Determinants of Consumer Behavior: Factors Influencing Electric Vehicle Adoption

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Spring 2024

Abstract

This research investigates the determinants of consumer behavior in electric vehicle (EV) adoption, focusing on EV costs, maximum driving ranges, and recharging times. The study aims to address the critical barriers hindering widespread adoption of EVs and recommends collaborative initiatives between auto manufacturers and government entities. Through a crowdsourced survey targeting residents aged 18 and above in the US, with 295 observations, the study delves into factors shaping consumer preferences and attitudes toward EV adoption. Reductions in charging time and increases in driving range were found to positively influence adoption, emphasizing the need to improve charging infrastructure and mitigate range anxiety. Surprisingly, upfront costs had a positive effect, indicating complex perceptions influenced by factors like ample current tax credits and market dynamics. The study recommends collaborative efforts to enhance charging infrastructure, address range concerns, and leverage political and socio-economic factors to promote widespread EV adoption, aligning with competition and sustainability imperatives in the automotive industry.

Acknowledgements: I extend my gratitude to Dr. Trevor O'Grady for his guidance as my second thesis advisor and for his instrumental role in setting up the survey. I also thank Dr. Richard Baker for his expertise in navigating Stata. I am grateful to The College of New Jersey Foundation for funding the survey, enabling this research endeavor. Lastly, I express my appreciation to my friends and family for their valuable input in refining the survey.

Table of Contents

Introduction

Climate change, an escalating global concern, outlines the excessive increase in global temperatures, primarily propelled by the alarming surge in greenhouse gas emissions (GHGs) resulting from human activities. This phenomenon has induced a proactive response in recent years. To mitigate emissions originating from human activities, there has been a shift towards the development and utilization of renewable energy sources. One notable shift is the advent of electric vehicles (EVs) as a sustainable alternative to traditional internal combustion engine (ICE) vehicles. EVs offer an alternative to reduce emissions, particularly in transportation.

The United States (US) Environmental Protection Agency (EPA) found that the transportation sector is the largest contributor to direct GHG emissions and second largest to direct and indirect emissions combined in 2022. Hence, this research explores the sustainable option in the transportation sector. It delves into components that govern the adoption of EVs by consumers. Central to this investigation are the factors of EV costs, maximum driving ranges, and recharging times, which collectively contribute to shaping consumer perspectives and preferences. By measuring the level of nuisance of these variables, the research seeks to provide valuable insights into the fundamental questions that observe the intersection of consumer behavior, automotive manufacturing, and governmental initiatives. It aims to uncover the response to the questions: Among driving range, upfront costs, and charging infrastructure availability, which factor poses the most significant barrier in promoting widespread adoption of EVs? What collaborative initiatives can be implemented between auto manufacturers and government entities to overcome barriers related to driving range, upfront cost, and charging infrastructure for EV adoption?

Background

Despite the significant environmental benefits of EVs in reducing carbon emissions, consumers weigh efficiency and features when making a vehicle purchase decision. Therefore, understanding consumer behavior is crucial to fostering EV adoption, considering current factors and potential future improvements. In light of these considerations, consumers must analyze whether the current statistics align with their utility preferences. *Consumer Reports*' 2022 survey, featuring Americans without immediate plans to purchase an EV, identified the top three barriers to adoption: charging infrastructure, driving range, and vehicle costs, in order of significance.

The transition to EVs represents a pivotal shift in the automotive landscape, driven by the imperative to address environmental concerns and reduce carbon emissions. Central to this transition is the concept of charging infrastructure, which plays a crucial role in facilitating widespread EV adoption. Understanding the factors influencing consumer behavior in adopting EVs, particularly in relation to charging infrastructure, is essential for shaping effective strategies and policies in the transportation sector.

One key aspect of charging infrastructure is its impact on consumer behavior regarding refueling habits and adoption decisions. In "Running on empty – Users' charging behavior of electric vehicles versus traditional refueling" by Ralf Philipsen, the study delves into the distinctive charging behavior of EV users compared to traditional ICE vehicle users. The research highlights that while financial considerations are less critical for EV users, the availability and accessibility of charging infrastructure significantly influence their charging decisions. This insight underscores the pivotal role of charging infrastructure in shaping EV adoption patterns and consumer behavior.

Similarly, "The role of demand-side incentives and charging infrastructure on plug-in electric vehicle adoption: analysis of US States" by Easwaran Narassimhan and Caley Johnson provides valuable insights into the interconnected nature of demand-side incentives and charging infrastructure in driving plug-in electric vehicle (PEV) adoption. The research emphasizes that the availability of public charging infrastructure, alongside incentives such as tax rebates and credits, plays a critical role in influencing per capita PEV purchases. This underscores the importance of strategic investments in charging infrastructure to complement incentive programs and drive widespread adoption of EVs.

In the context of my research on the determinants of consumer behavior in EV adoption, these studies contribute significantly by highlighting the multifaceted role of charging infrastructure. By examining how factors such as charging costs, accessibility, and convenience impact consumer decisions, we gain a deeper understanding of the complex dynamics driving EV adoption trends. This holistic perspective is instrumental in informing policy initiatives and strategic investments aimed at accelerating the transition to sustainable transportation solutions and addressing climate change challenges effectively.

Sequentially, the driving range of EVs is a critical factor influencing consumer adoption and addressing range anxiety, a common concern among potential EV buyers. As of 2022, the Department of Energy reports that the median maximum driving range for EVs stands at 234 miles, significantly lower than ICE vehicles boasting a range of 403 miles. This disparity, with EVs' range being approximately 60% of that of ICE vehicles, underscores the importance of expanding EV infrastructure to alleviate range anxiety and enhance consumer confidence in EVs.

Christian Hinton's article, "Study Reveals EV Charging Station Density vs. Gas Stations," provides valuable insights into the current state of EV charging infrastructure compared to traditional gas stations. The study highlights an imbalance in charging station density, with an average of 104 gas pumps per 1,000 road miles compared to only 22 EV charging ports. State-specific analyses further reveal disparities, with certain states exhibiting a more favorable ratio of EV charging opportunities.

The disparity in charging infrastructure has critical implications for potential EV adopters, particularly regarding range anxiety and convenience. While some regions show promising signs of an evolving EV infrastructure, the overall shortage of charging stations compared to gas stations could act as a substantial barrier for consumers considering the switch to EVs.

Addressing these infrastructure gaps becomes imperative, as highlighted in the study by Yongjun Ahn and Hwasoo Yeo, "An Analytical Planning Model to Estimate the Optimal Density of Charging Stations for Electric Vehicles." The study introduces the Estimating the Required Density of EV Charging (ERDEC) model, designed to project the optimal density of charging stations, especially in urban environments. Through a compelling case study in Daejeon, South Korea, the ERDEC model provides actionable guidance for urban planners and policymakers by estimating optimal charging station density and generating detailed maps illustrating this density. By addressing concerns about driving range anxiety and providing insights into optimal charging station distribution, the ERDEC model contributes significantly to expanding EV adoption and bolstering EV-friendly infrastructure essential for sustainable urban mobility.

Finally, the price of EVs plays a crucial role in shaping consumer behavior and adoption trends, considering both the initial purchase price and long-term cost of ownership. Examining the existing landscape of EVs, data from Justin Fischer's December 2023 report in Car Edge reveals that, on average, the purchase price of EVs is $51,762, approximately 8% higher than vehicles with any powertrain, which have an average price of $47,936. This price disparity shows the financial considerations that consumers weigh when contemplating the switch to EVs.

However, it is important to consider the implications of The Inflation Reduction Act of 2022, which introduced new criteria for qualifying for credits in the realm of clean vehicles. This initiative aims to incentivize the adoption of cleaner vehicles, particularly those meeting specific mineral and battery standards and assembled in North America. The availability of tax credits and incentives can significantly influence consumer decisions regarding EV purchases, mitigating the higher initial costs associated with EVs.

A comprehensive analysis conducted by Roberto Baldwin in October 2022, titled "EV vs. Gas: Which Cars Are Cheaper to Own?" provides valuable insights into the total cost of ownership for EVs compared to traditional gas-powered vehicles over a three-year period. While EVs often come with higher initial costs, factors such as reduced maintenance and energy expenses, coupled with potential tax incentives, can make EVs cost-competitive or even economically advantageous over time. This comparative assessment emphasizes the importance of considering long-term cost savings and incentives when evaluating the affordability of EVs.

In a related investigation by Junhai Ma, "Pricing strategy and coordination of automobile manufacturers based on government intervention and carbon emission reduction," the study explores the competitive landscape between EVs and ICE vehicles, focusing on pricing decisions in the context of government intervention policies. The study highlights the impact of consumption subsidies for EV consumers and carbon taxes on fuel vehicles, illustrating the complex dynamics influencing pricing strategies and market behavior within the automotive industry.

By examining the interplay of pricing, government incentives, and long-term cost considerations, we gain valuable insights into the factors influencing consumer behavior and adoption of EVs. These insights are crucial for developing strategies to address affordability concerns, incentivize EV adoption, and promote sustainable transportation solutions.

Methodology

The data for this study was collected through a crowdsourced survey targeting residents aged 18 and above in the US to capture American drivers, car owners, and prospects of both. The survey was created using *Qualtrics* and the crowdsourcing platform is *Amazon Mechanical Turk.* The survey resulted in a total of 295 observations. The structure encompassed three main sections. The first section gathered demographic information, including age, gender, education level, and geographic location, to provide context for the analysis. The second section focused on capturing antecedent attributes related to respondents' knowledge of vehicle costs, technical proficiencies, innovation orientation, and predetermined plans of purchasing a vehicle within the next years, which are particularly relevant to EVs. The behavior section aimed to establish a baseline understanding of respondents' familiarity with EV-related concepts and technologies to limit omitted variable bias.

The third section of the survey presented treatment scenarios to assess respondents' likelihood of adopting EVs within the next five years. Each respondent encountered randomized treatments that varied in three key factors: charging infrastructure improvements, driving range increases, and upfront price decreases. Charging speed was manipulated, ranging from 15 to 40 minutes for a full recharge, while driving range options were set between 350 to 500 miles. Additionally, upfront prices for EVs were varied, with averages ranging from $35,000 to $40,000. These treatment variations allowed for an exploration of how changes in these critical factors influenced respondents' attitudes and intentions toward EV adoption, and how elastic their behaviors are to changes in these factors.

To ensure data quality and mitigate selection bias, I crowdsourced the survey to random *Amazon* workers available to all US residents. Then, I randomized the level of treatments assigned to each of them as they were asked to answer all three treatment questions (charging speed, range, and upfront cost). Moreover, in the treatment section, the subjects were provided with a uniform table to use as reference for their decision-making. Table 1 mitigates starting point bias as I asked the subjects to strictly base adoption decisions on the information available in the table.

Table 1: Treatment Reference Table

	Gas Powered Vehicles	Electric Vehicles
Average Driving Range	350 miles	220 miles
Average Cost before Rebates	$45,000	$50,000
Average Cost after Rebates	$45,000	$42,500
Average Price of Gas or Electricity per Month	$175	$60
Average Time to Refuel/Recharge	10 minutes	45 minutes

Using the table, attention checks and treatment comprehension questions were also incorporated in the survey to measure the respondents' attentiveness to survey details and their comprehension of the treatment scenarios presented.

Quantitative analysis techniques, such as statistical modeling and multiple regression analysis, will be employed to analyze the survey responses. The relationships between demographic factors, antecedent attributes, treatment scenarios, and EV adoption likelihood will be explored, providing insights into the factors driving consumer behavior in the context of EV purchasing decisions.

Data and Hypotheses

As previously indicated, the data comes from 295 random residents from varying states across the US. The purpose for diversifying the subjects' geographical backgrounds is to capture narrow insights into EV adoption since state legislatures and regional urbanization have theoretical impacts to residents' perceptions of the topic as they can influence costs and charging infrastructure.

Table 2 illustrates the dependent variables collected from the survey's treatment. As described in the second column of the table, the subjects were asked to share the scale of their likelihood of adopting EV as their next vehicle from 0 to 10 with 0 being least likely and 10 being most likely. There are three treatments with their distinct scenarios under the description column.

Table 2: Dependent Variables

Variables	**Description**	**Expected Effect**
Answer_Charge	Likelihood of choosing EV as next vehicle given charging infrastructure	Dependent Variable
Answer_Range	Likelihood of choosing EV as next vehicle given driving range	Dependent Variable
Answer_Cost	Likelihood of choosing EV as next vehicle given upfront costs	Dependent Variable

Meanwhile, Table 3 presents the independent variables randomly assigned to subjects to test their respective influence on the dependent variables. Table 1 was consistently used as a reference point, while changes in the independent variables: recharging time, driving range, and upfront cost were incorporated in the survey questions. For recharging time, the starting point was set at 45 minutes and the subjects were randomly assigned a drop within the range of 15-40 minutes with an interval of 5 minutes. For instance some were assigned 20, 25, 30 minutes, etc. On the other hand, the driving range was set to 220 miles for starting point. Then, the subjects were randomly assigned a range increase within 350 to 500 miles in 30 mile intervals. Finally, the upfront cost starting point is $42,500, which already includes the $7,500 tax credit. They were then randomly assigned to a drop within the range of $35,000 to $40,000 with a $1,000 interval.

The charging and range changes were justified by hypothetical technological advancements, while the cost drops by a hypothetical extended tax credit in the survey. Charging time is expected to have a negative impact on the subjects' adoption level as it becomes more convenient and faster charging reduces the range anxiety for drivers. As for the driving range, a positive impact from an increased range of adoption is expected due to the landscape of the US that heavily relies on driving even in most cities. This environment shapes American drivers' demand for a higher driving range. Lastly, the upfront cost will have a negative effect on adoption because of the law of demand, however, there should be a minimal effect due to the current tax credit.

Table 3: Independent Variables

Variables	**Description**	**Expected Effect**
EVcharge	Charging time dropping from 45 minutes to a range of 15-40 minutes	Lower charging time will have an inverse impact on adoption
EVrange	Driving range increasing from 220 miles to a range of 350-500 miles	Increased range will have a positive impact on adoption
EVcost	Upfront cost dropping from $42,500 to a range of $35,000-$40,000	Due to the current tax credit system, dropped price should have a minimal increase in adoption

The control variables consist of demographic and behavioral data. Similar to the previous tables, the description of each control is as presented in the second column of Table 4, while expected effects are in the third column. Firstly, the natural log of age (*lnage*) will be used to control for age. Although percentage changes for age may not be typical means of interpreting age, it will be a useful measure in the context of the varying dependent variables.

Since the dataset contains categorical variables like *polcat* and *incomeca*, the tabulated responses were assigned to numerical values. The variable *polcat* identifies the subjects' political affiliation. Subjects were prompted to choose the following options: Democrat, Republican, Independent, Others. The Republican option was assigned the lowest numerical value followed by Independent and Others, then the Democrat with the highest value. This setup allows an analysis of the relationship between liberal ideology and EV adoption. As for the *incomeca* variable, it identifies the subjects with their respective household income brackets. The numerical values assigned to the income brackets correspond in an ascending manner to control for household income.

Yearsedu, child, and *veh* are exactly as described in Table 4, and they served directly as numerical variables. As for *stateden*, Hinton's study examined earlier, discussed the disparity of charging ports in the US. He provided a chart of EV drivers to public charging port ratio in every state. Therefore, this state density information was assigned to the respective states of the subjects and will be used as a numerical variable to explore its influence on EV adoption.

Finally, the subjects were asked scaling questions to collect data for *innov* and *vehfive* variables. For *innov*, they were asked on a scale of 0 to 10 with 0 being least agreement and 10 being most agreement to the statement "I am motivated by challenges that require creative problem-solving." This variable controls for innovation orientation- how accepting the subjects are to innovative or creative ways of resolution. On the other hand, for *vehfive*, the subjects faced the same set up in terms of the scaling but this time, 0 being least likely and 10 being most likely of buying, leasing, or financing any vehicle within the next five years to account for predetermined plans of purchasing vehicles and analyze how it might relate to EV adoption.

Table 4: Control Variables

Variables	**Description**	**Expected Effects**
lnage	Control for age (natural log)	Inverse impact on adoption
yearsedu	Years of education completed starting first grade	Positive impact on adoption
polcat	Individual political affiliation categorized into numerical values	Democratic views positive impact on adoption
incomeca	Household income brackets categorized into numerical values	Positive impact on adoption
child	Number of children	Inverse impact on adoption
stateden	Charging station density from each state	Inverse impact on adoption
veh	Number of vehicles owned by household	Positive impact on adoption
weekdri	Average hours driven on a weekly basis	Inverse impact on adoption
innov	Motivation by challenges requiring creative problem-solving	Positive impact on adoption
vehfive	Predetermined plans of purchasing a vehicle within the next five years	No effect

The variables in the table encompass a range of factors influencing the adoption of EVs. *Lnage* is expected to inversely impact adoption, indicating that older individuals may be less likely to adopt EVs as younger people tend to have incentives to mitigate environmental damages as future harms and costs could be detrimental. Conversely, *yearsedu* is anticipated to have a positive impact on adoption, suggesting that higher education levels lead to a greater likelihood of adoption, likely due to stronger awareness. *Polcat*, particularly with democratic views, is expected to positively influence adoption, implying that individuals with such political leanings are more inclined to adopt EVs. *Incomeca* is also expected to positively impact adoption, indicating that higher-income households are more likely to adopt EVs. On the other hand, *child* is expected to have an inverse impact on adoption, suggesting that households with more children may be less likely to adopt EVs due to capacity issues. *Stateden* is expected to inversely impact adoption, implying that areas with higher charging station densities may experience lower adoption rates. *Veh* is expected to positively influence adoption, indicating that households with more vehicles are more likely to adopt EVs, the greater the income share for vehicles or vehicle count, the more feasible EV adoption is. *Weekdri* is anticipated to inversely impact adoption, with individuals driving more hours per week being less likely to adopt EVs due to disparity in available chargers and recharging speed. *Innov* is expected to positively influence adoption, indicating that individuals motivated by challenges requiring creative problem-solving are more likely to adopt EVs. Finally, *vehfive* is expected to have no effect on adoption, suggesting that predetermined plans for future vehicle purchases do not significantly influence current adoption decisions as buying behavior can be volatile and unpredictable.

Results

Multiple regression analysis will be conducted for each of the dependent variables. It is an ideal setup considering the treatments were set to be independent of each other in the survey. Also, it allows a deliberate examination of the relationship between the independent and control variables to the dependent variables.

The results of the independent variables are presented in Table 5 with the sequence being the entire sample (n=295) for the first three columns followed by those who only passed the attention checks of the survey for the other three (n=285). Both segments illustrate the following dependent variables in order: charging time, driving range, and upfront costs. Nevertheless, it is important to note that the values across the full sample against the filtered do not show any significant difference, so the full sample will be used for interpretation. These minimal changes can be justified by the small difference between the sample size of the two segments.

Table 5: Independent Variables Regressions

				X≥0.667	X≥0.667	X≥0.667
	Answer_Charge	Answer_Range	Answer_Cost	Answer_Charge	Answer_Range	Answer_Cost
Variable	n=295	n=295	n=295	n=285	n=285	n=285
	-0.0331 **	0.0053 **	0.0001	-0.0327 **	0.0054 **	0.0001
	(0.0154)	(0.0025)	(0.0001)	(0.0156)	(0.0025)	(0.0001)

Standard deviations are reported in parentheses.
*, **, *** indicates significance at the 90%, 95%, and 99% level, respectively.

To generate a practical interpretation for each variable, the number of units used to determine the dependent variables will be leveraged to be consistent with the intervals used in the treatment (charging time=5 minutes, driving range=30 miles, and upfront cost=$1,000). This method grants more rational comparison than comparing results at one unit change.

Out of the three dependent variables, charging time and driving range are statistically significant at 95% level. As expected, charging time yielded an inverse relationship with EV adoption, where a 5 minute decrease in charging time is associated with an additional 0.166 adoption level. This result is the most impactful out of the three, and it can be justified by the charging port disparity highlighted in Hinton's paper. Moreover, the significant amount of time required to recharge EVs plays a part in this barrier. These factors drive people's reluctance to EV adoption when considering charging time.

In driving range, the result was as expected as well, with increased range having a positive effect on EV adoption. This result follows the charging time variable at being an impactful barrier to EV adoption. A 30-mile increase in average range is associated with an additional 0.159 adoption level. This yet another significant finding is justified by people's range anxiety due to being used to traditional ICE vehicles that tend to have higher driving range relative to EVs. It is also essential to note that range anxiety stems from underdeveloped charging infrastructure. In Appendix A, *EVcharge* is positively correlated to EV adoption while perceiving range (*Answer_Range*) at 95% level of statistical significance. This correlation highlights how the two factors are strongly linked to each other.

Finally, an unexpected positive effect emerges from upfront costs to EV adoption, which in theory, defies the law of the demand as people appear to desire higher upfront costs. A $1,000 increase in cost is associated with an additional 0.100 adoption level. Out of the three treatments, this result is the most minimal and is not statistically significant at any levels. The unexpected positive result can be justified by the already ample tax credit in the US that offers up to $7,500, making EV purchasing costs competitive against ICE vehicles already. Another thing to highlight is that during the survey, there was a surplus in the EV market, where car dealers were offering lowered prices and promos to sell certain models. Lastly, there could be subjects only interested in luxurious EV models by manufacturers (ie. BMW, Tesla, Genesis, etc.), as preferring luxurious goods make them indifferent about tax credit since most of them would not have been eligible for the rebate. These factors account for the subjects' indifferent and seemingly irrational reaction to lowered costs.

Table 6: Control Variables

				X≥0.667	X≥0.667	X≥0.667
Variable	Answer_Charge n=295	Answer_Range n=295	Answer_Cost n=295	Answer_Charge n=285	Answer_Range n=285	Answer_Cost n=285
lnage	-3.0237 ***	-2.5965 ***	-2.1328 ***	-3.0807 ***	-2.7017 ***	-2.2258 ***
	(0.4822)	(0.4767)	(0.4989)	(0.4853)	(0.4801)	(0.5036)
yearsedu	0.4075 ***	0.2790 ***	0.2784 **	0.3990 ***	0.2486 **	0.2554 **
	(0.1060)	(0.1043)	(0.1094)	(0.1079)	(0.1063)	(0.1117)
polcat	0.4668 ***	0.7424 ***	0.5401 ***	0.4686 ***	0.7409 ***	0.5545 ***
	(0.1450)	(0.1430)	(0.1498)	(0.1449)	(0.1432)	(0.1505)
incomeca	0.1003	0.0398	0.0418	0.1134	0.0553	0.0689
	(0.0854)	(0.0843)	(0.0884)	(0.0880)	(0.0870)	(0.0915)
child	-0.2440 **	-0.3553 ***	-0.3252 ***	-0.2560 **	-0.3592 ***	-0.3356 ***
	(0.1148)	(0.1135)	(0.1189)	(0.1145)	(0.1133)	(0.1190)
stateden	-0.0293	-0.0061	0.0036	-0.0319	-0.0062	0.0004
	(0.0240)	(0.0238)	(0.0249)	(0.0241)	(0.0239)	(0.0251)
veh	0.2959 **	0.3900 ***	0.3085 **	0.2912 *	0.3997 ***	0.2857 *
	(0.1483)	(0.1462)	(0.1532)	(0.1493)	(0.1471)	(0.1546)
weekdri	-0.0195	-0.0171	-0.0118	-0.0200	-0.0177	-0.0126
	(0.0128)	(0.0127)	(0.0132)	(0.0127)	(0.0126)	(0.0132)
innov	0.2318 ***	0.2997 ***	0.2829 ***	0.2346 ***	0.2936 ***	0.2854 ***
	(0.0587)	(0.0580)	(0.0607)	(0.0591)	(0.0585)	(0.0614)
vehfive	0.2610 ***	0.2508 ***	0.2084 ***	0.2603 ***	0.2505 ***	0.2132 ***
	(0.0526)	(0.0521)	(0.0545)	(0.0542)	(0.0538)	(0.0563)

Standard deviations are reported in parentheses.
*, **, *** indicates significance at the 90%, 95%, and 99% level, respectively.

Concurrently, the regression results in Table 6 reveal significant insights into the controls and how incentives can be aligned with these factors. Firstly, *lnage* shows a negative effect, indicating that younger individuals are more inclined to adopt a sustainable lifestyle, possibly due to increased environmental awareness or technological interest. Regardless, *lnage* is intricate. Appendix B provides detailed insight on how behavior and mindset influences adoption and how they relate among younger and older people. For younger people, these behavior variables do not drive their perception on adoption, while for older people, their vehicle cost knowledge and technical proficiency significantly influence their adoption level.

On the other hand, higher levels of education (*yearsedu*), income (*incomeca*), and owning more vehicles (*veh*) exhibit a positive effect, suggesting that individuals with higher education and income levels, as well as those owning multiple vehicles, are more likely to adopt EVs. This association between education, income, and adoption aligns with the perception that higher socioeconomic status correlates with a greater propensity to invest in new technologies and sustainable practices, while higher education correlates not only with higher expected income, but also awareness of EV adoption's positive environmental impact.

Furthermore, political affiliation (*polcat*) shows a positive effect, with Democrats favoring adoption. This finding reflects a potential alignment between political values and environmental consciousness, where individuals with democratic views are more inclined to support and adopt environmentally friendly initiatives such as EV adoption. Conversely, the number of children (*child*) exhibits a negative effect, highlighting the impact of budget allocation and limited capacity within households, potentially making EV adoption less feasible for families with more children.

Additionally, the density of EV charging stations (*stateden*) shows a negative effect, indicating that a denser ratio of EVs to charging ports is less desired, possibly due to concerns about charging accessibility and convenience. The negative effect of lower driving range (*weekdri*) reinforces the importance of addressing range anxiety and improving EV technology to increase consumer confidence and desire for adoption. Despite neither *stateden* nor *weekdri* being statistically significant, they both provide valuable insight into geographical and behavioral effects to EV adoption.

Lastly, variables related to an innovation orientation (*innov*) and predetermined purchasing plans (*vehfive*) exhibit positive effects on adoption. These results suggest that individuals with an innovative mindset, driven by challenges and creative problem-solving, are more likely to adopt EVs. Additionally, having predetermined plans to purchase a vehicle within the next five years is unexpectedly associated with adoption, indicating a proactive approach to embracing new technologies and sustainable transportation options.

Conclusion

Improving charging infrastructure emerges as a critical recommendation based on the regression results. The negative impact of high recharging time, highlighted by the significant inverse relationship between charging time and EV adoption, underscores the urgency to address this barrier. This recommendation is further supported by the disparity in charging ports, as indicated by the significant effect of charging time on adoption. As mentioned before, perception of charging time is linked to range anxiety. Therefore, mitigating the charging factor should extend to limit range as well. To resolve these issues, collaborative efforts between the government and recharging services are recommended, focusing on joint investments to expand the availability of charging stations. Additionally, the development of faster charging technologies and standardized protocols is crucial to enhance the charging experience and alleviate concerns about recharging time and accessibility. A considerable amount of people are concerned with technological implications of adoption, like charging, so simplifying and introducing a standardized protocol should alleviate technical concerns.

Meanwhile, addressing range anxiety emerges as a significant consideration based on the regression outcomes. The positive influence of increased range on EV adoption exhibits the necessity of mitigating range-related concerns. While driving range has proven significant, a focus on robust charging infrastructure could substantially alleviate range anxiety already. Moreover, the considerable improvement in average driving range over the last five years reflects positive progress, driven by market competition. Therefore, excessive government intervention, such as subsidies, might not be beneficial, potentially leading to tax revenue loss without significant advantages.

Additionally, the most impactful findings from the control variables in this study point towards recommendations that align with political and socio-economic factors. Given the positive effect of political affiliation, particularly with Democrats favoring adoption, policy initiatives that cater to diverse ideological beliefs could enhance EV adoption rates. Additionally, addressing budget constraints associated with household size, as indicated by the negative effect of the number of children variable, through targeted financial incentives or support programs could make EVs more accessible to families. These recommendations focus on leveraging political alignment and addressing practical financial barriers to promote widespread adoption of EVs.

In summary, this research emphasizes the crucial role of improving charging infrastructure in accelerating the widespread adoption of EVs. The findings highlight the urgency to reduce recharging times and enhance the availability of charging stations, emphasizing collaborative efforts between government and recharging services. By focusing on these critical areas, the transportation sector can transition towards a more sustainable future, mitigating greenhouse gas emissions and contributing to global efforts in combating climate change. This study not only sheds light on the barriers hindering EV adoption but also provides actionable recommendations to foster collaboration and innovation in the automotive industry and government policies. Through strategic investments and technological advancements, the vision of a greener and more efficient transportation sector can be realized, paving the way for a cleaner and healthier environment for generations to come.

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Appendices

Appendix A: EV Adoption Perceiving Driving Range

answer_range	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
EVrange	.0053447	.0024734	2.16	0.032	.0004759	.0102135
EVcharge	.0263611	.0151359	1.74	0.083	-.003433	.0561553
EVcost	.0000286	.0000725	0.39	0.694	-.000114	.0001712
lnage	-2.565706	.4762276	-5.39	0.000	-3.503133	-1.62828
yearsedu	.2586773	.1047324	2.47	0.014	.0525177	.4648369
polcat	.7571477	.1429576	5.30	0.000	.4757438	1.038552
incomeca	.0430742	.0841948	0.51	0.609	-.1226584	.2088068
child	-.3513198	.1132718	-3.10	0.002	-.5742889	-.1283508
stateden	-.0078607	.0237724	-0.33	0.741	-.0546553	.0389338
veh	.4041819	.1461418	2.77	0.006	.1165101	.6918536
weekdri	-.0177765	.0126659	-1.40	0.162	-.0427086	.0071556
innov	.3058279	.0580244	5.27	0.000	.1916103	.4200455
vehfive	.2489183	.0520209	4.78	0.000	.1465183	.3513184
_cons	1.807371	3.815099	0.47	0.636	-5.70243	9.317171

Appendix B: Lnage Behavioral Correlations (Younger than 40 years vs 40 years and older)

. cor lnage vehcost vehimp techprof innov risktake if age<40
(obs=188)

	lnage	vehcost	vehimp	techprof	innov	risktake
lnage	1.0000					
vehcost	-0.0542	1.0000				
vehimp	0.0549	0.6180	1.0000			
techprof	0.1721	0.2827	0.3188	1.0000		
innov	-0.0869	0.4744	0.5515	0.2895	1.0000	
risktake	0.0216	0.2419	0.2862	0.1588	0.1051	1.0000

. cor lnage vehcost vehimp techprof innov risktake if age>=40
(obs=107)

	lnage	vehcost	vehimp	techprof	innov	risktake
lnage	1.0000					
vehcost	-0.3105	1.0000				
vehimp	-0.1609	0.6782	1.0000			
techprof	-0.2973	0.5223	0.4295	1.0000		
innov	-0.1190	0.4263	0.4196	0.4976	1.0000	
risktake	-0.0910	-0.0538	-0.2305	-0.2025	-0.2797	1.0000