

## Are Malaysian Consumers Willing to Pay for Hybrid Cars' Attributes? (Adakah Pengguna Malaysia Bersedia Membayar Sumbangan Kereta Hibrid?)

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### ABSTRACT

The Malaysian government has recently introduced a new National Automotive Policy in 2014. The policy aims to make Malaysia an Energy Efficient Vehicle (EEV) and component production hub for the ASEAN region. Since consumers' preference of Hybrid Cars (HCs)/EEVs is strongly influenced by the attributes of those cars, thus this study wishes to investigate whether respondents' preference for HCs is due to environmental or economic attributes. The study uses Choice Experiment technique where respondents' preference are measured in terms of their Willingness to Pay for such attributes. Two formats of factors are applied, bundle of attributes and individual attributes. The objective of applying these two factors is to investigate whether bias in Independent Valuation and Summation (IVS) happens or not. The results on bundle show that the respondents prefer environmental attributes more than economic attributes when buying HCs. In terms of IVS, we found that bias in IVS does not occur. Three policy implications can be drawn. First, the Malaysian government needs to take necessary measures if they are keen to encourage the public to buy HCs. Second, more understanding and awareness campaigns on HCs need to be done by the government. Third, the noise levels of the engine is an important attribute that needs to be considered in developing the EEV industry in Malaysia.

*Keywords:* Choice Experiment (CE); Hybrid Cars (HCs); Independent Valuation and Summation (IVS); Willingness to Pay (WTP)

### ABSTRAK

Kerajaan Malaysia telah mengumumkan Dasar Automotif Nasional yang baharu pada 2014. Dasar baharu ini bertujuan membangunkan Malaysia sebagai hub serantau bagi Kenderaan Cepak Tenaga (EEV). Memandangkan keutamaan pengguna untuk menggunakan Kereta Hibrid (HCs)/EEVs ini sangat dipengaruhi oleh ciri-ciri yang terdapat pada kereta berkenaan, maka kajian ini bertujuan untuk mengkaji adakah permintaan pengguna terhadap kereta ini disebabkan oleh ciri-ciri alam sekitar ataupun ciri-ciri ekonomi. Kajian ini menggunakan teknik Eksperimen Pilihan di mana keutamaan responden diukur melalui tingkat kesanggupan membayar mereka bagi ciri-ciri tersebut. Keutamaan ciri-ciri ini dikaji kepada dua pendekatan- terkumpul dan individu. Tujuan dua pendekatan ini adalah untuk mengkaji samada wujud masalah bias dalam Independent Valuation and Summation (IVS) atau tidak. Hasil kajian yang menggunakan pendekatan terkumpul menunjukkan responden cenderung kepada ciri-ciri alam sekitar berbanding ciri-ciri ekonomi. Dari segi IVS, hasil kajian mendapati tidak berlaku masalah IVS. Tiga implikasi polisi dapat disimpulkan. Satu, Kerajaan Malaysia perlu melakukan langkah yang diperlukan sekiranya ingin menggalakkan penduduk Malaysia membeli HCs. Kedua, Kerajaan Malaysia perlu mengadakan banyak kempen yang dapat meningkatkan kefahaman dan kesedaran masyarakat tentang HCs. Ketiga, tahap kebisingan enjin kereta hibrid perlu ditekankan dalam membangunkan industri EEV di Malaysia.

*Kata kunci:* Eksperimen Pilihan (CEs); Kereta Hibrid (HCs); Independent Valuation and Summation (IVS); Kesanggupan untuk Membayar (WTP)

### INTRODUCTION

Emissions of greenhouse gases (GHGs), such as carbon dioxide (CO<sub>2</sub>), is a serious matter in Malaysia, especially in the automotive industry. Car ownership in Malaysia is

the third highest in the world which is at 93 percent, with 54 percent of households having more than one car. As such, the Malaysian government has recently introduced a new National Automotive Policy (NAP), NAP 2014, so as to move the automotive industry towards reducing



the environmental impact of energy consumption and mitigating the effects of global warming. This is in accordance with Malaysia's commitment, as a participant of the Paris 2015 COP 21 Conference (United Nations Conference on Climate Change), to cut carbon emissions' intensity up to 45 percent by 2030 as part of its obligation to combat climate change.

The NAP 2014 was introduced as a roadmap to strengthen the whole automotive industry as it aims to become an Energy Efficient Vehicle (EEV) and component production hub for the region, especially in the ASEAN market. EEV is defined as vehicles that meet a set of specification in terms of carbon emission level (CO<sub>2</sub>/km) and fuel consumption (litre/km). EEV includes fuel-efficient internal combustion engine (ICE) vehicles, hybrid, electric vehicles (EV) and alternative fuelled vehicles such as compressed natural gas (CNG), liquefied petroleum gas (LPG), biodiesel, ethanol, hydrogen and fuel cell. By 2020, the government expects 80% of all vehicles produced locally to be EEVs.

Hybrid cars (HCs) are not considered new in developed countries such as Germany, Japan and the United States. Their acceptance in developing countries however is still low, mainly due to their high prices and society's indifference attitude towards environmental degradation. One of the economics tools that can be used in reducing the HCs prices is to give an exemption on excise and import duties for the cars. Such reducing in HCs prices will eventually encourage consumers for using the cars. This measure was implemented by the Malaysian government. In 2013, as an effort to promote the usage of HCs, the Malaysian government provided incentives in the forms of exemption on excise and import duties for the purchasing of Completely Built-Up (CBU) HCs with an engine size of 2.0L and below.<sup>1</sup> As a result, the number of HCs that were registered in 2013 had skyrocketed when compared to 2011 and 2012. The total number of HCs that were registered with Malaysia's Ministry of Transport in 2013 was 16,867 units, compared to 26 units in 2012 and 364 units in 2011. The share of HCs in the Malaysia's automotive market however, is considered small. For instance, with the total of 592,311 units of cars registered in 2013, the share of HCs was less than three percent. Apart from that, factors such as the hike in petrol prices also contributed to the increase in HCs' sales volume.<sup>2,3</sup> The incentives, however, had expired at the end of December 2013. Consequently, the HCs received less demand from the public in 2014 with only 7,677 units of HCs were registered, which seen a reduction of more than 50% as compared to the figure in 2013. The reduce in registered HCs has encouraged the study to be carried out.

The main objective of the study is to investigate whether consumers' preference for HCs was due to the exemption of duties or other factors. To achieve this objective, we have identified two factors that need to be analysed; economic and environmental factors. Apart

from that, the study also wishes to estimate respondents' Willingness to Pay for the different attributes of HCs. Lastly, the study is designed to test whether bias in Independent Valuation and Summation (IVS) happens or not. Measuring the willingness to pay (WTP) on such attributes is not considered something new and has been applied by many researchers (Rahmani & Loureiro 2018; Fernandez-Antolin et al. 2018; Beck et al. 2011; Mabit & Fosgerau 2011; Maness & Cirillo 2012). However, what is new is the introduction of Independent Valuation and Summation (IVS) in our study. IVS is a scenario where analysts investigate whether the summation value of individual attributes are statistically different from the value placed on a bundle (Garrod & Willis 1999). The details of IVS will be explained in the following section.

This paper is organised as follows. Section 2 explains the details of HCs, the valuation technique and IVS bias. The section also explains the valuation technique employed in the study, which is the Choice Experiment (CE) technique. Section 3 describes the study's design. This includes the selection of attributes (i.e. a bundle of attributes and individual attributes), their levels (i.e. small, medium and large for economic factor or low, medium and high for environmental factor) and the formation of choice cards. Section 4 presents the results where public preferences for HCs are presented and discussed. The results of marginal Willingness to Pay (WTP) and Independent Valuation and Summation (IVS) are also discussed in the section. Finally, some conclusions and policy implications are presented in Section 5.

#### HYBRID CARS (HCs), VALUATION TECHNIQUE AND INDEPENDENT VALUATION AND SUMMATION (IVS)

Although the history of HCs dated back to 1834, intensifying efforts in developing HCs only begun in 1970s, due to the energy crisis at that time (i.e. the Arab oil embargo). The United States, for example, had launched the Electric and Hybrid Vehicle Research, Development and Demonstration Act in 1976. The first modern HC that was introduced in the automotive market was by Toyota in 1997, with its Prius model. It was then followed by the Honda Insight and the Honda Civic Hybrid. To date, more than 30 HC models are used on the road.

Studies on HCs have been conducted in various disciplines such as in engine technology (e.g. Chan 2007), its impact on the environment (e.g. Romm 2006) and on government policies (e.g. Sallee 2011). Using a tax-subsidies approach on Toyota Prius, Sallee (2011) found that consumers in the United States received the most benefits from government policies on HCs. Another significant literature on HCs is regarding the consumers' preference for these cars. Since the HCs were

not available at that time, most studies were conducted on Electric Vehicles. Researchers such as Train (1980), Beggs and Cardell (1980), among others, had investigated consumers' preference for Electric Vehicles and their attributes.

Train (1980) looked at consumers' preference for specific types of non-gasoline car. Working together with Lawrence Livermore Laboratory, the researcher's objective was to estimate values that serve as "base-case" for analysing purposes. The researcher estimated the "base-case" for two cases; the most likely car and the optimistic car. A similar study was conducted by Beggs and Cardell (1980) in the Baltimore area in the United States. They found that poor households put more emphasis on purchasing cost rather than operating cost when deciding to buy a car. Meanwhile, Hidrue et al. (2011) investigated the relationship between socio-economic characteristics and the demand for HCs. They discovered that younger and educated respondents were more inclined in buying HCs. Respondents who foresee higher gas prices in the future also had a similar tendency. Other characteristics included factors such as a green lifestyle and the availability of electric plug at home.

Consumer's preference for HCs is determined by using the Stated Preference Technique. The technique is used to estimate the monetary value of environmental goods and services that are not traded in the market such as, but not limit to, recreational parks, the quality of rivers and scenic views. Stated Preference Technique has been used by government agencies to estimate environmental damages such as the oil spill incident by Exxon Corporation in Prince William Sound, Alaska and the environmental effects of uranium mining in Kakadu National Park in Australia. One of the most widely used Stated Preference Technique for estimating environmental goods and services is the Contingent Valuation Method (CVM).

CVM, however, has received many criticisms. One of these criticisms is on how questions are posed to the respondents in order to elicit their Willingness to Pay (WTP) values. In CVM, respondents are required to state their WTP directly. However, due to their unfamiliarity with the goods they are evaluating, respondents are unable to state the true values particularly when open-ended contingent valuation is applied (Willis 2002). In addition, the technique is also susceptible to a strategic bias where respondents are most likely to place false values if they believe that their answers will influence the outcome of the survey (Garrod & Willis 1999). Due to the bias, results from such technique are usually questioned and challenged by the affected parties. For example, Exxon Corporation and the uranium mine operators in Kakadu National Park had questioned the credibility of the technique and the estimated cost of damages. However, this strategic bias occurs mainly in the double-bounded contingent valuation, but less likely

to happen in an open-ended format. To avoid the issue of strategic bias, most of the studies in environmental valuation literature have now focused on the elicitation technique (e.g. Cameron & Quiggin 1994; Kealy & Turner 1993; Ready et al. 2001). Other valuation methods have also been investigated and the one that will be discussed below and applied in this study is the Choice Experiment (CE) Technique.

CE was introduced in the literature by Louviere and Woodworth (1983) and the technique has been applied in marketing studies before being used in the valuation of environmental goods and services. The CE methodology is based on the Lancaster's approach and the random utility model (Lancaster 1966; McFadden 1974), where researchers work on models that are based on utility functions which are composed of attributes and their levels. The technique requires respondents to choose their most preferred alternative from a series of alternatives presented to them (Bateman et al. 2002). The technique has many advantages compared to the CVM, although both of them belong to the Stated Preference Technique family (Hanley et al. 2001). First, instead of asking respondents to state their WTP directly as applied in CVM, CE embeds the WTP together with other attributes in the alternative. In other words, respondents are required to consider other attributes that appear in the alternatives before choosing their most preferred alternative. By doing so, certain problems that always occur when WTP is asked directly (i.e. starting behaviours, yea-saying, protest bids, etc.) could be reduced. Second, CE is informative because respondents are required to state their preferences on a number of alternatives presented to them. This argument is espoused by Adamowicz et al. (1998) where they claimed that CE may help researchers to understand respondents' preferences over the attributes of the scenario, rather than specific scenarios *per se* as in CVM. Finally, CE is considered to be flexible when compared to CVM. This is because the former allows researchers to investigate multidimensional changes as compared to the latter, where specific changes are required. Even though CVM can still be applied to investigate multidimensional changes by applying multiple CVM exercises, the sum of the valuation obtained from a series of these exercises is questionable. It is argued that the value obtained from multiple CVM exercises is susceptible to bias problems, known in the economic valuation literature as a bias in Independent Valuation and Summation (IVS).

The issue of IVS has been introduced to the literature by Hoehn and Randall (1989). Their concern on the issue arose when many proposals on public works in the United States have been approved based on the benefit-cost criterion. The authors argued that the benefit-cost procedures used at the time always overstate the value of benefits. This came from an independency of proposal evaluation where each agency evaluates its proposal independently from other agencies. Therefore,

benefits estimated from a project might be considered as a different benefits in other projects. Some analysts (Bateman et al. 1997; Bernard & Bernard 2010; Boyle et al. 1994) used the term “part-whole” rather than IVS. But throughout this article, the term IVS will be used instead. The bias in IVS is said to happen if the summation value of individual attributes is statistically different from the value placed on a bundle of attributes (Garrod & Willis 1999).

Due to the fact that respondents in CVM are asked to value scenario as a whole, this suggests that the method is not practical to investigate the IVS bias. Although the multiple CVM studies can be applied to investigate the IVS, and it has proven to be effective in reducing several biases such as the internal inconsistency in double bounded dichotomous choice format and anchoring effect in CVM (Bateman et al. 2008), this approach is more costly and can be time-consuming. In addition, Adamowicz et al. (1998) claimed that it would be difficult to maintain some degree of orthogonality in the design and administration of the study if respondents are asked a series of contingent scenarios. Hence, we suggest applying the CE because the goods illustrated in the technique encompass the attributes and their levels. Therefore, the summation of values for different attributes and at different levels can easily be conducted.

Following the Random Utility Theory, the estimation of CE data can follow the Random Utility Models. In the models, the utility of an individual can be decomposed into two components, deterministic and stochastic (Parsons & Massey, 2003). To illustrate the model, let us assume that the utility of an individual  $n$  from buying a HC is as shown in (1):

$$U_n = V_n + e_n \quad (1)$$

In a scenario where an individual  $n$  is facing an alternative of whether to buy a hybrid car A or B, she will choose hybrid car A only if  $U_{An} > U_{Bn}$ . Therefore, the probability that the individual will buy hybrid car A is shown in (2):

$$\begin{aligned} P_{An} &= P_r(U_{An} > U_{Bn}) \\ &= P_r(V_{An} + e_{An} > V_{Bn} + e_{Bn}) \\ &= P_r(e_{Bn} - e_{An} < V_{An} - V_{Bn}) \end{aligned} \quad (2)$$

In this study, we employed two types of CE questions. One type requires respondents to answer a whole set of questions, which are grouped into either economic or environmental bundle, that influence them when purchasing HCs. By bundle, we mean that the attributes of the economic factor or the attributes of the environmental factor are bundled together and analyse as one, and not individually. The other type of CE questions relates to individual attributes, i.e. each individual attribute is evaluated separately. The reason for having these individual attributes is to investigate the IVS bias. The individual attributes that belong to the economic bundle are driving range; life span of

hybrid battery; and government incentives, while those belong to the environmental bundle are CO<sub>2</sub> emission level; source of energy; and sound of engine. Two experimental design (for bundle and individual attributes) are employed in constructing the list of potential alternatives. Since the design procedure for both experiments is similar, only an explanation in designing the alternative for individual attributes is provided in the following section.

## CHOICE EXPERIMENTS

### SELECTION OF ATTRIBUTES

The attributes and their levels in this study were determined from a procedure suggested by Bateman et al. (2002). The procedure began with the identification of potential attributes in which the sources came from relevant studies. At this stage, we looked at studies on consumers' preferences related to the attributes of HCs (e.g. Hidrue et al., 2011; Hoen & Koetse 2014; Liu 2014; Messagie et al. 2014); government policies/ incentives of HCs (e.g. Antweiler & Gulati 2013) and the impacts of HCs on the environment (e.g. Doucette & McCulloch 2011; Messagie et al. 2014). Next, three focus group meetings were conducted in order to shortlist the relevant attributes for this study. The number of participants in each meeting was between six (6) and eight (8) people as suggested by Morgan (1997). In the first meeting, the participants were those who actually owned HCs, while participants in the second meeting were those having regular cars. However, in the third meeting, participants were a mixture of hybrid and regular car owners. The next stage of the study was conducting a meeting with the stakeholders/policymakers in the automotive sector such as government agencies and workshop owners. This is important in order to ensure that the proposed attributes are not only demand relevant, but will adhere to the policy requirements as well. In the final stage, the attributes' suitability was investigated by conducting a pilot survey.

### SELECTION OF ATTRIBUTES: ECONOMIC BUNDLE

The individual attributes in the economic bundle are driving range (e.g. Ewing & Sarigöllü 2000; Achtnicht 2012), life span of hybrid battery (e.g. Hoen & Koetse 2014) and government incentives towards HCs (e.g. Axsen et al. 2009). One of the promotional campaigns in encouraging consumers to buy HCs is the driving range or better mileage. This attribute refers to the ability of drivers to travel more distance when using HCs as compared to regular ones. Simply put, HCs consume less fuel for the same distance travelled. Honda, for instance, in its campaign promoting the Jazz hybrid model explained how fuel consumption could be saved

with hybrid engine. The manufacturer claimed that fuel consumption is reduced when the source of energy to accelerate the vehicle does not rely on the fuel solely, but depends on the battery as well. Three levels of driving range were used in this study, namely 20km/litre (the baseline), 25km/litre and 30km/litre.

The second individual attribute is the life span of the hybrid battery as pointed out by Hoen and Koetse (2014). We used the warranty period provided by the HC manufacturer as a proxy for the attribute. People are unwilling to buy HCs partly because the cost of the battery is too expensive and its lifespan is considered short (i.e. 4-6 years) (Erdem et al. 2010). These grouses are undeniably true with earlier HC models but this is no longer an issue as the advancements in battery technology have been continuously improved. This can be seen when Honda is able to reduce its battery replacement costs and extend its warranty period up to 8 years with unlimited mileage. In line with the technology advancements in HCs, we anticipate that this warranty period will be extended even further in the near future. Hence, the years of warranty period in this study varied from a minimum of 8 years (the baseline), to 10 years, and the maximum of 12 years. The last attribute is the incentives provided by the government. The determination of government incentive attribute in HCs study subjects to the study's objective. For example, Axsen et al. (2009) applied three different incentives in their study on the consumers' preferences of HCs in Canada and California states: a subsidy to HEV capital cost, carbon tax and a combination of fee and rebate (feebate) scheme. The reason they applied different incentives was for policy simulations purposes. Meanwhile, Hoen and Koetse (2014) applied the incentives of free parking, access to bus lane, and policy changes on a road tax. They used these incentives as a test for respondents' sensitivity for policy intervention. Since there are no concrete findings in suggesting which government incentives that should be applied then the application of any incentives are possible. Therefore, in this study we applied a combination of excise duty and insurance rebate. Three levels were used; no excise duty (the baseline); no excise duty plus a 10 percent car insurance rebate; and lastly, no excise duty plus a 20 percent car insurance rebate.

#### SELECTION OF ATTRIBUTES: ENVIRONMENTAL BUNDLE

We used three individual attributes for the environmental bundle; CO<sub>2</sub> emission level (e.g. Ziegler 2010; Achtnicht 2012; Ewing & Sarigöllü 2000), source of energy (e.g. Achtnicht 2012; Messagie et al. 2014), and sound of the hybrid engine. One of the main reasons for choosing HCs is due to its low carbon dioxide (CO<sub>2</sub>) emissions. Car manufacturers in developed countries are now facing regulations capping CO<sub>2</sub> emissions at certain levels. The European Commission and the European Automobile

Manufacturers Association (ACEA), for example, have agreed on a new target of CO<sub>2</sub> emissions. The target for a new car is 120 grams per kilometre and by 2020, the target for the average emission is to reduce to 95 grams per kilometre. By using this agreement as a benchmark, we used three levels of CO<sub>2</sub> emissions; i.e. 100 (the baseline), 90 and 80, where all were measured in grams per kilometre. In our survey however, respondents were asked in terms of low, medium or high reduction of CO<sub>2</sub> emissions that corresponds to 100 grams, 90 grams and 80 grams, respectively.

The next individual attribute is the source of energy to accelerate the vehicle. The current technologies of hybrid engines allow people to choose the source of energy, whether to use fuel, battery or both. Since battery is said to be more environmentally friendly compared to petrol (Messagie et al. 2014), we applied three levels to the attribute where petrol was made the baseline (not environmentally friendly), followed by the combination of petrol and battery, and finally only battery. Although we may argue that there is a high correlation between CO<sub>2</sub> emissions and the source of energy, the orthogonality property in the experimental design will ensure that the correlation between attributes (in this case CO<sub>2</sub> and the source of energy) in the design is zero or uncorrelated (Michiel et al. 2006).

The last attribute is the sound of the hybrid engine. The respondents were asked to listen to a recorded engine sound when we explained about the attribute. The examples of these sounds were obtained from the National Highway Traffic Safety Administration (NHTSA) which can be accessed at <http://www.nhtsa.gov/SampleSounds>. We applied three sound levels designated as noisy (the baseline), mild, and quiet.

#### CHOICE CARDS

The full factorial design of these three attributes with three levels each will produce 27 alternatives. Requiring respondents to answer all these alternatives are not advisable since the response from respondents might be less reliable due to issues such as cognitive burden (Hensher 2006). Therefore, the study used the fractional factorial design by the SPSS orthogonal design where the total number of alternatives generated from the design was nine. In terms of pairing the alternatives to form a choice card, the study applied the randomly pairing technique without replacement. As a result, the total number of choice cards that were used in the study was nine. With a rotation approach, each respondent was required to answer four choice cards but in a rotational manner. Hence, the first respondent answered cards were numbers 1, 2, 3, and 4. The second respondent answered cards were numbers 2, 3, 4 and 5, and the rotation continues. The example of choice cards for bundle and individual attributes are shown in Figures 1 and 2.

Choice Card			
	Hybrid A	Hybrid B	Hybrid C
Environmental Friendly	Low	High	Low
Economic Benefits	Large	Medium	Small
Cost	RM9,500	RM12,500	RM8,000
My Choice	<input type="text"/>	<input type="text"/>	<input type="text"/>

FIGURE 1. An example of Choice Card for Bundle Attribute

The alternatives in CE are presented in a choice card format, which consists of a Status Quo alternative combined with hypothetical alternatives. The reason of including hypothetical alternatives is to portraying various scenario to respondents. However, such inclusion has drawbacks. One of the drawbacks is susceptible to a hypothetical bias. Hypothetical bias is a scenario when preferences expressed in a hypothetical survey questionnaire differs from those expressed in a real situation. Several approaches could be applied to reduce the bias such as inferred valuation (Lusk & Norwood 2009) and visual aids (Whittington & Pagiola 2012). But the one that we used in this study is a cheap talk scripts approach. The approach was introduced by Cummings and Taylor (1999) where researchers read a short scripts to respondents, hoping that they will give a realistic answers. We used the following scripts prior to the CE questions. *“We know this is a hypothetical question and you are not obliged to follow what you have decided in the question in a real situation. It is common to see people do different things in a real situation compared to what they have said in the hypothetical question. But we hope you could imagine this is a real situation that requires you to make a decision and think carefully the consequences of your decision. Again, please think carefully the actual things that you would do when you answer the questions in*

*the questionnaire.”* The respondents in this study were required to answer two set of CE questions, individual and bundle attributes.

THE CHOICE DATA

This study focuses on consumers who have real interest in buying cars in the near future, be it a hybrid or regular car. Therefore, to ensure that this can be achieved, the respondents were approached to participate in the study at a few car showrooms. Apart from that, we applied three screening questions in order to select the respondents, i.e. (1) are they presently searching to buy hybrid/regular cars?; (2) do they have enough savings or are they eligible for car loans?; and (3) are they planning on buying a car in the next 12 months? If the respondents answer ‘yes’ to all these questions, then the respondents will be asked to answer questions in the subsequent sections. The approach taken in finding respondents at car showrooms has many benefits including providing a higher probability of meeting respondents who really want to buy a car. However, it comes with a cost. For example, the respondents could only be approached if they are already leaving the showroom. The problem here is that they might be in a hurry when answering the questions. Such factors could influence their responses and perhaps provide ill-informed

Choice Card			
	Hybrid A	Hybrid B	Hybrid C
Driving range(km)/litre	25km/litter	30km/litter	20km/litter
CO <sub>2</sub> Emission(g)/km	High (80g/km)	Medium (90g/km)	Low (100g/km)
Battery Warranty (years)	10 years	12 years	8 years
Source(s) of Energy	Petrol and Battery	Battery	Petrol
Government Incentives	No excise tax + Insurance Rebate 20%	No excise tax + Insurance Rebate 10%	No excise tax
Sound of Hybrid Engine	Quiet	Mild	Noise
Cost	RM9,500	RM12,500	RM8,000
My Choice	<input type="text"/>	<input type="text"/>	<input type="text"/>

FIGURE 2. An example of Choice Card for Individual Attribute

answers. This scenario could affect the study's results in terms of coefficients' significance or the model's goodness of fit.

The data were gathered from August to December 2014, with the study's locations being cities in the northern part of Peninsular Malaysia, namely Alor Setar, Kedah and Kangar, Perlis. A total of 242 respondents were interviewed but only 197 were useful for the estimation purposes. The remainders were excluded because they were identified as 'not consistent' when answering the CE questions. The consistency procedure was done as follows. After answering all the choice cards, the respondents were asked to answer one additional choice card. This card has already been presented to the respondents previously. If the answer is identical to the previous answer then the respondents are considered consistent. Otherwise they are excluded from the study. Since each respondent was required to answer four choice cards, except the card for consistency purposes, the total number of observation was 788.

### RESULTS AND DISCUSSION

Table 1 presents the socio-demographic characteristics of the respondents in the study. The table shows that more than 60% of the respondents were male where Malays recorded 48%, followed by Chinese with 36%

TABLE 1. Socio- demographic characteristics (%)

	Category	Percentage
Gender	Male	64%
Ethnicity	Malay	48%
	Chinese	36%
	Indian and Others	16%
Age Group	17- 35 years old	28%
	36- 45 years old	36%
	46 years old and above	36%
Education	Non-degree	60%
	Degree	40%
Driving Range	Less than 30,000 km in a year	55%
	30,000 km and above in a year	45%
Understand Hybrid Car	Yes	75%
	No	25%
Aware Hybrid Car	Yes	80%
	No	20%
Intend to buy Hybrid Car	Yes	20%
	No	80%

and Indians and others, 16%. In terms of age group, the percentage of respondents in the age group 17 to 35 years old was 28%, 36 to 45 years old was 36% and 45 years old and above, was also 36%. For education level, 40% of the respondents had at least attained a first degree at university. Although the majority of respondents understood and aware of the availability of HCs, only 20% of them intend to buy HCs in the near future.

This section also presents the results of the analysis of the CE data. The indirect utility functions for the bundle and individual attributes are shown in Equations (3) and (4), respectively. Both functions consist of basic and extended models. The two models are estimated as a way to study heterogeneity in preferences. The extended model accounts for heterogeneity while the basic model does not. The difference between the basic and the extended models lies in the coefficient  $\beta_n$  where n denotes knowledge (i.e. awareness and understanding) on HC and driving range. We used a dummy for the coefficient  $\beta_n$ . Those who drive more than 30,000 km are considered as having a longer driving range. The extended model includes these interaction coefficients (AwaPri, UstdPri, DriPri), while the basic model does not.

$$V = \beta_1.ENV1 + \beta_2.ENV2 + \beta_3.ECO1 + \beta_4.ECO2 + \beta_5.Pri + \beta_n.Z_n \tag{3}$$

$$V = \beta_1.DIS1 + \beta_2.DIS2 + \beta_3.CO_21 + \beta_4.CO_22 + \beta_5.BAT1 + \beta_6.BAT2 + \beta_7.ENE1 + \beta_8.ENE2 + \beta_9.INS1 + \beta_{10}.INS2 + \beta_{11}.SNDS1 + \beta_{12}.SNDS2 + \beta_{13}.Pri + \beta_n.Z_n \tag{4}$$

All variables except price have three levels; small, medium and large for economic bundle, and low, medium and high for environmental bundle. The price variable has four levels, i.e. RM8,000, RM9,500, RM11,500 and RM12,500. This variable refers to annual running costs for HCs including the depreciation rate and maintenance costs. Other variables such as driving range, battery and source of energy are self-explanatory and can be referred to Section 3.1. The number of categorical variables that can be entered into the estimation model is equal to  $J-1$  where  $J$  is the total number of categories. The categories for each variable are explained in Table 2. The multinomial logit (MNL) models are estimated using the maximum likelihood procedure as stated in equation (5), where will take the value 1 if buyer  $n$  choose HC and zero otherwise.

$$\log L = \sum_{i=1}^N \sum_{in=1}^N y_{in} \log \left[ \frac{\exp(V_{in})}{\sum_{j=1}^J \exp(V_{in})} \right] \tag{5}$$

### ESTIMATIONS OF ECONOMIC AND ENVIRONMENTAL BUNDLES

The results of MNL estimates on bundles for the basic and extended models are reported in Table 3. The

TABLE 2. Variables for Random Utility Models

Variable	Type	Definitions
ECO	Qualitative	Economic benefits of buying a HC. It has three levels- <b>small</b> , medium and large.
ENV	Qualitative	Environmental friendly of buying a HC. It has three levels- <b>low</b> , medium and higher.
DIS	Quantitative	Driving range. It has three levels- <b>20km/ litre</b> , 25km/litre and 30km/litre.
CO <sub>2</sub>	Quantitative	CO <sub>2</sub> emission. It has three levels- <b>100gm/ km</b> , 90gm/ km and 80gm/ km.
BAT	Quantitative	Warranty of hybrid battery. It has three levels- <b>8 years</b> , 10 years and 12 years.
ENE	Qualitative	Sources of energy to propel the car. It has three levels- <b>petrol</b> , petrol and/or battery and battery.
INS	Qualitative	Government incentives when buying a HC. It has three levels- <b>no excise duty</b> , no excise duty plus 10% car insurance rebate and no excise duty plus 20% car insurance rebate
SNDS	Qualitative	Sound of Hybrid engine. It has three levels- <b>noisy</b> , mild and quiet.
Pri	Quantitative	Annual running costs for HCs including depreciation rate and maintenance costs. It has four levels- <b>RM 8 000</b> , RM9 500, RM 11 500 and RM 12 500.
AwaPri	Qualitative	The interaction between HC awareness and HC running costs. It uses dummy coding; 1 for aware and 0 otherwise.
UstdPri	Qualitative	The interaction between HC understanding and HC running costs. It uses dummy coding; 1 for understand and 0 otherwise.
DriPri	Qualitative	The interaction between driving range and HC running costs, It uses dummy coding; 1 for 30,000 km/ year and 0 otherwise.

\*The bold denotes base level.

goodness of fit for both models are considered low with the McFadden psuedo  $R^2$  at 1.81% and 3.0%, respectively. According to Hosmer and Lemeshow (2000), these low values are normal and expected in MNL regression. Therefore, some researchers such as Long (1997) proposed to use the Classification Table  $R^2$  as an alternative to measure the model goodness of fit psuedo  $R^2$ . The researcher opined that the MNL model is considered acceptable if the Classification Table  $R^2$  value is greater than the critical percentage. Since the choice question in the study provides three options, the critical percentage is 33.3%. The results in Table 3 show that the Classification Table  $R^2$  for both models is 35%. Hence, both models are significant at 5% level where the likelihood ratio statistics have exceeded the critical value.<sup>4</sup> This means that the null hypothesis where the coefficients are jointly zero is rejected at this significant level. The results in Table 3 show that all attributes are significant at 1% level and have the *a priori* expected signs. The positive signs of attributes for environmental (ENV) and economic bundles (ECO) in both models indicate that the respondents are expecting an increase in utility if they buy HCs. In terms of preference order, the results show that the respondents prefer environmental bundle than the economic one. Thus, we can conclude that both environmental and economic bundles are important to the respondents when they are choosing to buy HCs but given the choice, they would prefer environmental bundle than economic bundle.

The interactions between price and knowledge of HCs (awareness and understanding), and price and driving range were conducted in the extended model.

These interactions are supposed to investigate the possible sources of heterogeneity in preferences. Though the r-squared has not improved compared to the basic model, all these interaction estimates are significant at least at 10% except for the understanding coefficient. The positive sign of the attribute for interaction between awareness and price suggests that the respondents who are aware of the existence of HCs expect an increase in their utilities when buying these vehicles. In terms of interaction between driving range and price, the positive sign of the coefficient value means that buying HCs would increase respondents' utilities if the driving range increases.

The results in Table 3 also enable us to calculate the marginal willingness to pay (WTP) of the attributes. This marginal WTP is obtained by calculating the ratio of the attribute and the price's coefficients. The highest WTP (or consumer surplus derived from existing level) in the basic model is the environmental factor at a higher level (ENV2) where the amount is RM2,899. This is the additional amount that the average respondents are willing to pay in order to see an improvement in the environmental factor from the current state to a higher level in HCs. Meanwhile, the respondents are willing to pay RM2,262 for an increase in the economic factor from the existing level to a higher level. However, if we take into account the heterogeneity in preferences, different values of WTP are obtained. For those respondents who are aware and understand the issues regarding HCs and prefer longer driving range, then they would be willing to pay more than those who are not aware and do not understand about HCs and do not prefer longer driving range. The results show that the former are willing to



pay RM6,906 for an improvement in the environmental factor from the current level, which is an extra RM4,000 compared to the latter.

ESTIMATIONS OF INDIVIDUAL ATTRIBUTES

The results of MNL estimates on individual attributes for the basic and extended models are reported in Table 4. The interpretations of the coefficients are similar to Table 3, and the McFadden Psuedo R2 are 1.4% and 2.7%, respectively. For the Classification Table R2, the values of the basic and extended models are 35% and 37%. Both models are significant at 5% level. This indicates that the estimation models are significant. However, the results in Table 4 show that only one economic attribute (battery) and two environmental attributes (CO2 and sound) are significant in the analysis. The CO2 attribute is significant only at the medium level while battery and sound attributes are significant at medium and high levels.

The significance of battery (BAT) attribute at the medium and high levels with the a priori sign is expected. This is because the respondents prefer higher warranty period for HCs' batteries. In the case of CO2 emissions, it is natural that respondents would

prefer lower emission level; i.e. from 100 grams/ per km to 90 grams/ per km. However, the estimate is not significant at the high level (i.e. from 90 grams/ per km to 80 grams/ per km), i.e. respondents seem to believe that further reduction of CO2 to 80 grams/ per km as not important. This puzzling outcome could be due to the inability of the respondents to fully comprehend the questionnaire that they are supposed to answer, resulting in the inconsistent result.

Another feature of hybrid vehicles is the engine sound. HCs are considered environmentally friendly because their engines are quieter compared to the regular ones. However, a quieter engine is not always preferred by consumers. The negative sign of the coefficients at both levels indicate that the utility of respondents decreases if the engine of HCs is too quiet. This behaviour is consistent to the findings in the United States that compelled its National Highway Traffic Safety Administration (NHTSA) to propose in 2013 that HCs must produce a louder engine sound by installing recording of regular cars' sounds. This artificial engine sound approach has also been tabled and approved by the European Parliament for HCs in 2014 and will come into effect in Europe by 2019.

Interactions between knowledge (i.e. awareness and understanding) and price, and driving range and price were undertaken in the bundle as well as in the

TABLE 3. The Multinomial Logit (MNL) estimates for Bundle Attributes

Attributes	Basic	WTP (in RM)	Extended	WTP (in RM)
ENV 1	0.40403*** (0.12127)	1,544.81	0.41914*** (0.12059)	3,880.60
ENV 2	0.75827*** (0.13485)	2,899.22	0.74600*** (0.13429)	6,906.71
ECO 1	0.38127*** (0.12054)	1,457.78	0.37818*** (0.12012)	3,501.36
ECO 2	0.59177*** (0.13158)	2,262.61	0.57865*** (0.13125)	5,357.33
PRI	-0.00026154*** (0.000053051)		-0.00039833*** (0.000086097)	
AwaPri	n.a		0.00027721** (0.00013205)	
UstdPri	n.a		-0.00020692 (0.00012983)	
DriPri	n.a		0.00018994*** (0.000069211)	
<b>Summary Statistics</b>				
Log-likelihood function:	-843.3811		-836.6785	
Log-likelihood function:	-858.9088		-858.9088	
McFadden Psuedo R <sup>2</sup>	0.018		0.037	
Classification Table R <sup>2</sup>	0.35		0.35	

\*, \*\*, and \*\*\* denote the significant levels at 1%, 5% and 10% respectively  
Standard errors are in parentheses

individual attributes. All these interaction estimates are significant at least at 5% level. The estimate signs are similar to that of the bundle except for the interaction between the variables understand and price. The coefficient, which is not significant in the bundle, becomes significant in the individual attribute, carrying a negative sign. The sign shows that an understanding of

HCS would decrease the buyers' utility. The result is also puzzling as this would suggest that the more the buyers know about HCS, the less interest they have in purchasing HCS. A similar puzzling outcome was obtained earlier in the case of CO<sub>2</sub> at a higher level. It is probable that this outcome is also due to the lack of understanding of the questions posed. Most probably, the unwillingness

TABLE 4. The Multinomial Logit (MNL) estimates for Individual Attributes

Attributes	Basic	WTP (in RM)	Extended	WTP (in RM)
DIS 1	-0.0349 (0.12492)	n.a.	-0.00426 (0.12444)	n.a.
DIS 2	-0.0847 (0.12875)	n.a.	-0.05704 (0.12966)	n.a.
CO <sub>2</sub> 1	0.40546*** (0.12331)	2,606.12	0.42495*** (0.12444)	2,628.09
CO <sub>2</sub> 2	0.13192 (0.13186)	n.a.	0.14372 (0.13257)	n.a.
BAT 1	0.29651** (0.12834)	1,905.82	0.29815** (0.12857)	1,843.92
BAT 2	0.38915*** (0.14001)	2,501.24	0.39615*** (0.14064)	2,449.98
ENE 1	0.11000 (0.14060)	n.a.	0.10342 (0.14302)	n.a.
ENE 2	0.05010 (0.13382)	n.a.	0.06482 (0.13507)	n.a.
INS 1	0.081556 (0.12647)	n.a.	0.087750 (0.12679)	n.a.
INS 2	-0.10682 (0.12081)	n.a.	-0.10392 (0.12167)	n.a.
SNDS 1	-0.23243* (0.12331)	-1,493.99	-0.23906* (0.12323)	-1,478.42
SNDS 2	-0.30789** (0.12548)	-1,978.97	-0.31928** (0.12667)	-1,974.58
PRI	-0.00015558** (0.000057034)		-0.00034145*** (0.00009079)	
AwaPri	n.a.		0.00021615*** (0.000068658)	
UstdPri	n.a.		-0.0003179** (0.00012890)	
DriPri	n.a.		0.00040806*** (0.00013142)	
<b>Summary Statistics</b>				
Log-likelihood function:	-848.7059		-837.3045	
Log-likelihood function:	-861.3375		-861.3375	
McFadden Psuedo R <sup>2</sup>	0.0146		0.0279	
Classification Table R <sup>2</sup>	0.35		0.37	

\*, \*\*, and \*\*\* denote the significant levels at 1%, 5% and 10% respectively  
Standard errors are in parentheses

of the respondents might change if they have a better understanding of how HCs help reduce environmental degradations.

In terms of WTP, the highest value is CO<sub>2</sub> at medium level. At this level, respondents are willing to pay up to RM2,600 if further reduction in CO<sub>2</sub> is achieved. For the engine sound, respondents expect a reduction in the HCs price if its engine sounds become quieter. The reduction is between RM1,478 and RM1,979. The WTP for driving range (DIS), energy (ENE) and incentives (INS) are not provided since their estimates are not significant.

#### INDEPENDENT VALUATION SUMMATION (IVS) ANALYSIS

This section investigates whether the summation of individuals WTP is independent from the bundle WTP. Since the objective is to determine whether the motivation of purchasing HCs is due to economic or environmental bundle, we have selected three individual attributes for each bundle. Their inclusion however is subject to whether their values are significant or not. If the individuals WTP are statistically significant then they can be included. Otherwise they are not considered.

Based on the arguments, the individual attribute representing the economic bundle is the life span of battery, while the individual attributes for the environmental factor are CO<sub>2</sub> and the sounds of the hybrid engine. A confidence interval approach is used where the similarity is determined through an overlapping format. In computing this confidence interval, we used the Delta method. Though other methods are available to compute confidence interval such as Krinsky and Robb method; bootstrapping or jackknifing, the Delta method is more accurate and it avoids extensive simulation as argued by Bliemer and Rose (2013). The confidence interval format has been used in many benefit transfer studies such as Morrison et al. (2002). For instance, if the confidence interval of individual summation WTP overlaps with the confidence interval of bundle WTP, then it suggests that the summation of individuals WTP are statistically similar to the bundle WTP.

The results of confidence intervals value for bundles and individual attributes are reported in Table 5.<sup>5</sup> The results show that all the WTP calculated

in the bundle are not statistically different from the WTP of the individual attributes, and hence does not exhibit IVS bias. The reported results are based on the extended MNL.

#### CONCLUSIONS

Our analysis of respondents' preference on bundles showed that the environmental bundle is preferred more than the economic bundle. The results for Basic MNL as shown in Table 3 suggest that the motivation of purchasing HCs is influenced more by the former where the respondents are willing to pay up to RM1,544 and RM2,899 if the attribute is improved from the current state to the medium and or higher levels. In terms of the economic bundle, the WTP is between RM1,458 and RM2,263 for similar improvements. For the analysis of individuals' attributes, we found that not all individual attributes representing the environmental and economic factors are significant. For environmental factor, only CO<sub>2</sub> (at medium level) and the engine sound (at both levels) are significant. The WTP for CO<sub>2</sub> is RM2,600. We found that a negative value for the engine sounds indicate that the public is expecting a reduction in HCs prices if the proposed engine sounds are quitter than the present one. The battery at both levels is the only significant attribute for the economic factor with the WTP at the medium and higher levels being RM1,900 and RM2,500.

In terms of the IVS analysis, the results show that all the WTP calculated in the bundle are not statistically different from the WTP of the individual attributes. Since there is no IVS bias, then the estimation of WTPs for economic and environmental factors could be done either by just evaluating the bundle or the relevant individual attributes. The IVS analysis applied in the study, however, can be followed by analysts who intends to undertake similar analysis in their valuation studies.

One of the puzzling results that we get in the analysis of this study is that the government incentives' attribute is not significant. If we look at the dramatic fall in demand for HCs after the Malaysian government revoked its incentives, it surely means that the incentives are important to buyers of HCs. This discrepancy probably occurred because the fall in demand for HCs is a national phenomenon while the results of this study is a localise one. If we look at the socio-demographic characteristics of the respondents, 80 percent are not interested to

TABLE 5. The Confidence Intervals (CI) for Bundle and Individual Attributes

Bundle Attributes	CI (in RM)	Individual Attributes	CI (in RM)
ENV 1	-3,465.44 to 11,226.65	CO <sub>2</sub> 1 and SNDS 1	-798.35 to 3,097.69
ENV 2	-5,808.72 to 19,622.14	CO <sub>2</sub> 2 and SNDS 2	-4,137.88 to 188.73
ECO 1	-3,083.46 to 10,086.19	BAT 1	88.19 to 3,599.64
ECO 2	-4,515.62 to 15,230	BAT 2	250.75 to 4,649.19

purchase HCs, thus government incentives are irrelevant to them. Furthermore, even those who are interested put higher preference on environmental rather than economic factor. So this might explain why government incentives is not that important amongst respondents in this study.

We believe that this study could contribute positively to the development of HCs/EEVs in the Malaysian automotive industry. Based on the results, we propose three HC/EEV policies that policy makers and stakeholders should be aware of.

First, we would like to suggest that the promotion of HCs/EEVs should focus more on the environmental attributes rather than the economic attributes as the outcome of this study suggested. For example, focus should be more on reducing CO<sub>2</sub> in cars rather than giving incentives for consumers to purchase HCs/EEVs. Thus, government should investigate alternative approaches to internalize the cost of CO<sub>2</sub> emissions either to buyers or manufacturers or both as a way to reduce CO<sub>2</sub> emissions. Giving incentives to consumers might increase the purchase of HCs/EEVs, but this policy would not discourage manufacturers from producing regular cars and would not discourage consumers from buying them. One possible approach is to employ the developed nations' (e.g. Germany, the UK, and Belgium) policies where the road tax is linked to the level of CO<sub>2</sub> emissions. Alternatively, the government could impose a tax on a non-environmental car or the government could impose a combination of fee and rebate. This is known in the economics literature as *feebate*.

Second, the government needs to double up its efforts in educating its citizens if it is keen on changing the public perceptions on HC/EEVs. Public educational campaigns on television and radio, newspapers and magazines, posters and billboards are examples that can be employed for this purpose. When citizens really understand and aware of the impact of regular cars on the environment, only then will there be demands for HCs/EEVs. Third, the sounds of the engine is an important part of consumers' preference for HCs/EEVs. Thus, we propose that the noise levels of the engine should be taken into consideration in developing the HC/EEV industry in Malaysia.

Due to the limitations of this study, we propose two major studies to be undertaken in the near future. First, studies on increasing public awareness on the benefits of HCs/EEVs. Second, simulation studies on the impacts of government incentives and penalties on HCs/EEVs, where such studies could be conducted on the pecuniary and non-pecuniary benefits.

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#### NOTES

- 1 Completely Built Up (CBU) refers to a vehicle that is completely built out of the country. On the other hand, Completely Knocked Down (CKD) refers to a vehicle which is assembled locally but using parts and technology from its country of origin.
- 2 The price of petrol (RON 95) in Malaysia was previously controlled by the government. The price per litre for RON 95 had increased since July 2010 from MYR1.85 to MYR1.90 (December 2010), MYR2.30 (September 2013) and recently, MYR2.30 (October 2014). In August 2018, the government decided to fixed the price at RM2.20 per litre.
- 3 The exchange rate in 2018 figure was RM4.15=USD1
- 4 The likelihood ratio statistics for basic and extended models are 31.0544 and 44.4606, respectively. These values were compared to the critical chi-squared values at the 5% significance level with 5 and 8 degrees of freedom, and .
- 5 The 95% confidence intervals obtained from asymptotic standard errors approximated by means of the delta method.

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