Determinants of electric vehicle adoption in Sweden

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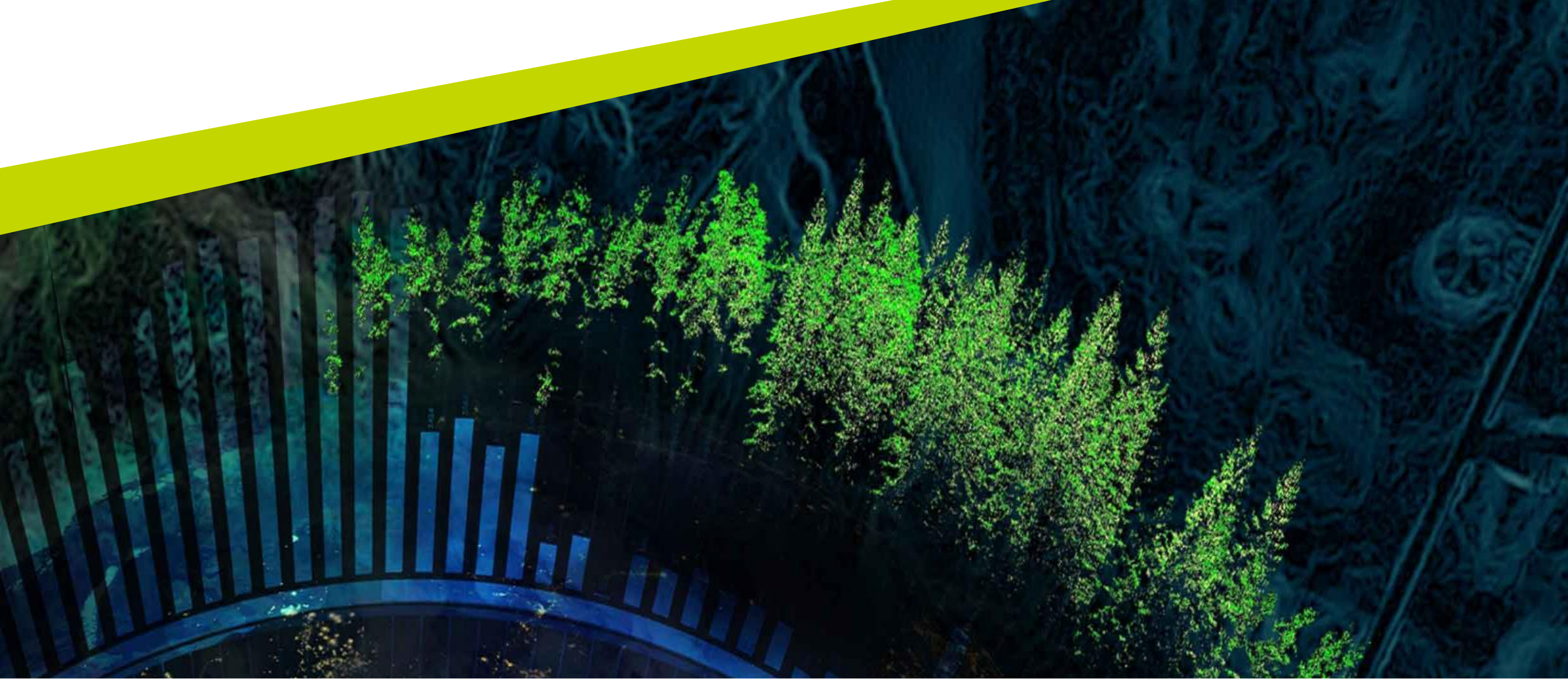

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Abstract

This thesis investigates the determinants of electric vehicle (EV) adoption in Sweden. A linear-logarithmic regression model is estimated on annual data from 2011 to 2020. In addition to a national level analysis, the thesis carried out separate analysis for the regions of Norrland, Götaland and Svealand to find any regional differences. The results show that the average distance travelled is significant in every regression alongside fuel taxes. This finding has two policy implications: Expanding EV charging infrastructure to entice non EV drivers to adoption and increasing fuel taxes to reduce the relative operating costs of EVs.

Table of contents

List of tables

1. Introduction

Climate change is currently one of the most discussed topics globally. It has increasingly become a pressing problem that human beings need to revert to mitigate the damages it causes to the planet. One of the mechanisms to reduce the impacts of climate change is technological advancement. Technological improvements and inventions help to build a greener and more sustainable planet. In this regard, battery electric and hybrid vehicles, collectively referred from now on as EVs, are emerging climate-friendly technologies that receive increasing policy support. In Sweden, the importance of alternative fuelling is increasing alongside the continuous improvement of EVs since gasoline prices are continuously rising, e.g., from 13.46 SEK/liter in January 2011 to 18.35 SEK/liter in January 2022 (Drivkraft Sverige, n.d). As a result, the number of EVs registered in Sweden increased from 241 to 13,046 between 2011 and 2022. According to Statistics Sweden's statistics on newly registered vehicles (SCB,2022), this trend seems to continue.

The aim of this thesis is to empirically investigate factors affecting EV adoption in Sweden. By doing so, the paper contributes to the literature on determinants of EV adoption with empirical evidence based on recent data. The thesis adds to existing literature on EV adoption such as Diamond (2009), Egnér and Trosvik (2018), Westin et al (2018) using recent data from Sweden, where the EV adoption rate is increasing.

The remainder of the thesis is structured as follows. Section two provides a review of previous relevant literature. Section three describes the methodology and data. Section four presents the results which is followed by section five which offers a discussion of the results and implications of the results for policy. Finally, section six concludes the thesis.

2. Literature review

A survey of previous studies indicates that higher income, education, environmental awareness as well as the increasing gasoline prices are important drivers for EV adoption (Egnér and Trosvik, 2018; Diamond, 2009; Westin et al, 2018). According to Westin et al (2018), the effect of socio-demographic factors becomes weak when explanatory variables for EV adoption such as age, gender, education, and income are included. Also, Westin et al (2018) discusses and notes that geography matters: EV adoption seems to cluster in neighbourhoods where there are a lot of other people who adopt EVs. The authors show that EV owners in Sweden are concentrated in the Stockholm region. Moreover, Westin et al (2018) shows that EV is most often the second car in the household, owners of these types of cars have higher income, higher education level and that they are in their middle-ages, which is in line with the finding of Egnér and Trosvik (2018) as well as Diamond (2009). Other factors such as distance travelled, and geography are also important determinants of EV adoption since EV drivers tend to have shorter distances places such as work and services. Westin et al (2018) ultimately suggest that policy makers should make EV adopters and the public charging infrastructure more visible as well as influence the norms and the neighbouring effect even if public charging might not matter as much for an owner after adopting EV. The authors have said that the effect of advertising should not be underestimated before the actual adoption.

Sweden’s map of public charging stations suggests that there are more charging stations in the central and the southern parts of the country compared to the northern part (alltomelbil, n.d). This implies that EV adoption is likely be higher in the middle and southern parts of Sweden compared to the northern part.

In the United States Diamond (2009) has studied how different government incentives policies and other determinants impact the hybrid electric vehicle (HEV) adoption. He has used a variety of socioeconomic and policy variables factors such as vehicle miles travelled per capita, yearly average gasoline prices per state, incentives (e.g., reduction or waivers for registration and inspection fees for a number of year) and income per capita. The incentive variable in Diamond (2009) is the combined value of federal and state monetary incentives, which ranges from $560 to $5618 depending on year and the State itself. He has used the share of HEVs in the United States as the dependant variable which is calculated by taking hybrids as the percentage of all new vehicles for the period. Monetary incentives and vehicles miles travelled directly affect the total ownership cost of a HEV in his study. Also, he has found that the gasoline prices are a significant factor in his study. Using gasoline prices to explain HEV adoption is understandable since it is a combined gasoline engine and electric motor vehicle. The vehicle depends on the gasoline if the electricity battery depletes on a HEV but if the gasoline price is used in a model where the shares of EVs are the dependant variable, the variable might instead explain how much the prices increase or decrease affect HEV adoption relative to vehicles using only conventional fuels. Diamond (2009) has opted to study a few states in the US instead of doing it nationally to be able to cover variation in between states. Dividing Sweden into smaller regions as Diamond (2009) has done with the US, would show variation between the regions which enables to understand how the effect of similar factors differ between those regions.

Empirical studies that have previously been performed are limited in numbers since the amount of EVs started to increase only after 2010, and the demand for EVs has used models based on survey data according to Egnér and Trosvik (2018). The aforementioned authors have researched EV adoption in Sweden and the impact of local policy instruments where they use the share of newly registered EVs in different municipalities. Egnér and Trosvik's (2018) main explanatory variables are public charging points, local policy instruments, parking benefits. Control variables such as average income and education as well as factors such as average vehicles kilometres travelled, and population density are included. Both Egnér and Trosvik (2018) and Diamond (2009) has found that distance travelled by car is significant, but the results mean different things which is noteworthy since they contradict each other. In the former, the average distance travelled has a negative coefficient which means that the longer drivers travel in a year, the less likely it is to own or buy an EV. Diamond (2009) on the other hand, states the opposite: adoption of HEVs increases with annual travel distance. Egnér and Trosvik (2018) as well as Westin et al (2018) indicate that increased number of public charging points have a significant and positive impact on the BEV adoption implying the expansion of the infrastructure is an effective way to promote EV adoption. Parking benefits are also found to result in increased EV adoption. Parking benefits and public charging points are not included in this thesis since there is not enough time to find and make data available for this analysis.

Other factors that are interesting and would be relevant to this thesis are owner characteristics. However, obtaining data on car owners' characteristics requires conducting a survey which is not feasible at this point though it is within the scope of a master's thesis. Finally, Egnér and Trosvik (2018) used is environmental awareness to explain adoption of EV, but it is debateable since awareness is considered as voting for the Swedish green party. Using the votes for the green party is problematic as it excludes those who consider the environment as important but does not vote for the green party. The study by Egnér and Trosvik's (2018) shows that higher income and education are statistically significant control variables which was expected and are in line with most of the previous literature.

3. Methodology and data

3.1 Method

To find out what factors affect the adoption of EVs, a linear-logarithmic regression model is estimated. Time series data from 2011 to 2020 is used. The share of EVs is the dependant variable. The decision to use a linear-logarithmic model is made to ensure that variable values are about the same scale, which reduces numerical issues in estimation. Four regressions are preformed, one which include the whole of Sweden, and three regressions on data from three regions in the country to enable analysis of any differences between regions. Data for all municipalities' newly registered cars are available but analysing 291 regressions is outside the scope of this paper. Therefore, the analysis in this thesis is limited to only three big regions namely Norrland, Svealand and Götaland. The regressions are performed in Stata.

3.1.1 Functional form

Presented below is the functional form used for the regressions where $ShEV_i$ is the share of EVs, i= R (Riket, the whole country), N (Norrland), S (Svealand), and G (Götaland). β_0 is the coefficient corresponding to the constant, while $\beta_1, \ldots, \beta_4$ are coefficients for Gas price (excluding taxes), ADTK (which stands for average distance travelled in kilometres), education, and fuel taxes respectively. All the explanatory variables are in a logarithmic form.

$$ShEV_i = \beta_0 + \beta_1 LnGasPrices + \beta_2 LnADTK + \beta_3 LnEducation + \beta_4 LnFueltaxes$$

3.2 Data

3.2.1 Description of variables

Table 1 presents a description of the variables used in the linear-logarithmic model including the variables that correspond to the different parts of Sweden as well as Sweden as whole.

Table 1. Description of variables

VARIABLE	DESCRIPTION	MEAN	STD. DEV	MIN	MAX
SHEVG	Share of newly registered EVs in Götaland	0.1446	0.1266	0.0213	0.4337
SHEVS	Share of newly registered EVs in Svealand	0.2051	0.1632	0.0421	0.5746
SHEVN	Share of newly registered EVs in Norrland	0.1625	0.1429	0.0192	0.4844
SHEVR	Share of newly registered EVs in the country	0.1717	0.1456	0.0284	0.5043
LNGASPRICES	Gasoline prices per litre in Sweden the 31st of December excluding taxes	8.289	0.9312	9.98	9.62
LNADTK	Average distance travelled in metric miles	7.0962	0.0375	7.0030	7.1388
LNEDUCATION	Number of people graduating higher levels of education logaritmized	11.0854	0.0565	10.9908	11.1839
LNFUELTAXES	Taxes on fuel in millions of SEK logaritmized	10.0123	0.1221	9.8688	10.1893

3.2.2 The dependable variable

Data for the dependable variable of EV adoption or ShEV as it is called in the model is obtained from Statistics Sweden's (SCB's) new cars register in Sweden. Previous literature has also used the share of EVs compared with gasoline and diesel fuelled vehicles instead of looking solely at numbers of EVs registered. The EV adoption has been manually calculated by taking the number of EVs divided by the total number of newly registered cars annually in the country as well as Norrland, Götaland and Svealand. The data available has been divided into the different counties of Sweden and have been worked on to obtain data for the desired regions.

Norrland, Svealand and Götaland's borders does not correlate to entail entire counties in Sweden and therefore, modifications has been made to ensure an accurate representation for the three regions. However, every county in Norrland's region is correctly included which comprises of Gävleborg, Västernorrland, Jämtlands, Västerbotten, and Norrbotten counties. For Svealand the counties of Stockholm, Uppsala, Södermanland, Värmland, Örebro, Västmanland, and Dalarna are included. Finally, for Götaland, the counties of Östergötland, Jönköping, Kronoberg, Kalmar, Gotland, Blekinge, Skåne, Halland, and Västra Götaland are included. Before deciding to go for this division, an attempt to localize what municipalities are included in Norrland, Svealand and Götaland has been made since data are available for the Swedish municipalities and that would be an even more correct merge of regions. Ultimately there are no information available for which municipalities belong where except the number of municipalities in each region and even if it is available, such endeavour would be too time consuming and outside the time scope for this thesis.

3.2.3 The explanatory variables

The explanatory variables included in the linear-logarithmic model are the gas prices, average distance travelled, education, and taxes on fuel. All these variables have been transformed into a logarithmic form to avoid unnecessary work as well as skewed results. The data is annual and ranges from 2011 to 2020. Monthly data would be preferred but only annual observations are available for average distance travelled as well as fuel taxes.

Annual gasoline price in is included in the model, following Diamonds (2009) where he has found that gasoline prices are a significant factor for the adoption of hybrid vehicles in the United States. It might have the same results for a Swedish perspective which would enable for new policy suggestions for the decision makers since this might show how the consumers think before buying a new vehicle. Each datapoint is taken on December 31st each year, and hence it is important to note that values are not average gasoline prices. This could be problematic. For example, during 2020 when people have been working home due to the pandemic, there were huge variation in gasoline prices, these variances cannot be fully observed due to the data being taken on the last day of each year, December 31st. In order to minimize correlation with fuel tax, the taxes included in the gas prices have been removed.

The average distance travelled in kilometres (ADTK), is sourced from Trafik Analys (TRAFA) (2022) and have been calculated with the help of a model that is based on the meter indication that Swedish inspection companies register during a vehicle's annual inspection. It is worth to note that the data refers only to vehicles that has been in use at least one day during a year. The average annual distance travelled has gone up and down since 1999 but has generally gone down since 2011 until 2020 as well as 2021. It has roughly gone down 130 metric miles from 1 260 to 1 112 with the all-time low during the first year in the pandemic (2020) with an average distance travelled of 1 110 metric miles. In the regression model, the ADTK is in 10s of kilometres, or metric miles. The variable has not been transformed into the actual kilometre value before transforming it into a logarithmic variable. This decision is made to minimize numerical issues in the regressions.

Since education has had a significant impact on EV adoption according to Egnér and Trosvik (2018) as well for Westin et al (2018), it has been included in the regression model. The number of people graduated from university or any other higher education institution in a given year was used as a proxy for education. With more time and better data, it would be preferable to capture education with data that represents owner statistics since the variable in its current form shows if the share of EVs increase of decrease when more people graduate. Although the data is not in the same form as those used by Egnér and Trosvik (2018) and Westin et al (2018) the results are expected to show a positive correlation.

The final variable that is included in the regression model is fuel tax. Fuel taxes represent the total amount of tax revenue that the government is receiving in a given year from fuel taxes which is taken from SCB (2020). The data points are in millions of SEK and were not transformed to its full numerical value to avoid having to work with too high numbers compared with the other variables included. Even if the regression model is using logarithmic explanatory variable, which makes the data easier to handle, having the data in its full value instead of MSEK is unnecessary. Due to a time restriction and data restrictions, the total value of the taxes for fuel are used to see how policies affect the adoption. If there were a longer time span and more data available, the taxes variable, would be interesting and perhaps more representative to the study if the median vehicle taxes value for a gas driven car was used instead of the total fuel taxes, which includes all vehicles.

Before presenting the results, it is important to mention that gender, age, and population variables were dropped due to high variance inflation factor (VIF) values. This may be due to the form of the data which, is discussed the discussion section.

4. Results

Table 2 presents the regression results where every explanatory variable's coefficient, the standard error (in the parenthesis), as well as significance level are indicated.

. The variables ADTK and Fueltaxes are significant in every estimate, where ADTK is significant at a 1% level and Fueltaxes at a 5% level. The mean VIF-value is at 3,20 which according to Choueiry (n.d), can either be indication for considerable multicollinearity or not depending on Choueiry's (n.d) references . However, the VIF-values as well as the results presented in this section are discussed in section five.

Table 2. Regression results

	Riket	*Norrland*	*Svealand*	*Götaland*
Variable	Estimate (std err)	Estimate (std err)	Estimate (std err)	Estimate (std err)
LnGasprices	-0.0064(0.139)	-0.0854(0.115)	0.0031(0.152)	-0.0105(0.130)
LnADTK	-2.7035(0.426)***	-2.7280(0.346)***	-2.9169(0.455)***	-2.3727(0.388)***
LnEducation	0.1629(0.291)	0.0518(0.242)	0.2607(0.318)	0.1017(0.271)
LnFueltaxes	0.3820(0.122)**	0.3384(0.101)**	0.4449(0.133)**	0.3350(0.114)**
R^2(adjusted R^2)	0.9817(0.9671)	0.9869(0.9764)	0.9827(0.9688)	0.9789(0.9621)

Variable significant at 90%=, 95%=**, 99%=****

When looking at the column for Sweden as whole (Riket), ADTK has a negative coefficient while Fueltaxes has a positive coefficient, -2.7035 and 0.3820. This means that if ADTK increases with one unit, the EV adoption will decrease with -2.7035 and for Fueltaxes, an increase of one unit will increase the EV with 0.3820 The goodness-of-fit in form of R^2 and adj-R^2 are high for Riket, which indicates a good fit for the model. The very high R^2 and adjusted R^2 high might be of concern considering that only half of the variables are significant and is good to have in mind when reading the rest of the thesis since every estimation have similar values. In Norrland's case, ADTK's coefficient is -2.7280 and Fueltaxes' is 0.3384 where changes in them impacts the adoption more than Riket and Götaland but less than Svealand. For this region, R^2 and adjusted R^2 is also high, and follows the same pattern as the coefficients. In Svealand, the aforementioned variables have coefficients of -2.9169 and 0.4449, which are the highest values coefficientwise compared to the other regressions still having high goodness-of-fit measures. The adjusted R^2 is higher than Götaland's and Riket's but less than Norrland's. Last regression presented is Götaland. ADTK is at -2.3727 and Fueltaxes at 0.3350 which are the lowest value alongside its R^2 and adjusted R^2. The significant determinants in Götaland affect the EV adoption the least.

5. Discussion and policy implications

After running the regressions multiple times and dropping three variables, final regressions has been performed, and results are obtained. All fours different regressions have two significant variables namely ADTK and Fueltaxes that respectively are significant at 1% and 5% level. The coefficients for ADTK in every regression are negative which means that an increase of the ADTK have a negative impact on the EV adoption. ADTK being significant is expected and the negative coefficient isn't surprising as it aligns with Egnér and Trosvik's (2018) results that a higher value of distance travelled decreases the EV adoption. ADTK always has a negative coefficient every region studied which means that the explanation adheres to every region. Higher ADTK means that people don't buy EVs if they expect to travel longer distances often, which can be connected with range anxiety. Fear of becoming stranded during a long trip when there are no charging stations available can inhibit the adoption (Axsen et al., 2010; Egbue and Long, 2012; Leiby and Rubin, 2004 see Egnér and Trosvik, 2018). To minimize the range fear and convince people to adopt EVs, it is necessary to inform about the range of an EV and expand public charging stations. Since the coefficient is one of the strongest in Norrland, which also constitutes majority of the country land while having the smallest population, just advertising public charging stations might not be enough. Norrland has the fewest amount of charging infrastructure for EVs according to a map of Sweden with this information (alltomelbil, n.d). It might be necessary to expand and advertise the infrastructure to increase the adoption in Norrland whereas it will be enough to only advertise the infrastructure for Götaland and Svealand since visible presence of charging points are significant factor when considering adopting EV (Carley et al, 2013 see Westin et al 2018).

When comparing the results for the different regions, the ADTK is significant and affect the adoption negatively regardless of region although the effect differs between them. Norrland lies slightly behind Riket which is at the middle whereas Götaland's adoption is affected the lowest and Svealand the most. Riket being in the middle is expected since it is supposed to represent the entire country which should intuitively be the median value. Götaland being affected the least could be explained by the amount of charging stations which enables longer travel easier or that the EV adoption. Svealand being the most affected by longer distances travelled is somehow unexpected, but at the same time expected. EV adoption is further along in Svealand and especially in the Stockholm region which can be an explanation that Stockholm drivers drive shorter distances since everything is in a closer proximity. Since they tend to drive shorter distances, EV is a good choice. If distances travel increase, the EV will be compared with a conventionally fuelled car and a longer distance would be in favour of a non EV. Norrland's coefficient could possibly be explained by having a lower EV adoption in the first place is because of the distance they are required to travel which means that the population there will not consider EVs. That is until technology advances enough to provide long range or the distances between necessities.

The fuel tax variable being significant is somewhat unexpected since the variable is not based on any of the previous literature that has been reviewed for this thesis. The fuel tax variable has a positive coefficient even though it is a small compared to the negative coefficients of ADTK. An increase in the fuel taxes leads to a higher share of EVs which is a quite intuitive result. When taxes increase, the relative operating costs of conventional fuel cars increases which induces people to consider adopting a differently fuelled vehicle such as an EV. This is a reasonable explanation to why people might choose to adopt since fuel taxes are effectively eliminated when driving an EV. Since a typical EV owner have higher education and higher salary, the increasing fuel taxes might affect their choice to adopt EV since they can afford to acquire a new EV to eliminate taxes from fuels. It might not be as easy for a household with lower income where they spend a higher share of their money on essentials such as rent, food and for many families, gasoline for their cars which revenue from the fuel taxes come from. When the prices are higher due to higher taxes, more of the income has to be allocated to gasoline since the car is essential for transportation to places such as school, work, grocery stores and more. This means that the household won't be able to save as much money as when the prices are lower and will have less money to allocate purchasing a new EV. This means that it will take longer for households with lower income to save for an EV when the tax on fuels increases which can explain the weak positive coefficient for fuel tax. EVs are usually the second car in a household which implies that lower income households are unlikely to have two vehicles and even if that is the case, it is even more unlikely that the second vehicle is an EV. In order to get lower income households to adopt EV, it is crucial to incentivise them economically to enable adoption. When looking at the regional differences for the fuel taxes, the difference as well as the value is minimal. The minimal difference seems plausible since the tax would affect everyone the same way having a conventionally fuelled vehicle and the even though it has a small effect on adoption.

Something that is unexpected with the results are that the R^2 and especially the adjusted R^2 for each can be considered very high. The lowest adjusted R^2 in this thesis has a value of 0,9621 from the regression for Götaland and the highest value of 0,9764 for Norrland. A high adjusted R^2 of itself indicates that the variables for the linear-logarithmic regression model is a good fit, this with the combination of only two significant variables raise questions. A high R^2 is expected since adding on to variable only increases the R^2 but a high adjusted R^2 indicate that those variables are a good fit. This might explain that the variables actually are a good fit despite a low amount of significance within them or it could flag that the data itself is in a bad format and has to be entirely revised. Another plausible explanation can also be that there are four explanatory variables in the regression model but only 10 observations in total which could mean that there is an overfit of the model. It could have been tested by taking more observations such as monthly form but that was restricted due to no data availability.

Other than the significance and the R^2 for the regressions, the regressions mean VIF-values being 3,20 does not mean any issue with multicollinearity which would support that the model is a good fit. In the pre-testing stages, a variable called population was included where the mean VIF-values were around 8 which could have indicated that there could be concerns for multicollinearity since it was >5 but <10 (Choueiry, n.d). If the mean VIF-values are above 10, it would be necessary to investigate. Since the levels were around 8, regressions were performed where the population was dropped from the estimation and the indication on multicollinearity dropped. Population correlated with the education variable. In future research, instead of using total population of a region, population density, number of households or number of people above 18 would've been an even more appropriate option which possibly can drop the VIF-values since it might correlate less with education. Population density being more appropriate is stemmed from the fact that if it was significant in the thesis model, it would confirm the neighbouring effect that Westin et al (2018) discussed, where denser populated and rural areas tend to have said effect if someone acquired an EV which influences their neighbours to also acquire one.

When the variables gender and age are included in the pre-testing regressions the VIF-values are >10 and do not provide anything in regard to the significance of variables as well as the fit for the model. The variables have chosen to be dropped alongside with population. Reasons for why the gender variables are unfit for the model is unclear but it could depend on being in either the wrong format or unfit because it states how many males and females own newly registered cars. The gender variables might possibly correlate quite strongly with population and education variables. It is also quite feasible that since survey data is used in Egnér and Trosvik's (2018) and Westin et al's (2018) research and that they have searched for different answers, it is a good fit for their models and unfit for the empirical data used in this thesis. Intuitively it makes sense since this paper has had the aim to find the determining factors for EV adoption while previous research has used gender in identifying owner characteristics of an EV. The same argument can partially be used in the age variables since it is used when identifying owner characteristics, but it still can be relevant for this type of research. There have been two variables which includes how many percent of people within the age of 25-44 and 45-64 have a driver's licence for class B, which is person cars and light weighed trucks. After performing the pre-testing regressions, the realisation has been that the data available is unfit and not the variable of itself. If the data was available as well as more time, a better age variable would be what the mean age of owners with a newly registered vehicle annually is instead of using percentages of people having driver's licence. Just because someone has a driver's licence does not mean that they own a vehicle and therefore should not be included in a regression where the pattern of purchased vehicles is studied, which makes it reasonable to have dropped the variable entirely from the regression. It also has a high multicollinearity since the percentage barely changes throughout the years.

With the results from the linear-logarithmic models, some policy implications are in place. Firstly, to make the share of EVs higher, advertise public charging stations to entice long distance drivers to purchase an EV since it is an option to a gas fuelled vehicle. In Norrland's case, advertise the charging stations as well as building more infrastructure to enable easier adoption for the population in less densely lived areas. Secondly, since higher fuel taxes increase the adoption, increase the taxes to incentivise higher income households to make the switch to EV. In order to increase the adoption, it is also crucial to enable lower income households to make the switch. To do so, a higher premium for acquiring an EV should be put in place, which would make the economic burden on lower income households lighter. To acquire funding for a higher premium, it could partially be funded by the increased revenue from fuel taxes as well as allocating assets from the Swedish budget that the government puts forward every year. This premium should be regulated by a system where income level should be considered since households with higher income do not depend on it in the same way that lower income households do.

6. Conclusion

EV adoption is on the rise since 2011, which has led to new EVs being the majority of the newly registered cars in Sweden in 2020. The adoption rate has to increase even more to lessen the emissions caused by gasoline fuelled vehicles and identifying the determinants of EV adoption is crucial. Identifying and interpreting the determinants can enable to obtain useful insights into the design of policies that increases the adoption and ultimately benefits the environment. Therefore, to ensure that the adoption increases, charging infrastructures have to be more advertised and also has to be expand in some regions with bad coverage to reduce range fear as well as increasing the fuel taxes alongside with a higher premium of acquiring EVs. The reasoning of a higher premium is used to enable lower income consumer to be able to adopt to EVs. A suggestion for future research is to use high frequency (e.g., monthly) observations and to consider factors that are deemed more appropriate to enable a more precise results without overfitting the model and identify more important determinants for adoption. More research has to be conducted alongside with new drastic policy changes to ensure the best course of action is taken since time is of the essence when it comes to climate change.

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