

# Understanding the used vehicle market and its implications for electric vehicles

Presenter: Theodora Konstantinou, Postdoctoral Researcher  
Electric Vehicle Research Center, UC Davis

Debapriya Chakraborty, Research Faculty  
Electric Vehicle Research Center, UC Davis

Julia Beatriz Gutierrez Lopez, Doctoral Candidate  
Chair of Energy Economics, Faculty of Economics, Technische Universität  
Dresden

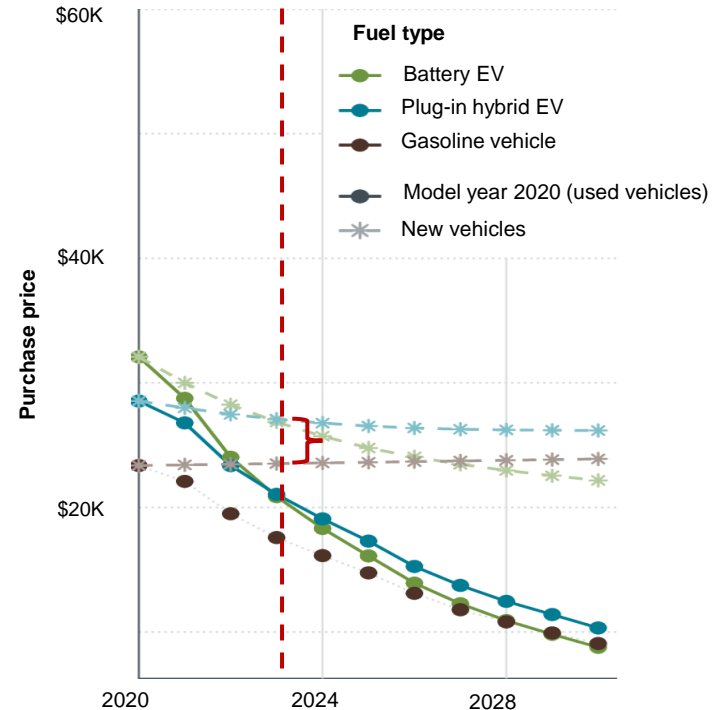
9/19/2023



# Role of the Used Vehicle Market

- Aggressive electrification targets set by regulations such as the Advanced Clean Car II regulation in California
- New EVs haven't reached cost parity yet (Bauer et al., 2021)
- Need to ensure electric vehicle (EV) affordability and accessibility for low and middle-income households
- Used vehicle buyers represent a potential segment for EV adoption

Purchase price of used (model-year 2020) and vehicles between 2020 and 2030  
Bauer et al. (2021)



# Literature Summary

---

Limited research  
on the used  
vehicle market  
and particularly  
EVs



Previous studies focused on specific study areas or descriptive statistics analyses or qualitative discussion.



Most studies are centered on electric passenger cars and do not account for the preference for larger vehicles such as light trucks, separately.



Few studies focus on both changes in EV technology costs and more household factors that may influence the cost of a new or used EV.

# Research Objectives

---



Examine new and used vehicle market by vehicle body type on a national scale



Provide an estimation of vehicle ownership cost by new and used vehicles and household segment



Help inform policies to also target used vehicle market and address equity concerns associated with the transition to EVs

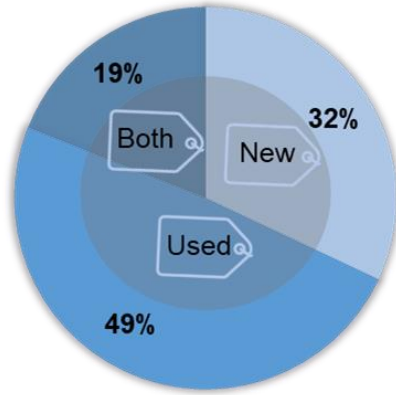
# Data

---

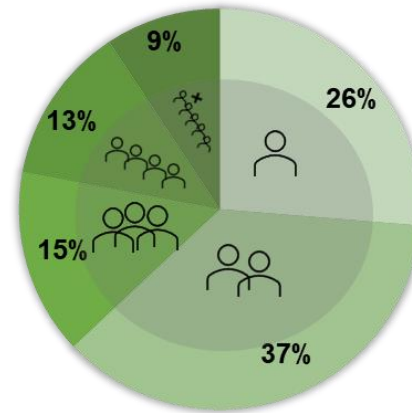
## Consumer expenditure survey (CES) data collected by the US Census Bureau (household level, interview survey)

- ☰ Data on sociodemographic characteristics and expenditure items
- ☰ Records over 4 years: 2018-2021
- ☰ Questions on whether a vehicle was new or used when it was first acquired, year of purchase, vehicle body type (car or truck/van; no further vehicle classification is provided)
- ☰ Vehicle acquisition cost: net purchase price (after discount, trade-in, or rebate, including destination fee) for each vehicle in the household
- ☰ Operating cost: quarterly expenditure for the total household fleet
- ☰ After data processing: 17,167 records

# Data Description

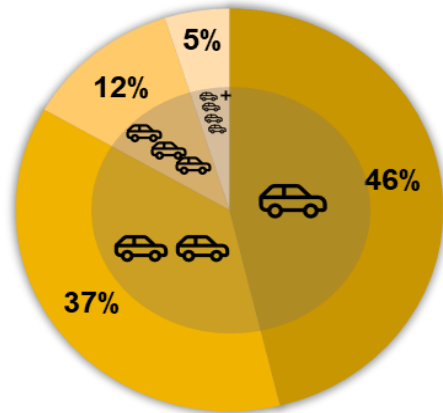


Used vs new vehicle buyers  
(vehicle holdings)

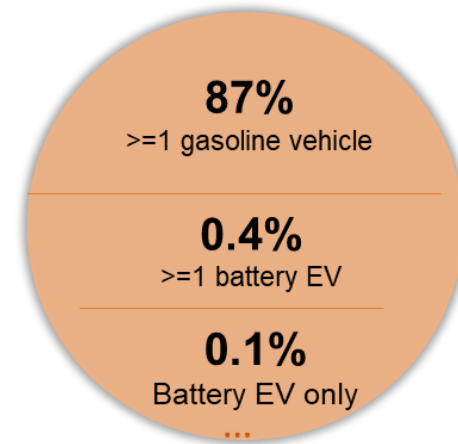


Household size

# Data Description

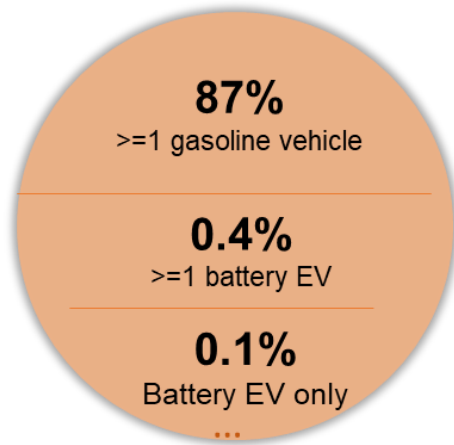


Number of vehicles owned

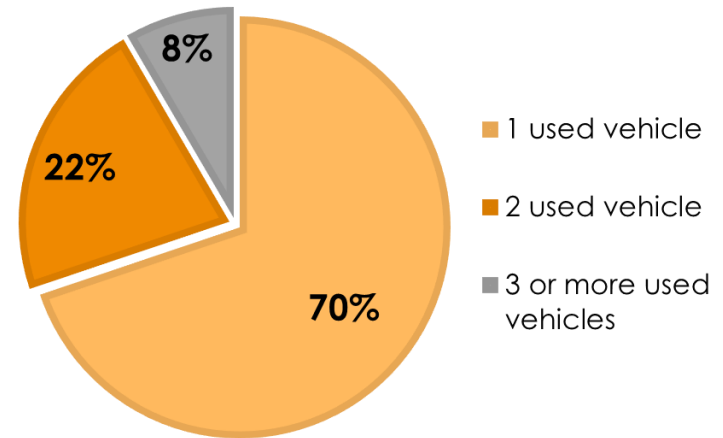


Fuel type of vehicles owned

# Data Description



Fuel type of vehicles owned

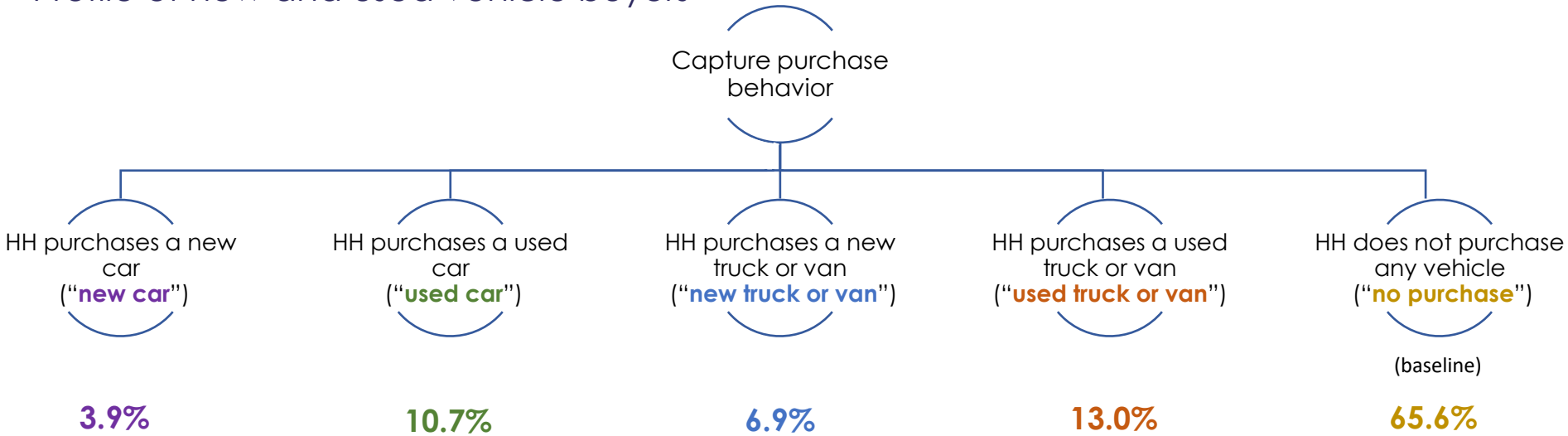


Number of used vehicles owned



# Methods for Logistic Regression

Profile of new and used vehicle buyers



\*HH: Household

Latest vehicle purchase: strongest impact on current purchase decision (Hocherman et al., 1983)  
Time frame: within one year up to the date of the interview

Mixed logit model (NLOGIT4)

# Methods of Vehicle Ownership Cost Analysis

Vehicle ownership cost analysis

Focus on newest vehicle purchased

Net present value, 5-year ownership period (N) (Chakraborty et al., 2021)

$$\text{Vehicle Ownership Cost} = \frac{\text{Vehicle acquisition cost}}{\frac{NPP_V \cdot APR}{1 - (1 + APR)^{-N}}} + \sum_{n=1}^N \frac{\text{Vehicle operation cost}}{(1+i)^n}$$

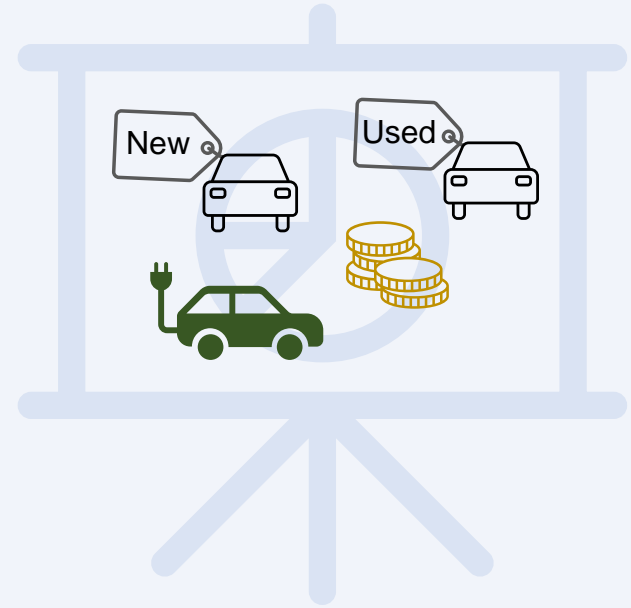
$NPP_V$  = Purchase price of a vehicle, assuming vehicles are always financed (Chakraborty et al., 2021)

$APR$  = Annual percentage rate of 5% (interest rate for loans considering an average credit score (Betterton, n.d.); the vehicle acquisition cost is a one-time cost. This is used to convert it to an annual estimate

$OC_V$  = Quarterly operating cost expenditure converted to an annual estimate




$i$  = Real interest rate of 1.25% (U.S. Department of The Treasury, n.d.)

# Results











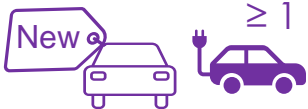



# Who are New and Used Vehicle Buyers?

## New car

HH size	
Housing tenure	
Urban/rural	
HH annual income	
Income earners	
Age	
Current vehicle holdings	

# Who are New and Used Vehicle Buyers?

	New car	Used car
HH size		
Housing tenure		
Urban/rural		
HH annual income		≠ (\$25K - \$70K) *
Income earners		
Age		40-50 years old
Current vehicle holdings		

# Who are New and Used Vehicle Buyers?

	New car	Used car	New truck/van	Used truck/van
HH size				
Housing tenure				
Urban/rural				
HH annual income		≠ (\$25K - \$70K] *	(\$100K - \$500]	(\$70K - \$100K]
Income earners				
Age		40-50 years old		<60 years old *
Current vehicle holdings				

# What is the Vehicle Ownership Cost?

By selected household characteristics that had a statistically significant impact on the vehicle purchase behavior

## Annual vehicle ownership cost by key household characteristics

	New Car (\$)	Used Car (\$)	New Truck or Van (\$)	Used Truck or Van (\$)
Family size between 2 and 4	18,713	15,326	18,649	16,043
Family size ≥5	20,200	16,198	20,752	17,786
Renters	19,408	15,725	20,869	17,511
Urban*	18,191	15,126	18,755	16,278
Rural*	16,249	12,270	16,387	14,375
<u>Income \$70-100K</u>	20,211	16,654	20,548	17,586
<u>Income \$100-500K</u>	18,198	15,672	18,309	16,363

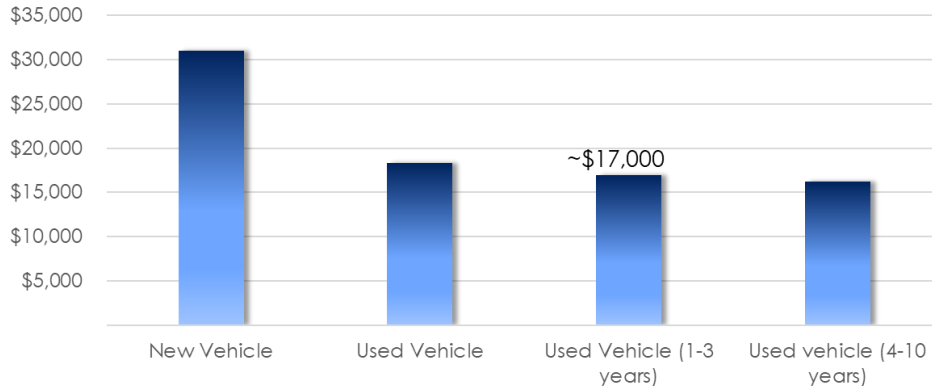
\*based on the US Census definition

# What is the Vehicle Acquisition Cost?

Average price paid for new and used vehicles



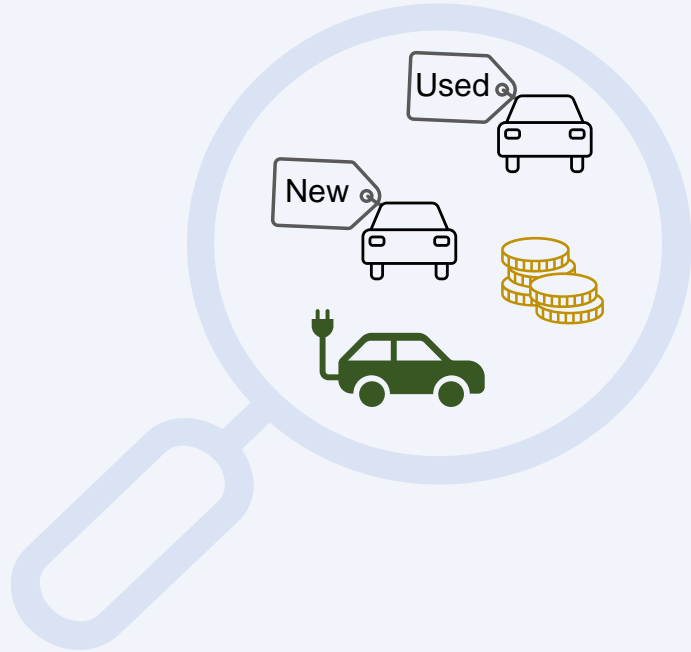
Across different income groups



Across vintage categories



# Final Remarks



# Conclusions & Implications

---



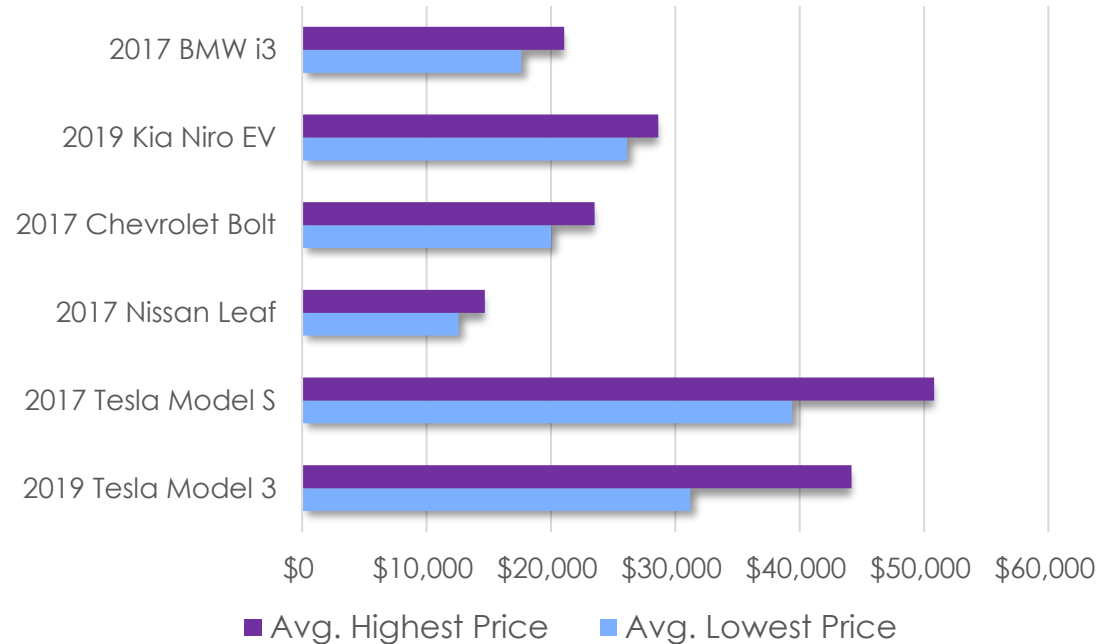
Inform about the needs of potential used EV buyers

- ☞ Having new or used vehicles can influence decisions for the purchase of new or used vehicles
- ☞ Incentives targeting larger families and communities with renters
- ☞ EV adoption by truck owners in rural areas may be slower
- ☞ Tailored strategies and initiatives to cater to the distinct needs and preferences of each market segment

# Conclusions & Implications

- Average price paid for 1–3-year-old used vehicles ~\$17,000
- Average purchase price of used EVs: varies between \$14,681 (2017 Nissan Leaf) and \$50,806 (2017 Tesla Model S)

Highest and Lowest Listed Price of Popular Used EVs  
(US News)



# Conclusions & Implications

---



Benchmark to compare used ICEVs and EVs & further explore the optimal types and monetary values of incentives used EVs

- ☞ Cost of used EVs: higher than what used vehicle buyers are currently incurring
- ☞ Concerns about equity and access to EVs

# Conclusions & Implications

---



Inform analyses exploring or modifying eligibility requirements for incentive programs

☛ Annual costs within different socioeconomic groups of new/used vehicle buyers

# Limitations & Future Work

---



- Sample includes few EV owners: collect data specifically from used EV owners in the US.
- Most recent vehicle purchase & snapshot of purchases: vehicle transactions model and changes in purchase decisions.
- CES data & cost analysis: supplement with vehicle usage- or travel behavior- related data as well as unobserved variables (e.g., psychographics, perceptions, attitudes etc.).
- Focus on vehicle acquisition and operation costs: total cost of ownership by market segment, comparison to estimated costs of EVs and cost savings for different market segments.

# Thank you

Theodora Konstantinou



[tkonstan@ucdavis.edu](mailto:tkonstan@ucdavis.edu)



Debapriya Chakraborty



[dchakraborty@ucdavis.edu](mailto:dchakraborty@ucdavis.edu)



Julia Beatriz Gutierrez Lopez



[julia.lopez@tu-dresden.de](mailto:julia.lopez@tu-dresden.de)



# Understanding the used vehicle market and its implications for electric vehicles

Presenter: Theodora Konstantinou, Postdoctoral Researcher  
Electric Vehicle Research Center, UC Davis

Debapriya Chakraborty, Research Faculty  
Electric Vehicle Research Center, UC Davis

Julia Beatriz Gutierrez Lopez, Doctoral Candidate  
Chair of Energy Economics, Faculty of Economics, Technische Universität  
Dresden

9/19/2023

