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King Abdullah Petroleum Studies and Research Center

Vehicle Retirement and Replacement Policy: Assessing Impact and Cost-Effectiveness

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About KAPSARC

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Key Points

Governments across the world, motivated by air quality improvement or by climate change mitigation goals, are trying to accelerate the turnover of older, higher-emitting vehicles and replace these with lower emission vehicles. One approach is to encourage consumers to scrap their old, inefficient and more polluting vehicles and buy new ones, typically plug-in electric vehicles (PEVs) and hybrid electric vehicles (HEVs). This can be expensive on a per-additional-vehicle basis if fixed subsidy programs allow those owners who would have replaced their vehicles with a low emission vehicle anyway to obtain these subsidies.

It is important that all parties — whether invested in conventional internal combustion engine (ICE), hybrid electric or newer, fully electric powertrains — understand the scope for more economically efficient policy to avoid incorrectly estimating the barriers to entry for new vehicle technologies. Previous KAPSARC research used counterfactual simulations to highlight the fact that policymakers might increasingly switch to targeted subsidy designs to improve the cost-effectiveness of low emission vehicle subsidies.

This study, however, explores the effectiveness of a real-world targeted subsidy policy, California's 'Replace Your Ride' (RYR) program. RYR gives targeted subsidies to lower-income households living in districts with poor local air quality to retire older vehicles and replace them with newer, cleaner vehicles. The effectiveness of the RYR policy is measured using new vehicle registration and sociodemographic data in a difference-in-difference analysis framework. The results suggest that:

> Additional sales of low emission vehicles resulting from the RYR policy are high. Sales of PEVs increased by around half and sales of HEVs by more than three-quarters. These additional sales would not have been made without the RYR subsidy.

> The per additional PEV cost of less than $17,600 results in the geography and income-based subsidy design of RYR being 1.5 times more cost-effective than California's previous income independent version of the Clean Vehicle Rebate Program, under which buyers of all new clean vehicles in California received the same rebate.

> Comparing the cost-effectiveness of the HEV subsidy relative to the PEV subsidy under the RYR policy, HEV:PEV ranges from 1.35 to 2.1 in terms of per additional vehicle cost and from 0.83 to 1.31 in terms of the cost per additional gallon of gasoline saved. The lower upfront cost and therefore lower subsidy required for HEVs relative to PEVs, combined with the high percentage of additional HEV sales due to the targeted subsidy design, keep the HEV subsidy as cost-effective as the PEV subsidy.

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Executive Summary

Vehicle retirement and replacement programs provide incentives for households to replace used, fuel-inefficient vehicles with new, fuel-efficient vehicles. For example, the 2009 United States (U.S.) 'cash for clunkers' program, formally known as the Car Allowance Rebate System, offered households a rebate of $3,500 to $4,500 towards the purchase of a new, fuel-efficient vehicle when they scrapped their older vehicle. Limited research to date on the program's cost-effectiveness and efficiency suggests that such subsidies did not lead to substantial additional sales. This was because everyone participating in the program was given the subsidy, including those who would have traded up to a lower emissions vehicle anyway, even without the subsidy.

Previous KAPSARC research (Sheldon and Dua 2018) highlighted the fact that policymakers might increasingly adopt targeted subsidy designs to improve the cost-effectiveness of such demand-side policies. Targeted subsidy designs are aimed at 'marginal' consumers who are still deciding or who could be persuaded by a subsidy to purchase a plug-in electric vehicle (PEV). Those findings were based on simulating counterfactual targeted subsidy policies, using a vehicle choice model, estimated using real-world data in which all PEV buyers received the same subsidy. In this paper, a difference-in-difference framework measures the impact and cost-effectiveness of an existing targeted subsidy policy. That is, the simulation-based findings of the previous paper are validated in this study using real-world data involving a targeted subsidy policy.

In particular, this study explores the effectiveness of California's integrated vehicle retirement and replacement incentive program – the Enhanced Fleet Modernization Pilot Program – more commonly known as 'Replace Your Ride' (RYR). This provides support to low-to-moderate income households in disadvantaged Californian communities to replace their older vehicles with cleaner ones. RYR offers targeted subsidies based on three criteria: household income (relative to the poverty line, which accounts for household size); geography (neighborhood air quality); and type of replacement vehicle (i.e., internal combustion engine vehicle, hybrid electric vehicle or plug-in electric vehicle). The program currently operates in two districts with relatively poor local air quality: the South Coast air quality management district (SCAQMD) and the San Joaquin Valley air pollution control district (SJVAPCD). The overarching goal of RYR is to help low-income families retire and replace their older vehicles with newer, cleaner vehicles and thus reduce greenhouse gas emissions and local air pollution in areas which have relatively poor air quality.

This paper estimates the cost-effectiveness of the RYR policy in terms of promoting additional clean vehicle sales. The policy's impact on clean vehicle sales is identified using a difference-in-difference strategy. It involves comparing changes in new PEV and hybrid sales between eligible and non-eligible households before and after the implementation of RYR.

Results show that purchases by eligible vehicle buyers under the policy accounted for at least 54 percent of battery electric vehicles (BEVs), 44 percent of plug-in hybrid electric vehicles (PHEVs) and 78 percent of hybrid vehicles (HEVs). In other words, these sales would not have taken place without the RYR subsidy. The RYR program's efficiency in promoting additional clean vehicles sales is higher than other demand-side policies – 17 percent has been recorded for the U.S. federal PEV subsidy policy and 7 percent for California's

Clean Vehicle Rebate Program (CVRP). In terms of cost-effectiveness, RYR, with a per additional PEV cost of less than $17,600, is more than 1.5 times more cost-effective in promoting PEV adoption than CVRP. Within RYR, comparisons across technology suggest that the HEV subsidy is 1.35 to 2.1 times more cost-effective than the PEV subsidy. In terms of per additional gallon of gasoline saved cost, the HEV:PEV subsidy cost-effectiveness ranges from 0.83 to 1.31. Despite HEVs lower fuel economy, the HEV subsidy remains as cost-effective as the PEV subsidy because of the higher percentage of additional HEV sales and the lower subsidy amount for HEVs compared with PEVs.

Using geography and income-based subsidy designs similar to RYR, i.e., targeting low-to-moderate income households living in zip codes with low current adoption of fuel-efficient vehicles, policymakers have the scope to improve the impact and cost-effectiveness of vehicle retirement and replacement programs.

Introduction

Vehicle scrapping, or 'cash for clunkers' policies incentivize the retirement and replacement of older, higher-emitting vehicles with newer, lower-emitting vehicles. The 2009 United States (U.S.) federal Cash for Clunkers program — officially known as the Car Allowance Rebate System — was also an attempt to stimulate the post-recession economy by giving $3,500-$4,500 subsidies for scrapping older vehicles. Research suggests the policy led to minimal environmental gains or economic stimulus.

One common finding is that the cash for clunkers programs led to a 'pull forward' effect, where consumers purchase new vehicles sooner than they otherwise might have done in order to receive the incentive — but these consumers are not necessarily additional, as they would have bought a new vehicle anyway in the near future. Hoekstra, Puller, and West (2017) find that 60 percent of vehicles purchased under the U.S. federal Cash for Clunkers program were non-additional. Evidence suggests that a household eligible for the Cash for Clunkers incentive was no more likely to have purchased a new vehicle within six to nine months after the program's inception than a non-eligible household (Mian and Sufi 2012; Hoekstra, Puller, and West 2017; Li, Linn, and Spiller 2013). Hoekstra, Puller, and West (2017) also find that, due to the fuel economy requirements for the new vehicle purchase to qualify for the incentive, consumers purchased less expensive vehicles with higher fuel economy, thus reducing total spending.

In terms of environmental gains, there is some evidence that Cash for Clunkers led to the purchase of more fuel-efficient vehicles (Hoekstra, Puller, and West 2017; West et al. 2017). In addition, West et al. (2017) do not find evidence of a rebound effect, observing instead that despite the lower cost per mile resulting from an increase in fuel economy, households did not respond by increasing the miles driven. However, environmental gains from this policy were relatively expensive. Knittel (2009) estimates an implied cost of $365 per ton of reduced CO_2 as a result of the federal Cash for Clunkers policy. Li, Linn, and Spiller (2013) estimate an implied cost of $91-$288 per ton of reduced CO_2 after accounting for the benefit of reduced criteria pollutants.

California is piloting an innovative vehicle retirement and replacement policy – the Enhanced Fleet Modernization Pilot Program – more commonly known as 'Replace Your Ride' (RYR). The policy was implemented in June 2015 by the California Air Resources Board and provides financial incentives for lower-income households to retire old vehicles and purchase newer, lower-emitting vehicles. To be eligible for the RYR incentives, households must not only qualify on the basis of income but must also live in the South Coast air quality management district (SCAQMD), or the San Joaquin Valley air pollution control district (SJVAPCD), two areas with relatively poor local air quality. The goal of RYR is to help low-income families to purchase clean vehicles, to reduce local air pollution in these districts and to reduce greenhouse gas emissions.

This paper uses a difference-in-difference strategy to identify the impact of RYR on clean vehicle purchases. It specifically compares changes in new plug-in electric vehicle (PEV) and hybrid purchases between eligible and non-eligible households before and after the implementation of RYR. The sample is limited to new vehicle purchases made by consumers resident in SCAQMD who owned a vehicle eligible for trade-in. Low-income consumers in this sample were eligible for the RYR incentives.

Policy Background

The Retire and Replace pilot program of California's Enhanced Fleet Modernization Program (EFMP) offers incentives for lower-income households in the greater Los Angeles area to retire older, higher-emitting vehicles and purchase newer, lower-emitting vehicles. The retirement component of EFMP has been in place since 2010, providing $1,000 for state residents to scrap older vehicles, or $1,500 for low-income participants. The mid-2015 changes made to EFMP include limiting the program to low-income households and providing additional incentives towards the purchase of a newer, cleaner vehicle. The base EFMP incentives are funded by a vehicle registration surcharge authorized by Assembly Bill 118, providing annual funding of almost $3 million (CARB 2016). Additional incentives are available to a subset of participants resident in or near a disadvantaged community census tract.

Proceeds from the Greenhouse Gas Reduction Fund's cap and trade auction fund these additional EFMP 'Plus-Up' incentives. Funding for this component was $2 million for fiscal years (FY) 2014-2015 and $10 million for FY 2015-2016, respectively (Pierce and DeShazo 2018). The base EFMP and the EFMP Plus Up are jointly operated and are jointly referred to as 'Replace Your Ride' (RYR). The first recorded vehicle transaction for the RYR program was on May 25, 2015, which is considered as the policy start date in this analysis.

Table 1 shows the RYR incentives offered to households resident in the South Coast air quality management district (SCAQMD) and the San Joaquin Valley air pollution control district (SJVAPCD). Low income is defined as having a household income less than or equal to 225 percent of the federal poverty line, moderate as less than or equal to 300 percent, and above moderate as less than or equal to 400 percent, where the federal poverty line is a function of the persons in the household. In addition to being geographically- and income-eligible, to receive the incentive a household must retire a

Table 1. Replace Your Ride incentives.

Base	Newer (2009 or newer) vehicle, 20+ MPG, conventional/hybrid	35+ MPG	PHEV	BEV	Public transit or rideshare
Low	$4,000	$4,500	$4,500	$4,500	$4,500
Moderate	Not available	$3,500	$3,500	$3,500	$3,500
Above moderate	Not available	Not available	$2,500	$2,500	$2,500
Base + 'Plus-Up'	Hybrid (20+ MPG)	Hybrid (35+ MPG)	PHEV	BEV	
Low	$6,500	$7,000	$9,500	$9,500	
Moderate	Not available	$5,000	$7,500	$7,500	
Above moderate	Not available	Not available	$5,500	$5,500	

Source: KAPSARC.

vehicle that is operational, older than model year 2007 or exceeds emissions levels of vehicles newer than model year 2000, which is gasoline or diesel powered, and has a gross vehicle weight rating of 10,000 pounds or less. To be considered operational, a vehicle must have been registered with the California Department of Motor Vehicles for the past two years or have documentation from an insurance company or automotive repair dealer proving two years of vehicle operation in California (CARB 2015).

As Table 1 shows, low-income households are eligible for a $4,000 subsidy towards the purchase of a newer, conventional, internal combustion engine (ICE) vehicle. Both low and moderate income households are eligible for a subsidy towards the purchase of a hybrid vehicle (HEV). Low, moderate, and above moderate income households are all eligible for a subsidy towards the purchase of a plug-in hybrid vehicle (PHEV) or an all-electric, battery electric vehicle (BEV). These three income groups are also eligible for public transit/rideshare vouchers in lieu of a vehicle purchase after retiring their old vehicle.

As of January 2016, 290 vehicles had been replaced in both the SCAQMD and SJVAPCD areas, a total of 580. In SJVAPCD, 25 percent of vehicles replaced were ICE, 45 percent HEV, 17 percent PHEV and 13 percent BEV, with 100 percent of participants from the lowest income category. In SCAQMD, 17 percent of vehicles replaced were ICE, 43 percent HEV, 21 percent PHEV and 19 percent BEV, with the vast majority of participants from the lowest income category (CARB 2016). In 2015, participants purchasing a PHEV or a BEV were also eligible for an additional $1,500 and $2,500 rebate, respectively, under the statewide Clean Vehicle Rebate Project.

Given the RYR budget for 2015 was $3 million for the base incentives, $2 million for the Plus-Up incentives in FY 2014-2015, and $10 million for the Plus-Up incentives in FY 2015-2016, and the reported number of RYR participants in 2015 (580), the 2015 budget could have run out. This would explain the relatively low participation rate despite the generous subsidies. Indeed, noted by Pierce and DeShazo (2018), by September 2015 there was a wait list to participate in RYR. Since there was excess demand for the program in 2015, this paper's analysis is limited in what it can show about induced vehicle retirements. The main question this analysis addresses is whether or not RYR changed the vehicle purchase decisions of those who participated in it. Specifically, it investigates whether the eligible population bought vehicles of technologies different than they otherwise would have, had the program not been in place.

Data

The primary dataset, Automotive DNA file, from Experian Information Solutions, Inc. (Experian 2015), includes all new vehicle registrations in California for 2014 and 2015 at the individual level, as well as sociodemographic variables. For all observations, the data also include information (make, model, year, etc.) up to the previous 11 household vehicle purchases. We match vehicle registrations to Edmunds' database of vehicle characteristics (Edmunds 2015), using 11 digit vehicle identification numbers. Vehicle characteristics include date purchased and fuel type (e.g., HEV, PHEV, BEV and ICE). Sociodemographic variables in this analysis include household size and income group — jointly used to determine income eligibility for participating in RYR — and Experian's proprietary 'mosaic household' segments (Experian 2014, 2016), included in the vector X_{it} in Equation 1, described in the methodology section. Experian uses a large set of demographics to classify households as belonging to one of 71 mosaic household segments, such as 'Sophisticated Singles,' 'Hard Working Blue Collar,' and 'Comfortable Retirement.'

Tables 2 shows summary statistics for our estimation sample, which includes all new vehicle purchases in SCAQMD by consumers likely to own a vehicle eligible for retirement under the RYR program.

Table 2. Summary statistics.

Total new vehicle purchases	**342,318**
HEVs	20,729
PHEVs	4,402
BEVs	3,586
Treated observations	7.08%
Post-RYR observations	31.03%
Income eligible observations	21.15%

Source: KAPSARC.

Methodology

A difference-in-difference approach is used to identify the impact of RYR on vehicle purchase decisions by estimating a multinomial logit where the probability, y_{it} , of the consumer purchasing a BEV, PHEV, or PHEV, relative to the omitted category of an ICE vehicle (ICEV), is a function of the following covariates:

$$Prob(y_{it} = 1) = f(RYR * Income\ Eligible_{it}, RYR_t, Income\ Eligible_i, \mathbf{X}_i, \gamma_t) \quad (1)$$

where

RYR_t: binary variable equal to 1 after the start of RYR on May 25, 2015.

$Income\ Eligible_i$: binary variable equal to 1 for households meeting RYR income eligibility requirements.

$\mathbf{X}_i$: vector of sociodemographic segment indicators.

γ_t: year by month fixed effects.

The sample is restricted to households resident in the SCAQMD area that are likely to have owned a vehicle eligible for retirement under the RYR program. The SJVAPCD area is excluded from the sample because nearly all replacement vehicles purchased there were used, and our data include only all new vehicle purchases. Reported household income and household size determine income eligibility, according to the policy criteria (CARB 2015).

All vehicles older than model year 2000 are eligible for trade-in. Vehicles older than model year 2007 are also eligible if they fail emissions tests. It cannot be known for sure which households own eligible vehicles but, having data on prior vehicle purchases, it was deemed possible for households to own an eligible vehicle if one of their last two vehicle purchases was of a vehicle older than model year 2007. Households whose last one or two vehicle purchases were not older than 2007, or households that have not purchased a vehicle in the past, are categorized as not owning an eligible vehicle.

The main assumption behind the identification strategy is the parallel trend assumption — that before RYR, vehicle purchase behavior by income eligible households followed the same trend as income ineligible households in the sample. In Equation 1, the estimated coefficient on the interaction term $RYR * Income\ Eligible_{it}$ represents the impact of RYR on the outcome variable, the probability of purchasing a BEV, PHEV, or HEV. Specifically, it is the difference in the outcome of income eligible households relative to income ineligible households after the implementation of RYR, controlling for household demographics.

Results and Discussion

Figure 1a shows total monthly purchases of new vehicles in the sample by the income eligible and income ineligible households. There does not appear to be any visible increase in new vehicle purchases by the subsidized population relative to the unsubsidized population after the RYR program implementation at the end of May 2015. This can be interpreted as evidence against a pull-forward effect. However, as noted in the policy background section, since there was unmet demand under the program during this time, it is impossible to ascertain whether or not there would have been an increase in vehicle purchase in the treated population had the program budget been larger. Figures 1(b-d) show the trends in BEV, PHEV, and HEV purchase probabilities by month for the income eligible and income ineligible populations. All three appear to have relatively parallel trends before the start of the policy in May 2015.

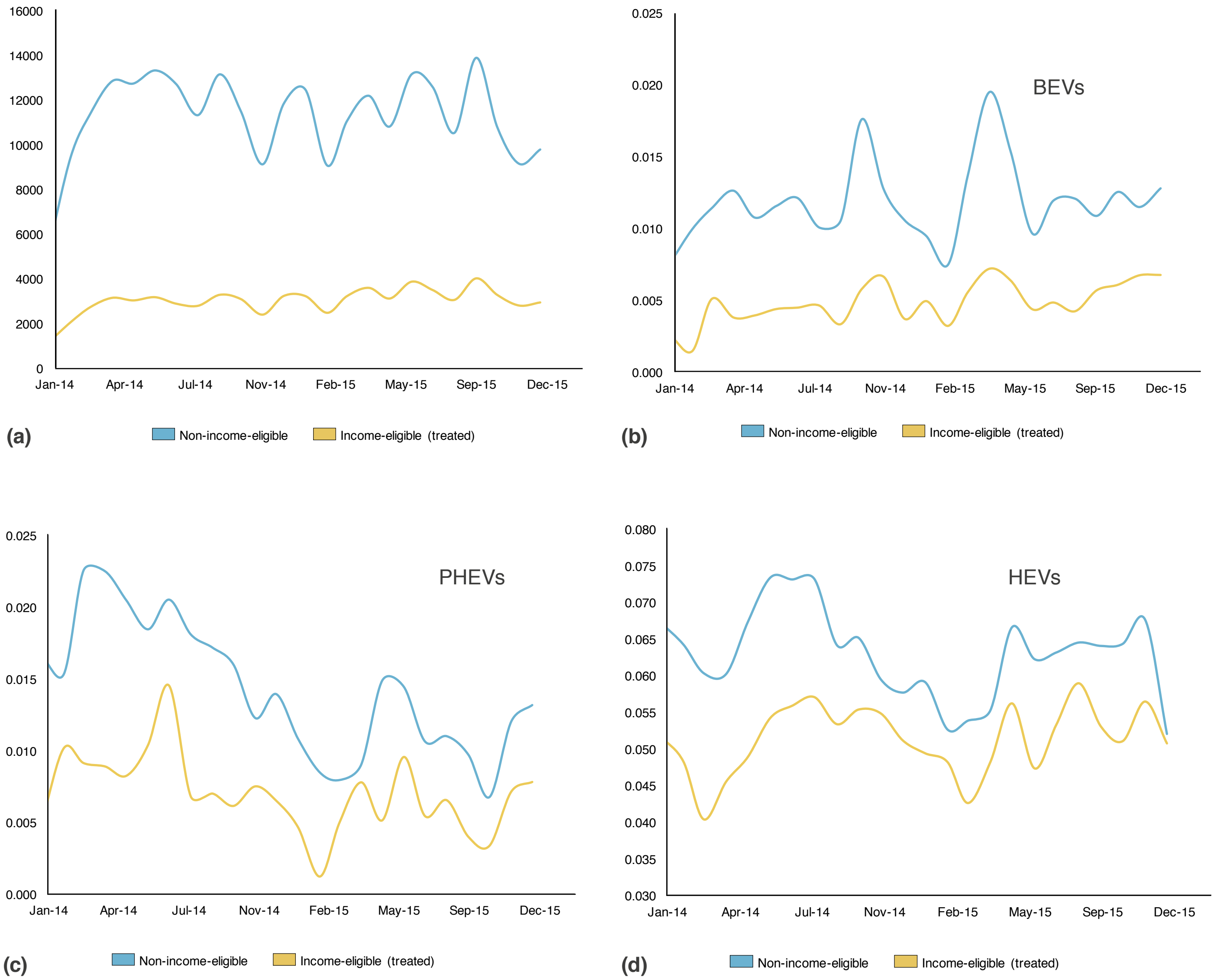

Figure 1. Trends for (a) totally monthly new vehicle purchases — purchase probability of (b) BEVs; (c) PHEVs; (d) HEVs – by non-income eligible and income eligible households.

Source: KAPSARC.

Table 3 displays the estimation results. The coefficients on income eligibility show that this population tends to be less likely to purchase BEVs, PHEVs and HEVs in general. This makes sense, as these vehicles tend to be more expensive than ICEs and the income eligible population is low income. The coefficients on the interaction term show that the RYR policy caused a statistically significant increase in the income eligible population's log odds of purchasing a BEV, PHEV and HEV by 0.237, 0.179 and 0.087, respectively. Exponentiation of these coefficients shows that the policy led to a 27 percent increase in the subsidized population's probability of purchasing a BEV, a 20 percent increase in their probability of purchasing a PHEV and an 8 percent increase in their probability of purchasing an HEV.

Using the estimated coefficients, predictions are made of BEV, PHEV and HEV purchases, both with (using actual treatment values) and without (assuming the interaction term equals zero) the RYR policy. The difference in purchases represents the number of purchases induced by the policy. The simulations suggest that from the RYR program implementation through to the end of 2015, the program gave rise to 27 additional BEV purchases, 24 additional PHEV purchases and 87 additional HEV purchases. According to official reports (CARB 2016), of the 290 vehicles purchased under the RYR program in SCAQMD in 2015, 89 percent were bought by low-income households, in which 19 percent (50) of replacement vehicles were BEVs, 21 percent (55) PHEVs and 43 percent (112) HEVs. Table 4 summarizes these numbers. New and used replacement vehicles were eligible for the RYR incentives. However, official reports do not state how many of the above replacement vehicles were new. As Table 4 shows, if all replacement vehicles purchased under RYR were new, then 54

Table 3. Difference-in-difference multinomial logit estimates.

	(1) BEV	(2) PHEV	(3) HEV
RYR* income eligible	0.237**	0.179**	0.078**
	(0.107)	(0.089)	(0.033)
RYR	-0.501**	0.528***	-0.104
	(0.206)	(0.159)	(0.080)
Income eligible	-0.352***	-0.231***	-0.064***
	(0.069)	(0.053)	(0.022)
Constant	-5.280	-4.507*	-2.761***
	(3.296)	(2.393)	(0.220)
Mosaic household indicators	Y	Y	Y
Year × month FE	Y	Y	Y
Observations	342,318	342,318	342,318

Bootstrapped standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: KAPSARC.

Table 4. Additionality of RYR in SCAQMD in 2015.

Fuel-type	Calculated purchases (new and used) by low-income households in SCAQMD under RYR using (CARB 2016)	Estimated additional purchases due to RYR	Additionality
BEV	50	27	≥54%
PHEV	55	24	≥44%
HEV	112	87	≥78%

Source: KAPSARC.

percent of BEVs purchased under the policy, 44 percent of PHEVs and 78 percent of HEVs would have been additional. That is, they would not have been purchased without the policy. Assuming that some of the replacement vehicles were used, additionality would be even greater.

Additionality of 50 percent would be a substantial improvement in cost-effectiveness compared with recent policies. For example, DeShazo, Sheldon, and Carson (2017) find that before the recent change in California's CVRP subsidies, the policy cost approximately $30,000 per additional PEV purchased. Assuming an average subsidy of $2,000 — at the time, BEV rebates were $2,500 and PHEV rebates were $1,500 — this implies additionality of 7 percent. On the other hand, the U.S. federal incentive structure was found to account for 17 percent additional PEV sales, with a cost of $35,601 per additional PEV (Sheldon and Dua 2018).

In comparison, assuming the maximum incentive of $9,500 per BEV, the 50 BEVs that participated in the program cost a total of $0.475 million. Dividing this cost by the predicted number of induced BEV purchases (27) implies a maximum per induced BEV purchase cost of approximately $17,600. This suggests RYR was 1.7 times as cost-effective as CVRP in 2015 in inducing BEV purchases. Similar calculations suggest a maximum per induced PHEV purchase cost of less than $22,000, which suggests that RYR was more than 1.3 times as cost-effective as CVRP in 2015 for inducing PHEV purchases. Assuming the maximum incentive of $7,000 for the 112 HEVs that participated in the program implies a total cost of $0.784 million. Dividing this cost by the predicted number of HEV purchases (87) implies a maximum per induced HEV purchase cost of approximately $9,000.

The within RYR policy cost-effectiveness of BEVs, PHEVs and HEVs is also computed in terms of U.S. dollars per gallon of gasoline saved. The fuel economy of the scrapped vehicle is not included in the gasoline savings calculation, to make a fair comparison among the three fuel types. It is also assumed that in the absence of a subsidy for each fuel type, the respective additional sales would go towards purchasing an ICEV with a fuel economy corresponding to the average fleet fuel economy of the treated ICEV population. This analysis arrives at a maximum per gallon cost of gasoline savings of $5.1, $7.7 and $4.7 for BEVs, PHEVs and HEVs, respectively, assuming a vehicle lifetime of 10 years and an annual mileage of 12,000 miles. Assuming 100 percent additional sales for all fuel types results in per gallon cost of gasoline savings of $2.7, $3.4 and $3.6 for BEVs, PHEVs and HEVs, respectively.

The lower per HEV incentive, coupled with the higher percentage of additional HEV sales, implies the HEV subsidy remains as cost-effective as the PEV subsidy. Consumers may derive higher utility from HEVs relative to PEVs because of the lower upfront cost and longer range of HEVs. Thus, it is possible that lower subsidy amounts could be sufficient to nudge low-income households to adopt HEVs.

Conclusion

This paper estimates the impact and cost-effectiveness of California's Replace Your Ride Program, using a difference-in-difference identification strategy to compare relative changes in the subsidized versus unsubsidized populations. The analysis suggests that in 2015, RYR was successful in promoting the adoption of clean vehicles. There is evidence that a majority of PEV and hybrid vehicle purchases made under the program in SCAQMD in 2015 were additional and would not have happened without the policy, unlike the 'cash for clunkers' program. This can be attributed to the highly targeted subsidy design of RYR, in that it offered higher subsidies for buying lower emitting vehicles to low-income households resident in regions with low prior clean vehicle adoption levels. Incentives for these vehicles were large: up to $9,500 for the RYR subsidy and up to $12,000 including the CVRP BEV rebate. Since the purchases were mostly additional, cost-effectiveness was better than the statewide CVRP program in 2015 and the U.S. federal incentive structure. Within RYR policy, HEV subsidy remains as cost-effective as the PEV subsidy because of a lower subsidy for HEVs relative to PEVs and a higher percentage of additional HEV sales due to the targeted subsidy design. However, any decline in battery costs and improvements in the electric range of EVs would disproportionately increase the cost-effectiveness of PEV subsidies.

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Notes

Notes

About the Team

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About the Project

Promoting adoption of energy-efficient vehicles has become a key policy imperative in both developed and developing countries. Understanding the impact of various factors that affect adoption rates forms the backbone of KAPSARC's efforts in the light-duty vehicle demand field. These include (i) consumer-related factors – demographics, behavioral, psychographics; (ii) regulatory factors – policies, incentives, rebates, perks; and (iii) geo-temporal factors – weather, infrastructure, network effects. Our team is currently developing models at different levels of resolution: micro-level models using large-scale data comprising of new car buyers' profiles, and macro level models using aggregated adoption data, to understand and project the effects of various factors at play for the adoption of energy-efficient vehicles.

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