Can Subsidies Spur Electric Vehicle Adoption Nationwide?

David S. Rapson and Erich Muehlegger*

October 23, 2020

Policy-makers around the globe view adoption of electric vehicles (EVs) as a central element to addressing urban air pollution, lowering carbon emissions and reducing petroleum consumption. The long-run vision is one of a fully electrified transportation sector paired with a clean, renewable electricity sector. As a starting point to achieving these goals, local, state and national governments have set ambitious targets for widespread adoption of electric vehicles (EVs) or phasing out internal combustion engines (ICEs) entirely. In recent years, Norway (by 2025), India (by 2030), France and the United Kingdom (by 2040), and China have committed to banning conventional vehicles. Germany has announced plans to put 1 million electric vehicles on the road by 2020. In California, former Governor Brown issued an executive order in 2013 to put 1.5 million "Zero Emissions Vehicles" (ZEVs) on the road by 2025 (and 5 million by 2030) as part of a goal to reduce transportation emissions by 50 percent by 2030. More recently, Governor Newsom further committed the state to banning sales of new non-ZEV vehicles by 2035. And just yesterday, the New Jersey Department of Environmental Protection called for a similar ban on gasoline-powered vehicles by 2035.

To achieve these ambitious policy targets, policy makers have offered generous subsidies to stimulate adoption and overcome the upfront cost disadvantage EV face when compared to similar conventional vehicles. Federal incentives for electric vehicles total up to $1.5 billion per manufacturer. State governments have also been active in encouraging adoption. Over half of states have some sort of EV incentives in place. These ranged from point-of-sale subsidies to high-occupancy vehicle (HOV) lane stickers, sales tax waivers, registration fees (waivers or taxes), parking preferences, charging infrastructure subsidies and more. The total cost of these programs is considerable and presents stark tradeoffs for public funds. As of mid-2020, California has spent nearly $900 million on the state-wide vehicle subsidies, and recent proposals suggested allocating another $3 billion in the state.[1] Despite this substantial policy commitment by the federal and state governments, adoption of electric vehicles is still modest - the market share of new EV purchases nationwide is in the low single digits. Even in a state like California, the market share remains

*(Rapson) University of California - Davis. dsrapson@ucdavis.edu. (Muehlegger) University of California - Davis and NBER. emuehlegger@ucdavis.edu.

[1]Most of this funding supported California Clean Vehicle Rebate Program, which offers new EV buyers $1,500-$2,500 and (beginning in 2016) was means-tested to further stimulate lower-income EV adoption. In addition, some funds generated by the low carbon fuel standard (LCFS) are redirected to California electric utilities to subsidize EVs.

below 10 percent.

The wide gap between the current world and the ambitious policy targets motivates two proposed research questions. The first is retrospective – what fraction of national sales to-date are subsidy-induced? Or in other terms, how cost effective have existing subsidies been in stimulating demand for electric vehicles? To answer this question, we propose to pair sales and incentive data at the state-level and estimate the fraction of subsidy-induced based on our estimates from California (Muehlegger and Rapson (2018)) and estimates the broader literature on electric vehicle sales (Li et al. (2017), Li (2017) and Springel (2017)).

The extent to which subsidies induce "additional" EV purchases is an important determinant of cost-effectiveness and welfare effects of a subsidy policy. In the case of most EV subsidy programs, both subsidy-induced EVs and those that would have been purchased irrespective of the presence of a subsidy are subsidy-eligible. As targeted subsidies, aimed towards buyers for whom the subsidy is the determining factor in a purchase decision, are infeasible, the cost per additional (subsidy-induced) vehicle depends on the size of the market that would have been realized in a subsidy-free world and the elasticity of demand for electric vehicles.[2]

Table 1: Subsidy Additionality

		Price Elasticity of Demand		
		-1.5	-2.5	-3.5
Panel A: Fraction BEVs Subsidy-Induced				
Tesla:	California	0.19	0.30	0.39
	Rest of U.S.	0.15	0.23	0.31
Non-Tesla:	California	0.46	0.65	0.77
	Rest of U.S.	0.36	0.52	0.64
Panel B: Implied Subsidy per Induced BEV				
Tesla:	California	$ 51,727	$ 33,227	$ 25,365
	Rest of U.S.	$ 68,355	$ 43,153	$ 32,402
Non-Tesla:	California	$ 21,509	$ 15,448	$ 13,028
	Rest of U.S.	$ 27,945	$ 19,156	$ 15,522

Note: Calculations assume a) $7,500 in federal new BEV subsidies, b) $2,500 in California new BEV subsidies, and c) that all subsidy-eligible purchases receive the subsidy.

As a preliminary illustration, we present a "back-of-the-envelope" estimate of the fraction of EVs sold under the existing federal and California subsidy regimes that is subsidy-induced in Table 1.[3] In Panel A we report the implied fraction of battery electric vehicles (BEVs) that were "additional" under different assumptions about the demand elasticity. Consistent with intuition,

[2]The demand elasticity summarizes much of what is needed to predict what would have happened in this alternate, subsidy-free world. On one hand, a high demand elasticity will induce more EV purchases for a given amount of subsidy, thereby implying a higher degree of additionality than if demand were less elastic. On the other hand, as the proportion of subsidy-induced vehicles grows, the implication is that in a subsidy-free world the size of the EV market would have been that much smaller.

[3]The main elements of this calculation are data on actual EV purchase prices, California and federal EV subsidy amounts (which we assume to be $2,500 and $7,500 for California and federal subsidies, respectively), and data on the number of EV sales. We perform the calculations separately for Teslas to acknowledge the fact that Teslas are much more expensive than the vast majority of other EVs sold during the period of our data (before the end of 2018).

more elastic demand corresponds to a higher fraction of the market that is subsidy induced. An elasticity of -1.5 implies that the vast majority of BEVs would have been purchased even had the subsidies not been present. This is particularly true for Teslas. At the higher end of the elasticity range, -3.5, it still appears that most Teslas were likely not subsidy-induced purchases; but 64-77 percent of non-Teslas were. The other side of this coin is the implied subsidy per induced BEV, which decreases as demand becomes more elastic (moving left to right in the table). If most BEVs would have been purchased irrespective of subsidies, the implied subsidy cost per subsidy-induced purchase is large. If 80 percent of Teslas in California would have been purchased without subsidies (and assuming 100 percent subsidy uptake), then the average subsidy expense per subsidy-induced Tesla would be over $50,000.

The second research question we propose is prospective – if we hope to achieve ambitious policy targets, what can we say about the subsidy (or implicit subsidy created by a EV sales mandate, like the Zero-emission vehicle mandate in California) that might be required to achieve different levels of future EV adoption nationwide? Of course, this is more speculative as it requires assumptions on the future trajectory of battery costs, but is no less policy relevant. Even back-of-the-envelope calculations, grounded by parameter estimates from the literature, may provide guidance as to the necessary scope and budget of future EV subsidies.

References

Li, Jing, "Compatibility and Investment in the U.S. Electric Vehicle Market," Working Paper 2017.

Li, Shanjun, Lang Tong, Jianwei Xing, and Yiyi Zhou, "The market for electric vehicles: indirect network effects and policy design," *Journal of the Association of Environmental and Resource Economists*, 2017, *4* (1), 89–133.

Muehlegger, Erich and David S Rapson, "Subsidizing Mass Adoption of Electric Vehicles: Quasi-Experimental Evidence from California," Technical Report, National Bureau of Economic Research 2018.

Springel, Katalin, "Network Externality and Subsidy Structure in Two-Sided Markets: Evidence from Electric Vehicle Incentives," Working Paper 2017.