Assessing Effectiveness of Financing Subsidies on Clean Vehicle Adoption by Low- and Moderate-income Consumers

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A Research Report from the Pacific Southwest Region University Transportation Center

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16. Abstract
Clean vehicle adoption is an integral part of strategies in California and other jurisdictions to decarbonize transportation and mitigate climate change via reducing greenhouse gas emissions. However, cost barriers have thus far largely limited adoption of these technologies to more affluent households. Although California has instituted subsidy-based programs to reduce the effective cost of clean vehicles, financing policies and the performance of clean vehicle adoption incentives among low-moderate income households have been historically understudied. In their 2021 study, Sheldon, DeShazo, & Pierce use choice experiment data to create a conditional logit model of low-moderate income consumer vehicle preferences, which they then use to predict the performance of five different policy scenarios with respect to clean vehicle adoption among this demographic. Their results suggest that financing policies are significantly more cost-effective than subsidies at promoting clean vehicle adoption by low-moderate income households in California.

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Disclosure

JR DeShazo, Gregory Pierce and colleagues conducted this research titled, "Assessing Effectiveness of Financing Subsidies on Clean Vehicle Adoption by Low- and Moderate-income Consumers" at the UCLA Luskin Center for Innovation. The research took place from April 15, 2020 to June 30, 2021 and was funded by a grant from Caltrans in the amount of $107,548. The research was conducted as part of the Pacific Southwest Region University Transportation Center research program.

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Abstract

Clean vehicle adoption is an integral part of strategies in California and other jurisdictions to decarbonize transportation and mitigate climate change via reducing greenhouse gas emissions. However, cost barriers have thus far largely limited adoption of these technologies to more affluent households. Although California has instituted subsidy-based programs to reduce the effective cost of clean vehicles, financing policies and the performance of clean vehicle adoption incentives among low-moderate income households have been historically understudied. In their 2021 study—the findings of which are summarized in this report—Sheldon, DeShazo, & Pierce explored how such policies could influence behavior of these consumers with respect to clean vehicle adoption. Sheldon et al. used choice experiment data to create a conditional logit model of low-moderate income consumer vehicle preferences, which they then used to predict the performance of five different policy scenarios with respect to clean vehicle adoption among this demographic. Their results suggest that financing policies are significantly more cost-effective than subsidies at promoting clean vehicle adoption by low-moderate income households in California.

Assessing Effectiveness of Financing Subsidies on Clean Vehicle Adoption by Low- and Moderate-income Consumers

Executive Summary

California, along with many other jurisdictions, has begun instituting policies and programs to foment decarbonization of transportation as part of a broader, comprehensive climate mitigation strategy. Widespread adoption of clean vehicles—including hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and battery electric vehicles (BEVs)—is an integral part of this effort. However, to this point, adoption of these vehicle types has largely been confined to wealthier demographics. Achieving broader decarbonization goals will require expanding this trend to low- and moderate-income consumers.

To that end, California has recently ramped up efforts to enable clean vehicle adoption by low-moderate income households. Traditional incentive models have generally focused on subsidies or rebates to effectively reduce the up-front cost of clean vehicle purchases, while strategies aimed at promoting financing have been somewhat neglected. Moreover, the dearth of studies examining clean vehicle financing policies or focusing on low-moderate income consumers have made it difficult to assess whether clean vehicle subsidies are the most cost-effective approach, given the lack of a point of comparison.

To illuminate the potential of clean vehicle financing and assess how low-moderate income consumers will be impacted by clean vehicle adoption policies, the authors of the study this report summarizes (Sheldon, DeShazo, & Pierce 2021) used choice experiment data from low-moderate income Californian households looking to replace a vehicle soon to create a conditional logit model of consumer vehicle preference. This research was based on a statewide representative survey of 1,604 low- and moderate-income households. Across almost all variables examined this model found statistically significant impacts of considered factors (including fiscal factors, vehicle traits, and consumer preferences) on respondent vehicle choice.

This model was then used to predict vehicle adoption patterns by low-moderate income households in California in response to five different policy scenarios. These simulations considered varying levels of financing or subsidies for clean vehicles, predicting under each what percent of vehicle-buying consumers would purchase a new or used clean vehicle and comparing these results to a baseline. The results suggest that vehicle financing policies are more cost-effective than subsidies at promoting adoption of clean vehicles among low-moderate income Californians, producing a greater marginal increase in adoption for a given cost or, alternatively, achieving greater adoption levels for a given cost. The implications of these findings are relevant for clean, light-duty car policy expansion to meet the state's near-term air quality and transportation electrification mandates.

Introduction

As public institutions seek to mitigate climate change by reducing greenhouse gas emissions, transportation decarbonization has become an important priority in many jurisdictions. In California, where achieving State climate targets is a fraught proposition without addressing vehicle emissions, Governor Newsom directed the California Air Resources Board (CARB) to develop regulations that would end the sale of new fossil fuel-burning passenger vehicles in the State by 2035. Such steps presuppose a shift towards zero-emission vehicles (ZEVs) for a majority of households. Historically, high purchase prices and other barriers have meant ZEV ownership is largely restricted to higher income classes. As a percentage of household earnings, lower-income populations face disproportionate costs to maintaining and operating a vehicle.

To overcome the capital cost barrier, many jurisdictions offer financial incentives or subsidies to those purchasing new plug-in electric vehicles (PEVs), ranging from $1500 to $12000 depending on the program. Even with such subsidies in place, however, many lower-income households still face prohibitively high costs that impede PEV adoption. Optimally priced incentives and financing options can therefore promote household economic well-being while generating broader environmental and public health benefits through greenhouse gas emission reductions.

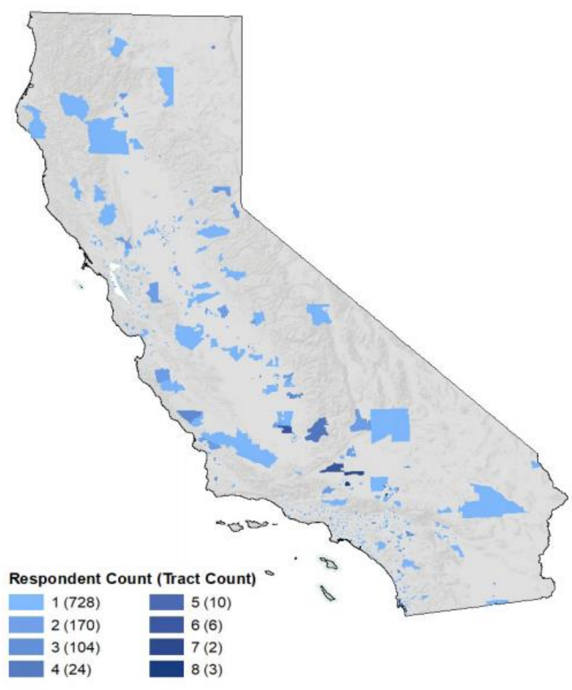
California has attempted to address this issue through clean vehicle adoption programs focused specifically on low-moderate income households. For instance, the recent Enhanced Fleet Modernization Program (EFMP) Plus-Up pilot program offers incentives for households to retire and replace fossil fuel-burning vehicles with clean alternatives. Even more recently, CARB has created an alternative financing program (the Financing Assistance Pilot Project), which provides low-interest loans, vehicle “buy down” grants, fiscal assistance for electric vehicle supply equipment, and education or assistance services for low-income households seeking to adopt electric vehicles.

In the paper that this report summarizes (Sheldon, DeShazo, & Pierce 2021), the authors address multiple gaps in the existing, policy-relevant literature regarding the cost-effectiveness of such clean vehicle programs. Their assessment considers financing—an understudied clean vehicle policy strategy—as well as the used vehicle market, which many previous studies have disregarded. Special attention is also given to low-moderate income consumers. This work builds upon a robust literature examining the effectiveness (e.g. Diamond, 2009; Gallagher and Muehlegger, 2011; Mian and Sufi, 2012; Li, Linn, and Spiller, 2013; Jin, Searle, and Lutsey, 2014; Sierzchula et al., 2014; Zhang et al., 2014), efficiency, and cost-effectiveness (e.g. Graff Zivin, Kotchen, and Mansur, 2014; Holland et al., 2016; Tal and Nicholas, 2016; Li et al., 2017; DeShazo, Sheldon, and Carson, 2017; Sheldon and Dua, 2018) of clean vehicle policies, as well as studies examining the performance of PEV subsidy-based policies (e.g. Tal and Nicholas, 2016; DeShazo, Sheldon, and Carson, 2017; Li et al., 2017; Sheldon and Dua, 2018) and potential refinements to such approaches (Li et al., 2017; (DeShazo, Sheldon, and Carson, 2017; Sheldon and Dua, 2018).

Data

Data was collected via an online survey administered in April and May, 2018, to a representative sample of Californian low-moderate income households—those with income less than 225% of the federal poverty line (FPL) (low income) or between 225% and 300% of the FPL (moderate income). The sample was also restricted to households who expressed their intent to replace a vehicle within three years, as households who are looking to acquire or change their vehicle fleet in the near-term are the target audience of vehicle replacement programs. Household income thresholds match those utilized by the California Air Resources Board to determine eligibility for the low-income transportation programs it administrates. All respondents were 18 years of age or older. Following assignment of weights by GfK (the company that administrated the survey), low-income respondents made up 68% of the sample (60% unweighted), with 32% (40% unweighted) being moderate income. Weightings were applied to make the sample representative of California's low-moderate income population. 52% of the sample (35% unweighted) were Spanish language speakers. Figure 1 shows a map of where survey responses were generated from across California.

Figure 1. Number of Respondents by Census Tract



The survey covered a variety of topic areas to this end, and included questions on the respondents' socioeconomic, demographic and geographic background, current household and vehicle characteristics, past purchase behavior and future purchase preferences, commuting patterns and needs, and willingness to consider alternative travel modes. These factors helped inform the central module of the survey, the Vehicle Choice Experiment. The vehicle choice set results enabled us to model predicted clean vehicle uptake for the low- to moderate-income households across differing incentive level and financing scenarios.

Survey respondents first supplied information regarding their anticipated replacement vehicle purchase, including body type (two most preferred), make (three most preferred), and fiscal strategy (down payment, maximum monthly payment, and loan term between 2 and 5 years). Next, respondents proceeded through three series of vehicle choice exercises (see Figure 2).

Figure 2. Example Vehicle Selection Questions from Survey

Below is a selection of vehicles that appear to match your preferences and fit within your budget. Please select which of the following vehicles you would be most likely to purchase if you were purchasing a vehicle now and these are your options. Assume the vehicles are different only in the ways we describe them below (in other words, assume they are all in similar, good condition). Prices shown are for the base models and do not include upgrades.

Select one answer from each row in the grid

Model Year	2017	2017	2015	2010	2010
Make & Model	Ford Fusion	Toyota Camry	Ford Fusion	Ford Focus	Ford Focus
Odometer	50,000 mi	0 mi (new)	150,000 mi	100,000 mi	50,000 mi
Cost per mile	$0.11	$0.11	$0.12	$0.11	$0.11
Fuel economy (MPG)	27	27	26	28	28
Price after incentives (if applicable)	$13,501	$17,323	$8,528	$5,038	$6,606
First Choice	○	●	○	○	○
Second Choice	○	○	○	○	●

Out of the following vehicles, please choose the vehicle that you would be most likely to purchase.

Select one answer only

Model Year	2017	2017	2013	2016
Make & Model	Toyota Camry	Toyota Camry	Toyota Avalon Hybrid	Ford Fusion Energi
Odometer	50,000 mi	50,000 mi	50,000 mi	100,000 mi
Engine Type	Gasoline	Gasoline	Hybrid	Plug-in Hybrid
Refueling cost per month **Fuel economy (MPG)**	$60 (27 mpg)	$60 (27 mpg)	$39 (42 mpg)	$24 (68 mpg)
Price after incentives (if applicable) **-Down payment** **=Loan amount**	$14,488* (pay in cash, no loan)	$13,039 -$8,000 =$5,039 loan	$13,032 -$8,000 =$5,032 loan	$10,338 -$8,000 =$2,338 loan
Monthly payment**	none	$128 *i*	$128 *i*	$65 *i*
Top choice	○	○	○	○

*This is the cash price of the vehicle
**Loan duration of 48 months

In each series, respondents were presented with an array of vehicles and supplied with relevant information, including picture, make/model/year, mileage, cost per mile, fuel economy, and market price (integrating impact of fiscal incentives for green vehicles).

1. *"Brown" Vehicle Choice*: Respondents were asked to choose their most preferred vehicle among sets of five fossil fuel-burning vehicles[1] that match their preferred body type and make and have an overall market price—incorporating the respondent's down payment, monthly payment, and loan term information and assuming a 10% interest rate—less than 130% of the respondent's maximum. At the end of the series, respondents choose the two vehicles of all previously selected vehicles they would be most likely to purchase (termed "brown1" and "brown2").
2. *"Green" Vehicle Choice*: Respondents were asked to choose their two most preferred vehicles (termed "green1" and "green2) among a random set of five "green" vehicles[2] that match their preferred body type and brand and have an overall market price less than 230% of the respondent's maximum. Vehicle choices include hybrids (HEVs), battery electric vehicles (BEVs), and Plug-in Hybrid Electric Vehicles (PHEVs), with at least one BEV or PHEV being included in each round if any meet the respondent's criteria.
3. *Combined Vehicle Choice*: In the final stage, respondents were asked to choose their most preferred vehicle from among four alternatives in each of six rounds. The alternatives included brown1 at market price, green1 and green2 with varying price and financing, and a hypothetical green version of brown1 with varying cost per mile, price, and financing. After the six rounds are complete, respondents were presented with the six selected vehicles and asked to choose their most preferred option among them (termed "overall1").

Choice Experiment Survey Descriptive Statistics

All respondents surveyed reported household incomes below 300% of the Federal Poverty Level (FPL), with 68% of the weighted sample reporting household incomes below 225% of the FPL. About two-thirds of respondents had an annual household income of less than $25,000 or between $25,000 and $49,999 (37%), compared to 23% of respondents making $50,000 to $74,999 and just 9% of households reporting more than $75,000 in income. Around 38% of the sample lived in a disadvantaged community at the time of the survey. Further, 52% of the weighted sample were Spanish speakers.

The survey results show a strong preference for used vehicles over new vehicles in both low- and moderate-income respondents, underscoring the need to assess the efficacy of clean vehicle policies within the used vehicle market. Among the various drivetrain technology options for clean vehicles, HEVs were the most popular overall pick (31% among both low- and moderate-income respondents), with PHEVs and BEVs composing 8-10% of overall picks. These pick rates are reflective of

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[1] Brown vehicle choices selected from 50 most popular used vehicle models by market share for 2010, 2015, and 2017. 2010 and 2015 models included mileage variants at the 50,000, 100,000, and 150,000 marks. 2017 models included a new vehicle and 50,000 mile variants. Market price information from www.Edmunds.com.

[2] Green vehicle choices selected from the 30 most popular hybrids by market share for 2010, 2011, 2013, 2016, and 2017, the 10 most popular PEVs in 2013, the 15 most popular PEVs in 2016, all PEVs in 2017 for which price data is available, and the 2011 Chevrolet Volt and Nissan Leaf. Mileage variants for each model included, where market price data available, at the 0, 50,000, 100,000, and 150,000 mile marks.

disproportionately high representation of clean vehicles among the choices offered to respondents, leading to expressed preference patterns that exceed the current market share.

Compared to low-income respondents, moderate-income respondents' preferences generally exhibit expected trends that would arise from higher disposable income. Moderate-income respondents selected new vehicles over used at higher rates, had a higher average desired vehicle price ($12,710 versus $11,056), chose financed vehicles at lower rates (16% versus 18%), had a higher average down payment ($3,682 versus $2,858), and higher monthly payments ($174 versus $168). Summary statistics are listed in Table 1.

Table 1: Summary Statistics of Choice Experiment

Respondent Preferences	Low-Income	Moderate-Income
New Vehicle	14%	22%
Used Vehicle	86%	78%
HEV	31%	31%
PHEV	8%	10%
BEV	8%	8%
Average Vehicle Price	$11,056	$12,710
Average MPG	31.3	32.2
Financed	18%	16%
Average Down Payment	$2,858	$3,682
Average Monthly Payment	$168	$174

Analysis Methods

The survey data across all choice experiment series was used to create a conditional logit model for consumer vehicle choice. In turn, this model was used to predict consumer choices in response to evaluated policy scenarios which modify fiscal factors pertaining to vehicle replacement.

The conditional logit model gauges utility as a function of fiscal factors (upfront cost—vehicle price or down payment, depending on financing status; monthly cost—refueling costs derived from cost per mile and monthly miles driven, plus monthly loan payment, if applicable; and financing status), vehicle traits (age, mileage, body type[3], make[4], and BEV or PHEV drivetrain technology), and indicators of consumer preference alignment (whether vehicle is of the respondent's most preferred body and/or most preferred brand, brown1, or green1). Additionally, fiscal factors and drivetrain technology indicators are

[3] Body type categories: SUV, small car, midsize car, large car, van/truck.

[4] Make categories: American, European, Asian, luxury.

interacted with income level as a binary variable (low-income or moderate-income, based on the 225% FPL dividing threshold) to allow for heterogeneity of preferences.

The original intention was to also evaluate how a change in the cost of e-VMT relative to fossil-fuel VMT affected respondents' willingness to adopt PEVs. In preparation for the conjoint experiment, we carefully introduced the concept of the cost per mile traveled and reminded the respondent that it varied systematically with both types of fuel and the fuel efficiency of specific vehicles. We then included the cost per mile of travel for each vehicle offered in the conjoint experiments that we presented to respondents. While nearly every other vehicle attribute that we included in the conjoint choice set was estimated with statistical precision, regrettably, the coefficient on the cost per mile was not. We suspect respondents simply did not pay sufficient attention to this attribute. The resulting statistical imprecision meant that we could not use this estimate parameter to model how changes in the cost per e-VMT would affect respondents' propensity to purchase PEVs.

The estimated model results almost universally align with expected direction of influence on preference (e.g. negative coefficients associated with costs and vehicle traits like age and mileage; positive coefficients for traits aligning with consumer brand or vehicle type preferences). Overall, the model shows a general preference away from financing, more so for low-income versus moderate-income consumers. At both income levels consumers prefer fossil fuel-burning vehicles or HEVs over BEVs, although moderate-income consumers also show favorability towards PHEVs. The model indicates a hierarchy of consumer preference by vehicle body type, with larger vehicles (vans/trucks, SUVs, and larger cars) being preferred over smaller vehicles (small cars, midsize cars).

Policy Simulations

Using a representative choice set of both fossil fuel-burning and clean vehicles, the vehicle choice model is used to predict low- and moderate-income households' vehicle adoption behaviors in response to changing policy conditions. Of these households that will replace a vehicle within three years, Sheldon et al. estimate the percentage that will adopt a new or used HEV, BEV, or PHEV. This analysis assumes that low-moderate income households in California purchase 1.98 million used and 0.59 million new vehicles annually,[5] and that only vehicle composition—not absolute number of vehicles sold—fluctuates in response to the considered policy scenarios.[6]

These scenarios consider two general policy types designed to facilitate uptake of clean vehicles by low-moderate income households: subsidized financing and direct subsidies. Sheldon et al. assess the impact on demand for clean vehicles among the target demographic in response to these policies with varying

[5] Vehicle purchase figures estimated based on national used and new vehicle purchase figures for 2017 (39.9 million and 17.1 million, respectively; 2018 Cox Automotive/AAA), proportionate households in California compared to national figures (12.8 million out of 117.7 million, or 10.88%; American Community Survey (ACS) 2013-2017), estimated proportion of California households with 2017 incomes less than $70,000 (45%, derived from median household size of 3, corresponding FPL of $20,420, 300% of FPL at $61,260, and 48.9% of California families with incomes less than $75,000 per 2017 ACS).

[6] This assumption consistent with paired retirement and replacement programs used by CARB.

magnitudes, which are compared to a baseline where no clean vehicle uptake incentives are in place. The costs of these policies to the state are estimated as follows:

- *Subsidized financing* costs are calculated by subtracting opportunity cost of capital (2%)[7] and the expected default rate (13%, ±3% sensitivity analysis)[8] from the interest rate earned (simulated at levels between 8% and 15%).[9]
- *Direct subsidy* costs are calculated as the total number of eligible clean vehicles sold multiplied by the per-vehicle subsidy amount.

Both policy programs are afforded a budget of $600 million for purposes of the simulation, with assumed overhead costs of 40% for the subsidized financing program and 25% for the direct subsidy program. The larger overhead costs for financing programs reflect the greater number of up-front and ongoing administrative tasks associated with such programs.

Results

The baseline simulation—one in which neither subsidized financing or direct subsidies for clean vehicles are in place—predicts that low-moderate income consumers constitute 1.8% of new HEV purchasers and 0.6% of new PHEV and BEV purchasers, as compared to representing about 40% of the state's population overall. With respect to the used vehicle market, the baseline simulation estimates that ~24% of HEVs, 4.3% of PHEVs, and 4.1% of BEVs will be purchased by low-moderate income consumers. For comparison, PEVs accounted for ~5% of California's new vehicle market in 2017 (Lutsey 2018) and 5-8% of the State's used vehicle market (Tal & Nicholas 2017), reflecting the impacts of existing subsidy programs and the current trend of PEV ownership being concentrated in higher-income echelons.

In each simulated policy scenario, the model predicts the percentage of consumers choosing clean vehicles, differentiating by consumer income (low or moderate) and drivetrain technology (HEV, PHEV, or BEV). The cost to the State per additional clean vehicle resulting from the policy is also calculated, being equal to the marginal increase in clean vehicle sales resulting from the policy divided by total policy cost (not including overhead). Five policy simulations were considered:

A) Flat 15% financing.
B) Flat 8% financing.
C) Varying interest rate financing minimizing cost per clean vehicle, constrained by $600 million budget.
D) Varying subsidy magnitudes resulting in adoption rates comparable to Policy C.
E) Varying subsidy magnitudes resulting in same total cost ($600 million) as Policy C.

Table 2 shows the projected choice results and cost per additional clean vehicle for low- and moderate-income consumers across the three considered drivetrain technologies. The three financing scenarios (A-C) predict a notable uptick in adoption of clean vehicles by low-moderate income consumers in

[7] Opportunity cost of capital based on approximate midpoint of Jan-Sept 2019 U.S. 10-year treasury bonds and 2029 maturity California municipal bonds.
[8] Default rate based on national and Californian auto delinquency rate data for subprime borrowers from Federal Reserve Bank of Kansas City and the Urban Institute.
[9] Simulated interest rates are reflective of historic loan interest rates in California's pilot program (8-10%) and potential higher interest rates under consideration (up to 16%).

response to the policies. Of particular note is a trend of financing leading to a large shift towards new BEVs, a portion of which manifests as a slight reduction in used BEV adoption. The variable-rate financing approach (Policy C) achieves optimal cost-effectiveness with low interest rates for new clean vehicles, no financing for used BEVs, and slightly higher rates for used HEVs and PHEVs. The cost-effectiveness advantage for the State (in terms of outcome per unit of expenditure) of Policy C over B is evidenced in the cost per additional clean vehicle, which averages $3,287 for Policy C versus Policy B's $5,963.[10]

In contrast, the upfront subsidy strategies (D and E) indicate poor performance relative to financing programs. These approaches either incur much higher costs to the State per additional clean vehicle and thus perform poorly with respect to cost-effectiveness (Policy D), or are significantly less effective at achieving intended outcomes—that is, promoting increased rates of clean vehicle adoption (Policy E).

[10] Cost per additional clean vehicle ranges for financing policies: A ($209-$506), B ($3,019-$6,632), C ($3,019-$3,799).

Table 2: Policy Simulation Results

Policy A	**Flat 15% financing**								
		New Vehicles				Used Vehicles			
			Percent Choosing				Percent Choosing		
	Income	Interest Rate	w/o Financing	w/Financing	Cost per Addtl	Interest Rate	w/o Financing	w/Financing	Cost per Addtl
HEV	Low	15.0%	1.73%	4.09%	$209	15.0%	24.21%	27.20%	$506
HEV	Moderate	15.0%	2.03%	3.32%	$266	15.0%	24.10%	26.52%	$497
PHEV	Low	15.0%	0.53%	1.63%	$234	15.0%	3.93%	5.08%	$346
PHEV	Moderate	15.0%	0.86%	1.62%	$276	15.0%	5.40%	6.39%	$389
BEV	Low	15.0%	0.57%	1.31%	$220	15.0%	4.19%	3.97%	-$727
BEV	Moderate	15.0%	0.65%	1.05%	$273	15.0%	4.00%	4.03%	$4,089

Policy B	**Flat 8% financing**								
		New Vehicles				Used Vehicles			
			Percent Choosing				Percent Choosing		
	Income	Interest Rate	w/o Financing	w/Financing	Cost per Addtl	Interest Rate	w/o Financing	w/Financing	Cost per Addtl
HEV	Low	8.0%	1.73%	4.43%	$3,019	8.0%	24.21%	27.81%	$6,632
HEV	Moderate	8.0%	2.03%	3.70%	$3,555	8.0%	24.10%	27.26%	$6,122
PHEV	Low	8.0%	0.53%	1.84%	$3,468	8.0%	3.93%	5.31%	$4,792
PHEV	Moderate	8.0%	0.86%	1.88%	$3,799	8.0%	5.40%	6.71%	$4,992
BEV	Low	8.0%	0.57%	1.42%	$3,189	8.0%	4.19%	4.00%	-$13,632
BEV	Moderate	8.0%	0.65%	1.18%	$3,659	8.0%	4.00%	4.07%	$30,236

Policy C	**Financing, equilibrating cost per additional PEV and subject to $600m budget**								
		New Vehicles				Used Vehicles			
			Percent Choosing				Percent Choosing		
	Income	Interest Rate	w/o Financing	w/Financing	Cost per Addtl	Interest Rate	w/o Financing	w/Financing	Cost per Addtl
HEV	Low	8.0%	1.73%	4.43%	$3,019	12.0%	24.21%	27.47%	$3,324
HEV	Moderate	8.0%	2.03%	3.70%	$3,555	12.0%	24.10%	26.85%	$3,162
PHEV	Low	8.0%	0.53%	1.84%	$3,468	10.5%	3.93%	5.23%	$3,277
PHEV	Moderate	8.0%	0.86%	1.88%	$3,799	10.5%	5.40%	6.59%	$3,491
BEV	Low	8.0%	0.57%	1.42%	$3,189		4.19%	4.19%	
BEV	Moderate	8.0%	0.65%	1.18%	$3,659		4.00%	4.00%	

Policy D	**Subsidy with same adoption levels as Policy C**								
		New Vehicles				Used Vehicles			
			Percent Choosing				Percent Choosing		
	Income	Subsidy	w/o Subsidy	w/Subsidy	Cost per Addtl	Subsidy	w/o Subsidy	w/Subsidy	Cost per Addtl
HEV	Low	$15,400	1.73%	4.77%	$24,165	$2,600	24.21%	27.58%	$15,399
HEV	Moderate	$11,200	2.03%	3.78%	$24,216	$0	24.10%	27.13%	
PHEV	Low	$15,300	0.53%	1.44%	$24,194	$2,400	3.93%	5.32%	$15,372
PHEV	Moderate	$11,100	0.86%	1.58%	$24,224	$0	5.40%	6.70%	
BEV	Low	$15,300	0.57%	1.54%	$24,207	$2,300	4.19%	4.19%	$15,335
BEV	Moderate	$11,100	0.65%	1.21%	$24,231	$0	4.00%	4.00%	

Policy E	**Subsidy with same total cost ($600m) as Policy C**								
		New Vehicles				Used Vehicles			
			Percent Choosing				Percent Choosing		
	Income	Subsidy	w/o Subsidy	w/Subsidy	Cost per Addtl	Subsidy	w/o Subsidy	w/Subsidy	Cost per Addtl
HEV	Low	$1,000	1.73%	1.86%	$14,097	$1,000	24.21%	26.06%	$14,082
HEV	Moderate	$0	2.03%	2.03%		$0	24.10%	24.10%	
PHEV	Low	$800	0.53%	0.56%	$14,059	$800	3.93%	4.16%	$14,060
PHEV	Moderate	$0	0.86%	0.86%		$0	5.40%	5.40%	
BEV	Low	$800	0.57%	0.60%	$14,089	$800	4.19%	4.44%	$14,106
BEV	Moderate	$0	0.65%	0.65%		$0	4.00%	4.00%	

Conclusion

The statewide representative survey, and more particularly, the vehicle choice set exercises we employed in California enabled us to model predicted clean vehicle uptake for the low- to moderate-income households across differing incentive level and financing scenarios. Results from the modeling suggest that, though the motivation behind California's programs aimed at promoting clean vehicle adoption by low-moderate income households are valid, the historic emphasis on subsidies or rebates may not be the most effective approach. Financing programs, which have been underutilized to this point, may be as or more effective at promoting uptake of clean vehicles among these demographics while being more cost-effective. Future research can help to enhance and expand policy efforts in California that most effectively promote the retirement of functional, high-emitting vehicles and the adoption of advanced clean vehicles among lower- income Californians.

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Data Management Plan

Products of Research
The statewide representative survey data used in this analysis was originally funded by CARB. A total of 1,604 fully completed surveys, from both the soft and full launch, were assigned weights by GfK to allow representativeness of the survey to the statewide low- and moderate-income population. See https://innovation.luskin.ucla.edu/wp-content/uploads/2019/06/Designing_Light-Duty_Vehicle_Incentives_for_Low-and_Moderate_Income_Households.pdf for more information.

All procedures and points-of-contact with respondents were also approved by the UCLA Institutional Review Board (IRB) under IRB approval #17-001704, Designing Light-Duty Vehicle Incentives for Low- and Moderate-Income Households.

Data Format and Content
The data are formatted in a STATA .dta file, with each row representing a household response.

Data Access and Sharing
The data are not publicly available at this time (see above).

Reuse and Redistribution
The data cannot be redistributed except with explicit permission granted by CARB.

Appendix

Table A1: Summary Statistics of Respondents (weighted sample)

Age	42.4
	(16.0)
Household Size	3.5
	(1.8)
Female	46.50%
Household Income Category	
Less than $25,000	31.2%
$25,000 to $49,999	37.3%
$50,000 to $74,999	22.8%
$75,000 or Above	8.7%
Federal Poverty Line	
225% or below FPL	68.3%
Above 225% FPL	31.7%
300% or below FPL	100.0%
Race/Ethnicity	
White, Non-Hispanic	27.1%
Black, Non-Hispanic	9.2%
Asian, Non-Hispanic	5.1%
Other, Non-Hispanic	4.7%
2+ Races, Non-Hispanic	2.2%
Hispanic	51.6%
Education	
Less than high school	15.3%
High school	45.6%
Some college	26.9%
Bachelor's degree or higher	12.2%
California Air Quality District	
Bay Area	10.8%
Sacramento Metro	3.0%
San Diego	9.3%
San Joaquin Valley Unified	11.8%
South Coast	46.3%
Other	18.9%
Geography	
Urban	43.0%
Suburban	42.5%
Rural	14.5%

Standard deviations in parentheses