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ANALYSIS OF CAR TYPE PREFERENCES AMONG STUDENTS BASED ON SEEMINGLY UNRELATED REGRESSION

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ABSTRACT
Vehicle type purchase intentions are interesting from a marketing point of view, as car manufacturers are competing to attract potential buyers. Furthermore, from the point of view of transport planners as well as the government there are environmental concerns. This paper focuses on students' intention for purchasing different types of vehicles. We obtain a sample of 1,229 students from seven countries in order to understand also cultural differences in preferences. Our dependent variables are intention to buy different types of car categories, including hybrid and electric cars. We aim to explain intentions with three categories of explanatory variables: psychological aspects, socio-demographics and site specific dummy variables. To account for correlation between our dependent variables, we use seemingly unrelated regression (SUR). We find that attitudinal factors are significant, particularly for the intention to buy more environmentally friendly types of vehicles and discuss policy implications. We observe specifically the importance of the symbolic-affective value of a car to explain car-type preferences as well as the importance of awareness to negative effects cars might have on the environment and society. We suggest these findings can be used to promote more environmentally friendly cars.

Keywords: car purchase intention, vehicle type choice, seemingly unrelated regression, alternative fuel vehicle

1. INTRODUCTION

Even customers with a limited budget have nowadays the choice among a large range of vehicles. In Japan, for example, so-called small box cars, though arguably not very fashionable from an aesthetic point of view, have become more popular due to the space they offer and since they can be bought as "light car" (in Japanese: kei-jidosha) with reduced tax. Furthermore, hybrid cars have become common in several countries. Also electric cars are slowly becoming an alternative option. At the same time fuel-consuming large SUVs (equipped for journeys that they might never make) remain to be seen driven in city centers.

This choice range motivates this paper. Car manufacturers are obviously not necessarily interested in selling the most environmentally friendly cars but instead rather want to maximize profit which shifts the responsibility back to policy makers and fuel, tax schemes as well as other regulations. The discussion on problems created by excessive car usage does not require much expansion in this article. Air and noise pollution are obviously worsened by vehicles with larger engines. SUVs further are seen as a safety risk in areas with many pedestrians, especially for children. These are all reasons for transport planners to aim to influence a population to using smaller and more environmentally friendly cars and to promote less-polluting alternative fuel vehicles (AFV).

To understand the future car market, we aim to understand specifically the car purchase intentions of younger students, including those from (rapidly) developing countries, which are an increasingly important market. Studies from Indonesia (*1*) or China (*2*) all show that young people there have nowadays strong intentions to enter the car market as first time buyers. This is partly in contrast with the peak car trend in developed countries (*3*; *4*).

We suggest that our analysis has several implications leading to policy suggestions. Suppose that many students in developing countries become keen to buy hybrid/electric cars, we can then possibly reduce some air pollution effects resulting from this growing car ownership. Moreover, understanding the vehicle type desire tells about the status of the car, e.g. a desire for sports car might indicate that cars are seen as "fun", whereas choice of luxury type vehicle might indicate that the status symbol aspect of the car is important. Therefore, we suggest that analyzing car type desire is also an important index for vehicle desire in general. Finally, the intention to purchase hybrid and electric vehicles can be seen as a reflection of environmental attitudes in general. All these reasons motivate us to study vehicle type desire not for marketing but for transport policy purposes.

Given this motivation, the structure of the reminder of this paper is as follows: Section 2 discusses previous research on vehicle type preferences and modelling. Section 3 describes how we collected the data. In Section 4 we explore the factors that potentially determine car ownership and provide descriptive statistics. In Section 5, we then develop our regression approach that aims to take into account correlation in our dependent variables. Finally, in Section 6 we discuss our findings and conclude by deriving implications for transportation planning.

2. LITERATURE REVIEW

Previous literature on factors explaining vehicle type choice can be firstly categorized into whether an aggregate or disaggregate modeling approach is used. Aggregate models use an accumulation of household decisions at different geographic scales as dependent variable to explain car ownership whereas disaggregate models use individual or households as the basic unit of analysis.

A first attempt to study household car type intention, a logit model with car characteristics and socio-economic variables as explanatory variables, is performed by Lave and Train (*5*). They distinguish 10 categories: subsubcompact, subcompact-A, subcompact-B, compact-A, compact-B,

intermediate, standard-A, standard-B, and sports and luxury cars. The main findings are that larger households are more likely choosing subcompact cars. The authors further fit their model by interacting vehicle attributes with socio-economic characteristics. Following Lave and Train (*5*), there are several studies that use similar dependent and explanatory variables such as Manski and Sherman (*6*), Hocherman et al. (*7*), Berkovec and Rust (*8*), Mannering and Winston (*9*), Brownstone et al. (*10*), and Mannering et al. (*11*).

Differently from the above studies, Choo and Mokhtarian (*12*) explore the role of attitudes, personality, lifestyle and mobility factors as explanatory variables for vehicle choice decisions along with demographic factors using logit models. Vehicle types are grouped into nine categories based on size and functionality. The data used in this study is from a 1998 mail-out/mail-back survey of 1,904 residents in the San Francisco Bay Area. They conclude that models of vehicle type choice can be substantially more powerful with the inclusion of travel attitudes, personality, lifestyle, and mobility factors.

While previous studies discuss about car types mainly based on size, recent literature instead focuses more on customer willingness to purchase alternative fuel vehicles (AFV). One example is the study by Ziegler (*13*) which is based on data from 598 potential car buyers in Germany. Ziegler distinguished 7 types of cars (gasoline, diesel, hybrid, gas, biofuel, hydrogen, and electric). The study aims to explain preferences for these types by considering purchase price, motor power, fuel costs per 100 km, CO_2 emissions, and service station availability. The main findings are that hydrogen vehicles are more likely purchased among men, young people, and environmentally aware people.

Partly in line with the aforementioned study by Choo and Mokhtarian (*12*) and following the Theory of Planned Behavior (*14*; *15*) as well as Thøgersen's (*16*) extended norm taxonomy, attitudes, norms (subjective norms, integrated norms, introjected norms), and perceived behavioral control (PBC) can also be incorporated in vehicle type choice decision modeling. An example of this is the study in a Norwegian context by Nayum et al. (*17*). They study the choice among diesel cars, five-door estate car with standard petrol engine, station wagon with diesel engine and SUVs with psychological factors as independent variables. They conclude that psychological factors such as social norms, integrated norms, attitudes and PBC explained 63.2% of the variance in car type choice intention.

There are also two studies about car type choices focusing on AFV using Dutch data. Kim et al. (*18*) incorporate social attributes (social influence variables) besides other psychological factors and vehicle characteristics aspects to model the decision to purchase electric cars (EC) or non-electric cars. They conclude that people strongly consider opinions about EC in their social network for purchase intentions. Hoen and Koetse (*19*) study again preferences among various types of AFV. The respondents are 1,903 car owners of both new and secondhand cars (petrol, diesel or LPG). These car owners were asked whether they were planning to replace their current car with a new or secondhand car in the next 3-4 years. These respondents were given eight choice tasks where in each choice task there were three options of cars from the following eight types of cars, three types for current technology (petrol; diesel; LPG) and five AFVs (hybrid; plug-in hybrid; fuel-cell; electric; flexifuel). Their results show that whenever current technology cars showed up in the choice task, these were preferred over AFVs.

Finally, Tanaka et al. (*20*) compare respondents' willingness to pay for AFV in the US and Japan. They investigate the choice among nine types of vehicles size and 3 motor types (electric; hybrid electric; gasoline). They investigate the choice based on scenarios regarding AFV prices and factors such as fuel costs and charging station availability. They found that US respondents are more sensitive to fuel cost reductions and station availability than Japanese respondents. In a

base case scenario, conventional gasoline vehicles still dominate both in the US and Japan. In an innovation scenario, there is a high penetration of alternative fuel vehicles both in the US and Japan.

In conclusion, while there are many studies discussing several types of cars including types of fuel (fossil fuel and AFV) and factors influencing the decision to buy that particular type of car, none we have seen so far asked respondents to scale their intention to buy different types of cars. Intention to buy a different type of car might not be mutually exclusive or exhaustive; therefore, in this paper we asked our respondents to rate their intention to buy seven different types of cars such as sports cars, luxury cars, and electric cars. Since some car types share some attributes, correlation to answers are likely and seemlingly unrelated regression (SUR) appears to be appropriate.

SUR is a modelling method that estimates two or more regressions where the error term between regressions are correlated for a given individual but are uncorrelated across individuals (*21*). It is a collection of two or more regression relations that can be analyzed separately while each has its own dependent variable and potentially different sets of exogenous explanatory variables. In transportation research SUR has been used to e.g. examine the effects of fuel price on people's travel time expenditure for different kinds of activities (*22*).

3. DATA AND DESCRIPTIVE ANALYSIS

3.1. Respondents

Our sample is the same as the one studied in Belgiawan et al. (*23*) where we investigate car purchase desire per se. All respondents are undergraduate students from a wide variety of disciplines. The data were collected between January-June 2013 in seven different countries. The sites are chosen to cover a wide range of countries (and partly due to previously established research connections).

Four of the sites are from Asia. Indonesia is included as a fast developing country with rapidly increasing motorization among younger people. Taiwan is chosen as a more developed Asian country in which currently the motorbike is the dominating mode among younger people. China, particularly Shanghai, is included as a city where the desire to own a car has lately been rapidly increasing especially among younger people (*2*). Japan is included as a more developed country in which car ownership has been increasing until lately. Beirut, Lebanon, a city in which the car is the dominating mode among all generations is further included. As examples from "Western 1st world countries," this paper includes Utrecht, The Netherlands and Berkeley, U.S.A., two cities with very different mobility patterns and spatial organization.

In all countries, the survey was translated into the local language with the exception of Lebanon where the survey was conducted in English, which is the language of instruction at the American University of Beirut (AUB). All responses were gathered via a web-based survey, although the methods to recruit respondents differed in each country. In Indonesia, surveying agencies recruited respondents in person on the campuses of the University of Indonesia in Jakarta and the Bandung Institute of Technology. In Japan, the recruitment was via emails sent to engineering departments in several universities.

In China, the recruitment was via email and through an internet forum in Shanghai with a small incentive in the form of a mobile phone voucher for those who complete the survey. Since most of the respondents come from outside Shanghai, so in the subsequent analysis we use China instead. In Berkeley, recruitment was handled by the Experimental Social Science laboratory, and each respondent received a financial incentive for participating. In Beirut, the recruitment was

done via emails sent to approximately one third of AUB students (chosen randomly). In Utrecht, recruitment was done via an announcement in a general student newsletter. In Taiwan, recruitment was done via an announcement in a popular Bulletin Board System (Ptt.cc). No financial incentives were used other than in Shanghai and Berkeley.

In total 2,272 undergraduate and graduate students accessed the survey website, of which 1,806 completed the survey. For better cross-site comparability, in this paper only the data from the undergraduate students are reported. Further data cleaning is performed, ignoring incomplete surveys and responses that were completed in fewer than eight minutes, which seems a lower limit to answer all of the survey questions in a serious manner. This results in a sample size of 1,229 used for the analysis below. For more detail about the surveying methods and contexts of our specific sites, we refer the reader to Belgiawan et al. (*23*).

3.2.Dependent Variables

We firstly ask respondents how likely they are in general to purchase a car. We then measure our dependent variables of main interest by asking students this question "Now realistically, and assuming you will buy a car in the future, please rate how likely you are to buy following type of car for your next car." The response rate is on a 7-point Likert scale (very unlikely – very likely) and the type of cars is as follows: Small, Mid-size, Large, Luxury, Sports, Hybrid and Electric.

The descriptive statistics of our dependent variables can be seen in Table 1. The mean value for general car purchase intention for all samples is higher than the intention to buy specific types of cars which appears to be reasonable. However, if we look at specific sites we can see a few exceptions. For example, respondents answer in Taiwan that they are more likely to purchase a small car then a car in general.

TABLE 1 Dependent Variables Mean Value

Variables (number of observations)	All (μ (σ)) (1229)	Utr (84)	Jpn (142)	Brkly (226)	Twn (139)	Idn (200)	Chn (167)	Brt (271)
Car purchase intention (general)	5.15 (1.62)	4.55	4.62	4.92	4.99	5.24	5.42	5.65
Small Car	4.58 (1.87)	4.77	4.32	4.49	5.17	4.96	5.48	3.58
Mid-Size Car	5.06 (1.39)	4.98	5.20	5.17	4.91	5.54	4.53	4.96
Large Car	3.52 (1.71)	3.23	3.46	2.94	3.25	5.15	2.71	3.58
Luxury Car	3.65 (1.84)	2.87	3.46	3.14	3.17	4.78	3.16	4.14
Sports Car	3.59 (1.94)	2.38	2.87	3.06	3.20	4.67	3.17	4.46
Hybrid Car	4.52 (1.62)	4.08	4.74	4.67	4.81	5.02	4.24	4.06
Electric Car	4.19 (1.68)	3.94	4.39	4.09	4.05	4.83	4.15	3.86

For small cars, the mean value for China and Taiwan is quite high compared to other sites, while for Mid-size car the mean values observed for Indonesia, Japan and Berkeley are quite high. Interestingly the average for large car is quite small in most countries except for Indonesia. Luxury and sports cars are less desired among students from developed countries which is in line with research showing the changing image of cars and arguments that the peak car discussion can be partially explained with the car losing some of its status symbol value. Instead, the mean values of hybrid and electric cars are quite high compared to luxury and sports cars.

In order to control for differences in the overall desire to obtain a car in the subsequent analysis, we are not using the mean value as in Table 1 but instead the relative value of car intention. The relative value is calculated by subtracting from each intention variable the average of the

intention for the seven types of cars as denoted in Eq. 1 where y_{ij} denotes the intention of person i to purchase a vehicle of type j. A positive (negative) value for $\tilde{y}_{ij}$ denotes hence that the person is more (less) likely to purchase a specific car type than his/her average desire to purchase any of the seven types.

$$\tilde{y}_{ij} = y_{ij} - \frac{1}{7}\sum_{j=1\ldots7} y_{ij} \quad (1)$$

The results are depicted in Figure 1. We observe country specific differences now even clearer.

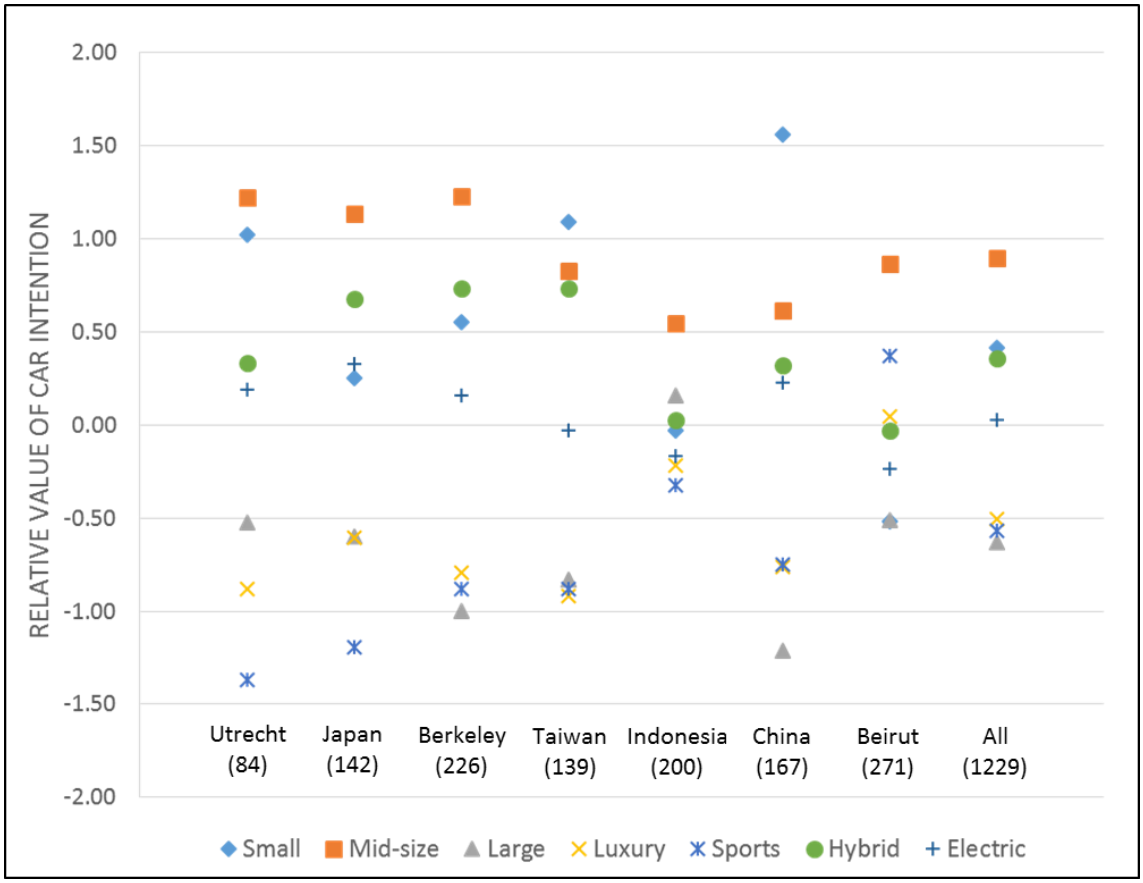

FIGURE 1 Car type desire relative mean value.

In Utrecht there is a big gap in intention to buy large, luxury and sports car with sports car being the least favorite. Similarly in Japan sports car is the least favorable and there is a big gap with luxury and large car. In Berkeley, China, and Beirut, large car is the least favorite though in Berkeley the gap between large car and the other less favorite car is not quite big. In Taiwan the least favorite choice is luxury car but there seems to be no big gap between the three least favorite options. In Indonesia the least favorite car is sports car but large car is more favorite car which is quite different from the other sites. Interestingly in all developing countries, except for China, electric cars are less favorable possibly because of the lack of (trust in) charging infrastructure; that is charging stations as well as supply of energy in some areas.

If we look at more favorable car, in most of the sites, the most favorite car is mid-size car, with few exceptions in Taiwan and China who favor small car. In Utrecht two of the most favorite

cars are mid-size and small, but hybrid and electric are also more favored. In Japan and Berkeley, we see a similar pattern in that mid-size and hybrid are the most favorite. Beirut is the only site where sports car is the most favorite after mid-size.

In general, for almost all countries, the intention to buy large, luxury and sports car are below the relative mean value, while especially small and mid-size vehicles have positive values. Interestingly hybrid vehicles get generally positive values, showing their wider acceptance. In developed countries further desire for electric cars is similar to that for convential motor types. In contrast to (19) this possibly suggests that their acceptance is increasing especially among young people. In Section 4 we will try to explain these different preferences.

3.3. Determinants of Vehicle Choice Intention

Attitudes towards Cars

The students are given a range of questions regarding their attitudes/perceptions toward cars and public transportation (PT). Each question is posed on a seven-point Likert scale with verbally defined endpoints (strongly disagree – strongly agree). The questions are based on surveys used in previous research in particular the studies by Steg (*24*), Van and Fujii (*25*), and Belgiawan et al. (*1*).

There are 20 attitudinal variables toward cars obtained from the survey. To understand better "emotional attachment" of students to cars, the attitudinal questions are analysed and grouped with PCA. The results of this PCA can be seen in Table 2.

TABLE 2 Rotated Factor Loadings on Attitudes Toward Cars

Variables	Symbolic Affective	Independence	Negative Aspects	Social/env. Care
	(22.3%)[a]	(16.1%)	(9.9%)	(9.4%)
Cars allow to distinguish oneself from others	**0.78** [b]	0.01	0.19	0.08
Cars are trendy	**0.75**	0.14	0.00	-0.09
Cars bring prestige	**0.74**	0.00	0.22	0.08
Cars are cool	**0.70**	0.18	-0.06	0.22
Cars allow to express oneself	**0.70**	-0.02	-0.02	0.06
Cars are fun to have	**0.66**	0.27	-0.14	0.07
Cars are convenient	0.05	**0.80**	-0.09	0.12
Cars give freedom to travel anytime	0.05	**0.79**	-0.11	0.02
Cars help one to save time when making a trip	0.08	**0.75**	-0.05	-0.01
Cars are useful to pick up or drop off others	0.22	**0.54**	0.17	0.05
Cars are expensive to own and maintain	-0.13	0.29	**0.71**	0.09
Cars are disturbing one's neighborhood	0.03	-0.16	**0.67**	-0.15
Cars are giving an arrogant impression	0.33	-0.26	**0.60**	-0.10
Cars allow one to travel safely	0.14	0.09	0.00	**0.81**
Cars are environmentally friendly	0.08	0.02	-0.12	**0.78**

[a]Numbers inside brackets are total variance explained by each factor.
[b]Bold means that the variable in the row is grouped to the respective column factor

Based on varimax rotation, four factors with eigen values larger than one could be extracted. These factors are consistent with findings in the literature: Symbolic Affective (explaining 22.3% of the variance) (*1*; *24*; *25*), Independence (16.1% of the variance) (*1*; *24*),

Negative Aspects of car (9.9% of the variance) (*2*), and Social/Env. Care (9.4% of the variance). Finally, the mean value of each attitudinal factor can be seen in Table 3.

Expectation of others

To measure the person group specific expectations of others to buy a car (e_m), the respondents were asked "To what extent does each of the following groups *m* {1. Your parents, 2. Your partner, 3. Your family members and relatives, 4. Your close friends, 5. Your classmates, friends and peers at university, 6. People in your neighborhood and 7. People in your province/state} expect you to buy a car within the next 10 years?" Responses to this group of questions were measured on a 7-point Likert scale ranging from -3 (they strongly expect me not to buy a car) to 0 (they have no expectation) as middle point and +3 (they strongly expect me to buy a car) as the other end point. Then, responses to each scale are summed up as shown in Eq. 2. This is similar to the bipolar measurement of normative belief in TPB (*14*). The descriptive statistics of total expectation ($\hat{e}$) for each country can be seen in Table 3.

$$\hat{e} = \sum_{m=1}^{7} e_m \qquad (2)$$

Other explanatory variables

The students are asked about their average income, age, gender, as well as their current living situation: whether they live by themselves, with their family or friends or whether they live in a dormitory or apartment[1].

TABLE 3 Explanatory Variables Mean Value

Variables (number of observations)	All (μ (σ)) (1229)	Utr (84)	Jpn (142)	Brkly (226)	Twn (139)	Idn (200)	Chn (167)	Brt (271)
Symbolic Affective	4.41 (1.43)	3.71	3.73	4.66	4.49	4.70	4.29	4.52
Independent	5.77 (1.17)	5.92	5.83	6.16	5.63	5.03	5.86	5.86
Negative Aspect	4.23 (1.32)	4.32	4.41	4.07	4.37	4.27	4.14	4.49
Social Environmental Care	3.92 (1.39)	3.71	4.12	3.80	4.61	4.24	4.03	3.41
Total Expectation ($\hat{e}$)	4.71 (7.42)	-3.93	5.58	5.48	5.22	4.70	4.60	6.11
Regular user car owner	0.46 (0.50)	0.21	0.24	0.31	0.39	0.57	0.26	0.86
Regular user non car owner	0.07 (0.25)	0.06	0.02	0.17	0.02	0.08	0.02	0.04
Gender split (% male)	0.57 (0.50)	0.55	0.77	0.50	0.73	0.52	0.60	0.45
Av. personal income (10^{-3} US$)	0.52 (0.61)	0.70	0.36	0.62	0.56	0.32	0.40	0.97
Missing Income Dummy	0.12 (0.33)	0.00	0.11	0.07	0.03	0.33	0.03	0.16

The income categories are adjusted according to the typical student income in the respective countries. We added a "missing income dummy" for those not providing income information. We also control for car usage. We define regular car user as using car at least twice a

[1] Note that we also asked students about their current type of car. However, since there are too many missing observations, we omit that variable from our analysis. We also have family/household income; since that variable significantly correlates with personal income, we decided to omit it to minimize multicollinearity.

week and distinguishing them by the ownership of car. To distinguish among the seven sites, we add site-specific dummy variables into the model with Berkeley as reference variable.

Table 3 also shows the descriptive statistics of the socio-demographic aspects regarding car usage. The average age of students in the sample is between 19-21 and 84% of our respondents grew up with car. That means even though their age is very close to the minimum age to drive a car, for most of the respondents it is familiar experience to have access to cars. In terms of gender, the Japanese, Taiwanese, and Chinese samples are unbalanced, which is a result of the recruitment methods. Monthly income is specified as a continuous variable. Each category of respective country is transformed into US$ by using the purchasing power parity conversion factor published by the World Bank (*26*). Average personal monthly income is, as expected, lowest among Indonesian students while the students with the highest income are those from Beirut followed by Utrecht and Berkeley students. Finally, regarding car usage, car owners are more dominant than non-car owners especially in Indonesia and Beirut.

4. CAR TYPE INTENTION

In this section we describe our modelling method. The SUR method that we present here is an adjustment of the Zellner (*21*) method. Detailed discussion on SUR can be found in Srivastava and Giles (*27*). Our SUR model is a system of 7 equations. It consists of j=1,…,7 linear regression equations for i=1,…,N individuals. The j^{th} equation for individual i is:

$$y_{ij} = \boldsymbol{X}^T{}_{ij}\boldsymbol{\beta}_j + \varepsilon_{ij},\ j = 1,2,\dots,7 \tag{3}$$

where y_{ij} is the buying intention for car type j for individual i, $\boldsymbol{X}_{ij}$ is a vector of the K explanatory (exogenous) variables for individual i, $\boldsymbol{\beta}_j$ is the parameter vector of size K for each car type j and ε_{ij} is an error term of the j^{th} equation for individual i. Note that in our case all explanatory variables are identical for the seven car types so that in fact X_{ijk} reduces to X_{ik} (for a variable k). Summing up over all individuals i the system can also be written as:

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_7 \end{bmatrix} = \begin{bmatrix} \mathbf{X_1} & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \mathbf{X_2} & \cdots & \mathbf{0} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & \mathbf{X_7} \end{bmatrix} \begin{bmatrix} \boldsymbol{\beta_1} \\ \boldsymbol{\beta_2} \\ \vdots \\ \boldsymbol{\beta_7} \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_7 \end{bmatrix} \tag{4}$$

We assume that there is no correlation of error terms across individuals as in Eq. 5 but that for a given individual the errors are correlated across equations as in Eq. 6. Furthermore, we assume that for each individual the mean error terms for all car types are zero as in Eq. 7.

$$E\left(\varepsilon_{ij}\varepsilon_{i'j}|\boldsymbol{X}\right) = 0\ where\ i \neq i' \tag{5}$$

$$E\left(\varepsilon_{ij}\varepsilon_{ij'}|\boldsymbol{X}\right) = \sigma_{jj'}, and\ \sigma_{jj'} \neq 0\ where\ j \neq j' \tag{6}$$

$$E\left(\varepsilon_{ij}|\boldsymbol{X}\right) = 0 \tag{7}$$

Thus, the covariance matrix $\boldsymbol{\Omega}$ of all error terms is:

$$E(\varepsilon\varepsilon') = \boldsymbol{\Omega} = \boldsymbol{\Sigma} \otimes \boldsymbol{I}^N \quad (8)$$

where $\boldsymbol{\Sigma}$ is the error covariance matrix with elements $\sigma_{jj'}$, $\otimes$ is the Kronecker product, $\boldsymbol{I}^N$ is an identity matrix of dimension *N* where *N* represents the number of observations in each of the seven equations. The optimal estimation of SUR is by using generalized least squares (GLS) estimation (*28*). The SUR estimators and their covariance can be obtained by Eqs. 9 and 10.

$$\hat{\beta} = (\boldsymbol{X}^T \widehat{\boldsymbol{\Omega}}^{-1} \boldsymbol{X})^{-1} \boldsymbol{X} \widehat{\boldsymbol{\Omega}}^{-1} y \quad (9)$$

$$\widehat{COV}[\hat{\beta}] = (\boldsymbol{X}^T \widehat{\boldsymbol{\Omega}}^{-1} \boldsymbol{X})^{-1} \quad (10)$$

5. MODEL ESTIMATION

The models were estimated using system fit packages in R (*28*). In Table 4, we present the correlation of error terms between equations. We can see that those who have a preference for small cars are a distinctive group, with negative preference for all other car types, except midsize cars, being positive. As for luxury and sports cars, we can see a positive correlation, possibly indicating a group of people considering car as status symbol. Another cluster are those with preference for AFV; these are likely to be environmentally conscious students confirming the findings of Ziegler (*13*). They are especially opposed to luxury and sports cars. The high correlations between equations confirm that the SUR is needed instead of normal separate ordinary least square equation.

The lower part of Table 4 shows the parameter estimates. The *symbolic affective* factor is not significant for small, midsize and large cars indicating that status symbol is not a reason to buy those types of car. In contrast, and in line with our expectations, the symbolic affective meaning of cars appears to be a reason to purchase luxury and sports cars with the expected sign. Interestingly students who regard car as a status symbol are less likely willing to buy hybrid and electric cars. *Independence* is positively significant for small (10% level) and mid-size cars implying that these cars are mainly desired for the convenience value. We further find a negative correlation with the desire to purchase electric vehicles, indicating possibly that the charging process and limited distance of electric vehicles is perceived an obstacle for those valuing convenience and independence. For all other types of cars, independence is not found to be significant.

Students who are aware of the negative aspects of cars less likely intend to buy luxury and sports car; however, they are more likely to have an intention to buy AFV. Similarly, students who do not perceive the social and environmental impacts of cars as important more likely intend to buy hybrid and electric cars. Note that "Social/env. care" is measured on a reversed scale, which means that those intending to buy small cars or electric cars perceive cars as not environmentally friendly). And those who do not consider the social and environmental aspects are more likely to buy luxury and sports cars.

"Total expectation (social norm)" has a negative and significant (at 10% level) coefficient only for large car indicating that the more students expect that their peers want them to buy a car the less likely they want to buy this type of car and the opposite for sports car. In general, it appears that perceived expectations of others cannot explain students' intentions to buy specific types of car. These results are different from what we found for the case of social norms for car desire in general (*23,29*). We emphasize though that the question was posed as expectation of others to buy

a car in general and not to buy a specific type. In further research one might ask students for specifically trendy cars among their peers.

TABLE 4 Generalized least square model estimation of car type

Variable	Small	MidSize	Large	Luxury	Sports	Hybrid	Electric
Correlation of error terms between equations							
Small		0.09	-0.35	-0.38	-0.37	-0.20	-0.11
Midsize			-0.02	-0.31	-0.30	-0.24	-0.27
Large				0.08	-0.07	-0.28	-0.30
Luxury					0.35	-0.31	-0.35
Sports						-0.26	-0.31
Hybrid							0.46
Parameter estimates							
Constant	**1.10**	**1.70**	**-1.10**	**-1.23**	**-1.45**	**0.83**	0.15
Psychological aspects							
Symbolic affective	-0.08	0.02	0.00	**0.28**	**0.22**	**-0.23**	**-0.20**
Independent	*0.10*	**0.11**	0.00	-0.04	*-0.08*	0.01	**-0.10**
Negative aspects	-0.01	-0.04	0.02	**-0.08**	**-0.11**	**0.09**	**0.14**
Social/env. care (reverse scale)	**-0.15**	-0.02	0.04	**0.17**	**0.12**	-0.03	**-0.12**
Total expectation (social norms)	-0.02	-0.02	*-0.11*	0.07	*0.12*	0.01	-0.04
Other explanatory variables							
Regular car user and owner	-0.08	**-0.22**	0.02	**0.36**	0.11	**-0.18**	0.00
Regular car user and non-car owner	**-0.52**	-0.25	0.25	**0.45**	0.25	-0.16	-0.02
Gender (Male)	**-0.45**	-0.12	**0.17**	-0.03	**0.46**	-0.01	-0.01
Income	**-0.38**	**-0.28**	*0.14*	**0.30**	**0.23**	0.02	-0.02
Income dummy	-0.22	-0.09	0.00	**0.39**	**0.35**	**-0.28**	-0.16
Location specific							
Utrecht	0.32	-0.21	*0.35*	*0.31*	-0.12	**-0.59**	-0.07
Japan	-0.32	*-0.27*	**0.36**	**0.56**	-0.14	*-0.29*	0.09
Berkeley	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Taiwan	**0.71**	**-0.47**	0.09	-0.09	-0.05	-0.07	-0.13
Indonesia	**-0.50**	**-0.76**	**1.16**	**0.37**	**0.39**	**-0.48**	-0.18
China	**0.93**	**-0.82**	-0.23	*0.25*	*0.27*	**-0.51**	0.11
Beirut	**-1.05**	**-0.34**	**0.47**	**0.66**	**1.23**	**-0.64**	**-0.33**
Model Fit							
Sample Size	1,229	1,229	1,229	1,229	1,229	1,229	1,229
Multiple R-squared	0.17	0.05	0.10	0.17	0.21	0.11	0.08
Adjusted R-squared	0.16	0.04	0.09	0.16	0.20	0.10	0.07
Bold = p value <0.05; Italic p value<0.10							

Students who regularly use car and own it, are more likely to have an intention to buy luxury cars and less likely to buy midsize or hybrid cars. One might explain this with the convenience of luxury cars. As for regular car users who do not own a car, they are more likely to buy luxury cars and less likely want to buy small cars. Men are less likely to buy small cars, but more likely to buy large cars and sports cars. Gender does not appear to have a significant effect on preferences for AFV and similarly for income. For income we observe further the expected effected that those with higher income are more likely to purchase larger cars.

Considering the location specific dummy variables, we find that respondents from Taiwan and China are more likely to purchase small cars compared to our reference location, Berkeley, US. Instead, still compared to Berkeley, Indonesian and Beirut students are less likely to buy small cars. For Berkeley students mid-size cars appear to be more popular than for students from other countries. One explanation for these observations might be that in Taiwan and China smaller cars are seen as the standard option whereas in Berkeley it is mid-size cars. Indonesian students stick out in our sample for their relative preference for large cars. Most different from other samples appear to be the Beirut students though. In Beirut we observe a relatively strong preference for luxury cars as well as for sports cars and large cars. This indicates that in Beirut the role and symbolic meaning of the car is (still) very different compared to other countries.

Regarding AFV car, interestingly it appears that Berkeley students are more likely to buy hybrid cars compared to students from other sites. One might argue that this is because US students might be more used to this technology though this argumentation does not apply to students from Japan. This result supports findings reported in (*20*) though, who found that 78% of their respondents from California (including Berkeley) have interest to change to AFV compared to Japanese respondents where 70% of respondents have an interest in AFV. For electric cars we do not have significant country differences except for Beirut. This is possibly because students do not have yet a strong (negative or positive) impression about electric cars.

Considering the model fit, we can explain desire for sports, luxury and small cars most, possibly because they have some clear charateristics. With some reasoning based on the above discussion, it is not surprising that we observe the lowest model fit for mid-size and electric cars.

6. CONCLUSION

This paper focused on students' intention for purchasing different types of vehicles. We notice that this age group might have a tendency to change the first few cars pretty quickly. However, some studies have found that habits developed during adolescence have significant impact on lifelong lifestyle of individuals including influencing habits for mobility decision (*30*; *31*; *32*).

Explaining preferences will help to promote more environmentally friendly vehicles. In the literature we find that there is no agreement on which vehicle types should be distinguished. In this paper we distinguish five vehicle types of normal fuel i.e: small, midsize, large, luxury, and sports; and two types of alternative fuel vehicle such as hybrid and electric. We asked our respondents to rate their intention to buy each of these seven vehicle types and employ SUR.

From our seven correlated models, we learn that psychological aspects are significant for different types of cars. Symbolic affective has a positive significant effect for expensive types of car but a negative significant effect for more environmentally friendly cars. This result indicates that cars are still perceived as status symbol by some. However, when students are aware of environmentally socially negative impacts of cars, they prefer to buy more environmentally AFVs. This is an important finding to promote more environmentally friendly cars as an alternative to gasoline car. By some campaign of promoting more environmental concerns, we might be able to strengthen attitudes towards more environmentally friendly cars. In summary, the signs of the

coefficients of all attitudinal variables are in line with our expectations. We observe the importance of the symbolic-affective value of a car to explain preferences as well as the importance of awareness to negative effects the car might have on the environment and society.

Finally, as further direction of work, we emphasise that the attitudinal variables used in this paper are not specific to the particular typs of cars; instead we asked students consciously about attitudes towards cars in general. We did this consciously to explain how general attitudes will influence car type preferences. However, one might also argue that there will be differences in attitudes towards different car types, in particular fossil fuel cars and AFVs. Further studies might hence consider asking respondents about their attitudes, and possibly perceived social norms, towards particular types of car. Such a study will be important specifically for understanding future market shares, whereas our study here aimed more at generally understanding factors that influence car type desire.

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