THE IMPACT OF HOUSEHOLD CHARACTERISTICS ON AUTOMOBILE CHOICE IN MALAYSIA: AN APPLICATION OF THE MULTINOMIAL LOGIT MODEL

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ABSTRACT

This paper analyzes how the household head's choice among three automobiles (Proton, Perodua and foreign automobiles) in Malaysia is affected by the household characteristics and also changes in the household characteristics by using the multinomial logit model. The results show that Perodua is more preferable to older person compared to foreign automobiles. In addition, Proton and Perodua appear to cater to those with lower income while foreign automobile appears to cater to higher income. Based on the results, local car producers should concentrate on the market for older persons and affordability in order to compete with foreign automobiles.

JEL Classification: C25, D12.

Keywords: Automobile choice, Multinomial logit, Household characteristics, Malaysia.

1. INTRODUCTION

Globalization, particularly the formation of ASEAN Free Trade Area (AFTA), might have a huge impact on domestic automobile producers, Proton and Perodua, in the near future. Hence, understanding consumer needs and making an adequate provision for them are important ways for local producers to survive in a globalized market economy. Historically, national automobiles in Malaysia have persistently dominated the domestic automobile market, where the market share of national automobiles (Proton and Perodua) grew from as low as 47% when they were first introduced to as high as 91% in 2001 and 2002. The market share of national automobiles for later years has declined slightly due to the Malaysia's participation in AFTA. In the year 2008, for example, the market share of national automobiles

(Proton and Perodua) fell to 56.4%. With the full implementation of AFTA in the near future, the Malaysian automobile industry is expected to face greater challenges from neighboring countries, particularly Thailand.

Traditionally, researchers and economists have been interested in identifying factors that influence consumers' automobile buying behavior, and have developed various models of automobile type choice. Discrete choice models such as multinomial logit model (e.g., Choo and Mokhtarian, 2004; Lave and Train, 1979; Mannering and Winston, 1985) and nested logit model (e.g., Berkovec, 1985; Berkovec and Rust, 1985) have been used to explain automobile type choice. The household automobile type holding has been the focus of extensive research in the fields of transportation and economics. According to Bhat and Sen (2006), there are two reasons for this. First, the household automobile holdings have a significant impact on the travel behavior of individuals and households. Second, the automobile type holdings play a vital role in determining consumer demand for the type of automobiles. Thus, the demographic characteristics of the population and the preferences for different automobile types in the population provide information to the automobile manufacturers to design future automobiles and to market automobiles by adopting targeting strategies.

They have been several studies focusing on the influence of household characteristics (such as age, gender, marital status and ethnicity) on the preference for different types of automobiles. Some researchers use the characteristics of household heads (Dargay and Vythoulkas, 1999) while other researchers use the characteristics of car drivers to understand automobile type choice (Train, 1986; Golob, 1997), household head's income, household income, the number of children, and household size (Kitamura, 2000; Mannering and Mahmassani, 1985; Mohammadian and Miller, 2003; Lave and Train, 1979; Train and Lohrer, 1982; Train and Winston, 2004), and household location (urban and rural) (Bhat and Guo, 2007; Bhat, Sen and Eluru, 2009; Pagliara and Preston, 2003). However, they do not consider the work status of the spouse of household head, although much research found that spouse's working status affects the family buying decision (Cosenza and Davis, 1980; Schaninger and Allen, 1981; and Lee and Beatty, 2002). In addition, most of the previous researches relating to household characteristics on the choice of automobiles have been conducted in developed markets, especially in the U.S. (Qian, 2009).

Although household characteristics offer a useful insight for decision makers as well as the automobile manufacturers and the transportation planners developing transportation polices related to automobile ownership (Bhat, Sen, and Eluru, 2009; Choo and Mokhtarian, 2004; Sen, 2006), there are no studies in Malaysia on this area except for Mustafa and Abdul Razak (2009). The current study is designed to fill the gap. In particular, the purpose of this paper is two-fold. First, to examine the impact of household characteristics and the change in household characteristics on the probability of buying a particular automobile in Malaysia by employing a discrete

choice model based on household characteristics. Second, to examine whether the impact of household characteristics and the change in household characteristics on the probability of choosing a particular automobile in Malaysia differs between urban and rural consumers.

The remainder of this paper is organized as follows. Section 2 provides an overview of the Malaysian automobile market. Section 3 describes the method of analysis as well as the data used for this study. Section 4 presents and discusses the empirical results. Finally, section 5 offers concluding remarks with a particular emphasis on the policy implications of the findings.

2. AN OVERVIEW OF MALAYSIA AUTOMOBILE MARKET

The automobile industry has been considered the "industry of industries" of the last century because of its spin-off effects (Dicken, 1988). During the period 1967–1977, the main Japanese and Western automobile corporations relocated automobile production to Malaysia induced by the Malaysian import substitution policy. In the 1960s, the government of Malaysia encouraged foreign producers to build automobile assembly plants in Malaysia. The main objectives were to create employment and provide the base for the transfer of technology. The national automobile project was carried out in the 1980s as part of the industrial policy where the government of Malaysia proposed a joint venture with a Japanese company, Mitsubishi, to build Malaysian automobiles.

The national automobile project, Perusahaan Otomobil National (Proton), initiated and patronized by the then Prime Minister of Malaysia, Tun Dr Mahathir Mohamed, was established on May 7th, 1983 (*http://proton.com.my/*). The first Proton model, known as Proton Saga, was launched on July 9th, 1985. After the success of the first national automobile, Perusahaan Otomobil Kedua Sdn. Bhd. (Perodua) was established in October 1992. Currently, there are four national vehicle producers in Malaysia, Proton, Perodua, Naza, and Inokom. Together, these automobile makers have rolled out 34 different models, of which 14 models have been produced by Proton, seven by Perodua, eight by Naza, and five by Inokom. With a strong government commitment, now Malaysia has a fairly strong vehicle industry. Besides the national vehicle project, well known marques are assembled here, ranging from Honda, Toyota, and Kia, to name a few. The importance of the vehicle industry is evident from its substantial contribution to the government revenue. It is estimated that the industry accounts for 65% of the government annual excise duty revenue or approximately RM3.3 billion. It also contributes approximately 30% of sales tax revenue (*http://proton.com.my/*). It is surely in the government's interest to see the automobile industry in the country to flourish further.

In 1992, the ASEAN countries (Malaysia, Singapore, Brunei, Thailand, Indonesia and the Philippines) signed an (AFTA) agreement. Under the agreement, Malaysia will cut duties on imports from other Southeast Asian countries to below than 5%

from the year 2005. It has been predicted that national automobiles may have a hard time competing against tariff-free automobiles from other ASEAN countries under the agreement. Top global automakers such as Ford, BMW and General Motors have already set up manufacturing plants in Thailand aiming for the Malaysian market (Hashim, 2008). Therefore, the main challenge for the Malaysia's automobile industry is competition from the Thailand's automobile industry in the area of production, technology and sales. In 2003, Thailand ranked the top position of ASEAN automobile markets, capturing a market share of 41.3%, while Malaysia was second with a share of 31.3%. In the global market, Thailand ranked as the 15th largest automobile manufacturer in the world (Michael & Edmonds, 2004).

Figure 1 shows a recent trend in the new automobile sales by major automobile producers in Malaysia: Proton, Perodua, Toyota, and Honda. The sales figure shows that Proton's sales have been decreasing over the past few years while Perodua's sales have been increasing. For instance, Proton sales for 2001 were 208,746 as compared to 214,373 in 2002 and 155,538 in 2006 and 148,031 in 2009 while Perodua sales for 2001 were 94,476 as compared to 114,265 in 2002 and 152,733 in 2006 and 166,736 in 2009 (*http://autoworld.com.my*). On the other hand, the foreign automobiles sales have increased significantly. The sales figure shows that the Toyota sale increased over the past few years. Toyota sales for 2001 were 5,801 as compared to 81,785 in 2009, Honda sales for 2001 were 4,165 as compared to 38,783 in 2009, in spite of the fact that the national automobiles have been sheltered from competition through tariff protection, trade barriers, tax exemptions, rebates, subsides and other government incentives.

Figure 1
Market Share of Sales of Automobiles in Malaysia (%), 2001-2009
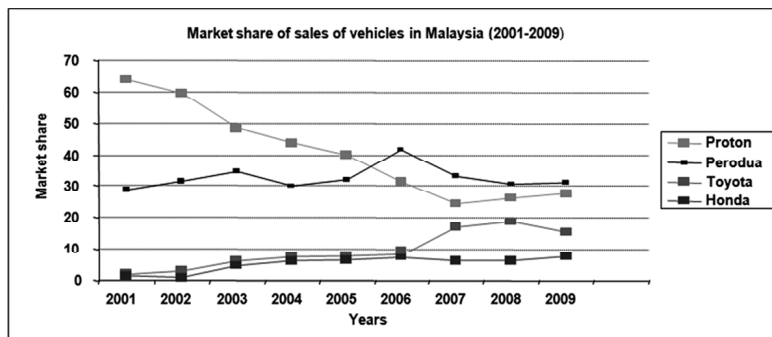
3. METHODOLOGY AND DATA

In this study, the dependent variable is the choice of a particular automobile in Malaysia (Proton, Perodua and foreign automobiles). Letting these automobiles be indexed by J (for $J = 1, 2,$ and 3), then the choice by consumer i (for $i = 1, 2, …, N$) can be written as

$$y_i = \begin{cases} 1 & \text{if consumer buys a Proton automobile} \\ 2 & \text{if consumer buys a Perodua automobile} \\ 3 & \text{if consumer buys a foreign automobile} \end{cases} \tag{1}$$

Let the explanatory variables be the various characteristics of a household, denoted by

$$\mathbf{x'_i} = [gend_i \ marr_i \ race_i \ relig_i \ age_i \ educ_i \ meho_i \ worsp_i \ income_i] \tag{2}$$

where *gend* is a dummy variable for gender of a household head (equal to 1 for males and 0 otherwise), *marr* is a dummy variable for marital status of a household head (1 for married individuals and 0 otherwise), *race* is a dummy variable for race of the household head (which is equal 1 for Malay and 0 otherwise), *relig* is a dummy variable for religion of the household head (which is equal 1 for Muslim and 0 otherwise), *age* is the age of a household head, *meho* is the number of household members, *educ* is the amount of education for the household head (measured by the number of years of schooling). *worsp* is a dummy variable for work status of the spouse of a household head (which is equal 1 if the spouse is working and 0 otherwise), and *income* is the income of the household. The choice of these variables is based on the literature review.

The use of a relatively large number of explanatory variables (9) raises some concern over whether our results are plaqued by multicollinearity. As a matter of fact, a collinearity check indicates there is a high correlation between the race and religion of the household head ($r = 0.963$). This hints that there is a severe multicollinearity problem (Hair, Black, Babin, Anderson, & Tatham, 2006). Therefore, we drop the religion variable from our specification.

Given the categorical nature of the dependent variable, as well as the individual specific nature of the explanatory variables, our model can be specified as the probability of choosing any particular automobile *j* by consumer *i* conditional on the explanatory variables, Prob ($y = j \,|\, \mathbf{x}_i$). This probability can, in turn, be expressed by a multinomial logit model:

$$\text{Prob} \,(y_i = j \,|\, \mathbf{x}_i) = \frac{\exp(\beta_j x'_i)}{\displaystyle\sum_{j=1}^{J} \exp(\beta_j x'_i)} \tag{3}$$

If we define $P_{ij} = \text{Pr}\,(y_i = j \,|\, \mathbf{x}_i)$, then the marginal effect of a specific explanatory variable x_{ik}, on the probability of choosing a specific automobile, P_{ij}, is given by

$$\frac{\partial P_j}{\partial x} = P_j \left(\beta_j - \sum_{j=1}^{3} P_j \beta_j \right), \quad j = 1, 2, 3. \tag{4}$$

The marginal effect analysis can help us answer many interesting questions such as: what is the impact on the probability of buying Proton, Perodua, or foreign

automobiles if there is an increase in (a) income, (b) education, or (c) age; and what is the difference in the probability of buying Proton, Perodua, or foreign automobiles between (a) married and single households, (b) Malay and non-Malay households, or (c) working and nonworking spouse households?

Although the population for this research consists of the entire Malaysian, cost considerations (i.e. financial and time) necessitate that the sample be confined to those who live in some selected areas. The selection of samples is based on the stratified sampling method where the population of our study (i.e., all car owners in Malaysia) is divided into urban and rural areas. For urban areas, we choose Alor Setar, Ipoh, Kuala Lumpur and Georgetown; for rural areas, we choose Pendang, Bachok, Sepang and Kuala Pilah. Once these areas have been picked, 100 respondents from each area are interviewed. The interview was conducted by eight numerators in May 2010, one for each area. The duration of the interview was between two and three weeks.

Although the total number of respondents is originally 804, missing values reduces the sample size to 793, of which 398 live in urban and the remaining 395 live in rural areas. Of the 793 total respondents, 48.38% of them chose Proton, 25.13% chose Perodua, and 26.50% chose foreign automobiles. The respondents' profiles are as follows: The number of household member ranges between 1 and 15 (the average is six members), age of household head ranges between 18 and 75 years old (the average is 41 years old), education of household head ranges between 0 and 23 years, household income ranges between RM400/month and RM35,500/month (the average is RM4084.446), 92.41% of household heads are males, 88.81% of them are married, 86.18% of them are Malays, 86.55% of them are Muslim, 97.01% of the household head are working, and 40.01% of the wife of household head are working (Appendix A).

4. RESULT AND DISCUSSION

Maximum Likelihood method is used to estimate the parameters of the multinomial logit model. The Likelihood function is the product of the probabilities of the chosen alternative over all consumers, that is,

$$L(\theta) = \prod_{i=1}^{N} \prod_{j=1}^{3} \Pr[y_i = j]^{I[y_i = j]},$$

where θ summarizes the model parameters. Taking the logarithm provides the log-likelihood function as below.

$$\ell(\theta) = \sum_{i=1}^{N} \sum_{i=1}^{N} I[y_i = j] \log \Pr[y_i = j].$$

The maximum likelihood estimator is the parameter value $\hat{\theta}$ that corresponds to the largest value of the log likelihood function over the parameters. By solving the first order condition we can find this maximum.

We begin by conducting a multinomial logit model (MNL) analysis for a sample of 793 household head in the Malaysia based on Equation 3. Results of the estimation are presented in Table 1.

Table 1
Estimates of the MNL Model (Full Sample, $n = 793$)

	Proton Coef.	Perodua Coef.
Constant	1.3080	3.6159
	(0.124)	(0.000)
Gender of HHH	1.4797**	0.2499
	(0.026)	(0.712)
Marital status of HHH	−2.0600***	−1.534**
	(0.000)	(0.012)
Race of HHH	−0.5527*	−0.9583***
	(0.070)	(0.005)
Age of HHH	−0.0063	0.0120
	(0.531)	(0.276)
Education Year of HHH	0.0567**	0.0102
	(0.046)	(0.754)
No. Household members	0.2847***	−0.0906
	(0.000)	(0.177)
Work status of Spouse	0.1519	0.6787***
	(0.499)	(0.009)
Household Income	−0.0004***	−0.0005***
	(0.000)	(0.000)

Note: The figures in parenthesis are p-value; ***, **, and * denote that the corresponding coefficient is significant at the 1%, 5%, and 10% level, respectively. The choice of foreign automobile is the base outcome.

For Proton (see column 2 of Table 1), we see that three of the estimated coefficients are statistically significant at the 1% level (i.e., marital status, number of household members and household income), two estimated coefficient are statistically significant at the 5% level (i.e., gender of household head and education of household head) and one estimated coefficient is significant at the 10% level (i.e. race of household head). For Perodua (see column 3 of Table 1), we note that three of the estimated coefficients are statistically significant at the 1% level (i.e., race of household head, work status of wife of household head and household income) and one estimated coefficient is significant at the 5% level (i.e., marital status).

Hausman test was also carried out to test the assumption of Independence of Irrelevant (IIA) and the null hypothesis,: Odds (Outcome – *J* vs. Outcome – *K*) are

independent of other alternative, was not rejected (Table 2). We see that two of the test statistics are negative, which we find to be very common. Hausman and McFadden (1984, 1226) note this possibility and conclude that a negative result is evidence that IIA has not been violated. The Hausman Test is also carried out to test the IIA with different base category and we find the IIA has not been violated.

Table 2
Hausman Test of IIA: Ho: Odds (Outcome-*J* vs. Outcome-*K*) are Independent of Other Alternatives

	Full Sample			*Urban area*			*Rural area*			
Omitted choice	*Chi-Sq*	*df*	*P>chi-Sq*	*Chi-Sq*	*df*	*P>chi-Sq*	*Chi-Sq*	*df*	*P>chi-Sq*	*Evidence*
Proton	6.924	8	0.545	10.196	8	0.252	6.964	7	0.433	Cannot reject H_0
Perodua	−5.224	8	1.000	−56.491	8	1.000	−0.430	8	1.000	Cannot reject H_0
Foreign	−4.834	8	1.000	−2.764	8	1.000	−552.326	7	1.000	Cannot reject H_0

Note: Choice of foreign automobiles is the base outcome.

Unlike the binomial logit analysis, however, the estimated coefficients in this multinomial logit model are of limited use because they cannot be used to infer the direction of the marginal effect of each explanatory variable. The reason is that, as shown in Equation 4, the marginal effect of a given variable on the probability of

Table 3
Marginal Effect of the MNL Model (Full Sample)

	Proton	*Perodua*	*ForeignAutomobile*
Gender HHH	0.3105***	−0.1047	−0.2058
	(0.001)	(0.372)	(0.167)
Marital status	−0.2540***	0.0225	0.2315***
	(0.002)	(0.767)	(0.000)
Race HHH	−0.0014	−0.1106**	0.1121***
	(0.981)	(0.049)	(0.005)
Age HHH	−0.0030	0.0029*	0.0001
	(0.130)	(0.062)	(0.947)
Education Year HHH	0.0129**	−0.005	−0.0079
	(0.028)	(0.298)	(0.113)
No. Household members	0.0820***	−0.0507***	−0.0313***
	(0.000)	(0.000)	(0.002)
Work status of Spouse	−0.0470	0.1057***	−0.0587
	(0.299)	(0.007)	(0.124)
Household Income	−0.00004***	−0.00004***	0.00008***
	(0.000)	(0.000)	(0.000)

Note: The figures in parenthesis are p-values; ***, **, and* denote that the corresponding coefficient is significant at the 1%, 5%, and 10% level, respectively. Choice of foreign automobiles is the base outcome.

choosing any particular automobile is a function of all the estimated coefficients. Hence, we proceed by calculating the marginal effect of each explanatory variable on the probability of choosing each of the automobiles. As documented in Table 3, we find the following. First, the difference in the probability of choosing an automobile across gender of the household head is significant for Proton only. In particular, the probability of choosing Proton is 31.05% higher for men. These results indicate that Proton appears to cater to men's, but Perodua and foreign automobiles seem to be indifferent towards gender of the household head.

Second, the difference in the probability of choosing an automobile across marital status is significant for Proton and foreign automobiles only. In particular, the probability of choosing Proton is 25.40% higher for unmarried people, while the probability of choosing foreign automobiles is 23.15% higher for married people. These results indicate that Proton cater to unmarried people while foreign automobiles appear to cater to married individuals, but Perodua seem to be indifferent towards marital status. Third, the difference in the probability of choosing an automobile across race of the household head is significant for Perodua and foreign automobiles only. In particular, the probability of choosing Perodua is 11.06% higher for non-Malay ethnic group, while that of foreign automobiles is 11.21% higher for Malay ethnic group. These results indicate that Perodua appear to cater to non-Malays, foreign automobiles to Malays, and Proton seem to be indifferent to household head ethnic group.

Fourth, the marginal effect of household head's age on the probability of choosing an automobile is significant for Perodua only. In particular, if household head age increases by one year from its mean value of about 41 years old, the probability of choosing Perodua rises by 0.29%. These results show that Perodua appear to cater to older people, Proton and foreign automobiles seem to be indifferent towards age of the household head. Fifth, the marginal effect of years of education of the household head's on the probability of choosing an automobile is significant for Proton only. In particular, if the education of household head increases by one year from its mean value of about 11, the probability of choosing Proton rises by 1.29%. These results indicate that Proton appear to cater to those with higher level of education people while Perodua and foreign automobiles seem to be indifferent towards years of education.

Sixth, the marginal effect of household size on the probability of choosing an automobile is significant for all automobiles. In particular, if the number of household member increases by one person from its mean value of six persons, the probability of choosing Proton rises by 8.2%, the probability of choosing Perodua falls by 5.07%, and that of foreign automobiles falls by 3.13%. These results suggest that Perodua and foreign automobiles appear to cater to households with fewer than six members while Proton to households with more than six members, respectively. Seventh, the difference

in the probability of choosing an automobile across work status of household wife is significant for Perodua only. In particular, the probability of choosing Perodua is 10.57% higher for work of wife of household head. These results indicate that Perodua appear to cater to a married women working and Proton and foreign automobiles seem to be indifferent towards work of wife of the household head. Finally, the marginal effect of household income on the probability of choosing an automobile is significant for all automobiles. In particular, if household income increases by RM1000 from its mean value of RM4084, the probability of choosing Proton and Perodua falls by 0.04%, while the probability of choosing foreign automobiles rises by 0.08%. These results suggest that Proton and Perodua appear to cater to lower-income people while foreign automobiles appear to cater to higher-income people.

A question of special interest is how the effects of consumer behavior on automobile choice differ between all households and specific households (i.e. urban and rural households). To help answer this question, we repeat our analysis for urban and rural area separately. We begin by conducting a multinomial logit model analysis for sample of 398 and 395 household head in the urban and rural areas respectively, and report the results in Table 4. In the urban area, we see that only three of the estimated coefficients are individually significant at the 1% level (i.e., number of household members and household income) and one estimated coefficient is significant at the level 5% (i.e. marital status) for Proton (see column 2 of Table 3), and we see that only one of the estimated coefficients are individually significant at the 1% level (i.e. household income), one estimated coefficients are individually significant at the 5% level (i.e., marital status) and one estimated coefficient are individually significant at the 10% (i.e., race of the household head) for Perodua (see column 3 of Table 3).

In the rural area, we see that only three of the estimated coefficients are individually coefficient at the 1% level (i.e., marital status, number of household members and household income) and one estimated coefficient is significant at the level 10% (i.e., gender of the household head) for Proton (see column 4 of Table 3), and for Perodua (see column 5 of Table 3), we note that only two estimated coefficients are individually significant at the 1% level (i.e., race of household head and household income), and two estimated coefficients are individually significant at 5% level (i.e., age of household head and work status of wife of the household head).

From the previous discussion, we find the following: First, the estimated coefficient for gender of the household head is individually significant in the full sample and in the rural area for Proton and insignificant for both automobiles (Proton and Perodua) in the urban areas. Second, the estimated coefficient for marital status is individually significant for both automobiles (Proton and Perodua) in the full sample, urban and rural areas except for Perodua in the rural area. Third, the estimated coefficient for race of the household head is individually significant in the full sample,

urban and rural areas for Perodua while the estimated coefficient for this explanatory variable is significant in the full sample only for Proton. Fourth, the age of the household head is significant in the rural area for Perodua only. Similarly, the education of the household head is significant in the full sample for Proton only. Fifth, the estimated coefficient for the number of household members is individually significant in the full sample, urban and rural areas for Proton only and we found that the estimated coefficient for work status for the household head wife is significant in the full sample and rural area for Perodua only. Finally, household income is individually significant at the 1% level for Proton and Perodua in the full sample, urban and rural areas.

Table 4
Estimates of the MNL (Urban vs. Rural Areas)

	Urban area (n = 398)		Rural area (n =395)	
	Proton Coef.	*Perodua Coef.*	*Proton Coef.*	*Perodua Coef.*
Constant	3.2469	6.6899	−0.5580	−15.5176
	(0.062)	(0.000)	(0.728)	(.)
Gender HHH	0.5730	−0.1900	1.5879*	−0.0586
	(0.684)	(0.888)	(0.051)	(0.947)
Marital status	−2.0465**	−2.066**	−2.1049***	−1.1541
	(0.033)	(0.041)	(0.004)	(0.169)
Race HHH	−0.3848	−0.7140*	0.4626	16.5645***
	(0.315)	(0.086)	(0.707)	(0.000)
Age HHH	−0.0225	−0.0100	0.0075	0.0324**
	(0.175)	(0.570)	(0.562)	(0.028)
Education Year HHH	0.0521	−0.0345	0.0355	0.0182
	(0.301)	(0.538)	(0.313)	(0.669)
No. Household members	0.3665***	−0.1123	0.2564***	−0.0587
	(0.000)	(0.355)	(0.000)	(0.473)
Work status of Spouse	−0.1288	0.3713	0.2070	0.8595**
	(0.700)	(0.315)	(0.519)	(0.026)
Household Income	−0.0005***	−0.0006***	−0.0003***	−0.0005***
	(0.000)	(0.000)	(0.000)	(0.000)

Note: The figures in parenthesis are *p*-value. ***, **, and * denote that the corresponding coefficient is significant at the 1%, 5%, and 10% level, respectively. Choice of foreign automobiles is the base outcome.

Next, we calculate the marginal effect of each explanatory variable on the probability of choosing each of the automobiles. As documented in Table 5, we find the following. First, the difference in the probability of choosing an automobile across gender of the household head is significant for Proton only in the rural area. In particular, the probability of choosing Proton is 35.80% higher for men in the rural area.

These results indicate that, men prefer Proton in the rural area and Perodua and foreign automobiles seem to be indifferent towards gender of the household head and this explanatory variable does not affect the choice of all automobiles (Proton, Perodua and foreign automobile) in the urban areas. These results for the rural area are consistent with those in the full sample.

Second, the difference in the probability of choosing an automobile across marital status is significant for foreign automobiles in the urban area and significant for Proton and foreign automobiles in the rural area. In particular, the probability of choosing foreign automobiles is 18.11%, 28.44% higher for married people in the urban and rural areas respectively, while the probability of choosing Proton is 34.22% higher for unmarried people in the rural area. These results indicate that, married people prefer foreign automobiles in the both areas. Unmarried people prefer the Proton in the rural area, and marital status does not affect the choice of Perodua in the urban and rural areas beside the Perodua in the rural area. These results for the rural area are consistent with those in the full sample. Third, the difference in the probability of choosing an automobile across race of the household head is significant for Perodua only in the rural area. In particular, the probability of choosing Perodua is 20.57% higher for Malay people in the rural area. These results indicate that, the

Table 5
Marginal Effect of the MNL Model (Urban vs. Rural Areas)

	Urban area			Rural area		
	Proton	Perodua	Foreign	Proton	Perodua	Foreign
Gender HHH	0.1695	−0.1255	−0.0440	0.3580***	−0.1411	−0.2169
	(0.431)	(0.524)	(0.849)	(0.001)	(0.346)	(0.252)
Marital status	−0.1188	−0.0622	0.1811***	−0.3422***	0.0578	0.2844***
	(0.474)	(0.699)	(0.000)	(0.000)	(0.410)	(0.000)
Race HHH	0.0140	−0.0849	0.0709	−0.0184	0.2057***	−0.1874
	(0.840)	(0.182)	(0.138)	(0.952)	(0.000)	(0.541)
Age HHH	−0.0041	0.0013	0.0028	−0.0017	0.0040**	−0.0029
	(0.189)	(0.623)	(0.232)	(0.686)	(0.023)	(0.260)
Education Year HHH	0.0178*	−0.0141	−0.0037	0.0072	−0.0006	−0.0066
	(0.075)	(0.105)	(0.608)	(0.338)	(0.905)	(0.347)
No. Household members	0.1068***	−0.0741***	−0.0327**	0.0693***	−0.0318***	−0.0375***
	(0.000)	(0.000)	(0.032)	(0.000)	(0.001)	(0.005)
Work status of Spouse	−0.0851	0.0903*	−0.0052	−0.0341	0.1128**	−0.0787
	(0.179)	(0.100)	(0.914)	(0.609)	(0.033)	(0.192)
Household Income	−0.00004***	−0.00004***	0.00008***	−0.00004***	−0.00004***	0.00008***
	(0.003)	(0.004)	(0.000)	(0.007)	(0.000)	(0.000)

Note: The figures in parenthesis are p-values; ***, **, and* denote that the corresponding coefficient is significant at the 1%, 5%, and 10% level, respectively. Choice of foreign automobiles is the base outcome.

Malays prefer Perodua in the rural area and Proton, foreign automobiles seem to be indifferent towards race of the household head and this explanatory variable does not affect the choice of all automobiles (Proton, Perodua and foreign automobile) in the urban areas. These results are largely consistent with those in the full sample.

Fourth, the marginal effect of household head's age on the probability of choosing an automobile is significant for Perodua in the rural area only. In particular, if household head age increases by one year from its mean value of about 42 years old in the rural area, the probability of choosing Perodua rises by 0.40% in the rural area. These results suggest that Perodua appear to cater to older people and Proton, foreign automobiles seem to be indifferent towards age in both urban and rural areas. The results for the rural area are consistent with those in the full sample. Fifth, the marginal effect of the education year of the household head's on the probability of choosing an automobile is significant for Proton only. In particular, if the education year of household head increases by one year from its mean value of about 11 of education years, the probability of choosing Proton rises by 1.78%. These results indicate that Proton appears to cater to higher education consumers and the Perodua and foreign automobiles seem to be indifferent towards education years. These results for the urban area are consistent with those in the full sample.

Sixth, the marginal effect of household size on the probability of choosing an automobile is significant for all automobiles in the urban and rural areas. In particular, if the number of household member increases by one person from its mean value of about six persons, the probability of choosing Proton rises by 10.68% and 6.93% in the urban and rural areas, respectively. While the probability of choosing Perodua falls by 7.41% and 3.18% in the urban and rural areas, respectively. And also the probability of choosing foreign automobiles falls by 3.27% and 3.75% in both urban and rural areas, respectively. These results suggest that Perodua and foreign automobiles appear to cater to households with fewer than six members while Proton to households with more than six members, respectively. These results are consistent with those in the full sample.

Seventh, the difference in the probability of choosing an automobile across work status of wife of the household head is significant for Perodua only in the urban and rural areas. In particular, the probability of choosing Perodua is 9.03%, 11.28% higher for work of wife of household head in the urban and rural areas, respectively. These results indicate that, the married women working prefer Perodua in the urban and rural areas and work status of wife of the household head does not affect the choice of Proton and foreign automobiles in both areas. These results for the urban and rural areas are consistent with those in the full sample. Finally, the marginal effect of household income on the probability of choosing an automobile is significant for all automobiles in the urban and rural area. In particular, if a household income increases by RM1000 from its mean value of RM4395 and RM 3766 in the urban and

rural areas respectively, the probability of choosing Proton falls by 0.04% in the urban and rural area. Perodua also falls by 0.04% in the both areas, while the probability of choosing foreign automobiles rises by 0.08% in the urban and rural areas. These results suggest that Proton and Perodua appear to cater to lower- income people while foreign automobiles appear to cater to higher-income people in both areas. These results are consistent with those in the full sample.

5. SUMMARY AND CONCLUSION

To recap, this paper analyzes how the household head choice among three automobiles (Proton, Perodua and foreign automobiles) is affected by the household characteristics and also changes in the household characteristics. Our empirical analysis produces the following results. In general, the coefficient of household income and marital status are significant for almost all the automobiles (Proton, Perodua and foreign automobiles) and samples. On the other hand, the coefficient for gender of the household head is significant only in the case of Proton while the coefficient for race of the household head is individually significant in all samples in the case of Perodua. The coefficient of age of the household head and education of household head is only significant in the case of Perodua. The coefficient of number of household members is only significant in the case of Proton while the coefficient for work status of wife household head is significant only in the case of Perodua.

For the marginal effect we found the followings. First, we found that married people prefer foreign automobiles while unmarried people prefer the Proton. Marital status does not affect the choice of Perodua. Second, the probability of choosing an automobile differs across ethnic group of the household head. The results indicate that the Malays prefer foreign automobiles and Perodua while the non-malays prefer Perodua. Third, the results suggest that Perodua appear to cater to older people while Proton and Foreign automobiles does not depends on household head's age. Fourth, we found that Proton appear to cater to those with higher level of education while Perodua and foreign automobiles seem to be indifferent towards years of education of the household head. Fifth, the results indicate that the Perodua and foreign automobiles appear to cater to the small family while Proton appears to cater to the big family. Sixth, the results indicate that those with wife who are working prefer Perodua. Finally, the results also indicate that Proton and Perodua appear to cater to those with lower income while the foreign automobile appears to cater to higher income. Based on the results, local car producers should concentrate on the market for older persons and affordability in order to compete with foreign automobiles. In addition, the results also suggest that the impact of household characteristics and the change in household characteristics on the probability of choosing a particular automobile in Malaysia differs between urban and rural consumers. Hence, local car producers should take into cognizant the heterogeneity in the behavior of consumers.

Appendix A
Descriptive Statistics

Panel 1
Discrete Variables

		Full sample		Urban area		Rural area	
		Freq	Percent	Freq.	Percent	Freq.	Percent
Choice	Proton	387	48.38	201	50.00	186	46.73
	Perodua	201	25.13	106	26.37	95	23.87
	Foreign automobile	212	26.50	95	23.63	117	29.40
Gender	Male	743	92.41	383	94.80	360	90.00
	Female	61	7.59	21	5.20	40	10.00
Marital Status	Married	714	88.81	372	92.08	342	85.5
	Others	90	11.19	32	7.9	58	14.50
Race	Malay	692	86.18	298	73.95	394	98.50
	Others	111	13.82	105	26.05	6	1.5
Religion	Islam	695	86.55	302	74.94	393	98.25
	Others	108	13.45	101	25.06	7	1.75
Work status HHH	Work	780	97.01	396	98.02	384	96.00
	Others	24	2.99	8	1.02	16	4.00
Work status Spouse	Work	322	40.05	188	46.53	133	33.25
	Others	482	59.95	216	53.47	267	66.75

Panel 2
Continuous Variables

	Full sample				Urban area				Rural area			
	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max
No. of household members	5.734	1.935	1	15	5.569	1.574	1	13	5.905	2.222	1	15
Age of HHH	40.660	11.032	18	75	39.015	10.008	18	73	42.348	11.756	18	75
Education Year of HHH	10.575	4.1310	0	23	11.315	3.287	0	21	9.829	4.723	0	23
Household Income	4084.446	3050.058	400	35500	4395.408	2471.164	410	14250	3766.051	3508.135	400	35500

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