A HOUSEHOLD ANALYSIS OF
AUTOMOBILE PURCHASING DECISIONS IN SINGAPORE

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Abstract

Income is the primary driving force to automobile ownership. Growth in real income over the past 30 years has led to increase in automobile ownership in Singapore. Between 1988 and 1998 real income increased by 50% in contrast to household automobile ownership, which increased by 17%. The relationship between automobile ownership and income is complicated by the presence of the Automobile Quota Scheme and the Preferential Additional Registration Fee. Thus, an increase in income increases the probability of owning one automobile relative to owning none but increases the probability of replacing automobile relative to owning two automobiles and buying a bigger automobile than a smaller automobile and vice-versa. This study examines the effect of income on automobile purchase decision-making in Singapore. An indirect utility function for automobile ownership is formulated with respect to income, the number of adults and children in the household, COE premium and COE related variables to estimate the probabilities of bidding COE through dealer and submit the bid himself. This study suggests that the size of the automobile is unresponsive to overall change in income. COE premiums and household size are more likely to affect the size of the automobile. However, income growth will remain the main driving force even though changes in income changes will not affect automobile size greatly. The implication of this is the 'leveling' of COE premiums across all categories thus making categories by engine size obsolete. Lower income owners achieve allocative efficiency at the expense of equity and loss in consumer welfare.

1. Introduction

Income is a primary driving force that positively affects automobile ownership[1]. Between 1988 to 2002, real income in Singapore increased from SGD21,250 to SGD36,776 while automobile access increased to 34.6 percent from 29.8 percent over the same period.[2] This 50 percent increase in real income was matched by an increase in household automobile ownership by 17 per cent. There are several reasons for this. First, more automobiles are being replaced than owned. While an increase in income increases the probability of owning one automobile relative to none, it also increases the probability of replacing the currently owned

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[1] Dargay and Gately (1999) has analyzed the relationship between income and automobile ownership in the OECD and in LDCs and projected the growth in automobile stock to the year 2015.
[2] Singapore Department of Statistics, 2002.

automobile with a bigger model relative to owning two automobiles. Second, the introduction of the Automobile Quota Scheme (VQS) in May 1990 effectively introduced a cap on automobile ownership and growth.

This is a study on automobile purchasing decisions and in particular the impact of income on automobile size and influence of Certificate of Entitlement (COE) premiums in influencing purchases. Buying an automobile in Singapore requires a huge financial commitment second only after property. This is because of the fees and taxes associated with ownership.[3] For example, an automobile of less than 1600 cc costs between SGD65,000 and SGD80,000.[4] This is about half the cost of a 3-room apartment! The statutory lifespan of the automobile is 10 years if one wishes to reap a residual value or revalidated the lifespan for either another 5 or 10 years with a new COE. When a prospective buyer buys an automobile the price has an embedded stochastic element. This is because the COE premium or price is determined through a bid process and as such premiums fluctuate within large bands.

There are basically 3 categories for automobiles, Category A (Engine capacity up to < 1600 cc), Category B (Engine capacity between >1600 cc) and Open Category which can be used to purchase automobile of any capacity. Between January 2000 and November 2001 COE premiums for Category A range from SGD101 to SGD44,000 while Category B COE premiums range between SGD12,000 and SGD53,000.

The wide changes in COE premiums have lead wide fluctuations in the prices of automobiles. For example, the 'on-the road' cost of a typical 2000 cc automobile such as the Mitsubishi Galant ranged from between SGD119,800 and SGD99,888 (inclusive of COE and tax) in September 2000 and January 2001 respectively (Straits Times, 26 January 2001). Expectations of lower future COE premiums could be the reason for this downward price adjustment. The corresponding COE premiums for this automobile category for September 2000 and January 2001 were SGD34,800 and SGD30,526 respectively. The decline in COE premium of SGD4,274 was matched by a much larger fall in the automobile price by SGD19,912. This suggests that changes in COE premiums do not necessarily result in a 1-for-1 change in automobile prices. Table 1 shows top 5 highest price change of selected automobile models over a five-month period. At least 17 models have had their prices 'slashed' amounting to between SGD10,000 and SGD19,000.

Table 1 Top five changes in new automobile price

Make	Sept/Oct'00	Jan'01	Price Difference
Ford Focus 1.6	SGD99,999	SGD83,999	-SGD16,000
Kia Rio 1.3	SGD71,800	SGD56,999	-SGD15,801
Mitsuhishi Galant 2.0	SGD119,800	SGD99,888	-SGD19,912
Seat Toledo 1.6	SGD95,800	SGD78,800	-SGD17,000
Volvo S401.8	SGD132,888	SGD116,888	-SGD16,000

Source: Straits Times Classifieds and New Automobile Distributors

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[3] The basic costs of a automobile in Singapore comprises of its open market value (OMV)[3], custom duties[3], the Goods and Services Tax (GST)[3], a registration fee of SGD140, an Additional Registration fee (ARF)[3] and lastly the price of the Certificate of Entitlement (COE).

[4] For example, a 1.6 litres automatic Toyota Corolla cost SGD92,488 in October 2001, but the basic costs inclusive of a closed tender COE total SGD84,249. The difference between the selling price and the cost price is the markup determined by the distributor. This does not include operating costs and commission to the salesperson. Changes in COE premiums will lead to fluctuations of automobile prices.

COE premiums directly influence purchases of automobiles in particular one's choice of whether to replace an existing automobile with a new one or purchase an additional automobile. Given that the COE costs are usually packaged together with the automobile cost, the selling price gives an indication of the estimated COE premium for that month provided that the COE is bided via the automobile distributor on behalf of the buyer. Moreover, the actual fall or rise in automobile prices is not proportionate to the rise or fall in COE premiums. In view of this, the automobile prices used in this study are drawn from a survey conducted among owners. The prospective buyer effectively pays for a package the final payment depends on the COE premium. There is no incentive for the buyer to bid for his own COE because dealers eventually charge a higher price for an automobile purchased without a COE.

It thus makes sense for a buyer to request the dealer to bid for the COE on his behalf. If the COE premium for a particular bid is lower than the pre-determined premium in the package, the buyer may get a rebate. This only applies if the successful COE bid is lower than the price of the Category E COE[5]. Successful bidders of the Category E COE can gain immediate access to the automobile. Thus, bidding via the automobile distributor may be more convenient.

The objective of this study is to explore consumer choice behavior when deciding to purchase an automobile. Given socioeconomic and automobile ownership data drawn from a survey of households conducted in 2001. Based on 194 completed questionnaires, an indirect utility function for automobile ownership incorporating income, the number of adults, the number of children in a household and COE premium was used to estimate the probabilities of bidding COE through the distributor. General observation suggests that about 95 per cent of consumers bid for a COE through dealers.

The following section reviews dynamic models of automobile ownership frequently employed followed by an analysis of the information from the survey conducted. Section 4 presents the results of the Binary Logit Model. The final section discusses policy implications drawn from the results.

2. Automobile ownership, vehicle quotas and price
2.1 Income and automobile ownership
Goodwin et al (1995) observed that up to the early seventies, automobile ownership increased more rapidly than income levels i.e., income elasticity of demand in excess of unity. However, for the last 25 years income elasticity of demand appears to be around one. This decline in income elasticity is confirmed by Dargay and Gately (1997), where the average long-run elasticity for Organization for Economic Cooperation and Development (OECD) countries was 1.0 in 1992, compared to 1.6 in the Less Developed Countries (LDCs). Automobiles have become a necessity than a luxury in developed economies.

The conclusion from Dargay (2001) and other studies[6] suggest that the income elasticity is not constant over time, and is dependent on the level of automobile ownership. The income

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5 Category A: Automobile (1600 cc & below) and Taxi; Category B: Automobile (1601 cc & above); Category C: Good Automobiles and bus; Category D: Motorcycle; Category E: Open (for any kind of automobiles). Category E COE can be used to purchase any type of automobile. Bidders of the motorcycles in the Open Category paid one-third of the quota premium in that category.
[6] Pendyala et al (1995), using repeated cross-section data from the Dutch National Mobility Survey, found that the relationship between automobile ownership and income is not constant over time and concluded that the income elasticity changes with the level of motorization.

elasticity declined with increasing automobile ownership, from well over unity at low automobile ownership levels to under unity at higher ownership levels, as saturation is approached. The results also indicate that automobile ownership responds more strongly to rising rather than decreasing income i.e. 'stickiness' in the downward direction. Responses to income changes are not instantaneous and that adjustment takes place slowly over time.

Train (1986) estimated a demand model for a household's size of automobile fleet based on socioeconomic factors and automobile ownership. An increase in income level increases the probability of owning one automobile in relative to no automobiles. It also increases the probability of owning two automobiles in relative to no automobiles. Moreover, for households with higher income, an increase in income has a smaller effect on the relative probability of owning a given number of automobiles. If a current household's automobile fleet matches its needs, there will be a greater probability of owning the desired number of automobiles.

Most studies examined consumers' choices on the number of automobiles owned (Train (1980, 1986), Pendyala, Kustyniuk & Goulias (1995) and Dargay (2001) Smith, Hensher and Wrigley (1989)). Few studies examine how income changes influence the choice of different selection of automobile makes, models and vintage choices. Furthermore, little is understood about how falling income affects the replacement and purchase of new automobiles. There are basically three responses, a smaller size automobile, keep their existing automobile, or reduce the number of automobiles owned. This study examines the sensitivity of different automobile model ownership to the changes in income level.

2.2 The Vehicle Quota Scheme

The Vehicle Quota Scheme (VQS) was introduced in May 1990 to moderate the growth in automobile ownership in Singapore at a long-term growth of 3 per cent per annum. It is also a long-term target to increase the automobile-population ratio from to 1 automobile to 7 persons by year 2010 from the current ratio of 1 automobile to 10 persons. The VQS effectively allows a certain number of new vehicles per year. A prospective car owner or a current owner who wishes to extend the life span of an automobile which is 10 years or older will have to bid for a Certificate of Entitlement (COE)[7]. A COE entitles the owner to own and drive an automobile for 10 years. Thereafter, the COE may be renewed at a "Prevailing Quota Premium[8]" (PQP) if the owner wishes to continue to keep the automobile. PQP is defined as the historical 12-month moving average of the COE premium. As of November 1998, the PQP was computed based on a 3-month moving average of the quota premium in the respective automobile categories.

Currently a mid-quota year review is undertaken to ascertain if the difference between the original projection and actual number of automobile de-registrations for any category is significant. This difference would be spread out over the remaining months of the current quota year as well the next quota year. However, a cap of a 20 per cent of the month's COE quota is maintained.

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[7] In May 1999, Categories 1 and 2 were merged to form Category A, while Category 3 and 4 merged to form Category B. The new quota categories were classified as follows: Category A:Automobile (1600 cc and below) and Taxi; Category B:Automobile (1601 cc & above); Category C:Good Automobiles and Bus; Category D:Motorcycle; Category E:Open (for any kind of automobiles)

[8] The successful bid price of the COE is commonly known as the COE premium.

Since June 2001, the open bidding system has been introduced for bids for COEs under Category E. All other categories of COEs subsequently utilize the open bidding system from November 2001. The open bidding system provides a greater degree of transparency. A bid deposit of SGD 10,000 is required for all Categories A to E, except for Category D (SGD 200). The individuals may either submit the bid personally or delegate this to automobile distributors.

2.3 Automobile price and COE premium

There are basically three reasons why the task of submitting a bid is given to the automobile distributor. First, the individual having successfully bid for a COE will often end up paying more for the automobile if he purchases an automobile from dealer. Second, one may not have enough information on motor distributors bid strategies. Third, relatively high search and transactions costs. Dealers offer a package to the prospective buyer. The package for new automobiles include the expected COE premium together with the COE rebate (should the actual premium be lower than the projected premium), attractive accessories and financial schemes.

The dealer or distributor can either bid for a COE in the buyer's name without revealing the bid amount or through proxies. Bidding through 'proxies' enables the distributor to secure as many COEs as possible and offer huge discounts to attract buyers. This is known as the 'distributor effect'. This strategy prevents the occurrence of a situation where distributors have the automobile stocks and potential consumers but are unable to sell their automobiles because neither they nor their customers have COEs. The financial strength of automobile distributors as well as better access to market information imply some degree of influence over movements of premiums.

A typical strategy employed by the distributor is to bid at a premium of SGD m (where m is variable depending on profit targets and market share). If the actual successful premium is greater than SGD m, the automobile distributor absorbs the loss. However, if the actual premium c, is less than SGD m, then a rebate of SGD $(m-c)$ is given back to the buyer. For periods when COE premiums are high, the automobile distributors tend to increase the automobile package price by maintaining the COE premium to "camouflage" the high COE premiums in attempts to maintain market share. This marketing strategy seems to attract many prospective buyers to opt for the automobile cum COE rebate package plus financial scheme even in times of high COE premiums. Price rebates, discounts and cash rebate may also be offered if the repayment schemes are financed through certain banks. Distributors also cater to new automobile buyers who may be short of up front cash for down payment (10% of the price of an automobile).

2.4 The replacement and purchase of automobile

Studies on the timing of replacement and choice of type of automobile may not describe (or describe inaccurately) the preceding decision-making process. For example, Gilbert (1992) estimated the duration of automobile ownership but was not able to accurately identify the process of pre-automobile purchase or replacement. Marell, Davidsson and Garling (1995) utilized the path analysis to indicate that purchase intentions are related to differences between aspiration level and the current status. The replacement intention was hypothesized to relate to the difference between an assessment of the current quality level of the owned automobile and an aspiration level defining a minimal quality. However, new automobile purchases are

not included in view that the current quality level of the owned automobile does not apply to these consumers.

This study intends to develop a model that includes the intentions behind purchasing a new automobile. The decision process consists of two stages. Each household will be asked to recall the last purchase. Stage one consists of the decision on engine size or category and alternative models available. In deciding which automobiles to own, the choice space includes all the available makes, models and vintages of automobiles in the market at the time of purchase. Each alternative make available to the household consist of a set of characteristics. Within the choice set of automobiles, factors such as household characteristics, automobile models and vintage of automobile by its purchase price, fuel economy, number of seats and engine capacity are studied.

Stage two will focus on choice of different packages offered by distributors. Upon deciding on the type of automobile, buyers are faced with many different packages from the distributors and options. For example, i) buying an automobile with no COE; ii) automobile with three rounds of COE bidding and financing package; iii) automobile with Category E COE and financing package etc. Choice of an option will depend on the ability to pay the statutory up-front 10% of purchase price and access and ability to financing arrangements. This study is an attempt to describe the decision framework from the initial search of a automobile to the final purchase. Singapore is unique in that the COE premium features prominently in the price of the automobile.

This study is motivated by the realization that there is no published empirical research that attempt to uncover the factors influencing the consumer's choice of automobile that incorporates the COE premium in the price of an automobile. In addition, there are few studies on how the COE affects automobile purchase decision-making. Binary Logit Model is employed to examine the choice of two categories of passenger automobiles, namely passenger automobiles that are 1600 cc or below (small-medium category) and passengers automobiles that are above 1600 cc (large category) vis-à-vis income levels, COE automobile prices and household sizes. Stage 2 of the analysis examines the choice of options in obtaining a COE for each category of passenger automobiles.

3. Survey framework and analysis
3.1 Sample design and data collection

The choice of automobile models is estimated based on a random survey of households in Singapore who have purchased new automobiles in 2001. The samples were collated on the back of public surveys of households, which have bought of new automobiles. The respondents were first contacted by phone to seek their participation in the study. The telephone pre-notification was considered to be necessary because of the need to identify the main decision-maker in the household and to seek his or her cooperation in filling out the questionnaire. Data obtained from 224 respondents. This is response rate of 70 per cent from a base of 300 households identified. A further 30 were eventually discarded due to incomplete information either because the COE premium indicators were not available or refusal to reveal income group. This study is based on 194 valid responses. Of this 136 respondents own small-medium automobiles, and 58 own large automobiles.

3.2 Structure of questionnaire

The questionnaire consists of six pages soliciting information on the activities and decisions undertaken by the respondent and household members in choosing a new automobile. The questionnaire requested for information pertaining to automobile make, level of satisfaction with automobile purchased etc. Information was also requested with regards to the nature and type of pre-search decisions already made (i.e. those relating to automobile size, price range, number and identity of makes considered, COE bidding method, financial scheme, etc.). Demographic information concerning the age, educational qualifications, income-earned, the number of and identities of decision-makers in the household etc. was also collected. The income information income is based on a household's annual income. Additional information such as the availability of various financial schemes, magnitude of COE rebates and the process of bidding for COEs was also collected. A survey on the response to open bidding for COEs was also conducted.

3.3 Respondents' characteristics

Figure 1 reveals that the age structure of the sample. Most of the respondents are between 25 to 40 years old. This is not surprising as individuals within this age group are most likely to afford to own automobiles.
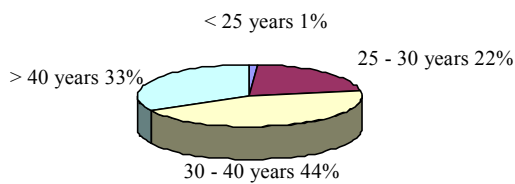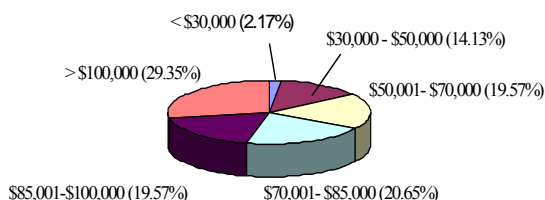

Figure 1 Distribution of respondent's age

Figure 2 Distribution of Income group

The Census of Population 2000 reported that 34 per cent of the Singaporean households earn less than SGD30,000 a year that most households in this category are captive to public transport. This survey did not attempt to capture the whole population but rather focused on automobile owners. The distribution of income groups in this survey is evenly distributed between households earning SGD30,000 and SGD70,000 and above SGD100,000.

3.4 Socio-economic characteristics

Most respondents are married and possess tertiary education (see table 2). The majority of the respondents' age fall within the 30 to 40 years old category (44 per cent) as well as in the greater than 40 years old category (33 per cent). There seems to be a correlation between age

and marital status in influencing the demand for bigger automobiles. This is not surprising in view of the need for families with children to have bigger automobiles. Income level affects the respondents' ability to afford a change of bigger automobile or to buy a new automobile, though affordability does not necessarily lead to effective demand of automobile. Table 2 shows that 28 per cent of total respondents belong to the annual household of over SGD100,000 and 20 per cent of total respondent households earn between SGD70,000 and SGD85,000. It is plausible that higher income increases the ability to purchase a new automobile.

Table 2 shows that households with higher income tend to buy larger automobiles. About 55 per cent of respondents who buy bigger automobiles have annual household income levels of more than SGD100,000 compared to only 16 per cent of respondents in the same income category who buy smaller automobiles. Consumers who earn between SGD70,001 and SGD85,000 will prefer to buy smaller automobiles than bigger automobiles. Figure 3 shows that both automobile categories move in different directions as income level increases i.e., as income level increases, the demand for big automobiles increase and that demand for smaller automobile falls and vice versa. Both categories are close substitutes.

The number of automobile replacements is another important indicator to note. The survey showed that 66 per cent of the total respondents have had at least one automobile previously. This may imply that the higher income level may increase the speed of replacement of existing automobiles. From 2 bigger households do not necessarily buy bigger automobiles implying that there is no direct relationship between automobile and household size.

3.5 Automobile ownership

139 of the 194 respondents own an automobile of 1600 cc or below. Table 1 shows that most consumers prefer smaller-engine capacity than larger automobiles. In addition, larger automobiles are too expensive for the average Singaporean (SGD100,000 and above). The extent to which the decisions are made prior to information seeking varies across respondents. On one extreme, there are buyers who have decided on the brand and the retailer prior to any external research, while on the other hand, there are those who adopt an open mind with a good buy in mind. The sample covers a wide range of automobile brands ranging from the smaller and less expensive automobiles to larger and more expensive automobiles such as the Mercedes and BMW (see Table 3). There seems to be a preference for Toyota and Nissan, which market small to medium size automobiles. BMW and Mercedes belong to the bigger range category. Automobile information are usually obtained from automobile distributors, automobile magazines and newspapers and helps consumers make informed decisions ahead of actual purchases.

Table 2 Socio-economic characteristics

I. Distribution of age of respondents				
Age	< 25 years	25 - 30 years	30 - 40 years	> 40 years
	1%	22%	44%	33%

II. Income and size of automobile				
Income range	Total respondent	1600 cc or below	Above 1600 cc	
< SGD30,000	2%	1%	4%	
SGD30,000 - SGD50,000	13%	18%	4%	
SGD50,001 - SGD70,000	18%	19%	17%	
SGD70,001 - SGD85,000	20%	27%	3%	
SGD85,001 - SGD100,000	19%	19%	17%	
> SGD100,000	28%	16%	55%	

III. Number of automobiles owned	
First Automobile	34%
Second Automobile and above	66%

IV. Distribution of automobile category	
<1600 cc	70%
Above 1600cc	30%

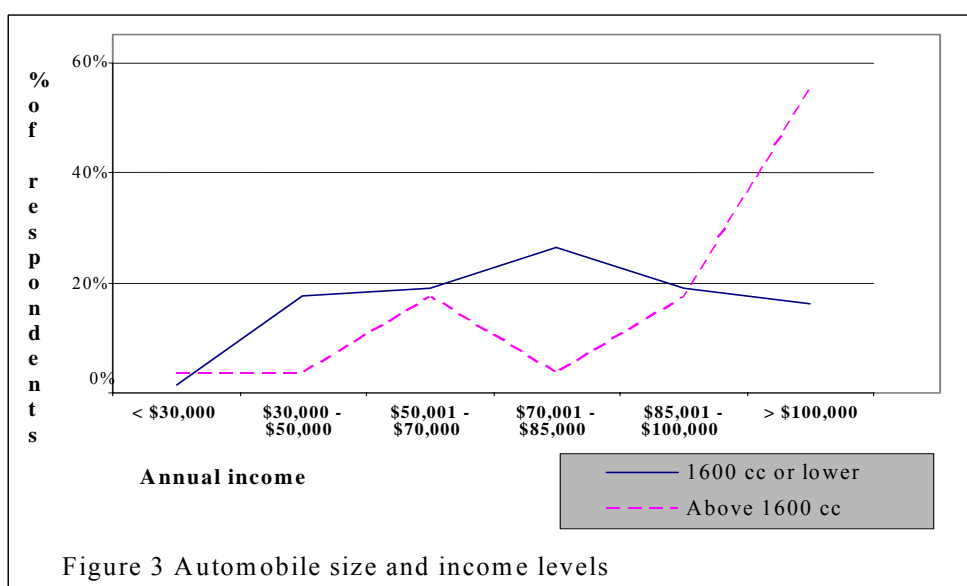| V. Household size and automobile ownership by engine size			
Size of Household	Total respondent	1600 cc or below	Above 1600 cc
2	46	17	6
3	36	17	1
4	54	22	5
5	43	7	10
6	10	2	3
7	6	1	2
More than 7	8	2	2

Figure 3 Automobile size and income levels

Most consumers buy automobiles from the distributors given the attractive offer packages (34 %) as compared to automobile branding (27%). The prices quoted by the automobile distributors include attractive financial packages, COE rebates and free maintenance or other automobile accessories. Thus prices and attractive packages are important factors in affecting consumer choice of a particular automobile.

Most buyers in the big automobile category tend to buy the automobile from the main distributor due to brand loyalty or brand preference (38%) rather than the presence of good offer package (21%). However those in the 1600 cc or below category, tend to regard the price as more important. This implies that price sensitivity is higher for the lower range automobiles than the higher end ones. This may also explain why the automobile distributors highly differentiate the market with different categories of automobile. In practice, the automobile distributors compete aggressively in price in the smaller automobile category, and project an image of brand loyalty and brand preference for higher end automobiles.

3.6 Revealed preference for COE

A number of questions were designed so as to ascertain preferences and the choices for COE bidding. Table 4 suggest that only 5 percent of the total respondents attempted to personally bid for a COEs while the rest of the respondents left the bidding process to the automobile distributors. About 7 per cent of the respondents who own automobiles 1600 cc or below personally bid for a COE compared to 4 per cent for owners of larger automobiles. Respondents were asked for the reasons on asking automobile distributors to bid on their behalf. Convenience is stated as the most important reason.

The dependence on the distributor implies that respondents either are aware of the high transactions and search costs involved (time and monetary costs) or are risk averse. Becker (1965), observed that a rise in income levels, compensated by a decline in other sources of income such that total income level would remain unchanged, would induce a decline in the amount of time used at consumption activities. This is because time has become expensive.

If the consumer chooses to bid for the COE personally, one has to bid for the COE first and then proceed to buy the automobile. This is involves more time and the automobile would probably cost more as distributors are unlikely to give discounts. This sends a very strong message to other prospective buyers. The cost of automobile without the COE package will also be slightly higher than the cost of a automobile, which is inclusive of a COE package. This marketing strategy employed by automobile distributors effectively discourages buyers to bid personally. Hence, most distributors will price their automobiles that exclude the COE package at a much higher level than that of a automobile, which comes with a COE package.

The most popular option was to allow automobile distributors to bid for at least three rounds as this increases the chances of obtaining a COE at a preferred premium. 34% of small and medium-size automobile and 49% of large automobile buyers depended on automobile distributors to bid for three rounds.

Table 3 Automobile owner purchase characteristics

Brand	Total respondent	1600 cc or lower	Above 1600 cc
Toyota	23%	28%	10%
Nissan	19%	22%	10%
Honda	12%	13%	10%
Other	18%	15%	24%
BMW	7%	0%	24%
Mitsubishi	3%	4%	0%
Ford	5%	4%	7%
Hyundai	4%	6%	0%
Mercedes	4%	0%	14%
Suzuki	3%	4%	0%
Proton	2%	3%	0%

Most important factor in choice of automobile and distributor

Factors	Total respondents	1600 cc or below	Above 1600 cc
Brand Loyalty or brand preference	27%	22%	38%
Good offer package	34%	40%	21%
High resale value	11%	10%	14%
Friend and relatives' recommendation	5%	6%	3%
Good engine	14%	15%	14%
Variety	3%	3%	3%
Others	5%	4%	7%

Table 4 COE bid preferences

Bid options	Total respondent	1600 cc or below	Above 1600 cc
Bid COE yourself	5%	7%	4%
Buy category E COE	8%	17%	4%
Ask the distributor to bid for 1 round COE	15%	10%	18%
Ask the distributor to bid for3 rounds COE	44%	34%	49%
Buy guaranteed COE	28%	32%	25%

The reason for this is obvious. COE premiums lie within a large range. The maximum COE premium during the period of this study ranged between SGD 53,000 an SGD 101. The COE premium for Category A dropped to an all-time-low of SGD101 during the June 2001 tender caused largely by order cancellations and purchase deferments because of weak economic sentiments. Category A premiums, for automobiles up to 1600 cc, fell from SGD 32,100 about one-eighth of the premium for motorcycles! The COE premiums for other categories show similar volatility. The number of bids received for that period was a little higher than the quota, there by discounting any excessive demand. Automobile distributors (Business Times, 10 May 2001) attributed this to deferment of purchases in view of weak economic conditions, which led to a fall of the COE premium of Category A to SGD 101. Although COE premiums

in all categories except D returned to the SGD26,000 level (given demand in excess of the quota by at least three times in each category), the general downward trend in COE premiums in June 2001 led automobile distributors to reduce prices for Category A automobiles by SGD6000 to SGD10,000.

This survey was conducted prior to the introduction of an open bidding system, which was introduced in June 2002. 39% of the total respondents are unable to decide whether to use the COE open bidding system to personally bid for the COE in their next purchase. As with the closed bidding system, most consumers do not have sufficient cash for personal bids nor adequate knowledge of the market to make strategic bids.

3.7 Conclusion

The survey suggests that income levels have a positive and significant influence on the size of automobile purchased. Higher income levels will affect the respondents' ability to afford and upgrade to a larger automobile or to buy a new automobile, although affordability does not necessarily lead to effective demand of automobiles. Moreover, most consumers in the sample prefer Toyota and Nissan, which are in the small range category rather than BMW and Mercedes, which belong in the bigger range category.

In selecting the automobile make and model, most consumers in the bigger automobile category tend to be influenced by brand loyalty or brand preference while those in the smaller automobile category were influenced by price. 95% of respondents rely on automobile distributors to bid for the COE on their behalf and convenience is the main reason this. Finally, 39 per cent of the total respondents were unsure in bidding for a COE personally under the open bidding system for the next purchase. Convenience and attractive packages offered by the automobile distributors are the two most important reasons in addition with the inability to place a down payment for the bid.

4. Empirical findings
4.1 Model selection

This section focuses on factors that influence an individual's decision on purchasing a new automobile or replacing an existing automobile. Drawing on the survey data, an attempt will be made to explain how income levels and COE premiums affect decision-making in automobile purchasing. A standard binary choice model is used here where the dependent Y takes the value 1 when the individual picks an automobile in the small-medium category (1600 cc or below) and 0 if otherwise. A Binary Logit Model is used where the dependent Z takes that value 1 if COE is bid through the distributor and 0 if otherwise. The usual assumptions are made on the individual's indirect utility function in choosing the type of and size of automobile.[9]

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[9] This utility (U) function is made up of the systematic component (V_i), which consists of a vector of observable attributes, and the random component (ε_i), which contains the unobservable attributes. The individual's choice set is predetermined; this implies that the effect of the constraints has already been taken automobile of and does not affect the process of selection among the available alternatives.

$U_I = V_i + \varepsilon_I$ where $i = 0, 1, 2, 3, \ldots, J$ and $V_i = \beta'X_i$

Where β is a vector of model coefficients, and the objective of model estimation is to determine the parameter β. This can be accomplished by using the maximum likelihood method. In the Multinomial Logit Model, the probability that a consumer selects alternative i ($i = 1,\ldots,J$) equals the probability that the conditional indirect utility is associated with alternative J and U_i is greater that the indirect utility associated with all other alternatives. That is, $P_i = Pr\ (U_i > U_j)$ $= Pr\ (V_i + \varepsilon_i > V_j + \varepsilon_j) = Pr\ (\varepsilon_j - \varepsilon_i < V_i - V_j)$ $i = 1, \ldots,J; i \neq j$

The Binary Logit Model is chosen for the purpose of examining the influence that income and COE premium has on the choice of automobile sizes given that the other two common binary choice models, Linear Probability and the Probit Models are not suitable.[10] In order to have the probability in a closed form, and with a "normal-like" disturbance (random components), the Binary Logit Model is best to find the probabilities of choice of automobile sizes. Such model follows a Gumbel distribution, which approximates well to the normal distribution when number of observations is large.

The Binary Logit Model takes the following functional form:

$$\ln [P/(1 - P)] = \beta X + \xi \qquad\qquad (1)$$

where P is the probability of the event. To transform the above equation into an operation form, we assign variable Y into the equation:

$$Y = [P/(1 - P)] = \beta X + \xi \qquad\qquad (2)$$

where dependent variable Y takes the value of 1 when event is to occur and O if otherwise. Thus, predicted Y value can be calculated by the following equation:

$$\ln [P_i/(1 - P_i)] = E(Y) = (V_i - V_j) = \beta'X \ \text{ for specific X value.} \qquad (3)$$

The probability of choosing smaller size automobiles in this study can be obtained by exponentiating both sides of equation 3,

$$P_i \quad = \quad 1/(1+e^{-E(Y)})$$

The ratio of the probability is only a function of characteristics pertaining to these two alternatives (Ben-Akiva and Lehman, 1985). In this study, the Binary Logit Model is base on both the automobile size and the COE bidding models. The ratios of choice probabilities of automobile size and say where 1600 cc automobile is independent of whether motorcycle is

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The difference in the level of $(V_i - V_j)$ and $(\varepsilon_j - \varepsilon_i)$ are important in this model given that the different alternatives are independent and identically distributed. The assumption of independence implies that there are no common unobserved factors affecting the utilities of the various alternatives. The assumption of identically distributed (across alternatives) random utility implies that the extent of variation in unobserved factors affecting model utility is the same across all sizes of automobiles purchased.

[10] This is because the Linear Probability Model, which is simply estimated by Ordinary Least Square (OLS), allows us to explain a binary response using the regression analysis. The OLS estimates are interpreted as changes in the probability of "success" (y = 1), given a one-unit increase in the corresponding explanatory variable. As the fitted model is linear and dependent variable Y is constrained between 0 and 1, it may produce predicted probabilities that are less than zero or greater than one. It implies a constant marginal effect of each explanatory variable that appears in its original form, and that the random variable is heteroskedastic. In particular, my program participation might also be correlated with unobserved factors that affect the dependent variable, resulting in the usual omitted variable bias. Heteroskedasticity does invalidate the usual OLS standard errors and test statistics, but this is easily fixed in a large sample.

To explain the behavior of a dichotomous dependent variable, we will have to use a suitably chosen cumulative distribution function. The Probit model assumes that the random variable is normally distributed and it is independent of independent variable. However, the Probit model cannot be expressed in a closed form; that means when variance tends toward infinity, individual behavior is completely unpredictable.

available. Respondents are not segregated and we assume that automobile consumers are highly rational. The aim of this model is to ascertain how income levels, COE pricings and household sizes affect size of automobile purchased.

This aggregate approach has given us a deeper knowledge of the socio-economic factors of importance for household automobile ownership behavior. It also made more tractable the influence of local conditions such as the supply of COE quotas and shock factors like the Gulf War and the September 11 World Trade Centre incidents.

The Binary Logit Model is employed to ascertain the probabilities of each COE bid choice. There are two sets of respondents, owners of small-medium size automobiles and owners of large automobiles. Two Binary Logit Models are considered for these two categories. The aim of segregating the respondents is to examine the significance of the factors to each group, as well to ascertain the attractiveness of each COE bidding method between the two groups.

4.2 Empirical analysis on automobile size

The basic model took the following form:

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \qquad (4)$$

where,

$Y = 1$ if respondent revealed their choice to buy automobile that is 1600 cc or lower; 0 if otherwise;

$X_1 =$ 1 if annual household income is between SGD30,000 and SGD50,000,
    2 if annual household income is between SGD50,001 and SGD70,000,
    3 if annual household income is between SGD70,001 and SGD85,000,
    4 if annual household income is between SGD85,001 and SGD100,000,
    5 if annual household income is over SGD100,000, and 0 if otherwise;

$X_2 =$ household size;

$X_3 =$ 1 if automobile price paid is less than SGD80,000,
    2 if automobile price paid is between SGD80,000 and SGD100,000,
    3 if automobile price paid is between SGD100,001 and SGD120,000,
    4 if automobile price paid is between SGD120,001 and SGD150,000,
    5 if automobile price paid is above SGD150,000;

β_o to β_3 are the parameters to be estimated and ξ is the random term.

As the logit model is a nonlinear function, maximum likelihood estimation (MLE) is employed to estimate the parameters. The general theory of (conditional) MLE for random samples implies that, under very general conditions, the MLE is consistent asymptotically normal, and asymptotically efficient. The following models are tested,

Model 1: $V_1 = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \xi$
Model 2: $V_2 = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_3 + \xi$

Model 3: $V_3 = \gamma_0 + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 + \xi$

Table 5 The Binary Logit Model of automobile size choice

Independent Variables	Model 1	Model 2	Model 3
Constant coefficient	4.450693	6.712332	8.12525
(p-value)	(0.0004)	(0.0001)	(0.0000)
X_1 = Income coefficient	-0.458019	-0.410253	-0.284852
(p-value)	(0.0295)	(0.0562)	(0.2272)
X_2 = Household coefficient	-0.409265		-0.457824
(p-value)	(0.0344)		(0.0588)
X_3 = Automobile Price coefficient		-1.444043	-1.539777
(p-value)		(0.0000)	(0.0000)
LR statistics (p-value)	16.22026	50.21432	54.30390
	(0.0000)	(1.25E-11)	(9.67E-12)
McFadden R-squared	0.137068	0.424331	0.458889

Number of observations: 1600 cc or below =   136, Above 1600 cc = 58

Three models are estimated and the results of the model estimations are shown in Table 5 Model 1 has the lowest McFadden R-squared value and is rejected. Model 2 and 3 have relatively higher MaFadden R-squared values. Model 3 estimates suggest that the largest effect on the choice of size of automobile is price and household size. However, the relatively high p-value for the income variable in Model 3[11], suggests dropping it altogether. Including income levels and automobile prices as explanatory variables resulted in income levels being insignificant at 6 per cent level. Using the redundant variable test, household variable is not a redundant variable at 5% significance level. Household size variable included in the model. We focus on Model 3 instead of Model 2.

Also, all three models have obtained a positive coefficient for the intercept and negative slope coefficients for automobile prices, income levels and household sizes variables. The significance of prices suggests that it affect the size of the automobile. Intuitively negative relationship sign suggests that when the automobile price increases, the probability of choosing falls. Or automobile prices fall the probability of purchasing a smaller automobile increases as more can afford automobiles. The negative income coefficient supports view that consumption increases due to the income effect. Higher income levels leads to purchase of larger automobile. However the coefficient of -0.284852 remains and it is not significantly different from zero.

The estimated model 3 is highly significant, with a likelihood ratio test of the hypostudy that the coefficients (in all 3 models) are zero based on a chi-squared value of 54.30390 with 3 degrees of freedom. The model predicts 86.17 per cent of the observations correctly with a likelihood ratio index of 0.458889. Using the Expectation-Prediction table, when y=1 given P>0.5, predicts 86 out of 97 or 88.66 per cent of the observations correctly (See table 6). This result suggests that the model is a good fit.

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[11] Significance statistics shows the probability that the parameter (β) would takes value of O. Hence, higher significance statistics imply that the respective variable is less influential over the dependent variable.

Table 6 Prediction efficiency of model 3

	Predicted		
	Dep=0	Dep=1	Total
P(Dep=1)<=C	22	4	26
P(Dep=1)>C	7	64	71
Total	29	68	97
Correct	22	64	86
% Correct	75.86	94.12	88.66

4.3 Sensitivity studies

Given different automobile prices, sensitivity studies have been conducted to examine how different income levels and prices affect the probabilities of buying small-medium size automobiles. Figure 4 shows the probabilities purchase at different income levels for each automobile price levels. This suggests that as household income increases, the probability of owning smaller automobiles decreases. This also implies that the probability of owning bigger automobiles increases, but at a slower and gradual rate of increase.
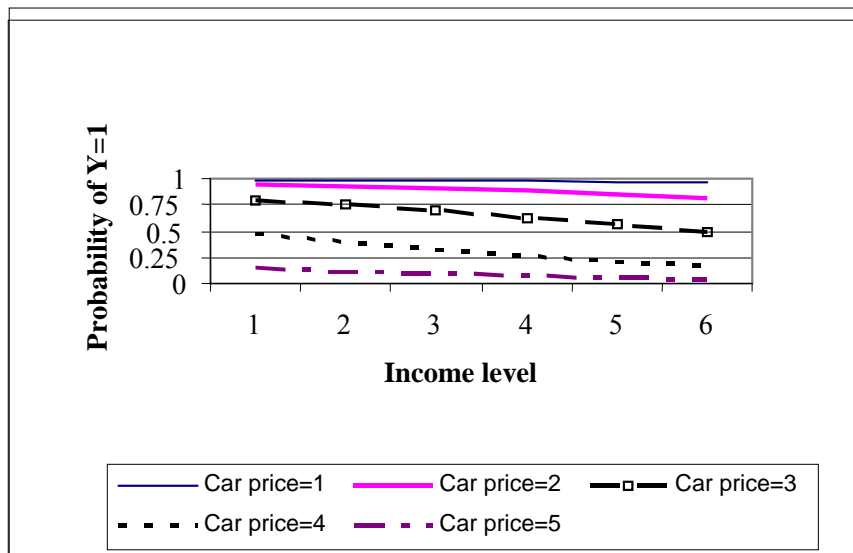

Figure 4 Probability of purchasing a small-medium size car at different income levels

However, when automobile price increases (*ceteris paribus*), the probability of buying smaller automobiles decreases. This finding contradicts seems counter intuitive. A suggested explanation for this contradiction is that price increases as a result of higher COE premiums increases the cost of owning a small-medium size automobile relative to a larger one. This makes buying a large automobile relatively cheaper and increases the probability (Chin and Smith 1997). If prices fall, the probability of buying smaller automobiles should increase; the sensitivity results suggest that buying of smaller automobile increases. While this explains current owners of small-medium size automobiles, falling prices may influence non-owners to purchase. The model is not able to differentiate between the first time buyers and up-graders.
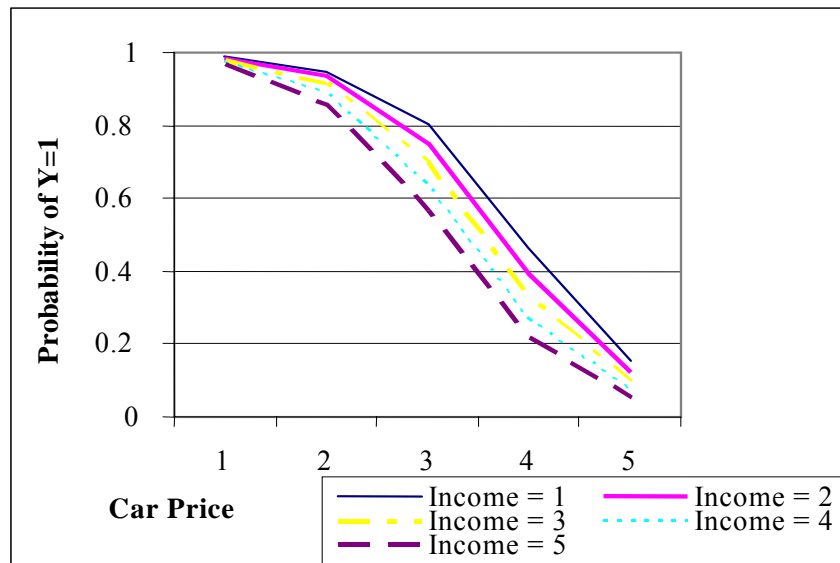
Figure 5 Probability of purchasing a small-medium size car at different prices

Note that as income increases from SGD30,000 to SGD70,000, the probability of owning a bigger automobile increases gradually (see figure 5). When income level is above SGD70,000, the probability of owning bigger automobiles increases, and this probability increases at an increasing rate. Lastly, when automobile price increases from SGD100,000 onward, the probability of owning big automobiles increase at an increasing rate as the slope of the function is steeper between SGD100,000 and SGD150,000.

4.4 Analysis on COE bids
The basic model took the form:

$$Z = \beta_o + \sum_{i=1}^{n} \beta_i W_i + \xi \quad \text{for } i = 1, 2, \ldots, 4 \qquad (5)$$

where,

Z = 1 if respondent revealed their choice to bid COE through a distributor; 0 if otherwise;

W_1 = COE premium paid in Singapore dollars;

W_2 = 1 if respondent chooses the bidding method due to convenience; 0 if otherwise;

W_3 = 1 if respondent chooses the bidding method due to good offer package; 0 if otherwise;

W_4 = 1 if annual household income is between SGD30,000 and SGD50,000,

    2 if annual household income is between SGD50,001 and SGD70,000,

    3 if annual household income is between SGD70,001 and SGD85,000,

    4 if annual household income is between SGD85,001 and SGD100,000,

    5 if annual household income is over SGD100,000, and 0 if otherwise;

β_o to β_4 are the parameters to be estimated;

ξ is the random term.

The following models were estimated,

Model 4: $V_4 = \beta_{o} + \beta_1 W_1 + \beta_2 W_2 + \beta_3 W_3 + \xi$

Model 5: $V_5 = \alpha_0 + \alpha_1 W_2 + \alpha_2 W_3 + \alpha_3 W_4 + \xi$

Model 6: $V_6 = \gamma_0 + \gamma_1 W_2 + \gamma_2 W_3 + \xi$

The models for two categories of automobiles are estimated and the coefficients are given in Tables 7 and 8. The White test was used to correct for heteroskedasticity in e. COE premiums and income levels exhibit high p-values (See Table 7). Redundant variable tests to test for 'COE Paid variable' confirms this. The log likelihood ratio for redundant COE premium variable test is 1.122558, and the probability of redundancy is as high as 28 per cent for the small-medium category. Moreover, the COE paid coefficient is insignificant and is close to zero. This implies that the probability of choosing distributor to bid a consumer's COE does not depend on COE premiums but other factors such as attractive packages offered by the distributors and the conveniences that the distributors are offering. Therefore we accept Model 6 for 1600 cc or below automobiles.

Table 7 Binary Logit Model of COE bids for small-medium size automobiles

Variable	Models		
Independent Variables	Model 4	Model 5	Model 6
Constant coefficient	6.277516	-4.114110	-0.405465
(p-value)	(0.2070)	(0.2182)	(0.6569)
W_1 = COE premium coefficient	-0.000223		
(p-value)	(0.1850)		
W_2 = Convenience	41.65121	44.17961	43.62551
(p-value)	(0.0000)	(0.0000)	(0.0000)
W_3 = Good Offer Package	39.76112	42.37362	42.09475
(p-value)	(0.0000)	(0.0000)	(0.0000)
W_4 = Income coefficient		0.975864	
(p-value)		(0.1725)	
LR statistic	18.98327	19.10966	17.86091
(p-value)	(0.000276)	(0.000259)	(0.000132)
McFadden R-Squared	0.771959	0.777099	0.726318

Number of observations = 137

Table 8 Binary Logit Model of COE bids for large automobiles

Variable	Model 6
Independent Variables	Model 6
Constant coefficient	-1.48E-14
(p-value)	(1.0000)
Convenience	42.72975
(p-value)	(0.0000)
Good Offer Package	41.70496
(p-value)	(0.0000)
LR statistic	9.010201
(p-value)	(0.011052)
McFadden R-Squared	0.619029

Number of Observations = 58

Given the limited number of observations in the large automobile category Model 6 was used incorporating only the 'Convenience' and 'Good offer package' variables (See Table 8).

The Model 6 with only two independent variables has small standard errors for each of the coefficients of the explanatory variables in both categories. The McFadden R-squares are high at 0.619029 and 0.726318 for the large and small-medium size categories respectively. Using the Expectation-Prediction table to predict that $z=1$ given $P>0.5$, predicts 66.07 out of 68 or 97.17 per cent of the observations correctly for small-medium size automobiles, and it predicts 27 out of 29 or 93.10 per cent of the observations correctly for larger automobiles. The goodness-of-fit suggests that the model for these two categories is quite a good.

This model suggests that consumers bid for COEs through distributors because of convenience and good packages offered by distributors. It is much cheaper to bid COE through a distributor who is familiar with COE premium trends and market conditions, thus saving time and costs. Further a buyer who has successfully bid for a COE will end up paying more for the cost of the automobile. The distributor's marketing strategy to package the COE together with a total package deal which offer good value but allows the distributor to earn at the margin through price markups. The financial package is inclusive of COE rebates, special offers, free services and high trade-in value. This explains the high number of respondents who bid for COEs

Price and household size have significant influence on the choice of the automobile size. It is observed that the automobile price has a direct and significant influence on the probability of owning bigger automobiles. This may seem contradictory but can be explained by the observation that all respondents already own an automobile and find it affordable. Thus one either upgrades to a newer or larger automobile. The income effect here is not as important as the price effect.

The COE premium does not affect the choice of whether to bid personally or through the distributor as factors such as convenience and good offer packages have a greater influence. High time, search and transactions costs plus being risk adverse deters personal bids.

5. Conclusion

This study drew from a survey of 194 automobile owners of whom 70% own small-medium size cars. Of this only 5 per cent of respondents were willing to bid for a COE personally. The study also suggests that income does not seem to have a large influence on automobile size and that price had a larger and direct effect. Convenience and good offer packages are the two most important factors that influence buyers bid for a COE through distributors.

Within the context of the study lies the wider dilemma faced by Singapore. These are, land constraints[12], intense competition for better land use and meeting the higher expectations of society. With rising affluence, the basic need for an automobile for increased mobility and convenience is increasingly replaced by quality and as a symbol of status and success. However, with smaller households but higher incomes there will be a demand for more small-medium size automobiles. Increase in income levels will increase the demand for automobiles at all levels. Since the choice of automobile size is conditional on automobile ownership, the income level would also affect automobile ownership. The effect of income changes will not

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[12] Singapore is a small island-state with a land area of 682.7 sq km and a population of 4.017 million people (Ministry of Health, 2001).

affect automobile size greatly, although it may indirect affect automobile size choice via automobile ownership.

Automobile price will increase the influence on the choice of automobile size purchases significantly. The high COE premium for a smaller automobile accompanied by its higher retail automobile price suggest an increase in the demand for bigger automobile size as the relative price of large automobiles decreases. High COE premiums may lead to an increase in demand for bigger automobiles relative to smaller automobiles. This will have implications on equity.

However, the study is not able to capture brand preference and loyalty. Many prefer bigger automobiles due to the desire to own brands such as BMW and Mercedes Benz. As such, prices are not an effective deterrent to owning bigger automobiles. Increasing the cost of automobile ownership will not deter high-income household to purchase bigger automobiles.

The desire to allow dealers to bid on one's behalf implies that the open COE bidding may not encourage personal bid even though the new system provides more transparency in bids. Most buyers prefer distributors to assist in automobile financing and bidding. The main beneficiaries are likely to be the automobile distributors who are now able to monitor COE premiums closely and thus improve both the efficiency and profits. This may lead to lower package prices. The probability of low COE premiums is not possible with openness and transparency but it will help stabilize COE premiums in the long run. However, this does not prevent automobile distributors in enhancing their positions as dominant players in the car market.

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