CLARIFYING THE FACTORS TO DECIDE TO PURCHASE HYBRID ELECTRIC VEHICLES (HEVS) AND ELECTRIC VEHICLES (EVS)

by

Eiichi Haraya

Dr. Brian C. Murray Advisor

May 2011

Masters project submitted in partial fulfillment of the

requirements for the Master of Environmental Management degree in

the Nicholas School of the Environment of
Duke University

MP advisor signature

CONTENTS

ACKNOWLEDGMENTS

→ I

LIST OF TABLES

→ II

LIST OF FIGURES

→ V

ABSTRACT

→ VIII

1. INTRODUCTION

→ 1

2. METHODOLOGY

2.1. General methodology

→ 3

2.2. Focus group

→ 3

2.3. Expert review

→ 3

2.4. Pre-testing

→ 4

2.5. Implementation

→ 4

3. RESULTS

3.1. Socioeconomic characteristics of sample

→ 5

3.2. Decision criteria

→ 6

3.3. Willingness to pay (WTP)

→ 6

3.4. WTP multiple regression analysis

→ 7

3.5. Marginal effects for WTP multiple regression analysis

→ 8

4. DISCUSSION

→ 10

5. LITERATURE CITATIONS

→ 14

TABLES

→ 16

FIGURES

→ 34

APPENDIXES

ACKNOWLEDGMENTS

I am most thankful to Dr. Brian C. Murray for his support, encouragement and suggestions regarding the present study and the completion of my masters project. I am appreciative to Dr. Randall A. Kramer for his effective support, suggestions, and guidance on the survey in my study. I am also thankful to Ms. Cynthia Peters for supporting my life and study for three years.

I would like to express my deep gratitude to Dr. Jeffrey Vincent for assisting my course work and masters project. I am thankful to Dr. Martin Smith for his advice and support to develop my masters project. I would like to express my gratitude to Mr. Yasuo Nishimoto and Mr. Jie-Sheng Tan-Soo for their daily encouragement.

I wish to express my deepest gratitude to my mentor, the founder of Soka University, Dr. Daisaku Ikeda for his continuous support and encouragement in my life. No words can express my gratitude. Finally, I am appreciative to my family members for their usual support and encouragement throughout my life.

LIST OF TABLES

Table 1. The frequency of the vehicle types that are most often driven.

→ 16

Table 2. The frequency and mean calculation of interest level on HEVs and EVs.

→ 17

Table 3. The frequency and mean calculation of WTP for gasoline vehicles.

→ 18

Table 4. The frequency and mean calculation of WTP for HEVs and EVs.

→ 19

Table 5. The frequency of gender.

→ 20

Table 6. The frequency and mean calculation of age.

→ 21

Table 7. The frequency of marital status.

→ 22

Table 8. The frequency and mean calculation of number of children.

→ 23

Table 9. The frequency and mean calculation of number of household vehicles.

→ 24

Table 10. The frequency of education level.

→ 25

Table 11. The frequency and mean calculation of annual driving distance.

→ 26

Table 12. The frequency and mean calculation of annual household income.

→ 27

Table 13. The frequency and mean calculation of global warming interest level.

→ 28

Table 14. The frequency and mean calculation of environmental issues interest level.

→ 29

Table 15. The chi-square test result for WTP for HEVs and EVs, and WTP for gasoline vehicles.

→ 30

Table 16. Result summary of WTP multiple regression analysis.

→ 31

Table 17. Result summary of marginal effects for WTP multiple regression analysis on gasoline vehicles.

→ 32

Table 18. Result summary of marginal effects for WTP multiple regression analysis on HEVs and EVs.

→ 33

LIST OF FIGURES

Fig. 1. Decision criteria of deciding vehicles (respondents can select top three factors among given criterion).

→ 34

Fig. 2. The types of the vehicle which is most often driven under HEVs and EVs (0), Gasoline Vehicle (1), and Don't Have a Vehicle (2), respectively.

→ 35

Fig. 3. Level of interest on HEVs and EVs under Very Low (1), Low (2), Neutral (3), High (4), and Very High (5), respectively.

→ 36

Fig. 4. WTP for gasoline vehicles under less than $20,000 (1), $20,000-$24,000 (2), $24,001-$28,000 (3), $28,001-$32,000 (4), $32,001-$36,000 (5), and more than $36,000 (6), respectively.

→ 37

Fig. 5. WTP for HEVs and EVs under less than $20,000 (1), $20,000-$24,000 (2), $24,001-$28,000 (3), $28,001-$32,000 (4), $32,001-$36,000 (5), and more than $36,000 (6), respectively.

→ 38

Fig. 6. Gender under Male (0) and Female (1), respectively.

→ 39

Fig. 7. Age under 18-30 years (1), 31-40 years (2), 41-50 years (3), 51-60 year (4), and Over 61 years (5), respectively.

→ 40

Fig. 8. Marital status under Single (0), Married (1), and Other (2), respectively.

→ 41

Fig. 9. Number of children.

→ 42

Fig. 10. Number of household vehicles.

→ 43

Fig. 11. Education level under Some High School or Less (1), High School Graduate (2), Some College (3), Four-Year College Graduate (4), and Postgraduate Degree (5), respectively.

→ 44

Fig. 12. Average annual driving distance under less than 2,500 miles (1), 2,500-5,000 miles (2), 5,001-7,500 miles (3), 7,501-10,000 miles (4), 10,001-20,000 miles (5), and more than

20,000 miles (6), respectively.

→ 45

Fig. 13. Annual household income under less than $10,000 (1), $10,000-$20,000 (2), $20,001-$30,000 (3), $30,001-$40,000 (4), $40,001-$50,000 (5), $50,001-$75,000 (6), and more than $75,000, respectively.

→ 46

Fig. 14. Global warming interest level under Very Low (1), Low (2), Neutral (3), High (4), and Very High (5), respectively.

→ 47

Fig. 15. Environmental issues interest level under Very Low (1), Low (2), Neutral (3), High (4), and Very High (5), respectively.

→ 48

ABSTRACT

Recently, gasoline vehicles are more frequently being replaced by hybrid electric vehicles (HEVs) and electric vehicles (EVs). For private companies interested in selling HEVs and EVs, it is crucial to understand why people purchase HEVs and EVs rather than gasoline vehicles in order to promote those sells effectively. Additionally, replacing gasoline vehicles with HEVs and EVs leads the automobile industry and its customers to take responsibility to reduce carbon dioxide emission. The purpose of this study is to comprehend the factors affecting decisions to purchase HEVs and EVs.

A survey instrument on factors determining individual vehicle purchase decisions was developed and refined through a focus group, an expert review, and a pre-testing. Using the completed instrument, an intercept survey was conducted at Durham (NC) farmers' market and the religious meeting.

The result indicated that willingness to pay (WTP) for HEVs and EVs is statistically higher than WTP for gasoline vehicles. WTP for HEVs and EVs is positively related to number of children, number of household vehicles and average annual driving distance, while it is negatively related to an individual's stated level of importance for fuel-efficiency.

1. INTRODUCTION

In the past century, fluctuating global surface temperatures, precipitation, sea level, cloud cover, ocean temperatures and currents, and other environmental factors have raised concern about climate change. According to the report published by Intergovernmental Panel on Climate Change (IPCC) in 2007, this climate change is attributed to greenhouse gas (GHG) emitted from human activities (IPCC, 2007a; IPCC, 2007b). The most prevalent GHGs are carbon dioxide, methane, nitrous oxide, water vapor, and ozone. A large amount of those gases result from the combustion of fossil fuels.

The rate of GHG emissions depends mostly on the size of the economy. The United States is the second largest GHG emitter in the world. In 2007, GHG emitted by the U.S. are approximately 20% of total global GHG emissions (CDICA, 2007). One quarter of all U.S. GHG emissions are due to combustion of fossil fuels in the transportation sectors (US EPA, 2010). 60% of all emissions from the transportation sector are attributable to passenger cars and light trucks. Therefore, the U.S. passenger cars and light trucks emit 3.0% of all GHG emissions on the earth.

The National Highway Traffic and Safety Administration (NHTSA) have administered the Corporate Average Fuel Economy (CAFE) program since 1975. The purpose of the program is to increase fuel-efficient vehicles and reduce fuel consumption (NHTSA, 2009). In the CAFE program, NHTSA sets fuel economy standards for all automobiles sold in the U.S. Also, the U.S. Environment Protection Agency (EPA) calculates fuel efficiency and designates vehicle fuel efficiency.

The U.S. EPA, identifies the cleanest and most fuel-efficient vehicle that meets customer needs (U.S. EPA, 2010). This EPA guidance gives the rating of the vehicles' fuel-efficiency based on emission levels and fuel economy values. The rating is from 0 to 10, where 10 is the most fuel-efficient.

Two of the most popular fuel-efficient vehicle alternatives are hybrid electric vehicles (HEVs) and electric vehicles (EVs). EVs have only the high-voltage battery and electric motor, while HEVs have a high-voltage battery and electric motor of an electric vehicle in addition to the internal combustion engine of a conventional vehicle. Toyota Prius II and Honda Civic are two major HEVs that have been sold in the U.S. The driving test in the urban area showed Toyota Prius II and Honda Civic reduce fuel usage by 60 and 40 percent, respectively, compared to conventional gasoline vehicles (Fontaras et al., 2008). Nissan released the Leaf model at the end of 2010 in the U.S. According to Nissan, Leaf emits no carbon dioxide at the point of driving. It is fairly obvious that carbon emissions occur in the generation of electric power.

For private companies interested in selling HEVs and EVs, it is crucial to understand why customers purchase HEVs and EVs rather than gasoline vehicle in order to effectively promote sells. Replacing gasoline vehicle with HEVs and EVs leads automobile companies and their customers to take responsibility for reducing carbon dioxide emission. Thus, this study was conducted in order to clarify the factors determining whether to purchase HEVs and EVs rather than gasoline vehicles. The goal of study is to help companies determine how to price and improve sells of HEVs and EVs.

2. METHODOLOGY

2.1. General methodology

In order to clarify the underling customers' consciousness of HEVs and EVs, a survey of potential car buyers was conducted and analysis of the survey data was performed. Prior to conducting the survey, there were several steps to develop the survey instrument: a focus group, an expert review, and a pre-testing. Subsequently, the survey was implemented and all data aggregated from the survey were quantitatively and qualitatively analyzed.

2.2. Focus group

Prior to implementation of the survey, a focus group was conducted in order to receive feedback on draft survey instrument and ensure points that could be improved. Focus group participants were recruited from Duke University students and staffs. The focus group was held on the night of February 20, 2011 with three attendees. The focus group attendees gave constructive recommendations that led to modifications of the survey instrument. For instance, questions about environmental issues were moved from the top of survey to the end of the survey. To answer those questions at the top of survey might lead respondents to alter their responses to portray environmental sympathies or opposition.

2.3. Expert review

The survey instrument was refined through an expert review by Dr. Brian C. Murray, my advisor and Dr. Randall A. Kramer, Professor of Environmental Economics. For instance, the terms for fuel-efficient vehicle were specified as "hybrid electric vehicles (HEVs) and electric vehicles (EVs)" since it was otherwise too vague for respondents to meaningfully answer the questions. Furthermore, a question to ask WTP for gasoline vehicles was added as a reference. The expert pointed out this question would be helpful to compare it with WTP for HEVs and EVs and understand how much respondents put a premium on HEVs and EVs.

2.4. Pre-testing

Subsequent to feedback from the focus group and expert review, the revised survey instrument was pre-tested. Feedback from respondents was collected via email. Based on feedback from the pre-testing phase, the survey instrument was further revised. For instance, a question to ask risk attitude was deleted because all participant to pre-testing did not clearly understand the meaning of this question.

2.5. Implementation

The final survey instrument consisted of a total 15 questions, including nominal, ordinal, and interval questions. All questions were closed-end multiple answered questions.
The survey instrument has three parts: (A) gasoline vehicles vs. HEVs and EVs; (2) socioeconomic information; (3) decision criteria and environmental interest level.

Survey implementation occurred on March 5, 2011 at the Durham farmer's market and on March 6, 2011 at the religious meeting. An intercept survey, designed to complete within 7 minutes, was conducted.

3. RESULTS

3.1. Socioeconomic characteristics of sample

In the survey instrument, survey respondents answered which types of vehicles, gasoline vehicles or HEVs and EVs, they most often drove currently. The result of the question showed 90.3% of survey respondents drove gasoline vehicles, while 7.7% of them drove HEVs and EVs (Fig. 2). The survey asked respondents their interest level on HEVs and EVs. Table 2 reports frequency and calculated mean of interest level on HEVs and EVs. Mean interest level on HEVs and EVs was 4.1 (5 is highest, 1 is lowest). The calculation is shown on Table 2.

In terms of gender, 67.3% of respondents were female, while 32.7% of respondents were male (Fig. 6). Computed average age of respondents was 47 years old (Table 6). With regard to marital status, 54% of respondents were married, while 42.3% of them were single (Fig. 8). The respondents' mean number of children is 1.38 (Table 8). The average number of vehicles, each respondent has is 1.63 (Table 9).

The result of the question about education level showed that 61.5% of survey respondents were four-year college graduates or higher, while 38.5% of them were some college graduates or less (Table 10). Furthermore, calculated mean of respondents' annual driving distance was 9,069 miles per year (Table 11). Calculated mean of annual household income was $54,300 (Table 12). At the end of survey, respondents were asked their global warming interest level. Table 13 stated calculated mean of global warming interest level was 4.37 (5 is highest, 1 is lowest). Furthermore, Table 14 showed computed mean of environmental issues interest level was 4.37 (5 is highest, 1 is lowest).

3.2. Decision criteria

The respondents answered a question specific to decision criteria when they purchased vehicles. In the question, they could select the top three among given criteria: design, safety, acceleration, ease of driving, price, fuel efficiency, and other. Fig. 1 indicated that survey respondents were concentrated among three decision criteria: safety (n=38), fuel efficiency (n= 37), and price (n=32).

3.3. WTP

Survey respondents were asked willingness to pay (WTP) for buying new gasoline vehicles and new HEVs and EVs. Table 3 showed distribution of WTP for gasoline vehicles and a way of calculation to get mean WTP. The computed mean WTP for gasoline vehicles was $21,231. On the other hand, Table 4 showed distribution of WTP for HEVs and EVs and how to calculate average of WTP for HEVs and EVs. The calculated mean of WTP for HEVs and EVs was $22,462. This price was higher than WTP for gasoline vehicles. The difference between them was $1,231.

WTP for HEVs and EVs was statistically different from WTP for gasoline vehicles, which was demonstrated by a chi-square test (Table 15). Pearson chi-square was 80.4222, which was much higher than 15.09 at 0.01 significant level.

3.4. WTP multiple regression analysis

A multiple regression analysis was conducted on WTP for gasoline vehicles and WTP for HEVs and EVs. The model of WTP for gasoline vehicles was:

WTP for gasoline = $\alpha_0 + \alpha_1 \times$*(Types of vehicles)* + $\alpha_2 \times$*(Interest level on HEVs and EVs)* + $\alpha_3 \times$*(Gender)* + $\alpha_4 \times$*(Age)* + $\alpha_5 \times$*(Marital status)* + $\alpha_6 \times$*(Number of children)* + $\alpha_7 \times$*(Number of vehicles)* + $\alpha_8 \times$*(Education level)* + $\alpha_9 \times$*(Annual driving distance)* + $\alpha_{10} \times$*(Income)* + $\alpha_{11} \times$*(Design)* + $\alpha_{12} \times$*(Safety)* + $\alpha_{13} \times$*(Acceleration)* + $\alpha_{14} \times$*(Ease of driving)* + $\alpha_{15} \times$*(Price)* + $\alpha_{16} \times$*(Fuel efficiency)* + $\alpha_{17} \times$*(Other decision criteria)* + $\alpha_{18} \times$*(Global warming interest level)* + $\alpha_{19} \times$*(Environmental issue interest levels).*

The result summary of the WTP multiple regression analysis for gasoline vehicles is shown in Table 16. It shows that WTP for gasoline vehicles is positively related to number of children, annual driving distance, and environmental issues interest level. On the other hand, WTP for gasoline vehicles is negatively related to income, fuel efficiency, and global warming interest level. In terms of other variables, no statistical relation was detected.

Next, in model of WTP for HEVs and EVs, all variable are the same factors. The model was shown below:

WTP for HEVs and EVs = $\alpha_0 + \alpha_1 \times$*(Types of vehicles)* + $\alpha_2 \times$*(Interest level on HEVs and EVs)* + $\alpha_3 \times$*(Gender)* + $\alpha_4 \times$*(Age)* + $\alpha_5 \times$*(Marital status)* + $\alpha_6 \times$*(Number of children)* + $\alpha_7 \times$*(Number of vehicles)* + $\alpha_8 \times$*(Education level)* + $\alpha_9 \times$*(Annual driving distance)* +

α_{10}×*(Income)* + α_{11}×*(Design)* + α_{12}×*(Safety)* + α_{13}×*(Acceleration)* + α_{14}×*(Ease of driving)* + α_{15}×*(Price)* + α_{16}×*(Fuel efficiency)* + α_{17}×*(Other decision criteria)* + α_{18}×*(Global warming interest level)* + α_{19}×*(Environmental issues interest level).*

The result summary of multiple regression analysis on WTP for HEVs and EVs was stated in Table 16. It indicated that WTP for HEVs and EVs was positively related to number of children, number of vehicles, and annual driving distance, while it was negatively related to fuel efficiency. No statistical relation was detected on relationship between other variables and WTP for HEVs and EVs.

3.5. Marginal effects for WTP multiple regression analysis

In Table 17, marginal effects of income was 0.137 in Prob (Y=less than $20,000 for gasoline vehicles). It means that high income respondents are 13.7% more likely to pay less than $20,000 than low income respondents. In Prob (Y=less than $20,000 for gasoline vehicles), a marginal increase in WTP occurs on income, fuel efficiency, and global warming interest level, while a marginal decrease occurred on number of vehicles, annual driving distance, and environmental issues interest level. It is particularly worth noting that there is high collinearity of global warming and environmental issues interest level that could be contributing to the odd result here.

Table 18 shows a results summary of marginal effects for WTP for HEVs and HVs. In Prob (Y=less than $20,000 for HEVs and EVs), a marginal increase occurred on fuel efficiency, while marginal decrease occurred on number of children, number of vehicles, and annual driving distance.

4. DISCUSSION

In this study, WTP for HEVs and EVs was positively related to number of children, number of vehicles, and annual driving distance, while it was negatively related to fuel efficiency. This was basically unexpected because the previous research for HEVs, conducted on 1983 Turkish people in 2009, showed that education level and income were positively related to WTP for HEVs (Erdem *et al*, 2010). This result difference might be caused by sample population difference between the U.S. and Turkey. Average U.S. per capita income, around $47,000 is higher than Turkish per capita income, around $12,000. The per capita income of this study, $54,300 is further higher than average U.S. per capita income. This income level difference might comprehensively affect decision making toward purchasing HEVs and EVs. Furthermore, the difference might be fundamentally caused by the way the surveys were structured and analysis was performed.

No relationship occurred between WTP for HEVs and EVs, and global warming and environmental issues interest level at a statistically significant level. This is also unexpected because several studies showed positive relationship between WTP for HEVs and environmental issues interest level (Erdem *et al*, 2010; Flint, 2007). This might be attributed to high collinearity of global warming and environmental issues interest level in the analysis. The calculated mean of global warming and environmental issues interest level were identical. Both of them were 4.37 (5 is highest, 1 is lowest). It is suspected that their correlation is very high. In a multiple regression analysis, highly correlated variables reduce reliability of the model.

WTP for HEVs and EVs, $22,462 is statistically higher than WTP for gasoline vehicles, $21,231. The difference between those WTPs was $1,231 and it could be regarded as a premium for HEVs and EVs. A premium for HEVs and EVs in this study is not relatively much higher than $858, a premium for HEVs in a research conducted in Turkey. It might be attributed to even though per capita income was different in U.S. and Turkey; price of HEVs is basically same. Each customer has information about price of HEVs and based on it they had had indicated WTP for HEVs and EVs.

In the U.S., one of the most popular gasoline vehicles is Toyota Cammry, whose lowest price model is sold in $19,820 (Toyota, 2011). One of the most selling HEVs in the U.S. is Toyota Prius, whose lowest price model is sold in $23,050 (Toyota, 2011). The price of latest released EV, Nissan Leaf, is $33,720 (Nissan, 2011). The calculated differences between Camry and, Prius and Leaf are $3,230 and $13,900, respectively. The respondent premium for HEVs and EVs, $1,231 is lower than the computed average differences. Since this gap might lead to make customers be reluctant to choose HEVs and EVs, auto markers need to fill in the gaps by abating car price or boosting up customers premium for HEVs and EVs.

The most unique characteristic of this study is asking WTP for gasoline vehicles, identifying the factors to decide to purchase gasoline vehicles, and comparing this result with result of HEVs and EVs. WTP for HEVs and EVs was positively related to number of children, number of vehicles, annual driving distance, and fuel efficiency. However, among them, number of vehicles, annual driving distance, and fuel efficiency had same relation to WTP for gasoline vehicles. It means those three factors were not unique factors to decide to purchase HEVs and EVs. They were adaptable for all vehicles, including HEVs, EVs, and gasoline vehicles. For automobile makers, this finding is useful not only for sells promotion of HEVs and EVs but also gasoline vehicles. Only unique characteristic for HEVs and EVs was number of children. It means larger families might be the target of HEVs and EVs sales.

Though this study gave various findings, it was a pilot study. Due to time constraints, manpower, and a variety of other factors, only 52 responses were obtained. Also, the study sample was not demographically distributed and this sample population was higher income class than U.S. average. In future study, it is necessary to get more number of responses and conduct research on evenly distributed sites in the U.S. It would lead to cover various U.S. customers from low to high class. The average income would converge to average income of the U.S.

In this study, though several types of multiple regression analysis were conducted, the result of multiple regression analysis showed collinearity occurred. As a next step, if a different regression model were adapted like a single regression model with variables in WTP in order to minimize collinearity, different result of correlations might be appeared.

My study target was set as HEVs and EVs. Since automobile markers promote those sells recently, HEVs and EVs were treated as if they are the same when asking respondents their WTP. However, they are quite different. EVs require plugging in at night and run greater risk of losing power while in use. The most significant difference is price. One of the most popular HEVs, Toyota Prius is $23,050, while recently released EV, Nissan Leaf, is $33,720. The price gap is $13,900. The more information respondents have about HEVs and EVs, the more difficult to answer questions is. Thus, future study needs to treat HEVs and EVs in a different manner. For instance, WTP for EVs must be set different price ranges from those of HEVs and gasoline vehicles.

5. LITERATURE CITATIONS

Carbon Dioxide Information Analysis Center, 2007. “Top 20 Emitting Countries by Total Fossil-Fuel CO_2 Emissions for 2007,” http://cdiac.ornl.gov/trends/emis/tre_tp20.html, accessed on Oct. 4.

Environmental Protection Agency (EPA), 2010. “Green Vehicle Guide,” http://www.epa.gov/greenvehicles/Index.do, accessed on Sept. 25. 2010 Experimental evaluation of hybrid vehicle fuel economy and pollutant emissions over real-world simulation driving cycles.

Environmental Protection Agency (EPA), 2010. “Climate Change,” http://www.epa.gov/climatechange/fq/emissions.html#q5, accessed on April 3. 2011. What are greenhouse gas emissions from the transportation sector?

Erdem, Cumhur, Sentürk, Ismail, Simsek, Türker, 2010. Identifying the factors affecting the willingness to pay for fuel-efficient vehicles in Turkey: A case of hybrids. Energy Policy 38, 3038-3043

Flint, J., 2007. “The Hybrid Dilemma,” http://www.forbes.com/2007/07/16/prius-toyota-detroit-oped-cz_jf_0716flint.html , accessed on March 16. 2011

Fontaras, G., Pistikopoulos, P., Samaras, Z., 2008. Experimental evaluation of hybrid vehicle fuel economy and pollutant emissions over real-world simulation driving cycles. Atmospheric Environment 42, 4023–4035.

Intergovernmental Panel on Climate Change (IPCC), 2007a. Climate Change 2007: The Physical Science Basic. Contribution of Working Group I to the Fourth Assessment Report, Geneva, Switzerland: IPCC

Intergovernmental Panel on Climate Change (IPCC), 2007b. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report, Geneva, Switzerland: IPCC

National Highway Traffic Safety Administration (NHTSA), 2009. Average Fuel Economy Standards, Passenger Cars and Light Trucks, MY 2011-2015, Washington, DC, the United States: NHTSA.

Nissan, 2011. "Nissan Leaf Price Estimator," http://www.nissanusa.com/leaf-electric-car/index#/leaf-electric-car/estimator/index, accessed on April 26. 2011

Toyota, 2011. "Toyota Camry," http://www.toyota.com/camry/, accessed on April 26. 2011

Toyota, 2011. "Toyota Prius," http://www.toyota.com/prius-hybrid/, accessed on April 26. 2011

Table 1. The frequency of the vehicle types that are most often driven.

Types of the Vehicle	Frequency (f)
HEVs OR EVs	4
GASOLINE	47
DON'T HAVE A VEHICLE	1
	52

Table 2. The frequency and mean calculation of interest level on HEVs and EVs.

Interest Level	m[a]	Frequency (f)	fm[a]
VERY LOW	1	2	2
LOW	2	1	2
NEUTRAL	3	6	18
HIGH	4	24	96
VERY HIGH	5	19	95
		52	213

$$\bar{x} = \frac{\sum fm}{n} = \frac{213}{52} = 4.10$$

Table 3. The frequency and mean calculation of WTP for gasoline vehicles.

WTP (Gasoline)	m[a]	Frequency (f)	fm[a]
less than $20,000	$18,000	28	504,000
$20,000-$24,000	$22,000	15	330,000
$24,001-$28,000	$26,000	3	78,000
$28,001-$32,000	$30,000	3	90,000
$32,001-$36,000	$34,000	3	102,000
more than $36,000	$38,000	0	0
		52	1,104,000

$$\bar{x} = \frac{\sum fm}{n} = \frac{1{,}104{,}000}{52} = 21{,}231$$

Table 4. The frequency and mean calculation of WTP for HEVs and EVs.

WTP (HEVs and EVs)	m[a]	Frequency (f)	fm[a]
less than $20,000	$18,000	20	360,000
$20,000-$24,000	$22,000	17	374,000
$24,001-$28,000	$26,000	7	182,000
$28,001-$32,000	$30,000	5	150,000
$32,001-$36,000	$34,000	3	102,000
more than $36,000	$38,000	0	0
		52	1,168,000

$$\bar{x} = \frac{\sum fm}{n} = \frac{1{,}168{,}000}{52} = 22{,}462$$

Table 5. The frequency of gender.

Gender	Frequency (f)
MALE	17
FEMALE	35
	52

Table 6. The frequency and mean calculation of age.

Age	m[a]	Frequency (f)	fm[a]
18-30 years	24	8	192
31-40 years	35	4	140
41-50 years	45	13	585
51-60 year	55	21	1,155
Over 61	65	6	390
		52	2,462

$$\bar{x} = \frac{\sum fm}{n} = \frac{2,462}{52} = 47$$

Table 7. The frequency of marital status.

Marital Status	Frequency (f)
SINGLE	22
MARRIED	28
OTHER	2
	52

Table 8. The frequency and mean calculation of number of children.

Number of Children	m^a	Frequency (f)	fm^a
0	0	17	0
1	1	13	13
2	2	14	28
3	3	4	12
4	4	1	4
5 AND ABOVE	5	3	15
		52	72

$$\bar{x} = \frac{\sum fm}{n} = \frac{72}{52} = 1.38$$

Table 9. The frequency and mean calculation of number of household vehicles.

Number of Vehicles	m^a	Frequency (f)	fm^a
0	0	2	0
1	1	22	22
2	2	21	42
3	3	7	21
4	4	0	0
5 AND ABOVE	5	0	0
		52	85

$$\bar{x} = \frac{\sum fm}{n} = \frac{85}{52} = 1.63$$

Table 10. The frequency of education level.

Education	Frequency (f)
SOME HIGH SCHOOL OR LESS	1
HIGH SCHOOL GRADUATE	8
SOME COLLEGE	11
FOUR-YEAR COLLEGE GRADUATE	14
POSTGRADUATE DEGREE	18
	52

Table 11. The frequency and mean calculation of annual driving distance.

Annual Driving Distance	m[a]	Frequency (f)	fm[a]
less than 2,500 miles	1,250	10	12,500
2,500-5,000 miles	3,750	12	45,000
5,001-7,500 miles	6,250	3	18,750
7,501-10,000 miles	8,750	7	61,250
10,001-20,000 miles	15,000	15	225,000
more than 20,000 miles	25,000	4	100,000
		51	462,500

Note: Nonresponse =1.

$$\bar{x} = \frac{\sum fm}{n} = \frac{462,500}{51} = 9,069$$

Table 12. The frequency and mean calculation of annual household income.

Annual Income	m[a]	Frequency (f)	fm[a]
less than $10,000	$5,000	1	5,000
$10,000-$20,000	$15,000	7	105,000
$20,001-$30,000	$25,000	7	175,000
$30,001-$40,000	$35,000	5	175,000
$40,001-$50,000	$45,000	5	225,000
$50,001-$75,000	$62,500	8	500,000
more than $75,000	$90,000	17	1,530,000
		50	2,715,000

Note: Nonresponse =2.

$$\bar{x} = \frac{\sum fm}{n} = \frac{2,715,000}{50} = 54,300$$

Table 13. The frequency and mean calculation of global warming interest level.

Interest Level	Value (m^a)	Frequency (f)	fm^a
VERY LOW	1	1	1
LOW	2	1	2
NEUTRAL	3	6	18
HIGH	4	14	56
VERY HIGH	5	30	150
		52	227

$$\bar{x} = \frac{\sum fm}{n} = \frac{227}{52} = 4.37$$

Table 14. The frequency and mean calculation of environmental issues interest level.

Interest Level	Value (m^a)	Frequency (f)	fm^a
VERY LOW	1	0	0
LOW	2	3	6
NEUTRAL	3	3	9
HIGH	4	18	72
VERY HIGH	5	28	140
		52	227

$$\bar{x} = \frac{\sum fm}{n} = \frac{227}{52} = 4.37$$

Table 15. The chi-square test result for WTP for HEVs and EVs, and WTP for gasoline vehicles.

WTP for Gasoline	WTP for HEVs and EVs 1	2	3	4	5	Total
1	18	6	2	2	0	28
2	2	11	2	0	0	15
3	0	0	3	0	0	3
4	0	0	0	2	1	3
5	0	0	0	1	2	3
Total	20	17	7	5	3	52

Pearson chi square (16) = 80.4222
Fisher's exact = 0
Pr = 0.000

Table 16. Result summary of WTP multiple regression analysis.

Variables	WTP for Gasoline		WTP for HEVs and EVs	
	Coefficients	P values	Coefficients	P values
Types of vehicles	-0.187	0.842	0.177	0.843
Interest level on HEVs and EVs	0.215	0.484	0.570	0.112
Gender	-0.254	0.581	-0.053	0.903
Age	0.287	0.273	-0.291	0.265
Marital status	-0.576	0.301	0.026	0.958
Number of children	0.165	0.450	0.534**	0.017
Number of vehicles	0.815**	0.046	0.811**	0.033
Education level	0.035	0.866	-0.124	0.520
Annual driving miles	0.693**	0.005	0.590**	0.012
Income	-0.352*	0.052	-0.211	0.170
Design (Decision Criteria: DC)	0.784	0.109	-0.035	0.940
Safety (DC)	1.035	0.128	0.815	0.146
Acceleration (DC)	0.431	0.594	-0.818	0.353
Ease of driving (DC)	0.008	0.990	0.849	0.132
Price (DC)	-0.101	0.872	-0.898	0.115
Fuel efficiency (DC)	-1.193*	0.058	-1.851**	0.002
Other (DC)	-0.757	0.394	-0.552	0.521
Global warming interest level	-2.205**	0.002	-0.887	0.117
Env. Issues interest level	2.140**	0.003	0.464	0.375

** Significant at 5 percent level.

* Significant at 10 percent level.

Table 17. Result summary of marginal effects for WTP multiple regression analysis on gasoline vehicles.

Variables	Prob (Y=0)	Prob (Y=1)	Prob (Y=2)	Prob (Y=3)	Prob (Y=4)
Types of vehicles	0.073	-0.049	-0.011	-0.010	-0.002
Interest level on HEVs and EVs	-0.084	0.056	0.013	0.012	0.003
Gender	0.099	-0.065	-0.016	-0.015	-0.003
Age	-0.112	0.075	0.018	0.016	0.003
Marital status	0.224	-0.151	-0.035	-0.031	-0.007
Number of children	-0.064	0.043	0.010	0.009	0.002
Number of vehicles	**-0.317**	**0.213**	**0.050**	**0.044**	**0.010**
Education level	-0.014	0.009	0.002	0.002	0.000
Annual driving miles	**-0.270**	**0.181**	**0.043**	**0.038**	**0.008**
Income	**0.137**	**-0.092**	**-0.022**	**-0.019**	**-0.004**
Design (Decision Criteria: DC)	-0.304	0.176	0.055	0.057	0.016
Safety (DC)	-0.357	0.261	0.048	0.040	0.008
Acceleration (DC)	-0.171	0.098	0.032	0.032	0.009
Ease of driving (DC)	-0.003	0.002	0.000	0.000	0.000
Price (DC)	0.039	-0.026	-0.006	-0.006	-0.001
Fuel efficiency (DC)	**0.448**	**-0.210**	**-0.090**	**-0.108**	**-0.039**
Other (DC)	0.258	-0.197	-0.032	-0.025	-0.005
Global warming interest level	**0.858**	**-0.576**	**-0.136**	**-0.120**	**-0.026**
Env. Issues interest level	**-0.833**	**0.559**	**0.132**	**0.117**	**0.025**

Note: Bold means statistically significant.

0 = Less than $20,000
1 = $20,000-$24,000
2 = $24,001-$28,000
3 = $28,001-$32,000
4 = $32,001-$36,000

Table 18. Result summary of marginal effects for WTP multiple regression analysis on HEVs and EVs.

Variables	Prob (Y=0)	Prob (Y=1)	Prob (Y=2)	Prob (Y=3)	Prob (Y=4)
Types of vehicles	-0.067	0.031	0.020	0.013	0.003
Interest level on HEVs and EVs	-0.215	0.100	0.065	0.041	0.008
Gender	0.020	-0.009	-0.006	-0.004	-0.001
Age	0.110	-0.051	-0.033	-0.021	-0.004
Marital status	-0.010	0.005	0.003	0.002	0.000
Number of children	**-0.201**	**0.094**	**0.061**	**0.039**	**0.008**
Number of vehicles	**-0.306**	**0.143**	**0.092**	**0.059**	**0.012**
Education level	0.047	-0.022	-0.014	-0.009	-0.002
Annual driving miles	**-0.222**	**0.104**	**0.067**	**0.043**	**0.009**
Income	0.080	-0.037	-0.024	-0.015	-0.003
design (Decision Criteria: DC)	0.013	-0.006	-0.004	-0.003	-0.001
safety (DC)	-0.314	0.183	0.077	0.045	0.008
Acceleration (DC)	0.317	-0.213	-0.066	-0.034	-0.005
Ease of driving (DC)	-0.284	0.069	0.105	0.086	0.024
Price (DC)	0.311	-0.100	-0.107	-0.083	-0.022
Fuel efficiency (DC)	**0.502**	**0.038**	**-0.186**	**-0.234**	**-0.120**
Other (DC)	0.216	-0.132	-0.051	-0.028	-0.005
Interest level on global warming	0.334	-0.156	-0.101	-0.064	-0.013
Interest level on env. issues	-0.175	0.082	0.053	0.034	0.007

Note: Bold means statistically significant.

0 = less than $20,000
1 = $20,000-$24,000
2 = $24,001-$28,000
3 = $28,001-$32,000
4 = $32,001-$36,000

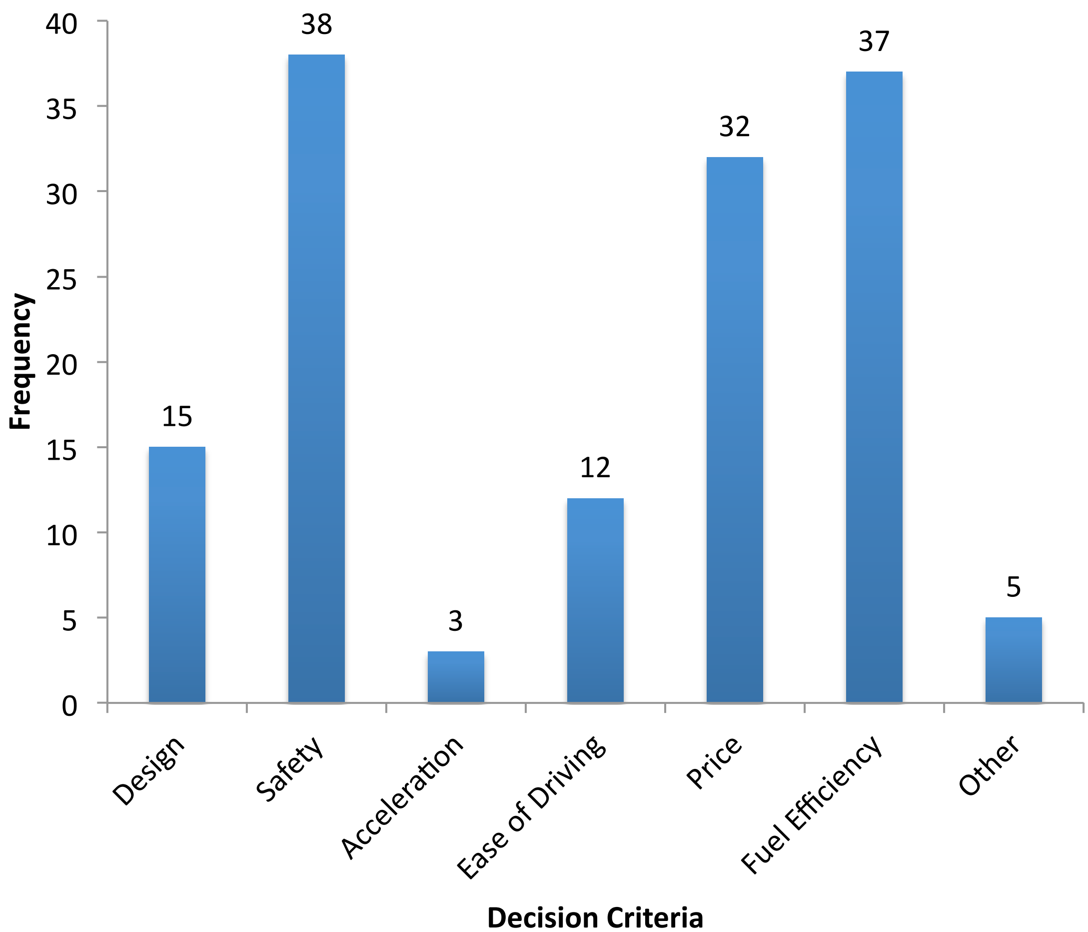

Fig. 1. Decision criteria of deciding vehicles (respondents can select top three factors among given criterion).

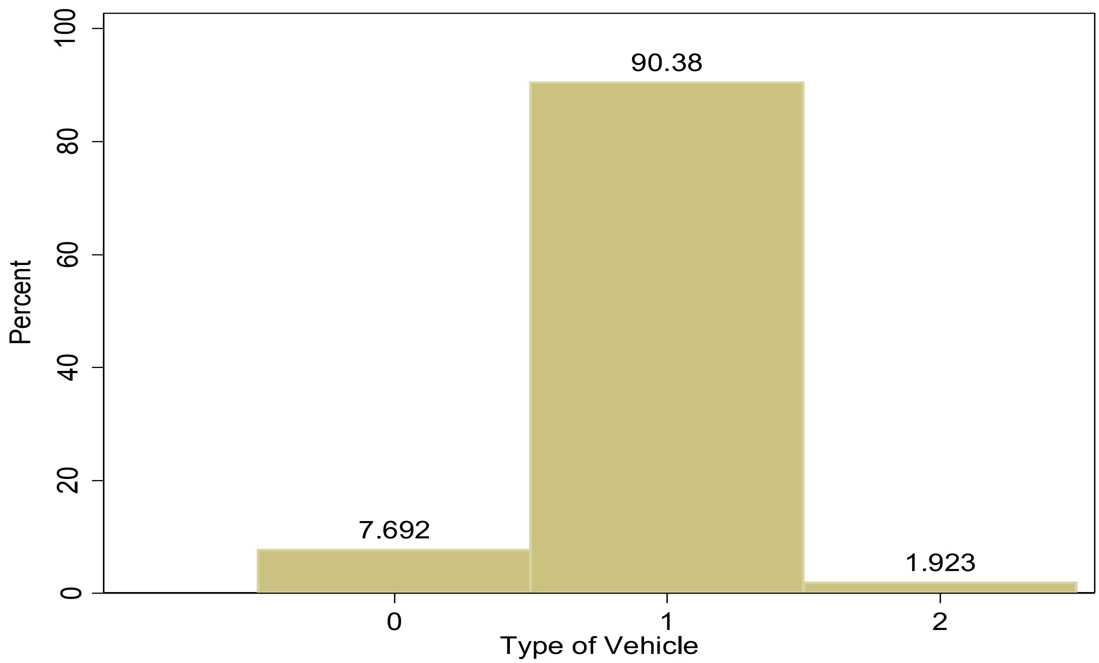

Fig. 2. The types of the vehicle which is most often driven under HEVs and EVs (0), Gasoline Vehicles (1), and Don't Have a Vehicle (2), respectively.

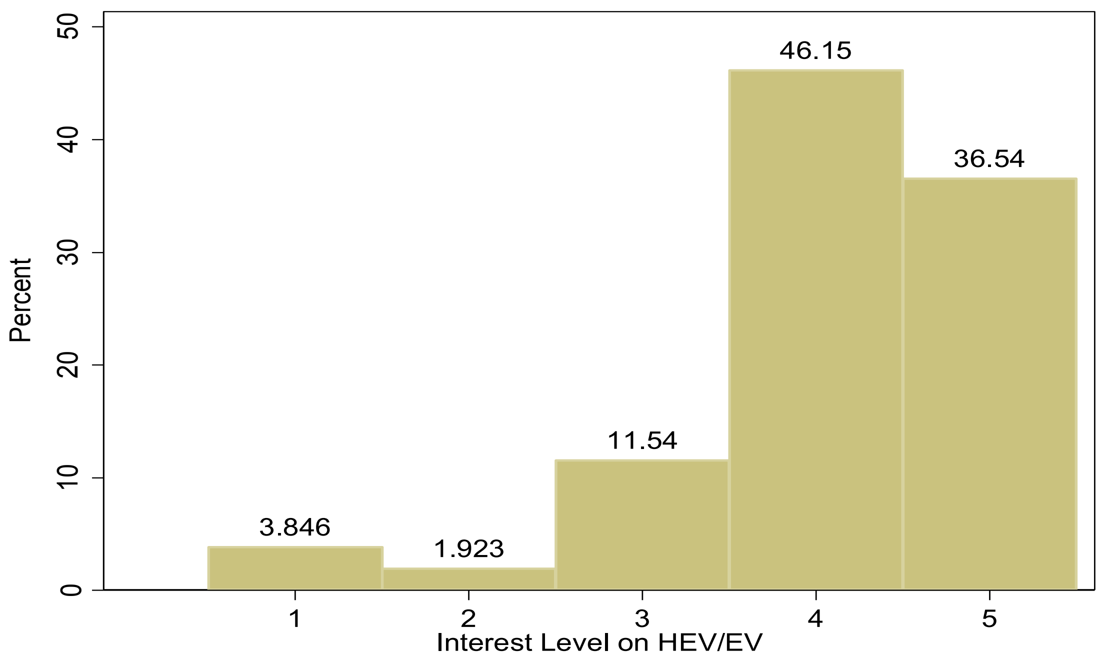

Fig. 3. Level of interest on HEVs and EVs under Very Low (1), Low (2), Neutral (3), High (4), and Very High (5), respectively.

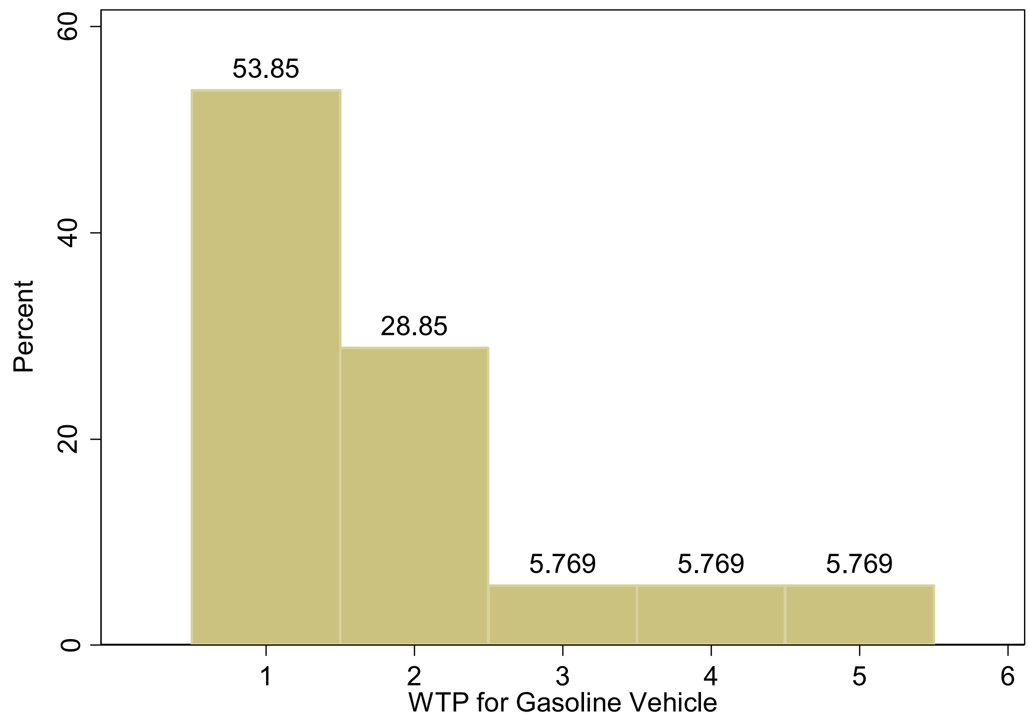

Fig. 4. WTP for gasoline vehicles under less than $20,000 (1), $20,000-$24,000 (2), $24,001-$28,000 (3), $28,001-$32,000 (4), $32,001-$36,000 (5), and more than $36,000 (6), respectively.

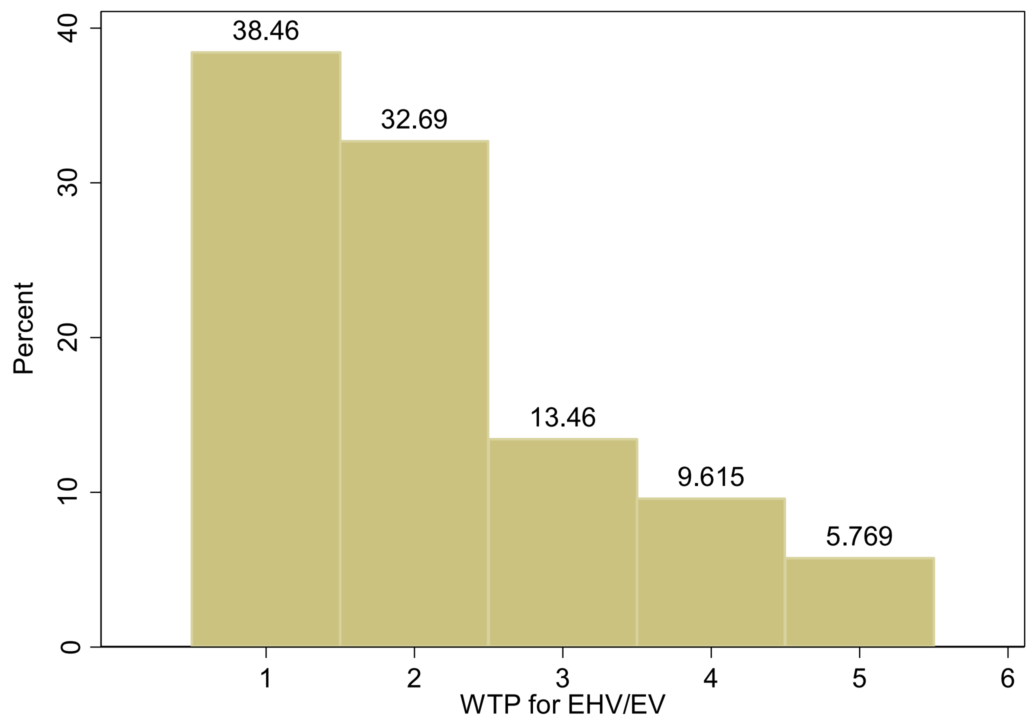

Fig. 5. WTP for HEVs and EVs under less than $20,000 (1), $20,000-$24,000 (2), $24,001-$28,000 (3), $28,001-$32,000 (4), $32,001-$36,000 (5), and more than $36,000 (6), respectively.

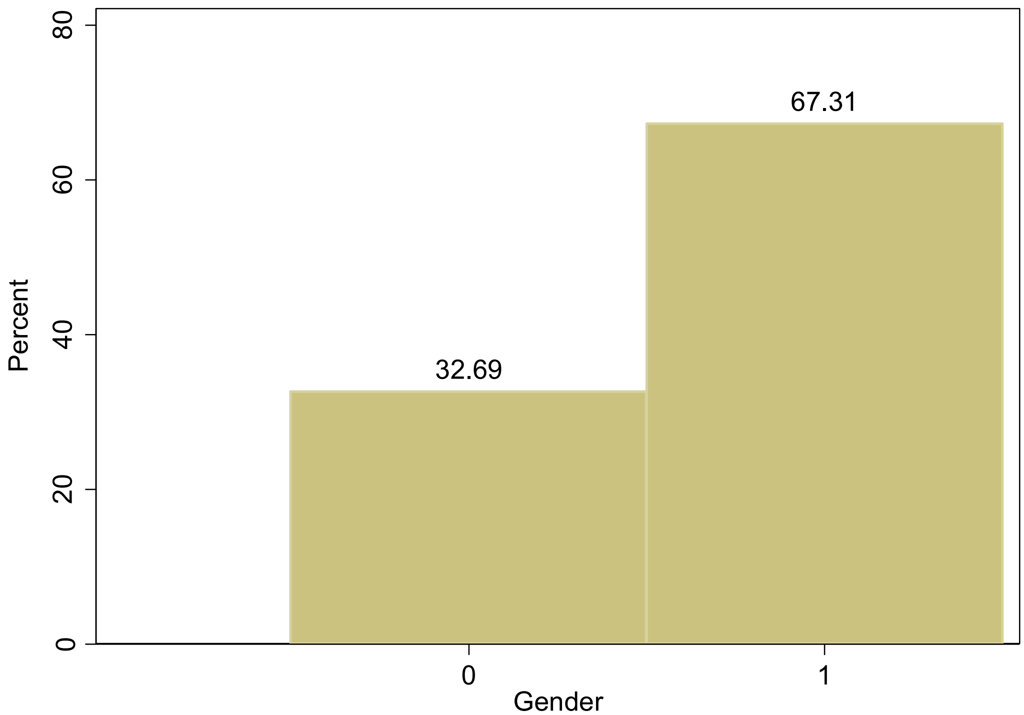

Fig. 6. Gender under Male (0) and Female (1), respectively.

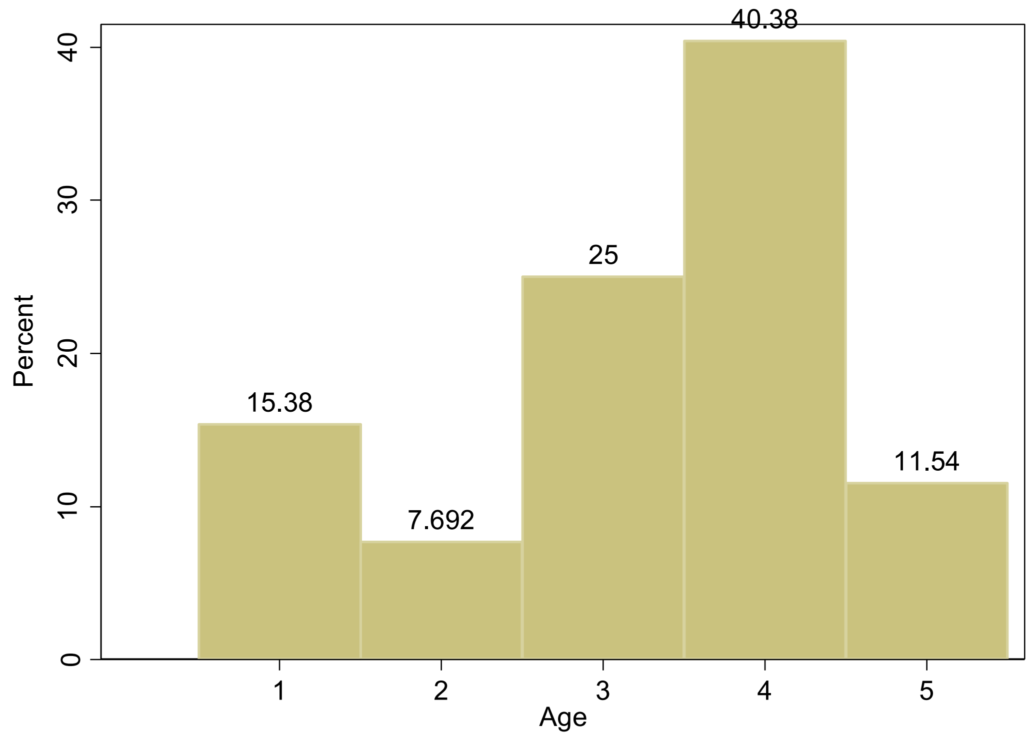

Fig. 7. Age under 18-30 years (1), 31-40 years (2), 41-50 years (3), 51-60 year (4), and Over 61 years (5), respectively.

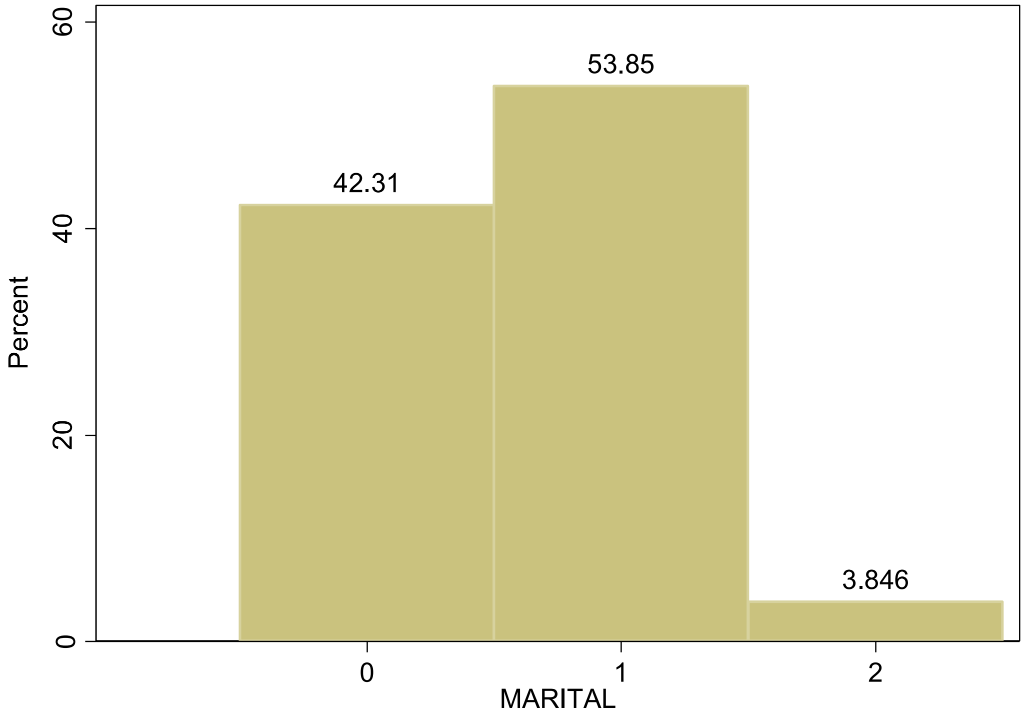

Fig. 8. Marital status under Single (0), Married (1), and Other (2), respectively.

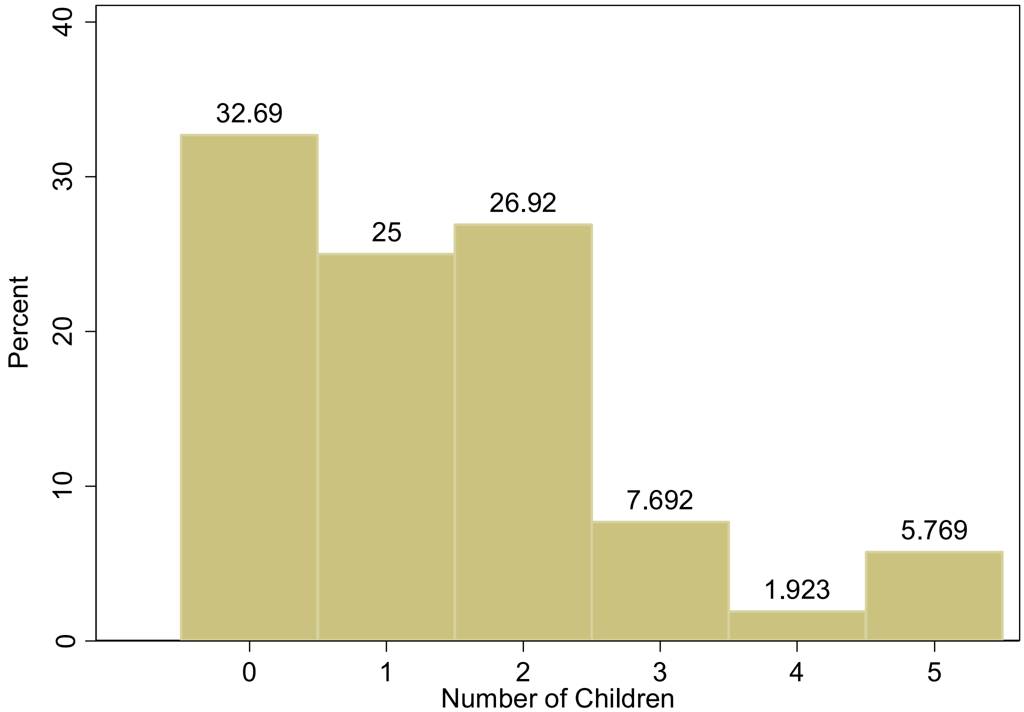

Fig. 9. Number of children.

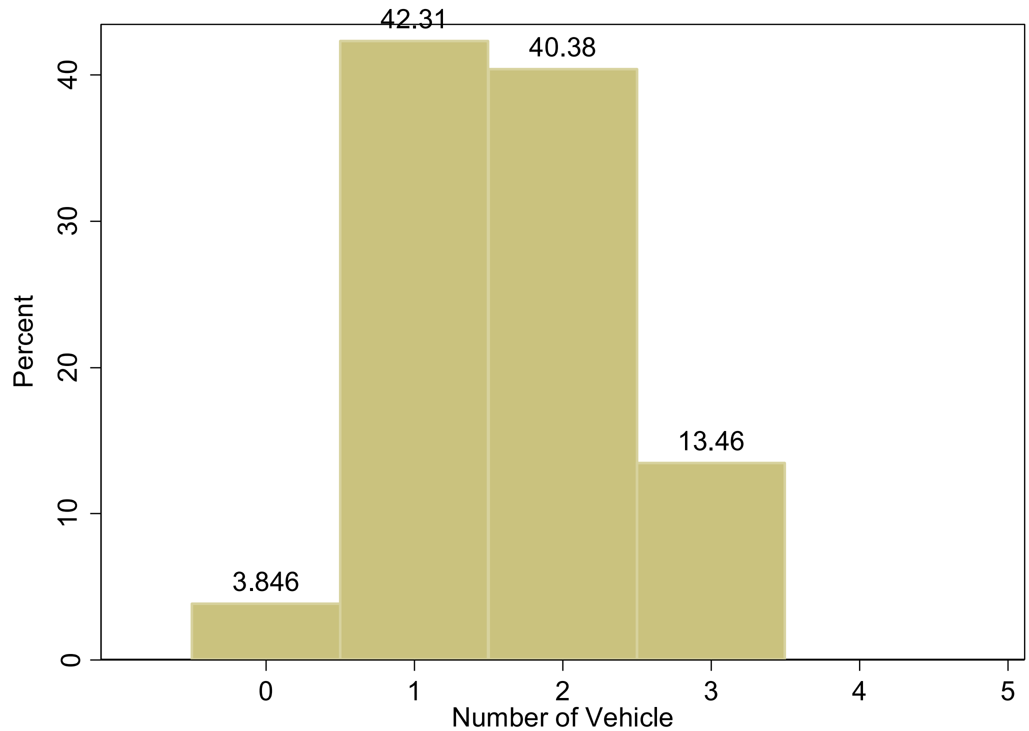

Fig. 10. Number of household vehicles.

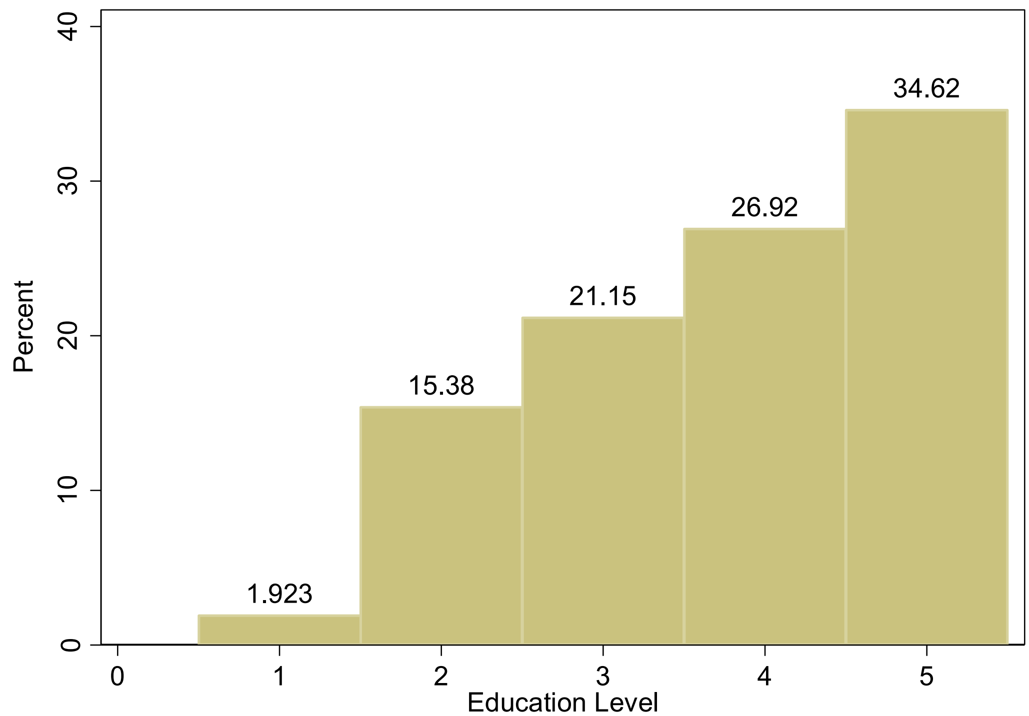

Fig. 11. Education level under Some High School or Less (1), High School Graduate (2), Some College (3), Four-Year College Graduate (4), and Postgraduate Degree (5), respectively.

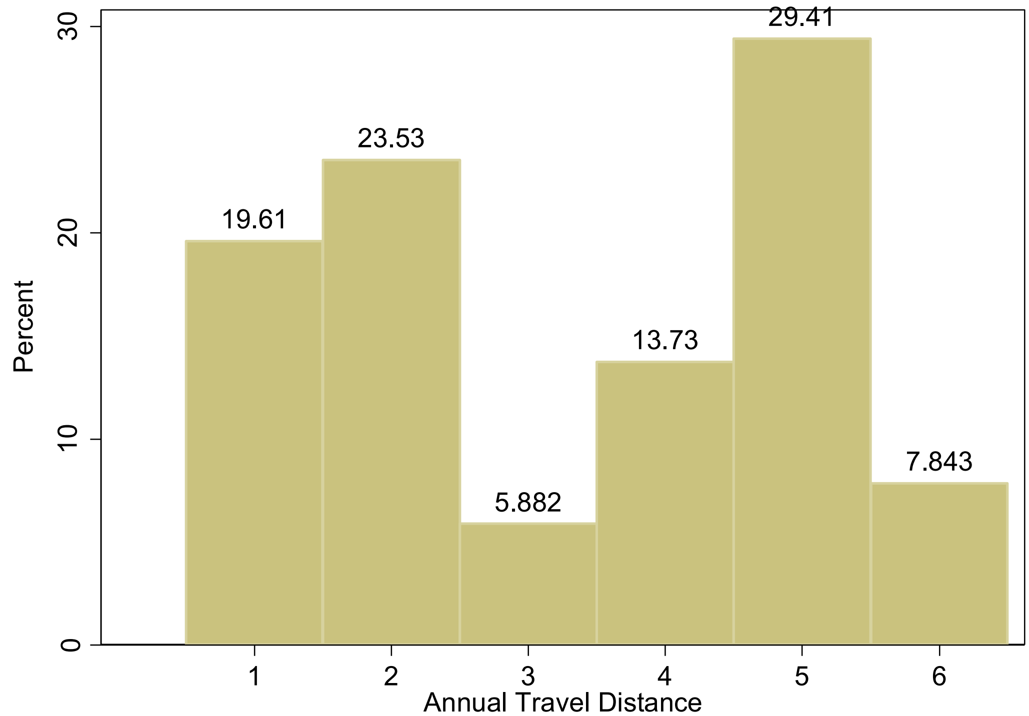

Fig. 12. Average annual driving distance under less than 2,500 miles (1), 2,500-5,000 miles (2), 5,001-7,500 miles (3), 7,501-10,000 miles (4), 10,001-20,000 miles (5), and more than 20,000 miles (6), respectively.

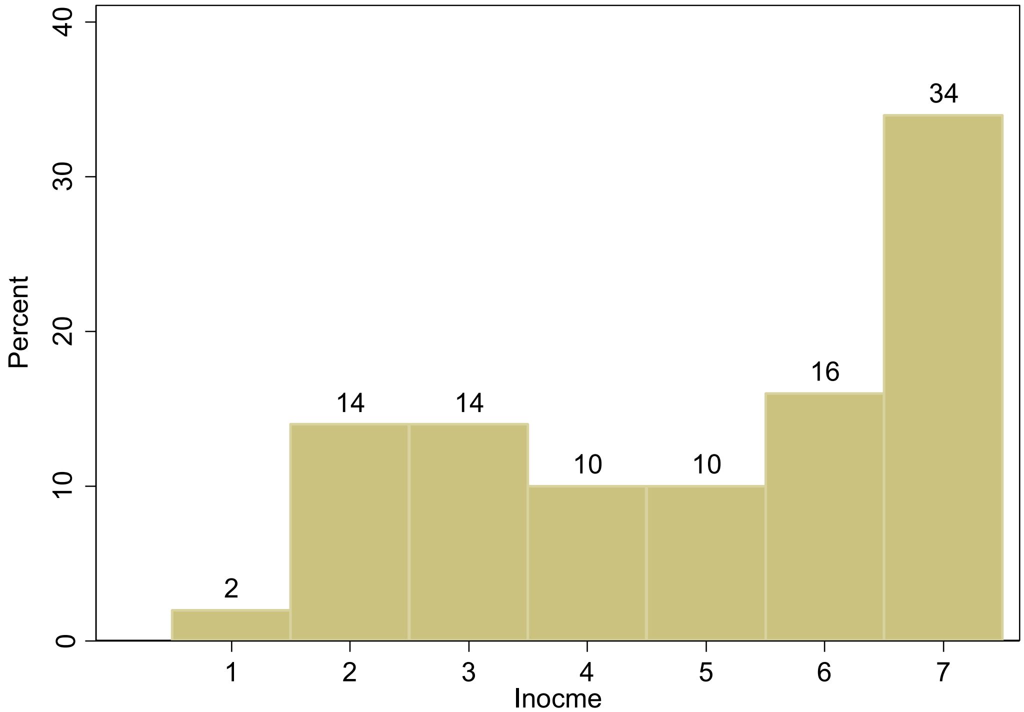

Fig. 13. Annual household income under less than $10,000 (1), $10,000-$20,000 (2), $20,001-$30,000 (3), $30,001-$40,000 (4), $40,001-$50,000 (5), $50,001-$75,000 (6), and more than $75,000, respectively.

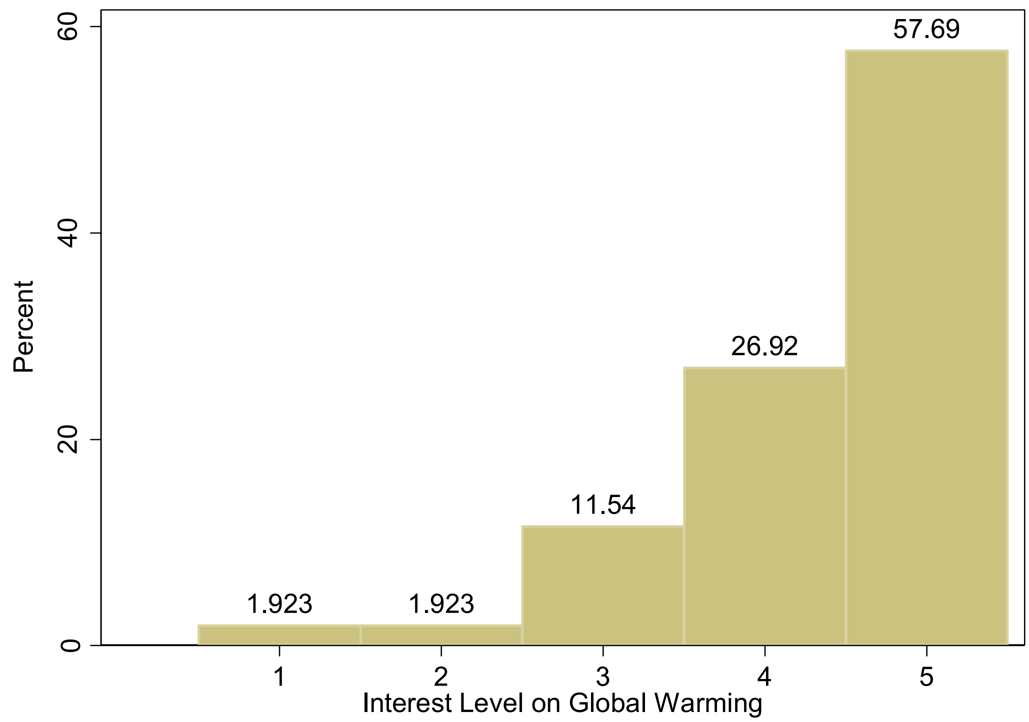

Fig. 14. Global warming interest level under Very Low (1), Low (2), Neutral (3), High (4), and Very High (5), respectively.

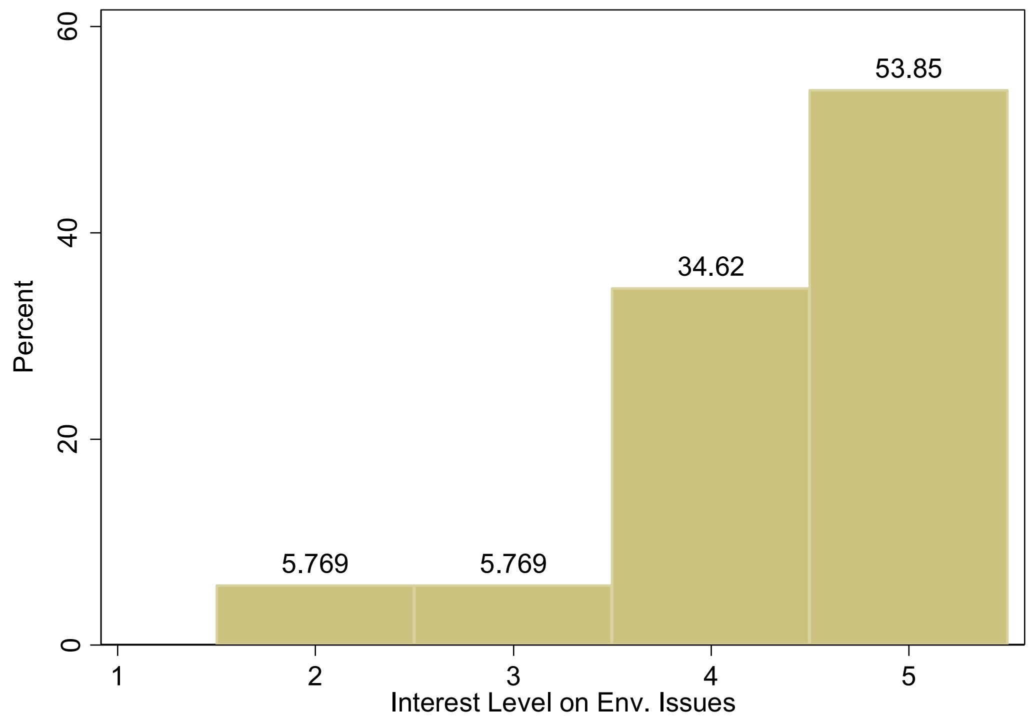

Fig. 15. Environmental issues interest level under Very Low (1), Low (2), Neutral (3), High (4), and Very High (5), respectively

Appendix 1. Survey Instruments

Informed Consent

Hi, my name is Eiichi Haraya. I am a Duke University student. I am conducting a quick survey for my master's project research on factors that help decide the purchase of a hybrid or electric vehicle. Your participation in this survey is completely voluntary and all your responses will be kept confidential. It should not take more than 5 minutes. Your responses to this survey are important. No personally identifiable information will be collected or associated with your responses in any reports of this data. All data will be reported in aggregate.

Thank you for your time and consideration in completing this survey. If you have any further questions or comments, please feel free to contact me at eiichi.haraya@duke.edu.

Please take this page home with the purpose of keeping my contact info.

Questionnaire

A. Gasoline Vehicle and Hybrid or Electric Vehicles

1. Please indicate a type of the vehicle that you most often drive.

    1. Gasoline vehicle
    2. Hybrid or electric vehicle
    3. Don’t have a vehicle

2. How interested are you in hybrid or electric vehicles?

    1. Very high
    2. High
    3. Neutral
    4. Low
    5. Very Low

3. If you were in the market for a new vehicle now, how much you are willing to pay for a new gasoline vehicle.

    1. <$20,000
    2. $20,000-$24,000
    3. $24,001-$28,000
    4. $28,001-$32,000
    5. $32,001-$36,000
    6. >$36,000

4. If you were in the market for a new vehicle now, how much you are willing to pay for a new hybrid or electric vehicle.

    1. <$20,000
    2. $20,000-$24,000
    3. $24,001-$28,000
    4. $28,001-$32,000
    5. $32,001-$36,000
    6. >$36,000

B. Basic Information about Yourself

1. What is your gender?

1. Female
2. Male

2. Please indicate the range that best represents your age?

1. 18-30 years
2. 31-40 years
3. 41-50 years
4. 51-60 years
5. Over 61

3. What is your marital status?

1. Married
2. Single
3. Other

4. How many children do you have?

1. 0
2. 1
3. 2
4. 3
5. 4
6. 5 and above

5. How many vehicles does your household have?

1. 0
2. 1
3. 2
4. 3
5. 4
6. 5 and above

6. What is the highest level of formal education that you have achieved?

1. Some high school or less
2. High school graduate
3. Some college
4. Four-year college graduate
5. Postgraduate degree

7. Please indicate the range that best describes average annual distance you travel in your car.

1. <2,500 miles
2. 2,500-5,000 miles
3. 5,001-7,500 miles
4. 7,501-10,000 miles
5. 10,001-20,000 miles
6. >20,000 miles

8. Please indicate the category that best represents your total annual household income including annual tax return.

1. <$10,000
2. $10,000-$20,000
3. $20,001-$30,000
4. $30,001-$40,000
5. $40,001-$50,000
6. $50,001-$75,000
7. >$75,000

C. Information about your preference

1. Please rank the top 3 factors that impact your decision to purchase a vehicle.

___ Design
___ Safety
___ Acceleration
___ Ease of driving
___ Price
___ Fuel efficiency
___ Other

2. How interested are you in global warming?

1. Very high
2. High
3. Neutral
4. Low
5. Very Low

3. How interested are you in environmental issues?

1. Very high
2. High
3. Neutral
4. Low
5. Very Low

Thank you for your time!

Appendix 2. Ordered bit model calculation on WTP for gasoline vehicle.

```
Ordered probit regression                         Number of obs   =         50
                                                  LR chi2(19)     =      34.44
                                                  Prob > chi2     =     0.0163
Log likelihood = -42.558007                       Pseudo R2       =     0.2881
```

wtp_for_ga~e	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
type_of_ve~e	-.1870729	.9384887	-0.20	0.842	-2.026477	1.652331
interest_l~v	.2149712	.3069164	0.70	0.484	-.386574	.8165164
gender	-.2535412	.4597574	-0.55	0.581	-1.154649	.6475668
age	.2866706	.2616171	1.10	0.273	-.2260895	.7994307
marital_st~s	-.5760493	.5569952	-1.03	0.301	-1.66774	.5156412
number_of_~n	.1649675	.2184346	0.76	0.450	-.2631564	.5930915
number_of_~e	.8145788	.408916	1.99	0.046	.0131182	1.616039
education_~l	.0348701	.2065983	0.17	0.866	-.3700552	.4397953
annual_tra~e	.6930475	.2448217	2.83	0.005	.2132058	1.172889
income	-.352363	.1813657	-1.94	0.052	-.7078332	.0031072
design	.7841371	.4888402	1.60	0.109	-.173972	1.742246
safety	1.034738	.6791396	1.52	0.128	-.2963511	2.365827
acceleration	.4311119	.8081087	0.53	0.594	-1.152752	2.014976
ease_of_dr~g	.0075074	.5737997	0.01	0.990	-1.117119	1.132134
price	-.1007723	.6240171	-0.16	0.872	-1.323823	1.122279
fuel_effic~y	-1.192905	.6283928	-1.90	0.058	-2.424532	.0387225
other	-.7570135	.8872845	-0.85	0.394	-2.496059	.9820323
interest_l~g	-2.204507	.7284797	-3.03	0.002	-3.632301	-.7767131
interest_l~s	2.140133	.7085887	3.02	0.003	.7513249	3.528941

Appendix 3. Ordered bit model calculation on WTP for HEVs and EVs.

```
Ordered probit regression                         Number of obs   =         50
                                                  LR chi2(19)     =      41.95
                                                  Prob > chi2     =     0.0018
Log likelihood = -48.423639                       Pseudo R2       =     0.3022
```

wtp_for_eh~v	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
type_of_ve~e	.1768389	.8936078	0.20	0.843	-1.5746	1.928278
interest_l~v	.5697668	.3587215	1.59	0.112	-.1333143	1.272848
gender	-.0528882	.4356774	-0.12	0.903	-.9068002	.8010238
age	-.2907037	.2607934	-1.11	0.265	-.8018494	.2204421
marital_st~s	.0261027	.4923262	0.05	0.958	-.938839	.9910444
number_of_~n	.5341538	.2243835	2.38	0.017	.0943702	.9739374
number_of_~e	.8110805	.3806344	2.13	0.033	.0650508	1.55711
education_~l	-.1243406	.1932828	-0.64	0.520	-.5031679	.2544867
annual_tra~e	.5904433	.2354387	2.51	0.012	.1289919	1.051895
income	-.2114795	.1539633	-1.37	0.170	-.5132419	.090283
design	-.0353703	.4715292	-0.08	0.940	-.9595504	.8888099
safety	.8154457	.5609007	1.45	0.146	-.2838995	1.914791
acceleration	-.8178309	.8813928	-0.93	0.353	-2.545329	.9096673
ease_of_dr~g	.8485848	.5629389	1.51	0.132	-.2547552	1.951925
price	-.8975901	.5690642	-1.58	0.115	-2.012935	.2177552
fuel_effic~y	-1.850964	.6113769	-3.03	0.002	-3.04924	-.652687
other	-.5523794	.8604309	-0.64	0.521	-2.238793	1.134034
interest_l~g	-.8870299	.5657957	-1.57	0.117	-1.995969	.2219093
interest_l~s	.4642628	.5233819	0.89	0.375	-.5615468	1.490072

Appendix 4. Marginal effects of ordered profit model calculation on WTP for gasoline vehicle.

```
Marginal effects after oprobit
      y  = Pr(wtp_for_gasoline_vehicle==1) (predict, outcome(1))
         =  .58835739
```

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
type_o~e	.0727933	.36477	0.20	0.842	-.642134	.787721	.94
intere~v	-.083649	.11863	-0.71	0.481	-.316162	.148864	4.1
gender*	.0992162	.18	0.55	0.581	-.253578	.452011	.66
age	-.1115484	.10099	-1.10	0.269	-.309486	.086389	3.26
marita~s	.2241507	.21436	1.05	0.296	-.195988	.644289	.6
number~n	-.0641917	.08434	-0.76	0.447	-.229489	.101105	1.4
number~e	-.3169666	.1581	-2.00	0.045	-.626845	-.007088	1.64
educat~l	-.0135685	.08039	-0.17	0.866	-.171132	.143995	3.8
annual~e	-.2696767	.09143	-2.95	0.003	-.448884	-.09047	3.38
income	.1371105	.0694	1.98	0.048	.001086	.273135	4.96
design*	-.3043527	.18186	-1.67	0.094	-.660786	.052081	.3
safety*	-.3569047	.18969	-1.88	0.060	-.7287	.01489	.74
accele~n*	-.1705711	.31698	-0.54	0.590	-.791839	.450697	.06
ease_o~g*	-.0029225	.22348	-0.01	0.990	-.440935	.43509	.24
price*	.0393326	.24412	0.16	0.872	-.439128	.517793	.66
fuel_e~y*	.4476277	.20532	2.18	0.029	.045205	.850051	.76
other*	.2584915	.24319	1.06	0.288	-.218158	.735141	.1
intere~g	.8578115	.27606	3.11	0.002	.316748	1.39888	4.36
intere~s	-.8327625	.27212	-3.06	0.002	-1.36611	-.299414	4.38

```
Marginal effects after oprobit
      y  = Pr(wtp_for_gasoline_vehicle==2) (predict, outcome(2))
         =  .34594239
```

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
type_o~e	-.0488756	.24454	-0.20	0.842	-.528169	.430418	.94
intere~v	.0561644	.08303	0.68	0.499	-.106579	.218908	4.1
gender*	-.0646768	.11448	-0.56	0.572	-.289059	.159705	.66
age	.0748969	.07237	1.03	0.301	-.066943	.216737	3.26
marita~s	-.1505014	.15183	-0.99	0.322	-.448087	.147085	.6
number~n	.0431002	.05927	0.73	0.467	-.073068	.159268	1.4
number~e	.2128208	.12285	1.73	0.083	-.027959	.4536	1.64
educat~l	.0091103	.05422	0.17	0.867	-.09715	.11537	3.8
annual~e	.1810689	.08618	2.10	0.036	.012164	.349974	3.38
income	-.0920601	.05481	-1.68	0.093	-.199492	.015372	4.96
design*	.1763444	.10418	1.69	0.090	-.027835	.380524	.3
safety*	.2608112	.1567	1.66	0.096	-.046322	.567944	.74
accele~n*	.0980922	.14845	0.66	0.509	-.192858	.389042	.06
ease_o~g*	.0019598	.14963	0.01	0.990	-.291314	.295233	.24
price*	-.0261263	.16079	-0.16	0.871	-.341261	.289008	.66
fuel_e~y*	-.2103737	.09449	-2.23	0.026	-.395575	-.025172	.76
other*	-.1968137	.20746	-0.95	0.343	-.603429	.209802	.1
intere~g	-.5759601	.25528	-2.26	0.024	-1.07631	-.075614	4.36
intere~s	.5591414	.24504	2.28	0.022	.078873	1.03941	4.38

```
Marginal effects after oprobit
      y  = Pr(wtp_for_gasoline_vehicle==3) (predict, outcome(3))
         =  .03657976
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
type_o~e	-.0114994	.05807	-0.20	0.843	-.125321	.102322	.94
intere~v	.0132144	.01933	0.68	0.494	-.024666	.051095	4.1
gender*	-.0162616	.03213	-0.51	0.613	-.079237	.046714	.66
age	.0176218	.01838	0.96	0.338	-.018396	.053639	3.26
marita~s	-.03541	.03807	-0.93	0.352	-.110035	.039215	.6
number~n	.0101406	.01401	0.72	0.469	-.017319	.0376	1.4
number~e	.0500725	.03739	1.34	0.180	-.023208	.123353	1.64
educat~l	.0021435	.01274	0.17	0.866	-.022826	.027113	3.8
annual~e	.0426019	.02591	1.64	0.100	-.008175	.093379	3.38
income	-.0216599	.01605	-1.35	0.177	-.053126	.009806	4.96
design*	.0553153	.04754	1.16	0.245	-.03787	.148501	.3
safety*	.0479078	.03537	1.35	0.176	-.021408	.117224	.74
accele~n*	.0316321	.07069	0.45	0.655	-.10691	.170175	.06
ease_o~g*	.0004625	.03546	0.01	0.990	-.069029	.069954	.24
price*	-.006303	.03961	-0.16	0.874	-.083947	.071341	.66
fuel_e~y*	-.0901216	.06692	-1.35	0.178	-.221289	.041046	.76
other*	-.0321687	.02903	-1.11	0.268	-.08906	.024723	.1
intere~g	-.1355119	.0843	-1.61	0.108	-.300747	.029723	4.36
intere~s	.1315548	.08434	1.56	0.119	-.033744	.296854	4.38

```
Marginal effects after oprobit
      y  = Pr(wtp_for_gasoline_vehicle==4) (predict, outcome(4))
         =  .02512185
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
type_o~e	-.0102027	.0522	-0.20	0.845	-.112518	.092113	.94
intere~v	.0117242	.01729	0.68	0.498	-.022167	.045615	4.1
gender*	-.0148846	.03082	-0.48	0.629	-.075297	.045527	.66
age	.0156346	.0166	0.94	0.346	-.016905	.048174	3.26
marita~s	-.0314169	.03571	-0.88	0.379	-.101414	.03858	.6
number~n	.0089971	.0124	0.73	0.468	-.015303	.033297	1.4
number~e	.044426	.03519	1.26	0.207	-.024539	.113391	1.64
educat~l	.0019018	.01119	0.17	0.865	-.020031	.023835	3.8
annual~e	.0377979	.02456	1.54	0.124	-.010343	.085939	3.38
income	-.0192174	.01489	-1.29	0.197	-.048399	.009965	4.96
design*	.0569149	.05365	1.06	0.289	-.048234	.162064	.3
safety*	.0399187	.03203	1.25	0.213	-.022866	.102704	.74
accele~n*	.0322275	.08064	0.40	0.689	-.125816	.190271	.06
ease_o~g*	.0004108	.03154	0.01	0.990	-.061401	.062223	.24
price*	-.0056548	.036	-0.16	0.875	-.07621	.0649	.66
fuel_e~y*	-.1083395	.0983	-1.10	0.270	-.301004	.084325	.76
other*	-.0249475	.02343	-1.06	0.287	-.070867	.020972	.1
intere~g	-.1202308	.08225	-1.46	0.144	-.281441	.04098	4.36
intere~s	.1167199	.08141	1.43	0.152	-.042848	.276288	4.38

Marginal effects after oprobit
y = Pr(wtp_for_gasoline_vehicle==5) (predict, outcome(5))
= .0039986

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
type_o~e	-.0022156	.01141	-0.19	0.846	-.024573	.020142	.94
intere~v	.002546	.00472	0.54	0.589	-.006697	.011789	4.1
gender*	-.0033933	.0079	-0.43	0.668	-.018879	.012093	.66
age	.0033951	.00502	0.68	0.498	-.006436	.013226	3.26
marita~s	-.0068224	.01041	-0.66	0.512	-.027231	.013586	.6
number~n	.0019538	.0034	0.57	0.565	-.004709	.008617	1.4
number~e	.0096473	.01267	0.76	0.447	-.015193	.034488	1.64
educat~l	.000413	.00248	0.17	0.868	-.004442	.005268	3.8
annual~e	.008208	.01038	0.79	0.429	-.012145	.028561	3.38
income	-.0041732	.00539	-0.77	0.439	-.014731	.006385	4.96
design*	.0157781	.0226	0.70	0.485	-.028509	.060065	.3
safety*	.0082669	.01104	0.75	0.454	-.01338	.029914	.74
accele~n*	.0086193	.02696	0.32	0.749	-.044221	.06146	.06
ease_o~g*	.0000894	.00686	0.01	0.990	-.013354	.013533	.24
price*	-.0012486	.00836	-0.15	0.881	-.017625	.015128	.66
fuel_e~y*	-.0387929	.05094	-0.76	0.446	-.138629	.061044	.76
other*	-.0045617	.00685	-0.67	0.506	-.01799	.008867	.1
intere~g	-.0261088	.03292	-0.79	0.428	-.090625	.038408	4.36
intere~s	.0253464	.03189	0.79	0.427	-.037149	.087842	4.38

Appendix 5. Marginal effects of ordered profit model calculation on WTP for HEVs and EVs.

```
Marginal effects after oprobit
      y  = Pr(wtp_for_ehv_ev==1) (predict, outcome(1))
         =  .36774257
```

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
type_o~e	-.0666352	.33693	-0.20	0.843	-.727001	.593731	.94
intere~v	-.2146956	.14076	-1.53	0.127	-.490583	.061192	4.1
gender*	.0198693	.16317	0.12	0.903	-.29994	.339679	.66
age	.109541	.09918	1.10	0.269	-.084848	.30393	3.26
marita~s	-.0098359	.18541	-0.05	0.958	-.373227	.353555	.6
number~n	-.2012762	.08946	-2.25	0.024	-.376613	-.025939	1.4
number~e	-.3056258	.14704	-2.08	0.038	-.593818	-.017434	1.64
educat~l	.0468532	.07333	0.64	0.523	-.09688	.190586	3.8
annual~e	-.2224868	.09574	-2.32	0.020	-.410139	-.034834	3.38
income	.0796882	.05888	1.35	0.176	-.035709	.195085	4.96
design*	.0133589	.17858	0.07	0.940	-.336642	.36336	.3
safety*	-.3135134	.21016	-1.49	0.136	-.725418	.098391	.74
accele~n*	.3173256	.32055	0.99	0.322	-.31094	.945591	.06
ease_o~g*	-.2837688	.16025	-1.77	0.077	-.597854	.030316	.24
price*	.3108524	.17916	1.74	0.083	-.040301	.662006	.66
fuel_e~y*	.501835	.1349	3.72	0.000	.237436	.766234	.76
other*	.2161534	.33808	0.64	0.523	-.446462	.878769	.1
intere~g	.3342445	.22003	1.52	0.129	-.097002	.765491	4.36
intere~s	-.1749403	.19933	-0.88	0.380	-.565618	.215737	4.38

```
Marginal effects after oprobit
      y  = Pr(wtp_for_ehv_ev==2) (predict, outcome(2))
         =  .51176393
```

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
type_o~e	.0311578	.16004	0.19	0.846	-.282508	.344823	.94
intere~v	.1003892	.09531	1.05	0.292	-.08642	.287198	4.1
gender*	-.009153	.07421	-0.12	0.902	-.154611	.136305	.66
age	-.0512201	.05519	-0.93	0.353	-.159391	.056951	3.26
marita~s	.0045991	.08647	0.05	0.958	-.164878	.174077	.6
number~n	.0941144	.07202	1.31	0.191	-.047036	.235265	1.4
number~e	.1429071	.10518	1.36	0.174	-.063242	.349056	1.64
educat~l	-.021908	.03672	-0.60	0.551	-.093878	.050062	3.8
annual~e	.1040322	.08018	1.30	0.194	-.053118	.261182	3.38
income	-.0372613	.03495	-1.07	0.286	-.105765	.031243	4.96
design*	-.0063216	.08573	-0.07	0.941	-.174352	.161708	.3
safety*	.1829838	.15603	1.17	0.241	-.122838	.488805	.74
accele~n*	-.212815	.27133	-0.78	0.433	-.744607	.318977	.06
ease_o~g*	.0692624	.07927	0.87	0.382	-.086097	.224622	.24
price*	-.099677	.08661	-1.15	0.250	-.269431	.070077	.66
fuel_e~y*	.0377881	.14031	0.27	0.788	-.237208	.312784	.76
other*	-.1317101	.25321	-0.52	0.603	-.627985	.364564	.1
intere~g	-.1562888	.14141	-1.11	0.269	-.43344	.120863	4.36
intere~s	.0818001	.10411	0.79	0.432	-.122247	.285848	4.38

```
Marginal effects after oprobit
      y  = Pr(wtp_for_ehv_ev==2) (predict, outcome(2))
         =  .51176393
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
type_o~e	.0311578	.16004	0.19	0.846	-.282508	.344823	.94
intere~v	.1003892	.09531	1.05	0.292	-.08642	.287198	4.1
gender*	-.009153	.07421	-0.12	0.902	-.154611	.136305	.66
age	-.0512201	.05519	-0.93	0.353	-.159391	.056951	3.26
marita~s	.0045991	.08647	0.05	0.958	-.164878	.174077	.6
number~n	.0941144	.07202	1.31	0.191	-.047036	.235265	1.4
number~e	.1429071	.10518	1.36	0.174	-.063242	.349056	1.64
educat~l	-.021908	.03672	-0.60	0.551	-.093878	.050062	3.8
annual~e	.1040322	.08018	1.30	0.194	-.053118	.261182	3.38
income	-.0372613	.03495	-1.07	0.286	-.105765	.031243	4.96
design*	-.0063216	.08573	-0.07	0.941	-.174352	.161708	.3
safety*	.1829838	.15603	1.17	0.241	-.122838	.488805	.74
accele~n*	-.212815	.27133	-0.78	0.433	-.744607	.318977	.06
ease_o~g*	.0692624	.07927	0.87	0.382	-.086097	.224622	.24
price*	-.099677	.08661	-1.15	0.250	-.269431	.070077	.66
fuel_e~y*	.0377881	.14031	0.27	0.788	-.237208	.312784	.76
other*	-.1317101	.25321	-0.52	0.603	-.627985	.364564	.1
intere~g	-.1562888	.14141	-1.11	0.269	-.43344	.120863	4.36
intere~s	.0818001	.10411	0.79	0.432	-.122247	.285848	4.38


```
Marginal effects after oprobit
      y  = Pr(wtp_for_ehv_ev==2) (predict, outcome(2))
         =  .51176393
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
type_o~e	.0311578	.16004	0.19	0.846	-.282508	.344823	.94
intere~v	.1003892	.09531	1.05	0.292	-.08642	.287198	4.1
gender*	-.009153	.07421	-0.12	0.902	-.154611	.136305	.66
age	-.0512201	.05519	-0.93	0.353	-.159391	.056951	3.26
marita~s	.0045991	.08647	0.05	0.958	-.164878	.174077	.6
number~n	.0941144	.07202	1.31	0.191	-.047036	.235265	1.4
number~e	.1429071	.10518	1.36	0.174	-.063242	.349056	1.64
educat~l	-.021908	.03672	-0.60	0.551	-.093878	.050062	3.8
annual~e	.1040322	.08018	1.30	0.194	-.053118	.261182	3.38
income	-.0372613	.03495	-1.07	0.286	-.105765	.031243	4.96
design*	-.0063216	.08573	-0.07	0.941	-.174352	.161708	.3
safety*	.1829838	.15603	1.17	0.241	-.122838	.488805	.74
accele~n*	-.212815	.27133	-0.78	0.433	-.744607	.318977	.06
ease_o~g*	.0692624	.07927	0.87	0.382	-.086097	.224622	.24
price*	-.099677	.08661	-1.15	0.250	-.269431	.070077	.66
fuel_e~y*	.0377881	.14031	0.27	0.788	-.237208	.312784	.76
other*	-.1317101	.25321	-0.52	0.603	-.627985	.364564	.1
intere~g	-.1562888	.14141	-1.11	0.269	-.43344	.120863	4.36
intere~s	.0818001	.10411	0.79	0.432	-.122247	.285848	4.38

Marginal effects after oprobit
y = Pr(wtp_for_ehv_ev==2) (predict, outcome(2))
= .51176393

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
type_o~e	.0311578	.16004	0.19	0.846	-.282508	.344823	.94
intere~v	.1003892	.09531	1.05	0.292	-.08642	.287198	4.1
gender*	-.009153	.07421	-0.12	0.902	-.154611	.136305	.66
age	-.0512201	.05519	-0.93	0.353	-.159391	.056951	3.26
marita~s	.0045991	.08647	0.05	0.958	-.164878	.174077	.6
number~n	.0941144	.07202	1.31	0.191	-.047036	.235265	1.4
number~e	.1429071	.10518	1.36	0.174	-.063242	.349056	1.64
educat~l	-.021908	.03672	-0.60	0.551	-.093878	.050062	3.8
annual~e	.1040322	.08018	1.30	0.194	-.053118	.261182	3.38
income	-.0372613	.03495	-1.07	0.286	-.105765	.031243	4.96
design*	-.0063216	.08573	-0.07	0.941	-.174352	.161708	.3
safety*	.1829838	.15603	1.17	0.241	-.122838	.488805	.74
accele~n*	-.212815	.27133	-0.78	0.433	-.744607	.318977	.06
ease_o~g*	.0692624	.07927	0.87	0.382	-.086097	.224622	.24
price*	-.099677	.08661	-1.15	0.250	-.269431	.070077	.66
fuel_e~y*	.0377881	.14031	0.27	0.788	-.237208	.312784	.76
other*	-.1317101	.25321	-0.52	0.603	-.627985	.364564	.1
intere~g	-.1562888	.14141	-1.11	0.269	-.43344	.120863	4.36
intere~s	.0818001	.10411	0.79	0.432	-.122247	.285848	4.38