Comparing Proposed E-Bike Rebates in DC to the ZEV Subsidy in Maryland: Calculations Appendix

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The calculations in the January 25, 2023, article in Greater Greater Washington are based on the linear economic models created by Bigazzi and Berjisian (2021) to model e-bike demand response to subsidy. Given that these models were based on zero emission vehicle (ZEV) demand models, I used them to model both e-bike and ZEV demand from the two subsidies.

Parameters:

Parameter	Description	Value	Notes	Source
ϵ_{bike}	Elasticity of bikes	-2.0		Bigazzi and Berjisian, 2021
ϵ_{car}	Elasticity of cars	-1.3	Based on the Jenn et al.'s finding that a single $1,000 subsidy generates 2.6% additional demand and that a ZEV is $50,000.	Jenn et al., 2018
r	Rebate value	Varies	See below for values	
n_r	Number of rebates (DC only)	1,500	This rebate cap is only for DC, which has 1500 $400 rebates and 1500 $1200 rebates.	Legislation
p	Base price		Varies. See below for values.	
d_b	Baseline demand		Varies. See below for values	
S_U	US sales	880,000	It is difficult to get national sales figures; this is for 2021.	Hurford, 2022
P_L	Local population			US Census
P_U	US population	331,893,760		US Census
M_L	Local bike-to-work mode share	0.021		US Census
M_U	US bike-to-work mode share	0.004		US Census

Functions:

	Demand-limited	Rebate-limited
Total demand w rebate, d_r	$d_b\left(1 - \frac{\epsilon r}{p}\right)$	
Add'l demand with rebate	$-d_b \epsilon \frac{r}{p}$	
Add'l sales	$-d_b \epsilon \frac{r}{p}$	$\frac{n_r \epsilon r}{\epsilon r - p}$
Portion of rebates to new purchasers	$\frac{\epsilon r}{\epsilon r - p}$	
Base demand, d_b	$S_U \frac{P_L M_L}{P_U M_U}$	

Maryland subsidy scheme input values:

Item	ZEVs	PIHs	Source
Estimated Base Price *p*	\$50,000	\$45,000	Newton, 2022
Rebate Value *r*	\$3,000	\$2,000	Legislation
Monthly Demand Growth Rate *g*	0.035	0.023	MVA
Proportion of Rebates to New Buyers	7.2%	5.5%	$\frac{\epsilon r}{\epsilon r - p}$
Gasoline Miles Eliminated per Purchase	100%	56.3%	Department of Energy
Per Capita VMT	9,966		MVA

Maryland subsidy scheme results:

Values after November 2022 are estimates. Fractional demand indicates a probability of sale.

	Zero-Emission and Electric Vehicles (ZEVs)			Plug-In Hybrid Vehicles (PIHs)				
Month	**Total ZEVs (baseline)**	**ZEV d_b**	**Add'l Demand**	**Total PIHs (baseline)**	**PIH d_b**	**Add'l Demand**	**Total Spent**	**Total Add'l VMT Saved**
10/2022	37,214	1,048		20,133	347			
11/2022	39,517	2,303		20,777	644			
12/2022	40,894	1,377		21,254	477			
1/2023	42,318	1,425	111.2	21,742	488	28.2	\$5,639,738	3,103,699
2/2023	43,792	1,474	56.5	22,242	499	14.2	\$2,860,262	
Total			167.7			42.4	\$8,500,000	

Note the drop-off from January to February. This is because the subsidy scheme is capped at \$8.5 million, most of which is spent in the first month of the program. To finish the money, I estimated how many vehicles might be sold daily in February by dividing the monthly values by 28. I then determined approximately how much subsidy would be spent each day and divided the remaining value of the subsidy by that amount. This estimates the subsidy will last an additional 14 days in February before running out, and these are roughly the number of vehicles that would be stimulated to be sold on those days.

To determine the VMT savings, I multiplied the number of vehicle sales induced, the gasoline miles saved, and the average per capita annual miles travelled for both the ZEV and the PIH sales:

$$3{,}103{,}699 = (167.7 \times 1.00 \times 9966) + (42.4 \times 0.563 \times 9966)$$

District of Columbia subsidy scheme results and input values:

Item	High-income value	Low-income value	District-Wide	Source
Estimated Number of Residents P_L	386,329	283,721	670,050	US Census
Estimated Base Demand d_b	5,378	3,949	9,327	$d_b = S_U \frac{P_L M_L}{P_U M_U}$

Estimated Base Price p	$2,000	$1,600	n/a	Estimate
Rebate Value r	$400	$1,200	n/a	Legislation
Total Demand with Rebate d_r	7,529	9,874	17,402	$d_b\left(1-\frac{\epsilon r}{p}\right)$
Additional Demand with Rebate	2,151	5,924	8,075	$-d_b\epsilon\frac{r}{p}$
Additional Sales s_r	429	900	1,329	$\frac{n_r\epsilon r}{\epsilon r-p}$
Proportion of Rebates to New Buyers	28.6%	60.0%	49.9%	$\frac{\epsilon r}{\epsilon r-p}$
Total Cost	$2,322,800	$5,818,800	$8,141,837	$r(d_b+s_r)$
Gasoline Miles Eliminated per Purchase	37%			Soöderberg et. al, 2020
Per Capita VMT	5,341			FHWA
VMT Saved	4,730,600			$\left(\frac{1329\times 5341}{3}\right)$

While the bike-to-work value is assumed to be equal for both high- and low-income residents, I estimated the number of residents above and below 80% of the median income in DC by using Census household data. This allowed me to break out the baseline demand for the District and get more accurate results.

Base price for an e-bike varies by income for two reasons. First, given that higher-income households are more likely to be able to purchase more expensive e-bikes, $2,000 is the median price of a relatively cheap e-bike. Second, the low-income household subsidy is capped at 75% of the total value of the e-bike, which implies a base price of $1,600.

The Maryland alternative values, wherein the state funded e-bike rebates instead of ZEV and PIH subsidies, is the same, though I had to tweak the number of rebates offered to fit it under the budget:

Item	**High-income value**	**Low-income value**	**District-Wide**	**Source**
Estimated Number of Residents P_L	2,599,219	3,565,910	6,165,129	US Census
Local Bike-to-Work Percentage, M_L	0.2%			US Census
Estimated Base Demand d_b	5,378	3,949	9,327	$d_b = S_U\frac{P_L M_L}{P_U M_U}$
Estimated Base Price p	$2,000	$1,600	n/a	Estimate
Rebate Value r	$400	$1,200	n/a	Legislation
Total Demand with Rebate d_r	4,824	11,819	16,643	$d_b\left(1-\frac{\epsilon r}{p}\right)$
Additional Demand with Rebate	1,378	7,091	8,469	$-d_b\epsilon\frac{r}{p}$
Additional Sales s_r	496	1,042	1,538	$\frac{n_r\epsilon r}{\epsilon r-p}$
Proportion of Rebates to New Buyers	28.6%	60.0%	49.9%	$\frac{\epsilon r}{\epsilon r-p}$
Total Cost	$1,576,740	$6,922,822	$8,499,562	$r(d_b+s_r)$

Gasoline Miles Eliminated per Purchase	37%	Soöderberg et. al, 2020
Per Capita VMT	5,341	FHWA
VMT Saved	4,730,600	$\left(\frac{1329 \times 5341}{3}\right)$