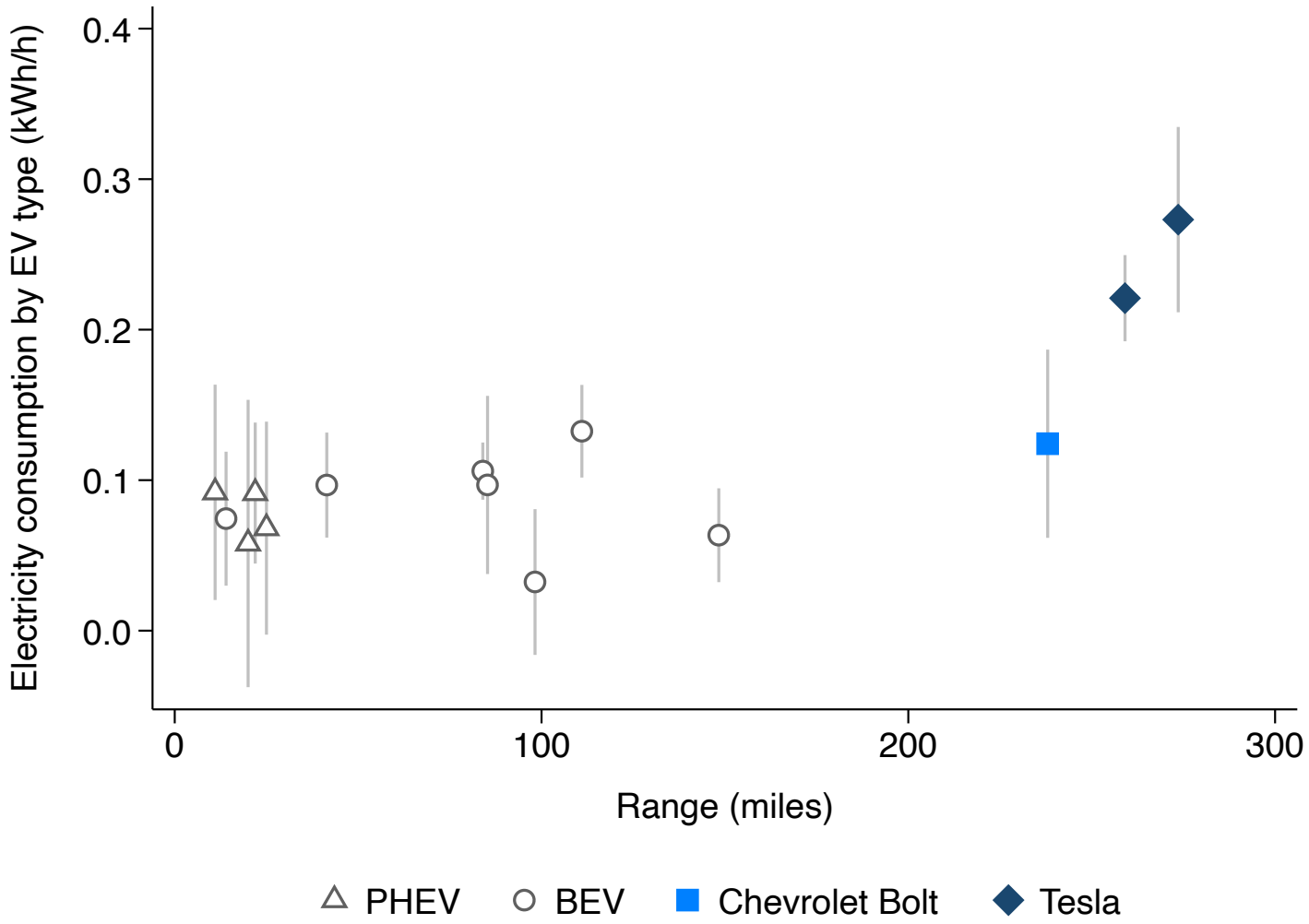
In progress:

- Are California's high electricity prices deterring driving?
- Is Northern California just different?
- Are there other undesirable attributes of EVs?
  - Poor charging infrastructure; price; comfort; size; no trucks; etc

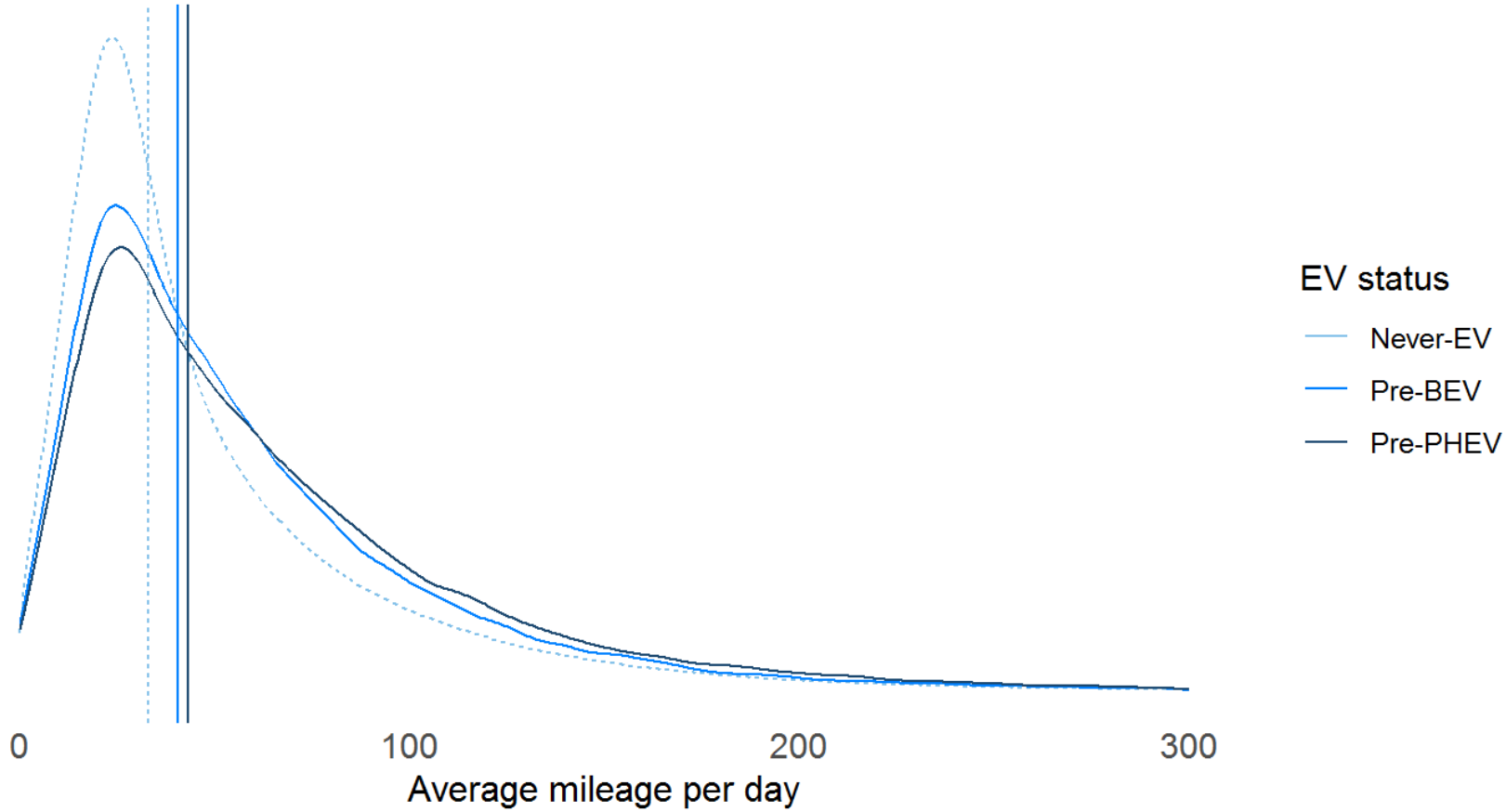
Early EVs don't look different from later ones



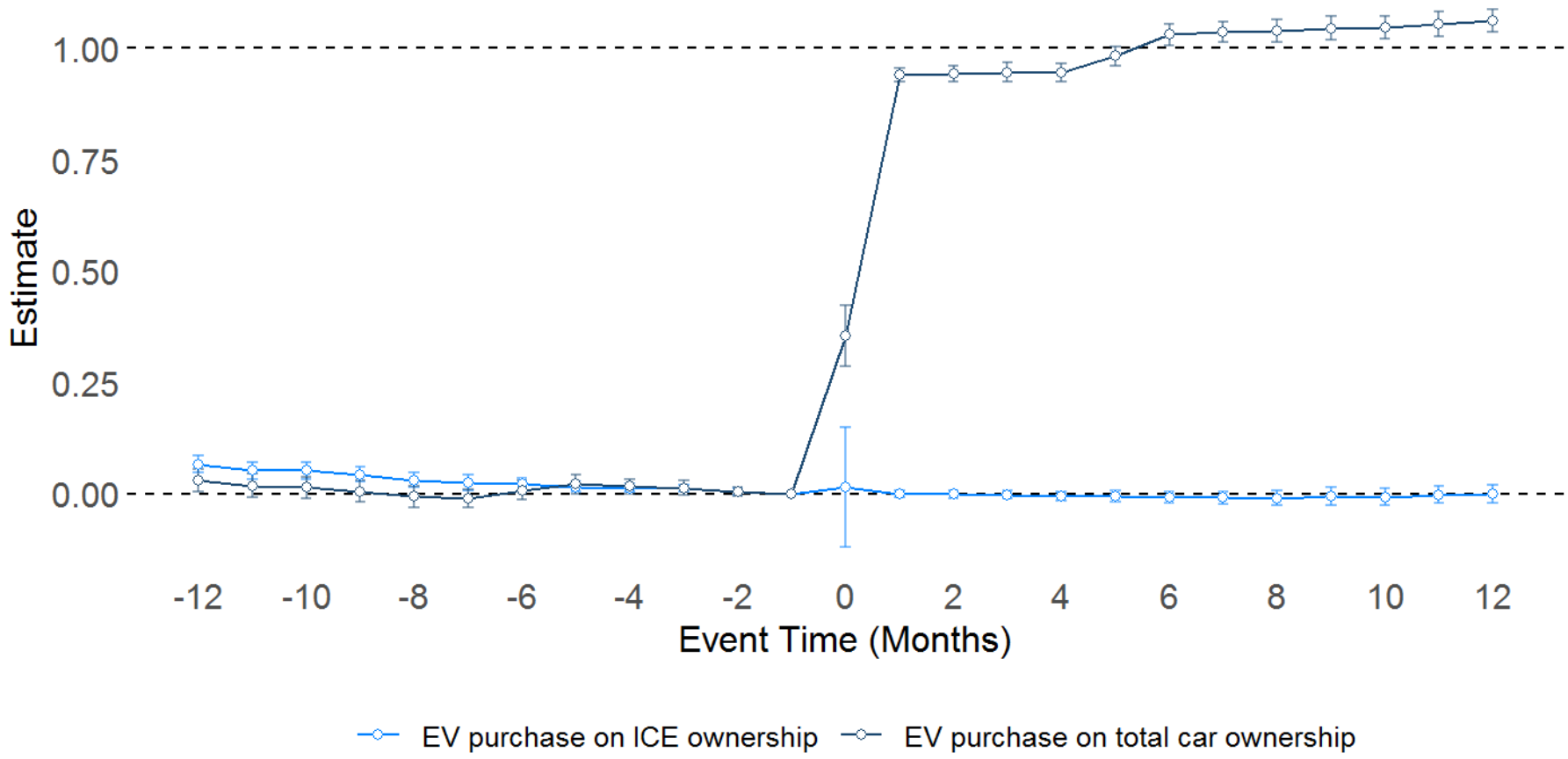
Bolts drive about as much as other EVs; Teslas exceptional



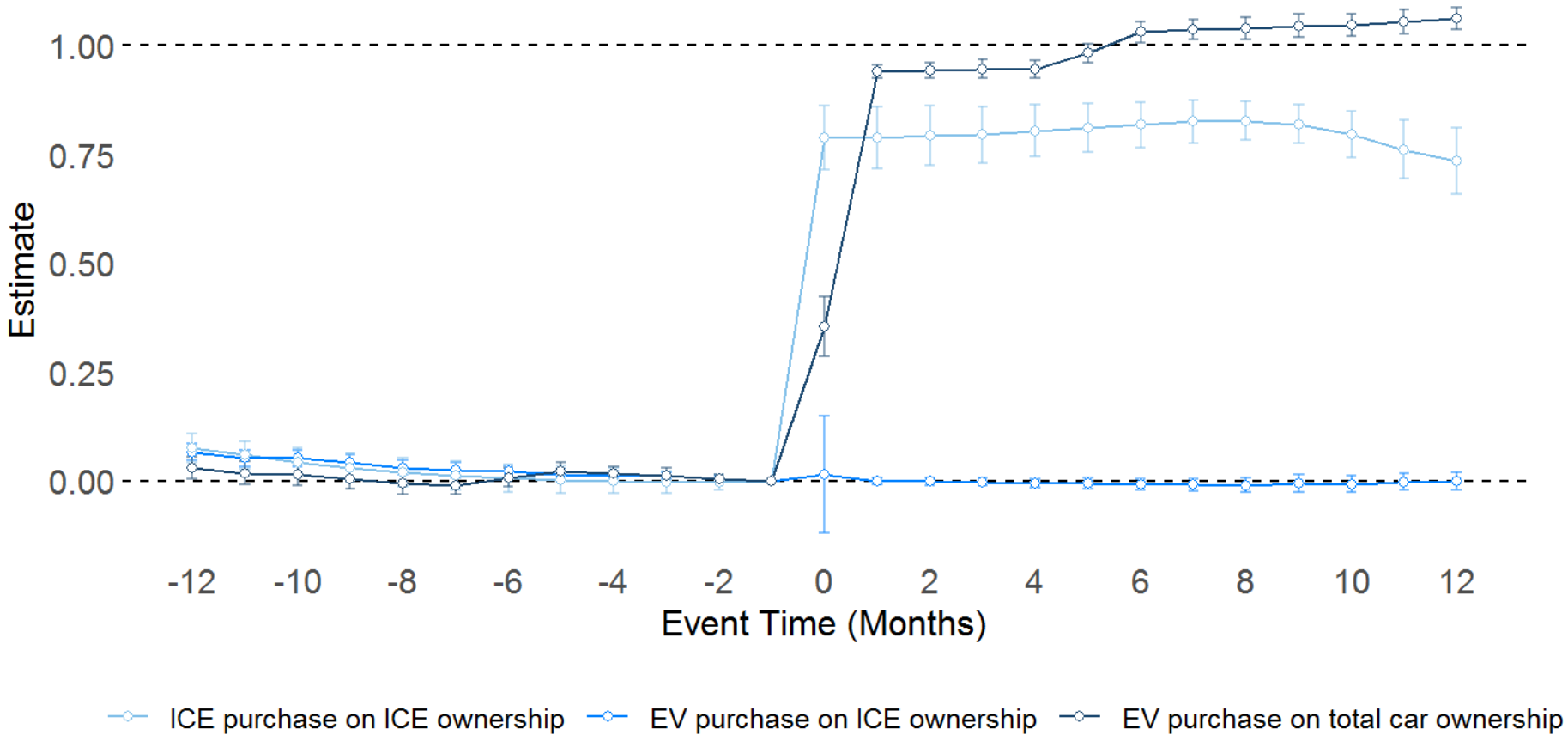
If anything, EV owners drove more pre-EV



EVs are additional cars, not substitutes



By contrast, 1 in 4 ICEs is a replacement



Summary: We estimate low EV driving

We show:

- EVs are additional cars, not substitutes

We provide evidence against:

- Early adopter effects
- Selection into EVs based on low VMT

Further evidence is required on:

- Battery size effects
- The role of electricity prices
- Hundreds of millions of mysterious unreported out-of-home kWh??
- Others?

We're making policy with limited evidence. We need more research!

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Thank you!

Comments? Questions?

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