

A STATED PREFERENCE ANALYSIS OF CHOICE OF CAR OWNERSHIP IN HONG KONG

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abstract: This paper investigates the willingness of Hong Kong people to own or dispose a car. With the use of stated preference survey, the effects of monthly personal income and parking cost on the choice of car ownership are examined. On the basis of the pilot survey results, various car owning choice models for car owner and non-car owner groups were calibrated, in which the binary logit model formula was adopted. The results were found that monthly personal income has the most statistically significant effect on the probability of preference to dispose or own a car.

1. INTRODUCTION

Travel behaviour models have traditionally been developed on the basis of data obtained by direct observation or by interview surveys where respondents are asked to choose the actual travel alternatives, i.e. revealed preference data. These revealed preference survey methods are one of the most appropriate tools for deriving utilities and calibrating models of travel behaviour. In practice, limitations of these methods (Kroes & Sheldon, 1988; Ortúzar & Willumsen, 1994) are basically associated with survey costs and the difficulty of distinguishing the effects of attributes which could not be observed or measured directly, e.g. those related to notions such as quality or convenience. Moreover, the revealed preference methods cannot be used directly to evaluate demand or to assess response under conditions which do not yet exist.

It is against the backdrop of such problems that the use of stated preference methods become an attractive option in transport research. Stated preference observations can be obtained by conducting relatively inexpensive surveys where respondents are presented with hypothetical alternatives and asked to indicate which of these alternatives is preferred (Bates, 1988). The stated preference methods are easier to be adopted as the researcher defines the conditions which are being evaluated by the respondents; they are more flexible (being capable of dealing with a wider variety of variables); and they are cost effective as each respondent can provide multiple observations for variations in the explanatory variables (Kroes & Sheldon, 1988).

The stated preference technique has become a very popular and important tool for developing travel behaviour models. For example, this technique has been used for studying

the choice of transport mode (Ortúzar & Garrido, 1994), the choice of parking (Axhausen & Polak, 1991 and Clark & Allsop, 1993); and the choice of route (Fowkes & Wardman, 1988 and Hensher *et al.*, 1988).

Car ownership has long been used as one of the major determinants of travel behaviour. Aggregate car ownership forecast has always been referred to the work by Tanner (1977), in which the growth in car ownership is a function of Gross Domestic Product (GDP), vehicle costs and traveling costs. The disaggregate model is usually developed on the relationship between household car ownership and household income. It is well-known that information on household's income, car ownership and household structure leads to a fairly reasonable estimate of that household's travel patterns. Based on this, models which describe the changes in the relationship between household car ownership and income by household type have recently developed and calibrated by Pendyala *et al.* (1995). Another framework developed by Kitamura (1987) is used to study the panel analysis of travel behaviour. The model system is to examine the longitudinal relationship between household car ownership and trip generation. i.e. to study the time effect and the correlation between car ownership and trip generation in a household. The results show that household income and number of high-school age children positively contributes to car ownership. Tam and Lam (1996) studied the changes in Hong Kong car ownership and investigated the factors that have significant effects on car ownership. A time-series model for estimating car ownership in Hong Kong was developed.

Hong Kong, a city of more than 6 million population with a land area of only 1,060 square kilometres, is one of the most densely populated cities in the world, with residential densities of approximately 39,000 persons per square kilometre of developed land. Expressed in terms of population, the number of private cars in various Asian countries are shown in Table 1 together with the GDP per head. It can be seen that Hong Kong has a slightly higher GDP per head in comparison with Singapore but the car ownership is only 40% of Singapore. With the rapid development of Hong Kong and the fast growing of its economy, the demand of car ownership has recently been increased significantly although geographical constraints are existed. In terms of buying power, the potential for car ownership in Hong Kong is very high.

Table 1. Car Ownership and GDP in Various Asian Countries

	Car per 1,000 population (1992)	GDP per head (US \$)
Hong Kong	41	17,300
Singapore	101	16,300
Taiwan	147	10,000
Japan	281	29,500
South Korea	75	6,800

From the statistics of Hong Kong Transport Department (1996), it shows that the number of people who have valid full driving licenses was more than one million. Among these people, some of them have owned cars and the others have not, but they have potential to buy the cars. The statistics also indicate that there was more than 306 thousands licensed private vehicles (cars and motorcycles) on the roads. In other words, about every 20 persons will own a private car or motorcycle. This figure is increasing at a rate faster than the

government infrastructure programmes and traffic improvement schemes that can ever hope to accommodate. If the present trends are allowed to continue, there will be widespread traffic congestion at considerable cost to the environment, the economy and the community.

In order to estimate the choice of owning a car in Hong Kong, the stated preference survey is used to assess the willingness of people to own or dispose a car. The effects of monthly income and parking cost on the choice of car ownership are investigated. The study is examined by the pilot and main surveys. This paper mainly reports the findings of the pilot survey, while the main survey will be carried out at the end of 1997.

2. STATED PREFERENCE SURVEY

The pilot survey was conducted in early of July 1996 during the office hours 9:00a.m.-4:00p.m. The stated preference survey was carried out at the Licensing Office of Hong Kong Transport Department. The sample frame is the person who is holding an effective driving license. Any licensed driver who entered the survey site would have an equal probability to be selected for interview. Three trained interviewers carried out the survey. Simple random sampling method was used for selection. During the survey period, the total population size is about 1200 persons.

The sample of the survey is classified into car owners and non-car owners who are both licensed drivers. The car owning and non-car owning groups are asked with different questions. Car owners were asked to answer the hypothetical questions of the stated preference experiment in views of the various changes in monthly personal income and parking rent. Similarly, non-car owners were asked concerning their responses to the changes of monthly personal income only. The hypothetical alternatives covered different increasing or decreasing rates of income, and the increasing rate of parking rent. The decision made by the car owners was at which level of income and parking rent that would affect them to dispose their cars. On the other hand, the decision for non-car owners was at which level of income that they would consider to own a car. This would reveal the relationship between people preference of owning a car and the effects of varying the changes in income and parking rent.

Each interviewee was also asked to provide the following personal information:

- gender
- age, within specified ranges
- monthly personal income, within specified ranges
- monthly household income, within specified ranges

In total, 218 samples were successfully interviewed. 21 samples were eliminated because their questionnaires were incomplete. As a result, there were only 197 valid observations which represent approximately 17.6% of the total population size during the survey period. Although monthly household income was asked, the response rate is comparatively low (only 50%). It was because either they are not willing to answer or they have no idea about the monthly incomes of their household members. Therefore, the monthly household income cannot be used to calibrate the models.

3. SURVEY RESULTS

Among the 197 observations, there were 82 car owners and 115 non-car owners. That is, about 41.6% of interviewees have cars or motor cycles available. Table 2 shows the personal information (age and sex) of the interviewees compared with the government statistics. In the survey, the ratio of selecting a man for interview is about one-third. However, there has a half chance for choosing a man to be interviewed from the whole population (with driving licenses or not) in Hong Kong. It may be due to the survey period was in office hours, most of the male is working in their offices. The differences of the female percentage between the statistics of survey and government are very significant, especially in the age groups eighteen to forty four. On the other hand, the differences of male percentage are comparatively small between the two sets of statistics. In fact, the government statistics are only indicators for comparing with the survey data. However, the government statistics are based on the whole population which includes both licensed drivers or not, and the survey results are only given by the licensed drivers. Therefore, some differences would be induced between the two sets of statistics.

Table 2. Comparison the Statistics of Survey and Government by Age and Sex

Item	Male (%)		Female (%)	
	Survey	Government	Survey	Government
18-24 years old	5.6	7.1	15.2	6.9
25-34	11.7	8.8	23.8	10.0
35-44	9.1	9.5	17.8	9.5
45-54	4.6	6.0	6.6	5.1
55-64	0.5	4.3	4.6	3.8
65 and above	0.0	4.6	0.5	5.5
Total	31.5	50.1	68.5	49.9

The monthly personal income distribution is also illustrated in Figure 1. There is about 82% of non-car owners in the income ranges of less or equal to HK\$20,000. Obviously, the percentage of car owners in the higher income ranges (above HK\$20,000) is about 66% which is comparatively higher than that of non-car owners. The average personal income of the car owners is about HK\$26,500 per month, and HK\$15,500 per month for the non-car owners. It was found that 40.2% of car owners always drive to work but only 6.1% of car owners sometimes drive to work. In the car owning group, 31.7% of them do not need to pay the parking rent as they either own parking spaces or have free parking spaces provided by their companies, or do not need a car parking space at all because they use motorcycles only.

The results of the stated preference survey for car owners show that about 20.7% of them would never dispose their cars whatever the monthly income is reduced, or even they are unemployed. Among this car owning group, about 17.9% of them who are renting the parking space, would never dispose their cars if their parking rent are greatly increased. These show that they are not sensitive to these two factors when they consider to dispose their cars. By examining the parking rent and household incomes of these people, most of them have high household income and relatively low parking rent. It is expected that their household's members would support the car owning and operating costs. Furthermore, most

of these interviewees represented that there is a need to use a car for their daily travel and the jobs.

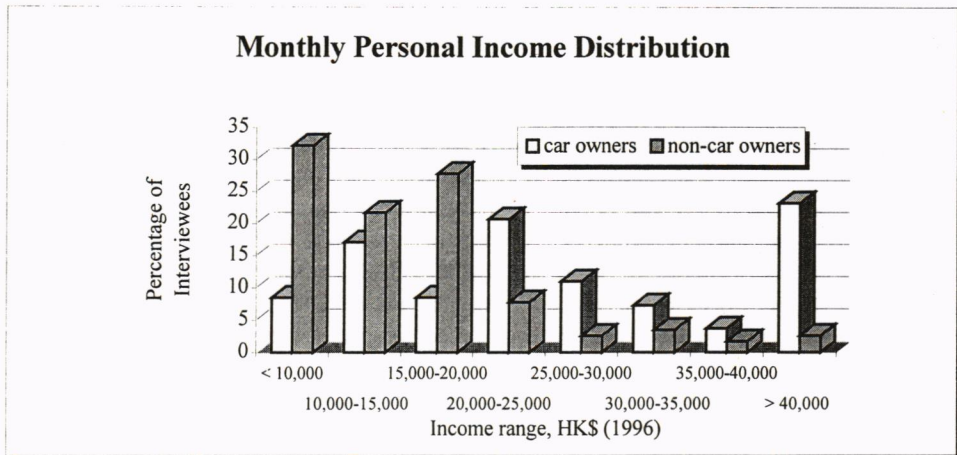


Figure 1. Monthly Personal Income Distribution

For the non-car owners, 55.7% will consider to buy a new car and 42.6% will buy an old car if they perceive the need. Only 1.7% showed that they never have an idea of owning a car. If there is an increase in the monthly personal income, 78.3% of non-car owners will choose a more expensive car than the original one.

4. MODEL CALIBRATION

The logit model is a choice model that represents the behaviour of individuals trading off among the attributes of alternatives when selecting one alternative out of a set of available alternatives (McFadden, 1974). A binary logit model was proposed for assessing the effects of different levels of decreasing income and increasing parking rent for car owners, or various degrees of increasing income for non-car owners. The car owning choice models were estimated separately for car owners and non-car owners. The general form of these models is given as below:

$$P_i = \frac{1}{1 + \exp U_i(X)} \quad (1)$$

where for the car owning group,

- P_i = the probability of an individual i owning a car with increasing monthly parking rent or decreasing monthly personal income, or both;
 X = the increased amount of parking rent or decreased amount of monthly personal income.

For the non-car owning group,

- P_i = the probability of an individual i still not owning a car with increasing monthly personal income;
 X = the increased amount of monthly personal income.

U_i is the utility value associated with an individual i and generally expressed as a linear form. By regression analysis, the choice models by car ownership and non-car ownership groups can be calibrated. The car owning choice models are shown in Figures 2 and 3 for illustrating the effects of increasing parking rent, decreasing and increasing income respectively.

In Figure 2, fifty percent of the car owners are willing to dispose their cars when the additional amount of monthly parking rent is HK\$1,658 while the other half car owners would retain their cars. This shows that increase of monthly parking rent would influence the willingness of owning a car. Figure 3 shows that fifty percent of non-car owners are willing to buy a car and half of car owners are still preferred to own their cars even if their monthly income is decreased or increased by HK\$9,386, respectively. An increase of income makes people to wish with higher living standard and choose better transport service. It can be seen that the amounts of addition and reduction in the monthly income for owning or disposing a car are the same at the probability of 0.5. This amount may be equivalent to the owning and operating costs of a car per month in Hong Kong.

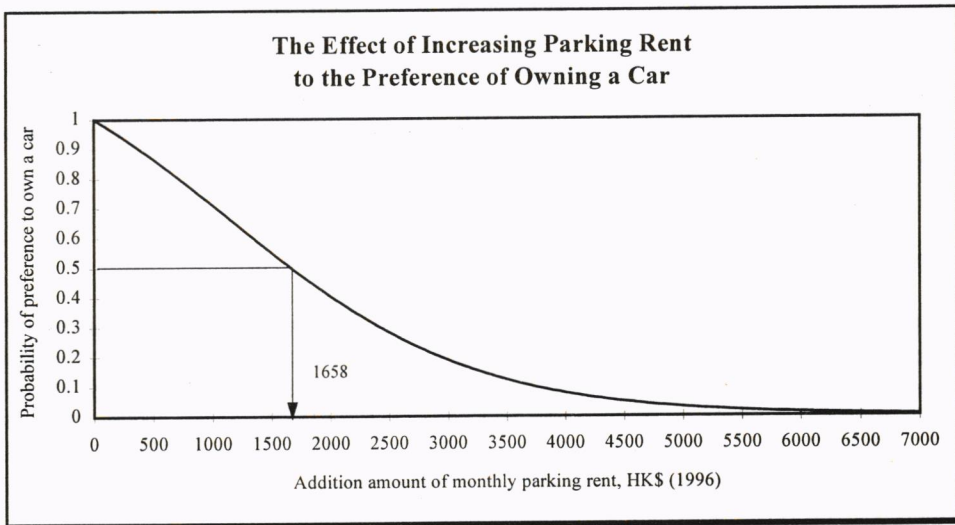


Figure 2. The Effect of Increasing Parking Rent to the Preference of Owning a Car

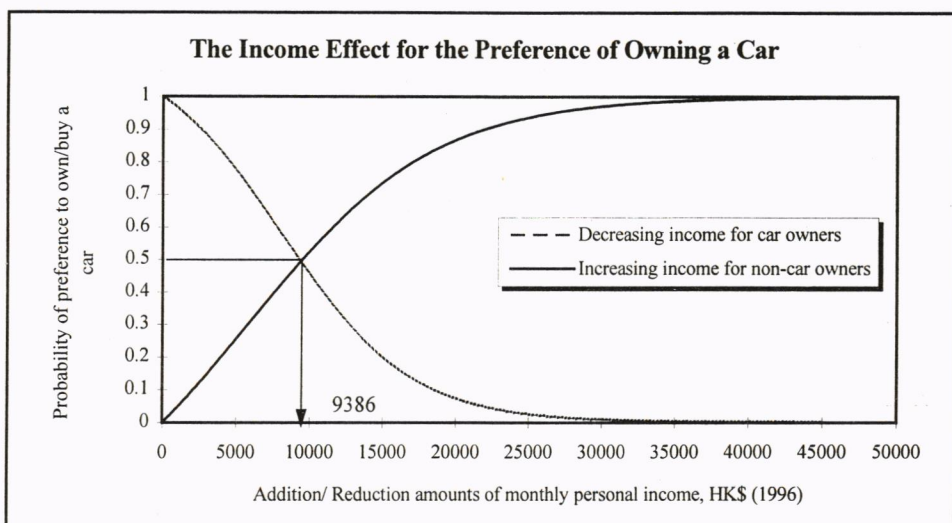


Figure 3. The Income Effect for the Preference of Owning a Car

In the Second Comprehensive Transport Study CTS-2 (Hong Kong Transport Department, 1995), the monthly car ownership and usage costs were derived on the basis of the Travel Characteristics Survey (TCS) data in 1992. Basically the ownership costs include the capital cost of the vehicle, first registration tax, annual license fee, insurance premium and the home-end parking cost. The usage costs include the costs of fuel, oil, tyres and spares, maintenance fee and the destination-end parking cost. The average monthly ownership and usage costs (HK\$ 1992) are HK\$5,266 and HK\$1,922 respectively. In other words, the total monthly cost is HK\$7,188 per car. Converting the price into 1996 money value by the composite consumer price index, the monthly cost of a car is about HK\$9,909. By comparing it with the above result in the study, the absolute difference is HK\$523 only and the relative difference is only 5.3%.

5. MODEL RESULTS

The calibrated car owning choice models are listed as follows.

(i) For car owners:

$$P_i = \frac{1}{1 + \exp\left(\frac{9.68684 \times 10^{-4} X - 1.108059}{(8.76) \quad (-4.21)}\right)} \quad (2)$$

where X is the addition amount of parking rent.

$$P_i = \frac{1}{1 + \exp\left(\frac{2.26967 \times 10^{-4} X - 1.837557}{(11.0) \quad (-7.80)}\right)} \quad (3)$$

where X is the reduction amount of income.

$$P_i = \frac{1}{1 + \exp(2.04026 \times 10^{-4} X_1 + 6.40595 \times 10^{-5} X_2 - 1.677241)} \quad (4)$$

(9.04) (0.63) (-9.40)

where X_1 = reduction amount of income,
 X_2 = addition amount of parking rent.

P_i is the probability of an individual i preference to still own a car in the equations (2), (3) and (4), and the t-values are indicated in the brackets.

(ii) For non-car owners:

$$P_i = \frac{1}{1 + \exp(1.5933 \times 10^{-4} X - 0.932875)} \quad (5)$$

(12.17) (-4.87)

where X is the addition amount of income, P_i is the probability of an individual i preference not to buy a car and the t-values are given in the parentheses.

For the car owners, the combined effects of parking rent and income on car owning choice can be examined with the use of equation (4). It was found that only the coefficients of X_1 , reduction amount of income, is significant at the 5 percent level. The t-value is very highly significant. It indicates that decrease in income has the most statistically significant effect on the probability of preference to dispose or own a car.

Sample estimates of the above four models are summarized in Table 3, together with their standard deviations and adjusted coefficients of determination which show the accuracy of the models. It can be found that the standard deviations of the sample estimates are very large although the adjusted coefficients of determination are both over 75%. The large standard deviations may be due to the wide ranges of the hypothetical choices. Therefore, further study is required to narrow the ranges by giving the well-defined hypothetical choices.

Table 3. Some Statistics of the Four Models

Characteristics	Sample Estimate	Standard Deviation	Adjusted Coefficient of Determination
Proportion of car owners retained the cars when the parking rent is increased	0.5082	0.2245	79.11%
Proportion of car owners retained the cars when the personal income is decreased	0.5383	0.2601	81.08%
Proportion of car owners retained the cars when the parking rent is increased and the personal income is decreased	0.5285	0.2523	78.96%
Proportion of non-car owners considered to buy a car when their personal income is increased	0.4097	0.2004	81.67%

6. CONCLUSIONS

In this paper, the willingness of car owners to dispose their cars and of non-car owners to own a car is estimated by the logit choice models. The effects of different levels of increasing or decreasing personal income and parking rent are investigated by using stated preference survey results. It was found that fifty percent of the car owners are willing to dispose their car when the monthly parking rent is increased by HK\$1,658. On the other hand, fifty percent of the non-car owners are willing to buy a car when their monthly personal income is increased by HK\$9,386. Nevertheless, half of the car owners would still prefer to own the car although their monthly personal income is reduced by the same amount. This amount is approximately equivalent to the costs of owning and operating a car per month in Hong Kong. Comparing with the similar cost reported in CTS-2 (1995), their difference is only about 5%. Therefore, half of the car owners and fifty percent of the non-car owners would make the decision of disposing or acquiring a car if their monthly income is decreased or increased with this amount, respectively. The results also show that reduction in income has the most statistically significant effect on the probability of preference to dispose or own a car.

The findings presented in this paper are only the preliminary results from the pilot survey. The main survey will be conducted at the end of 1997 with taking into account the findings in the pilot survey. The samples will be collected not only from the Licensing Office, but also from the other places based on the sampling theory. The sample sizes will be larger to increase the representative. The car users and motorcycle users will be distinctly interviewed because the effects of parking rent will be very different. The effect of parking cost will also be studied for the non-car owner to decide whether or not he owns a car. The information of monthly household income may be replaced by some other variables that can reflect their income levels.

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