THE ROLE OF REFERENCE POINTS IN DISCRETE CHOICE EXPERIMENTS

Abstract

The effect of a reference point on choice decisions is often ignored when analyzing consumer preferences. This reference point may be crucial for understanding choices. In order to show the importance of considering a reference point when assessing preferences, we carried out an application in the context of discrete choice experiments (DCEs) for hybrid electric vehicles (HEV). The novelty of our application relies on the use of individually specified reference abide points according to elicited data. Three models considering three different potential reference points were estimated and compared to a traditional no-reference model. The results demonstrate that choices are affected by reference points. Furthermore, in the current dataset, the results show that vehicle preferences are strongly based on individuals' current vehicle (status quo). The findings suggest that not considering the reference point may reduce the ability of DCEs to explain actual behavior.

Keywords: Discrete choice experiment (DCE), reference point, hybrid electric vehicle (HEV).

JEL codes: Q4, Q5

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1. Introduction

We often face decisions where we have to choose between several options. The question at hand is how we make these types of decisions. Do we assess all of the alternatives and choose the best one, independently of any reference alternative? Or do we choose an alternative that presents an improvement with respect to a given default option?

Prospect theory and cumulative prospect theory provide answers to these questions (Bleichrodt, 2009; Kahneman and Tversky, 1979; Koszegi and Rabin, 2006; Tversky and Kahneman, 1991). Prospect theory generally stipulates that in situations of uncertainly, behavior is guided by a reference point. Specifically, it states that preferences are more sensitive to disadvantages than advantages, referring to this type of behavior as 'loss aversion'. Prospect theory or some of its features have been tested and supported in several studies, including healthcare programs (Neuman and Neuman, 2008), environmental protection programs (Glenk, 2011; Lanz et al., 2009), brand choices (Hardie et al., 1993), and trip choices (De Borger and Fosgerau, 2008; Hess et al., 2008; Hjorth and Fosgerau, 2009). In addition, some authors have validated prospect theory in the case of the experimental behavior of inexperienced subjects (List, 2004).

Reference dependence is the main cornerstone of prospect theory, given that utilities are defined around the reference point. Therefore, it is vital for researchers to identify and take into account the appropriate reference point that individuals consider when making a choice.

The present empirical study shows that replacing the common no-choice option often included in discrete choice experiments (DCEs) by an individual reference point would improve behavior prediction. The DCE is applied to vehicle choices, and focuses on the valuation of improvement included in alternative fuel vehicles (AFV). This application seeks to identify the most accurate reference point considered by decision makers when buying a new vehicle, especially in the context of a discrete choice experiment (DCE). In particular, we explore three different possible reference points: the current endowment (Barton and Bergland 2010; Meyerhoff and Liebe, 2009) or actual status quo (current vehicle), the minimum requirements (Wang and Johnson, 2012) established for the new vehicle (MR), and the goal (Heath et al., 1999) or most desirable type of new vehicle (G). We find that not considering the reference point may lead to biased predictions. Furthermore, our results show that individual preferences are formed around the participants' current vehicle (current endowment or individuals' status quo).

This article is structured as follows: the first section presents a review of the related literature; this is followed by a description of the survey implementation and the DCE design. The next section is a description of the sample used, and the empirical models. The final section presents the results, concluding with some remarks and implications of our findings.

2. Literature Review

DCEs mostly include a status quo alternative in order to mimic choice situations as closely as possible (Carson et al., 1994), to improve market share predictions and welfare estimates (Bateman et al. 2002; Hensher et al., 2005), or to avoid forcing people to make choices that they may not like (Batsell and Louviere 1991). The election of the status quo option may reflect preferences for the current situation (Lanz and Provins, 2012), or simply the willingness to avoid complex choices (similar alternatives) in order to reduce mental and emotional efforts (Beshears et al. 2008), or to avoid possible regrets (Samuelson and Zeckhauser, 1988), or protesting (Meyerhoff and Liebe, 2009), while continuing checking for the best option (Dhar, 1997). Oehlmann et al. (2017) found that the election of the status quo increases with the number of choice tasks, the number of attribute levels, and the degree of similarity between alternatives; whereas they showed that the number of alternatives negatively influences the choice of the status quo option.

The opt-out option, when included in DCEs, is generally defined as a non-described "neither option" or a described status quo such as the current situation (Adamowicz et al. 1998; Scarpa et al., 2005). The current situation is most commonly included in DCEs as a common constant alternative for all participants (Barton and Bergland 2010; Meyerhoff and Liebe, 2009). However, the existence of differences between respondents' specific reference alternatives and this assumed common profile will lead to biases in welfare measures (Kataria et al., 2012). Therefore, considering respondent-specific reference options is preferred to a common profile (Rose et al., 2008; Barton and Bergland, 2010).

In addition to the current endowment, there are a wide variety of interpretations of the reference point in the existing literature, identifying it with goals (Heath et al., 1999), aspirations (Hoffmann et al., 2013), expectations (Bartling et al., 2015; Banerji and Gupta, 2014), and past acquisitions (Baker et al., 2012), among others. Several studies (Koop and Johnson, 2012; Stommel, 2013; Wang and Johnson, 2012) have reported that consumers simultaneously combine multiple reference points (Wang and Johnson, 2012). Wang and Johnson (2012) concluded that consumers seek to achieve a goal that is better than their current situation, and which exceeds certain minimum requirements.

The following empirical analysis is applied to vehicle choices, where we specifically test the performance of the three different definitions of the status quo, considering the reference point as the current vehicle, the minimum standards for an acceptable vehicle, and the most desirable (goal or aspirational) vehicle. Oehlmann et al. (2017) showed that welfare estimates depend considerably on the choice design. The following analysis focuses on the assessment of preferences for hybrid electric vehicles (HEV), assessing the impact of vehicle attributes, and the role of socio-demographic variables on choice decisions, considering the existence of various potential reference points. In addition, our work explores the previous phenomenon focusing on particular vehicle characteristics. This analysis focuses on both private and quasi-public attributes, contrary to most of the existing literature that mainly focuses on private attributes. Thus, the present work contributes to research that seeks to understand the nature of choices, especially in the context of DCE, where a given scenario (or status quo) is generally included and potentially understood in different ways. However, most of the literature deals with the opt-out (or status quo) option in a similar way, the most popular of which is the identification of this choice with a zero utility level.

3. Survey implementation

An online survey was addressed to a representative sample of adults. This survey was administered in July 2013 to a total of 878 individuals who expressed their desire to purchase a small or medium-sized vehicle in the future. The survey was designed so that it allowed for collecting detailed information about the participants' actual vehicles, driving and buying habits, environmental attitudes and behavior, HEV perceptions, future vehicle buying intentions in terms of the size and type of vehicle, and their socio-demographic characteristics. The participants' marginal valuations of these attributes were elicited with DCEs. Part of the information collected in the survey was used to identify the three possible reference points that may affect vehicle choices. In particular, the survey included questions that precisely identified the current vehicle, the minimum desirable characteristics of the new vehicle, and the characteristics of the most desirable vehicle.

3.1. Experimental design and DCEs

DCEs are stated preference approaches based on the assumptions of rationality and utility maximization of consumer choice, according to Lancaster's theory (Lancaster, 1966). They consist of presenting individuals with several vehicle alternatives, described in terms of attributes and their levels (Louviere et al., 2000). For each choice occasion, individuals are asked to choose their preferred vehicle. The individual is assumed to choose a vehicle that provides the maximum utility. The utility derived from choosing a vehicle is assumed to be equal to the sum of the marginal utilities associated with its attributes (Lancaster, 1966). DCE has already been used in several vehicle choice studies (Potoglou and Kanaroglou, 2007; Achtnicht, 2012; Ahn et al., 2008).

Taking into account existing literature on preferences for AFVs (Potoglou and Kanaroglou, 2007) and the fact that HEVs overcome the battery problems of electric vehicles, five vehicle attributes were used in the experiment. These were fuel type, purchase price, fuel consumption, carbon dioxide (CO_2) emissions, and the adaptation to biofuel. In the previous literature, price and fuel consumption have been found to be very significant when representing the economic dimension of vehicle choices (Adler et al., 2003). CO_2 emissions are often used in studies to express the level of vehicle pollution (Potoglou and Kanaroglou, 2007).

The attribute levels were defined according to the information obtained from vehicle suppliers in the Spanish market concerning small to mid-sized vehicles and previous studies (Achtnicht, 2012; Ziegler, 2012). In order to determine the range of the price attribute, we first selected the average price of a new vehicle in the Spanish market in 2012 (€16,000), and then considered two other levels around this average price: a lower price (€12,000) and a higher one (€20,000), respectively. We set these limits taking into account small-medium size vehicles, as well as the reduction of the purchasing power of Spaniards caused by the current economic crisis and the fact that in recent years the highest-selling vehicles in Spain were priced below €20,000. Regarding fuel consumption, we displayed its levels to respondents in terms of euros spent per 100 kilometer, as has been done in several recent studies (Achtnicht, 2012; Ziegler, 2012)[i]. Given our interest in small and medium vehicles and considering previous studies (Achtnicht, 2012; Ziegler, 2012), a total of two levels were considered: €5 (efficient level) and €7 (inefficient level) per 100 kilometers. Similarly, the levels of CO_2 emissions were displayed to our respondents in terms of grams emitted per kilometer, as has been done in recent studies (Achtnicht, 2012; Ziegler, 2012). Following previous studies (Achtnicht, 2012; Ziegler, 2012), we included an efficient and inefficient level (with 100gr per kilometer and 150gr per kilometer, respectively). With regard to biofuel adaptation, we considered this flex option in a vehicle as a dichotomous variable.

We used both the SPSS orthogonal design and Street and Burgess' (2007) procedure based on the D-efficiency value (vector of differences = 12111; design efficiency of 98%) to combine the five attributes and their levels. This combination generated a total of 8 choice sets. We allowed all attributes with their corresponding levels to be combined across conventional or HEVs. In the survey, each respondent was confronted with a total of 8 choice cards. In each card, respondents were asked to select their preferred option out of two vehicle alternatives (HEV vs. conventional) and the no choice option (status quo). Figure 1 shows an example of a choice card.

[Insert Figure 1]

In terms of the distributions followed by the considered attributes, we assume the PRICE attribute to be log-normally distributed (to make the parameter to be always negative), being introduced in the model as a continuous variable. We define two effect coding variables for the fuel consumption (SAVING-FUEL) and for CO2 emissions (ABATEMENT-CO2) of the vehicles. Both variables are assumed to be log-normally distributed. We chose the log-normally distribution in order to model positive preferences for these attributes (Achtnicht, 2012; Daziano and Achtnicht, 2014; Nixon and Saphores, 2011). We also specify the BIOFUEL variable to be effect coding. We test several distributions for this variable; however, their corresponding standard deviations were not statistically significant. Therefore, we specify the parameter of the BIOFUEL variable to be nonrandom. We also included two dichotomous specific constants called ASC_c and ASC_h, denoting the election of conventional and HEVs, respectively. Both constants are defined to be random and normally distributed, allowing preferences to be positive or negative for both vehicle types.

4. Data

The basic socio-demographic characteristics of the participants are shown in Table I. The mean age of the sample is 46 years. Fifty-one percent of the respondents are male, while forty-six percent have university studies. While a fifth of the participants are unemployed, the vast majority (seventy five percent) are members of households which earn a monthly income of more than €1,200. About ninety two percent of the participants currently own a vehicle. Finally, the average weekly driving frequency in the sample is of four days. Considering the age and driving frequency, we find that our sample was representative of average Spanish drivers (44-year-old men who drive 5 days per week, Spanish Observatory of Drivers, 2014).

[Insert Table I]

Table II presents the average of the individual status quo scenarios considered under the different reference points. The average price of the participants' current vehicle was €18,609.23 (Std. Dev = 4,075.38). This figure is higher than the average price of new vehicles purchased in Spain in 2013 (around €16,000). The elicited average fuel consumption of the participants' current vehicle was €3.195 (Std.Dev=2.885) per 100 km. The participants' current vehicles were utilitarian (34.35%), compact (25.42%), sedan (24.06%), wagon (2.59€), minivan (8.39€), SUV (3.08%), sports (1.48%), and cabriolet (0.62%). Based on the model and the age of the participants' current vehicle, we were able to estimate the average current vehicle emissions being around 167 grams per 1 km. (Std. Dev = 35.436).

[Insert Table II]

5. Discrete choice modeling

For our data analysis, we used random parameter logit (RPL) models which relax the IIA assumption of a multinomial logit (MNL) allowing for heterogeneous tastes, unrestricted substitution patterns, and correlation in unobserved factors over time (Hensher et al., 2015; Train, 2009). To assess the validity of this IIA assumption in our analysis, we applied the Hausman test, and we found that this IIA assumption is problematic[ii]. The RPL models are estimated using standard Halton sequences draws with 2000 replications (Hensher et al., 2005). We first estimate a traditional no reference dependent (NR) model, where the attributes of the status quo option have been coded as zeros (Table III). This model was employed as the baseline model of the utility-maximization framework.

[Insert Table III]

We estimate three different reference dependent models based on the three previously detailed reference points, comparing them to the traditional model with no reference point (NR). The results of this comparison may help us to identify whether a reference point model performs empirically better. The three estimated reference dependent models are: a) Actual choice (AC)- reference dependent model where participants' current main vehicle is considered as a reference point; b) Minimum requirements (MR)- reference dependent model, where accepted (MR) for the future vehicle were taken as a reference point; and c) Goal (G) reference dependent model- where the desired attributes of participants' future vehicle served as reference. We assume that PRICE, SAVING_FUEL and ABATEMENT_CO2 are log-normally distributed, while BIOFUEL is nonrandom parameter. Finally, ASC_c, and ASC_h are normally distributed as in the traditional no reference (NR) model.

6. Results and discussion

The results of the RPL models are shown in Table IV. Column 1 in Table IV shows the results of the traditional no reference point (NR) model. Columns 2, 3 and 4 in Table IV summarize the results of the three reference models: the Actual choice (AC) reference dependent model, the Minimum requirements (MR) reference dependent model, and the Goal (G) reference dependent model, respectively.

[Insert Table IV]

All estimated models provide somewhat similar results. Specifically, the effects of PRICE, SAVING_FUEL, ABATEMENT_CO2 and BIOFUEL have the expected signs and are statistically significant in all the estimated models. The exceptions are the two alternative specific constants, which are negative in the actual choice (AC) reference dependent model, but positive in the rest of the models. Moreover, the order of importance of the attributes is maintained across the different models, with the effect of the price variable being the greatest, and that of BIOFUEL the smallest. According to the Akaike information criterion (AIC), and the Bayesian information criterion (BIC), the model with the best overall goodness of fit is the actual choice (AC)-based reference dependent model. This result implies that participants evaluate vehicle alternatives thinking about their current vehicles attributes (reference level), providing evidence of an endowment effect in the valuation exercise. Although the average age of the respondents' current vehicle is about 8 years (73.47% of the respondents' current vehicles were purchased as new vehicles), the effect of this reference point in the respondents' vehicle choices under the DCE is strong. The fact that the reference point influences vehicle choices has important implications on programs launched for promoting HEV (advertising, financial help, etc.), given that it reveals a certain anchoring in purchasing behavior.

In order to facilitate the presentation of the current results, we compare the actual choice (AC)-based reference dependent model shown in column 2 of Table IV with the traditional non-reference dependent (NR) model shown in column 1 of the same table.

The estimated actual choice (AC)-based reference dependent model is statistically significant overall, and has a better statistical fit than the baseline model (chi2 (11) = 2,927.778 and a p-value of 0). All the mean coefficients of the random and nonrandom parameters are statistically significant and present the expected signs. In order to facilitate the interpretation of the log coefficients, the estimated log terms are converted to the original parameters (as shown in Table V). The effect of the price variable is negative, as expected. The effect of energy efficiency (SAVING_FUEL) on individuals' utility is positive, showing that in *ceteris paribus* conditions, individuals prefer more energy efficient vehicles. Similarly, the fact that a vehicle is environmentally efficient (ABATEMENT_CO2), other features being equal, yields a positive effect on respondents' utility. A vehicle adaptable to run with biofuels (BIOFUEL) also has a positive impact on individuals' utility. Finally, the choice-specific constants are significant and negative, indicating that individuals prefer staying with their current vehicles than choosing a new conventional model or HEVs. However, the disutility provided by conventional vehicles is twice as large than that of HEVs, and this difference is statistically significant (chi2 (1) = .668; P-value=.000). Therefore, policies aimed at promoting the adoption of new HEV would be likely to become more successful than those promoting regular vehicles.

[Insert Table V]

In the actual choice model, the standard deviations of all the random parameters are statistically significant, except that of CO_2 emissions (ABATEMENT-CO2), reflecting the presence of heterogeneity in preferences around the sample for the attributes PRICE, SAVING-FUEL, and the respective constants ASC_c and ASC_h.

An extended actual choice (AC) -based reference dependent model has been estimated in order to further understand the sources of the heterogeneity in preferences for conventional vehicles and HEVs. In particular, vehicle specific constants were interacted with some individual socio-demographic characteristics (MALE, AGE, LHINC, UNIV) suspected to explain part of the preference heterogeneity. We also expect that preferences heterogeneity for vehicle type may result from product knowledge differences. Thus, we interact the alternative specific constants with attributes reflecting whether participants know other HEV owners (KNOWLEDGE). Another possible source of vehicle type preference heterogeneity taken into account is a reputational incentive (IMAGE). The estimated results are shown in Table IV (column 5) and Table V. The results show that preferences heterogeneity for conventional vehicles is affected by the gender (MALE), age (AGE), level of education (UNIV), knowledge (KNOWLEDGE), and social prestige motivation (IMAGE) of the respondent. In addition, income (LHINC), level of education (UNIV), knowledge (KNOWLEDGE), and social image incentives (IMAGE) are significant to model preferences towards HEVs. Moreover, older individuals (AGE) are less likely to choose conventional or HEVs compared to the status quo (current vehicle) option. While the election of HEVs seems to decrease between individuals with low income (LHINC), the choice of conventional vehicles seems to be unaffected.

7. Conclusions and Implications

Although prospect theory improves behavior prediction when compared to expected utility theory, its application in research approaches continues to be quite reduced, especially in stated preference methods, such as DCEs. This empirical study tests to what extent reference points affect individual choice decisions in the context of DCEs, and whether replacing the traditional no-choice option often included in DCEs by individual reference points improves model performance. In particular, we conducted a DCE where we consider several different possible reference points expected to define this no-choice alternative. The DCE is applied to vehicle choices, and focuses on the valuation of improvement included in HEVs. This paper identifies the reference point considered by decision makers which better fits the choice data when buying a new vehicle. In the DCE, respondents were asked to choose between two new types of vehicles (HEV or conventional vehicles) and the no-choice option. The impact of three different reference points hidden behind the no-choice option is explored, and assessed whether people consider vehicle attributes thinking about any of these default options (reference points). The analysis is conducted using RPL models in order to capture heterogeneity in preferences. The results show that respondents' current vehicles are the reference point that best explains future vehicle choices. This means that the opt-out alternative represented by a described status quo option (current vehicle) leads to a better statistical performance of choice models than the no-choice option. The results demonstrate that it is important to account for reference points when eliciting preferences with DCEs. In particular, not considering the effect of a reference point decreases the statistical performance of the empirical models. The results also show that people prefer staying with their current vehicles rather than opting for conventional or

HEVs. However, they are relatively more likely to select HEVs than conventional vehicles, *ceteris paribus*.

Overall, it was found that the current reference point affects preferences for other alternatives. This may be related to the endowment effect, or simply loss aversion due to the lack of information on the participants' experience. Future research should be conducted in order to disentangle the potential effects related to loss aversion from the endowment effect.

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Endnotes

[i]) To convert the liters the vehicle would need to run 100 kilometers, the average price of the conventional fuel was taken into account (average price of diesel and gasoline) which was about €1.35 per liter during our experimental period.

[ii]) [omitted alternative is the regular vehicle: Chi-squared (5) =156.808; omitted alternative is the HEV: Chi-squared (5) =160.883; the 99%; critical value: Chi-squared (5) = 15,086].

Figure 1:

Choice experiment question and Card example

Section: Discrete choice experiment Please select the alternative car (car A, car B, neither A or B) you will buy. We show you several car choices to choose from in each set.			
	Conventional car	HEV	Status quo
Price (€).	€16,000	€20,000	Neither A or B
Fuel consumption (€ per 100km).	€7/100km.	€5/100km.	
Grams of CO_2 emitted per 1km.	150g/km.	100g/km.	
Biofuel adaptation	No	Yes	
I choose	□	□	□

Table I.

Some descriptive statistics.

Variables	Description	Mean	Std.Dev
MALE (dummy)	1 for male, 0 for otherwise.	.513	.499
AGE (Continuous)	Age of the respondents.	45.972	13.546
LHINC (dummy)	1 for monthly income under €1200 and 0 otherwise.	.246	.431
UNIV (dummy)	1 for respondent with university studies, 0 for otherwise.	.457	.498
KNOWLEDGE (dummy)	Individual who knows other owners of hybrid car.	.276	.447
IMAGE (dummy)	1 if "social image" is qualified as important or very important (score>3) and 0 otherwise.	.244	.429

Std.Dev. ==>Standard deviation.

Table II: The average of the individual status quo scenarios considered under the different reference points

	Actual choice (AC)	Minimum requirements (MR)	Goal (G)
PRICE (€)	18,609.23 (4,075.38)	14,355.22 (4,006.108)	16,359.81 (4,867.64)
FUEL CONSUMPTION (€/100KM)	3.195 (2.885)	5.670 (.857)	6.508 (1.074)
CO2 EMISSIONS (g/KM)	167 (35.436)	101.548 (22.550)	.

():Standard deviation.

Table III: Car-specific variables in the traditional no reference (NR) model

VARIABLE	CODING
PRICE	= 1.2 low level. 1.6 medium level. 2.0 high level. 0 Status quo.
SAVING_FUEL	= +1 if car is efficient (consumes €5 per 100 kilometers). -1 if car is inefficient (consumes €7 per 100 kilometers). 0 Status quo.
ABATEMENT_CO2	= +1 if car is environmentally efficient (emits 100 grams of CO_2 per 1 kilometer). -1 if car is environmentally inefficient (emits 150 grams of CO_2 per 1 kilometer). 0 Status quo.
BIOFUEL	= +1 if car is adapted to run with biofuels.

	-1 if car is not adapted to run with biofuels. 0 Status quo.
ASC_c	1 if car is conventional. 0 otherwise.
ASC_h	= 1 if car is HEV. 0 otherwise.

Table IV: Results of random parameter logit models

	Traditional no reference (NR) model	Actual choice (AC) based reference model	Minimum requirements (MR) based reference model	Goal (G) based reference model	Extended actual choice (AC) based reference model
Parameters in utility functions					
LOG(-PRICE)	1.213*** (.028)	.517*** (.054)	.658*** (.037)	.573*** (.044)	.505*** (.057)
LOG(SAVING_FUEL)	-1.256*** (.116)	-1.746*** (.215)	-1.154*** (.114)	-1.287*** (.152)	-1.732*** (.216)
LOG(ABATEMENT_CO2)	-1.505*** (.154)	-1.793*** (.219)	-2.306*** (.300)	-4.235*** (.062)	-1.804*** (.225)
BIOFUEL	.158*** (.021)	.256*** (.046)	.248*** (.044)	.186*** (.044)	.248*** (.046)
ASC_c	5.278*** (.117)	-1.396*** (.074)	.934*** (.075)	2.662*** (.115)	-1.376*** (.250)
ASC_h	6.035*** (.114)	-.727*** (.066)	1.549*** (.068)	3.275*** (.112)	-.957*** (.219)
Standard deviations of random parameters					
LSPRICE	.452*** (.018)	1.083*** (.032)	.705*** (.041)	.780*** (.041)	1.084*** (.034)
LSSAVING_FUEL	1.003*** (.100)	1.321*** (.133)	1.055*** (.072)	1.185*** (.107)	1.311*** (.138)
LSABATEMENT_CO2	1.128*** (.111)	1.653*** (.117)	1.553*** (.132)	.800*** (.029)	1.687*** (.119)
$NSASC_c$	1.349*** (.066)	1.341*** (.063)	1.367*** (.054)	.793*** (.049)	1.278*** (.064)
$NSASC_h$	.134 (.458)	1.256*** (.059)	1.259*** (.065)	.376*** (.091)	1.191*** (.061)
Heterogeneity in parameter means					
ASC_c * MALE					.786*** (.127)

ASC_c * AGE					-.016*** (.004)
ASC_c * LHINC					-.157 (.143)
ASC_c * UNIV					.321*** (.124)
ASC_c * KNOWLEDGE					.372*** (.107)
ASC_c * IMAGE					.456*** (.138)
ASC_h * MALE					.695*** (.125)
ASC_h * AGE					-.009** (.004)
ASC_h * LHINC					-.283** (.133)
ASC_h * UNIV					.279** (.118)
ASC_h * KNOWLEDGE					.366*** (.103)
ASC_h * IMAGE					.577*** (.128)
STATISTICS:					
N	7,000	5,995	6,448	6,440	5,995
GROUPS	875	875	875	875	875
NB. OBSRVS./GROUP	8	8	8	8	8
LL FUNCTION	-5,461.457	-5,122.291	-5,638.309	-5,230.007	-5,077.931
K	11	11	11	11	23
LRT: CHI SQUARED [K]	4,457.656***	2,927.778***	2,891.084***	3,690.110***	3,016.498***
R-SQRD	.289	.222	.204	.261	.229
R-SQRD ADJUSTED	.289	.222	.203	.260	.227
AIC	10,944.9	10,266.6	11,298.6	10,482.0	10,201.9
BIC	11,020,3	10,340.3	11,373.1	10,556.5	10,355,9

REPLICATIONS	2,000	2,000	2,000	2,000	2,000
SIMULATION	Halton	Halton	Halton	Halton	Halton

Note: Before the model estimation, we had inverted the price sign (expected to be negative) in order to overcome convergence problems; ***, **, * ==> Significance at 1%, 5%, 10% level; () ==> Standard Error; N==> Number of observations; LL==> Log likelihood function; LRT==> Log-likelihood ratio; K==> Number of factors; R-SQRD==> Coefficient of determination R squared; R-SQRD ADJUSTED==> Adjusted R-squared ;AIC==> Akaike information criterion; BIC==> Bayesian information criterion.

Table V: Converting the estimated log terms to the original parameters

PRICE PARAMETER		Traditional no reference (NR) model	Actual choice (AC) based reference model	Minimum requirements (MR) based reference model	Goal (G) based reference model	Extended actual choice (AC) based reference model
PRICE	Mean	-3.729*** (.115)	-3.019*** (.095)	-2.477*** (.090)	-2.406*** (.090)	-2.985*** (.098)
	Std. Dev.	1.778*** (.113)	4.514*** (.229)	1.989*** (.186)	2.206*** (.192)	4.469*** (.232)
	Median	-3.366*** (.095)	-1.678*** (.091)	-1.932*** (.072)	-1.774*** (.078)	-1.658*** (.095)
SAVING_FUEL	Mean	.470*** (.096)	.417*** (.038)	.550*** (.029)	.556*** (.151)	.418*** (.041)
	Std. Dev.	.620*** (.222)	.907*** (.196)	.786*** (.077)	.976** (.427)	.896*** (.208)
	Median	.284*** (.033)	.174*** (.037)	.315*** (.036)	.275*** (.041)	.176*** (.038)
ABATEMENT_CO2	Mean	.419*** (.034)	.652** (.266)	.332** (.167)	.019*** (.0008)	.683** (.288)
	Std. Dev.	.672*** (.125)	2.474 (1.518)	1.061 (.774)	.018*** (.0005)	2.752 (1.748)

	Median	.221*** (.034)	.166*** (.036)	.099*** (.029)	.014*** (.0009)	.164*** (.037)

***, **, * ==> Significance at 1%, 5%, 10% level; () ==> Standard Error; Std. Dev.==> Standard Deviation.

ANNEX 01:

Results of the Multinomial Logit (MNL) Model

	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval
PRICE	-2.056	.055	-36.96	.000	[-2.165 -1.947]
SAVING_FUEL	.281	.017	16.19	.000	[.247 .315]
ABATEMENT_CO2	.255	.017	14.65	.000	[.220 .289]
BIOFUEL	.100	.017	5.87	.000	[.066 .133]
ASC_c	2.980	.084	35.32	.000	[2.814 3.145]
ASC_h	3.402	.086	39.38	.000	[3.233 3.571]
STATISTICS:					
N	7,000				
GROUPS	875				
NB. OBSRVS./GROUP	8				
LL FUNCTION	-6,578.012				
K	6				
R-SQRD	.136				
R-SQRD ADJUSTED	.135				
AIC	13,168.0				
BIC	13,209.1				