Subsidy Effects on Used EV Purchases

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Motivation

RQ: How will the IRA's introduction of subsidies for used EVs affect vehicle purchases?

- How does this affect used BEV penetration?
- What do substitution patterns looks like?

Why do we care?

- Secondary market adoption of BEVs is key for decarbonizing vehicle fleet
  - Used vehicles accounted 70% of U.S. vehicle sales between 2010 and 2019
- Distributional effects - previous Federal EV subsidies only applied to new vehicle

Modeling Approach

Broadly...

- Use Washington state title transactions from 2017 through 2020
- Estimate parameters for a discrete choice model, including new and used vehicles as choices
- Generate prices for used BEVs under IRA subsidies
- Compute counterfactual sales under new prices

Related Research

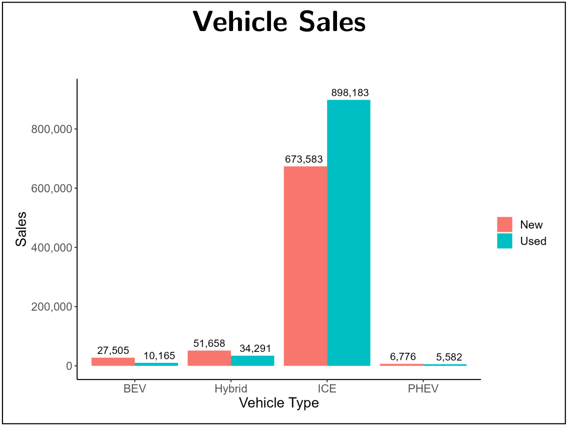
- Holland et al. (2016) examines emissions benefits associated with EV adoption and finds that on average, the optimal national subsidy for new EVs is negative, based on 2010-2012 electric grid
  - Holland et al. (2020) updates findings based on 2017 grid, finding optimal subsidies to be positive, but significantly lower than $7,500 credit
- Springel (2021) examines network effects on adoption of EVs, finding subsidies for charging stations to be more effective
- Xing et al. (2021) looks at subsitution between EVs and non-EVs and finds that EVs tend to replace already fuel efficient vehicles

Data

- Primary dataset is title transactions from Washington state between 2017 and 2020
  - Contains all title transactions, with transaction prices
  - Can identify new and used vehicles, buyer location, dealership transactions, out-of-state transfers, lease buyouts, and vehicles purchased for businesses
  - Limit data to 10-year old vehicles and newer, transacted at dealerships
    - Covers ~78% of title transactions in this period
    - Dealership transactions required for IRA credit
- Secondary datasets used for characteristics
  - NHTSA vPIC database, EPA Fuel Economy Data,EPA Vehicle Testing Data

Summary Statistics for Select Characteristics

	New	Used
Mean Price	$34,800	$20,400
Mean MPG	29.2	25.1
Mean Age	-	3.96
Total Sales	759,522	948,221
% BEV	3.6%	1.1%
% Hybrid	6.8%	3.6%
% ICE	88.7%	94.7%
% PHEV	0.9%	0.6%



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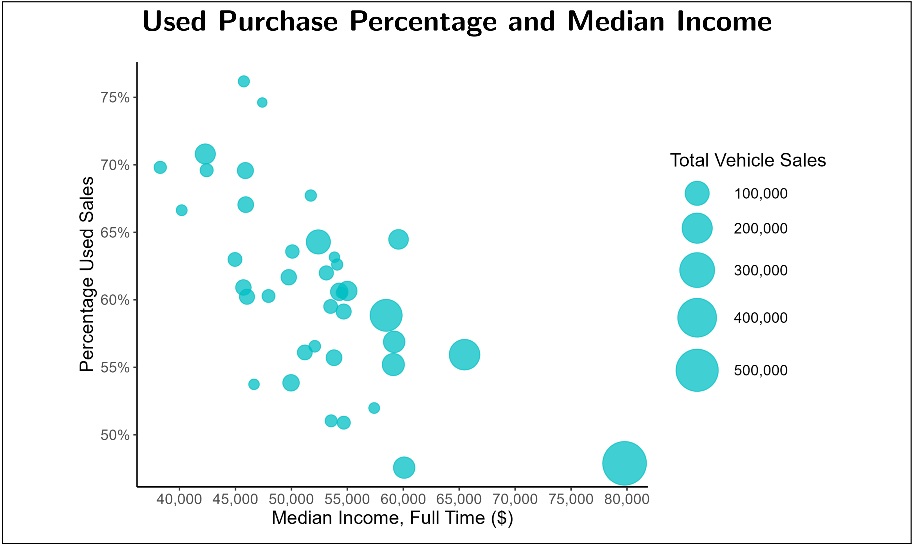
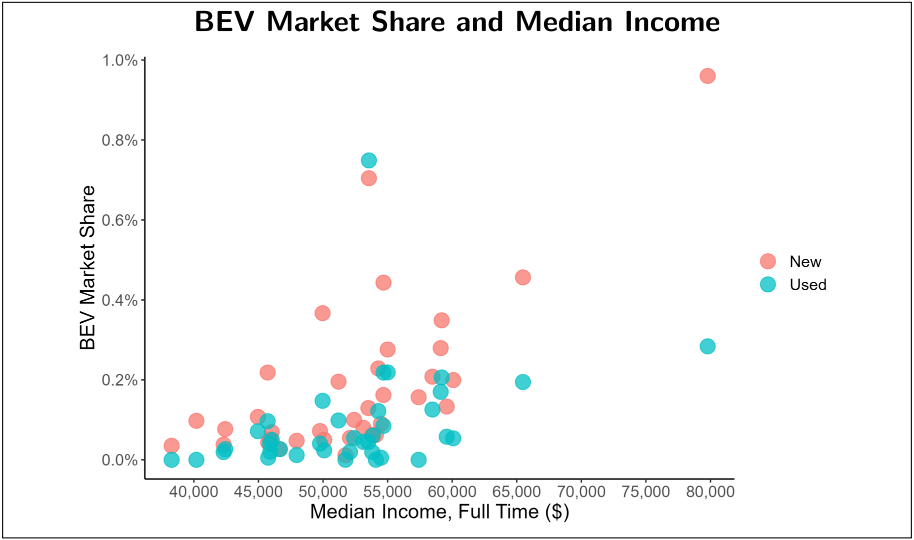

Used Purchase Percentage and Median Income
Percentage Used Sales
75%
70%
65%
60%
55%
50%
40,000
45,000
50,000
55,000
60,000
65,000
70,000
75,000
80,000
Median Income, Full Time ($)
Total Vehicle Sales
100,000
200,000
300,000
400,000
500,000

Data



BEV Market Share and Median Income
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
BEV Market Share
40,000
45,000
50,000
55,000
60,000
65,000
70,000
75,000
80,000
Median Income, Full Time ($)
New
Used

Modeling Consumer Choices

- Estimate parameters that govern demand for new and used vehicles
  - Emphasis on modeling parameters related to price
- Random-coefficients logit model
  - Extends logit discrete choice model by introducing heterogeneous taste preferences
  - Uses market shares to model consumer utility from vehicle choice:
    - $u_{ij} = \phi_j + \mu_{ij} - \alpha p_j + \epsilon_{ij}$
    - $\phi_j = \beta' x_j + \xi_j$, $\mu_{ij} = x_k' \Sigma \nu_i$
  - Implemented using BLP methodology
    - Involves simulating draws for ν_i and integrating over draws to form choice probabilities

Results

Quick overview:

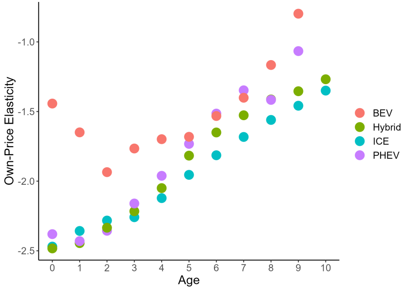
- Estimated linear parameters are significant and signed as expected
  - Negative estimated coefficients on price, fuel cost, and age
  - Positive estimated coefficients on horsepower/weight, range, weight, and dummy for new vehicles
- Reasonable, but slightly low, own-price elasticities

Elasticities

Price Elasticities

	BEV	Hybrid	ICE	PHEV
		Own-Price		
New	-1.56	-2.42	-2.37	-2.41
Used	-1.68	-1.94	-1.99	-2.11
		Cross-Price		
New	-1.34e-05	-3.99e-05	-3.15e-05	-2.79e-05
Used	-	-4.77e-05	-3.70e-05	-4.83e-05

Own-Price Elasticity by Age



Counterfactual Scenario

Goal: Model impact of IRA subsidy for used BEVs

- Subsidy applies to 2-years and older vehicles, purchased at dealerships
- Average modeled subsidy of $3,140
- Caveats:
  - Currently not modeling impact on PHEV
  - Assumes elastic supply of used BEVs
  - Assumes full pass-through and all consumers are eligible

Counterfactual Results

Sales, Actual vs. Counterfactual

	Actual	**Counterfactual**	Δ
New BEV	27,505	27,492	-13
New Hybrid	51,658	51,623	-35
New ICE	673,583	673,176	-407
New PHEV	6,776	6,772	-4
Used BEV	10,165	14,449	4,284
Used Hybrid	34,291	34,253	-38
Used ICE	898,183	897,448	-735
Used PHEV	5,582	5,576	-6

Discussion

- Model predicts that subsidies should have a fairly significant effect on used-EV sales
  - Counterfactual predicts 42% increase in sales
  - Increase adds 3,046 additional vehicles to fleet size (roughly 0.18% increase)
- Fleet fuel-economy gains are small
  - Average replaced vehicle has slightly above average fuel economy of 27.1 MPG
  - Overall average changes from 26.9 MPG to 27.1 MPG
  - Estimating changes in GHG emissions requires modeling VMT

Going Forward...

- What does this look like when the supply side is incorporated?
  - Used vehicles are limited and full pass-through of subsidy is unrealistic
- Is the policy worth it? What about alternatives?
  - GHG implications
  - Carbon tax
- What are the distributional impacts?

References

Holland, Stephen P. et al. (2016). "Are There Environmental Benefits from Driving Electric Vehicles? The Importance of Local Factors". In: *The American Economic Review* 106.12, pp. 3700–3729.

– (2020). "Decompositions and Policy Consequences of an Extraordinary Decline in Air Pollution from Electricity Generation". In: *American Economic Journal: Economic Policy* 12.4, pp. 244–274.

Springel, Katalin (Nov. 2021). "Network Externality and Subsidy Structure in Two-Sided Markets: Evidence from Electric Vehicle Incentives". In: *American Economic Journal: Economic Policy* 13.4, pp. 393–432.

Xing, Jianwei, Benjamin Leard, and Shanjun Li (2021). "What does an electric vehicle replace?" In: *Journal of Environmental Economics and Management* 107.

Appendix: Model Results

	Beta	Sigma
Intercept	-	2.17613
	-	(0.40163)
Price	-1.44730	0.53646
	(0.139061)	(0.040852)
$/Mile	-2.21576	-
	(0.293567)	-
Horsepower/Weight	18.57319	-
	(1.769104)	-
Range	0.00238	-
	(0.000072)	-
EV Range	0.00052	-
	(0.000478)	-
Tons	0.76744	-
	(0.08635)	-
Age	-0.25619	0.00000
	(0.02013)	(0.087213)
New Vehicle Dummy	0.61286	0.38516
	(0.05879)	(0.212431)
EV Dummy	0.49200	0.00000
	(0.073418)	(0.427816)
Hybrid Dummy	-0.60298	-
	(0.026714)	-
PHEV Dummy	-0.30287	-
	(0.050295)	-