EQUITY, PREFERENCE AND ACCEPTANCE OF THE CAR OWNERSHIP POLICY IN GUANGZHOU, CHINA

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Master of Science

by

Jun Wang

January 2017

© 2017 Jun Wang

ABSTRACT

This thesis provides an analysis of the results obtained from a survey in Guangzhou, China, where in August 2012, a one-year trial car ownership policy was implemented. This policy is a hybridization of the policies already established in Shanghai and Beijing, where there are auction and lottery processes for acquiring a new license plate. The thesis will focus on the perceived equity of the lottery and auction options, in correlation with different demographics of respondents, as well as people's preferences with regards to the various aspects of the policy.

Based on the obtained results, one of the main takeaways from this study is that the surveyed sample in Guangzhou has an overall marginal acceptance of the hybridized policy, and a stronger sense of equity towards the lottery option as compared to the auction. People's acceptance and preferences are also more influenced by their perception of fairness of the auction process.

BIOGRAPHICAL SKETCH

Jun Wang has an undergraduate degree in Applied Science in Civil Engineering focusing on Transportation Engineering from University of British Columbia in Vancouver, BC, Canada. During his undergraduate study, he became a research assistant for the School of Applied Science. He conducted multiple studies with Professor Jinhua Zhao in policy study. He then pursued his Master of Science degree in Transportation System Engineering from Cornell University. With the advising and guide from Professor Gao and Professor Daziano from School of Engineering, he finished his master thesis on the topic of a car ownership policy implemented in Guangzhou, China.

ACKNOWLEDGEMENTS

I would like to sincerely thank Professor Gao and Professor Daziano for their time, expert advice and encouragement throughout this difficult thesis writing process. Starting from topics, professional research guidance, and work revisions, Professor Gao and Professor Daziano were always available to be reached out. I will not have finished this work without their help, for that I would convey my sincerest thanks to them. I would also like to thank Professor Nozick and Mr. Vanek for their great lectures from which I learned a lot for building the foundation of the knowledge required to finish this thesis.

TABLE OF CONTENTS

List of Figures

List of Tables

List of Models

1. INTRODUCTION

1.1 Context

In 1994, the largest Chinese city, Shanghai, adopted the car license auction policy from Singapore in order to control the growth of privately owned vehicles. A certain quota of license plates is issued every month, and only those who bid higher than the lowest plate price can have a local Shanghai license. In 2011, another Chinese metropolitan, Beijing, implemented a car license lottery policy to moderate the growth rate of private owned cars. Lotteries are drawn every month to decide who can get a local Beijing license plate. In 2010, after 16 years of the implementation of the auction policy, car ownership level in Shanghai was significantly less than it is in Beijing by 1.7 million. Additionally, growth rate is also lower in Shanghai than in Beijing (Shanghai Statistic Bureau and Beijing Statistical Bureau, 2011).

As of August 1st, 2012, Guangzhou, a major city in the province of Guangdong in the southeast part of China, implemented a new car ownership policy for a one-year trial period, with the aim of controlling the city's car growth rate. The policy specified that 120,000 local Guangzhou license plates were going to be issued within the trial year. Guangzhou's newly implemented policy is unique as it combines the existing two ways of license allocation from other Chinese cities, namely, Shanghai and Beijing. In Shanghai, the car license auction was originally adopted from Singapore, in which a certain quota of license plates are issued every month, and only those who bid higher than the lowest license plate price can obtain a Shanghai license plate. In Beijing, the mechanism for license plate allocation is entirely through a lottery system drawn every month. Besides the hybridized feature, Guangzhou's policy also includes a new category, namely, "new energy car"; as a result, a dedicated lottery for new energy cars is drawn, accounting for 10% of

the total quota. Among the remaining 90% of the total quota, 50% is allocated through lottery and 40% is through auction.

1.2 Significance

Up to May, 2012, Guangzhou had a car ownership level of 2.4 million, among which 1.67 million were middle and small sized passenger vehicles. This is 2.5 times the car ownership level that was present five years ago. The average growth rate within five years is approximately 19%. This is to say, on average the number of passenger vehicle increased by approximately 300 thousand from 2011 to 2012 (Xu, Sui, & Huang, 2012). As discussed in section 1.1, the annual quota for local Guangzhou license plates is only 120 thousand, which is only about one-third of the increase in number of vehicles from the previous year. Assuming all Guangzhou people will register locally with Guangzhou license plates, at that time it is expected that this policy may cause issues among the potential car buyers as the supply of the license plate dramatically deceased while the demand remained the same if not increased. How local people perceive and accept this policy need to be examined.

Among all the Chinese cities, this is the first time that such a hybrid policy is being implemented. From past experience, both Shanghai's auction policy and Beijing's lottery policy have their own advantages, as well as limitations. Shanghai's auction allocates local license plates to those who have higher willingness-to-pay, in order to make the allocation more efficient; the high price of a license plate may favor the rich and has caused an equity concern. In Beijing, all license plate applicants have the same chance of obtaining a free local license plate by winning a lottery draw, but low winning odds and long waiting periods have also drawn concerns among all applicants. Guangzhou's public acceptance of this hybridized policy depends on whether it can alleviate some

of the existing problems, or if it exacerbates the issues inherited from Shanghai's auction and Beijing's lottery policies.

1.3 Objectives / Research Question

The objective of this study is to examine people's acceptance and their preference of the mechanism towards Guangzhou's car ownership policy after six months of implementation. As a result, the research question for the study is: what is the overall level of acceptance of this hybridized policy in the city of Guangzhou? Additionally, this study can also benchmark the overall acceptance level of the hybridized policy at the middle of its trial. To examine the factors that influence the overall acceptance level and preferred mechanism, this thesis aims to correlate the acceptance level and preference with the perception of equity of both auction and lottery systems. To investigate the overall perception of equity of the auction and the lottery, demographics and socioeconomics information of the respondents will be utilized to identify the key determinants that shape respondents' perception of equity.

2. LITERATURE REVIEW

The literature review will focus past studies and reports on effect, acceptance and transfer of similar policies. The two places with similar policies that will be looked at are Shanghai and Singapore. There has been a lottery license policy in place in Beijing since 2011, but there was little literature found regarding this policy. In addition, the literature review will look at other policies around the world and their effect, acceptance and transferability. Although this study of the policy in Guangzhou looks at preferred mechanism, it will not be highlighted in the literature review as the policy in Guangzhou is unique with the separation of auction, lottery, and new energy cars.

2.1 Effect of Policy

A comparison of the level of car ownership in Beijing and Shanghai, before Beijing implemented its car ownership policy, shows that the private car ownership grew much slower in Shanghai as compared to Beijing over the same period of time. In ten years (1998-2008), car ownership in Beijing grew from 40 to 185 while Shanghai grew from 20 to 60 (cars per 1000 people) respectively, showing that limiting the number of new vehicles allowed to register will axiomatically reduce the growth rate of car ownership (Hao 2011). In Shanghai, car ownership has started to become a status symbol and social norm for those of a particular socio-economic position. Those with higher incomes have a stronger tendency to own a new car (Goetzke 2012). It has been found that once a person owns a vehicle, they are much more likely to use that vehicle for their travel needs regardless of other travel options that may be present (Chin 1997).

There have been positive and negative effects resulting from the control or limitation of vehicle licenses, as explained by S. Feng in their paper "*Performance analysis on private vehicle plate auction in Shanghai*". Some of the noted positive effects include reductions in the growth rate of

vehicles on the road, increased revenues to be used for transportation, reduced pollution, and reduced wear and tear on transportation infrastructure. The negative impacts of this policy in Shanghai include adverse effects on the automotive industry, a sense of inequity, as some cannot afford a new license, and a portion of the population resorting to obtaining their license from neighboring areas (Feng 2010). Since the policy in Guangzhou is a hybrid of both the auction as in Shanghai and the lottery in Beijing, it shows promise for reducing some of the negative effects while still retaining the positive effects of the other policies.

2.2 Acceptance

As mentioned previously, there is a sense of discrimination with a bid policy as it makes it very difficult for those with low incomes that are in need of a car to afford the licensing fee. It is unlikely that any policy that makes it harder for those already at a disadvantage will be widely accepted (Gaunt 2007). A study of public acceptance of Shanghai car ownership policy was conducted by Chen and Zhao in 2011. In the paper, the authors investigated local public's acceptance towards the long-implemented car ownership policy. They found that perceived policy effectiveness, affordability, equity concerns, and policy implementation to be the most important factors that influence the acceptance (Chen & Zhao, 2011).Furthermore, the public's acceptable auction cost for a license in Shanghai was one fifth of the auction price, showing that the cost of a license has an effect on the acceptance of a policy (Chen 2013).

The acceptance of a policy will also be affected by how people perceive the policy's effectiveness in reducing congestion (Borjesson 2012). It was found in Stockholm, Sweden that the public acceptance of their congestion charging policy changed with time as it became the new norm (Borjesson 2012). In addition, educating the public regarding the policy can increase the acceptance levels in the public eye (Borjesson 2012). Those who do not agree with a policy may

find loopholes by which they can still obtain a car, such as in Shanghai where there has been a large increase in the number of licenses obtained from neighbouring regions (Feng 2010). The acceptance of people in Guangzhou is largely dependent on their understanding of the new policy and their perception of its effectiveness. The hybridized policy in Guangzhou has a good potential for acceptance since there are multiple methods for obtaining a license, and therefore there is less discrimination among people with varying socio-economic statuses. That being said, adequate supply of information to the general public regarding the policy's aims and benefits, and their input is also necessary for improving the acceptance levels.

2.3 Policy Transfer

Policy transfer is an important aspect of Guangzhou's car ownership policy, as it has undergone multiple transfers before getting there. Starting in Singapore, a policy was introduced in 1990 to limit car ownership growth (Chin 1997). The policy was then transferred to Shanghai in 1994 (Hao 2011), then Beijing adopted a modified policy that was lottery based in 2011, and lastly the trial hybridized policy arrived in Guangzhou in 2012. Important questions need to be asked when there is a transfer of policy from one area to another, as mentioned in Polski and Ostrom's paper called "*An Institutional Framework for Policy Analysis and Design*". Such questions include:

- How do observed outcomes compare to policy objectives?
- Which outcomes are satisfactory? Which are not?
- Which outcomes are most important?
- When/where are these outcomes occurring?

When the right questions are asked, a policy can undergo a transfer with a hybridization of other policies, which is a common form of policy transfer and allows for learning from the individual aggregate polices (Evans 2009). This process involves combining the various successful components of other policies, and tuning them to the nuances of a new area and culture (Evans 2009).

3. METHODOLOGY AND DATA

3.1 Framework

Based on the knowledge gained from previous literature and research, people's perception of equity towards auction and lottery will influence their acceptance level of the policy and their overall preference. The variations on the perception of equity differ among people with different demographic and socioeconomic statuses. Thus, a framework was developed (as illustrated in Figure 3-1) that includes the possible determinants that shape people's senses on equity and eventually affect the overall acceptance and preference.

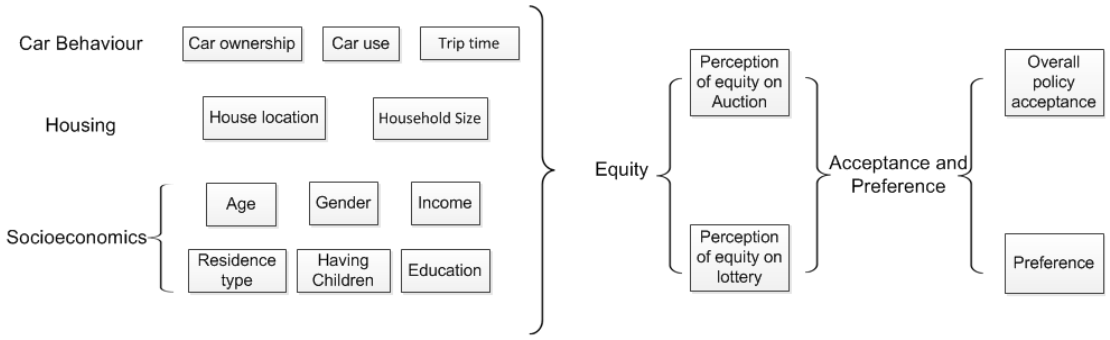


Figure 3-1: Flow Chart of Analysis

As shown in Figure 3-1, car behavior includes level of car ownership, percentage of car usage in people's total trips, and their trip time from home to work. Housing status include housing location (central city, new city and county city), and respondents' household size. Socioeconomics include age, gender, household income, education level, residence type, and having children or not. Equity includes people's perception of equity towards auction and lottery. One other key factor to be investigate is preference, which includes people's preferred hybrid ratio, and their attitude towards the quota allocated for the lottery, auction, and the new energy car options.

3.1.1 *Hypothesis*

There may be many conclusions that can be drawn from the data. Some of the hypotheses and expected results of this study are as follows;

- The overall level of acceptance is expected to be low.
- Attitudes towards the policy will vary depending on each person's perception of the policy fairness. However there may be other factors not considered in this study that also influence people's attitude and level of acceptance of this policy. Such factors may include the effectiveness of the policy on mitigating congestions and the complexity of the policy
- Attitudes towards the policy will vary depending on each person's socioeconomic status such as age, income, and dependency on car for transportation, and other factors such as whether they already own a car or not. However, not all of these correlations can be proven in this study, since the method of mathematical analysis will be by linear regression and structural equation model; both of which assess only linear relations, which may not be the case in reality.
    - Younger people may not show as much enthusiasm towards this policy.
    - People with higher incomes will tend to favour this policy.
    - People who already own a car will likely be more in favour of this new policy.
    - People who have a larger household size will likely be less in favour of this policy.
    - People with a higher level of education may be more in favour of this policy.
- Acceptance and the preference of the policy will also vary depending on each person's perception of the fairness of the policy. Presumably if people perceive the policy is fairer, they will also perceive the policy is more acceptable. In addition, people will be more

preferred to the option that they believe to be fairer relative to other people. The fairness of the auction and lottery each will possess a contribution weight in shaping people's acceptance of the policy; both are expected to be positive but the exact weights are difficult to forecast.

3.2 Questionnaire Survey

A survey has been conducted in Guangzhou, China which focuses on the people's attitude towards the new car ownership policy implemented in the city as of August 2012. People's attitude towards the policy includes implicit factors such as their perception towards equity, and their acceptance towards the policy. Questions regarding people's preferences, such as their ideal hybrid ratio, have also been included in the survey.

3.2.1 Questionnaire Design

The survey includes various questions relating to socioeconomic status, travel behavior, and attitude towards the car ownership policy. Most of the attitudinal questions are multiple choice with five choices, namely, strongly disagree, somewhat disagree, neutral, somewhat agree and strongly agree. Respondents need to select one answer to represent their attitude towards the statements. Some of the questions contain both positively toned and negatively toned statements in order to eliminate misunderstandings regarding the phrasing of the statements, while ensuring the quality of the responses, as conflicting answers can be easily identified. This will be discussed in section 3.2.2.

3.2.2 Questionnaire Structure and Contents

The survey is designed to take approximately 20-30 minutes to complete, and is divided into 8 main sections: 1) policy awareness, 2) vehicle ownership, 3) vehicle usage, 4) travel mode, 5)

attitude towards the car licensing policy, 6) non-local license plates, 7) comparison among Guangzhou, Shanghai and Beijing, and 8) personal information. The fifth section is the most significant in this study, as it assesses the overall acceptance towards Guangzhou's policy, perceived equity level, preferred hybrid ratio, and expectation of policy effectiveness.

3.3 Sampling Frame

A total number of 457 valid responses were collected from the previous respondents group. Samples were selected based on the following criteria: 1) gender, 2) age, 3) annual average household income, 4) education level, 5) residence type, 6) living area, 7) residence time in Guangzhou. The percentage of sample distribution within each criterion was determined based on the Guangzhou city statistics. However, due to lack of information on age structure and residence time distribution, the sample distribution has been set based on past experience.

3.4 Survey Data

Table 3-1 encapsulates the aforementioned sample characteristics along with other personal information such as car ownership level. The sampling frame was designed to be as close as possible to the Guangzhou Statistical Yearbook to ensure the representativeness of the data from this study. However, the sample was skewed in the following manner: 1) more male than female, 2) relatively young age group, 3) more people from the city center, 4) relatively high household incomes, and 5) high car ownership levels. These could be explained by the nature of the survey samples since the survey was distributed and conducted online. Certain groups of people such as the elder and the poor may not have access to this type of media.

Table 3-1: Survey Sample Characteristics (N = 457)

Variables of samples	Values	Survey sample (%)	City Statistics (%) (Guangzhou City Statistics Yearbook, 2012)
Demographics			
Gender	Male	61	49.3
	Female	39	50.7
Age	18 -24	7	16
	25 - 34	39	24
	35 - 44	45	15
	45 and above	9	21
Have children	Yes	72	
	No	28	
Household size	1	3	
	2	14	
	3	60	
	4+	24	
	Average household size=	3.2	3.2
Born in Guangzhou	Yes	62	
	No	38	
Residence time	More than 15 years	51	
	10 - 15 years	11	
	5 - 10 years	15	
	2 - 5 years	12	
	Less than 2 years	9	
Residence type	Guangzhou Hukou	63	
	HK and Foreign	0	
	Nonlocal with resident permit	20	
	Nonlocal with temporary resident permit	8	
	nonlocal with no permit and temporary permit	8	
Living area	Centre city	86	64

	New city	11	23
	County city	2	13
Socioeconomic			
Education level	High school or below	6	
	College/University	88	
	Master and above	6	
Household income	Low (< 4K RMB)	2	
	Middle(4K RMB - 10K RMB)	56	
	High (> 10K RMB)	42	
	Monthly household income	RMB 12,000	RMB 8,099
Car ownership	No	18	
	Yes:		21
	1	78	
	2+	4	

3.5 Data Processing

All the data was first normalized to make them comparable with each other. Also, there will be invalid responses among the respondents. It is important to eliminate such invalid responses before performing any data analysis. Sample distribution may not be ideal when compared to city statistics, so data weighting has to be performed to make the data more representative. In the following sections, data coding, cleaning and re-weighting will be briefly discussed.

3.5.1 Data Coding

The data obtained was originally coded by the survey company. All the answers were then coded from -2 to 2, except for the SEM section, in which they were coded from 0 – 10. The answer from -2 to 2 or from 0 – 10 respectively represent a scale from “strongly negative” to “strongly positive”. The SEM model uses such different coding scheme due to the easier normalization of direct input questions, such as age, gender, etc.

3.5.2 Data Cleaning

Some responses may be invalid due to various reasons, but regardless, those responses need to be eliminated before preceding any analysis. From past experience, I have realized that invalid responses may share some similar patterns. For example, some people may choose the same answers throughout one section. As discussed in the section 2.1., some questions contain both positively-toned and negatively-toned statements. Thus, if the aforementioned pattern were discovered, it will be counted as one invalid response. Also, some invalid responses may not follow this pattern as they may choose answers diagonally. However, some of these patterns may indeed be valid for some specific questions. Therefore, it requires sufficient understanding of the questions. The number of invalid responses will be counted and those respondents with the most invalid counts will be eliminated.

3.5.3 Data re-weighting

The data obtained was skewed and different from the city statistics. In order to achieve high representativeness of the data, the iterative proportional fitting (IPF) method was performed to re-weight the data based on the available city statistics. There are seven dimensions in the data sample that need re-weighting, namely, gender, age, income, education, house location, car ownership, and residence type. If sample distribution is close enough to the city statistics, IPF is not needed. Due the lack of some data, only three dimensions, namely, gender, car ownership and house location were able to be re-weighted. However, in the end, I decided not to use the weighted data for the data analysis. The reasons for this decision are discussed in section 7.1.

3.6 Modelling Method

3.6.1 Linear Regression

The linear regression modeling technique will be used for the analysis of people's attitude toward the Guangzhou car ownership policy. This technique focuses on the relationship between the dependent variable "attitude towards the policy'" and various independent demographic and socioeconomic variables including age, income, household size, etc. A hypothesis is first made regarding the correlation of variables, and is then tested by the linear regression model. The primary purposes for using this modeling technique are: 1) assessing the level of correlation between the dependent and independent variables and 2) determining the significance of each independent variable. Hypothesis and the expected results are explained in detail in the expected results section.

A mathematical function of the dependent variable (i.e. attitudes toward the policy) will be hypothesized based on the expected result. The function will be in the form $Y = \alpha + \Sigma(\beta_i)(X_i) + \varepsilon$, where Y is the independent variable, α is the constant estimator, β_i are the slope estimators, X_i are the dependent variables, and ε is error. Upon collecting the data from the questionnaire, the dependent and independent variables will be respectively quantified into mathematical values X and Y in the function. After construction of the linear regression model, all independent variables will have their significance and correlation with the dependent variables tested.

3.6.2 Structural Equation Model

The Structural Equation Model (SEM) was utilized to estimate the causal relationship between the dependent and independent variables, as well as the causal relationships among the independent variables themselves. It acts as a series of multiple regressions and also allows assessment of the

correlations between independent variables. To perform the structural equation model, M-plus will be the ideal software to use. However, due to the availability issue, free software, called “Amos”, was utilized to perform the SEM analysis. The results and the discussions of the model will be introduced in the following sections.

4. RESULTS

Based on the sample, the acceptance and preference are measured. The Guangzhou car ownership policy had an acceptance level of 0.17 in the sample group, based on an average and normalization of five survey questions relating to acceptance. Please refer to questions 24.1-24.5 in Appendix C. Negative 2 indicate a negative acceptance, positive 2 indicates a positive acceptance, and zero indicates neutral acceptance. Therefore the average acceptance level of 0.17 indicates marginal acceptance of the overall policy.

With respect to preference, the following chart indicates the sampled group's preference toward the options of the car ownership policy:

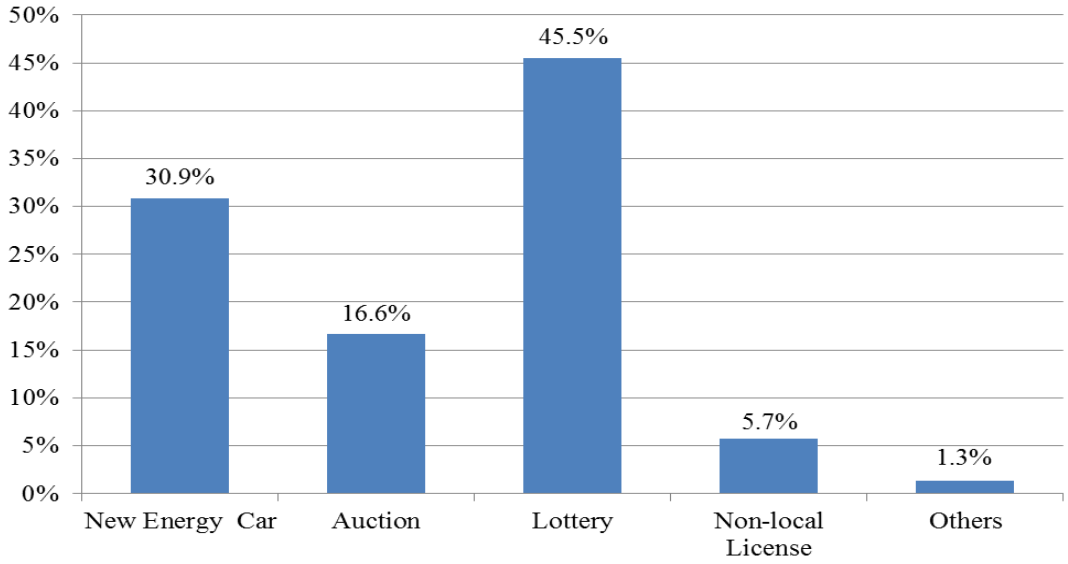


Figure 4-1: Preference toward Car Ownership Options

As depicted in Figure 4-1 above, people's preference towards the lottery option is highest, followed by the new energy car option, and then the auction option. In addition, a small portion of respondents has chosen a non-local license plate as their preference.

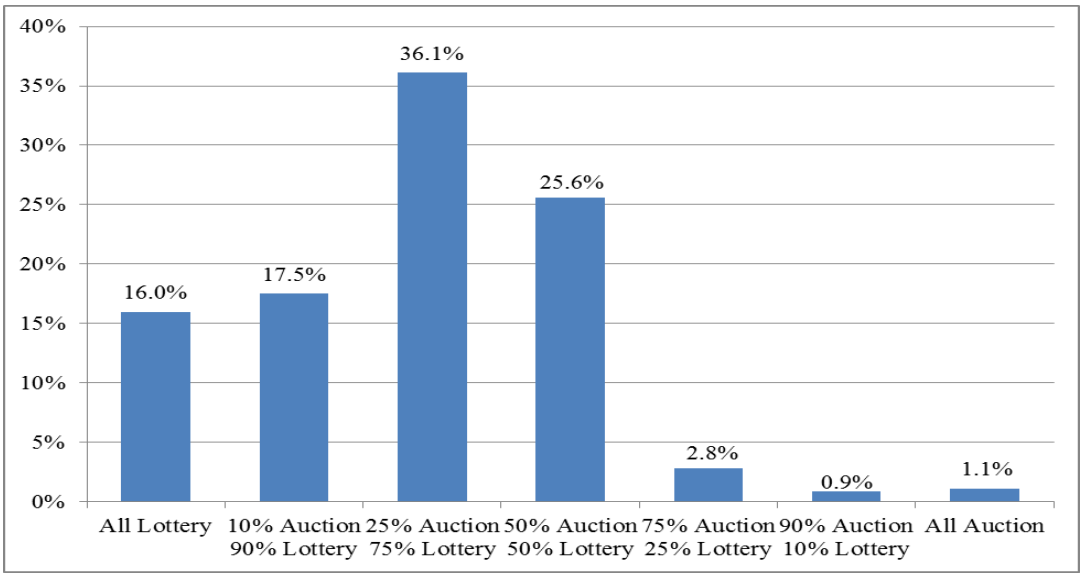


Figure 4-2: Preference toward Percentage Split between Auction and Lottery

With regards to the percentage split between the auction and lottery, the highest preference ratio has been given to 75% lottery and 25% auction, followed by the 50/50 split between auction and lottery. Only 2.8% of respondents showed support for 25% lottery and 75% auction, again confirming the fact that most people prefer to have a higher ratio of the quota allocated to lottery versus the auction.

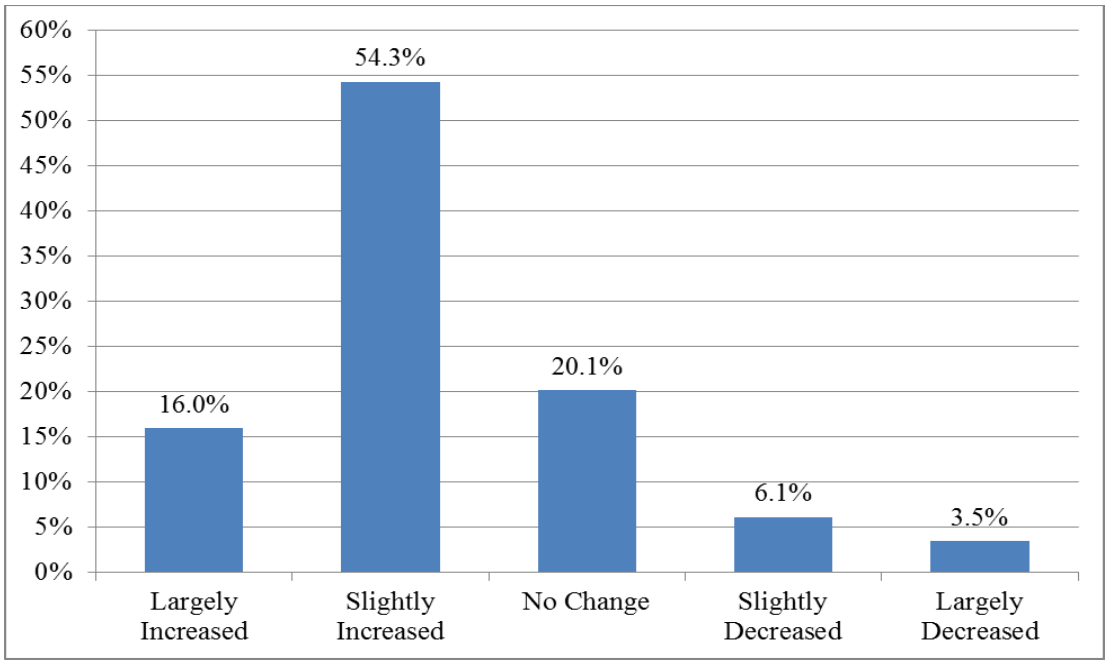


Figure 4-3: Preference toward the Car Ownership Quota

In terms of the preference towards the car ownership quota, most people (over 50%) felt that it should be slightly increased. This may be because they feel that increasing the quota can bring down the auction prices and improve the chances of winning the lottery. The next highest preference was for no change, coming from 20.1% of the total responses.

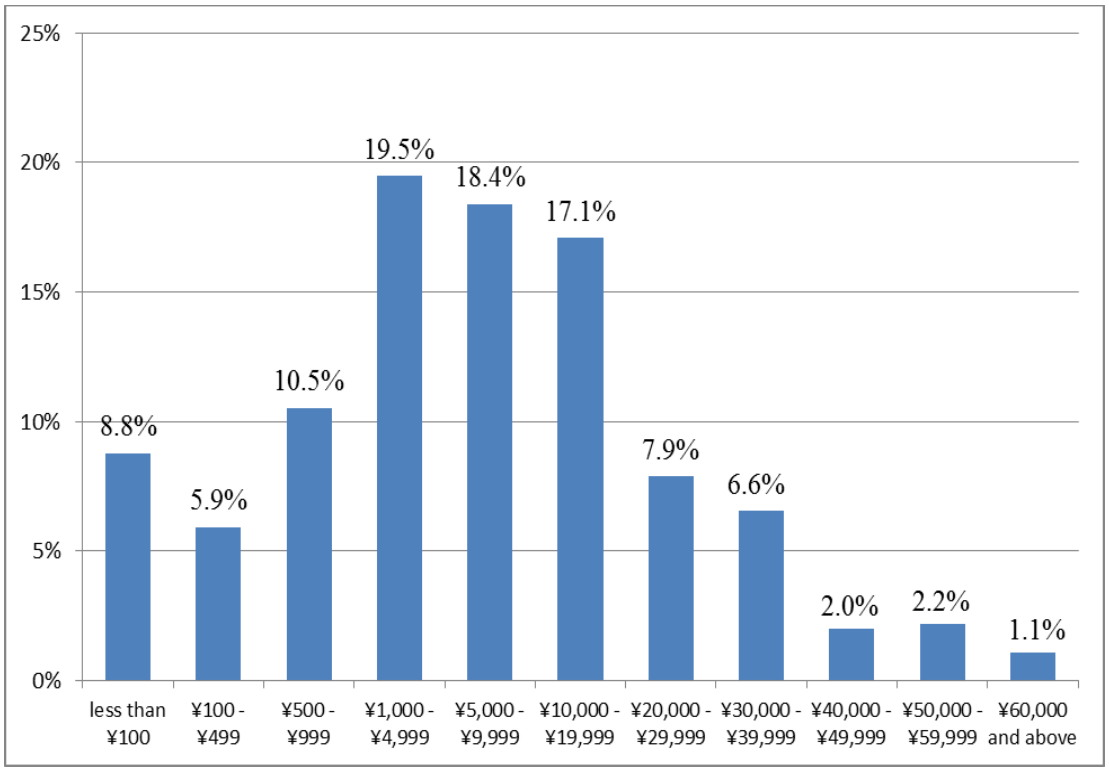


Figure 4-4: Preference toward Willingness to Pay for Auction

The highest preference towards willingness to pay for the auction process was for the ¥1,000 to ¥4,999 range, followed by the ¥5,000 to ¥9,999 range and then the ¥10,000 to ¥19,999 range. The average price for a licence plate in Guangzhou is about ¥10,000, and therefore it is relatively close to the amount that people are willing to pay. As compared to Shanghai, where licence plates can cost up to ten times more through the auction process, the auction prices in Guangzhou are fairly reasonable, and match people's preferences.

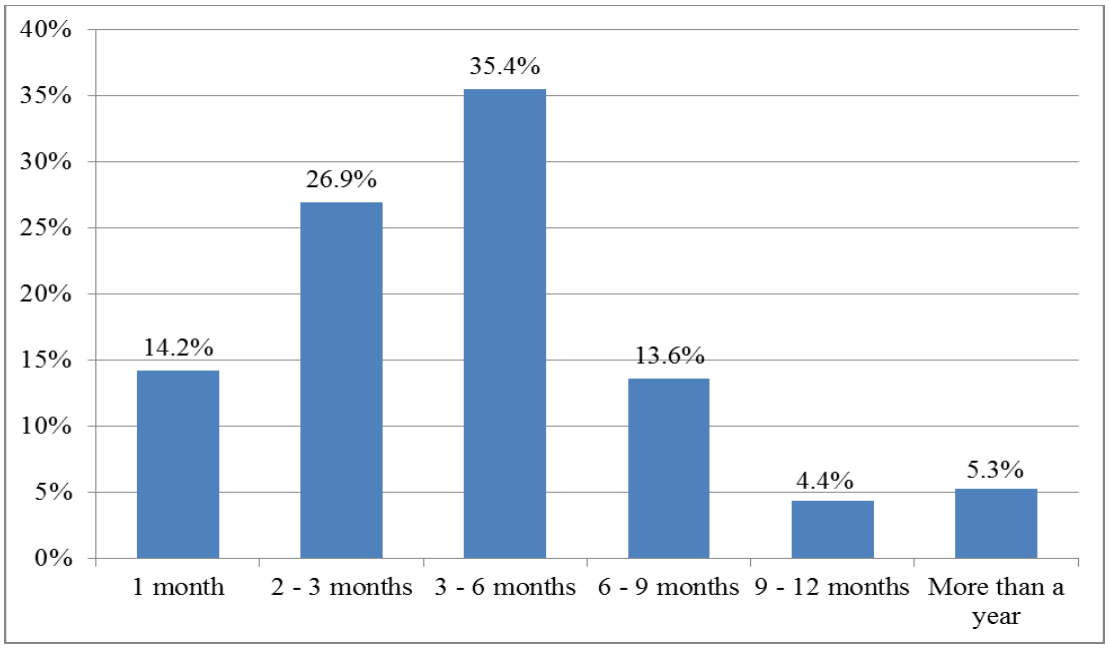


Figure 4-5: Preference towards Waiting Time for Lottery

With regards to the preference towards waiting time for lottery, most respondents (35.4%) are willing to wait up to 3-6 months, beyond which they would be dissatisfied. The next preference is for a waiting time of 2-3 months, with 26.9% of the respondents feeling that a waiting time beyond 3 months for obtaining a license plate through the lottery option is unreasonable.

5. ANALYSIS AND DISCUSSION

5.1 Equity

Equity is scaled from negative 2 to positive 2. Negative 2 represents a sense of inequity and positive 2 represents a sense of equity, with zero being a neutral equity. There were 3 questions (5.17.1-5.17.3 see appendix C) and 4 questions (5.15.1-5.15.4 see appendix C) asked of the fairness of the lottery and auction respectively. The lottery it looked at the chances of winning and the waiting time and the lottery in general and whether it seems fair. The questions for the equity of the auction are related to the 4 distinct aspects or effects of the policy. Two of these questions generally determine the equity of the auction by asking if is fair that the lottery benefits those that can afford to participate in the auction. Another looks at how the auction allows those that really need to buy a car to buy one. Also how the auction does not control the size and value of a car. All these results were for both lottery and auction were normalized and averaged to find the overall equity of the lottery and auction. Overall, there is a greater sense of equity towards the lottery, and a sense of inequity towards the auction. The resulting equity of the lottery and auction was 0.41 and -0.29 respectively.

The results of the survey are reported below, and broken down into seven different demographic parameters: age, gender, household size, car ownership, education level, type of residence, kids, trip time to work, percentage of car trips, district and household income.

5.1.1 Age

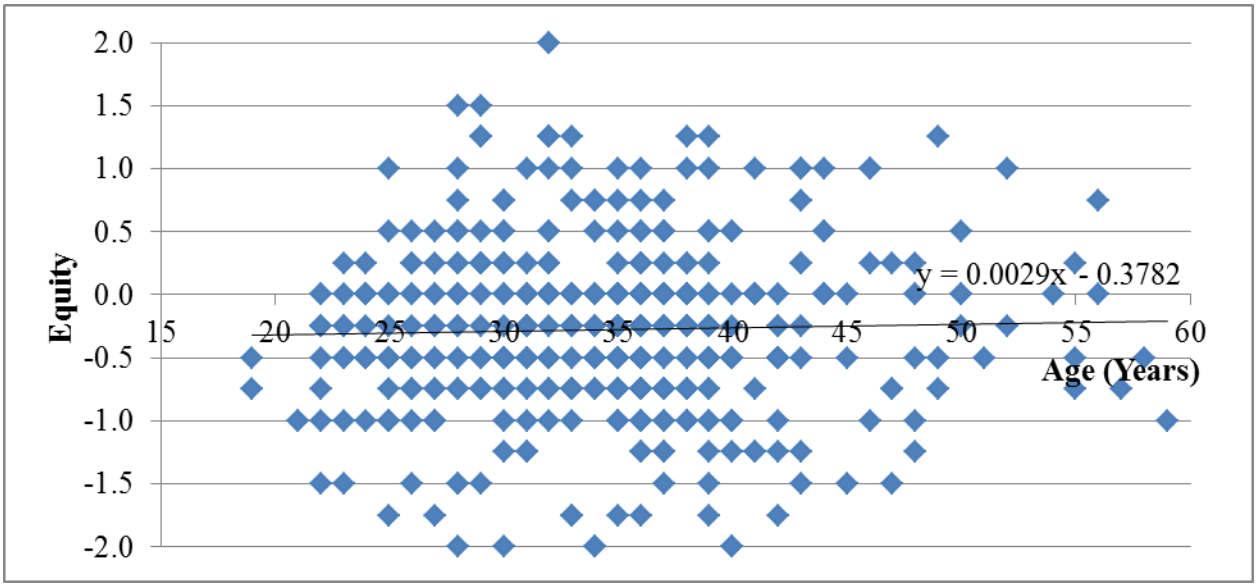


Figure 5-1: Equity of Auction vs. Age

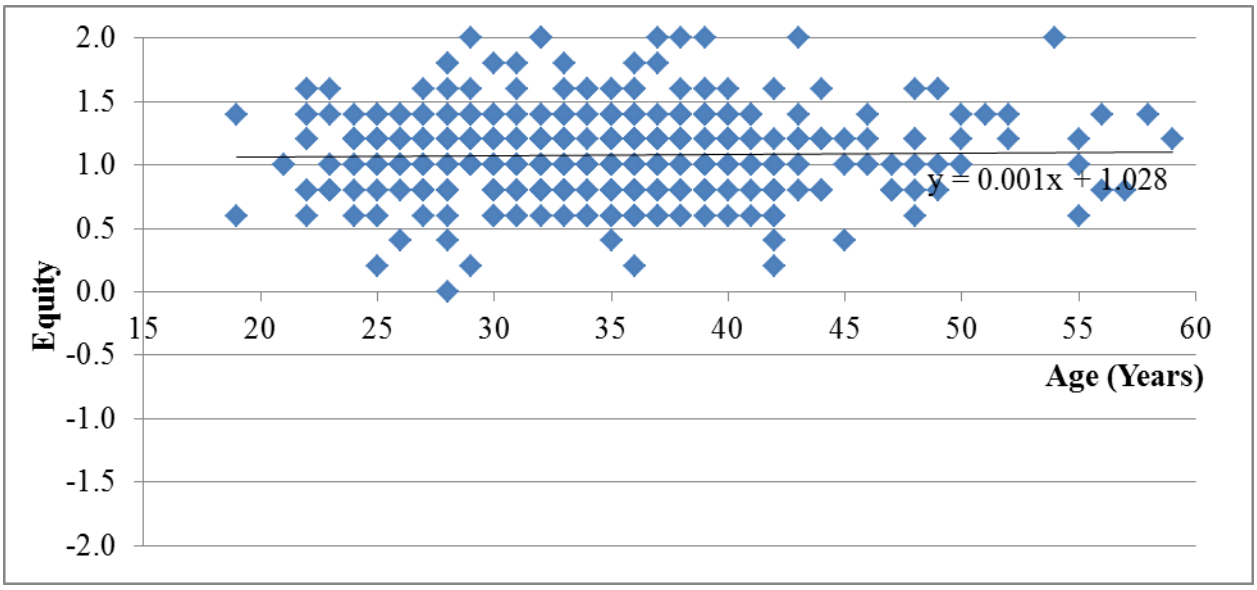


Figure 5-2: Equity of Lottery vs. Age

As depicted on the plots above, the average equity vlaues for the auction and lottery are fairly constant, although there is a slight positive slope for the best fit line in both cases. The slope of the best fit line for the auction equity vs. age is higher; therefore, the auction equity seems to be more sensitive to age than the lottery equity. The equity values for the lottery option are generally higher,

and almost all fall on the positive side of the scale. One reason for the positive correlation between age and auction equity may be that younger people have a more social attitude and are more eager to buy a new car; therefore they do not find it fair that they now have to pay a large sum of money to obtain a new license plate. They may also not be mature enough to understand the potential benefits that this policy may bring, making them feel that it is inequitable. One possible reason that the slope for the auction equity vs. age plot is higher is the fact that the auction option has an economic component to it, and therefore older people who typically have higher incomes, will likely have higher equity values, and since the lottery is free, there is a dampening effect on the sensitivity to age.

5.1.2 Gender

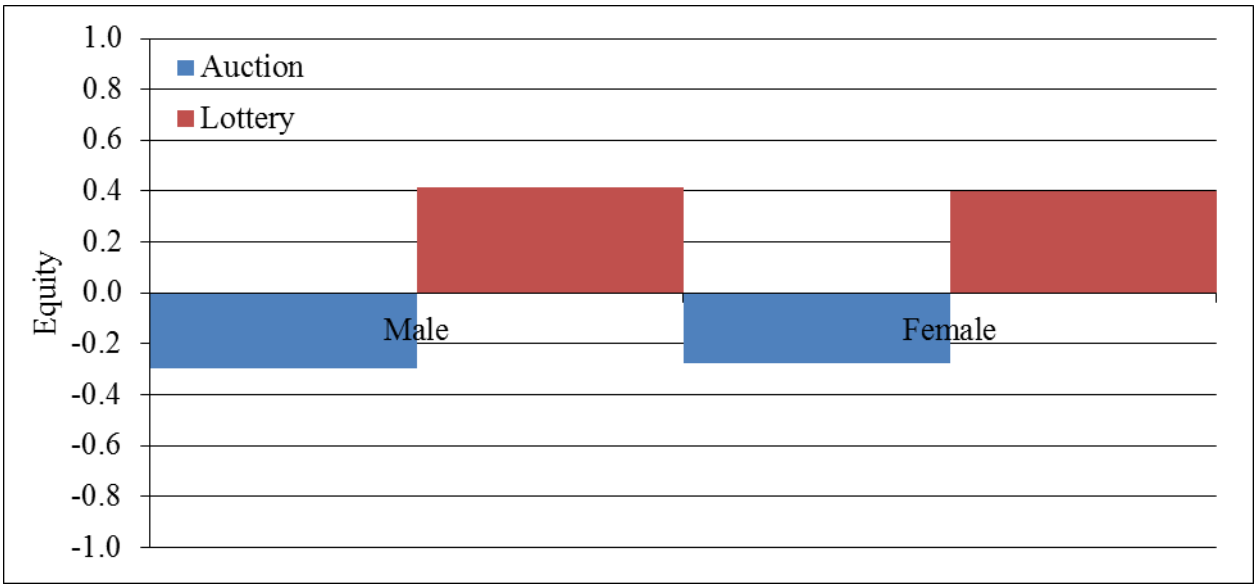


Figure 5-3: Equity vs. Gender

Based on the average equity values for male and female survey participants, with regards to auction, they both have negative average equity values, meaning that people do not feel that it is fair, and there is no significant difference between the male and female respondents. With regards

to the lottery option, the average equity values for both male and female participants are positive, and again there is not a major difference between the male and female results.

5.1.3 Household Size

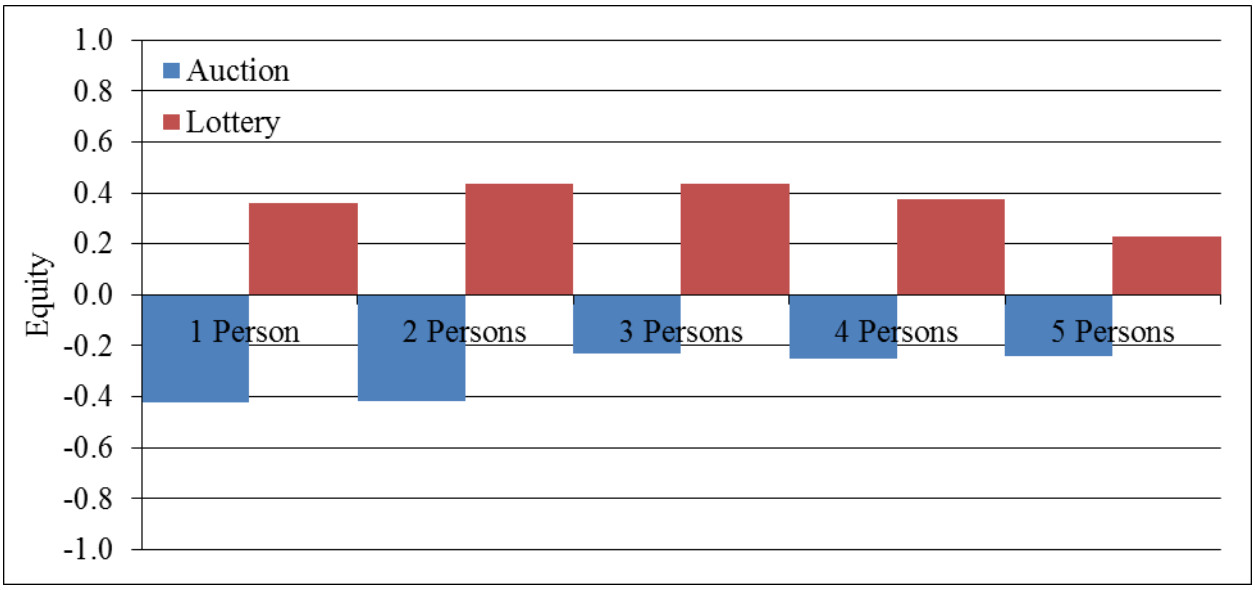


Figure 5-4: Equity vs. Household Size

The average equity values with regards to the lottery process slightly increase with larger household sizes, but then decrease beyond three people. This could potentially be due to the fact that larger households tend to want to buy more cars, and they would rather go through the lottery process and not pay for every new license place, but then households with four or five people likely have higher incomes and therefore may not care about paying through the auction process to guarantee getting their license plate. The equity for the auction process increases with larger household sizes up to three people, and plateaus on four and five person household sizes. The reason for this may be that again, larger households tend to have higher incomes, and can afford the auction process where two-person households and single people may not.

5.1.4 Car Ownership

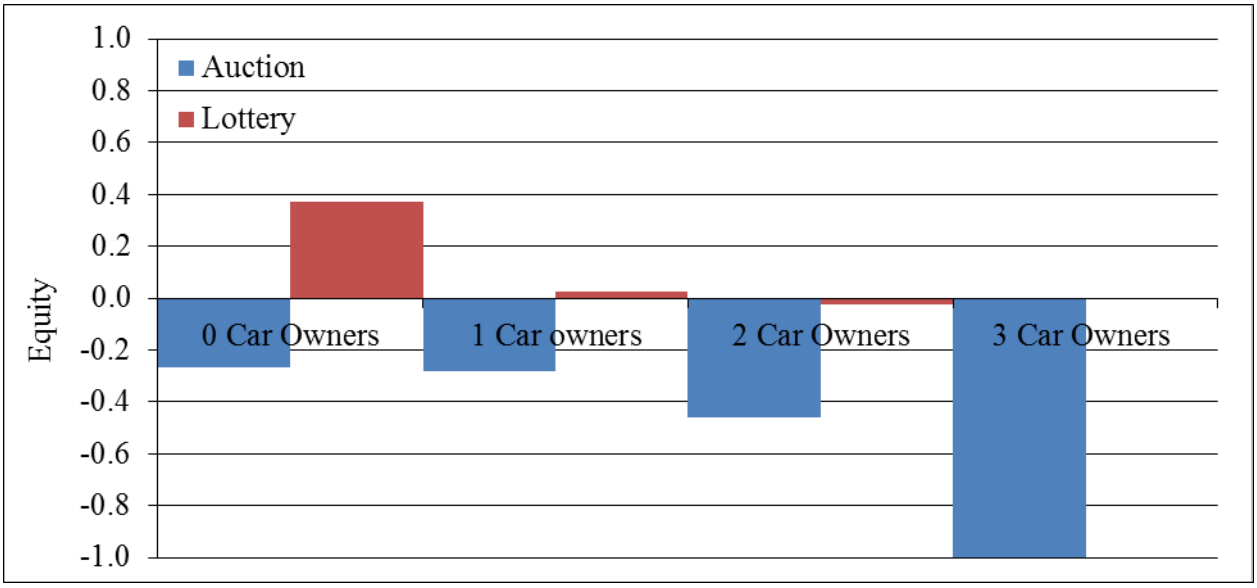


Figure 5-5: Equity vs. Car Ownership

From the plots above, it can be seen that as the number of cars increase within a household, the average equity values for the auction process diminish significantly. One possible reason for this may be that people with more cars tend to not be very rushed to get another one, and would rather go through the lottery process to avoid paying a fee for a new license plate, even though the chances of winning is low. Average lottery equity values are reduced between one to two cars, but relatively constant between two to four cars. One reason for the drop in support for the lottery option, for people who own more than one car, may be that again since people with more than one car typically have higher incomes, they would rather go through the auction process and pay, which will guarantee that they receive a new license plate.

5.1.5 Education Level

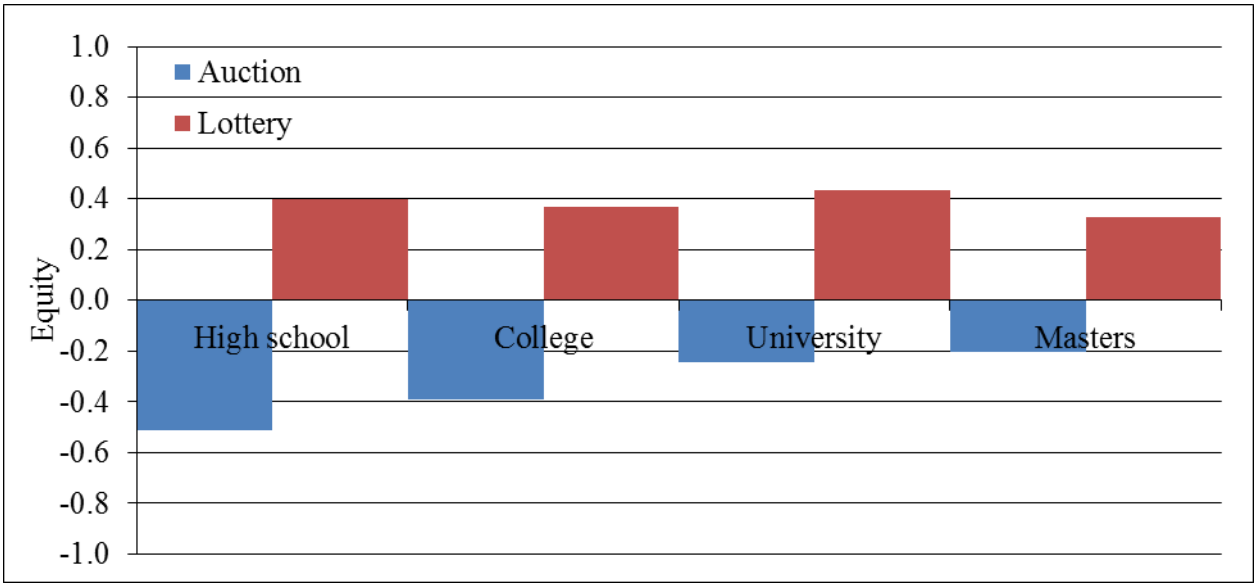


Figure 5-6: Equity vs. Education Level

The average equity values with regards to the auction process increase with higher education levels. This may be due to the fact that people with higher education levels are more likely to have higher incomes as well, and therefore they are more likely to pay through the auction. With regards to the lottery process, the average equity values are relatively constant among all education levels. The reason for this may be because the lottery is a free process, and economic factors do not play a factor between the different education levels.

5.1.6 Type of Residence

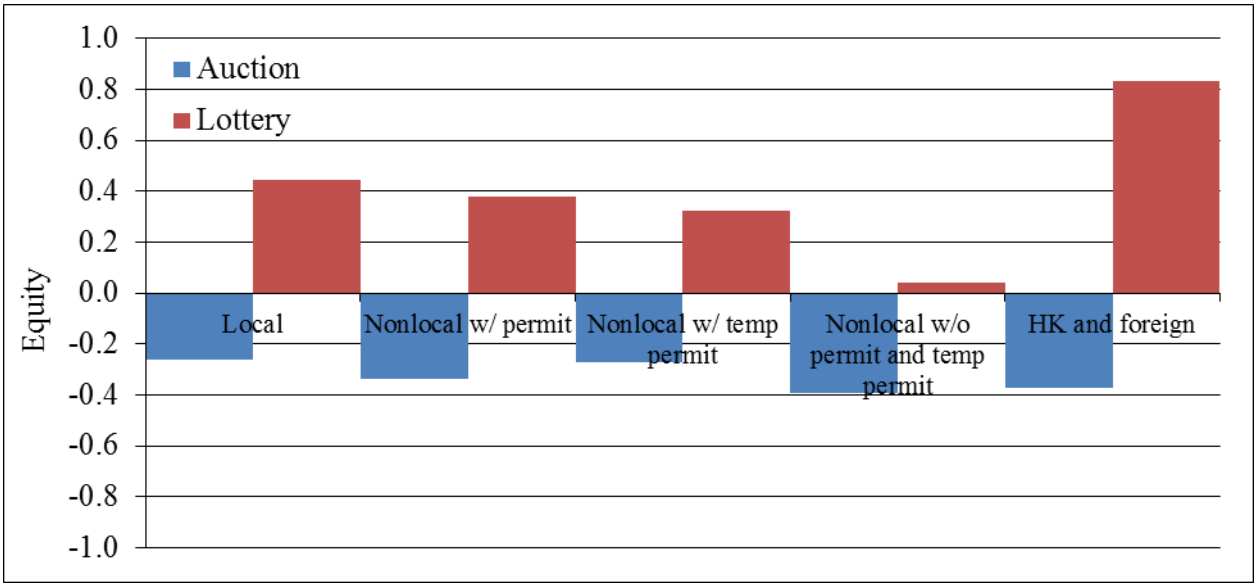


Figure 5-7: Equity vs. Type and Residence

The average equity values with regards to the lottery process generally high for local, Nonlocal without permit or temporary permit, and Nonlocal with permit, and highest for Hong Kong residents and foreigners. With regards to the auction process, the average equity values are higher for local and for non-locals with permit, although relatively constant between all residences.

5.1.7 Kids

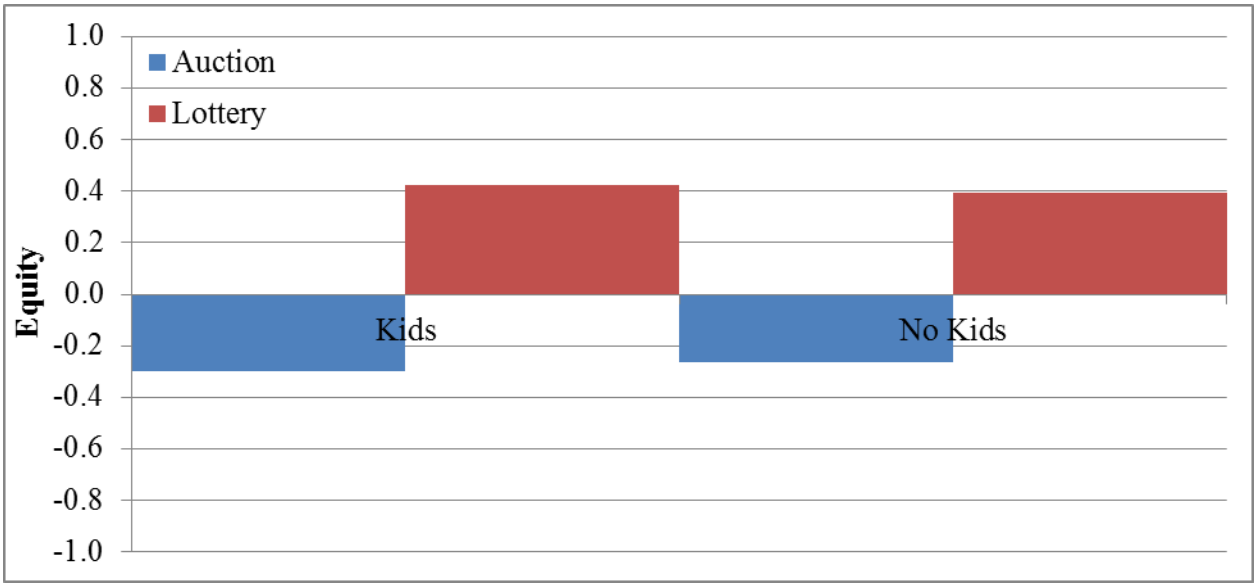


Figure 5-8: Equity vs. Kids

There is not a significant difference in the equity of the policy between people who have kids and those you do not.

5.1.8 Time to Work

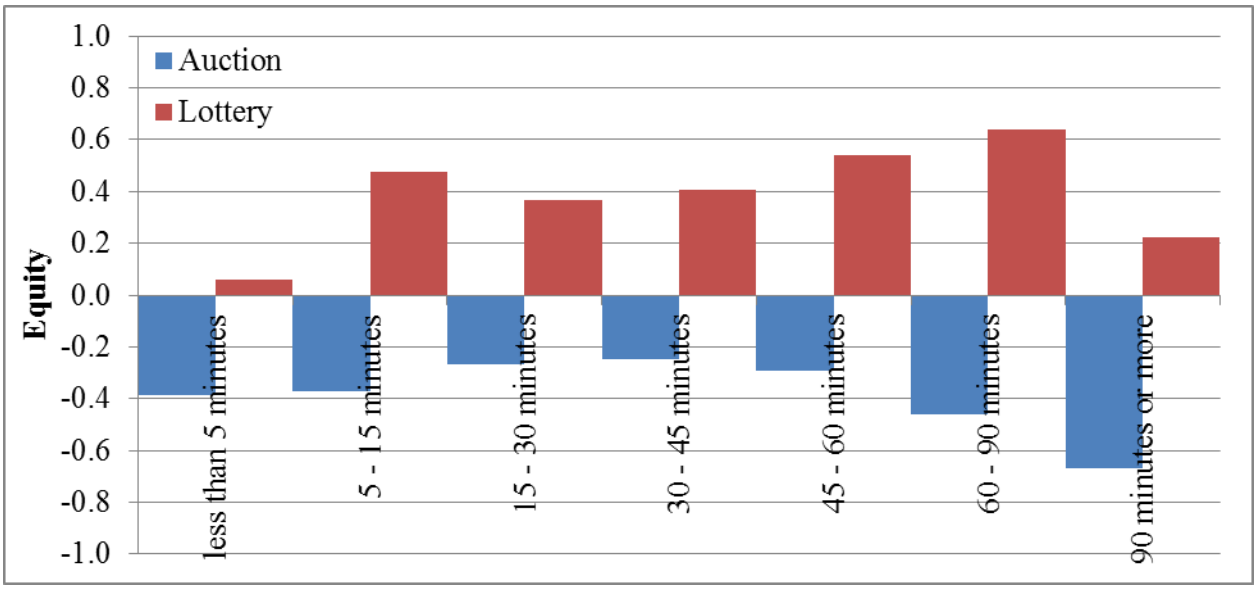


Figure 5-9: Equity vs. Travel Time to Work

There is an increased equity for lottery as the commute time increases, and along with that there is a decrease in the equity for auction. This may be because those with a longer commute time are

more likely to be the ones with lower income and no car, and therefore they are hoping to purchase a car in order to shorten their commuting time, preferably through the lottery process which is cheaper.

5.1.9 Percent Car Trips

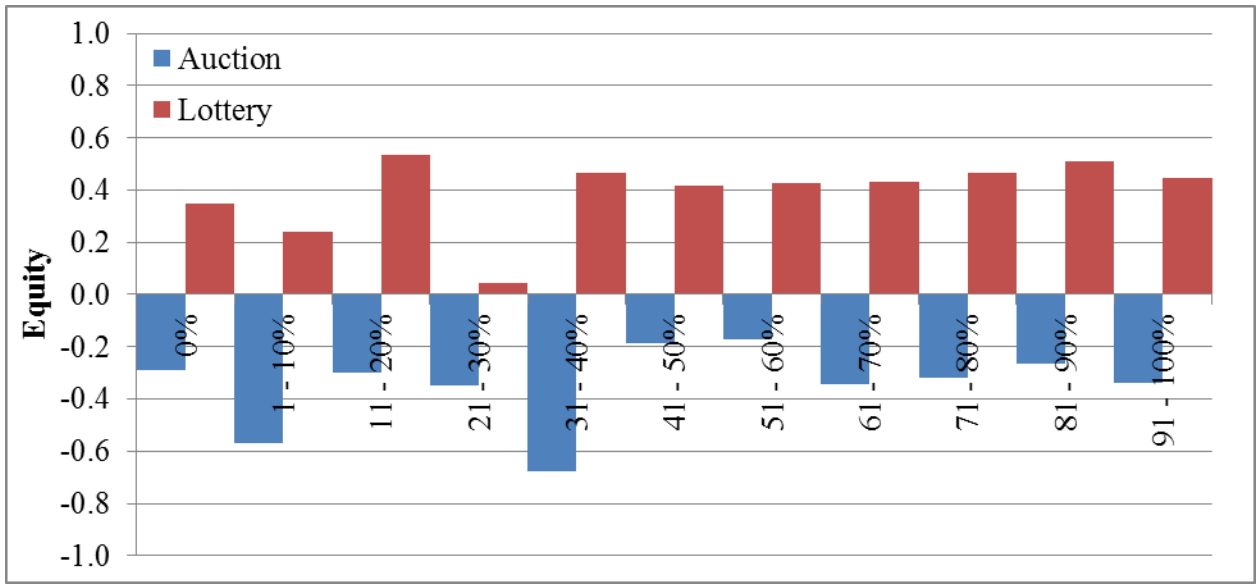


Figure 5-10: Equity vs. Car Usage

With regards to car usage, the average auction and lottery equity values seem to be fairly constant, although the lottery equity slightly increases and the auction equity slightly decreases with increasing car usage. One reason for the increase in lottery and decrease in auction equities may be that people who already use a car for most of their trips are less rushed to purchase a new car, and therefore the lottery option is favorable to them, since it is free but not guaranteed.

5.1.10 District of Residence

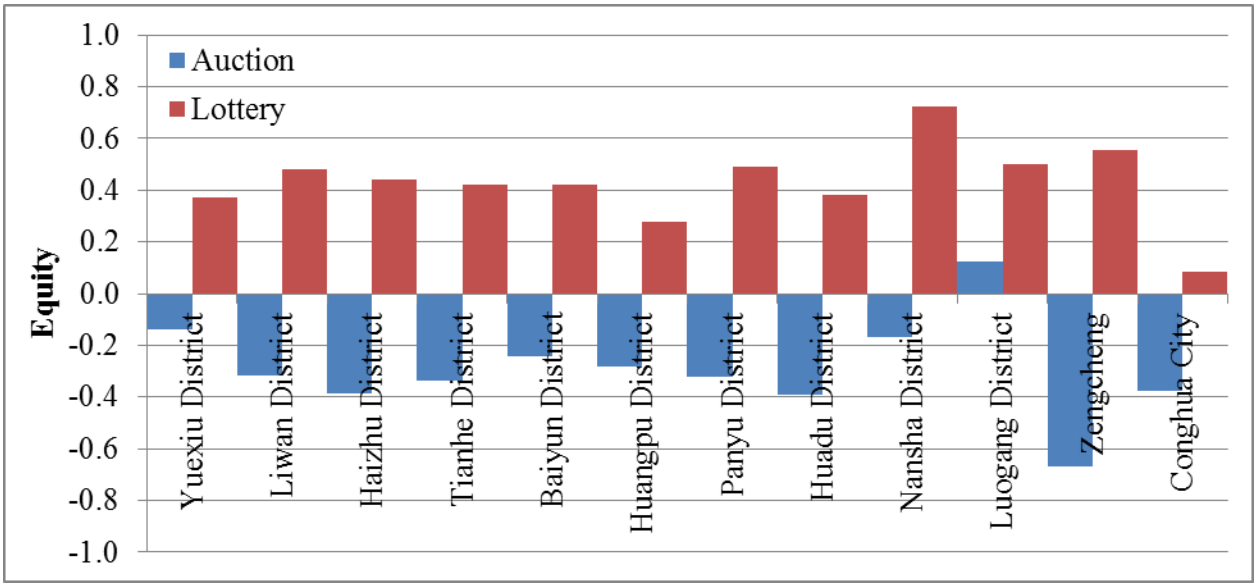


Figure 5-11: Equity vs. Place of Residence

There is not a strong variation in the equity of the lottery with regards to place of residence. It seem that in the Luogang District, the equity is positive toward both the lottery and the auction, although the confidence in this result is low as there was only 4 respondents from that district.

Figure 5-12: Equity and General Districts

With regards to general districts, the equity values are relatively constant for the central and new districts, while there is a lower lottery and auction equity for country-level cities.

5.1.11 Income

The income is recorded in Yuan (¥) per month

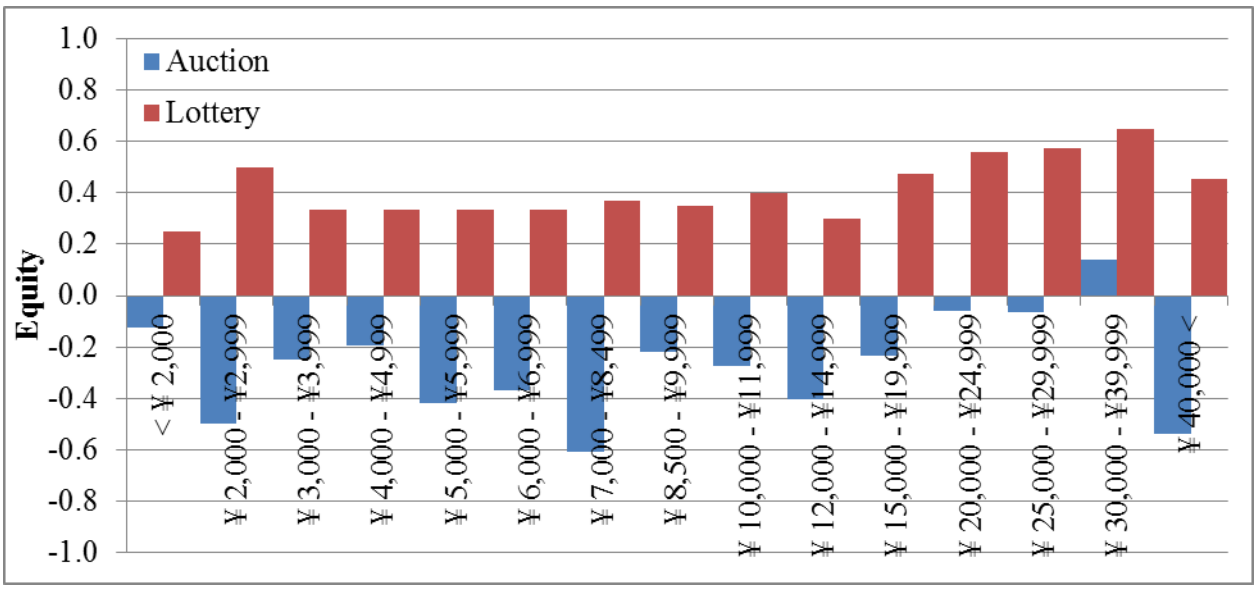


Figure 5-13: Equity vs. Income

As displayed in Figure 5-13, there is a stronger sense of equity related to the auction as incomes go beyond ¥15,000 per month, which makes sense as higher income citizens can more easily afford the auction process. Equity of the lottery also increases as income rises, although the reason for this is difficult to determine.

5.2 Summary of Regression Analysis

Table 5-1: Summary of Regression Analysis

Summary of Regression Analysis				
	Auction		Lottery	
Indep. Var	**T - Stat**	**P-value**	**T - Stat**	**P-value**
Age	0.62	0.536	0.69	0.490
Household Size	-0.14	0.886	-2.52	0.012
Car ownership	-0.99	0.323	-1.58	0.115

Education Level	2.49	0.013	1.00	0.317
Residence	-1.16	0.245	4.47	$9.7x10^{-6}$
Kids	1.68	0.091	3.23	0.0013
Time to Work	0.066	0.94	2.18	0.030
Percentage of Car Trips	-0.12	0.90	2.39	0.023
District	-0.87	0.39	-0.15	0.88
Income	1.89	0.059	2.66	0.0081

Regression analysis was performed on the main independent variables, including age, household size, car ownership, education level, and residence. The variables that showed high correlation ($t > 2.0$) to equity were household size, residence, kids, time to work, percentage of car trips, and income with respect to lottery equity, and education level with respect to auction equity. Therefore, there seems to be a high level of correlation between the lottery equity and the demographic and socioeconomic factors, and not much correlation between the auction equity and the same independent variables.

5.3 Acceptance Variation

The acceptance variation was checked among all the social-economic indicators, including age, gender, having children, household size, education, household income, residence type, residence time, and car ownership. According to ANOVA test at 95% confidence level, only the residence type, i.e born in Guangzhou or not, was found to yield a significant result. The average acceptance level towards the policy for people who was born and not born in Guangzhou was respectively 0.30 and 0.12. This implies that both groups have marginal acceptance toward the policy and

people who was born in Guangzhou has a higher level of acceptance. The complete ANOVA table is presented in Appendix B.

5.4 Preference

This section will look at the preferences for the car ownership policy, and examine the equity of the auction and lottery as it relates to the following preferences: method, ratio, quota, price, and waiting time.

5.4.1 Chosen Method

Figure 5-14: Equity vs. Chosen Method

From the above figure, it can be concluded that those with the strongest sense of inequity, for both the lottery and the auction options, will choose to bypass the policy and obtain a non-local license.

5.4.2 Lottery-Auction Ratio

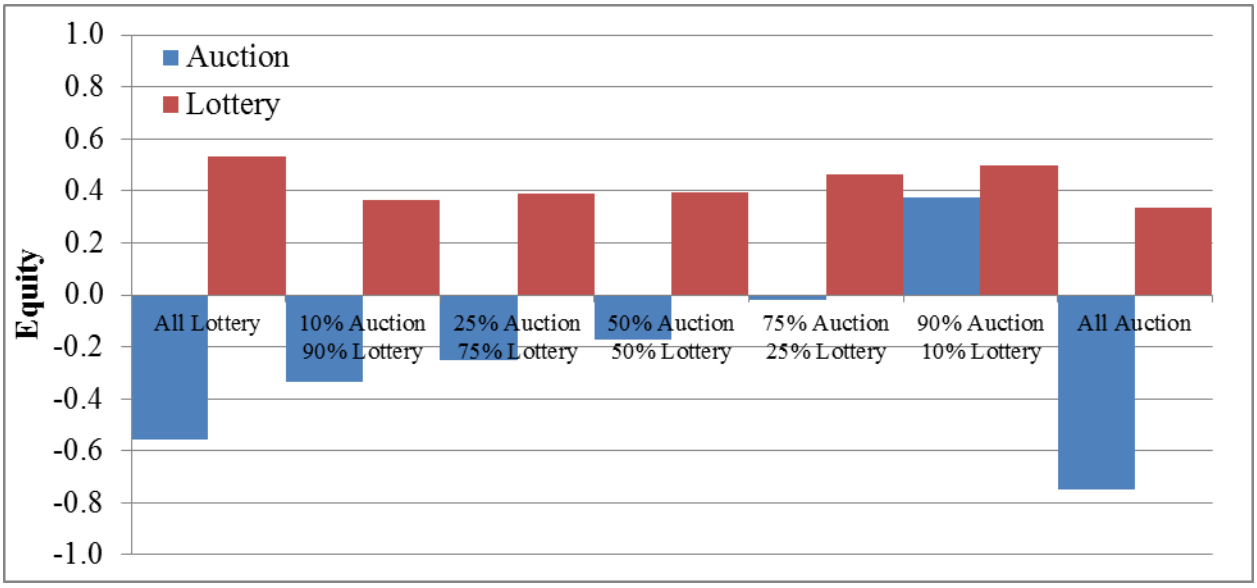


Figure 5-15: Equity and Preferred Lottery-Auction Ratio

As expected, those who prefer that there be a large portion of the quota dedicated to the auction process feel that it is more equitable. What is not expected is the fact that those who prefer the policy to be all auctions feel that the auction is less equitable.

5.4.3 Quota

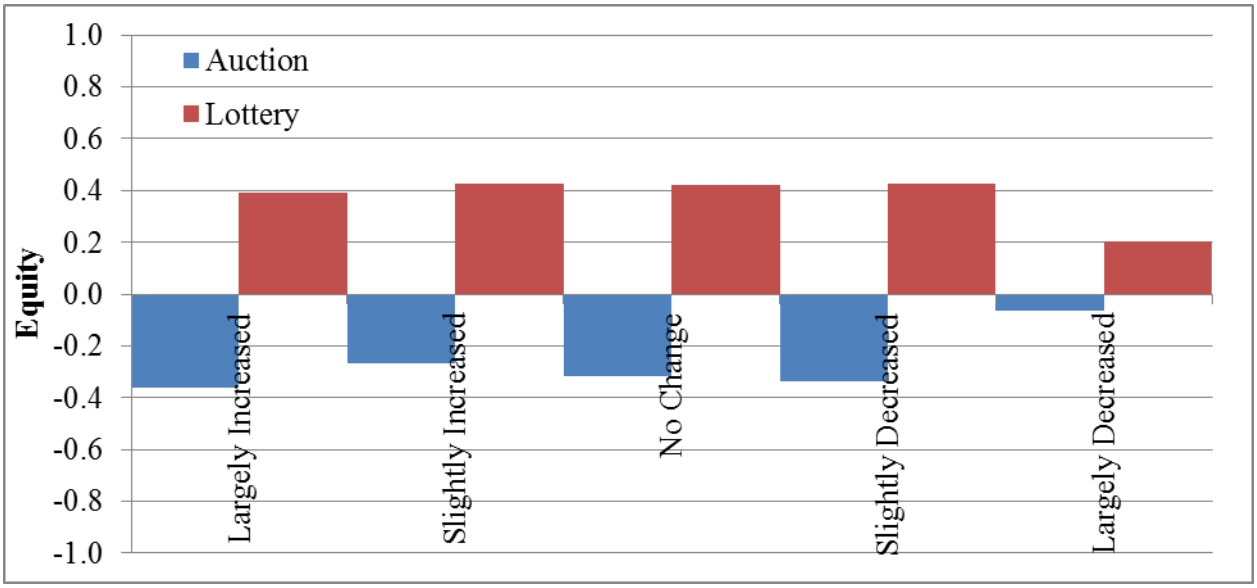


Figure 5-16: Equity and Quota of Licenses Available

The preferences with regards to the quota are depicted in figure 5-16 above.

5.4.4 Price

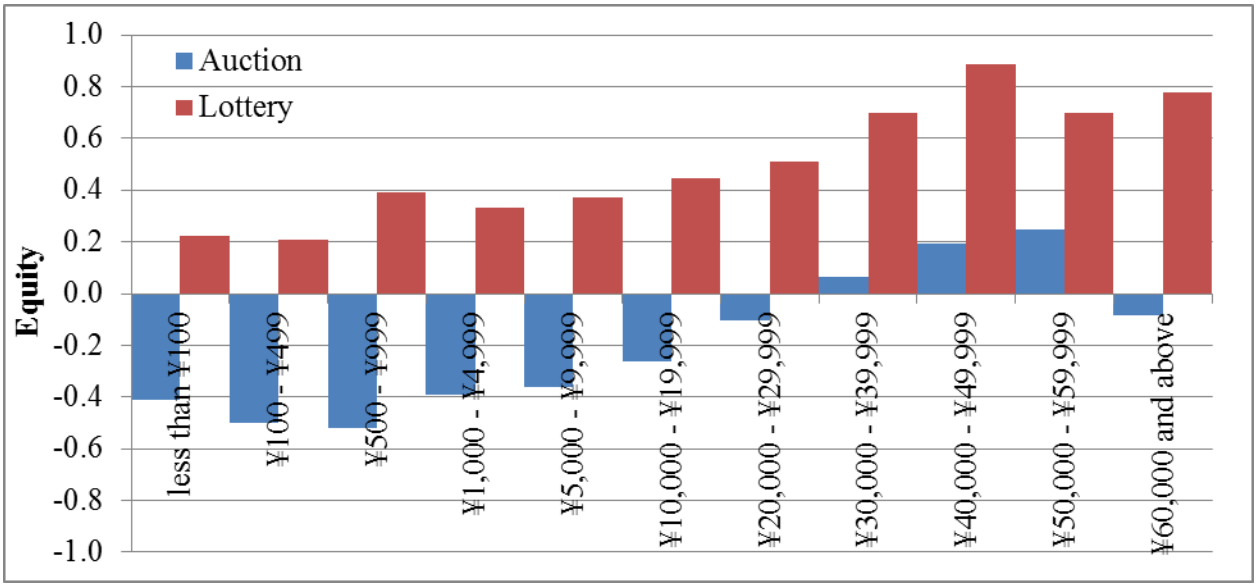


Figure 5-17: Equity and Acceptable Price of License at Auction

Based on figure 5-17, the more equitable the auction is for people, the more they are willing to pay to get a license through auction as expected. Also with the increase in the willingness to pay, there is also an increase in the equity of the lottery, so it seems like those with a higher willingness to pay feel that the overall policy is equitable.

5.4.5 Waiting Time

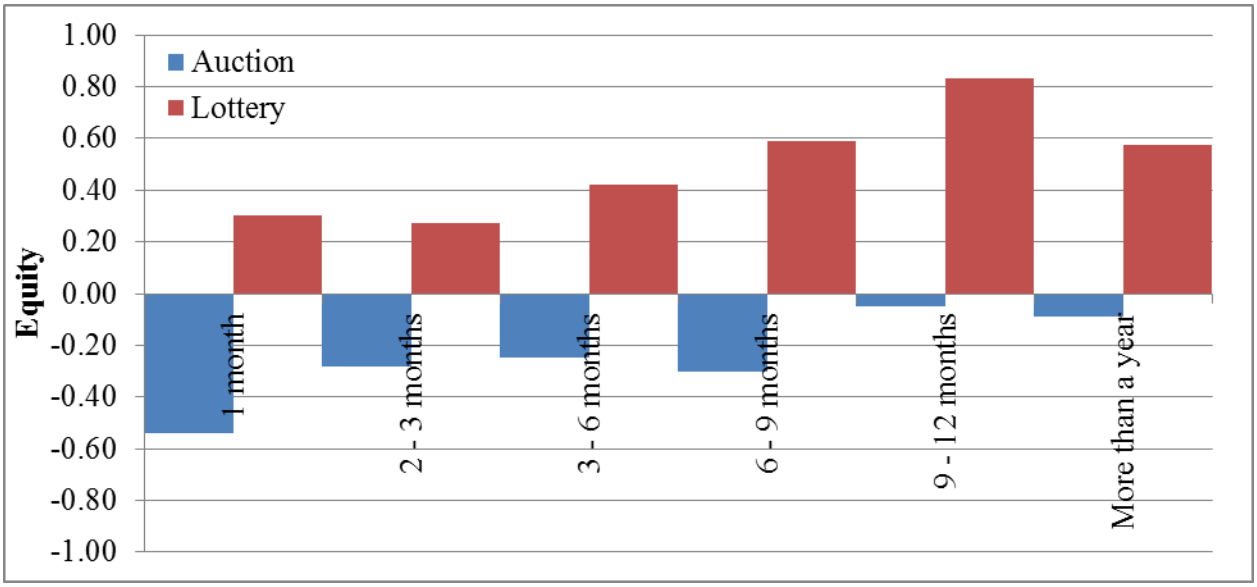


Figure 5-18: Equity and Acceptable Waiting Time for Lottery

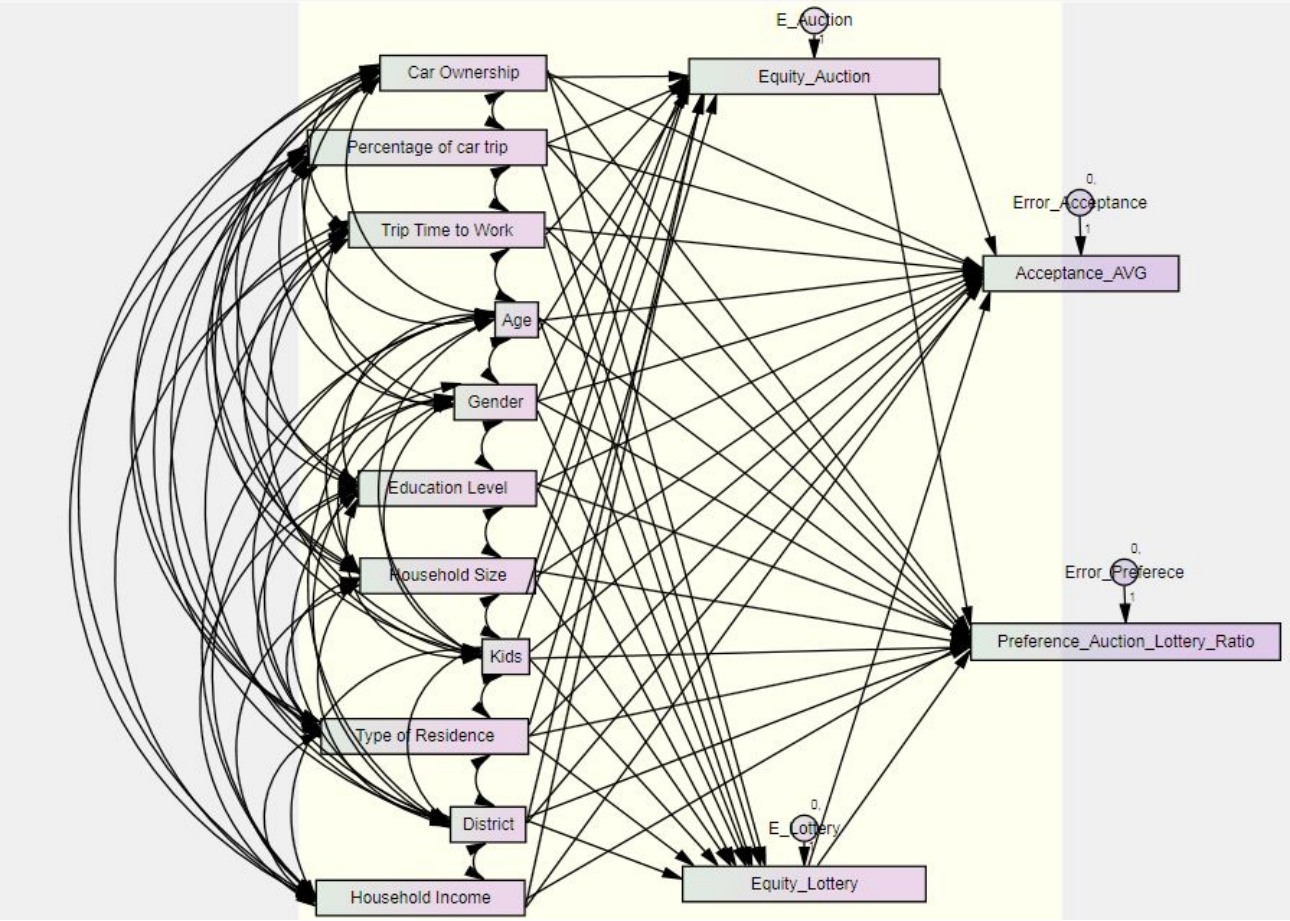
As shown above, those that are willing to wait longer to receive their licence feel the lottery and the auction are more equitable.

5.5 Structural Equation Model

5.5.1 Control Model

To assess the correlations between the demographic, equity, acceptance, and preference indicators, a structural equation model (SEM) has been constructed. The SEM acts as a series of multiple regressions and also allows assessment of the correlations between independent variables. The program used for the SEM analysis is SPSS AMOS. The SEM is constructed with four parts, respectively assessing the relations of (1) demographic to equity indicators, (2) demographic to acceptance and preference indicators, (3) equity to acceptance and preference indicators, and (4) demographic indicators amongst themselves. Initially, it was attempted to construct a SEM with all four parts; this model was purposely complex and was only to be used as a control model

primarily for previewing the correlations amongst variables. The control model is labeled as Model 1 and is shown below:



Model 1: Control Model

5.5.1.1 Control Model - Analysis

As depicted by Model 1, all indicator variables have been included in the model. Due to the completeness, the model was not expected to have a satisfactory goodness of fit or acceptable degree of error. After running the model, the program indicates that the model does not adequately fit according to Chi-square statistics but however has an acceptable Root Mean Square Error of Approximation (RMSEA). The Chi-square statistical probability level and RMSEA are 0.180 and 0.037 respectively. A complete analysis is provided in Appendix A.

In this model, each of the arrows between any two variables indicates an assumption. A one-way directional arrow indicates an assumed causal relationship and a two-way directional arrow indicates a correlation. Note that the causal relationships are only assumed to be such for this model; in reality, this model is insufficient to prove the causality. The Chi-square statistic tested the observed data with the expected data according to these specified assumptions. Based on the obtained Chi-square probability level of 0.180, the test is insufficient to reject the null hypothesis at the 0.05 confidence. Therefore, although the Chi-square probability level is not exceptional, it allows the assumptions made in this model to be temporarily accepted for further analysis purposes. Also, the RMSEA is 0.037, indicating a good fit of the data.

5.5.1.2 Control Model - Result

The observed estimates obtained from AMOS are assessed based on 95% confidence level. Any relations with a Probability of greater than 0.05 are rejected due to non-confidence. In other words, any relations with a Probability of less than 0.05 are failed to be rejected. Based on these governing definitions, the following causal relations are failed to be rejected:

<u>Part (1) Demographic with Equity Indicators:</u>

- Education Level → Equity of Auction (Average)
- Have kids → Equity of Lottery (Average)

<u>Part (2) Demographic with Acceptance and Preference Indicators:</u>

- Gender → Acceptance (Average)
- Car Ownership → Preference
- Percentage of car trip → Preference

Part (3) Equity with Acceptance and Preference Indicators:

- Equity of Auction (Average) → Acceptance (Average)
- Equity of Lottery (Average) → Acceptance (Average)
- Equity of Auction (Average) → Preference
- Equity of Lottery (Average) → Preference

Table 5-2 summarizes their estimate, standard error, z-stat, and probability level in detail. It can be seen that only a limited number of causal relations, especially those in part (1) and (2), can be concluded. This indicates that most of the demographic indicators cannot be concluded to have a linear causal relationship with the dependent variables. This may be due to the discrete nature of the demographic indicator, i.e. the choices for the demographic indicators are discrete and have no directions. Such discrete nature may cause the relations to be non-linear. For example, at first it was assumed that the household income would have a positive linear relation with the perception of the equity of the auction. However, the individual analysis presented in Section 5.2 indicated that the assumed positive relation was not correct and was in fact non-linear. Therefore, it can be seen that almost all demographic indicators behave like such and have to be eliminated due to non-confidence.

Table 5-2: SEM Regression Estimates

Dependent		Independent	Estimate	S.E.	C.R.	P
Equity_Auction	<---	Education Level	0.080	0.039	2.043	0.041
Equity_Lottery	<---	Kids	0.046	0.020	2.301	0.021
Acceptance_AVG	<---	Gender	-0.038	0.017	-2.266	0.023
Preference_Auction_Lottery_Ratio	<---	Car Ownership	-0.077	0.037	-2.074	0.038

Preference_Auction_Lottery_Ratio	<---	Percentage of car trip	0.084	0.045	1.876	0.061
Acceptance_AVG	<---	Equity_Auction	0.568	0.049	11.680	***
Preference_Auction_Lottery_Ratio	<---	Equity_Auction	0.209	0.054	3.856	***
Acceptance_AVG	<---	Equity_Lottery	0.385	0.051	7.590	***
Preference_Auction_Lottery_Ratio	<---	Equity_Lottery	-0.108	0.057	-1.909	0.056

5.5.1.3 Control Model - Discussion

Based on the obtained result discussed in the earlier part, this section discusses the possible interpretations of the relations.

Part (1):

- Education Level to Equity of Auction: positive relation, indicating that people with higher level of education tend to perceive the auction of the car ownership policy to be fairer.
- Have Kids to Equity of Lottery: positive relation, indicating that people with kids tend to perceive the lottery of the car ownership policy to be fairer.

Part (2):

- Gender to Acceptance: negative correlation, indicating that females tend to perceive the car ownership policy to be more acceptable.
- Car Ownership to Preference: negative correlation, indicating that people who already own a car tend to prefer lottery over auction and vice versa.
- Percentage of Car Trip to Preference: positive correlation, indicating that people who use their car more tend to prefer auction over lottery.

Part (3):

- Equity of Auction to Acceptance: positive correlation, indicating that people who perceive the auction to be more fair also tend to perceive the car ownership policy to be more acceptable.

- Equity of Lottery to Acceptance: positive correlation, indicating that people who perceive the lottery to be more fair also tend to perceive the car ownership policy to be more acceptable.

- Equity of Auction to Preference: positive correlation, indicating that people who perceive the auction to be fairer tend to prefer auction over lottery.

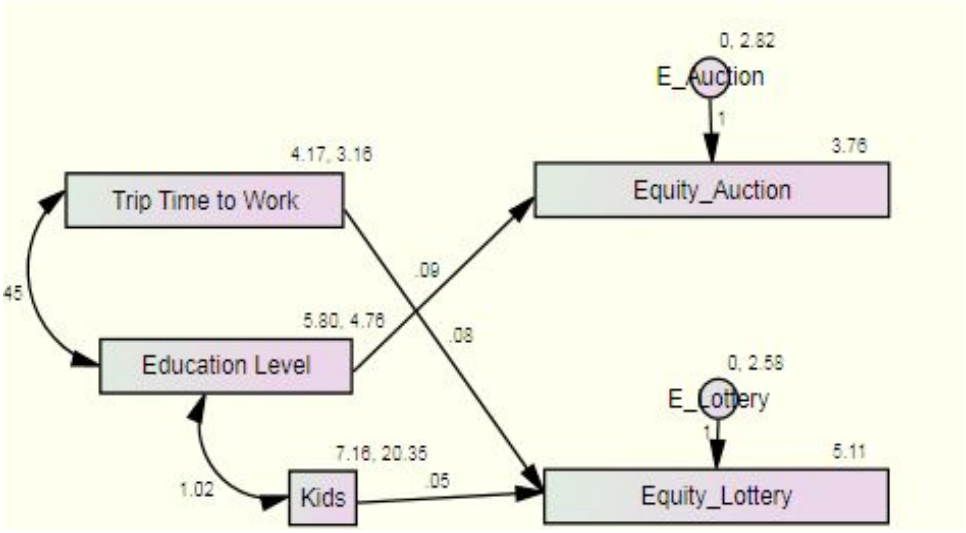
- Equity of Lottery to Preference: negative correlation, indicating that people who perceive the lottery to be fairer tend to prefer lottery over auction.

Note that part (4) of this data is not presented here. The correlations amongst the demographic variables are mostly intuitive and are therefore tedious (for example, people with more kids have a larger household size) to be in this thesis being focused on the car ownership policy. However, these correlations still allow analyzers to explore the combined effect of the indicators. For example, car ownership and the percentage of car trip are highly correlated; however car ownership is negatively related with preference but percentage of car is positively related with preference. The combined effects may promote, hinder, or neutralize one other if being considered together.

In summary, this model provides a generalized overview of all the observed indicators. Attempts were then made to improve the Chi-square goodness of fit by eliminating relations that do not make logical sense. Model 2 and 3 are therefore created based on Model 1.

5.5.2 Model 2 – Demographics to Equity

Model 2 is downsized from the model to assess the causal relation between the demographic and equity indicators. Relations that had insignificant level of confidence in the control model are excluded here. The flow of model 2 is shown below. As can be seen, almost all demographic indicators have been eliminated and only trip time to work, education level, and have kids are still significant at the 0.05 confidence level.



Model 2: Demographics vs. Equity

The Chi-square probability level of Model 2 is only 0.067. In addition, the RMSEA of the model is 0.048. Therefore this model has a poorer overall fitness than Model 1. This indicates that although some of the demographic indicators are related with the perception of equity, acceptance, and preference, overall they have a poor fit in the model. In other words, the observed data deviates significantly from the expected result (i.e. the assumptions made in the model).

When simple regressions were conducted (see Section 5.2), several other demographic indicators were determined to have significant confidence level. However in this multiple regression, only kids, education level, and trip time to work remained significant. There implies that demographics variables (those that were significant in simple regressions but not in multiple regression) do not

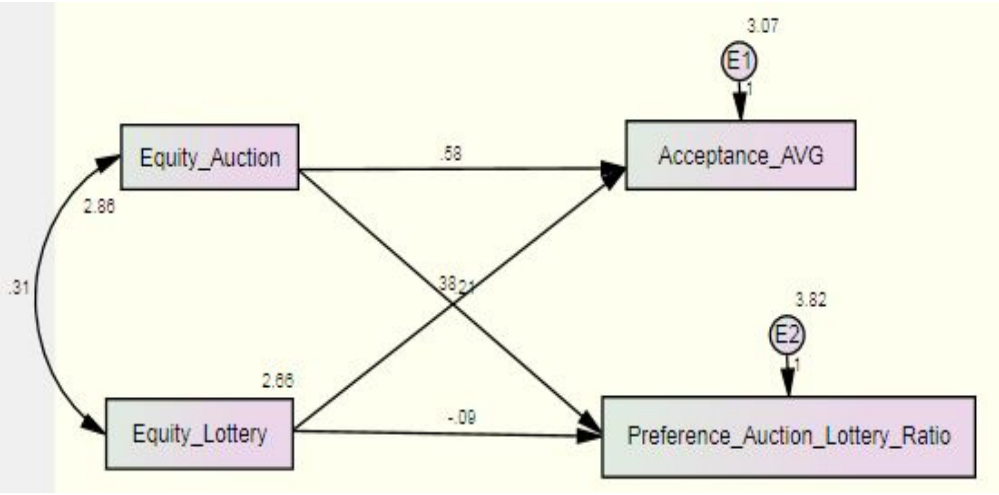
directly influence the dependent variables. Rather, they are correlated with one of kids, education level, or trip time to work, which then influence the dependent variables.

More modifications to the model should be done to improve the overall fitting. If possible, different combinations of variables or non-linear relations should be tested. It is insufficient to conclude the exact relations between the demographic and dependent indicators.

5.5.3 Model 3 – Equity to Acceptance and Preference

5.5.3.1 Results

Model 3 is also a downsized model derived from the control model. This model is developed to assess the causal relation of the equity indicators to the acceptance and preference indicators. The flow of model 3 is shown below:



Model 3: Equity vs. Acceptance and Preference

The Chi-square probability level of Model 3 is 0.994. In addition, the RMSEA of the model is 0.000. Therefore this model has an excellent overall fit. This indicates that the observed data highly fits the assumptions. In other words, the observed data does not deviate from the expected result. The regression weights for this model are presented below:

Table 5-3: Regression Estimates

			Estimate	S.E.	C.R.	P
Acceptance_AVG	<---	Equity_Auction	.576	.049	11.796	***
Preference_Auction_Lottery_Ratio	<---	Equity_Auction	.208	.055	3.805	***
Preference_Auction_Lottery_Ratio	<---	Equity_Lottery	-.094	.056	-1.666	.096
Acceptance_AVG	<---	Equity_Lottery	.383	.051	7.565	***
Equity_Auction	<-->	Equity_Lottery	.314	.130	2.418	.016

As shown, the regression weight, direction, and significant confidence level are almost identical to those shown in Model 1. However, the perception of equity of lottery is no longer in relation with preference at the 0.05 confidence level.

5.5.3.2 Discussion of Model 3

The results of this model are almost identical to that of model 1. The equity of the auction and lottery are both positively correlated with acceptance; in other words, people who perceive the auction and/or lottery to be fairer also tend to perceive the car ownership policy to be more acceptable. In addition, it is important to note that the auction has a higher regression than that of lottery. In other words, changing people's perception of the fairness of auction is more sensitive relative to people's perception of the fairness of lottery. Therefore, policy makers must allocate more resources towards improving people's perception of the auction process, in order to improve the overall public acceptance of the hybrid policy. With regards to preference, the regression coefficient of the equity of auction is also greater than that of the equity of lottery. This implies that the preference toward the auction is more sensitive to the perceived fairness of auction. In addition, since currently the average perceived fairness of auction is lower than that of lottery, improvements to the fairness of the auction is potentially more favorable. Thus, for policy makers

to shift the public's preference from lottery to auction, resources should be allocated in making the auction fairer.

Lastly it is also important to note that the equity of the auction and lottery are positively correlated. This is an interesting phenomenon; it implies that potentially a value-added effect may exist when the perception of auction or lottery is altered. For example, when one of the two perceived equity is improved/hindered, the other might also change correspondingly. Thus the modification of one part of the policy might have compounded overall effect.

6. Impact and Policy Implications

From the results of this study, there are several conclusions and policy implications that can be discussed. First of all, there is marginal acceptance of the policy as a whole, and it is apparent that the lottery portion of the policy is seen by the public as more equitable in comparison to the auction portion of the policy. This was verified both through the linear regression analysis, as the average equity values for the lottery were positive and higher than the auction in all cases, and also through the SEM model, which showed a higher average equity for the lottery as well. A modification to the car ownership policy could be to increase the amount of cars allotted to the lottery as people generally see that as more equitable. Along with the lottery, new energy cars also received strong support, and an increase in the amount of new energy cars available within the quota may make the policy as a whole more acceptable.

Also as was stated in Section 5.4.3.2, the fairness of the auction is more sensitive relative to the fairness of the lottery. The acceptance and preference are also influenced more by people's perception of the fairness of the auction than lottery. Therefore, policy makers should take careful consideration when allocating resources toward the auction and lottery. Ideally, resources should be allocated more toward improving the image of the fairness of the auction option.

7. Limitation

This study contains various limitations in its methodology. Also it is important to note that the derived results are based on various assumptions stated discretely in earlier sections of this thesis. Thus the presented results may only hold valid if the assumptions remain valid. Careful considerations should be taken when generalizing the results obtained from this research to a broader scope. This section hence outlines and summarizes the limitations of this research.

7.1 Limitations of the Data

The data are based on 457 respondents collected in Guangzhou 6 months after the implementation of the policy. The maturity of the perceptions is unknown; thus the perceived fairness, acceptance, and preference may still be at the adaptive stage and may be less sensitive as time progresses.

Also, although the sample size attempted to contain a similar demographic distribution as the census data, the sample is not fully representative. The weighting scheme, IPF, was attempted to weight the sample into similar demographic distribution as the population of Guangzhou. The weighting factor for each respondent was found but however was not applied. This is primarily due to the lack of confidence in generalizing the sample into the population. During the weighting process it was determined that one sample had a weighting factor of 38, which is 8% of the entire sample size. If the weighting factor had been applied, this sample would have represented 37 other arbitrary individuals. However, no evidence can prove that the other 37 individuals in the population would behave and respond in identical manners as the sample. Therefore, applying the weighting scheme to the current dataset would be incautious and was thus not used.

In addition, all responses in the questionnaire were designed to have directional or discrete choices. Directional choices often contain a set of answers from “strongly negative”, “somewhat negative”, “neutral”, “somewhat positive”, to “strongly positive”. Each of these choices, after quantification,

has constant intervals amongst its adjacent ones. In reality however, people have unique perceptions of the policy and may not perceive each choices to be the exact match of their perception. For example, in the data processing, “strongly negative”, “somewhat negative”, and “neutral” are respectively -2, -1, and 0, with an interval of 1; the respondent however may perceive “somewhat negative” at -1.4 or -0.5 but is still considered to be -1.0. This therefore leads to a mismatch of the real perception with the quantified perception.

7.2 Limitations of Analysis

Linear regression and structural equation models were used to assess the correlations between the indicator variables. These analyses assumed that the correlations are of linear relations. In reality this is almost never the case. This also explains the difficulties in relating demographic indicators to equity, acceptance, and preference. In fact, as was presented in the Result Section, most demographic indicators depicted no significant linear relation with the dependent variables. Some demographic indicators, such as household income, even showed a bi-modal distribution. Therefore, the linear regression models, especially those including the demographic indicators, are mostly to assess the direction of the relation rather than the actual influence.

In conclusion, further studies should be conducted with more considerations taken into accounts for these limitations.

REFERENCE

Börjesson, Maria et al. "The Stockholm Congestion Charges—5 Years on. Effects, Acceptability and Lessons Learnt." *Transport Policy* 20 (2012): 1–12. Web. 1 Mar. 2013.

Chen, X., & Zhao, J. (2013). Bidding to drive: Car license auction policy in Shanghai and its public acceptance. *Transport Policy*, *27*, 39–52.

Chin, A., & Smith, P. (1997). Automobile ownership and government policy: The economics of Singapore's vehicle quota scheme. *Transportation Research Part A: Policy and Practice*, *31*(2), 129–140.

Evans, M. (2009). Policy transfer in critical perspective. *Policy Studies*, *30*(3), 243–268.

Feng, S., & Ma, Z. (2010). Performance analysis on private vehicle plate auction in Shanghai. *6th Advanced Forum on Transportation of China (AFTC 2010)*, 6–12.

Gaunt, Martin, Tom Rye, and Simon Allen. "Public Acceptability of Road User Charging: The Case of Edinburgh and the 2005 Referendum." *Transport Reviews* 27.1 (2007): 85–102. Web. 1 Mar. 2013.

Goetzke, Frank, and Rachel Weinberger. "Separating Contextual from Endogenous Effects in Automobile Ownership Models." *Environment and Planning A* 44.5 (2012): 1032–1046. Web. 3 Mar. 2013.

Hao, H., Wang, H., & Ouyang, M. (2011). Comparison of policies on vehicle ownership and use between Beijing and Shanghai and their impacts on fuel consumption by passenger vehicles. *Energy Policy*, *39*(2), 1016–1021.

Polski, M. M., & Ostrom, E. (1999). An Institutional Framework for Policy Analysis and Design, 1–49.

Xu, H., Sui, J., & Huang, S. (2012, July 1). *Guangzhou limiting car purchase from the first day of this month, monthly quota being 10,000*. Retrieved April 8, 2013, from Sohu: http://auto.sohu.com/20120701/n346987364.shtml

APPENDIX A – SEM RESULT

Model 1 - SEM Analysis – Estimate Result:

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P
Equity_Auction	<---	Car Ownership	-0.021	0.032	-0.655	0.512
Equity_Auction	<---	Percentage of car trip	-0.023	0.038	-0.61	0.542
Equity_Auction	<---	Trip Time to Work	-0.031	0.046	-0.673	0.501
Equity_Auction	<---	Age	0.076	0.07	1.08	0.28
Equity_Auction	<---	Education Level	0.08	0.039	2.043	0.041
Equity_Auction	<---	Household Size	-0.028	0.038	-0.737	0.461
Equity_Auction	<---	Kids	0.027	0.021	1.273	0.203
Equity_Auction	<---	Type of Residence	-0.012	0.028	-0.44	0.66
Equity_Auction	<---	District	0	0.038	0.012	0.99
Equity_Auction	<---	Household Income	0.06	0.051	1.178	0.239
Equity_Lottery	<---	Car Ownership	0.003	0.031	0.099	0.921
Equity_Lottery	<---	Percentage of car trip	0.017	0.036	0.478	0.633
Equity_Lottery	<---	Trip Time to Work	0.071	0.044	1.624	0.104
Equity_Lottery	<---	Age	0.051	0.067	0.764	0.445
Equity_Lottery	<---	Gender	0.009	0.016	0.55	0.582
Equity_Lottery	<---	Education Level	0.024	0.036	0.667	0.505
Equity_Lottery	<---	Household Size	-0.032	0.036	-0.866	0.386
Equity_Lottery	<---	Kids	0.046	0.02	2.301	0.021
Equity_Lottery	<---	Type of Residence	-0.026	0.026	-1.023	0.306
Equity_Lottery	<---	District	0.035	0.037	0.963	0.336
Equity_Auction	<---	Gender	-0.005	0.016	-0.337	0.736
Acceptance_AVG	<---	Car Ownership	-0.031	0.033	-0.927	0.354
Acceptance_AVG	<---	Percentage of car trip	0.022	0.04	0.543	0.587
Acceptance_AVG	<---	Trip Time to Work	0.021	0.048	0.44	0.66
Acceptance_AVG	<---	Age	-0.036	0.073	-0.49	0.624
Acceptance_AVG	<---	Gender	-0.038	0.017	-2.266	0.023
Acceptance_AVG	<---	Education Level	0.041	0.041	0.992	0.321
Acceptance_AVG	<---	Household Size	-0.024	0.04	-0.613	0.54
Acceptance_AVG	<---	Kids	-0.005	0.022	-0.209	0.834
Acceptance_AVG	<---	Type of Residence	-0.013	0.029	-0.455	0.649
Acceptance_AVG	<---	District	-0.04	0.04	-1.015	0.31

Acceptance_AVG	<---	Household Income	-0.018	0.053	-0.336	0.737
Preference_Auction_Lottery_Ratio	<---	Car Ownership	-0.077	0.037	-2.074	0.038
Preference_Auction_Lottery_Ratio	<---	Percentage of car trip	0.084	0.045	1.876	0.061
Preference_Auction_Lottery_Ratio	<---	Trip Time to Work	0.076	0.053	1.423	0.155
Preference_Auction_Lottery_Ratio	<---	Age	-0.022	0.081	-0.265	0.791
Preference_Auction_Lottery_Ratio	<---	Gender	0.003	0.019	0.179	0.858
Preference_Auction_Lottery_Ratio	<---	Education Level	-0.028	0.046	-0.615	0.539
Preference_Auction_Lottery_Ratio	<---	Household Size	0.059	0.044	1.339	0.18
Preference_Auction_Lottery_Ratio	<---	Kids	-0.021	0.024	-0.869	0.385
Preference_Auction_Lottery_Ratio	<---	Type of Residence	-0.005	0.032	-0.164	0.87
Preference_Auction_Lottery_Ratio	<---	District	0.023	0.044	0.523	0.601
Preference_Auction_Lottery_Ratio	<---	Household Income	0.08	0.059	1.358	0.175
Acceptance_AVG	<---	Equity_Auction	0.568	0.049	11.68	***
Preference_Auction_Lottery_Ratio	<---	Equity_Auction	0.209	0.054	3.856	***
Acceptance_AVG	<---	Equity_Lottery	0.385	0.051	7.59	***
Preference_Auction_Lottery_Ratio	<---	Equity_Lottery	-0.108	0.057	-1.909	0.056

Means: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P
Car Ownership	8.206	0.18	45.666	***
Percentage of car trip	5.534	0.158	35.049	***
Trip Time to Work	4.168	0.083	50.057	***
Age	4.88	0.054	90.23	***
Gender	6.127	0.228	26.858	***
Education Level	5.799	0.102	56.722	***
Household Size	5.41	0.106	51.037	***
Kids	7.155	0.211	33.868	***
Household Income	6.193	0.092	67.644	***
District	0.81	0.1	8.064	***
Type of Residence	2.462	0.162	15.214	***

Covariances: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P
Type of Residence	<-->	District	1.508	0.354	4.26	***
Age	<-->	Gender	0.591	0.265	2.229	0.026

District	<-->	Household Income	-0.309	0.197	-1.571	0.116
Kids	<-->	Type of Residence	-5.361	0.772	-6.944	***
Household Size	<-->	Kids	3.957	0.513	7.715	***
Education Level	<-->	Household Size	-0.045	0.231	-0.195	0.846
Education Level	<-->	Gender	0.066	0.498	0.133	0.894
Trip Time to Work	<-->	Age	0.079	0.096	0.823	0.411
Percentage of car trip	<-->	Trip Time to Work	0.36	0.281	1.279	0.201
Car Ownership	<-->	Percentage of car trip	9.93	0.764	13.002	***
Type of Residence	<-->	Household Income	-2.936	0.345	-8.512	***
Kids	<-->	Household Income	3.095	0.438	7.072	***
Household Size	<-->	Household Income	1.019	0.213	4.792	***
Education Level	<-->	Household Income	1.494	0.212	7.054	***
Household Income	<-->	Gender	-0.367	0.446	-0.822	0.411
Age	<-->	Household Income	0.066	0.106	0.627	0.531
Trip Time to Work	<-->	Household Income	0.729	0.166	4.38	***
Percentage of car trip	<-->	Household Income	2.953	0.338	8.73	***
Car Ownership	<-->	Household Income	2.874	0.376	7.641	***
Kids	<-->	District	-1.745	0.46	-3.791	***
Household Size	<-->	District	0.16	0.227	0.704	0.481
Education Level	<-->	District	-0.683	0.221	-3.084	0.002
District	<-->	Gender	-1.131	0.492	-2.3	0.021
Age	<-->	District	0.026	0.116	0.228	0.819
Trip Time to Work	<-->	District	-0.311	0.179	-1.739	0.082
Percentage of car trip	<-->	District	-0.678	0.34	-1.996	0.046
Car Ownership	<-->	District	-0.298	0.385	-0.773	0.44
Household Size	<-->	Type of Residence	-0.914	0.369	-2.479	0.013
Education Level	<-->	Type of Residence	-1.656	0.362	-4.58	***
Type of Residence	<-->	Gender	1.219	0.79	1.543	0.123
Age	<-->	Type of Residence	0.077	0.187	0.414	0.679
Trip Time to Work	<-->	Type of Residence	-1.381	0.295	-4.684	***
Percentage of car trip	<-->	Type of Residence	-4.918	0.592	-8.305	***
Car Ownership	<-->	Type of Residence	-4.445	0.655	-6.788	***
Education Level	<-->	Kids	1.105	0.464	2.381	0.017
Kids	<-->	Gender	0.58	1.03	0.563	0.573
Age	<-->	Kids	0.833	0.247	3.373	***

Trip Time to Work	<-->	Kids	0.625	0.377	1.659	0.097
Percentage of car trip	<-->	Kids	4.718	0.746	6.326	***
Car Ownership	<-->	Kids	4.524	0.838	5.399	***
Household Size	<-->	Gender	-0.107	0.516	-0.207	0.836
Age	<-->	Household Size	0.024	0.122	0.193	0.847
Trip Time to Work	<-->	Household Size	0.122	0.189	0.649	0.517
Percentage of car trip	<-->	Household Size	0.983	0.36	2.727	0.006
Car Ownership	<-->	Household Size	1.447	0.412	3.51	***
Age	<-->	Education Level	-0.272	0.119	-2.29	0.022
Trip Time to Work	<-->	Education Level	0.482	0.183	2.63	0.009
Percentage of car trip	<-->	Education Level	1.23	0.349	3.52	***
Car Ownership	<-->	Education Level	1.36	0.397	3.423	***
Trip Time to Work	<-->	Gender	-0.084	0.406	-0.207	0.836
Percentage of car trip	<-->	Gender	-0.21	0.769	-0.273	0.785
Car Ownership	<-->	Gender	0.271	0.875	0.31	0.756
Percentage of car trip	<-->	Age	0.283	0.183	1.55	0.121
Car Ownership	<-->	Age	0.424	0.208	2.035	0.042
Car Ownership	<-->	Trip Time to Work	0.149	0.32	0.467	0.641

Variances: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P
Car Ownership	14.724	0.975	15.1	***
Percentage of car trip	11.368	0.753	15.1	***
Trip Time to Work	3.162	0.209	15.1	***
Age	1.334	0.088	15.1	***
Education Level	4.766	0.316	15.1	***
Household Size	5.124	0.339	15.1	***
Kids	20.354	1.348	15.1	***
Type of Residence	11.938	0.791	15.1	***
District	4.596	0.304	15.1	***
Household Income	3.822	0.253	15.1	***
Gender	23.73	1.572	15.1	***
E_Auction	2.776	0.184	15.1	***
E_Lottery	2.551	0.169	15.1	***
E_A_Avg	2.999	0.199	15.1	***
E_P2	3.716	0.246	15.1	***

Computation of degrees of freedom (Default model)

Number of distinct sample moments:	135
Number of distinct parameters to be estimated:	132
Degrees of freedom (135 - 132):	3

Result (Default model)

Minimum was achieved

Chi-square = 4.878

Degrees of freedom = 3

Probability level = .181

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	0.037	0	0.094	0.562
Independence model	0.156	0.148	0.164	0

Model 3 - SEM Analysis – Estimate Result:

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Acceptance_AVG	<---	Equity_Auction	.576	.049	11.796	***	
Preference_Auction_Lottery_Ratio	<---	Equity_Auction	.208	.055	3.805	***	
Preference_Auction_Lottery_Ratio	<---	Equity_Lottery	-.094	.056	-1.666	.096	
Acceptance_AVG	<---	Equity_Lottery	.383	.051	7.565	***	

Covariances: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Equity_Auction	<-->	Equity_Lottery	.314	.130	2.418	.016	

Variances: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
Equity_Auction	2.858	.189	15.100	***	
Equity_Lottery	2.662	.176	15.100	***	
E1	3.070	.203	15.100	***	
E2	3.824	.253	15.100	***	

Computation of degrees of freedom (Default model)

Number of distinct sample moments:	10
Number of distinct parameters to be estimated:	9
Degrees of freedom (135 - 132):	1

Result (Default model)
Minimum was achieved
Chi-square = 0.000
Degrees of freedom = 1
Probability level = .994

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.000	.000	.000	.996
Independence model	.267	.236	.299	.000

APPENDIX B – ACCEPTANCE VARIATION ANOVA TABLE

Explanatory Variables	sample size	policy acceptance (-2 to 2)	
Age	18-24	7%	0.29
	25-34	39%	0.25
	35-44	45%	0.23
	above 45	9%	0.14
	P-value		0.88
Gender	Male	39%	0.18
	Female	61%	0.33
	P-value		0.07
Having Children	Yes	72%	0.27
	No	28%	0.14
	P-value		0.16
Household Size	<3	16%	0.15
	3	60%	0.28
	>3	24%	0.16
	P-value		0.33
Education	high school and below	6%	0.22
	college and university	88%	0.22
	master and above	6%	0.47
	P-value		0.31
Household income	low (<4K)	2%	0.49
	Med (4K - 10K)	27%	0.08
	High (> 10K)	70%	0.28
	P-value		0.05
Born in Guangzhou or not	Yes	62%	0.30
	No	38%	0.12
	P-value		**0.03**
Residence time	Below 2 years	10%	0.15
	2 - 5 years	12%	0.11
	5 - 10 years	16%	0.18
	10 - 15 years	11%	0.10
	more than 15 years	51%	0.32
	P-value		0.23
car owner	Non car-owner	18%	0.25
	Car owners	82%	0.23
	P-value		0.81