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CONSUMERS PREFERRED CAR DRIVE BASED ON THEIR INCOME AND PROFESSIONAL OCCUPATION WITH REFLECTION TO ELECTRIC VEHICLES

Michal JANKOVIČ[1*], Henrich JUHÁS[2]

[1]*Department of Marketing, Faculty of Commerce University of Economics in Bratislava, Dolnozemnská cesta 1/b, Bratislava, Slovakia*
[2]*Department of International Trade, Faculty of Commerce, University of Economics in Bratislava, Dolnozemnská cesta 1/b, Bratislava, Slovakia*

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Abstract. The main aim of our paper is to confirm or deny, that Slovak consumers preference of car drives is based on their income and professional occupation. While similar researches were conducted before, none of them were focused on the particular problem of Slovak consumers choosing between different car drives. Our study will therefore bring clear results into this matter. The study group consisted of 356 respondents and was conducted between October of 2022 and January of 2023. The data obtained were analyzed in detail through Chi-square test and Fisher's exact test. Results of our paper show that people with lower income opted more towards conventional car drives, while people with higher income lean towards electric car drives. In terms of professional occupation, entrepreneurs choose electric car drives while students prefer conventional.

Keywords: consumer, consumer behavior, car drive, electromobility, electric cars.

JEL Classification: M30, M39, 013.

Introduction

Electromobility has been on a rise for at least last decade, while the concept exists for much longer than that, the concept itself exists since 1828 (Robertson, 2022), the concept was brought to life by Thomas Alva Edison in 1899, however, was quickly shutdown by the rise of Ford T (Chan, 2012). Latter success of electromobility dates to 2013, when Tesla, led by controversial owner Elon Musk, introduced their Model S which was an instant hit (Wu, 2022) and while it remains a leader of the electric market (Arrieche, 2023) other car manufacturers are catching up (Popli, 2022). According to Yales professor Kenneth Gillingham (2021): "The adoption of electric vehicles is a key part of the decarbonization of the economy." Saying what other studies have been saying that electric vehicle transition is inevitable (Eardley & Peplow, 2022). Our paper looks if the inevitable transition to electric vehicles is reflected by consumers choice of car drive in a new car. We agree and support this cause. While important and inevitable, electrification still is a divisive topic in the society and consumers may be divided by various factors (Sriram et al., 2022). Most important barrier and obstacle for a market uptake is high price (Bühne et al., 2015; Loveday, 2022). Other very important barrier slowing down electromobility are long charging time (Philipsen et al., 2015; Sadik-Zada et al., 2023) and still relatively short range (Kampker et al., 2022; Csonka et al., 2022).

As price represents the most important barrier, our paper looks into the problem and brings concrete proof whether Slovak consumer's income influences their preferred car drive. Secondly, we look how their professional occupation influences the same decision making. We have joined the battery electric vehicles and plug-in hybrids as they both fall under electric vehicles category. The relationship will be determined based on primary research conducted by the authors between November 2022 and January 2023 on consumers planning to buy a new car.

* Corresponding author. E-mail: *michal.jankovic@euba.sk*

1. Background theory

For the needs of our research, we first must define the car drives and professions named in our primary research.

1.1. Car drives overview

For our primary research we have divided car drives into these two categories:

Electric vehicle (EV): A EV is defined as a vehicle that can be powered by an electric motor that draws electricity from a battery and is capable of being charged from an external source. An EV includes both a vehicle that can only be powered by an electric motor that draws electricity from a battery (all-electric vehicle) and a vehicle that can be powered by an electric motor that draws electricity from a battery and by an internal combustion engine (plug-in hybrid electric vehicle) (Alternative Fuels Data Center [AFDC], 2023). For purposes of our research, electric vehicles have been sub-divided into these two categories:

Battery electric vehicle: Also known as All-Electric vehicles are using purely battery-powered electric drivetrain. The electricity used to drive the vehicle is stored in a large battery pack which can be charged by plugging into the electricity grid. The charged battery pack then provides power to one or more electric motors to run the electric car.

Plug-in Hybrid Vehicle: Also known as series hybrids are using both electric engine and conventional fuel powered engine. The battery is charged externally (Accelerated e-Mobility Revolution for India's Tran-sportation [AMRIT], 2023)

Conventional car drive: Conventional vehicles use an internal combustion engine fueled by gasoline or diesel to power the wheels. Electricity is used for some accessories but is not used to move the vehicle. This category also includes Conventional Hybrid Cars which supplement the internal combustion engine with electrical power produced by an on-board electric motor. The electrical system acts as a generator when a driver applies the brakes, converting kinetic energy into electrical energy that is stored in a small battery pack. The primary fuel, however, is gasoline or diesel (New York State Energy Research and Development Authority [NYSERDA], 2023).

1.2. Occupation divisions

For the needs of our research, we have divided consumers into these profession divisions:

Unemployed, Retiree, Student, Employee, Contractor, Entrepreneur. Further specifications are needed for:

Unemployed: The unemployed are people aged 15 and over who are unemployed in the reference week, who are actively looking for work in the last four weeks and who are able to start work within two weeks at the latest.

Retiree: Retiree is a person who has stopped working in regular paid employment because of their age.

Student: Any student who is over 18. Includes students who are currently working.

Employee: Employee as defined for our research is anyone who is employed in any company or works for the government.

Contractor: Anyone that undertakes a contract to provide materials or labor to perform a service or do a job. However, is not owner ow his own business.

Entrepreneur: For our research we define entrepreneurs as owners of their own business.

2. Literature review

An electric car can be a great way for the consumer to save money on fuel. However, there are more reasons why a consumer should invest in an electric car in the era of modern technology. Among the main ones, we recommend the following: Electric cars are energy efficient, electric cars reduce emissions, electric cars are highly efficient and easy to maintain, impact on population health (Peel et al., 2005; Raz et al., 2015; Rinkesh, 2022).

Although electric cars might have an advantage over cars with a conventional drive, there are definitely disadvantages as well, the main ones we are the following: price, infrastructure (Mavlyanov et al., 2018), range (Sumathy et al., 2018), availability of rare mineral materials (Ballinger et al., 2019).

According to Drábik (2021), despite the fact that the efforts of car producers and government institutions are growing every year, the average Slovak consumer is skeptical about electromobility. According to the results of his survey from 2021, the main barriers can be considered: High price, an insufficiently developed network of charging stations and a short range for one charge.

Electric vehicles are often perceived as unattainable, too costly (Ewing, 2022), out of reach (Welch, 2022). Not only cost of electric vehicles is one of the major concerns but consumers also find it hard to evaluate the future costs of maintenance, taxes, insurance and resell value (Hagman et al., 2016). According to YouGov research, price is the most important factor when buying an EV (Leggett, 2021). In Norway in 2019 10 percent of households with the highest income bought 37 percent of new electric vehicles while 50 percent of the lowest income households bought only 10 percent of new electric cars (Fjørtoft & Pilskog, 2020). Based on Figure 1 and Figure 2 created by European Automobile Manufacturers Association the increase of market share of electric vehicles in European Union is directly correlated to a country's national income (GDP per capita). Based on these facts it's safe to say, that affordability remains a major barrier to consumers in the European Union. According to European Automobile Manufacturers Association, there is also a clear split between Central-Eastern Europe and Western Europe in terms of affordability of electric vehicles (European Automobile Manufacturers' Association [ACEA], 2021).

Since price of the EV is a key factor determining whether the consumers buy EV or not it is not surprising

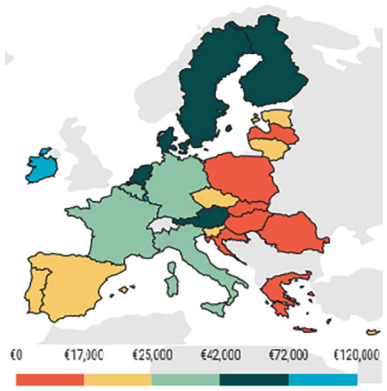

Figure 1. Gross domestic product per capita (source: European Automobile Manufacturers Association, 2022)

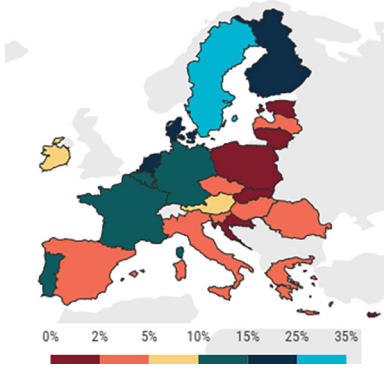

Figure 2. Market share of electrically chargeable cars (source: European Automobile Manufacturers Association, 2022)

that the drivers commonly have higher earning jobs or savings to spend. Go.compare's report shows that in UK retirees make up 10.5% of all EV owners and entrepreneurs account for 8% (Smith, 2021).

According to the research from 2022 conducted by Ernst & Young 52% of consumers plans to buy an electric vehicle, up 11% from 2021 and 22% from 2020 (Miller et al., 2022).

3. Methodology and methods

Based on the implementation of the primary survey and relevant literature, the main objective of the paper is to confirm or deny, that consumers preference of car drives is based on their income and professional occupation. Based on the scientific method of analysis, synthesis, and deduction, it was possible to process secondary data from professional literature in the form of book publications and online sources published on the Internet. After theoretical processing of the subject, the collection of primary data was carried out through the CAWI online questionnaire. The survey was divided into demographic questions, including the ones important to our study, income and professional occupation and their preferred car drive. The survey was conducted on Slovak consumers between October 2022 and January of 2023 and was attended by a total of 356 respondents. The questionnaire consisted of 23 questions, however for the needs of our paper we have picked only those relevant. The results of the primary survey were processed in the IBM SPSS Statistics. The data obtained were analysed in detail through Chi-square test and Fisher's exact test. The results of our survey should be based on the literature answer following research question and hypotheses:

RQ 1: *What car drive do respondents prefer when buying a new car?*

H_0: *There is no relationship between income and professional occupation of the respondent and his preferred car drive.*

H_1: *There is a relationship between income of the respondent and his preferred car drive.*

H_2: *There is a relationship between professional occupation of the respondent and his preferred car drive.*

To reach our objectives we have used various methods described below.

Analysis: The basis of the analysis is the decomposition of a whole into smaller parts and their subsequent examination. This method was used to identify key elements in electromobility.

Synthesis: The basic characteristic of synthesis is that it combines individual parts and components into a single whole. The synthesis method was applied especially in the final part of the paper when summarizing the results of the research, analyses and conclusions. Synthesis will also help us to form a coherent view of the issue.

Deduction: Deduction creates statements about specific facts from general knowledge. It is thus a means of logical analysis, on the basis of which we are able to form a specific true proposition, backed by several other general propositions. Thus, based on the general facts collected in the theoretical part of the thesis, we tried to reach specific facts on the basis of deduction, which will be the main output of the paper.

Questionnaire: A questionnaire is a research instrument used to gather information about the knowledge or opinions of respondents related to a particular fact. We used this research method in the proceedings of the paper to collect primary data from consumers to find out their views on electromobility.

Graphic methods: Graphic methods allowed us to translate the results into a clear and readable form. In the paper we mainly used graphs and tables, which served to facilitate the interpretation of the results of the thesis.

Mathematical methods of statistical analysis: Using mathematical-statistical methods, we processed the collected data from the primary survey, which served as a basis for the formulation of conclusion in the final parts of the paper.

Chi-Square statistic: A chi-square statistic is a test that measures how a model compares to actual observed data. The data used in calculating a chi-square statistic must be random, raw, mutually exclusive, drawn from independent variables, and drawn from a large enough

sample. Chi-square formula is:

$$x_c^2 = \frac{\sum(O_i - E_i)^2}{E_i},$$

where: c – Degrees of independence; O – Observed value; E – Expected value.

The degrees of independence in a statistical calculation represent the number of variables that can be varied in the calculation. Degrees of independence can be calculated to ensure the statistical validity of chi-square tests. These tests are often used to compare observed data with the data that would be expected if a particular hypothesis were true.

The observed values are those that you have obtained yourself.

Expected values are the expected counts based on the null hypothesis.

Fisher's Exact Test: Fisher's Exact Test is used to determine whether there is a significant association between two categorical variables. It is typically used as an alternative to the Chi-Square Test of Independence when one or more of the cells counts in a table is less than 5. Fisher's exact tests formula is:

$$p = \frac{(A+B)!(C+D)!(A+C)!(B+D)!}{N!A!B!C!D!}.$$

Fisher's exact test calculates the probabilities of all possible tables and adds those of the tables that have p values less than or equal to the observed one. This sum, multiplied by two, gives us the p-value for a two-tailed hypothesis contrast.

4. Results

The main objective of the paper is to confirm or deny, that consumers preference of car drives is based on their income and professional occupation. To reach this goal we asked the respondents their preferred car drive, income, and professional occupation. In Figure 3 we see that 51% chose battery electric vehicle (BEV), 12% chose plug-in hybrid and 37% chose Conventional car drive.

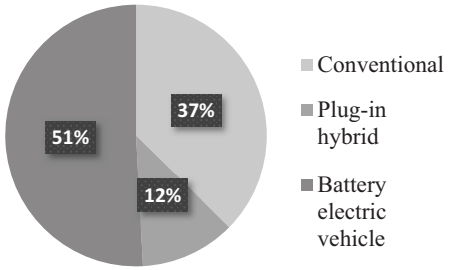

Figure 3. Respondents preferred car drive when buying a new car (source: Author's own research, 2023)

RQ 1: *What car drive do consumers prefer when buying a new car?*

Figure 3 provides us an answer to research question 1, 63% of respondents prefer electric vehicles with 51% preferring battery electric vehicle and 12% preferring plug-in hybrid. This corresponds with the research done by Ernst & young that shows that 52% of UK consumers planned to buy electric vehicles and that the EV demand is on a rise.

Figure 4 shows that 22% of respondents make more than 2501€ a month, 23% make from 1501 to 2500 €, 27% make between 1001 and 1500 €, 14% make from 701 to 1000 € and 14% make less than 700 € a month.

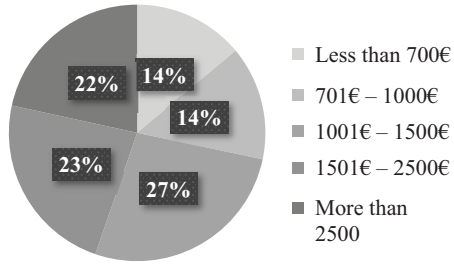

Figure 4. Respondents' monthly income (netto) (source: Author's own research, 2023)

Figure 5 shows that 58% of respondents are occupied as employee, 9% are contractors, 12% entrepreneurs, 4% retirees, 15% students and 2% unemployed.

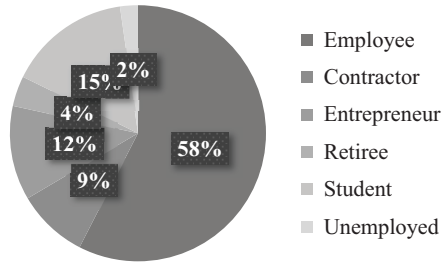

Figure 5. Respondents' professional occupation (source: Author's own research, 2023)

For the needs of our research, we have connected battery electric vehicles (BEV) and plug-in hybrids (PHEV) to one variable. Based on a Chi-square test results shown in Table 1 we **reject** the null hypothesis "H_0: *There is no relationship between income and professional occupation of the respondent and his preferred car drive.*" *and* **accept** alternative hypothesis "H_1: *There is a relationship between income of the respondent and his preferred car drive.*" On a 5% significance level as $p<0.05$.

Table 1. Results of chi-square test of a relationship between income and preferred car drive (source: Author's own research, 2023)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.192*	4	.037
Likelihood Ratio	9.787	4	.044
N of Valid Cases	356		

Note: a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 14.27.

Also based on post-hoc test and the adjusted residuals (Z-score) value in Table 2 we can deduce, that the significance was found in the category "Less than 700€", where the Z-score is above 1,96. Meaning, that low-income respondents are leaning significantly towards conventional car drive.

Table 2. Results of post-hoc test of chi-square test of a relationship between income and preferred car drive (source: Author's own research, 2023)

		BEV+PHEV	Conventional
		Adjusted Residual	Adjusted Residual
What is your monthly income (netto)?	Less than 700 €	–3.06	3.06
	700–1000 €	–0.44	0.44
	1000–1500 €	0.64	–0.64
	1500–2500 €	0.79	–0.79
	More than 2500 €	1.13	–1.13

Based on a Fisher's Exact Test results shown in Table 3 we **reject** the null hypothesis "H_0: *There is no relationship between income and professional occupation of the respondent and his preferred car drive.*" *and* **accept** alternative hypothesis H_2: *There is a relationship between professional occupation of the respondent and his preferred car drive*. On a 5% significance level as $p<0,05$.

Table 3. Results of Fisher's Exact Test of a relationship between professional occupation and preferred car drive (source: Author's own research, 2023)

Chi-Square Tests

	Value	df	Exact Sig. (2-sided)
Pearson Chi-Square	15.023*	5	.008
Likelihood Ratio	14.856	5	.014
Fisher-Freeman-Halton Exact Test	14.825		.007
N of valid Cases	356		

Note: a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.07.

Table 4. Results of post-hoc test of Fisher's Exact Test of a relationship between professional occupation and preferred car drive (source: Author's own research, 2023)

		BEV+PHEV	Conventional
		Adjusted Residual	Adjusted Residual
What is your current occupation?	Unemployed	–1.1	1.1
	Pensioner	0.1	–0.1
	Student	–3.3	3.3
	Employee	0.8	-0.8
	Contractor	0.3	–0.3
	Entrepreneur	2.2	–2.2

Based on post-hoc test and the adjusted residuals (Z-score) value in Table 4 we can deduce, that there was significance in Entrepreneurs leaning towards buying electric vehicles and students leaning towards conventional drives as their respective Z-scores were above 1.96.

5. Discussion

The main objective of the paper was to confirm or deny, that consumers preference of car drives is based on their income and professional occupation.

Before evaluating results of the main objective, we have looked at consumers preference for car drive divided into three categories, since based on the literature, the electrification of vehicles is inevitable. 51% of respondents preferred battery electric vehicle, 12% preferred plug-in hybrid and 37% preferred conventional car drive. Based on these results we can see that almost two thirds of all respondents preferred some type of electric car drive, this could be understood as a very positive trend and supports the provided theory.

Next, we divided our respondents into groups based on their income and professional occupation.

Based on results of mathematical methods of statistical analysis we have confirmed, that both income and professional occupation affect consumers preference of car drive.

The highest impact in terms of income is low-income respondents leaning towards conventional car drives by a huge margin. Each group including higher income then leans more and more towards electric car drives, meaning either battery electric vehicle or plug-in hybrids. The shift can be seen in Table 2, where respondents with income lower than 1000€ lean toward conventional car drive and respondents with income over 1000€ lean towards electric car drives. This follows the trend of the price being the number one disadvantage of electric cars based on several studies. Some studies however suggest, that this trend might actually be reversed and lower-income drivers could benefit from electric cars (Bauer et al., 2021).

In terms of professional occupation, the shift is not as clear as with the income. Based on the results seen in Table 4, group of respondents who stated their professional occupation is entrepreneur lean towards electric car drives, which supports the fact based on literature, where the second highest group of UK's electric vehicles owners are entrepreneurs. This could also be credited to and assumption that entrepreneurs and business owners tend to have higher income than other professional occupation (Todd, 2022). However, the same study suggests, that retirees are the biggest group that drives electric vehicles in UK, which is not reflected in our results, which could be credited to the fact, that many retirees in Slovakia live in poverty (Bačová, 2022). On the other hand, results of our study suggest that the group leaning towards conventional car drive the most are students, this might come as a big surprise as the younger generation should

strive towards better future, other studies however somewhat confirm this fact as well (Belgiawan et al., 2017). Unemployed leaned a bit towards conventional car drives but other professional occupation groups were almost equal in their decision.

Conclusions

Electromobility is undoubtedly one of the pillars of the future of transport in Slovakia and the world. In addition to contributing to limiting the burden on the environment by reducing greenhouse gas emissions, it helps to reduce energy dependence on oil, which is also very important in the light of the global geopolitical situation. The main obstacles for electric vehicles market uptake are price, long recharge time and short range. Our paper focused on the main one, price, from the consumers professional occupation and income point of view. In our paper we have confirmed, that the inevitable electrification is reflected in Slovak consumers choice of car drive as more than two thirds of respondents preferred electric car drive over conventional. Also, based on previous studies and implications, we have confirmed that the income of a respondent heavily influences his choice of car drive. While professional occupation follows the trend of previous studies, big outlier of the study were retirees and students, who we, based on previous research, expected to lean towards electric car drives. The results however show, that they prefer conventional car drives.

While our paper might give some general look into this topic, the results might be limited by countries BIASes and other factors. Average incomes vary a lot between countries withing European Union and others. Because the research was conducted on consumers in Slovak republic, the results might not be applicable on other countries. Further similar research would be preferred to confirm or deny hypotheses assumed in this article. The distribution of the research was also mediated mostly through social media, where the population might be leaning more towards technology, therefore panel study across the European Union could bring clearer results.

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