Is There an Overlapping Market between National Car Producers in Malaysia?

(Adakah terdapat Pertindihan Pasaran antara Pengeluar Kereta Nasional di Malaysia?)

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ABSTRACT

This paper examines how the choice of three broad categories of automobiles in Malaysia (i.e. Proton, Perodua, and foreign automobiles) is affected by a change in the price of a specific car model. Using a sample of 478 automobile owners in Malaysia, a discrete choice analysis is conducted based on the conditional logit model. In general, it is found that the own-price effect on Proton (Perodua) cars is negatively related to a specific Proton (Perodua) model; in contrast, the cross-price effect on Proton (Perodua) cars is positively related to a specific Perodua (Proton) model. Of the nine models evaluated, three of them show a significant overlapping market segment. This finding implies that Proton and Perodua should differentiate these products further to lessen competition between them.

Keywords: Automobile choice; Proton, Perodua; overlapping market; conditional logit model.
JEL Classification: D12, C25

ABSTRAK

Artikel ini mengkaji bagaimana pilihan tiga kategori utama kereta di Malaysia (iaitu Proton, Perodua dan kereta asing) dipengaruhi oleh perubahan harga bagi sesebuah model khusus kereta. Dengan menggunakan sampel 478 pemilik kereta di Malaysia, analisis pilihan diskrit digunakan berdasarkan model 'conditional logit'. Secara umumnya didapati bahawa kesan harga sendiri bagi kereta keluaran Proton (Perodua) berhubung secara negatif dengan sebarang model keluaran Proton (Perodua); sebaliknya, kesan harga bersilang bagi kereta keluaran Proton (Perodua) berhubung secara positif dengan sebarang model keluaran Perodua (Proton). Daripada sembilan model yang dikaji, tiga daripadanya menunjukkan pertindihan segmen pasaran yang signifikan. Dapatan kajian ini menyarankan bahawa Proton dan Perodua harus melakukan pembezaan produk yang lebih ketara terhadap produk-produk tersebut untuk mengurangkan persaingan sesama sendiri.

Katakunci: Pilihan kereta; Proton; Perodua; pertindihan pasaran; model 'conditional logit'.
Klasifikasi JEL: D12, C25

INTRODUCTION

Proton and Perodua are the two main local automobile manufacturers in Malaysia. Since both of them are government-owned, their very existence is to complement each other in the sense that each manufacturer caters to the needs of different segments of the automobile market. For instance, Proton produces Saga and Wira for middle-income and mid-size families while Perodua produces Kancil and Kelisa for relatively low-income and small-size families. However, the enlarged product lines for both car makers over the years (to date, there are more than 20 models) might have resulted in the overlapping of the market segments, thereby triggering competition among them.

To determine the extent of overlapping in the car market segments, we examine how the choice of automobiles by households in Malaysia is influenced by the price of a given model of automobile. Towards this end, we conduct a discrete choice analysis based on the conditional logit model using a sample of 478 households in Malaysia. The dependent variable in this study is

the choice among three broad makes of automobiles (i.e. Proton, Perodua, and foreign) and the explanatory variables are the prices of various models belonging to the above three broad makes. Our study contributes to the literature by studying automobile choice in Malaysia which is lacking in the literature. In particular, we look at how consumers make their choices between two local cars, Proton and Perodua by using the conditional logit model.

The remainder of this paper is organized as follows. Section 2 provides an overview of Malaysia's automobile market. Section 3 reviews the relevant literature. Section 4 describes the method of analysis as well as the data used for this study. Section 5 presents and discusses the results of empirical analysis. Finally, Section 6 offers concluding remarks with a particular emphasis on the policy implications of our findings on the automobile industry in Malaysia.

AN OVERVIEW OF THE MALAYSIAN AUTOMOBILE MARKET

The automobile industry is an important sector of the economy in the world. In 2005, the industry employed nine million people around the world to manufacture more than 65 million automobiles. The automobile industry's employment constitutes over 5% of the world's total manufacturing employment. In addition, the automobile industry plays a key role in the level of technology of other industries and is one of the main contributors to government revenues around the world. It contributes more than four hundred billion Euros to various economies of the world (International Organization of Motor Vehicle Manufacturers, or OICA (2011)).

Compared to other industries in Malaysia, the automobile industry has been earmarked to boost the industrialization process so that Malaysia can achieve the 2020 vision to be a developed country. This is evident from the substantial contribution of the automobile industry to the government revenue. It accounts for about 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 has a significant effect on the economy by creating jobs in the manufacturing spare parts and support industries such as retailing and repair parts. In addition, it provides direct and indirect employment to thousands of people. In 2003, for example, the industry hired 16,851 employees, of which 6,101 worked for Proton and 5,800 worked for Perodua. In addition, the industry helps the economy in terms of direct and indirect taxes. From 1995 to 2002, for example, Proton has contributed RM13.14 billion to the Malaysian government in the form of direct and indirect taxes (http://proton.com.my/). It has also contributed to human resource development in terms of training. It is therefore in the interest of the government to ensure the steady and speed growth of the automobile industry in the country.

Figure 1 shows a recent trend in the new passenger automobile sales by major automobile producers in Malaysia: Proton, Perodua, Toyota, Honda and Nissan. The market share of Proton was 61% in 1995 as compared
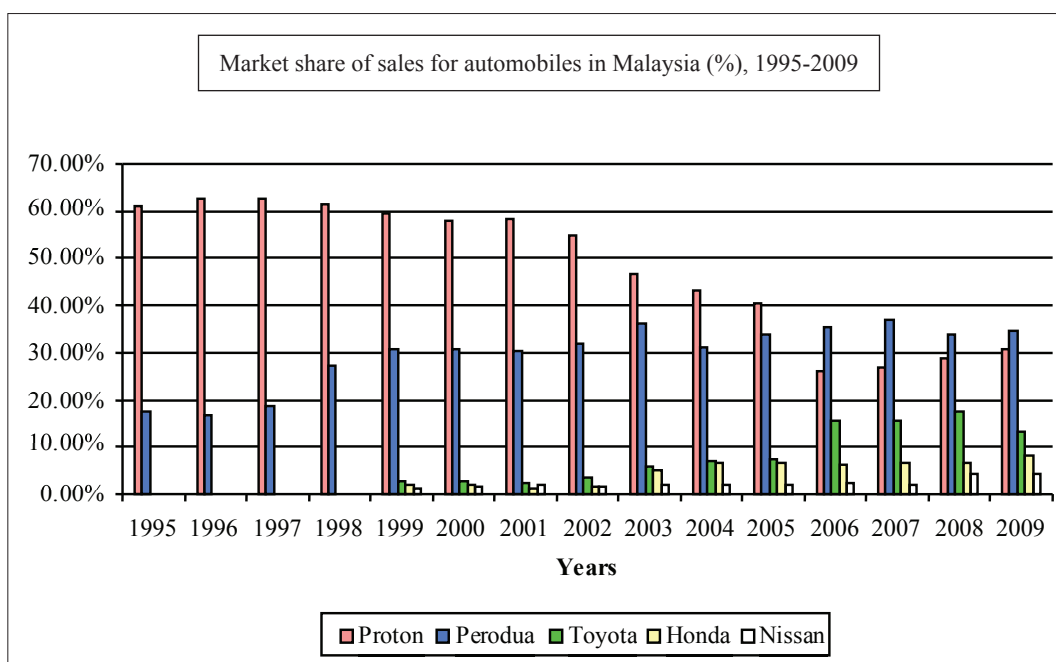
Source: http://autoworld.com.my. Note: Data for Toyota, Nissan and Honda are not available prior to 1999.

FIGURE 1. Market share of sales for passenger automobiles in Malaysia (%), 1995-2009.

to 47% in 2003 and 30% in 2009, while the market share of Perodua was 18% in 1995 as compared to 37% in 2003 and 35% in 2009; in contrast, the market share of Toyota was negligible in 1999 (less than 5%) as compared to 16% in 2006 and 13% in 2009 (a roughly similar trend can be discerned for Honda) (http://autoworld.com.my/).

Although the national automobiles have been sheltered from foreign competition through tariff protection, trade barriers, tax exemptions, rebates, subsides and other government incentives, the market shares of national automobiles for later years have declined slightly. For example, the combined market share of Proton and Perodua declined from 90% in 1999 to 82.8% in 2003 (a reduction of 7.2%) and to 64.65%in 2009 (a drop of 23.35%). In contrast, the market shares of foreign automobiles have increased significantly. For example, the market share of Toyota rose from 2.6% in 1999 to 5.7% in 2003 (a rise of 3.1%) and to 13.4% in 2009 (a rise of 10.8%), while the market share of Honda rose from 1.8% in 1999 to 5% in 2003 (a rise of 3.2%) and to 8% in 2009 (a rise of 6.2%).The decrease in the market share for Proton and Perodua was attributed to consumers withholding their purchases due to anticipation of lower prices with the coming of the ASEAN Free Trade Area (AFTA).

REVIEW OF THE LITERATURE

The vehicle type choice model can be grouped into two categories, vehicle purchase models and vehicle ownership models, depending on whether the chosen automobile is considered as already owned or newly bought. These models differ from one another due to the different dependent variables and explanatory variables employed. Usually the automobile ownership models include the vehicle age, transaction cost and scrap page rate as explanatory variables.

In a study conducted by Lave and Train (1979), ten vehicle classes (such as luxury, sports, compact, intermediate, etc.) were used as the dependent variables and the purchase price of vehicle, number of vehicles, vehicle age and weight, etc. as the explanatory variables. Berkovec (1985) employs the choice among 13 vehicle classes (such as luxury, standard, sports, compact, subcompact, etc.) as the dependent variable, whereas the explanatory variables include the purchase price, number of seat, and the proportion of makes/models in class to total make/models. Berkovec and Rust (1985) use the vehicle purchase price, vehicle age, engine size, etc. as the explanatory variables whereas the dependent variable is the choice among five classes (similar to those used by Lave and Train (1979)).

On the other hand, Mannering, Winston and Starkey (2002) use vehicle acquisition type and vehicle makes/ models as the dependent variable and the vehicle purchase price, horsepower, etc. as the explanatory variables.

Kitamura et al. (2000) employ the purchase price, transit accessibility and number of household, etc. as the explanatory variables while the dependent variable is the choices among six vehicle class (such as sports car, sports utility, 4-door sedan, 2-door coupe, etc.). Choo and Mokhtarian (2004) employ the choice among nine vehicle categories (such as luxury, large, mid-sized, compact, small, SUV, etc.) as the dependent variable, whereas the explanatory variables are grouped into, demographics, lifestyle, personality, mobility, travel liking and attitudes. Thus, comparison of the significant variables across the models is difficult because each model has a different set of vehicle categories. However, in many models, the most common explanatory variable is the automobile purchase price, which tends to be negatively correlated and significant with the dependent variable across all studies except for Murtaugh and Gladwin (1980) and Kitamura et al. (2000).

MODEL SPECIFICATION AND DATA

In this study, the dependent variable is the choice of three broad makes of automobiles in Malaysia (i.e. Proton, Perodua, and foreign automobiles) and the explanatory variable is a vector of the prices of automobile models. Letting the automobile makes be indexed by j (for j =1, 2, 3), then the choice by consumer i (for i = 1, 2… N) can be formally written as

$$y_i = \begin{cases} 1 \text{ if concumer } i \text{ buys a Proton automobile} \\ 2 \text{ if concumer } i \text{ buys a Perodua automobile} \\ 3 \text{ if concumer } i \text{ buys a foreign automobile} \end{cases} \quad (1)$$

The data are primarily obtained from a sample of automobile owners in some selected locations in Malaysia. Perhaps an ideal way to obtain a representative sample would be to employ the random sampling method on the Malaysian households. Unfortunately, this method requires the need to conduct a survey on the predetermined number of respondents on the basis of the sampling frame for the entire Malaysian population. Accordingly, we opt for the stratified sampling method whereby we envision that the Malaysian households can be divided into two groups on the basis of their residential areas – urban and rural – under the assumptions that urban and rural households might behave differently in terms of automobile purchase and ownership.

Once the stratification has been made, the next decision to be made concerns the minimum number of households to be interviewed. According to Sekaran (2000), the minimum sample size needed is 384 households for a population of at least one million people. In 2009, the total population of Malaysia was 27.9 million people, of which 36.7% lived in the rural area while 63.3% lived in the urban area. In the same year too, the total number of households in Malaysia was 6.02 million. If the rural-urban ratio of population is

applied to households, then about 2.2 million households lived in the rural area while about 3.8 million households lived in the urban area in 2009 (Malaysia 2010). Since each urban and rural population in Malaysia well exceeds one million households, a sample size of 384 households for each area should be sufficient. To be more conservative, however, we set a sample size of 400 households for each area.

Since the urban and rural areas are widely scattered all over Malaysia (for convenience, this study focuses on Peninsular Malaysia only), we decide to select four different locations that are geographically dispersed for each area. For the urban area, we pick Alor Setar, Georgetown, Ipoh, and Kuala Lumpur. For the rural area, we pick Pendang, Bachok, Sepang, and Kuala Pilah. Once the locations have been chosen, a sample of 100 households per location is selected as respondents and questionnaires are administered to them through personal interviews by local enumerators, yielding a total of 804 respondents (one enumerator interviewed 104 respondents). The interviews took place in May and June 2010.

From the distributed questionnaires, the data for automobile choice and automobile characteristics are obtained for each household. Since the inclusion of these variables entails missing and dubious values, our sample size reduces from 804 to 756 observations. Given the reduced sample size, some adjustments need to be made for both types of variables. For automobile choice, there is a need to drop any observations where potential alternatives are not available among the three broad classes of automobiles (i.e. Proton, Perodua, and foreign) at the time of the purchase of a particular automobile. One way in which potential alternatives are not available is when a household purchased an automobile prior to 1994 since Perodua had not begun its production yet. Hence, automobiles which were purchased before 1994 are dropped from our sample.

Another way in which potential alternatives are not available is when a household purchased a very expensive automobile (usually a foreign automobile). For example, if a household bought a RM200,000 Mercedes Benz, then it is hard to imagine an alternative from Perodua (which might cost as much as RM55,000 for Myvi) or even from Proton (which might cost as much as RM100,000 for Perdana). Therefore, any expensive automobiles are dropped from our sample. Common sense suggests that car buyers are willing to consider buying a reasonably more expensive car if the car is of much higher quality. For example, if a person considers buying a Proton Waja which costs him about RM60,000, he might accept a Nissan Sentra which might cost him as much as RM75,000 if he is confident that the more expensive car is of much higher quality. We set RM15,000 as the cut-off price differential between a chosen alternative and non-chosen alternatives. With the criterion of the availability of potential alternatives

(i.e. omitting the purchase made prior to 1994 and the purchase of too expensive car), our sample size reduces further from 756 to 674 observations.

Provided that the criterion of the availability of potential alternatives is adhered to, an adjustment is still needed for automobile characteristics in view of the fact that there is asymmetry in the characteristics of the three broad classes of automobiles. To begin with, there exist many models of automobiles among the three broad classes that might qualify as potential alternatives. However, the attributes (or characteristics) of these models are asymmetric in the sense that what is available in one model is absent in other models. If we consider engine size, for example, we see that Perodua Kancil comes with 660cc and 850cc only, Proton Saga comes with 1300cc and 1500cc only, Toyota Vios comes with 1500cc and 1600cc only, and so forth. Similarly, if we consider the transmission type, we see that some models come with the manual transmission only such as Proton Saga 1300cc and Proton Wira 1300cc, while others with the automatic transmission only such as Proton Saga 1500cc. By the same token, if we consider seating capacity, we see that most of the available models come with five-seaters. Exceptions are the multi-purpose vehicles (MPVs) such as Exora, Alza, Avanza, and Innova.

For this reason, it is not possible to include engine capacity, transmission type, and seating capacity in the list of automobile attributes to be studied. Hence, we are left with price as the only attribute to be studied. Given price as the only attribute under consideration, it is important to note that there exists a huge array of automobile models in our sample, ranging from the one with as low price as Perodua Kancil, to the one with as high price as Toyota Vios. However, some of them are already out of production (Proton Wira 1300cc, Proton Wira 1500cc, Perodua Kancil 660cc, Perodua Kancil 850cc, Perodua Kelisa 1000cc, and Nissan Sentra 1600cc). Hence, we do not consider these models as explanatory variables. However, they are still included in the sample since household's automobile choice at the time of the purchase is not affected by whether the model is out of production now.

It is important to note that the adjustments made to automobile characteristics do not result in the sample size reduction. Hence, we still have 674 observations which correspond to 674 quantities of automobiles. Of the 674 purchased cars, there are 48 different models, the quantity of which ranges from as low as one (i.e. Savvy 1200cc automatic and Satria 1500cc automatic) to as high as 68 (i.e. Wira 1500cc manual). To make our analysis manageable (otherwise, there will be too many explanatory variables), we drop the price variables of any models with quantities less than six from the list of explanatory variables. Like out-of-production automobiles too, they are still included in our sample. As a consequence, we are left with nine price variables only:

TABLE 1. Distribution of Households by Areas/Locations

Alor Setar	Pendang	Ipoh	Bachok	Kuala Lumpur	Sepang	Georgetown	Kuala Pilah	Total
53	50	58	46	90	56	68	57	478
(11.09)	(10.46)	(12.13)	(9.62)	(18.83)	(11.72)	(14.23)	(11.92)	(100)

Note: Figures in each cell denote the number of households. Figures in the parentheses denote the percentages of households.

$$\mathbf{x}_{ij} = \begin{bmatrix} psaga13m \ psaga15m \ pwaja16m \ pwaja16a \\ psona16m \ pmyvi13m \ pviva10m \\ pcity15m \ pvios15a \end{bmatrix} \quad (2)$$

where *psaga13m* is the price of Saga 1300cc manual, *psaga15m* is the price of Saga 1500cc manual, *pwaja16m* is the price of Waja 1600cc manual, *pwaja16a* is the price of Waja 1600cc automatic, *psona16m* is the price of Persona 1600cc manual, *pmyvi13m* is the price of Myvi 1300cc manual, *pviva10m* is the price of Viva 1000cc manual, *pcity15m* is the price of Honda City 1500 manual, and *pvios15a* is the price of Toyota Vios 1500cc automatic.

Given the discrete nature of the dependent variable in Eq.(1), the appropriate statistical model to be employed is the discrete choice model where an individual makes a choice from among a few available discrete alternatives. Hence, when a household chooses a particular automobile model which belongs to one automobile class, he must have chosen it from the pool of three available alternatives [see Eq.(1)]. Given the individual- and alternative-specific nature of the explanatory variables in Eq. (2), the appropriate discrete choice model to be employed is the conditional logit model where every choice made by a household is recorded as three observations (i.e. one for the chosen alternative and two for the non-chosen alternatives).

In order to identify the non-chosen alternatives for each of the 674 chosen automobiles, we carefully match the automobile characteristics of the alternatives to those of the chosen ones as closely as possible. For example, if a household bought a brand new Proton Savvy in 2007, then its plausible alternatives might have been brand new Perodua and foreign models in 2007 too, and their purchase price and engine size must not deviate too much from the chosen ones. Similarly, if a household bought a three-year-old Perodua Myvi in 2009, then its plausible alternatives might have been a three-year-old Proton and foreign models in 2009 with reasonable price ranges and similar engine sizes.

Needless to say, the process of identifying the alternatives is cumbersome. Accordingly, we first rely on the sample data. For example, if a chosen model is a brand new 2007 Proton Wira, then we may want to match it to, say, brand new 2007 Perodua Myvi and Nissan Sunny (provided that their price range and engine capacity are roughly similar) based on the data furnished by the respondents in our sample. Once the matching is done, we can cross-tabulate the data if a chosen model

is a brand new 2007 Proton Myvi (or Nissan Sunny). If the sample data do not deliver the needed information, then we turn to the office of the Malaysian Automotive Association (MAA) in Petaling Jaya for information on brand new cars, and to the Stars newspaper office in Penang for information on used cars. With these exercises, we manage to obtain information for a large number of automobiles. Nevertheless, there are quite a number of cases where the required information is absent. As a result, the sample size drops from 674 to 478 observations. It should be noted that the various adjustments made to the variables and data result in a huge reduction in the sample size (i.e. from the original 804 observations to the final 478 observations) which, in turn, results in a non-uniform distribution of households across locations (see Table 1).

It remains to specify the conditional logit model. Formally, the model can be expressed as follows:

$$P_{ij} \equiv \text{Prob}\,(y_i = j | \mathbf{x}_{ij}) = \frac{\exp\,(\mathbf{x}'_{ij}\boldsymbol{\beta})}{\sum_{j=1}^{3} \exp\,(\mathbf{x}'_{ij}\boldsymbol{\beta})} \quad (3)$$

where the marginal effect of the price of a specific car model, x_m (where m is a specific alternative), on the probability of choosing a specific automobile, P_{ij}, is given by

$$\frac{\partial p_{ij}}{\partial x_m} = [1(j = m) - P_m]P_j\beta \quad (4)$$

where the function $1(j = m)$ equals one if j equals m and zero otherwise. Eq.(4) implies that the sign of the marginal effect depends on the sign of β conditional on whether $j = m$. If $j = m$, then the bracketed expression is positive. Since P_j is also positive, then the sign of the marginal effect is the same as that of β. If $j \neq m$, then the bracketed expression is negative. Since P_j is positive, then the sign of the marginal effect is opposite to that of β.

Eq.(4) can help us answer many interesting questions such as: What is the impact on the probability of choosing 1) Proton, 2) Perodua, or 3) foreign automobiles if there is a rise in the price of 1) Saga 1300cc manual, 2) Saga 1500cc manual, 3) Viva 1000cc manual, 4) Myvi 1300cc manual, or 5) Toyota Vios 1500cc automatic?

Answers to these questions may shed light on the basic principles of demand theory. To begin with, the quantity demanded of a good is a negative function of its own price (i.e. the own-price marginal effect is negative) and a positive function of the price of a substitute good

(i.e. the cross-price marginal effect for a substitute good is positive). This concept is borrowed from basic demand theory, which states that two goods are substitutes to each other if an increase in the price of one good has a positive impact on the quantity demand of another good. Suppose we pick Proton Saga 1300cc manual and Perodua. If they are substitutes, then an increase in the price of Proton Saga 1300cc manual is expected to have a positive impact on the choice of Perodua. Accordingly, the sign of the marginal effect conveys information on whether two different car models are substitutes or not.

In addition, the magnitude of the marginal effect may shed light on the degree of substitutability between the models (Saga 1300cc manual, Kancil 850cc manual and Toyota Vios 1500cc automatic, to name a few) and make (Proton, Perodua and foreign automobiles). For example, if a RM1000 increase in the price of Proton Waja 1600cc manual raises the probability of buying Perodua by 5% and a 10% increase in the price of Proton Saga 1300 manual raises the probability of buying Perodua by 15%, then Proton Saga 1300cc manual is closer substitute to Perodua than Proton Waja 1600cc manual.

EMPIRICAL RESULTS

It should be noted that, since every choice made by a household is recorded as three observations in the conditional logit model, the *effective* sample size is thrice as large as the *actual* sample size. It follows that, with the *actual* sample size of 478 observations, the *effective* sample size is 1,434 observations (= 478 × 3). Given the necessary data for the *effective* sample of 1,434 observations, we estimate the conditional logit model in Eq.(3) based on the maximum likelihood (ML) method. As shown in Table 2, the ML estimation yields 11 estimated coefficients, of which the first two are intercept coefficients for Proton and Perodua cars (the intercept coefficient for foreign cars is set to zero for identification purposes) and the remaining nine are slope coefficients. For the estimated intercept coefficients, we see that both of them are greater than unity and significant at the 1% level. Since the magnitude of the coefficient for Proton is greater than that for Perodua, we conclude that Proton cars outperform Perodua cars on the road. Since the estimated intercept coefficient for foreign cars is zero by default, we conclude that Perodua cars outperform foreign cars on the road.

For the estimated slope coefficients, we see that all of them enter with negative signs and significant at the usual levels of significance. These results indicate that the choice of any broad classes of automobiles is negatively related to the price of any one of its models. Apart from these estimated coefficients, a relatively large likelihood ratio of 369.65 and pseudo-R^2 (McFadden's R^2) of 0.3522 indicate that this conditional logit model fits the data well (Park, 2009). Finally, the Hausman test to validate the

TABLE 2. Estimates of Intercept and Slope Coefficients
(Obs = 1434)

Variables	Coefficient	p-value
Proton	1.5791***	0.000
Perodua	1.2237***	0.000
P-Saga 1300cc (M)	−0.4031***	0.000
P-Saga 1500cc (M)	−0.2543**	0.012
P-Waja1600cc (M)	−0.2704**	0.025
P-Waja1600cc (A)	−0.1671**	0.012
P-Persona1600cc (M)	−0.2012***	0.004
P-Myvi1300cc (M)	−0.4004***	0.000
P-Viva1000cc (M)	−0.3471***	0.008
P-City1500cc (M)	−0.1683**	0.014
P-Vios1500cc (A)	−0.2449***	0.003
LR chi^2(17)	369.65	
Pseudo R^2	0.3522	

Note: ***, ** and * denote that the corresponding coefficient is significant at the 1%, 5% and 10% level, respectively. Choice of foreign automobiles is the base alternative, M refers to manual and A refers to automatic.

property of Independence of Irrelevant Alternatives (IIA) yields the p-value of 0.5592, suggesting that the null of IIA is unlikely to be rejected.

Once we have confirmed the sign and significance of the estimated parameters, we proceed by computing the marginal effects as expressed in Eq.(4). As shown in Table 3, we find that the marginal effect of the price of any one car model conforms to the demand theory in all cases; i.e. for any automobile choice, the own-price effects are negative (with the probability ranges from −0.43% to −9.15%) while the cross-price effects are positive (with the probability ranges from 0.14% to 8.46%).

Nonetheless, what is at stake here is the magnitude of the own- and cross-price effects (which is measured by the absolute value of the change in the probability). In order to fix ideas, it is imperative that we introduce the following designations: substantial, moderate, and negligible. Letting q denote the magnitude of the own- and cross-price effects (in absolute terms), then the price effect can be designated as a) substantial if $\theta \geq 7\%$; b) moderate if $3\% < q < 7\%$; and negligible if $q \leq 3\%$. Given these designations, we find the following:

1. *A rise in the price of Saga 1300cc (M)*. The own-price effect on Proton cars and the cross-price effect on Perodua cars are substantial, while the cross-price effect on foreign cars is negligible. This means that a rise in the price of Saga 1300cc (M) is expected to have a i) *substantially negative* impact on the sale of Proton cars, ii) *substantially positive* impact on the sale of Perodua cars, and iii) negligible impact on the sale of foreign cars.

2. *A rise in the price of Saga 1500cc (M)*. The own-price effect on Proton cars and the cross-price effect on

Perodua cars are moderate, while the cross-price effect on foreign cars is negligible. This means that a rise in the price of Saga 1500cc (M) is expected to have a i) *moderately negative* impact on the sale of Proton cars, ii) a *moderately positive* impact on the sale of Perodua cars, and iii) negligible impact on the sale of foreign cars.

3. *A rise in the price of Waja 1600cc (M).* The own-price effect on Proton cars and the cross-price effect on Perodua cars are moderate, while the cross-price effect on foreign cars is negligible. This means that a rise in the price of Waja 1600cc (M) is expected to have a i) *moderately negative* impact on the sale of Proton cars, ii) *moderately positive* impact on the sale of Perodua cars, and iii) negligible impact on the sale of foreign cars.

4. *A rise in the price of Waja 1600cc (A).* The own-price effect on Proton cars and the cross-price effect on Perodua cars are moderate, while the cross-price effect on foreign cars is negligible. This means that a rise in the price of Waja 1600cc (A) is expected to have a i) *moderately negative* impact on the sale of Proton cars, ii) *moderately positive* impact on the sale of Perodua cars, and iii) negligible impact on the sale of foreign cars.

5. *A rise in the price of Persona 1600cc (M).* The own-price effect on Proton cars and the cross-price effect

of Perodua cars are moderate, while the cross-price effect on foreign cars is negligible. This means that a rise in the price of Persona 1600cc (M) is expected to have a i) *moderately negative* impact on the sale of Proton cars, ii) *moderately positive* impact on the sale of Perodua cars, and iii) negligible impact on the sale of foreign cars.

6. *A rise in the price of Myvi 1300cc (M).* The own-price effect on Perodua cars and the cross-price effect on Proton cars are substantial, while the cross-price effect on foreign cars is negligible. This means that a rise in the price of Myvi 1300cc (M) is expected to have a i) *substantially negative* impact on the sale of Perodua cars, ii) *substantially positive* impact on the sale of Proton cars, and iii) negligible impact on the sale of foreign cars.

7. *A rise in the price of Viva 1000cc (M).* The own-price effect on Perodua cars and the cross-price effect on Proton cars are substantial, while the cross-price effect on foreign cars is negligible. This means that a rise in the price of Viva 1000cc (M) is expected to have a i) *substantially negative* impact on the sale of Perodua cars, ii) *substantially positive* impact on the sale of Proton cars, and iii) negligible impact on the sale of foreign cars.

8. *A rise in the price of City 1500cc (M).* The own-price effect on foreign cars and both of the cross-price

TABLE 3. Estimates of Marginal Effects (Obs = 1434)

Explanatory variables	Dependent variable		
	Proton	Perodua	Foreign
P-Saga 1300cc (M)	−0.0915***	0.0846***	0.0069***
	(0.000)	(0.000)	(0.000)
P-Saga 1500cc (M)	−0.0577**	0.0534**	0.0044**
	(0.011)	(.0.012)	(0.024)
P-Waja1600cc (M)	−0.0613**	0.0567**	0.0046**
	(0.023)	(0.024)	(0.038)
P-Waja1600cc (A)	−0.0379**	0.0351**	0.0029**
	(0.011)	(0.012)	(0.027)
P-Persona1600cc (M)	−0.0457***	0.0422***	0.0034**
	(0.003)	(0.003)	(0.014)
P-Myvi1300cc (M)	0.0840***	−0.0874***	0.0034***
	(0.001)	(0.001)	(0.009)
P-Viva1000cc (M)	0.0728***	−0.0758***	0.0029**
	(0.010)	(0.009)	(0.027)
P-City1500cc (M)	0.0029**	0.0014**	−0.0043**
	(0.034)	(0.046)	(0.037)
P-Vios1500cc (A)	0.0042**	0.0021**	−0.0063**
	(0.015)	(0.023)	(0.016)

Note: The figures in parentheses 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 alternative, M refers to manual and A refers to automatic.

effects are negligible. This means that a rise in the price of City 1500cc (M) is expected to have a negligible impact on the sale of any cars.

9. *A rise in the price of Vios 1500cc (A).* The own-price effect on foreign cars and both the cross-price effects are negligible. This means that a rise in the price of Vios 1500cc (A) is expected to have a negligible impact on the sale of any cars.

A question of special interest is whether the impact of the prices of automobile models on automobile choice is uniform across all households. To address this issue, we divide our original sample into urban and rural samples (807 and 627 observations, respectively) and repeat our previous analysis. As reported in Table 4, the ML estimation results indicate that the estimated coefficients are broadly similar between urban and rural samples. Consider the intercept coefficients. In both samples, Proton and Perodua intercepts are both greater than unity and significant. Since the magnitude of Proton intercept is greater than that of Perodua, we conclude that Proton cars are the most popular make on the road, followed by Perodua cars, and then foreign cars (since the intercept coefficient for foreign cars is zero by default). In both samples, the results mimic those in the full sample.

Now consider the slope coefficients. In both samples, all of them enter with the negative signs and most of them are significant. The only exception is Waja 1600 (M) in the urban sample. The negative signs and significance of almost all of the estimated price coefficients indicate that the choice of any broad classes of automobiles is negatively related to the price of any one of its models.

As before, large likelihood ratios of 179 and 202 (in the urban and rural sample, respectively) as well as pseudo-R^2 of 0.3030 and 0.4408 (in the urban and rural sample, respectively) indicate that this conditional logit model fits the data well. The Hausman test to validate the IIA property yields the p-values of 0.9982 and 0.2686 (in the urban and rural sample, respectively), suggesting that the null of IIA is unlikely to be rejected in each sample. Overall, the results indicate that the impact of the prices of automobile models on automobile choice is uniform across urban and rural households.

Next, we conduct the marginal effect analysis and present the results in Table 5. As was the case with the full sample, the marginal effect of the price of a given car model conforms to the demand theory for each sample. Hence, we turn to the consideration of the magnitude of own- and cross-price effects. In particular, we find the following:

1. *A rise in the price of Saga 1300cc (M).* In both samples, the own-price effect on Proton cars and the cross-price effect on Perodua cars are substantial, while the cross-price effect on foreign cars is negligible. Hence, the results are uniform across the samples and mimic those of the full sample.

2. *A rise in the price of Saga 1500cc (M).* In the urban sample, the own-price effect on Proton cars and the cross-price effect on Perodua cars are moderate, while the cross-price effect on foreign cars is negligible. In the rural sample, the own-price on Proton cars and the cross-price effect on Perodua cars are substantial, while the cross-price effect on foreign cars is negligible. Hence, the results are different between urban and rural samples. The

TABLE 4. Estimates of Intercept and Slope Coefficients (Urban vs. Rural)

Variables	Urban (Obs = 807)		Rural (Obs = 627)	
	Coefficient	p-value	Coefficient	p-value
Proton	1.5502***	(0.000)	1.7265***	(0.000)
Perodua	1.0550***	(0.000)	1.6078***	(0.000)
P-Saga 1300cc (M)	−0.4256**	(0.021)	−0.4173***	(0.002)
P-Saga 1500cc (M)	−0.1923*	(0.070)	−0.4118*	(0.068)
P-Waja1600cc (M)	−0.1744	(0.130)	−0.7682**	(0.037)
P-Waja1600cc (A)	−0.1795**	(0.044)	−0.1441*	(0.052)
P-Persona1600cc (M)	−0.2157*	(0.068)	−0.2090**	(0.019)
P-Myvi1300cc (M)	−0.3175***	(0.007)	−0.7419*	(0.059)
P-Viva1000cc (M)	−0.2927*	(0.062)	−0.3903*	(0.062)
P-City1500cc (M)	−0.1159**	(0.031)	−0.3517**	(0.015)
P-Vios1500cc (A)	−0.2162**	(0.026)	−0.3091*	(0.059)
LR chi^2(17)	179.10		202.07	
Pseudo R^2	0.3030		0.4408	

Note: ***, ** and * denote that the corresponding coefficient is significant at the 1%, 5% and 10% level, respectively. Choice of foreign cars is the base alternative, M refers to manual and A refers to automatic.

TABLE 5. Estimates of Marginal Effect (Urban vs. Rural)

Explanatory Variables	Urban			Rural		
	Proton	Perodua	Foreign	Proton	Perodua	Foreign
P-Saga 1300cc (M)	−0.0980**	0.0866**	0.0115***	−0.0910***	0.0889***	0.0021*
	(0.017)	(0.024)	(0.005)	(0.001)	(0.001)	(0.057)
P-Saga 1500cc (M)	−0.0443*	0.0391*	0.0052*	−0.0898*	0.0877*	0.0021**
	(0.068)	(0.069)	(0.064)	(0.063)	(0.065)	(0.048)
P-Waja1600cc (M)	−0.0402**	0.0355**	0.0047*	−0.1676*	0.1637**	0.0039**
	(0.028)	(0.030)	(0.055)	(0.059)	(0.012)	(0.038)
P-Waja1600cc (A)	−0.0414**	0.0365**	0.0048*	−0.0314*	0.0307*	0.0073**
	(0.040)	(0.042)	(0.068)	(0.054)	(0.054)	(0.044)
P-Persona1600cc (M)	−0.0497*	0.0439*	0.0058*	−0.0456**	0.0445**	0.0011**
	(0.064)	(0.067)	(0.088)	(0.015)	(0.015)	(0.045)
P-Myvi1300cc (M)	0.0646***	−0.0688***	0.0042**	0.1581*	−0.1598**	0.0017
	(0.008)	(0.008)	(0.027)	(0.088)	(0.025)	(0.229)
P-Viva1000cc (M)	0.0596*	−0.0635*	0.0039*	0.0832*	−0.0841*	0.0008
	(0.068)	(0.066)	(0.094)	(0.074)	(0.074)	(0.240)
P- City1500cc (M)	0.0031*	0.0016*	−0.0047*	0.0018	0.0008	−0.0026
	(0.064)	(0.080)	(0.067)	(0.149)	(0.207)	(0.161)
P-Vios1500cc (A)	0.0058*	0.0029*	−0.0087*	0.0016	0.0007	-0.0023
	(0.054)	(0.069)	(0.056)	(0.205)	(0.256)	(0.216)

Note: The figures in parentheses 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 alternative, M refers to manual and A refers to automatic.

results for the urban sample mimic those of the full sample.

3. *A rise in the price of Waja 1600cc (M)*. In the urban sample, the own-price effect on Proton cars and the cross-price effect on Perodua cars are moderate, while the cross-price effect on foreign cars is negligible. In the rural sample, the own-price on Proton cars and the cross-price effect on Perodua cars are substantial, while the cross-price effect on foreign cars is negligible. Hence, the results are different between urban and rural samples. The results for the urban sample mimic those of the full sample.

4. *A rise in the price of Waja 1600cc (A)*. In both samples, the own-price effect on Proton cars and the cross-price effect on Perodua cars are moderate, while the cross-price effect on foreign cars is negligible. Hence, the results are uniform across the samples and mimic those of the full sample.

5. *A rise in the price of Persona 1600cc (M)*. In both samples, the own-price effect on Proton cars and the cross-price effect on Perodua cars are moderate, while the cross-price effect on foreign cars is negligible. Hence, the results are uniform across the samples and mimic those of the full sample.

6. *A rise in the price of Myvi 1300cc (M)*. In the urban sample, the own-price effect on Perodua cars and the cross-price effect on Proton cars are moderate, while

the cross-price effect on foreign cars is negligible. In the rural sample, the own-price effect on Perodua cars and the cross-price effect on Proton cars are substantial, while the cross-price effect on foreign cars is nil. Hence, the results are different between urban and rural samples. The results for the urban sample mimic those of the full sample.

7. *A rise in the price of Viva 1000cc (M)*. In the urban sample, the own-price effect on Perodua cars and the cross-price effect on Proton cars are moderate, while the cross-price effect on foreign cars is negligible. In the rural sample, the own-price effect on Perodua cars and the cross-price effect on Proton cars are substantial, while the cross-price effect on foreign cars is nil. Hence, the results are different between urban and rural samples. The results for the urban sample mimic those of the full sample.

8. *A rise in the price of City 1500cc (M)*. In the urban sample, the own-price effect on foreign cars and both of the cross-price effects are negligible. In the rural sample, the own-price effect on foreign cars and both of the cross-price effects are nil. Hence, the results are different between urban and rural samples. The results for the urban sample mimic those of the full sample.

9. *A rise in the price of Vios 1500cc (A)*. In the urban sample, the own-price effect on foreign cars and both

of the cross-price effects are negligible. In the rural sample, the own-price effect on foreign cars and both of the cross-price effects are nil. Hence, the results are different between urban and rural samples. The results for the urban sample mimic those of the full sample.

As a whole, the results indicate that the demand effect of a rise in the own-price of cars (in particular, Myvi and Viva) in the rural area is larger relative to the urban area. This is consistent with the fact that we should expect demand to be more elastic in the rural area. As income in the rural area is much lower than in the urban area, the cost of owning a car as a proportion of the household budget is relatively higher in the rural area. As a result, demand should be more elastic in the rural area.

CONCLUSION

We employ a discrete choice model, in particular, conditional logit model for automobile type choice to estimate the effect of price of each automobile model and impact of a change in the price of each automobile model on the probability of choosing each automobile type (Proton, Perodua and foreign automobiles).

Our empirical analysis produces a number of key results. First, the own-price effect on Proton cars is negative with respect to any *one* of its model in all of the samples (i.e. full, urban, and rural). In the full and urban samples, the own-price effect is substantial for Saga 1300cc (M). In the rural sample, the own-price effect is substantial for Saga 1300cc (M), Saga 1500cc (M), and Waja 1600cc (M). Second, the cross-price effect on Proton cars is positive with respect to a specific Perodua model in all of the samples (the effect is nil with respect to a specific foreign model in some cases). In the full and rural samples, the cross-price effect is substantial for Myvi 1300cc (M) and Viva 1000cc (M). Third, the own-price effect on Perodua cars is negative with respect to any one of its model in all of the samples; moreover, the effect is substantial in the full and rural samples. Fourth, the cross-price effect on Perodua cars is positive with respect to a specific Proton model in all of the samples. In the full and urban samples, the cross-price effect is substantial for Saga 1300cc (M). In the rural sample, the cross-price effect is substantial for Saga 1300cc (M), Saga 1500cc (M), and Waja 1600cc (M).

What are the policy implications that might emerge from the above findings for domestic auto makers (i.e. Proton and Perodua)? First, raising the price of Saga 1300cc (M) is probably not a good idea for Proton because its sale is expected to drop substantially. Second, Proton would benefit the most from the increase in the prices of Myvi 1300cc (M) and Viva 1000cc (M). Third, raising the price of Myvi 1300cc

(M) and Viva 1000cc (M) is perhaps not a good idea for Perodua because its sale is anticipated to fall sharply. Fourth, Perodua would benefit the most from the rise in the price of Saga 1300cc (M). Overall, there seems to be a significant overlapping market segment among the three car models: Saga 1300cc (M), Myvi 1300cc (M), and Viva 1000cc (M). Hence, Proton and Perodua should differentiate these products further to lessen competition between them. The results provide useful information to Proton and Perodua so that they might avoid competing with each other yet are able to compete more successfully with foreign automobiles. In addition, car makers should design different pricing strategies for rural and urban market as their price elasticity of demand differs.

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