

Assessing CVRP Designs: Lessons from New Car Buyers

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Research Questions

How big is the consumer market for BEVs and PHEVs that could be effectively targeted by a rebate?

How many additional PEVs sales are associated with the CVRP program?

How can better targeting of the CVRP program increase the cost effectiveness and improve equity outcomes?



CVRP Research Findings (1)

When thinking about where rebates are needed

- ▶ WTP for BEVs is lower than for PHEVs
- ▶ New car buyer market is highly segmented
 - 32% of new car buyers would purchase BEVs with significant rebate.
 - 74% of new car buyers would purchase PHEVs, many without any rebate.



CVRP Research Findings (2)

Rebates...

- ▶ Significantly impact PEVs sales in California...inducing about a 7% increase in sales. (large for the auto industry)
- ▶ Can be more cost effectively and equitably designed by targeting:
 - BEVs and larger battery vehicles,
 - Lower income relative to higher income households,
 - Moderately- to lower-priced vehicles (smaller equity impact).

Study Data Sources (1)

- ▶ New car buyer survey
 - 1261 prospective new car buyers in California
 - Household and vehicle data
 - Vehicle choice experiments
 - Allow us to identify preferences for vehicles that do not currently exist but are likely to in the future
 - Allow us to identify preferences along different dimensions of heterogeneity

Study Data Sources (2)

- ▶ Caltrans “2010–2012 California Household Travel Survey”
 - Cross-check representative sample of new car buyers
 - Cross-check vehicle class share with revealed preference data
- ▶ California New Car Dealers Association’s “California Auto Outlook 4Q2013”
 - Cross-check vehicle brand market share data



Figure 3: New Car Buyer Survey: Brand Choice

Out of the following, which brands are you most likely to purchase for your next new vehicle purchase? (please select top three choices) *please scroll down.*

1st Choice:

Select one answer only

Please Select

2nd Choice:

Select one answer only

Please Select

3rd Choice:

Select one answer only

Please Select

Next

Figure 4: New Car Buyer Survey: Top Vehicle Choice

If the set of vehicles to choose from were those in the table below, what would your choice be?

For QC:

'MercedesBenzcompactsedan2', 'Nissancompactsedan1', 'AudicompactSUV5', 'MitsubishicompactSUV1', 'VolkswagencompactSUV4'

	Vehicle 1	Vehicle 2	Vehicle 3	Vehicle 4	Vehicle 5
Brand and Model	Mercedes Benz C-Class Sedan	Nissan Sentra Sedan	Audi SQ5 SUV	Mitsubishi Outlander Sport SUV	Volkswagen Tiguan SUV
Refueling cost (per mile)	\$0.18	\$0.15	\$0.20	\$0.17	\$0.22
Purchase price	\$38,350	\$15,990	\$51,900	\$19,470	\$22,995
Select your first choice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Next

Survey: PEV Choice Module

Please choose the vehicle you would be most likely to purchase if you were purchasing a new vehicle.

	Vehicle 1	Vehicle 2	Vehicle 3	Vehicle 4	Vehicle 5
Fuel Type	gasoline	all-electric	all-electric	dual-fuel	dual-fuel
Brand and Model	Toyota RAV4 SUV				
Electric range	0 miles	75 miles	200 miles	60 miles	10 miles
Gasoline range	300 miles	0 miles	0 miles	300 miles	300 miles
Fuel cost per gasoline mile	\$0.18 Like \$4.40 gal gas	n/a	n/a	\$0.12 Like \$2.80 gal gas	\$0.08 Like \$2.00 gal gas
Fuel cost per electric mile	n/a	\$0.06 Like \$1.50 gal gas	\$0.06 Like \$1.50 gal gas	\$0.04 Like \$0.90 gal gas	\$0.06 Like \$1.50 gal gas
HOV Access	No	No	No	Yes	Yes
Purchase Price	\$23,300	\$29,125	\$34,950	\$26,795	\$24,465
Select your top choice	<input type="radio"/>				

Next

Table 2: Attribute Levels

Purchase Price¹ (% of conventional)	
Gasoline	100%
BEV	105%, 115%, 125%, 150%
PHEV	105%, 115%, 125%, 150%
Gasoline Refuel Cost (\$ per gal)	
Gasoline ²	\$4.00, \$4.40, \$4.80, \$5.60
BEV	n/a
PHEV ³	\$2.00, \$2.20, \$2.40, \$2.80
Electric Refuel Cost⁴ (\$ per gal equivalent)	
Gasoline	n/a
BEV	\$0.90, \$1.10, \$1.50, \$2.50
PHEV	\$0.90, \$1.10, \$1.50, \$2.50
Gasoline Range (miles)	
Gasoline	300
BEV	300
PHEV	0
Electric Range (miles)	
Gasoline	n/a
BEV	50, 75, 100, 200
PHEV	10, 20, 40, 60
HOV Access	
Gasoline	no
BEV	no, yes
PHEV	no, yes

WTP for BEVs is less than for PHEVs

Table 4: Willingness to Pay

	WTP (Price Normally Distributed)	WTP (Price Log Normally Distributed)
BEV	- \$5,759	-\$5,459
PHEV	\$7,692	\$9,432
Additional Mile of Electric Range	\$63	\$143
Additional \$ per Gal Refuel Cost	-\$698	-\$728
HOV Access	\$1,369	\$1,082

1. How big is the consumer market for BEVs and PHEVs that could be effectively targeted by a rebate?



Three major consumer segments for BEVs and PHEVs

42% of respondents express large disutility for BEVs while finding PHEVs comparable in utility to ICEs.

26% express large disutility for both BEVs and PHEVs.

32% express smallest disutility for BEVs while finding PHEVs comparable in utility to ICEs



Table 8: Latent Class Model: Segment Preferences

	Segment 1	Segment 2	Segment 3
Price (\$1,000s)	-0.193*** (0.016)	-0.387*** (0.052)	-0.024*** (0.007)
BEV	-3.752*** (0.382)	-3.031*** (0.485)	-0.197 (0.300)
PHEV	0.643** (0.298)	-1.531*** (0.403)	0.511** (0.251)
Range	0.051*** (0.003)	0.013** (0.006)	0.018*** (0.003)
Range ²	-0.0002*** (0.00002)	-0.00003 (0.00002)	-0.00003*** (0.00001)
Refuel	-0.219*** (0.073)	-0.088 (0.105)	-0.123** (0.052)
HOV	0.382*** (0.089)	-0.073 (0.156)	0.232*** (0.064)
Class Share	42.4%	26.1%	31.5%
Observations	24,940	24,940	24,940

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Max Level of Incentives across States

Maximum Possible Incentive Per Vehicle



Automakers and Dealers

Routinely use rebates, cash back and discounts to sell vehicles and capture market share.

Some deals available for you today....





FIND YOUR TAG, GET

- \$2,000 CUSTOMER CASH
- \$1,000 DOWN PAYMENT ASSISTANCE
- \$1,500 OPTION PACKAGE DISCOUNT
- + \$2,000 PURCHASE BONUS CASH

\$6,500 TOTAL VALUE⁵

ON SELECT 2015 VEHICLES IN STOCK WHEN YOU FINANCE THROUGH SELECT LENDERS



Get up to \$3,000 Factory Cash Back on a New 2015 Avalon.

**\$2,500 cash back on select Kia
Cadenza models**

Featured Offer

•\$2,500 cash back

Offer only valid 11/03/2015 through
1/04/2016 *Applies to select new 2015
Kia Cadenza.*



**Get up to \$4,500 Total Savings Value
On a 2015 DART GT**

Retail Consumer Cash ^[1]	\$3,000
Conquest ^[2]	\$1,000
CBC Chrysler Capital ^[3]	\$500
Total Savings Value	\$4,500

2. How many additional PEVs sales are associated with the CVRP program?
3. How can better targeting of the CVRP program increase the cost effectiveness and improve equity outcomes?



Policy Simulations

1. Estimate empirical model using survey data
2. Predict PEV sales using representative sample of new car buyers and currently available conventional vehicles and PEVs
3. Compare predictions as PEV prices are reduced by differing rebate amounts and policy designs



CVRP Policy Comparison

1. Current “status quo” policy
2. Price cap for vehicle eligibility
3. Income–tested policies



Judging the Performance of Alternative CVRP Policies

Compare over 3-year policy period:

- Total additional PEVs purchased
- Cost per induced vehicle purchase
- Total program cost
- Equity: distribution of rebate funding across consumer income classes

(*Income defined for individuals not households.)



California Status Quo Rebate Policy

- ▶ Rebate is estimated to induce 9,699 PEV purchases (7% increase over no rebate policy)
- ▶ Higher WTP for PHEVs over BEVs
- ▶ Lower income classes have lower values (WTP) for both PHEVs and BEVs

Policy	Income	BEV Rebate	PHEV Rebate	Baseline BEVs Sold	Baseline PHEVs Sold	Addt'l BEVs Sold	Addt'l PHEVs Sold	Additional PEVs Sold	Total PEVs Sold
Status Quo Policy	Under \$25k	\$2,500	\$1,500	2,899	6,203	473	719	9,699	158,335
	\$25-\$50k	\$2,500	\$1,500	6,065	18,191	775	1,278		
	\$50-\$75k	\$2,500	\$1,500	10,313	18,667	664	963		
	\$75-\$100k	\$2,500	\$1,500	6,349	16,981	645	1,001		
	\$100-\$175k	\$2,500	\$1,500	19,822	35,735	985	1,250		
	Over \$175k	\$2,500	\$1,500	4,060	3,371	557	389		

California Status Quo Rebate Policy

- ▶ Every additional PEV purchased requires California to spend \$30,000
- ▶ 42% of the value of the rebates is allocated to consumers making less than \$75,000

Policy	Income	BEV Rebate	PHEV Rebate	Baseline BEVs Sold	Baseline PHEVs Sold	Add'l BEVs Sold	Add'l PHEVs Sold	Additional PEVs Sold	Total PEVs Sold
Status Quo Policy	Under \$25k	\$2,500	\$1,500	2,899	6,203	473	719	9,699	158,335
	\$25-\$50k	\$2,500	\$1,500	6,065	18,191	775	1,278		
	\$50-\$75k	\$2,500	\$1,500	10,313	18,667	664	963		
	\$75-\$100k	\$2,500	\$1,500	6,349	16,981	645	1,001		
	\$100-\$175k	\$2,500	\$1,500	19,822	35,735	985	1,250		
	Over \$175k	\$2,500	\$1,500	4,060	3,371	557	389		

Policy	Income	BEV Rebate	PHEV Rebate	BEV Budget	PHEV Budget	Total PEVs Sold	Total Cost (\$ Millions)
Status Quo Policy	Under \$25k	\$2,500	\$1,500	\$8,431,349	\$10,383,030	158,335	\$291
	\$25-\$50k	\$2,500	\$1,500	\$17,101,072	\$29,202,579		
	\$50-\$75k	\$2,500	\$1,500	\$27,442,629	\$29,444,460		
	\$75-\$100k	\$2,500	\$1,500	\$17,484,884	\$26,973,264		
	\$100-\$175k	\$2,500	\$1,500	\$52,018,618	\$55,478,170		
	Over \$175k	\$2,500	\$1,500	\$11,541,233	\$5,639,740		

Policy	Additional PEVs Sold	Additional PEVs Sold*	Total Cost-Effectiveness	Add'l Dollar Needed to Induce One Add'l PEV*	Total Cost (\$ Millions)	Total Cost* (\$ Millions)	Allocative Equity
Status Quo Policy	9,699	N/A	\$30,017	N/A	\$291	N/A	42%

* Compared to Status Quo Policy

Principles for more cost effective rebates

Target consumers who otherwise would not have purchased PEV.

- Consumers have a lower WTP for BEVs than PHEVs.

Target consumers who are more responsive to the rebate offered.

- Lower income rather than higher income consumers.



Vehicle Price Cap on Rebate Eligibility

- ▶ Vehicle price cap of \$60,000
- ▶ Highest income class reduces BEV purchases (from 557 to 194) much more than PHEV purchases (from 389 to 377)
- ▶ 10% reduction in induced PEV purchases compared to status quo

Policy	Income	BEV Rebate	PHEV Rebate	Baseline BEVs Sold	Baseline PHEVs Sold	Addt'l BEVs Sold	Addt'l PHEVs Sold	Additional PEVs Sold	Total PEVs Sold
Policy 3: Vehicle Price Cap at \$60,000	Under \$25k	\$2,500	\$1,500	2,899	6,203	410	719	8,651	157,308
	\$25-\$50k	\$2,500	\$1,500	6,065	18,191	649	1,269		
	\$50-\$75k	\$2,500	\$1,500	10,313	18,667	515	944		
	\$75-\$100k	\$2,500	\$1,500	6,349	16,981	507	995		
	\$100-\$175k	\$2,500	\$1,500	19,822	35,735	847	1,227		
	Over \$175k	\$2,500	\$1,500	4,060	3,371	194	377		

Vehicle Price Cap on Rebate Eligibility

- ▶ 26% improvement in cost-effectiveness and \$100 million reduction in total program cost
- ▶ Only a small improvement in allocative equity (from 42% to 45%)
 - Higher-income consumers also purchase lower-priced PEVs
 - Price cap does not influence allocation of rebates to other vehicles

Policy	Income	BEV Rebate	PHEV Rebate	Baseline BEVs Sold	Baseline PHEVs Sold	Addt'l BEVs Sold	Addt'l PHEVs Sold	Additional PEVs Sold	Total PEVs Sold
Policy 3: Vehicle Price Cap at \$60,000	Under \$25k	\$2,500	\$1,500	2,899	6,203	410	719	8,651	157,308
	\$25-\$50k	\$2,500	\$1,500	6,065	18,191	649	1,269		
	\$50-\$75k	\$2,500	\$1,500	10,313	18,667	515	944		
	\$75-\$100k	\$2,500	\$1,500	6,349	16,981	507	995		
	\$100-\$175k	\$2,500	\$1,500	19,822	35,735	847	1,227		
	Over \$175k	\$2,500	\$1,500	4,060	3,371	194	377		

Policy	Income	BEV Rebate	PHEV Rebate	BEV Budget	PHEV Budget	Total PEVs Sold	Total Cost (\$ Millions)
Policy 3: Vehicle Price Cap at \$60,000	Under \$25k	\$2,500	\$1,500	\$5,525,708	\$8,734,800	157,308	\$191
	\$25-\$50k	\$2,500	\$1,500	\$12,516,008	\$26,627,751		
	\$50-\$75k	\$2,500	\$1,500	\$12,416,557	\$20,625,015		
	\$75-\$100k	\$2,500	\$1,500	\$11,125,314	\$23,355,006		
	\$100-\$175k	\$2,500	\$1,500	\$26,472,618	\$40,322,793		
	Over \$175k	\$2,500	\$1,500	\$2,510,984	\$748,341		

Policy	Additional PEVs Sold	Additional PEVs Sold*	Total Cost-Effectiveness	Addt'l Dollar Needed to Induce One Addt'l PEV*	Total Cost (\$ Millions)	Total Cost* (\$ Millions)	Allocative Equity
Policy 3: Vehicle Price Cap at \$60,000	8,651	-1,048 (-10%)	\$22,075	-\$7,942 (-26%)	\$191	-\$100 (-34%)	45%

* Compared to Status Quo Policy

Income-Tested Rebate Levels

- ▶ One of most cost-effective policies and one of lowest total program costs
- ▶ 100% of rebates allocated to households with incomes less than \$75,000
- ▶ Superior to status quo policy

Policy	Income	BEV Rebate	PHEV Rebate	Baseline BEVs Sold	Baseline PHEVs Sold	Addt'l BEVs Sold	Addt'l PHEVs Sold	Additional PEVs Sold	Total PEVs Sold
Policy 5: Progressive Rebate Increase by Income	Under \$25k	\$7,500	\$4,500	2,899	6,203	1,635	2,392	9,434	158,090
	\$25-\$50k	\$5,000	\$3,000	6,065	18,191	1,629	2,610		
	\$50-\$75k	\$2,000	\$1,000	10,313	18,667	528	639		
	\$75-\$100k	\$0	\$0	6,349	16,981	-	-		
	\$100-\$175k	\$0	\$0	19,822	35,735	-	-		
	Over \$175k	\$0	\$0	4,060	3,371	-	-		

Policy	Income	BEV Rebate	PHEV Rebate	BEV Budget	PHEV Budget	Total PEVs Sold	Total Cost (\$ Millions)
Policy 5: Progressive Rebate Increase by Income	Under \$25k	\$7,500	\$4,500	\$34,009,626	\$38,679,027	158,090	\$215
	\$25-\$50k	\$5,000	\$3,000	\$38,472,680	\$62,401,798		
	\$50-\$75k	\$2,000	\$1,000	\$21,681,786	\$19,305,549		
	\$75-\$100k	\$0	\$0	\$0	\$0		
	\$100-\$175k	\$0	\$0	\$0	\$0		
	Over \$175k	\$0	\$0	\$0	\$0		

Policy	Additional PEVs Sold	Additional PEVs Sold*	Total Cost-Effectiveness	Addt'l Dollar Needed to Induce One Addt'l PEV*	Total Cost (\$ Millions)	Total Cost* (\$ Millions)	Allocative Equity
Policy 5: Progressive Rebate Increase by	9,434	-265 (-3%)	\$22,743	-\$7,274 (-24%)	\$215	-\$77 (-26%)	100%

* Compared to Status Quo Policy

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Ways to design PEV rebates

Vary rebate levels for:

- different types of vehicles

 - (battery size; BEVs vs. PHEVs; new vs. used)

- different types of consumers

 - (lower vs. higher income)

- geographic areas

 - (transportation air pollution impacts vary)

Vary eligibility guidelines for given rebate

- Vehicle price exclusions

- Consumer income exclusions

- Purchase vs. lease of vehicle

