Jurnal Ekonomi Pembangunan
Volume 21 (2): 191-199, December 2023
P-ISSN: 1829-5843; E-ISSN: 2685-0788

Research article

The Impact of Government Incentives on Electric Vehicle Adoption in the Metropolitan Jakarta Area

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Article Info: Received: 14 November 2023; Accepted: 25 January 2024; Published: 31 January 2024

Abstract: This study investigates the effect of government economic incentives on electric vehicles (EV) in the metropolitan Jakarta area (Jakarta, Bogor, Depok, Tangerang, Bekasi). A survey was collected from 121 prospective and current EV users in Jakarta and its neighboring regions area. The collection was then analyzed using logistic regression. The research finds that EV subsidy, EV infrastructure, EV tax deduction, and age have significant effects on EV adoption. According to this stance, higher EV subsidy propels more EV adoption. In addition, respondents significantly consider the availability of EV infrastructure for EV adoption. Our study also reveals that the younger the age, the higher the preference for EV adoption. Furthermore, the lower the tax deduction, the increasing adoption of electric vehicles. Those variables are important factors to amplify EV adoption among our research respondents. This study implies that potential consumers are aware of and react positively to policy efforts to reduce upfront and maintenance costs for the transition to EV cars in the metropolitan Jakarta area.

Keywords: electric vehicle adoption, incentives, transportation economics, metropolitan Jakarta area

JEL Classification: C90, D12, R41

Abstrak: Penelitian ini menyelidiki pengaruh insentif ekonomi pemerintah terhadap kendaraan listrik (EV) di wilayah metropolitan Jakarta (Jakarta, Bogor, Depok, Tangerang, Bekasi). Sebuah survei dikumpulkan dari 121 calon pengguna kendaraan listrik dan saat ini di Jakarta dan wilayah sekitarnya. Koleksi tersebut kemudian dianalisis menggunakan regresi logistik. Penelitian menemukan bahwa subsidi kendaraan listrik, infrastruktur kendaraan listrik, pengurangan pajak kendaraan listrik, dan usia mempunyai pengaruh yang signifikan terhadap adopsi kendaraan listrik. Berdasarkan pendirian ini, subsidi kendaraan listrik yang lebih tinggi akan mendorong lebih banyak adopsi kendaraan listrik. Selain itu, responden secara signifikan mempertimbangkan ketersediaan infrastruktur kendaraan listrik untuk adopsi kendaraan listrik. Studi kami juga menunjukkan bahwa semakin muda usia, semakin tinggi preferensi untuk mengadopsi kendaraan listrik. Selanjutnya, semakin rendah pengurangan pajak, maka adopsi kendaraan listrik semakin meningkat. Variabel-variabel tersebut merupakan faktor penting untuk memperkuat adopsi kendaraan listrik di kalangan responden penelitian kami. Studi ini menyiratkan bahwa calon konsumen menyadari dan bereaksi positif terhadap upaya kebijakan untuk mengurangi biaya di muka dan pemeliharaan untuk transisi ke mobil EV di wilayah metropolitan Jakarta.

Kata kunci: adopsi kendaraan listrik, insentif, ekonomi transportasi, wilayah metropolitan Jakarta

How to Cite:
Hasudungan, A., Andean, B., Aurelius, E., Widarsyah, R., & Artha, I. K. D. S. (2023). The Impact of Government Incentives on Electric Vehicle Adoption in the Metropolitan Jakarta Area. *Jurnal Ekonomi Pembangunan, 21*(2), 191-199. DOI: 10.29259/jep.v21i2.23050

1. INTRODUCTION

Electric vehicles (EVs) have been introduced as an alternative to fossil fuel vehicles to promote clean transportation in Indonesia. Some studies illuminate the benefits of adopting battery electronic vehicles (BEVs) to replace fossil fuel cars. The BEV does not emit air, as the petrol source comes from electricity (Schulz & Rode, 2022). Despite the expensive up-front purchase price, EVs offer lower maintenance costs than fossil fuel cars (Gass et al., 2014). In Indonesia, EVs are being recommended by policymakers as a more environmentally friendly vehicle alternative. With such economically and environmentally feasible transportation, the government has introduced several incentives to reduce the burden of ownership and maintenance of the EV. In addition, more supporting infrastructures for BEVs have been made available in the metropolitan Jakarta area. Despite the government policies offering more incentives to increase BEV adoption, there is a lack of Indonesian scholars who evaluate the effectiveness of various tax deductions on prospective consumers of EVs. For instance, recent research tends to concentrate on product design and marketing factors to induce purchasing of EVs in Indonesia (e.g., (Candra, 2022; Febransyah, 2021; Gunawan et al., 2022; Utami et al., 2020). Indeed, there was a very low adoption rate within the EV market in Indonesia. For instance, EVs have a much lower penetration than fossil fuel vehicles, less than 1 percent (Adiatma & Marciano, 2020).

The incentives in this study corroborate EV policymaking and the evaluation of incentives from overseas countries to adopt EVs. EV incentives, in this study, consist of EV subsidy, value-added tax (VAT) deduction, traffic exemption, and the availability of EV energy charging. Firstly, some policies related to EV subsidy were introduced in Europe and other advanced industrial countries, such as the United Kingdom and the United States, to overcome consumers' hesitance to pay the high upfront purchasing price for EVs (Sheldon et al., 2023). With the EV subsidy, a deduction is applied when consumers make a straight purchase of EVs (Gass et al., 2014). Gass et al., (2014) found in Europe that sufficient government support to assist with upfront costs increases the public acceptability to adopt EVs. Moreover, in the United Kingdom, to stimulate the adoption of EVs, the government introduced a government subsidy equivalent to a purchase price discount (Hardman, 2021). In 2021, buyers were eligible for 2500-pound sterling discounts when they purchased EVs (Reuters, 2021). With the new policy, some consumers applauded the enthusiastic intention to purchase electric cars as a personal choice (Reuters, 2021). Furthermore, the United States had some earlier EV subsidies beyond those of the United Kingdom. The probability of prospective consumer intention to adopt and willingness to pay will be higher with the introduction of such an EV subsidy (Daziano et al., 2017; Jenn et al., 2018). Aside subsidy, governments in some EV-adopted countries introduced tax discounts on the value-added tax, or tax rebates when owning EV cars (Hardman, 2021).

Besides, when evaluating the impact of VAT subsidy on the adoption of EVs, there has been a positive and significant effect of EV on more consumer adoption on EV. The governments in some advanced countries announced Good and Service tax (GST) rebates to prospective EV consumers. In the United Kingdom, such a tax rebate was not directly deducted from the point of purchase of EV (Kohn et al., 2022). The compensation of the tax rebate came in the form of income tax cuts to the equivalent tax rebate benefits for those consumers (Kohn et al., 2022). In Australia, a British commonwealth country, the tax rebate was in the form of free registration for the electric vehicle (Gong et al., 2020). That announcement regarding the tax rebate inspired greater EV adoption in the United Kingdom and Australia (Gong et al., 2020; Hardman & Sperling, 2020). In addition, tax rebates have been adopted in the United States to induce more EV adoption. In the United States, the tax credit is available after individuals making a purchase verify the purchase according to the policy of the federal state region Federal Tax Credit (Hardman, 2021). In the European EV market, the tax rebate comes through discounted added value tax for EVs. In pioneering the green vehicle, discounted value-added taxes were promoted to induce more EV adoption among the existing CV consumers (Yan, 2018). In Germany, value-added tax reduction (VAT) has been introduced to induce an increased consumer shift into EVs, and prospective consumers seemed to make more decisions to shift into EVs (Münzel et al., 2019).

Some countries have enforced traffic restriction policies to reduce urban congestion and air pollution. Some large cities including Paris, Rome, and London have successfully applied traffic restriction policies to reduce congestion (Barahona et al., 2020). Despite the effectiveness of reducing congestion during peak hours, air pollution remains high during the weekend (Falbo et al., 2022). In emerging countries (e.g., Mexico, Brazil, and China), traffic restriction policies have been implemented, but the impact on air pollution remains ambiguous (Davis, 2008; Gallego et al., 2013; Sun et al., 2014; Viard & Fu, 2015). For instance, considering Asian countries such as China, driving restriction policies were exercised during peak hours, yet congestion during non-peak hours increased (Yang et al., 2018). In Indonesia, despite the controversies of the limited velocity of EV in Indonesia to access toll roads, the government allows EVs to access toll roads to exempt them from the traffic of fossil fuel cars. Yet, the impact of that traffic exemption has not been evaluated in Indonesian economic studies.

This study also evaluates the impact of increased EV infrastructure on consumer adoption of EVs in major industrialized countries. This is taken into consideration of rare academic contribution in the economic scholarships to evaluate the effectiveness of financial and non-financial incentives to wider the electric vehicles' adoption in Indonesia. Different results have emerged on that impact in different countries. For instance, in France, local car users were enthusiastic to use EVs. However, in the initial development, charging stations were not widely available (Haidar & Rojas, 2022). With these bottlenecks, national and local transport authorities encountered a complex environment with the possible interruption of EV adoption. They implemented more EV charging stations to induce more EV adoption (Haidar & Rojas, 2022). With these endeavors, Haidar and Rojas (2022) observed significantly more EV sales with a more even geographic distribution of charging stations in France. In the United States, car users have especially relied on the decision to shift from conventional cars to EVs because of the even distribution of EV charging stations. Hardman and Sperling (2020) suggested that, besides financial incentives, charging stations are required to ease users' worries. The availability of charging stations inspires word of mouth from EV car users to influence CV users to purchase EVs (Hardman & Sperling, 2020).

The objective of this study, hence, is to evaluate the impact of various government incentives on the adoption of EVs. The academic contribution of this study is that it uncovers the economic impact assessment study that evaluates the appropriate incentives from buyers' and prospective buyers' preferences. Furthermore, it benefits public policymaking, as understanding and identifying appropriate BEV incentives will help policymakers craft a more effective public policy that urges the public to use or buy EVs. Using these theoretical perspectives, this study aims to answer the following research question: How do EV subsidy, VAT deduction, EV traffic exemption, and EV charging infrastructure impact EV adoption in the metropolitan Jakarta area? EV adoption in the area is defined as the prospective consumers' willingness to adopt a new technological product and shift to EV use (Figenbaum et al., 2014). The benefit of this study is to assist the findings of the significant factors that can influence EV adoption in the metropolitan Jakarta area.

2. RESEARCH METHODS

This study employs primary sampling. The details of the respondents will be explained in the following subsection of data. The first step is to examine the validity and reliability tests of the primary data. Validity aims to measure the appropriate respondents' answers to the respective questions. On the other hand, reliability examines the representativeness of the indicators toward the variables. In this statistical assessment, the specific reliability was the Spearman coefficient correlation. Meanwhile, the reliability of the variable was examined using Cronbach's alpha(Sekaran & Bougie, 2016). Afterward, a logit regression was run to examine the effect of the independent variables on the dependent variable. Furthermore, the robustness of the logistic regression was scrutinized using the stability of the regression and multicollinearity relationships among the independent variables (Hilbe, 2016).

2.1. Data

This paper uses convenient sampling to collect data from 121 buyers and prospective buyers of EVs in the metropolitan Jakarta area. Convenient sampling is the kind of data collection to chooses respondents with some criteria to be capable of answering the questions (Sekaran & Bougie, 2016). In this stance, purposedly, Convenience sampling is a non-probability sampling technique that selects respondents who have the capabilities to answer related to EV (Edgar & Manz, 2017; Sheldon et al., 2023). The collection of the data was conducted through an online questionnaire. To ensure the validated questionnaire, the pre-tested questionnaire was initiated among 10 respondents (Sekaran & Bougie, 2016). After clarification had been completed, the self-administrative was distributed to 121 samples. In collecting the primary data, the researchers also provided the email address to assist them if they required any additional information related to the primary survey.

2.2. Model

The dependent variable is the willingness of the respondent to choose an EV as their daily means of transportation (EV adoption). Meanwhile, the independent variables consist of four incentive structures of EV subsidy, VAT deduction for EV, exempting odd-even car license plate restriction, and EV charging infrastructure. The control variables in this study are demographic indicators such as age and income. In this study, the dependent variable applies dichotomous information (Yes/No). With those characteristics, this study examines the relationship with logistic regression function as follows.

$$\left(ln\frac{p(EV)}{1-p(EV)}\right)_i = \beta_0 + \beta_1 S_i + \beta_2 T_i + \beta_3 Ex_i + \beta_4 Inf_i + \beta_5 A_i + \beta_6 I_i + \varepsilon_i \quad (1)$$

where $p(EV)$ stands for the probability of choosing an EV as daily transportation; S is the EV subsidy. T stands for VAT deduction for EV; Ex is the EV traffic exemption; β_0 is the equation intercept; ε stands for error; and i is the cross-section of individuals. Besides, Inf stands for charging infrastructure; A is the age of the respondent, and I is denoted for the respondents' income. In the equation, all variables are converted into logistic regression. Hence, ln denotes for the logarithmic transformation.

3. RESULTS AND DISCUSSION

The paper will provide the reliability test, the results of the statistical test, and some discussion of the results. In analyzing the data, this paper will present the validity and reliability of selected indicators for the regression, as in Table 1.

Table 1. Validity and reliability of selected EV indicators

Indicators	Correlation Coefficient	Cronbach Alpha
Traffic Exemption 1	0.553	0.703
EV VAT 1	0.468	0.704
EV VAT 2	0.414	0.740
EV VAT 3	0.706	0.661
EV Infrastructure 1	0.410	0.713
EV Infrastructure 2	0.432	0.717
EV Infrastructure 3	0.604	0.682
EV Subsidy 1	0.642	0.675
EV Subsidy 2	0.670	0.671
EV Adoption 1	0.483	0.704
EV Adoption 2	0.563	0.707
Overall Value		**0.718**

Source: Authors' calculation, 2023

Table 1 reports that the Cronbach's alpha value for the selected indicators is above 0.6, and the overall value of Cronbach's alpha is above 0.7. It proves that the survey is valid and reliable. Hence, the next procedure can be executed to find the variables that can significantly affect EV adoption in the metropolitan Jakarta area. The examined variables are approximated from the weighting average of those selected indicators. After that, the logistic regression (odds ratio) is estimated to determine the significant determinants to boost EV adoption in the metropolitan Jakarta area. The logit econometric regression result is displayed in Table 2.

Table 2 shows that the EV subsidy has a positive and significant effect on EV adoption, suggesting that greater EV subsidy increases the odds of EV adoption by a factor of 14.004. In this context, assuming others are constant, EV subsidy increases the likelihood that people will adopt EV to 2.727. This regression suggests that EV VAT deduction has a positive and significant impact on EV adoption to 10 percent significance. From this stance, an EV VAT deduction increases the odds of EV adoption by a factor of 2.571. In this context, the EV VAT deduction increases the likelihood that people will adopt EV to 2.571, ceteris paribus.

Table 2. Logistic Regression for determining variables for EV adoption

Variables	Odds Ratio	Std Error	Z-statistics	Prob-Z
EV Subsidy	14.004	13.781	2.68	0.007***
EV VAT Deduction	2.571	1.445	1.68	0.094*
EV Traffic Exemption	1.247	0.491	0.56	0.575
EV Infrastructure	5.634	4.188	2.33	0.02**
Income	1.476	0.571	1.01	0.315
Age	(-)0.091	0.111	(-) 1.97	0.049
Constant	(-)1.23e-06	6.00e-06	(-) 2.78	0.005***
Pseudo R-squared	68.12%			
LR-Chi-Square Statistics	47.01			
Probability of Chi-Square	0.000			

Note: Significance level at *10%, **5%, ***1%
Source: Authors' calculation, 2023

In addition, EV infrastructure has a positive and significant influence on EV adoption. It can be inferred that more EV infrastructure increases the odds of EV adoption by a factor of 5.634. EV infrastructure increases the likelihood that people will adopt EVs to 5.634, given all else is constant. The statistical result also reveals a negative and significant influence of age on EV adoption. This means that, at an older age, EV adoption will likely decrease by a factor of 0.091. It means that age will decrease the probability of 0.091 that people will adopt EV, ceteris paribus.

Table 3. Multicollinearity test (post-estimation)

Variables	VIF (Variance Inflation Factor)
EV Traffic Exemption	1.05
EV VAT Deduction	1.20
EV Infrastructure	1.18
EV Subsidy	1.22
Income	1.44
Age	1.33

Source: Authors' calculation, 2023

In this statistical assessment, income and traffic exemption do not have a significant effect on EV adoption at the 5 percent and 10 percent significance levels. In the statistical assessment, this paper evaluates the robustness of the logistic regression with multicollinearity and statistical robustness assessment. The statistical results as displayed in Table 3 show a value below 10. This means in the statistical textbook, there is no correlation relationship among the independent variables (Young, 2018). As shown in Table 4, the authors found that the result is reliable.

Table 4. Stability Check for Logit Regression (post-estimation)

Indicators	Percent (%)
Sensitivity	99.10
Positive Predictive Value	98.21
Negative Predictive Value	88.89
Correctly Classified Parameter	97.52

Source: Authors' calculation, 2023

Several reasons explain the positive impact of various incentives on EV adoption. Firstly, the logistic regression also shows a positive and significant relationship between EV subsidy and EV adoption. In past studies, the bottleneck of purchasing EVs is the high upfront cost (Gass et al., 2014). Providing EV subsidies becomes a propelling trigger for consumers to transition into EV (Gass et al., 2014). In some European consumer contexts, this EV subsidy indicates financial consideration to adjust their preference spectrum to lower their opportunity cost of selecting EVs over conventional vehicles (Bjerkan et al., 2016). Some other studies also conclude that the EV subsidy will be an incremental consideration for individuals to add more of their spending budget to afford EV in their consumer choices (Jenn et al., 2018; Springel, 2021). This past study strengthens the positive relationship between EV subsidy and EV adoption for selected respondents in the metropolitan Jakarta area.

Secondly, this econometric regression result supports previous research that reveals a positive connection within that variable. The income tax cut is perceived as a positive benefit for consumers to select EVs as their daily mode of transportation (Kohn et al., 2022). With that kind of positive experience, consumers will be more attracted to owning EVs (Kohn et al., 2022). In addition, Hardman (2021) suggests that VAT deduction is an attractive financial incentive to influence consumers' choices. Besides, tax subsidy is necessary to extend the prospective users not only to the richest but also to a variety of economic classes to afford that electricity city car technology (Sheldon et al., 2023).

Thirdly, this econometric result supports the previous studies related to more availability of EV infrastructure to boost EV adoption. Hardman and Sperling (2020) found that more EV charging stations will bring more accessibility to daily EV operations. Hence, their research suggests even the availability of EV charging stations in the different states of one country. Moreover, Haidar and Rojas (2022) state that EV infrastructure is an attractive driver for people to purchase and use EVs. In addition to that, the spreading charging station availability will ease the new users of EVs to recharge their power. Without the availability of charging stations, those new users found that adopting EVs would be as challenging as their personal choices (Micari et al., 2017). Another advantage to fostering charging stations will create opportunities to reduce vehicle consumption of fossil fuel energy (Kumar et al., 2021). Our literature on EV places no age on influence toward EV adoption. It is common, however, for those of a younger age to favor more complex technology that can enhance economic efficiency and productivity (Magsamen-Conrad & Dillon, 2020).

4. CONCLUSIONS

This study investigates the effect of some financial and non-financial incentives on EV adoption in the metropolitan Jakarta area. The findings conclude that demographic and economic policies have a significant impact on EV adoption in our metropolitan Jakarta area case study. We find that the government policies to provide subsidies on purchasing EVs, EV tax deduction, EV infrastructure (charging station), and age have significant influence on EV adoption. This paper has both academic and practical implications for EV growth in Indonesia. Academic implications suggest that consumers react positively with the appropriate incentive to reduce their upfront costs (EV subsidy, EV VAT deduction) and more infrastructure to support EV development. Hence, these factors are sensible and motivate some individuals to transition to EVs. The policy implication of this study is that more financial and non-financial incentives of EV subsidies, tax subsidies, and more EV charging infrastructure will enhance the transition from fossil fuel cars into that EV. This could reduce the government's financial burden of spending on fossil fuel-based energy from overseas.

However, this study is not without limitations. Firstly, due to the limited financial resources, this paper highlights the result of the limited scope of the selected respondents in the metropolitan Jakarta area. This was also considered that EV usage was still limited use in the metropolitan Jakarta area when the researchers collected the data. Future research may provide a comparative study of EV adoption in Indonesia and overseas. Furthermore, it is acknowledged that many other variables were not taken into consideration in this study. Given the cutting-edge focus on incentive factors, the mentioned variables are investigated. Future studies could explore the emotional and functional incentive determinants in behavioral economic assessments.

ACKNOWLEDGMENTS

The authors express gratitude for the financial and technical support from the Research Office, School of Business and Economics, Universitas Prasetiya Mulya, Indonesia.

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