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Assessing consumer preferences for luxury and economy electric vehicles in a post- tax credit market

Michaela Nam, University of Michigan

Center for Local, State, and Urban Policy
Gerald R. Ford School of Public Policy
University of Michigan

Michaela Nam

Dr. Sarah Mills

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ABSTRACT

Since the introduction of the Federal Tax Credit (FTC) for electric vehicles, the US has been able to reduce the number of gasoline powered vehicles on the road by incentivizing users to purchase electric vehicles (EVs). However, as the FTC phases out for some EV models, it poses questions as to whether or not further incentives will be needed to encourage households to continue to purchase EVs at the same or greater rate. In this paper, I use qualitative statistical analysis to measure to what extent the sales of EVs are impacted by the FTC versus consumer behavior. Through this analysis, I find that the FTC has no significant impact on the sale of luxury EV models; while the FTC may encourage some users to adopt EVs, it is the brand reputation and image that strongly impacts the competition and rate in which models are sold. Using these observations, I provide potential solutions to help inform future EV policy that targets certain populations for EV adoption.

INTRODUCTION

One of the biggest contributors to US greenhouse gas (GHG) emissions comes from the transportation sector. The United State Environmental Protection Agency (US EPA) found that around 28% of GHG is attributed to transportation, the largest portion of any sector (US EPA, 2015a). Within transportation, around 90% of the fuel is petroleum-based with the majority coming from light-duty vehicles. The amount of GHG emissions we release each year from transportation keeps rising. In 2019, 276 million light duty vehicles—passenger cars, motorcycles, light trucks, and buses to name a few—were registered in the US. 17 million of the registered cars were newly registered (*Number of cars in US*, n.d.).

With an increasing number of vehicles on the road, it is important to take advantage of opportunities that allow us to reduce the greenhouse gas emissions. Currently, technology to improve the design and functionality of cars come from manufacturing electric vehicles (US EPA, 2015b). This is important to reducing GHG emissions because conventional petroleum based cars produce emissions through the tailpipe and evaporation from the fueling system and process. However, electric vehicles do not produce any direct emissions (*Alternative Fuels Data Center*, n.d.).

As we attempt to transition towards a cleaner future, incentives from the government help expedite the rate in which consumers adopt electric vehicles (EVs). The federal tax credit is a result of the government's efforts to create purchase incentives for EVs; it allows buyers to receive a maximum of $7,500 back on their purchase. In addition to tax credits on a federal level, several states offer additional purchase incentives. Thus, the maximum tax credits an individual can receive varies state by state. Because the purpose of this tax credit is to help offset the initial high upfront costs of EVs and increase access to the cars, the total number of rebates given to each EV manufacturer phases out after 200,000 quantifying sales. Due to this number, manufacturers like Tesla and General Motors—leaders in EV sales—are seeing a phase-out of federal assistance for their models. It was strategically designed as such so that mature businesses who do not need additional incentives to purchase EVs increasingly receive less on their rebates.

This statistic reveals important consumer information about electric vehicles purchases. First, the federal EV tax credit has a positive impact on the EV market; it incentivizes individuals to purchase EVs as opposed to conventional vehicles. Second, brand recognition plays a factor into the sales of EVs. While the number of sales are dependent on the timing of when car manufacturers enter the EV market, the rate in which they receive 200,000 quantifying purchases differ. As more and more manufacturers phase out the federal tax credit, it impacts their future sales as it can drive consumers away and to other car brands. The literature remains outdated and general when describing the influences of the federal tax credit in conjunction with the brand identity of certain models (ie. luxury vs. economy EV models) (Tal, n.d.). This leads to an interesting gap in which we can explore the extent to which EV sales reflect consumer preferences. My paper will focus on this gap and attempt to better understand the influences and market of electric vehicles sales as it relates to brand identity.

LITERATURE REVIEW

The current body of knowledge regarding electric vehicles and consumer perception remain diverse. Hayashida's (2021) research lays an important foundation in regards to approaches to EV research. Using fixed effects panel econometric methods, Hayashida presents various data like gas taxes, unemployment, and air quality side by side. Through this, she observes that EV policies are most sensitive to environmental ideology and politics. For instance, states with higher vehicle miles traveled per capita were more likely to have home charger subsidies but less like to have purchase subsidies. Hayashida's research highlights the importance of analyzing various economic, political, demographic, and environmental policies in tandem with each other to understand shifts in state-based EV policies. This reveal is important to note because it highlights the complicated nature of understanding EV policy. A comprehensive understanding of consumer perception and EV adoption relies on various factors in environmental policy, politics, economics, etc. Without proper understanding of a sector, a paper that isolates variables together can skew and mislead results.

Contrary to Hayashida (2021), whose focus is on state adoption of EV policy, Nazari's (2018) research explores the trade-offs between fuel costs savings, capital cost, and environmental benefits to understand consumer decision-making processes when purchasing EVs. Nazari attempts to understand consumer preferences and dynamics in response to EV cost and policy. Using a connected, two-stage, dynamic model of PEV adoption and vehicle-transaction decision-making, Nazari reveals that households of upper-level income and education are more likely to adopt PEVs most likely due to accessibility to charging stations. His research is confirmed by Wolbertus' (2018) research as he analyzes the long term and short term effects of adopting electric vehicles. By combining state and preference data, Wolbertus measures the effects certain policies have on EV adoption and charging behavior. He finds that daytime charging policies are effective in decreasing under-utilized EV charging stations. However, if there is a rise in concern regarding the availability of charging stations near households, it reduces purchase intentions for EVs.

Wolbertus' findings open an interesting perspective on the socioeconomic divide between EVs. While upfront costs are an important factor to consider when incentivizing EV purchases, it is important to also note the availability of EV charging stations and work-life balances of different households. Due to the limited range and time it takes for EVs to refuel, it is vital to define the population in which current EV models cater to. Rezvani's (2015) research provides a comprehensive framework and methodology in his assessment of advances in consumer electric vehicle adoption research. He looks at various studies to draw upon theoretical frameworks like rational choice theory, normative theories, and self-image congruence theory to understand consequences of EV decision making. By recognizing the range anxiety individuals face as well social implications of owning EVs, it poses an interesting relation to environmental and consumer attitudes. While literature exists in regards to consumer adoption behavior, the literature remains outdated and a gap remains where it relates to social and brand identity. Previous research by Skippon and Garwood (2011), focused on pro-environmental behavior and purchase incentives, reveals that there is a substantial weight social factors play in the purchase of EVs. For some, the purchase of EVs allows consumers to consider themselves an environmentalist. For others, it can serve as a signal to their identity and status when behavior costs are higher. While the literature regarding various psychological behaviors to EV purchases by Skippon and Garwood (2011) and Rezvani (2015) are thorough, the latest literature from the two were presented in 2015. Since then, various new models have arisen, perception towards EVs and policy have changed, and EV technology has advanced exponentially.

The only finding that remains clear in encouraging the adoption of EVs are financial purchase incentives. Hardman's (2017) research analyzed different types of financial incentives from various regions to observe the extent in which financial incentives are effective. Using systematic review, Hardman was able to review 35 different studies that seek to understand the relationship between plug-in electric vehicle (PEV) sales and financial purchase incentives. He concluded that there is in fact a strong correlation. Given these findings, it can be hypothesized sales of EV and motivations to adopt can steeply decline as the federal tax credit and state-based incentives phase out. However, Hardman isolates his research strictly to financial incentives and does not consider any other factors that could complicate his findings. As Hayashida (2021) reveals, it is important to conduct research on the cross-effects certain policies have on each other. Without doing so, it can mislead conclusions.

The existing literature underscores that there are personal motivations as well as public incentives when considering the purchase of EVs. As the availability of federal tax credits decrease and EV models retain a high upfront cost, it poses questions as to whether EVs will contribute to a socioeconomic divide. The purpose of EV technology is to reduce our use of GHG emissions, however, as the current literature suggests, it is mainly accessible to high-income households. By analyzing the variances in purchase incentives across different models over time, coupled with access to federal tax incentives, this paper attempts to provide a better understanding of how different models reflect consumer preferences and values. Thus, this research seeks to answer the question: *Do EV sales reflect consumer preferences for luxury vehicles even after accounting for differences in federal tax credits?* In doing so, it can reveal potential personal incentives of EV adoption and help in assessing the value of federal tax credits and proposing policy that targets certain populations for EV adoption.

METHODS

With this question in mind, it is important to understand the method by which the analysis will be conducted: quantitative statistical analysis. Quantitative statistical analysis emphasizes objective measurements using statistical data. It is most suitable to answer the proposed research question because it allows the use of various variables and controls to measure to what extent the Federal Tax Credit (FTC) reflects consumer preferences and attitudes towards EVs.

Multiple sources of information are included to execute this research. Variances to the FTC as it relates to each car brand from 2011-2020 is collected and analyzed. This information will be used to compare with data on the number of car sales from each brand over a period of time. Evidence on consumer preferences and attitudes is obtained mainly through a cross analysis between the manufacturer's suggested retail price (MSRP) and annual car sales for different car brands. Obtaining these datasets can reveal consumer attitudes on luxury vs. economy vehicles when purchasing EVs.

To make such a project feasible within the given timeframe, it is necessary to set a scope and address limitations to the research. Because the FTC is an American federal policy, the population is limited to the US. While the overall purchase price of a vehicle can vary state by state due to additional state incentives, this research will not factor in individual state incentives because reports on the number of car sales by each state is not available; there would be no accurate way to address overall purchase price by state. However, it is important to note that additional state incentives can range from $0-$4000, potentially influencing consumer decisions. (*State Policies Promoting…*, n.d.).

The independent variables for this research are the purchase price of the car as well as the categorization of the car as luxury or economy. The categorization of the luxury vs. economy models is defined by the brand reputation of each model as well as the MSRP; only brands with an MSRP of at least $40,000 for their EVs will be considered because the average price for an entry-level luxury vehicle is around $40,000 (Luxury Cars, 2019). Of the brands considered, the brands categorized as "luxury" are Audi, BMW, Porsche, Tesla, and Jaguar. The brands categorized as "economy" are Fiat, Ford, Chevrolet (Chevy), Hyundai, Nissan, Volkswagen (VW), and Kia. The data is depicted below.

Table 1: MSRP of Top 12 Car Brands EV Models

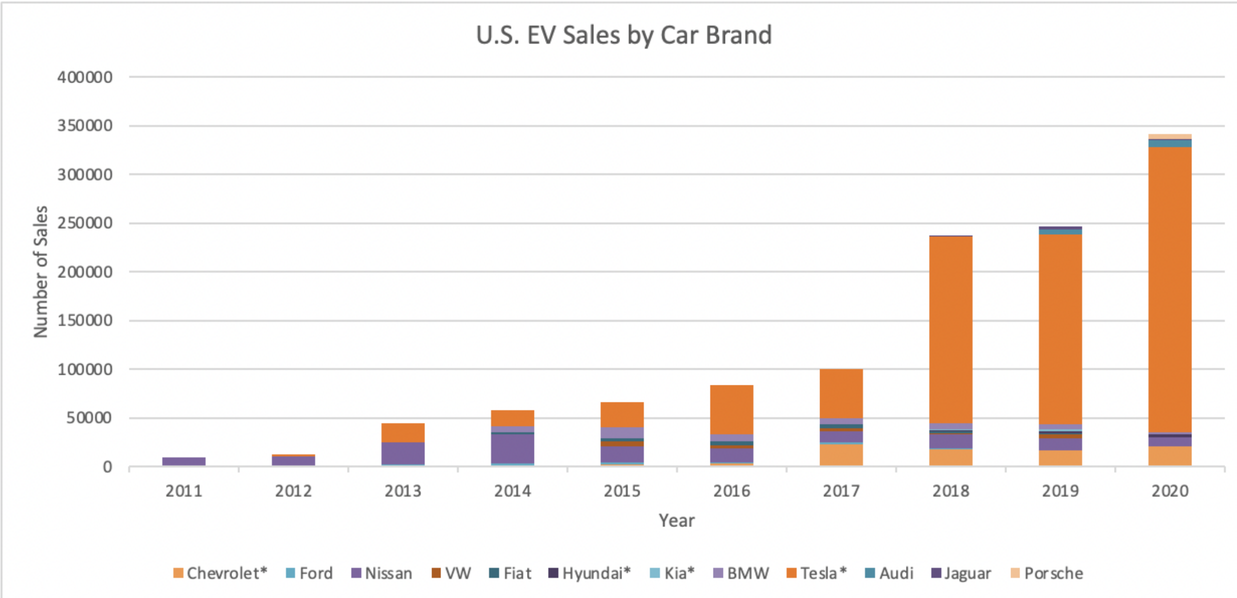
Vehicle	MSRP (2020 model or latest available)
Audi e-tron	65900
BMW i3	44450
Chevy Bolt	36500
Chevy Spark	13400
Fiat 500E	33210
Ford Focus EV	29200
Hyundai Ioniq EV	33245
Hyundai Kona Electric	37390
Jaguar I-Pace	69850
Kia Niro EV	39090
Kia Soul EV	33950
Nissan Leaf	31620
Porsche Taycan	79990
Tesla Model 3	35000
Tesla Model S	79990
Tesla Model X	79990
Tesla Model Y	49990
VW e-Golf	31895

While most brands have one EV model, Chevy, Hyundai, Kia, and Tesla have multiple models; Table 2 asterisks the brands with multiple EV models. As a result, the average MSRP of the models were taken into consideration for this research. The dependent variable is the annual number of sales of each vehicle model as shown in Table 2 and Graph 1. It is important to note the year in which each model was released because such data affects the total number of sales for each brand. N/A is assigned if a car has not been released, discontinued, or not enough information exists to determine the annual number of sales.

Table 2: U.S. EV SALES BY BRAND

U.S. PEV Sales by Brand (top 12)												
Avg MSRP	Brand	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total Sales
24950	Chevrolet*	N/A	N/A	560	1145	2629	3614	23320	18026	16419	20753	86466
29200	Ford	N/A	683	1738	1964	1582	901	1817	560	N/A	N/A	9245
31620	Nissan	9674	9819	22610	30200	17269	14006	11230	14715	12365	9564	151452
31895	VW	N/A	N/A	N/A	357	4232	3937	3534	1354	4863	406	18683
33210	Fiat	N/A	N/A	260	1503	3477	3737	3336	2250	632	N/A	15195
35317.5	Hyundai*	N/A	N/A	N/A	N/A	N/A	N/A	432	345	2460	2964	6201
36520	Kia*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1134	1673	N/A	2807
44450	BMW	N/A	N/A	N/A	6092	11024	7625	6276	6117	4854	1502	43490
58600	Tesla*	N/A	2400	19400	16750	26408	49800	49970	191627	195125	292902	844382
65900	Audi	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5369	7202	12571
69850	Jaguar	N/A	N/A	N/A	N/A	N/A	N/A	N/A	393	2,594	1,546	4,533
79990	Porsche	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4414	4414

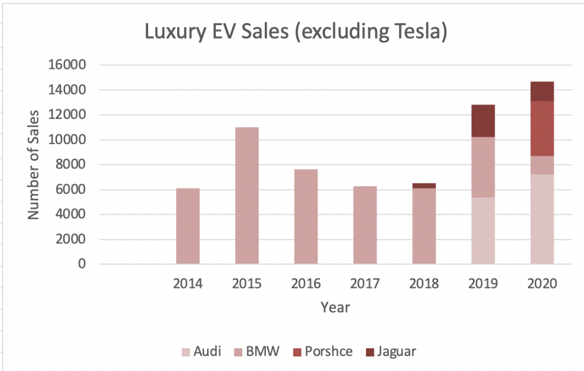
Graph 1: U.S. EV SALES BY BRAND



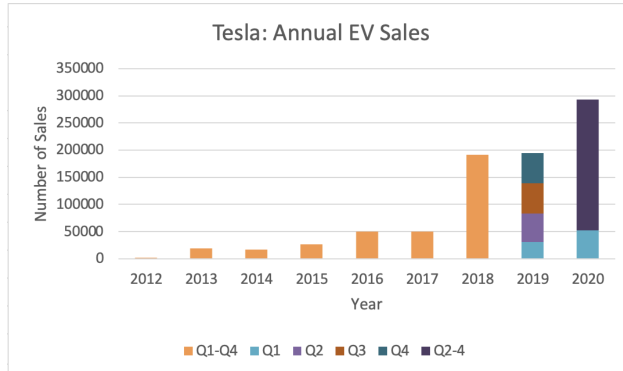
The approximate purchase price of the car is determined mainly by the FTC. The Alternative Fuels Data Center (AFDC) maintains a list of federal incentives, organizing a list of vehicle models that are eligible for a federal income tax credit of $7500. Of all car brands, Chevrolet and Tesla are the only brands who no longer qualify for the FTC. Chevrolet's phase out period began on April 1, 2019 (Q2). The maximum rebate was adjusted to $3,750. Starting October 1, 2019 (Q4), the maximum rebate was readjusted to $1,875. Any purchases after March 31, 2020 (Q2) were no longer eligible for any federal tax credit. The number of sales per phase out period is more clearly depicted in Graph 2b. Tesla's phase out period began on January 1, 2019 (Q1). The maximum rebate was adjusted to $3,750. Starting July 1, 2019 (Q3), the maximum rebate was readjusted to $1,875. Any purchases after December 31, 2019 were no longer eligible for any federal tax credit. The number of sales per phase out period is more clearly depicted in Graph 2d. Because Tesla and Chevrolet are the two most popular brands for EV purchases and are the only two brands who have sold more than 200,000 EVs in the US, a separate analysis was conducted to access if the phase out period affected sales.

Graph 2: Luxury v. Economy Annual Sales

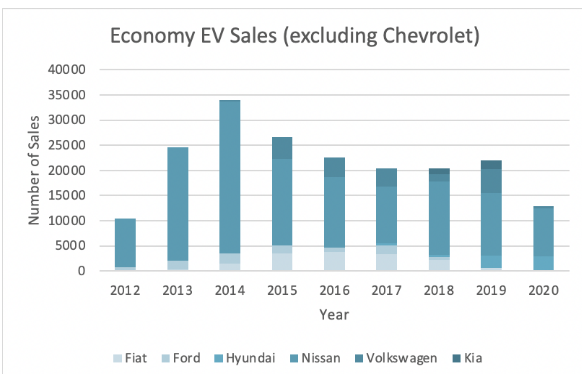
2a.



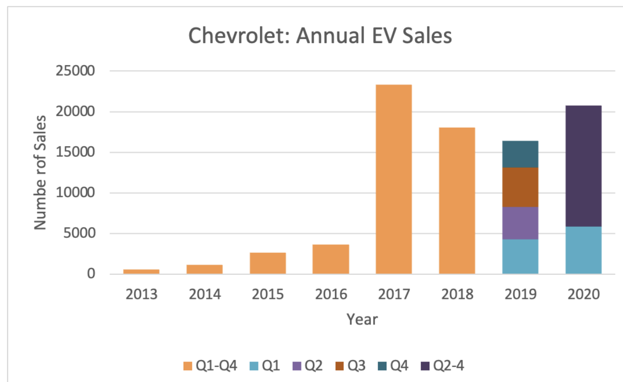
2b.



2c.



2d.



RESULTS AND ANALYSIS

Overall, EV sales have gradually increased. Total annual EV sales indicate a positive change in percent meaning more EVs are being sold each year (table 3).

Table 3: Luxury v. Economy Percent Change in Annual Sales (from Graph 2)

Year	Tesla (% change)	Luxury (% change)	Chevy (% change)	Economy (% change)	Total (% change)
2013	708.33	N/A	N/A	245.44	245.43
2014	-13.66	N/A	104.46	30.16	30.16
2015	57.66	80.96	129.61	14.84	14.84
2016	88.58	-30.83	37.47	25.52	25.52
2017	0.34	-17.69	545.27	19.49	19.49
2018	283.48	3.73	-22.7	136.72	136.72
2019	1.83	96.88	-8.91	4.16	4.16
2020	50.10	14.41	26.40	38.52	38.52

The graphs indicate spikes in sales at varying years for Tesla, Chevrolet, and Luxury EV sales (excluding Tesla). Much of this can be attributed to the fact that new EV models were introduced that year. For instance, Graph 2a depicts that new variables (Audi and Porsche) were introduced in 2019 and 2020, respectively. Furthermore, in 2017, the Tesla Model 3 (with an MSRP of $35,000) and Chevrolet Bolt (with an MSRP of $36,500) were released leading to the surge in annual sales for both companies. While most companies faced a gradual decrease in sales after an initial spike in annual sales, Tesla is the only company that saw a gradual increase in sales (Graph 2a-2b). This is surprising because starting in 2019, Tesla started phasing out of the FTC; Hardman (2017) revealed that as the FTC incentives phase out, sales of EV can steeply decline. This may suggest that Hardman's research is flawed or the relationship between EV sales and financial purchase incentives is weak. As opposed to the FTC, environmental factors or social identity factors, as Skippon and Garwood (2011) suggests, may have more significant influences in incentivizing EV purchases. As previously noted, the Tesla Model 3 was released in 2017 and is Tesla's most affordable option; the price point is comparable to the MSRP of economy brand models (Table 1). This is important to note because it explains the shift in market share for luxury EVs. Using the data from Table 2 and Graph 2, Table 4 assesses the market share for luxury and electric vehicles.

Table 4: Luxury and Economy EV Market Share

Year	Luxury EV Market Share (%)	Economy EV Market Share (%)
2016	68.67	31.33
2017	56.29	43.71
2018	83.77	16.23
2019	84.41	15.59
2020	90.13	9.87

While the market share between luxury and economy EVs is comparable in 2017, the luxury EV market gradually dominates, maintaining 90.13% of the market share in 2020. This can be explained due to the Tesla Model 3 because when further isolating the luxury EV market, Tesla maintains the majority of the luxury EV market, making up 96.71% of the luxury EV market in 2018 and 81.02% of the total EV market (Table 5a).

Table 5: Tesla and Chevy Market Share

5a.

Year	Tesla EV Market Share (%)	% of Luxury EV Market
2016	59.56	86.72
2017	50.01	88.84
2018	81.02	96.71
2019	79.21	93.84
2020	85.83	95.23

5b.

Year	Chevy EV Market Share (%)	% of Economy EV Market
2016	4.32	13.80
2017	23.34	53.40
2018	7.62	46.96
2019	6.66	42.74
2020	6.08	61.61

This data affirms Skippon and Garwood's (2011) findings that social factors have a substantial weight in the purchase of EVs. As a luxury brand, the Tesla Model 3 allows users to drive a luxury vehicle at the price point of an economy car. The luxury brand image of Tesla incentivizes users to purchase EVs despite the fact that Tesla no longer qualified for the FTC in 2020. Another factor to the dominance of luxury brands in EV sales can be explained by Nazari's (2018) analysis that households of upper-level income are more likely to adopt PEVs most likely due to accessibility to charging stations. As households of higher-income are more likely able to afford and own luxury vehicles, it can explain the greater number of luxury models sold. As a result, both higher and middle-income households are more likely to be attracted to the luxury EV market; if middle-income households have access to both the luxury and economy EV market (ie they are financed comparably), they prefer luxury brands. Thus, when looking at EV sales after accounting for variances in federal tax credits, it is evident that consumers have a strong preference for luxury vehicles as opposed to economy vehicles.

CONCLUSION

As more and more car brands enter the EV market, the FTC holds less value in influencing consumers to adopt EVs. The research suggests that social factors like brand reputation and the ownership of certain EV brands as a status symbol plays a significant role in consumer decision making for EVs. However, more research must be done to fully understand consumer behavior in regards to electric vehicles. As Hayashida (2021) concludes, there are multiple factors that can influence EV adoption. This research only analyzed one aspect of electric vehicles-- price as it relates to brand status as luxury or economy. Furthermore, it only considered fully electric vehicles. Plug-in hybrid models are also available that qualify for the FTC. Plug-in hybrid models use solar energy as well as gasoline to power the vehicle; future research that includes EVs and plug-in hybrids could lead to different conclusions and highlight different factors that impact consumer decision making processes. Furthermore, in the upcoming years, as more startups specialize in selling only EVs (like Tesla), it can lead to opportunities for research on consumer attitudes towards EV specialized brands vs. car brands that also sell gasoline-powered vehicles. Such research can more accurately explain whether there is a higher market penetration from targeting environmentalists or from marketing it's social symbolism.

As the nature of the FTC is to gradually phase out as EVs become more established in the vehicle market, it poses questions as to whether or not the government should continue to have subsidies for EV adoption. Currently, EVs are most accessible to households in more affluent neighborhoods; lack of access to charging stations and the high initial costs of electric vehicles deter consumers from low-income neighborhoods (Nazari, 2018). As a result, future policy should focus on sponsoring charging stations in neighborhoods without already established EV charging stations. Furthermore, establishing additional incentives for individuals in lower income brackets could encourage more individuals to adopt EVS and lead to a more equal EV market share between the luxury and economy sector. Overall, a holistic understanding of consumer behavior and a collaborative effort between policymakers and EV makers are needed to significantly reduce the amount of CO_2 emissions from the transportation sector.

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